

WORKSHOP MANUAL
FOR
PERKINS
DIESEL ENGINES



*Perkins Diesel (Overseas) Pty. Ltd.
Princes Highway
Dandenong, Vic.*

REPRESENTED BY

R. B. Cheshire

DANDENONG 1277-1278

F. PERKINS LIMITED
PETERBOROUGH
ENGLAND

WORKSHOP MANUAL

And Instruction Book for

PERKINS

P6 and P4 Diesel Engines



— F. Perkins Limited —

Service Department

QUEEN STREET, PETERBOROUGH

ENGLAND

List No. 4042

Revised January, 1954

'Phone }
'Grams } Peterborough 3241

PRICE
20/-

Cables : "Perkoil," Peterborough

5888 5000 1153 30800

Printed in England

F. PERKINS LTD.—OVERSEAS COMPANIES

CANADA

F. Perkins (Canada) Ltd.
237/239 McRae Drive
Leaside
TORONTO, 17
Ontario, Canada

Cables : Perkoil, Toronto
Telephone : Mohawk 4348/9

FRANCE

F. Perkins S.A.
2 rue Catulle-Mendes
PARIS, 17e.
France

Cables : Perkoil, Paris
Telephone : GALvani 67-35

SOUTH AFRICA

F. Perkins (S.A.) (Pty.) Ltd.
P.O. Box 9951
156 Main Reef Road
JOHANNESBURG
South Africa

Cables : Saperk, Johannesburg
Telephone : Johannesburg 24-3087

AUSTRALIA

Perkins Diesel (Overseas) Pty. Ltd.
Princes Highway, Dandenong
MELBOURNE
Victoria, Australia

Cables : Diesel, Dandenong
(Victoria, Australia)
Telephone : Dandenong 1277/8

CONTENTS

	Page
FOREWORD	4
ENGINE DESCRIPTION	5
SETTINGS AND DATA	8
STARTING THE ENGINE	10
DO AND DO NOT	13
FAULT DIAGNOSIS	14
RUNNING INSTRUCTIONS	15
PERIODICAL ATTENTIONS	17
FROST	21
LUBRICATING SYSTEM	22
FUEL INJECTION SYSTEM	25
TIMING	39
ENGINE PHOTOGRAPHS	Centre of Book
CYLINDER HEAD MAINTENANCE	45
SERVICING THE WATER PUMP	48
FAN & DYNAMO BELT ADJUSTMENT	52
MAJOR OVERHAUL	53
ALIGNMENT OF THE CLUTCH HOUSING AND FLYWHEEL	63
SCHEDULE OF FITS AND TOLERANCES	65
FILTERS	71
EXHAUSTERS	80
"P" SERIES MARINE	85
LUBRICATING OIL SPECIFICATIONS	Appendix

FOREWORD

The Diesel Engine closely resembles its petrol counterpart inasmuch as the mechanism is essentially the same. Its cylinders are arranged above its closed crankcase, its crankshaft is one of the same general type as that of a petrol engine; it has the same sort of valves, camshaft, pistons, connecting rods and lubrication system.

It follows, therefore, that to a great extent, it requires the same treatment as that which any intelligent and careful operator would accord to a petrol engine and that gross negligence such as running the engine short of oil, with sludged oil, or with the water boiling will have the same expensive consequences.

Where the Diesel Engine does differ from the petrol motor, however, is in the method of handling and firing its fuel. Carburetter and ignition systems are done away with and in their place is a single component—the Fuel Pump—which performs the functions of both. This confers upon the Diesel a quite exceptional reliability, since the chances of breakdown are halved. In fact it may be axiomatically stated that a Diesel Engine never has an involuntary stop (other than one caused through mechanical damage due to abuse), unless there is a shortage of fuel.

The fuel pump though very simple in principle, must necessarily be a piece of precision engineering. Many years of experience and many hundreds of thousands of miles of running ensure that the fuel pump fitted to Perkins engines will, given only ordinarily decent treatment, continue to function faultlessly. It must however be regarded in the same light as a magneto, inasmuch as it should not be interfered with and that its repair, should it need attention, is definitely beyond the skill of any but specially trained workmen. Like the magneto it is built as a unit, so that in the rare event of failure it can be replaced en bloc.

Unremitting care and attention at the Perkins factory have resulted in an engine capable of hundreds of hours profitable service. **WHAT THE MANUFACTURER CANNOT HOWEVER CONTROL IS THE TREATMENT**

THAT HIS PRODUCT WILL RECEIVE IN SERVICE. That part rests with you.

This manual is designed to be a guide to the Distributors of, and Dealers in vehicles equipped with the Perkins Diesel engine; also to others who are concerned with the sale and subsequent maintenance of such engines.

F. Perkins Ltd. are at one with all these Distributors and Dealers in the desire to ensure that the Perkins Diesel engines in the hands of users shall give complete satisfaction.

An essential factor in the attainment of that object is efficient servicing. As manufacturers of the engine, the company provides a number of facilities with that end in view; one of them is this manual. In presenting it to responsible Distributors and Dealers the Company are in effect inviting their co-operation and at the same time providing an effective aid to that co-operation.

Immediate action to be taken on receipt of this manual: hand it over to the foreman who will be responsible for carrying out the maintenance operations which are described therein. Do not, please, file it in the office.

The issue of this manual has been described above as being one of the many aids which F. Perkins Ltd. provide in order to ensure efficient service for the engines they make. Two of the others may appropriately be mentioned here.

A school of instruction is maintained at Peterborough where the mechanics employed by Distributors, Dealers and users are given instruction on the special characteristics of the engine.

Then there is the Perkins Perpetuity Plan which is, in fact, an engine exchange scheme of peculiar description having numerous special advantages. A booklet describing this can be obtained on request.

In conclusion we recommend Dealers, Distributors and users to communicate with the Service Department of F. Perkins Ltd., Peterborough in case of need.

ENGINE DESCRIPTION

Perkins Diesel engines are vertical four-stroke Power Units. They are entirely of British design and manufacture and are protected under Perkins British and World Patents.

The engine embodies the results of experience gained in the production of Diesel engines over a period of many years.

The materials and workmanship throughout are of the highest class. Most parts are guaranteed interchangeable, jigs being used everywhere in course of manufacture, and all parts pass through a system of thorough inspection where they are checked to the closest limits. Each engine is subjected to stringent tests before leaving the Works.

General.

The Perkins P4 & P6 Diesel, with which this Manual is concerned, is a 4 or 6 cylindered unit, having a bore and stroke of $3\frac{1}{2}$ in. and 5 in. respectively.

Cylinder Block.

The cylinder block and crankcase comprise a one-piece high duty cast iron alloy casting, scientifically designed to give maximum strength and rigidity. The camshaft chamber is situated high up in this casting. The water jackets are carried down the length of the cylinders which are fitted with renewable high duty cast iron alloy dry liners to give maximum resistance to wear.

Cylinder Head.

The cylinder head is a one-piece chromium iron casting, secured by a large number of through studs. Valves and tappets are carried directly in the head on the top of which the rocker shaft is mounted. The whole is enclosed in a light alloy die cast cover. It is possible to remove the head completely without disturbing the timing. All valves are of special alloy steel, the inlet being larger to ensure maximum volumetric efficiency. No masks or deflectors are fitted. The spherical combustion chamber is formed half in the head and half by a detachable steel cap and is the subject of Br. Pat. Nos. 401,703, 417,221, 486,208 ;

other patents pending. The valve assembly arrangement is the subject of Br. Pat. No. 404,943.

Camshaft.

The camshaft is carried high up on the off-side of the cylinder block, and is provided with journals of generous bearing area. This construction eliminates push rods and is the subject of Br. Pat. No. 404,943.

Crankshaft.

SEVEN MAIN BEARINGS (P6). FIVE MAIN BEARINGS (P4). The crankshaft is extremely rigid, being supported by a bearing between each cylinder, and is statically and dynamically balanced. The crankshaft is machined from a solid nickel chrome molybdenum steel forging and has a large flange formed at the rear end for mounting the flywheel.

Main Bearings.

ANTI-FRICTION METAL. These provide generous bearing area, and consist of removable thin steel shells, lined with copper lead metal, and are locked in position by dowels in the crankcase and caps. The main bearing caps are located in position by two large diameter dowels and are securely fastened to the crankcase by large high tensile steel set bolts.

Connecting Rods.

ALLOY STEEL. Light "H" section nickel chrome molybdenum steel stampings are used and are kept as light as possible to reduce inertia stresses consistent with ample strength. The big end bearings are lined with lead bronze metal and are lead indium coated.

A locating lip on the outside of the shell fits in a recess provided in the connecting rod parent bore to secure them in position.

Pistons.

The pistons are flat-topped. They are of special light aluminium alloy or cast iron, according to type of engine, with ample metal in the crown to

carry off the heat of combustion. They are suitably ribbed to take the load directly to the gudgeon pin bosses. Three compression rings of which one is of laminated steel and one scraper ring, are fitted above the gudgeon pin. There is one scraper ring below that pin. In certain tractor and industrial engines the scraper ring normally fitted above the gudgeon pin is replaced by a special spring loaded laminated ring.

Timing Gear.

The camshaft and fuel pump shaft are driven by a triple roller chain enclosed in the timing case at the front of the engine. Chain whip is taken up by an automatic chain tensioner and a fibre damper is provided. The camshaft sprocket is provided with an arrangement whereby close adjustment of the timing may be made when necessary.

Lubrication.

The lubrication is high pressure forced feed throughout the engine. The pump is driven through gears from the fuel pump drive shaft by steel spindles which are of robust construction. It is fully capable of maintaining an adequate pressure at all running speeds. The pump itself is of aluminium. There is a large capacity gauze full flow filter in the engine sump well and another filter in the pressure system mounted in an accessible position on the engine.

Crankcase Ventilation System.

To relieve the crankcase of excess pressure and fumes, a system of pipes is used to connect the interior of the engine to atmosphere.

Fuel Pump and Atomisers.

The fuel pump is of the unit type fitted with pneumatic governor. Idling speed can be varied at will from the driver's seat.

The atomisers are located in a very accessible position on top of the cylinder head and have two sprays, one into the combustion chamber and the other into the cylinder itself, giving the engine the easy starting qualities associated with a direct injection engine.

Owing to the characteristics of the Perkins patented combustion system, no advance and retard device is required.

Cooling.

The cooling water is pump circulated, the pump, of the impellor type, being located in an accessible position on the front end of the cylinder head. It is belt driven from a pulley on the crankshaft at one and a third times engine speed. Provision is made for fitting a fan on the front end of the pump pulley.

Cooling water from the pump is delivered to manifold feeding connections in the cylinder head. The cooling surfaces in the cylinder block and head are of ample area. Large passages between the block and head allow the former to be cooled by thermo-syphon.

Air Intake

A large air cleaner is fitted, through which must pass all air drawn into the engine. Harmful dust is thus excluded and the life of the cylinders correspondingly prolonged. The air cleaner is mounted on a venturi inlet, housing the butterfly throttle valve, which, apart from the stopping lever, is the only control on the engine.

Suspension.

The rear end of the engine is arranged to be carried by suitable brackets off the flywheel bell housing, whilst the forward end is supported from facings with four studs on either side of the cylinder block, which by suitable brackets can be arranged for either three or four point mounting.

Cold Starting Equipment.

Comprises hand pump, atomiser, fuel tank, piping, induction heater and starter/heater switch. The induction heater, which is the subject of Br. Pat. No. 541,400, is not in contact with the burning gases in the cylinder. It is located in the inlet manifold and is used only during starting under very cold conditions.

Electric Starting Equipment.

Electric starting equipment incorporates an Electric Starter 12-volt Axial type. This is mounted on the off side of the cylinder block beneath the camshaft chamber, and does not, in this position, materially increase the width of the engine.

Dynamo.

12-volt (earth return) type, complete with Control Box and Fuse Box. A facing is provided on the off side of the cylinder block for mounting the dynamo, the drive being by V-belt from the crankshaft. See page 85 for P Series Marine.

Exhauster.

Where a servo system is required, a sliding

vane exhauster is fitted driven in tandem with the fuel pump and supplied complete with vacuum tank, non-return valve, piping and vacuum gauge, as required. Air drawn through the snifter valve is circulated round the exhauster via a passage in the exhauster bracket and therefore avoids raising the pressure in the engine sump.

Note :—The manufacturers reserve the right to alter this specification without notice.

SETTINGS AND DATA

P6 & P4 ENGINES

	P4	P6
Bore	3½ in.	3½ in.
Stroke	5 in.	5 in.
No. of Cylinders	4	6
Swept Volume	3.14 litres	4.73 litres
Firing Order	1,3,4,2	1,5,3,6,2,4
Horse-Power .....	.....	See this page
Inlet Valve Opens B.T.C. ....	.....	13 degrees
Exhaust Valve Closes A.T.C. ....	.....	10 degrees
Valve Lift .....	.....	.36 in.
Compression Ratio .....	.....	16.5 : 1
Spill Timing	29 degrees B.T.C.	
Atomisers : Body		Pt. No. 30015
Nozzle		Pt. No. 31990
Injection Pressure .....	.....	See Page 35
Tappet Clearances .....	.....	.010 in. hot
Recommended Torque Tensions.		Lbs./Ft.
Cylinder head nuts .....	.....	55—60
Con. rod nuts .....	.....	70
Main bearing setscrews .....	.....	120
Flywheel setscrews .....	.....	75

PISTON TYPES

Pistons are made of two alternative materials, Cast Iron and Light Alloy, they are used as follows:

Cast Iron. All types of engines with a maximum rated speed of up to and including 1,500 r.p.m.

Light Alloy. All types of engines with a maximum rated speed in excess of 1,500 r.p.m.

SUMP CAPACITIES.

P6 Vehicle.

- Non-Exhauster engine with Steel Sump. 2 gallons
- Exhauster " " " " 1½ gallons
- Non-Exhauster engine with Die-cast Sump. 2 gallons 5 pints.
- Exhauster engine with Die-cast Sump. 2 gallons 5 pints.

P4 Vehicle.

- Non-Exhauster engine 1½ gallons

P6 Marine and P4 Marine.
See under Marine engines.

P6I. Bearer Mounted.

Mark I and II	5½ gallons
Mark III	4¼ gallons

P6I. Base Mounted.

Mark I and II	6 gallons
Mark III	5½ gallons

P4I. Bearer Mounted.

Mark I and II	3½ gallons
Mark III	3¼ gallons

P4I. Base Mounted.

Mark I and II	3 gallons 7 pints
Mark III	4½ gallons

Tractor Engines.

Fordson Tractor	3 gallons
Massey-Harris Tractor	2 gallons
Nuffield Tractor	2 gallons

HORSE POWER

P6V as supplied for Road Transport Vehicles.

Normal Engines :—

Horse Power	70 B.H.P. at 2,200 r.p.m.
Maximum Torque	184 lb./ft.

High Speed Engines :—

Horse Power	74 B.H.P. at 2,400 r.p.m.
Maximum Torque	184 lb./ft.

High Rated Engines :—

Horse Power	83 B.H.P. at 2,400 r.p.m.
Maximum Torque	204 lb./ft.

Supplied with or without Exhauster for servo-assisted brakes.

P4V as supplied for Road Transport Vehicles.

Normal Engines :—

Horse Power	46 B.H.P. at 2,200 r.p.m.
Maximum Torque	123 lb./ft.

Settings and Data—continued

High Rated Engines :—

Horse Power	54 B.H.P. at 2,400 r.p.m.
Maximum Torque	133 lb./ft.

Supplied with or without Exhauster for servo-assisted brakes.

For identification purposes all High Speed or High Rated Engines have either H.S. or H.R. stamped adjacent to the engine number.

MARINE ENGINES

P6M.

Horse Power	65 B.H.P. at 2,000 r.p.m.
	44 B.H.P. at 1,500 r.p.m.

P4M.

Horse Power	43 B.H.P. at 2,000 r.p.m.
	22 B.H.P. at 1,000 r.p.m.

Sump Capacity varies according to gearbox type, etc., and is between 2½ gallons and 6½ gallons.

Interlocking Gear.

The interlocking gear between gearbox and venturi is set to limit the engine speed to 1,500 r.p.m. in astern.

Gearbox.

Two alternative types of gearbox, one mechanical and one hydraulic, have been fitted.

The Mechanical type is designated Type 36. Older engines may have Type 120 fitted which is very similar in appearance and operation.

The Hydraulic type is designated Type MR10.

Types MR10A and MR10B are used and the difference is that MR10B has a self-contained sump and oil supply. Latest engines may have type MR11 gearboxes fitted which also incorporate a self-contained sump and oil supply.

Reduction Gear.

Two types of reduction gearbox are used.

When requesting information regarding the engine, the engine number should be quoted. This can be found on the camshaft tunnel near the reducing valve or alternatively on the top rear corner of the fuel pump side of the cylinder block.

- (1) Internal Gear type.
- (2) External Gear type.

The only ratio supplied in the case of the Internal Gear type reduction box is 2 : 1, but with the External Gear type reduction box, 2 : 1 and 3 : 1 ratios are available.

Shaft Rotation.

The rotation of all P Series Marine engines not fitted with reduction gear is anti-clockwise when looking at the output face of the shaft flange.

The rotation of engines fitted with Internal Gear type reduction boxes is anti-clockwise, but with two pinion External Gear type reduction boxes, the rotation is clockwise, and with three pinion External Gear type reduction boxes, the rotation is anti-clockwise when looking at the output flange.

For additional information on gearboxes, etc., apply to the Service Department, Messrs. F. Perkins Limited, Queen Street, Peterborough.

INDUSTRIAL ENGINES AND PLANT.

Details of power outputs and ratings can be obtained upon request from the plant manufacturers or engine manufacturers.

In the case of queries on other types of applications, apply to Service Dept. quoting the engine number.

TRACTOR ENGINES.

Fordson Tractor.

Horse Power P6(TA) 45 B.H.P. at 1,500 r.p.m.

Massey-Harris Tractor.

Horse Power P6(TA) 46 B.H.P. at 1,350 r.p.m.

Nuffield Tractor.

Horse Power P4(TA) 39 B.H.P. at 2,000 r.p.m.

STARTING THE ENGINE

PREPARATION FOR STARTING

Check the radiator water level.
Check the engine sump oil level.
See that there is fuel oil in the tank.

Make quite sure that the connections on the pipe from the butterfly valve to the pneumatic governor on the fuel pump are tight.

Check that the starter battery is fully charged and that all electrical connections are properly made and all circuits in order.

Priming the Fuel System.

In the case of a new engine or an engine which has been laid up it is important that the fuel system is "bled" as follows :—

Pressure Fed Systems.

Slacken the small plug on the top of the final fuel filter and operate the hand primer on the fuel lift pump until fuel free from air bubbles issues from the plug hole. Tighten the plug.

Slacken the bleed cock on the top of the fuel pump.

Again operate the hand primer on the fuel lift pump until fuel issues from the bleed cock and all signs of air have disappeared.

Tighten the bleed cock securely and give the primer a few more strokes in order to deliver the fuel through the relief valve on the filter, clearing this part of the system of air. The engine is now ready for starting.

Gravity Fed Systems.

Slacken the small plug on the top of the final fuel filter and turn on fuel tank supply tap until fuel free from air issues from the plug hole. Tighten the plug.

Slacken the bleed cock on the top of the fuel pump and allow fuel to run until no trace of air remains.

Tighten the bleed cock securely whilst fuel is still issuing.

The engine is now ready for starting.

COLD STARTING EQUIPMENT.

Method of Operation.

The Pump Type K.48 (see Fig. 1) is constructed with an inlet and outlet port. On the upward stroke of the pump, fuel is drawn through a copper pipe from the tank into the pump body. On the downward stroke, fuel is pressure fed through the outlet port and a copper pipe to an atomiser fitted in the induction manifold. A swirl in the atomiser causes the fuel to be sprayed into the induction manifold.

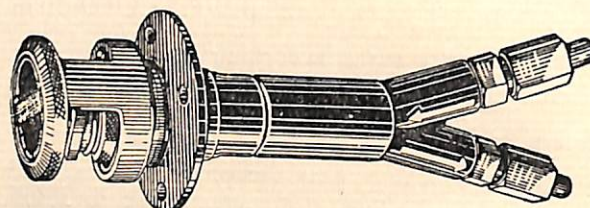


FIG. 1.

The spray is directed onto a heater plug which is also fitted into the induction manifold and is either twin or single pole. (See figs. 2 and 3).

The resistance wire on the heater plug is heated by an electric current when the heater button is pressed on the "Heater-Starter" switch.

As the pistons travel down on the suction stroke, the fuel spray, which has been fired by the hot resistance wire on the plug, is drawn into the cylinder bore to assist easy starting.

The wiring diagram (see Figs. 4 and 5) show all necessary details of the "Heater-Starter" switch and Heater plug connections.

USE OF EQUIPMENT.

The equipment is used in conjunction with the "Heater-Starter" switch for starting in cold weather.

Excessive use of the equipment is to be deprecated as it is liable to be harmful to the engine and could damage the piston rings.

In normal circumstances when the engine is warm use the starter motor only.

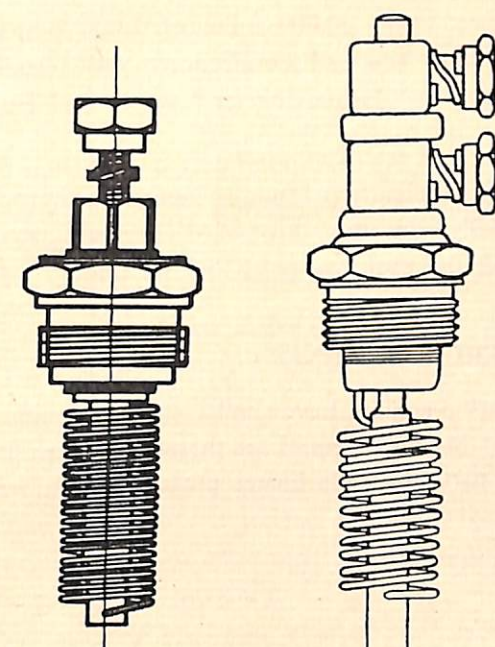
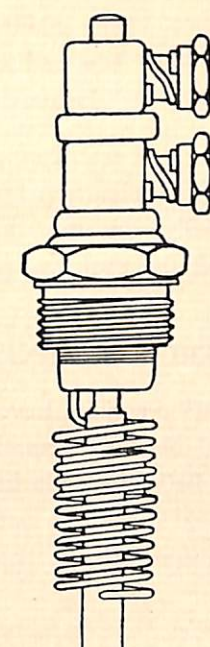
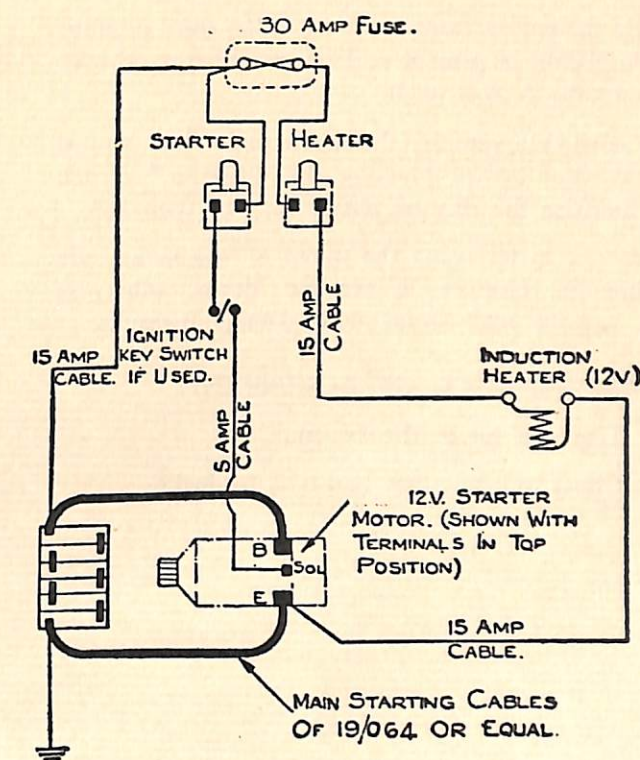
FIG. 2
PLUG HEATER
SINGLE POLEFIG. 3
PLUG HEATER
DOUBLE POLE

FIG. 4. DOUBLE POLE WIRING DIAGRAM

In cold weather proceed as follows :

See that the tank contains fuel oil.

In certain fuel systems no separate tank is fitted.

Instead the pump draws fuel from the final fuel filter.

In this case the procedure is as laid down above except that the tap provided on the filter should be turned on before using the equipment.

After use be sure to turn off the tap and screw down the pump, otherwise fuel may drain from the main tank into the engine.

Give the pump plunger one stroke of about half an inch.

Press the "Heater" switch for about half a minute. (Count forty fairly slowly). Then with the "Heater" switch still pressed, and the speed control lever in the full open position, press the "Starter" switch and give short strokes on the pump.

The engine should then start.

If it does not, wait half a minute and try again.

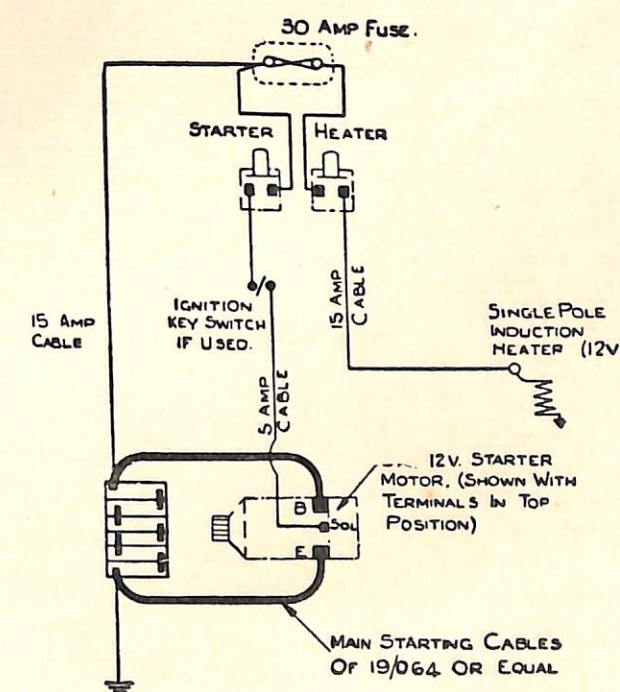


FIG. 5. SINGLE POLE WIRING DIAGRAM

If the engine does not start at the third attempt some fault is present and an examination should be made to discover it.

Always be sure that the starter pinion has stopped revolving before pressing the "Starter" switch otherwise the ring or pinion may be damaged.

NOTE. After using the pump always make sure that the plunger is screwed down, otherwise a leakage may occur with damaging results.

MAINTENANCE OF EQUIPMENT.

Use fuel oil in the system.

Check unions, pipes, and tank for leaks.

Inspect every 20,000 miles or 1,000 hours to make sure that all connections and terminals are tight on "Heater-Starter" switch and Heater plug.

If any difficulty is found in operating the pump especially on the downward pressure stroke, inspect the atomiser swirl and jet hole.

P SERIES MARINE

Marine engines have similar starting equipment but of 24-volt type and are therefore always fitted with two twin pole heater plugs wired in series.

DO ————— AND ————— DO NOT

DO KEEP THE ENGINE CLEAN.

DO keep this book where it is conveniently accessible.

DO pay particular attention to lubrication.

DO use only approved grades of oil and grease.

DO use only GENUINE PERKINS SPARE PARTS.

DO keep all bolts and nuts tight.

DO eliminate all air from the fuel system and keep all fuel oil unions AIR-TIGHT.

DO examine engine oil level in sump daily and replenish if necessary.

DO completely change engine oil in accordance with periodical attentions pages 17-20.

DO renew element in lubricating oil filter in accordance with periodical attentions pages 17-20.

DO check oil flow to rocker arms and examine the valve springs in accordance with periodical attentions pages 17-20.

DO use only filtered fuel oil. Never tip into the tank a half-empty barrel of fuel oil, the bung of which may have been out for weeks.

DO keep a check on the temperature of the cooling water. It should not be allowed to boil. The best temperature is 140°F—170°F.

DO attend immediately to fuel and lubricating oil leaks.

DO grind in valves when necessary.

DO check tappet clearance from time to time (.010 in.) with warm engine.

DO tighten cylinder head nuts in correct order (See Fig. 26, page 47).

DO quote engine number when ordering spares.

DO keep essential spares in store.

DO drain radiator if engine is being left idle in frosty weather.

DO drain cylinder block if engine is being left idle in frosty weather (drain tap on side of block).

DO close these drain cocks and refill with water before attempting to re-start next morning.

DO when in doubt, read this Manual.

DO NOT neglect the routine attentions specified on pages 17-20.

DO NOT race the engine in neutral.

DO NOT run the engine unless the gauge SHOWS OIL PRESSURE.

DO NOT unnecessarily interfere with any adjustments.

DO NOT break the fuel pump seal—remember if broken your Guarantee is void.

DO NOT continue to run the engine if the cooling water boils.

DO NOT forget to grease the water pump.

DO NOT forget to keep the fan belt adjusted.

DO NOT continue to run the engine if black smoke is coming from the exhaust.

DO NOT if the engine stops without apparent reason, fail to make sure first of all that fuel is reaching the fuel pump.

DO NOT omit to wipe the engine over occasionally with a clean rag.

DO NOT take the fuel pump to pieces.

DO NOT use cotton waste or any fluffy cloth when cleaning.

DO NOT use any but approved brands of fuel or lubricating oil.

DO NOT store fuel oil in a galvanised container.

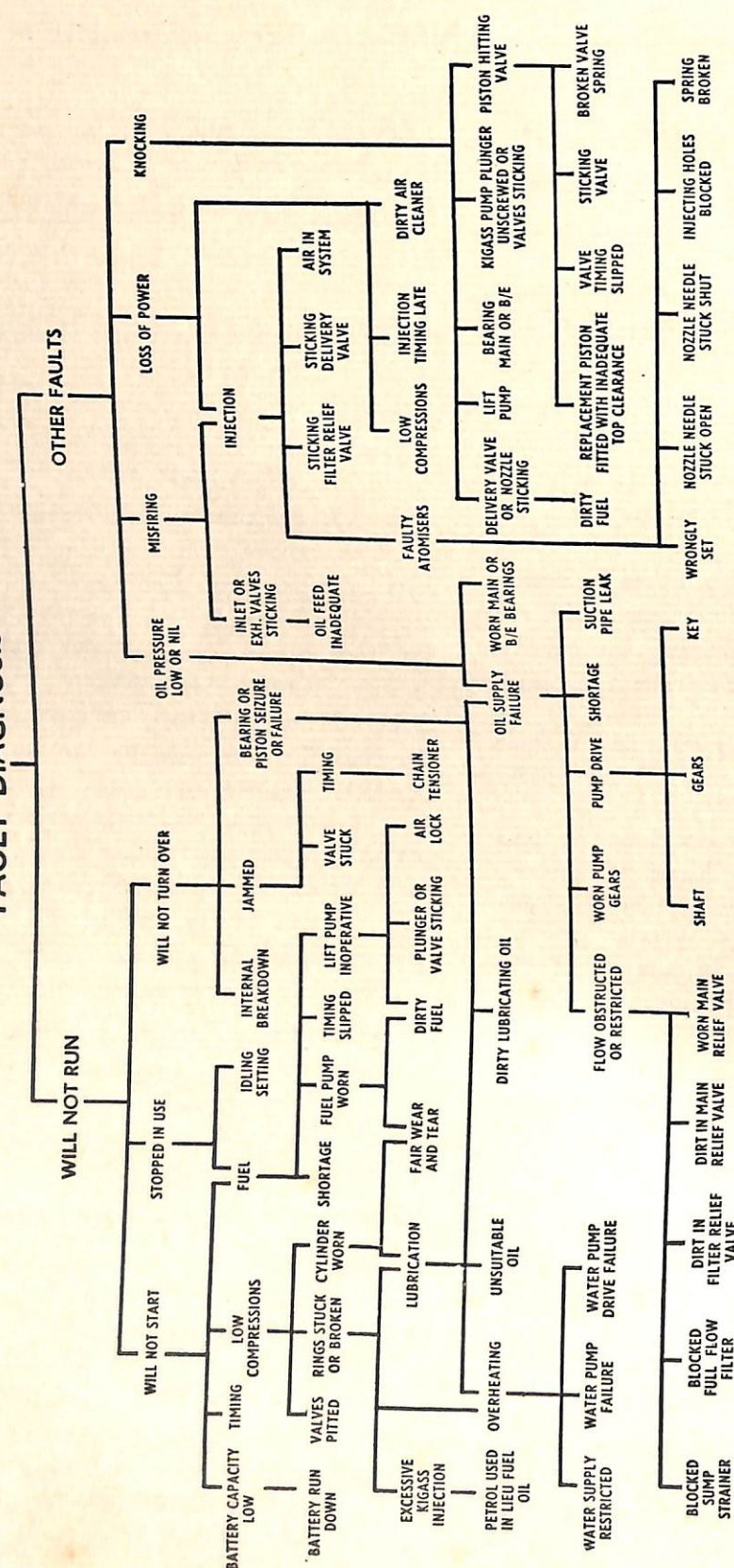
DO NOT subject any engine or vehicle to continuous overloading.

DO NOT load the vehicle to which this engine is fitted beyond the manufacturer's stipulated payload: it does not pay.

DO NOT coast when travelling down hill.

DO NOT guess. For additional information contact suppliers of the vehicle, Industrial Plant, Tractor, Marine Craft, or Engine.

FAULT DIAGNOSIS



The main value of this chart is to help maintenance staff to consider any engine fault with which they are confronted, in a logical and organised manner. Prevention is better than cure, but if the fault has not been prevented, find it on this chart and follow it back to its cause.

There is no machine made that is not liable to suffer occasional stoppage and/or failure. Sometimes the machine is at fault, but more often it is due to some human omission or neglect. Every effort is made to ensure that the Perkins engine is as near as possible fault proof, but for the benefit of those whose object it is to look after engines in service, the accompanying chart has been produced.

RUNNING INSTRUCTIONS

Difficult Starting.

No Fuel at Atomisers :—

- No fuel in tank.
- Fuel lift pump not working (pressure fed system only).
- Loose connections in the fuel system.
- Air in the fuel system (Trace from suction side).

Go over the whole of the above and make sure that the atomisers are fully primed and that the "pinging" or "squeaking" noise is heard from each atomiser when the engine is turned over by hand.

Engine not being turned over quick enough.

(Particularly in cold weather).

- Lubricating oil too thick (See Appendix).
- Battery not fully charged. Fit fully charged battery.
- Engine "gummy" due to standing in the cold.

Use the cold starting equipment (if fitted). (See page 10.)

Low Compression.

This may be due to dry cylinders and piston rings, worn piston rings, worn cylinders, or leaky valves.

Dirt between Valve and Seat.

Remove cylinder head cover and turn the engine. Note which valves leak. Bring corresponding piston to beginning of compression stroke, turn engine over compression at same time bouncing valve open by hitting valve rocker end down with a block of hard wood or the like. Repeat until dirt is blown out and valve holds compression.

Atomisers Faulty.

Test Atomisers for "ping" or "squeak" as already mentioned. If any atomiser fails to give this "pinging" or "squeaking" noise when that cylinder is pulled smartly over compression and it has been made certain that the atomiser is fully primed, then the atomiser should be tested by removing it from the cylinder head. (See page 34).

Disconnect pipes on other atomisers while making this test.

Sticking Valves.

Trouble with sticking valves may be due to overheating, the result of choked atomisers, or the use of unsuitable lubricating oil.

Test the atomisers as recommended on page 34 and clean them if necessary.

The lubricating oil used should be of an approved type. (See Appendix).

To free a valve, squirt a small quantity of paraffin down the valve guide and allow it to seep right through. The valve may then be given a sharp tap. This process will invariably free the valve. A quantity of clean oil should then be poured down the guide to lubricate the valve stem before again starting up the engine.

Sticking Rocker.

If the rockers stick the cause may be : the use of unsuitable oil, shortage of oil, or sludging. Use only oil of an approved type. (See Appendix). If there is a shortage of lubricant the passages and pipes to and from the camshaft reducer should be cleaned.

To free the rocker squirt a little paraffin into the bearings, allow it to seep through, then gently tap the rocker arm. This will free the rocker. Thoroughly lubricate with clean oil, and the engine may be re-started.

Fuel Oil.

It is essential to use clean fuel oil free from water, dirt or sand. The recommended specification for fuel is given on page 25. Providing clean fuel is used, no trouble should be experienced with the fuel system but dirty oil will lead to trouble due to choked pipes, choked filters, damaged fuel pump and atomisers. If the engine tends to run well for a short period and then to die away or stop altogether, the fuel system should immediately be suspected. The trouble may be due to the lift pump not working properly, to a loose pipe joint allowing air to get into the fuel system, to a dirty

fuel filter, or to a choked fuel pipe. The pre-filter in the fuel lift pump (when fitted) and intermediate filter element should be cleaned by washing in clean fuel oil, but the final filter should not need attention more than once in 20,000 miles or 1,000 hours, when a completely *new* filter element should be fitted. If the conditions lead to dust or contamination of the fuel, decrease the maintenance interval.

Always, after disturbing fuel line washers, re-

place with new washers to ensure the joints are air tight.

Air Cleaner.

In accordance with periodical attentions pages 17-20, clean the filtering element in paraffin, and, if of the oil bath type, dip in oil. In those filters which need it, fresh engine oil should be poured into the base, up to the level mark.

For maintenance instructions see "Filters," page 71.

PERIODICAL ATTENTIONS VEHICLE

Keep Engine Clean

DAILY

- Check water in radiator.
- Check oil level in sump.

EVERY 1,000 MILES

- Check adjustment of fan belt (See page 52).
- Grease water pump.
- Top up batteries with distilled water.

EVERY 2,000 MILES

- Drain oil from sump and renew.
- Clean pre-filter to fuel lift pump.
- Clean felt element in lubricating oil filter.
- Examine air cleaner (*See Note*).

EVERY 5,000 MILES

- Clean intermediate fuel filter.
- Clean and grease battery terminals.
- Refill greaser on dynamo (when fitted).

EVERY 10,000 MILES

- Clean out crankcase ventilation pipe.

Remove, clean and attend to air cleaner (*See Note*).

- Clean gauze trap in fuel oil filter (when fitted).
- Clean strainer in sump.
- Renew element in intermediate fuel filter.
- Remove and clean exhaust strainer.
- Renew felt element in lubricating oil filter.
- Clean gauze strainer in oil filter body.

EVERY 20,000 MILES

- Inspect commutator and brushes of dynamo.
- Renew element in final fuel filter.
- Remove cylinder head cover.
- Examine valve springs and tappets.
- Check oil flow to valve rocker shaft assembly.
- Clean and check atomisers.

NOTE

The time for cleaning the air cleaner depends on operating conditions, therefore under extremely dusty conditions, the time limit recommended above for cleaning should be decreased.

The correct maintenance of the air cleaner will greatly assist in reducing bore wear, thereby extending the life of the engine.

PERIODICAL ATTENTIONS TRACTOR

Keep Engine Clean.

DAILY

- Check water in radiator.
- Check oil level in sump (Make sure the tractor is on level ground).

EVERY 50 HOURS

- Check fan belt adjustment (See page 52).
- Clean air cleaner and renew oil (See Note).
- Grease water pump.
- Top up batteries with distilled water.
- Under worst conditions of service renew element in fabric filter (if fitted).
- Ensure that cylinder head cover nuts are tight.

EVERY 250 HOURS

- Clean element in lubricating oil filter.
- Drain oil from sump and renew.
- Clean strainer in sump.
- Unscrew drain plug on fuel filter, replace plug when clean fuel appears.
- Flush radiator with clean water.
- Clean and grease battery terminals.
- Clean gauze element in water trap type filter.
- Renew element in fabric filter (if fitted).
- Refill greaser on dynamo (when fitted).
- Clean fuel oil pre-filter (when fitted).

EVERY 500 HOURS

- Clean and check atomisers.
- Renew felt element in lubricating oil filter.
- Renew cloth in composite fuel filter but do not disturb or attempt to clean felt element.
- Clean gauze trap in lubricating oil filler body.
- Clean gauze trap in fuel oil filler (when fitted).

EVERY 1,000 HOURS

- Drain fuel tank, remove and clean.
- Inspect commutator and brushes of dynamo.
- Remove cylinder head cover.
- Examine valve springs and tappets.
- Inspect valve rocker shaft assembly for lubrication.
- Renew felt element in final fuel filter.

NOTE

The time for cleaning the air cleaner depends on operating conditions, therefore under extremely dusty conditions, the time limit recommended above for cleaning should be decreased.

The correct maintenance of the air cleaner will greatly assist in reducing bore wear, thereby extending the life of the engine.

PERIODICAL ATTENTIONS INDUSTRIAL

Keep Engine Clean.

DAILY

- Check water in radiator.
- Check oil level in sump.

EVERY 50 HOURS

- Check fan belt adjustment (See page 52).
- Grease water pump.
- Top up batteries with distilled water.

EVERY 100 HOURS

- Clean pre-filter to fuel lift pump (when fitted).
- Clean intermediate fuel filter.
- Examine air cleaner and replenish oil (See Note).

EVERY 250 HOURS

- Drain oil from sump and refill.
- Clean lubricating oil filter element.
- Clean and grease battery terminals.
- Refill lubricator on dynamo (when fitted).

EVERY 500 HOURS

- Remove, clean and attend to air cleaner element (See Note).
- Clean strainer in sump.
- Renew felt element in lubricating oil filter.
- Clean and check atomisers.

EVERY 1,000 HOURS

- Clean fuel tank in portable installation.
- Renew final fuel filter element.
- Inspect commutator and brushes in dynamo.
- Remove cylinder head cover.
- Check oil flow to valve rocker shaft assembly.
- Examine valve springs and tappets.
- Renew element in intermediate fuel filter.

NOTE

The time period for cleaning the air cleaner depends on operating conditions, therefore, under extremely dusty conditions, the time limit recommended above for cleaning should be decreased.

The correct maintenance of the air cleaner will greatly assist in reducing bore wear, thereby extending the life of the engine.

PERIODICAL ATTENTIONS

MARINE

Keep Engine Clean.

DAILY

- Check oil level in sump and gearbox.
- Turn screw greasers on water pump and tachometer drive connection and replenish when necessary.
- Check cooling water circulation.
- Check lubricating oil pressure.

EVERY 50 HOURS

- Top up batteries with distilled water.
- Clean gearbox oil filter.

EVERY 100 HOURS

- Check oil level in reduction gearbox (if fitted).
- Oil starter motor ring.
- Lubricate and examine adjustment of interlocking gear.
- Clean pre-filter (when fitted) to fuel lift pump.
- Clean (and check oil flow to) rocker shaft.
- Examine valve springs and check tappets.
- Check water pump packing gland.
- Examine and clean water inlet strainer.
- Examine engine holding down bolts.

EVERY 250 HOURS

- Turn screw greaser on dynamo.
- Oil bearings on starter motor.
- Drain oil from sump and fill with new lubricant.
- Clean felt element in lubricating oil filter.
- Clean intermediate fuel filter.

EVERY 500 HOURS

- Check oil feed to water pump chain drive.
- Renew element in intermediate fuel filter.
- Clean and check atomisers.
- Renew felt element in lubricating oil filter.
- Clean filter in oil filler tube.

EVERY 1,000 HOURS

- Examine heat exchanger for scale formation and descale if necessary.
- Inspect commutators and brushes of dynamo and starter.
- Renew element in final fuel filter.

Whenever engine is removed from boat.

- Clean sump strainer.
- Clean out fuel tank.

LAIID-UP ENGINE.

- Remove atomisers and spray into the cylinder bores one pint of lubricating oil divided between the six cylinders. Replace atomisers and bar engine slowly over compressions.
- Clean out crankcase ventilation pipes.
- Remove air cleaner and carefully seal venturi.
- Remove exhaust pipe and carefully seal opening in manifold.
- Drain water and flush water system with de-watering oil (or fresh water).
- Grease all auxiliary parts including flywheel and starter motor.
- Ensure the fuel gallery of the fuel pump is full of fuel oil, also the bottom chamber is filled with lubricating oil, if fitted with a drain pipe turn the pipe to face upwards.

FROST

Precautions against damage by frost must be taken before each winter, either by using an anti-freeze of reputable make or alternatively, the water circulating system must be drained if the application is to be left exposed to the weather.

It is not enough merely to open the radiator drain tap; the one on the cylinder block must also be opened, this tap may be on the near side of the cylinder block, near the flywheel, or on the offside near the middle.

When the engine is drained the water pump is also drained, but rotation of the pump may be prevented by:

- Locking of the impellor by ice due to the pump drain hole being blocked by sediment.
- The locking of the seal through the freezing of globules of moisture between the seal and the gland.

Operators are therefore advised to take these precautions when operating in temperatures below freezing point:

- Before starting the engine, turn the fan and water pump by hand; this will indicate if freezing has taken place. If freezing has taken place, this should free any ice formation.
- If it is impossible to turn the pump by hand, the radiator and engine should be filled with warm water.
- To avoid this trouble, the operator should, when all water has been drained, run the engine for a few seconds at idling speed, thus dispersing any moisture remaining in the pump.

LUBRICATING SYSTEM

Note :—Lubricating oil specifications in Appendix.

The importance of correct and clean lubrication cannot be stressed too highly and all references to engine oil should be taken to mean lubricating oil which falls within the specifications given in the Appendix. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

The sump should be filled with suitable lubricant to the correct level but do not attempt to overfill above the full mark. Before filling or checking the dipstick ensure the application is on level ground.

Oil Circulation.

The system of lubrication comprises pressure feed to main and big-end bearings, to camshaft bearings and to the rocker shaft, and auxiliary drive.

It is illustrated in detail in Fig. 9.

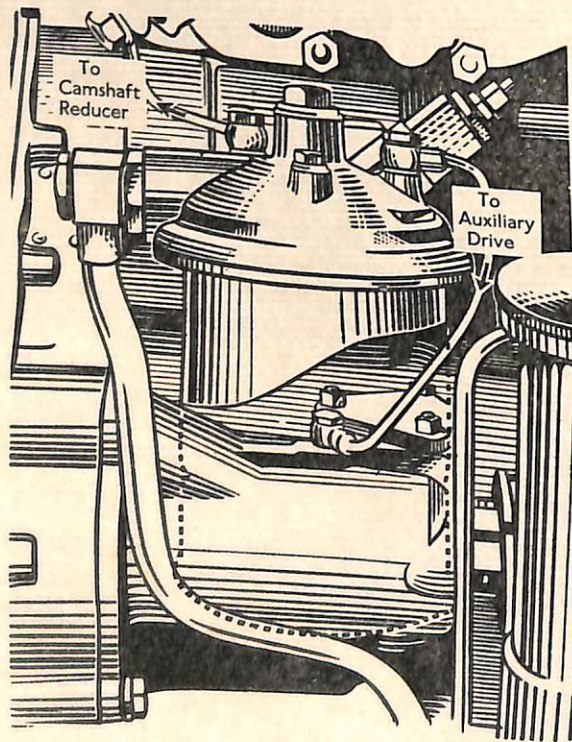


Fig. 9.

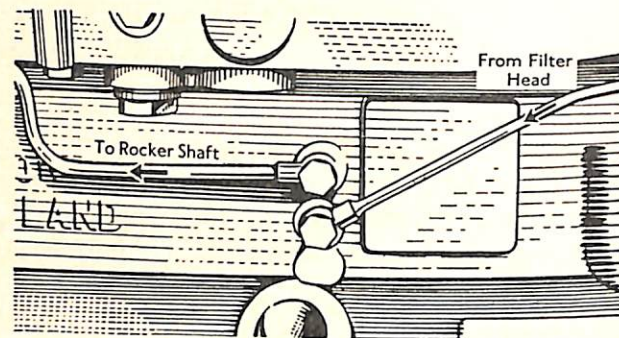


Fig. 7.

Referring to Fig. 9. The pump, 10, draws oil through the strainer, 9, from the sump, 5. It delivers to the relief valve cover, 12, through the outlet passage, 11.

The oil then flows along pipe 14 to the filter, 17.

At the outlet, 22, from this filter the flow passes along pipe 26, to the pressure rail, 7. The outlet union on the filter is drilled to allow for the connection of the oil pressure gauge pipe.

The pressure rail, 7, is an internal passage within the crankcase. Holes, 4, drilled in the crankcase webs, lead from this pressure rail to the crankshaft bearings, and holes, 3, in the crankshaft carry the oil to the big end bearings. Surplus oil is returned to the sump, 5.

An oil-thrower ring, 1, prevents oil from leaking along the crankshaft at its rear end, and any oil thrown from this ring returns by the passage, 2, to the sump.

Two oil feeds are taken from the oil filter head.

One pipe carries oil at full pressure to the auxiliary drive body, see fig. 6.

The other pipe carries oil to the lower of the two drillings in the camshaft tunnel on the centre line of No. 2 camshaft bearing, see fig. 7.

As the camshaft revolves oil is picked up and carried round in the narrow slot machined on No. 2 camshaft journal until it escapes through the upper drilling in the camshaft tunnel. The oil then flows through the pipe to the cylinder head whence a pipe conveys it to the hollow rocker shaft which feeds oil to the rocker lever bushes, etc.

It will be appreciated that owing to the small capacity of the slot on the camshaft journal only a reduced quantity of oil can pass to the rocker shaft during each revolution of the camshaft.

The overflow of oil from the rocker shaft flows from the head into the camshaft tunnel and from the front of the tunnel on to the timing chain and drive sprockets.

A further oil circuit is provided on engines fitted with an exhaustor. When the maximum degree of vacuum is reached in the vacuum tank the exhaustor ceases to operate in the normal way. Instead, it draws oil from the sump through the pipe, 8, and delivers it through a passage in the wall of the crankcase.

Oil Pressure.

See that oil pressure is registered on the gauge.

The actual pressure may vary with individual engines but the minimum pressure at normal working speed should not be less than 40 lbs. per sq. in.

There will be a pressure drop whilst idling and a slight decrease in normal working pressure when the engine is hot.

In the case of Industrial engines which run at a lower speed, the oil pressure should not fall below 30 lbs. per sq. in. at working temperature and normal running speed.

The Oil Pressure Relief Valve.

The relief valve, 30, prevents the pressure becoming excessive, as might otherwise happen when the oil is cold.

When the predetermined pressure is exceeded the valve opens against the spring, 31, and some of the oil is by-passed back into the sump. That continues until the oil warms up and flows at the desired pressure. The valve then closes.

If the oil pressure, as registered on the gauge, is less than it should be, the cause may be foreign matter on the seat of this relief valve, preventing it from closing.

To obtain access to the valve for cleaning, proceed as follows.

The oil pressure relief valve is located behind a small aluminium cover into which is screwed the lower banjo bolt of the main feed pipe to the lubricating oil filter. See Fig. 8.

It is necessary to remove the pipe from block to lubricating oil filter. Then remove the small cover plate which is held by three nuts, this exposes the oil pressure relief valve which can be drawn out of the block.

Wash the valve in fuel oil and blow the valve dry with compressed air. See that the ball and ball seat are perfectly clean and bedding correctly.

If, after the foregoing points have been checked, the oil pressure fails to register or is below normal it may be (a) that one or more joints in the piping is leaking (b) the strainer in the sump may be choked (c) the oil suction pipe may be loose, or (d) full flow filter may be choked.

The remedy is to trace the whole system of piping right through, tightening each union in turn.

On Vehicle, Tractor and Industrial engines the strainer can be removed without disturbing the sump, but in the case of Marine Engines the sump must be removed to clean the strainer.

When to renew oil.

The oil in the crankcase must be drained in accordance with periodical attentions pages 17-20, and replaced by new oil, of a specification suitable for the climate in which the engine is operated. (See Appendix).

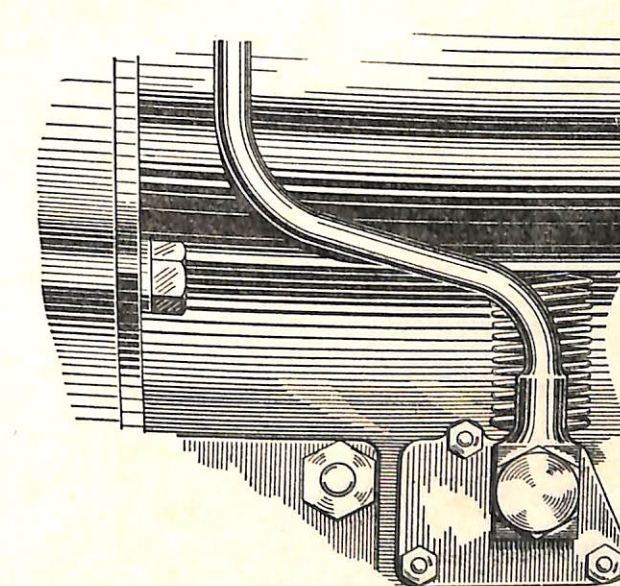


Fig. 8. Showing position of adaptor.

SPECIAL NOTE.—If a by-pass filter is fitted it will, after the sump has been newly filled, abstract a certain quantity of oil from the sump as soon as the engine commences to run. Run the engine for a quarter of an hour and pour oil into the sump to replace that which has been taken out to fill the filter.

Cleaning the Filters (See pages 68-70).

Cylinder Head Cover and Rocker Lubrication.

The rocker cover must be removed and the oil flow and valve springs checked periodically, see pages 17-20. Any sludge which may be found must be cleaned off the covers and heads, and away from the valve springs. This is most important. The springs may be cleaned by syringing with paraffin, care being taken not to allow any

appreciable quantity to find its way into the camshaft chamber.

General.

Particular care must always be taken that when any water which is splashed on to the engine at any time is wiped off.

Any water which may find its way into the sump from the exterior will tend to form sludge.

Failure to change the oil in the sump at recommended intervals is false economy, even if the oil seems good at the time of recommended change.

Dirty lubricating oil filters aggravate the formation of sludge, which in turn will further choke the filters. Regular filter inspection and cleaning at the specified periods is essential.

aces.

, the
sable

ump

the

east
ted.
unt,
of
deep

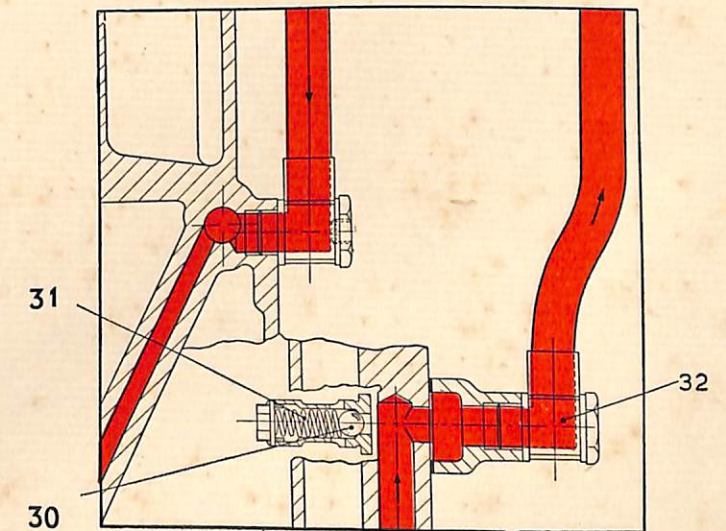
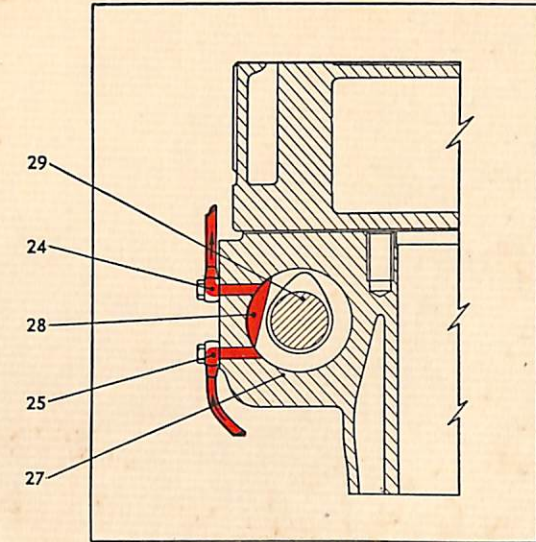
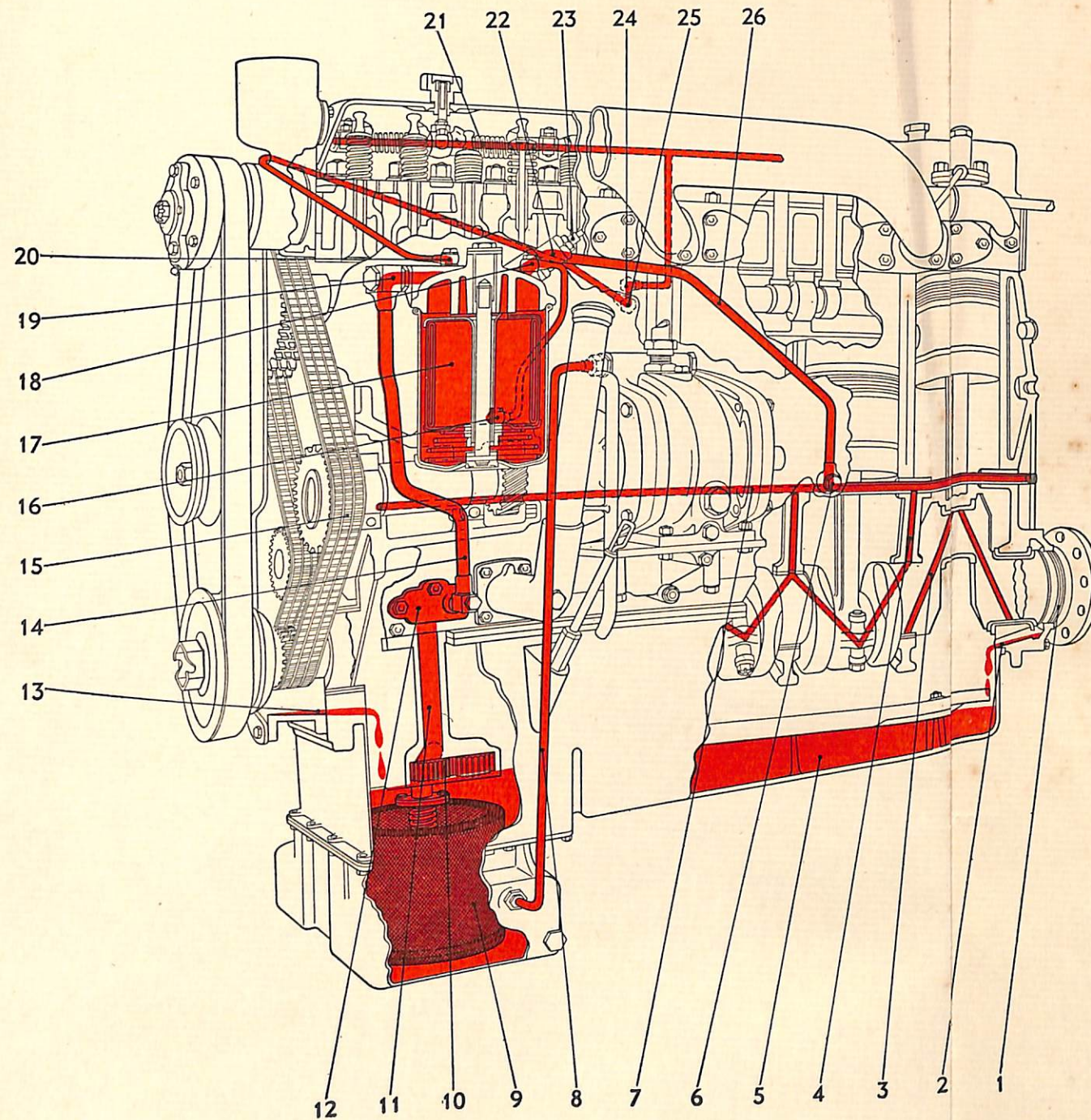
fed
ms,
late

ned
on
of

the
ed.
ich
the
uel
ed

n.
its
he
ng
cy

FIG. 9. LUBRICATING DIAGRAM



- 1 Oil Thrower
- 2 Oil Return Passage to Sump
- 3 Oil Holes in Crankshaft Webs
- 4 Oil Holes in Crankcase Webs
- 5 Sump
- 6 Inlet Union to Pressure Rail
- 7 Pressure Rail
- 8 Oil Pipe from Sump to Ex-hauster
- 9 Sump Strainer
- 10 Oil Pump

- 11 Outlet passage from Oil Pump
- 12 Oil Relief Valve Cover
- 13 Oil Return Passage from Timing Case
- 14 Main Oil Pipe—Relief Valve to Oil Filter
- 15 Timing Chain
- 16 Inlet Union to Auxiliary Drive
- 17 Oil Filter
- 18 Outlet Union from Filter to Auxiliary Drive

- 19 Inlet Union to Oil Filter
- 20 Outlet Union from Filter to Camshaft Reducer
- 21 Rocker Shaft
- 22 Outlet Union from Oil Filter
- 23 Connection to Pressure Gauge
- 24 Camshaft Reducer Outlet to Cylinder Head
- 25 Camshaft Reducer Inlet Connection

- 26 Main Oil Pipe—Oil Filter to Pressure Rail
- 27 Camshaft Bearing
- 28 Slot in No. 2 Camshaft Bearing Journal
- 29 Camshaft
- 30 Relief Valve
- 31 Relief Valve Spring
- 32 Outlet Union on Relief Valve Cover

FUEL INJECTION SYSTEM

This section is included mainly for the benefit of overseas users, and for those in out-of-the-way places.

As described, the maintenance and repair operations are made to appear quite simple : in reality, the risk of a mistake occurring which would cause damage to costly parts, is such as to make it inadvisable for any but experts to undertake the work.

The principal components of the equipment for delivering the fuel oil to the engine cylinders are : filters, fuel lift pump, fuel pump and atomisers.

The fuel lift pump "lifts" the fuel from the tank to the fuel pump which conveys it in measured quantities, and at appropriate intervals, to the atomisers.

The normal course of the fuel from the tank to the engine is by way of : first, the fuel lift pump, then the intermediate type filter, then a final filter, the fuel pump and the atomisers.

On certain tractor and industrial engines the fuel system is by gravity, and therefore no fuel lift pump is fitted. The filter system in these applications consists of a pre-filter, and a large capacity final filter.

Two conditions are essential for efficient operation.

First, that the fuel oil should be clean, free from water, suspended dirt, sand, or other foreign matter and should conform to the following specification :

FUEL OIL SPECIFICATION.

Spec. Gravity, .84 to .87.

Flash point above 150°F. (preferably about : 200°F.)

Viscosity Redwood No. 1 at 100°F. 34-45 secs.

Cold Test. Fuel remains fluid below 20°F.

Gross Calorific Value above 19,000 B.Th.U's. per lb.

Sulphur below 1%.

Water Content negligible.

Ash content negligible.

Hard Asphalt content negligible.

Second, that the fuel reaches the fuel pump in a perfectly clean state.

Fuel should be filtered before entering the tank.

Given these conditions, ninety per cent. at least of potential engine troubles would be eliminated. The attention of the operator is, on that account, earnestly directed towards those paragraphs of this Manual which refer to the care and upkeep of the filtering apparatus.

The Fuel Lift Pump.

The fuel lift pump is fitted in pressure fed systems only. In the case of gravity fed systems, the lift pump is removed and a blanking plate fitted in its place.

The lift pump is of the simple spring-retained plunger type. It is driven by its own cam on the camshaft of the fuel pump, on the side of which it is fitted. It is shown in Fig. 10.

A hand primer is fitted, Fig. 10, for use if the supply of fuel from the tank has at any time failed. To use this primer unscrew the handle, which is free to lift, and then pump by hand until the pipes, lift pump and fuel pump are full of fuel oil. To ensure that this is so, proceed as instructed on page 30.

Fuel Pump.

The fuel pump is an instrument of precision. Its working parts are made to extremely fine limits and mishandling in any shape or form, or the entry of the smallest particle of dirt into its working parts, may damage it and diminish its accuracy

of operation. Hence the importance of ensuring that the fuel is thoroughly filtered before the pump is reached.

Refer now to Fig. 20, the sectional drawing of a fuel pump.

Oil is supplied from the lift pump through the fuel inlet connection, 46, and entirely fills the fuel pump gallery, 39. This is a tubular passage running the full length of the fuel pump and closed at the end opposite to the inlet by the inlet closing plug. This fuel pump gallery is connected through small ports with all the pump barrels, 45.

In the base of the body of the pump is a camshaft. In contact with each cam is a cam roller, 14.

The roller is held in close contact with the cam by the spring, 15. The top of this tappet is in close contact with the lower end of the pump plunger, 42, contact being maintained between plunger and tappet by the pressure of the oil above the plunger.

As the pump plunger falls, oil flows into the barrel through the port. As the plunger rises it closes the port and propels the oil past the delivery valve, 40, into the pipe leading to the atomiser.

Fig. 11 shows how the upper part of the pump plunger is formed. Observe that an annular groove is cut in the plunger. The lower edge of this groove is level, or horizontal, the upper edge, B, is helical. In addition there is a vertical groove cut right to the top of the plunger and running into the annular groove.

This helical groove is the means of varying the quantity of fuel delivered per stroke. (See below).

The first sketch in Fig. 11, shows the working end of the plunger and barrel with the fuel port in the latter, which, it should be remembered, is in communication with the fuel gallery, 39, of the pump (Fig. 20). The plunger is shown at the bottom of its stroke with the cam at its bottom dead centre.

As the camshaft turns the plunger rises, but nothing happens until the top end of the plunger has reached the upper edge of the port in the barrel and closes it. Then the oil is propelled past the delivery valve and injection commences.

The camshaft of the fuel pump is driven direct from the engine timing gear at half engine speed.

It is "timed" like the magneto or distributor of a petrol engine, so that the closing of the port and commencing of fuel delivery to the engine, that is, injection, comes at a predetermined point in the compression stroke. The timing, of course, is precisely the same for each cylinder.

Oil continues to flow until the helical upper edge B of the groove in the pump plunger uncovers the port. When that happens communication is established between the oil above the plunger

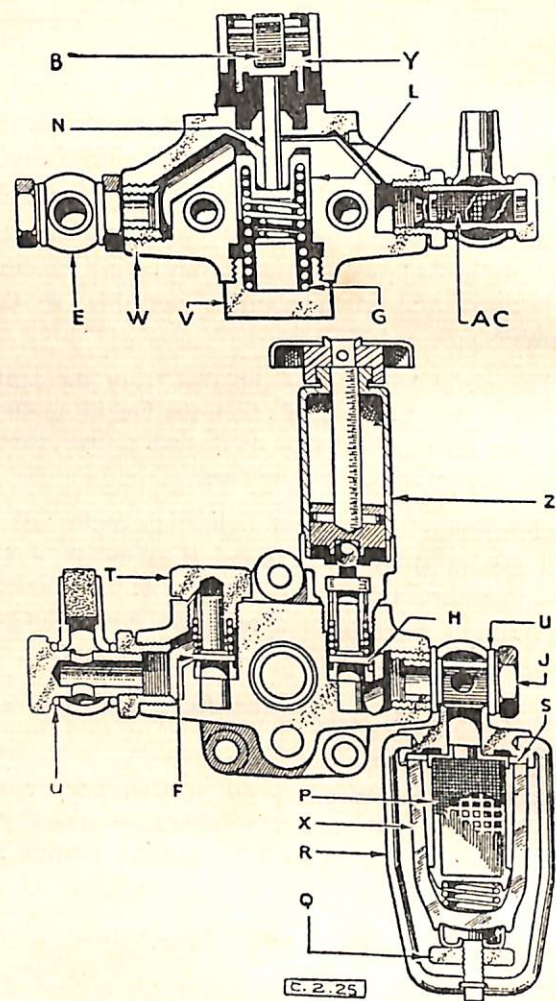


FIG. 10. FUEL LIFT PUMP.

(The preliminary filter is not always supplied).

- | | |
|-----------------------|-------------------------|
| B. Tappet Roller. | S. Packing Washer. |
| E. Fuel Outfit. | T. Valve Plugs. |
| F. Outlet Valve. | U. Copper-Asbestos |
| G. Plunger Spring. | Sealing Washers. |
| H. Inlet Valve. | V. Spring Chamber Caps. |
| J. Inlet. | W. Lift Pump Body. |
| L. Plunger. | X. Preliminary Filter |
| N. Guide Spindle. | Gauze Container |
| P. Preliminary Filter | Y. Spindle Guide. |
| Q. Clamping Nut. | Z. Primer. |
| R. Fixing Strap. | AC. Inlet Plug Filter |
| | Gauze. |

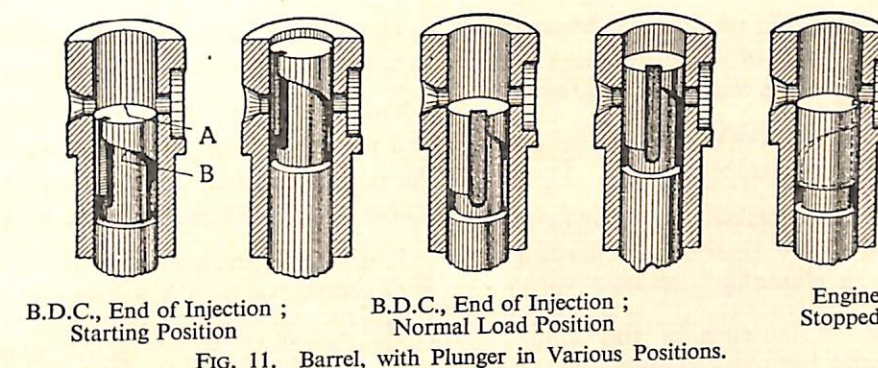


FIG. 11. Barrel, with Plunger in Various Positions.

and that in the gallery via (a) the vertical groove, (b) the annular groove, (c), the port in the pump barrel. (See Fig. 11).

That is the position shown in the second sketch of Fig. 11.

The oil then ceases to flow to the atomisers and is merely by-passed through these passages to the fuel pump gallery.

The upper, and helical edge of the annular groove thus serves as a valve. The higher that edge is in relation to the top of the plunger the sooner the cut-off and the less quantity of oil supplied to the atomiser per stroke.

By varying the level of that edge the quantity of oil supplied is controlled.

To alter that level, so that it uncovers the port in the pump barrel to vary the quantity of fuel delivered, the plunger is turned in its barrel by a simple means to be described shortly.

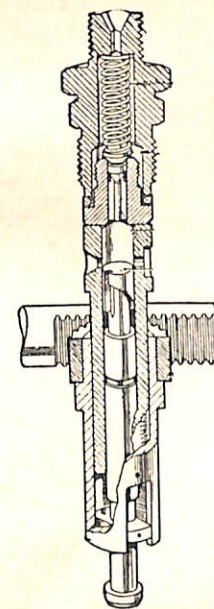


FIG. 12. Pump element shown in section.

In the first and second sketches of Fig. 11, the plunger is turned to one extreme position with the vertical groove just clear of one of the two port holes in the pump barrel. In that position the helical edge of the circular groove is at its lowest point and, so far as the port in the barrel is concerned the maximum quantity of oil is delivered. That is the

setting of the plunger for starting the engine.

In the third and fourth sketches the plunger is shown set for normal running. The precise position is varied by turning the plunger so that a greater or less quantity of oil is delivered to conform with the demand for power.

The other extreme position of the plunger is shown in the fifth sketch. This is the "stop" position: the vertical groove is now in line with the delivery port to the fuel pump gallery, which is thus put into communication with the top of the plunger, and oil therefore, merely passes down this vertical groove as the pump plunger rises. It is not delivered to the atomisers.

Rotation of the plunger into these different positions is brought about in this way. Near the lower end of each plunger are two lugs (see Fig. 12). The lugs are held in a slot on the actuating sleeve which is mounted on the outside of the pump barrel and can be rotated. Clamped to the upper end of each sleeve is a toothed quadrant. The teeth of the quadrant are engaged by a rack on the control rod (Fig. 20). To and fro movement of the rack turns the quadrants, the sleeves and the plungers.

Between the fuel pump and the atomisers are delivery valves, 40, one to each pump plunger, these serve the important purpose of preventing dribble at the atomisers. They do that by causing a sharp cut off in the oil supply at the end of each injection.

Fig. 13 shows a delivery valve. It is a poppet valve and a piston valve. The head is poppet-valve shaped and below that is a cylindrical portion which serves as a piston valve. In the left-hand sketch of Fig. 13 the valve is shown closed.

This valve has a high lift, so that, as shown in Fig. 13 the cylindrical part of the valve rises clear of the valve seat when the valve is fully open.

The way in which this valve operates to prevent dribble at the atomiser is as follows :—

As long as the fuel pump is delivering fuel oil the pressure of that oil on the underside of the valve keeps it wide open as in the third sketch of Fig. 13.

As soon as the helical edge of the annular groove on the pump plunger uncovers the port in the pump barrel the pressure of the oil below the delivery valve falls and that valve is promptly closed by its spring. As it falls the effects of the withdrawal of the piston part of the valve within the seat causes a drop in pressure in the pipe to the atomiser, causing the nozzle valve to snap on to its seat sharply, cutting off the fuel supply, so that there is no dribble.

Pneumatic Governor.

The position of the control rack, by means of which the quantity of fuel delivered to the engine is regulated as described above, is determined by a pneumatic governor. This governor, part of which is in the form of a venturi in the engine induction manifold, operates the control rack according to the degree of vacuum in the venturi passage.

There is a butterfly valve in the venturi. When that valve is closed, or nearly closed, the suction on the engine side of it is considerable, lessening as the valve is opened.

A pipe, 31, connects this venturi passage with a governor casing which is mounted on the fuel pump. See Fig. 20.

Reference to the drawing of the pneumatic governor, Fig. 20, will enable its operation to be understood.

The important element is the flexible leather diaphragm, 34, which divides the space inside the governor casing into two compartments, one of which, that on the left, is air-tight.

This air-tight compartment is in communication with the venturi by means of a pipe, 31. The vacuum in the venturi is thus communicated to the air-tight compartment on the left-hand side of the diaphragm.

The chamber, to the right of the diaphragm, is not subject to vacuum.

The diaphragm, therefore, is constantly subject to a pressure tending to draw it to the left, against the resistance of the light spring shown disposed within the left-hand chamber.

It will be appreciated that as the butterfly valve is closed the vacuum increases and the diaphragm moves to the left.

The centre of the diaphragm is coupled to the control rod of the fuel pump. Movement of this rod towards the governor tends to reduce the supply of fuel to the atomisers, as explained on page 27.

Thus, closing the butterfly valve increases the vacuum in the chamber, moves the diaphragm to the left, and reduces the supply of fuel to the engine.

The butterfly valve is operated by the throttle valve lever and in that way the speed of the engine is controlled.

Now here is a point of the very greatest importance.

Any leaks in the joints of the pipe, 31, in the pipe itself, or in the diaphragm, will diminish the degree of vacuum and cause the engine to run faster than it should and idle erratically.

Hence the instructions, given later, urging care in ensuring that there are no air leaks in the system.

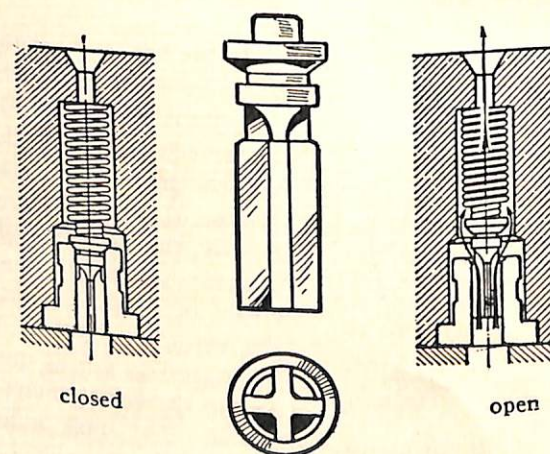


FIG. 13. Delivery Valve.

If the pipe, 31, were to become detached, or to be left uncoupled, and the engine run, it would race and very serious damage be caused.

Hence the warning, repeated later, that the engine must never be run unless the venturi control unit, pipe and induction manifold are in position and all joints tight.

Controlling the Idling Speed.

An important function of this pneumatic governor is that of controlling the idling speed of the engine.

That is the speed at which it rotates when the butterfly is in its nearly closed position. That position is determined and limited by an adjustable stop mounted on the body of the venturi.

With the butterfly valve control lever in this limiting position the vacuum in the air-tight chamber is at a maximum and the diaphragm together with the fuel pump control rod, is as far to the left as the damping spring, described below, will allow it to go. The minimum quantity of fuel, just sufficient to "idle" the engine, is then being delivered.

Under these conditions there is a tendency for the engine to "hunt" that is, for its speed to fluctuate.

It is to eliminate "hunting" and to ensure a steady idling speed, that the "damping" mechanism shown on the extreme left of the pneumatic governor is provided. Refer again to Fig. 20.

The idling control spindle, 32, which is under the control of a small strong spring, 30, contacts the centre of the diaphragm when the latter is in the extreme left or "idling" position and steadies it.

Adjustment is provided for the position of this spindle.

Screwing the adjustment in drives the spindle further in and increases the idling speed.

Adjustment of the idling speed is effected by alternate manipulation of the screw on the end of the pneumatic governor and the stop for the venturi lever.

This is a very delicate operation, only to be attempted by experts. It is completed at the works for every engine.

There is another adjustable stop on the venturi to limit the maximum speed of the engine, which is sealed. Disturbance of this seal may involve forfeiture of the manufacturer's guarantee.

To stop the engine the stop lever, 16, is moved anti-clockwise, carrying the control rack with it and turning the pump plunger into the position shown in the fifth sketch of Fig. 11, the "no fuel" position.

Atomisers.

After leaving the fuel pump the fuel passes through short steel pipes, 29, to the atomisers. Atomisers perform the function of injecting the fuel, in the form of fine sprays, into the cylinders, at the moment when the air in the cylinder has been compressed and, as the result of the compression, is at a temperature sufficient to ignite the incoming fuel.

An atomiser comprises two principal parts: the nozzle, 19, with its valve, 20, and the atomiser body, 23.

The atomiser nozzle and nozzle valves are the important parts. They are shown in Fig. 17.

Fuel is fed to the upper channel in the nozzle from the atomiser body and travels thence along a number of drilled holes to the lower circumferential channel. The outlet from the latter is normally closed by the valve as shown.

The atomiser body, complete with nozzle and nozzle valve, is shown in Fig. 20. The nozzle is held in place by the nozzle holder cap nut, 21. This holds the upper face of the nozzle in close contact with the corresponding lower face of the atomiser body. A metal to metal joint is made here.

Fuel is supplied through the fuel inlet connection, 28, and passes through the drilled holes down to the channel in the face of the nozzle.

In the centre of the atomiser body is the spindle, 22, surmounted by the valve spring, 24, and washer, on the top of which bears the compression screw, 26. There is a lock nut on this screw. A covering nut protects the upper part of the atomiser body and the compression screw.

The small quantity of fuel which by-passes the nozzle valve and accumulates within the atomiser body, lubricates the mechanism and is led away by a pipe, 27, connected to the leak-off nipple stud. At the start of injection the fuel pump delivers fuel at a high pressure into the channel round the lower end of the nozzle. The pressure of this fuel on the end surface of the cone of the valve lifts it against the tension of the spring and fuel passes through two small holes in the end of the nozzle as two fine sprays.

CARE OF THE INJECTION EQUIPMENT.

THE FILTERS.—See page 71.

LIFT PUMP.

The inlet valve of the lift pump is accessible after removal of the hand primer. The outlet valve is under the plug, T, Fig. 10. These valves and their seats must be perfectly clean.

The following are possible troubles with the lift pump and the way in which they can be remedied.

1. Lift Pump does not deliver Fuel.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
(a) Fuel tank empty.	Fuel tank.	Must contain an adequate supply.
(b) Fuel cock closed.	Fuel cock.	Must be open to its full extent.
(c) Preliminary filter choked.	Preliminary filter gauze P.	Remove by loosening round nut Q and lifting fixing strap R. Wash in clean fuel oil or paraffin. If damaged, replace. Take care to replace washer S.
(d) Inlet or outlet valves fouled or damaged.	Valves F. & H.	Remove by unscrewing hexagon plug T, and primer Z. Clean in fuel oil or paraffin. Take care to screw plug T and primer, Z in to the full extent when replacing.
(e) Plunger or tappet spindle fouled or damaged.	Plunger L and tappet spindle N.	Extract after unscrewing cap V. Clean in fuel oil or paraffin.

NOTE : If damaged, return complete with body to nearest agent.

2. Lift Pump does not deliver Sufficient Fuel.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
(a) Connection or pipes between the lift pump and fuel pump leaking.	Connection pipe	See that all joints and pipes are perfectly air-tight.
(b) Inlet or outlet valves leaking.	Valves F. & H.	Treat as for 1 (d).
(c) Plunger leaking.	Plunger L.	Treat as for 1 (e).
(d) Plunger spring damaged.	Plunger spring G.	Replace.
(e) Preliminary filter obstructed.	Preliminary filter Gauze P.	Treat as for 1 (c).
(f) Main pipe line filter obstructed.	Main filter.	Clean and Vent air as instructed on this page.
(g) Air locked system.	Main filter.	Vent air by opening vent screw on main filter and allowing fuel to flow until perfectly free from bubbles. See below

Air Venting the Fuel System.

If the fuel system has been opened at any time, say for an overhaul, it is necessary to ensure that all air has been removed before attempting to start the engine. This should be done as follows :

Pressure Fed Systems.

Slacken small plug on top of the final filter and operate the hand primer on the fuel lift pump until fuel free from air bubbles issues from the plug hole. Tighten the plug.

Slacken the bleed cock on the top of the fuel pump.

Again operate the hand primer on the fuel lift pump until fuel issues from the bleed cock and all signs of air have disappeared.

Tighten the bleed cock securely and give the primer a few more strokes in order to deliver the fuel through the relief valve on the final filter, clearing this part of the system of air.

Gravity Fed Systems.

Slacken small plug on the top of the final filter and turn on fuel tank supply tap until fuel free from air issues from the plug hole. Tighten the plug.

Slacken the bleed cock on the top of the fuel pump and allow fuel to run until no trace of air remains.

Tighten the bleed cock securely whilst fuel is still issuing.

ENGINE TROUBLES.

Fuel injection difficulties can arise on the engine from several causes, some of which may be traced to the fuel pump. Such difficulties, with the likely cause and suggested cure, are set out on the following table. The first move when a fuel pump is suspected should be to uncouple the piping between the fuel pump and the atomisers. If the engine is then rotated with the pump control rod set at full load position it will be seen whether or not the fuel is being delivered. Observe each discharge outlet on the fuel pump to see if all discharge outlets are in order. On the following table the word " pump " applies to the pump unit block as a whole or to individual elements, and the numbers referred to are shown in Fig. 20.

1. Engine will not Start, or Stops after a short time.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
Pump does not deliver fuel	(a) Fuel cock	Must be open.
	(b) Fuel tank	Must contain an adequate supply.
	(c) Fuel inlet pipe or filter elements.	Clean pipes, examine filter elements and, if choked, clean them as described on page 71.
	(d) Air in pump.	Air vent filter and pump as described on page 30.
	(e) Delivery Valve, 40.	Clean and inspect. If worn or damaged, replace both valve and seating.
	(f) Pump plunger, 42.	Return the pump intact to F. Perkins Ltd.
Pump does not deliver fuel uniformly.	(g) Air in pump.	Air vent filter and pump as described on page 30.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
	(h) Delivery valve spring, 41.	Replace if broken.
	(j) Delivery valve.	If damaged on face or guide replace. See (f) above.
	(k) Tappet spring, 15.	See (f) above.
	(l) Pump plunger, 42.	Proceed as (c).
	(m) Fuel inlet pipes or filter elements.	This pump may not be operating efficiently. See instructions on page 30.
	(n) Fuel lift pump.	Proceed as in (f) above
	(o) Tappet adjusting screw.	Proceed as in (f) above
	(p) Cam profiles.	Proceed as in (f) above

2. Engine does not pull.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
Quantity of fuel delivered per stroke insufficient.	(a) Delivery valve, 40.	Proceed as in (f) above
	(b) Pressure system joints.	If leaking, clean joint faces and tighten.

3. Engine emits black smoke.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
Quantity of fuel delivered per stroke excessive	(a) Regulating quadrant, 38.	If moved, due to screw being loose, proceed as in (f) above.

4. Maximum Speed of engine too high.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
Control rod has jammed.	(a) Pump plunger, 42.	Proceed as in (f) above
	(b) Control rod.	Proceed as in (f) above

NOTE : If air is in system, the suction side of lift pump should first be examined.

PNEUMATIC GOVERNOR.

Adjustment of the pneumatic governor is effected at the works when the engine is erected. It is an operation requiring considerable skill. The idling stop on the butterfly valve and the adjusting screw on the cap of the governor have to be manipulated alternatively until smooth running at the desired idling speed is achieved.

No subsequent adjustment is, in fact, needed. Any deterioration in the smoothness of idling is due to some defect which has arisen elsewhere and should be looked for under the paragraphs in this section devoted to care of the fuel system generally.

MAINTENANCE.

The tiniest pinhole or crack in the leather diaphragm will affect the operation of the governor. If such a fault is suspected, test in this way.

- Remove vacuum pipe, 31.
- Move the stop lever, 16, into "stop" position.
- Place a finger over the diaphragm housing union in order to seal it.
- Release the stop lever.
- The control rod should then slowly return to the maximum speed position after a quick initial movement for a fraction of the distance. If it returns quickly for the whole movement and the housings are clamped firmly together, then the diaphragm is leaking and should be replaced. Instructions for replacement are given below.

If the diaphragm appears to be sound as indicated by this test, suspect the vacuum pipe and test in a similar way. Replace the union of this pipe on the governor casing and uncouple it at the butterfly end. Repeat the test as before but placing the finger on the uncovered end of the vacuum pipe.

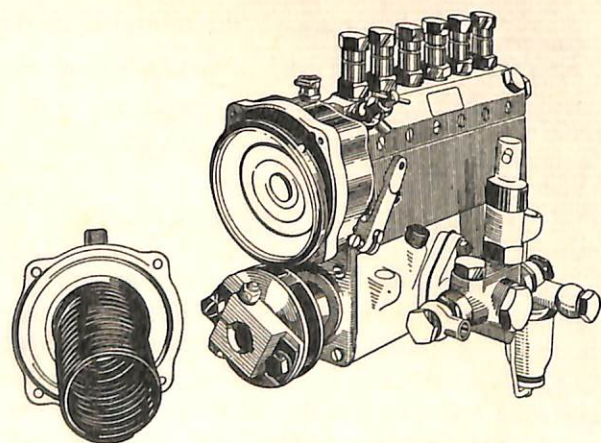


FIG. 14. Remove diaphragm from pneumatic governor.

To renew Leather Diaphragm.

To renew the leather diaphragm proceed as follows:

Disconnect the vacuum pipe.

Take out the screws holding the pneumatic governor in place.

The diaphragm will then be accessible. It is held in a light U-section metal rim which must be prised from the casing. See Fig. 14.

Great care must be exercised in this operation.

For preference, use a piece of sheet metal about $\frac{3}{4}$ in. wide, shaped at the end to fit the curve of the rim, and sharpened to an edge similar to that of a screwdriver.

Lift the edge of the rim carefully all round.

When the rim is free, slide the socket at the back of the diaphragm off the pin in the control rod.

Be careful not to mark the face of the fuel pump on to which the governor casing fits.

To replace the diaphragm first place the socket on the pin in the control rod.

Then press the rim firmly in its place.

Replace the governor casing, being careful to screw the setscrews very tightly and evenly in position.

CAUTION.

The pneumatic governor depends for its action upon pressure variations set up in the air intake pipe of the engine by the venturi control valve. If this should be removed either by itself or with the inlet manifold during overhaul or if the vacuum pipe unions are not always kept perfectly tight, then the governor may fail to operate causing damage to the engine.

IN NO CIRCUMSTANCES SHOULD THE ENGINE BE RUN WITHOUT VENTURI CONTROL UNIT, VACUUM PIPE OR INLET MANIFOLD.

Atomisers.

Each atomiser body consists of a steel body held to the cylinder head by means of a flange and two studs.

The joint between the atomiser and cylinder head is made by a special copper washer between the lower face of the nozzle cap nut and the metal of the cylinder.

When preparing to fit the atomiser into place in the cylinder head, care should be taken that only this special type of copper washer is used to make this joint. The metal of the cylinder head, the faces of the copper joint ring, and the corresponding face on the nozzle holder cap nut should be perfectly clean if a leak-proof joint is to result.

It is advisable to fit a new joint washer when the atomiser is replaced after having been removed or any reason.

Ensure that the old washer has been removed from atomiser or cylinder head.

The joint washer should be an easy, but not loose fit for the atomiser nozzle, and it is because this is such an important feature that the washers especially made for the purpose should be used and none other. On no account should ordinary sparking plug type washers be used.

The atomiser can now be fitted in place, care being taken to see that it is an easy fit in the cylinder head and on the holding-down studs, so that it can be placed down on the copper joint without force of any kind. The nuts on the flange should then be tightened down evenly in order to prevent the atomiser nozzle being canted and so "nipped" in the cylinder head. This is very important, since any unevenness in tightening down may cause distortion of the atomiser nozzle, resulting in its failure and will most certainly result in blow-by.

Fuel Pipes.

No two of the pressure pipes, from fuel pump to atomisers, are alike. Keep this in mind when replacing.

Examine the nipples which will be found on each end of these pipes.

If the union nuts have at any time been overtightened there is a risk that the nipples will have cracked or been unduly compressed. If so, leakage will result.

In this connection, bear in mind that the working pressure which these joints must sustain is several thousands pounds per sq. in. Only a perfect joint is satisfactory.

It is quite easy to replace these nipples.

Clean up a length of pipe near the end, using a fine cut file for the purpose, until the nipple will slide on to it.

Remove the nipple and replace the union nut and steel washer. The latter must have its countersunk face towards the nipple.

Now press the nipple on to the pipe, leaving $\frac{1}{64}$ in. of the latter protruding.

Hold the pipe in a vice so that the nipple rests on the washer and the washer rests on the top of the vice.

Rivet the protruding portion of the pipe over the nipple.

Take care that the hole in the pipe is not closed whilst rivetting.

Clean off with a fine cut file.

When refitting take care that it is the nipple which makes the joint and not the actual riveted portion of the pipe.

After fitting new nipples WASH THE FUEL PIPE WITH CLEAN FUEL OIL, using either the atomiser testing pump or the engine fuel pump, thus removing any filings which may be in the pipe.

Offer up the pipe to the delivery valve and atomiser unions to check that the pipe fits square at both ends. Do not fit one and then bend the pipe to square it with the other union.

When fitting the pipe tighten the unions alternately a little at a time, first one end and then the other.

If the nipples have been properly fitted and the pipe is square to the unions at each end as described above, no force will be needed to make a good joint. No force should be used.

Use only a standard open-ended $\frac{3}{8}$ in. by $\frac{7}{16}$ in. spanner.

If the union is tightened excessively the nipple may collapse and split. The same danger exists if the pipe is not square to and central with the union.

When changing an atomiser always remove the pipe entirely. Never undo only one end, leaving the other tight. Never bend the pipe.

MAINTENANCE

Atomisers should be taken out for examination at regular intervals. How long this interval should be is difficult to advise, because of the widely different conditions under which engines operate. When combustion conditions in the engine are good and the fuel tank and filtering system are maintained in first class order, it is often sufficient if the atomisers are tested twice yearly. For detailed times refer to periodical attentions, pages 17-20. It is no use taking atomisers out for attention unless the equipment described on page 35 is available, or spare atomisers are at hand for substitution.

The nearer the ideal conditions of good fitting with adequate cooling and absolutely clean fuel are realised, the less attention the atomisers will need, and so the longer their efficient life. In this connection, since there is no other item of the equipment upon which the performance of the engine depends so much, it pays the user handsomely to see that the engine never runs with any of its atomisers out of order.

Troubles in Service.

The first symptoms of atomiser troubles usually fall in one or more of the following headings :—

1. Knocking in one (or more) cylinders.
2. Engine overheating.
3. Loss of power.
4. Smoky exhaust (black).
5. Increased fuel consumption.

Often the particular atomiser or atomisers causing trouble may be determined by releasing the pipe union nut on each atomiser in turn, with the engine running at a fast "tick-over." This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after slackening a pipe union nut the engine revolutions remain constant, this denotes a faulty atomiser.

The nuts from the flange of the doubtful atomiser should be removed and the complete unit withdrawn from the cylinder head and turned round, atomiser nozzle outwards, "unwiped" on its pipe, and the unions re-tightened. After slackening the unions of the other atomiser pipes (to avoid the possibility of the engine starting), the engine should be turned until the nozzle sprays into the air, when it will be seen at once if the spray is in order. If the spray is unduly "wet" or "streaky" or obviously to one side, or the atomiser nozzle "dribbles," the spray holes should be probed with the special tool ET.120. (See Fig. 18). If after probing the spray holes, the condition of the atomiser is still faulty, remove the complete unit.

Great care should be taken to prevent the hand from getting into contact with the spray, as the working pressure will cause oil to penetrate the skin with ease.

The spare atomiser from the tool kit should be fitted, the faulty unit being placed in the tool kit securely wrapped in clean grease-proof paper or rag for attention on the maintenance bench.

Examination and Testing.

A bench suitable for working with atomisers is preferably linoleum-covered with glass on top. It should be entirely reserved for this work and kept absolutely free from dirt. The use of cotton waste or fluffy rags must be absolutely forbidden.

The bench should have a dust proof drawer for holding the atomiser cleaning tools and equipment described in detail below.

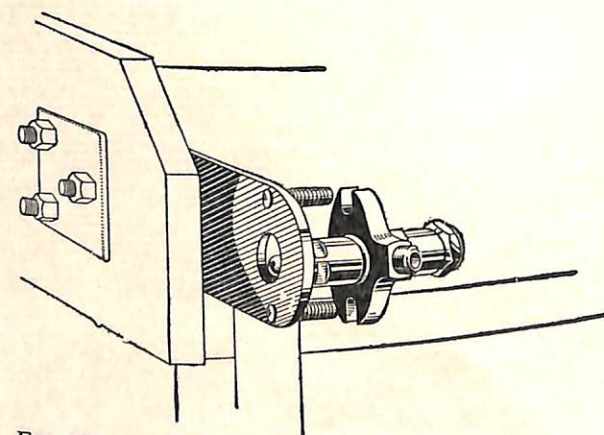


Fig. 15. Showing plate for holding atomiser while it is being dismantled.

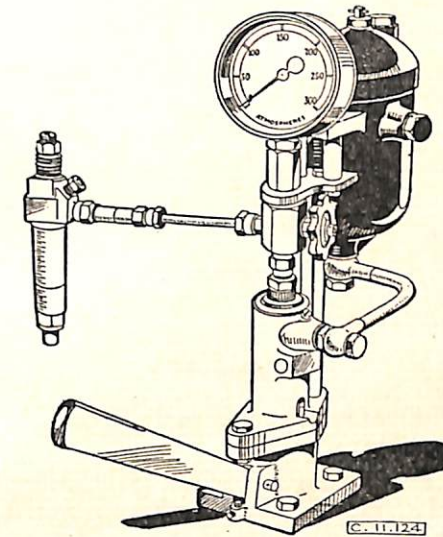


Fig. 16. Atomiser Testing Pump.

atomiser securely whilst various maintenance operations are proceeding.

An atomiser testing pump No. ET.122A (Fig. 16) should be available. This outfit has been specially designed to provide a reliable means of testing and setting the atomisers. It is made up of parts similar to the injection equipment fitted to engines.

The doubtful atomiser should be removed from its wrappings and fitted nozzle downwards, and still unwiped, to the testing pump.

No observations should be made until at least ten full strokes of the hand pump have been given to expel all air from the system.

Atomiser Pressures.

The pressure at which the spray breaks should then be recorded and checked against the recommended pressures which are : Tractor and Industrial Engines rated at 1,500 r.p.m. or less, 160 atmospheres. Atomisers set at this figure have dark blue painted caps and a figure 6 stamped on the right hand fixing flange. Engines rated above 1,500 r.p.m. are set at 120 atmospheres. The following are exceptions :

- P4(TA) engines 160 atmospheres.
 - P6(M) and P4(M) engines 160 atmospheres.
 - P6 and P4 Car and Taxi engines 100 atmospheres.
- Atomisers set at 100 atmospheres have orange painted caps.

The spray should now be observed for uniformity at a rate of pumping of not less than 20 strokes per minute.

Each should be a misty spray spreading to about 3 inches diameter at about one foot away from the atomiser nozzle, then breaking into a very fine mist. There should be two sprays from each atomiser nozzle, one pointing outwards from the top hole, and the other pointing downwards from the lower hole, when the atomiser is in a position corresponding to its working position.

An atomiser is good for service if, when operating the atomiser testing pump at the above speed, it gives two effective sprays as above described.

An atomiser is dirty and requires reconditioning if (a) when proceeding as above it throws out solid wet jets and not broken up spray or (b), if either of the holes are choked or partially choked so that spray issues from one hole in the atomiser only or appreciably more spray issues from one hole than the other.

In this connection, as the Perkins engine idles at about 500 r.p.m. the atomiser is never called upon to work in the engine more slowly than 200 injections per minute. Thus by taking the atomiser spray at 20 strokes per minute, ample margin is allowed.

When removing an atomiser from the testing pump close valve by rotating the hand-wheel and screw off the union nut a little at a time so that the pressure falls gradually.

All atomisers are set to operate at the pressures described above before leaving the works. If a new atomiser nozzle is fitted to an atomiser body it is not necessary to reset the pressure. After the atomiser has been in service for some time, the opening pressure tends to fall, but provided that the atomiser nozzle holes do not choke up, there is no need to adjust the pressure.

NO ATTEMPT SHOULD BE MADE TO ADJUST THE INJECTION PRESSURE WITHOUT A PROPER TESTING PUMP AND PRESSURE GAUGE AS DESCRIBED AND ILLUSTRATED ABOVE. IT IS QUITE IMPOSSIBLE TO ADJUST THE SETTING OF ATOMISERS WITH ANY DEGREE OF ACCURACY WITHOUT PROPER EQUIPMENT.

If the atomisers are interfered with, on the assumption that so many turns of the adjusting screw represents so many pounds, they may vary

A plate, made up as shown in Fig. 15, should be secured to the bench. Its purpose is to hold the

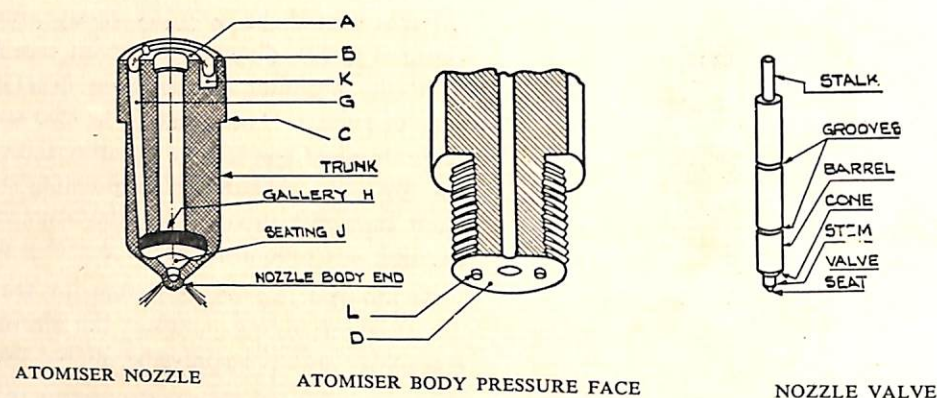


FIG. 17. Diagrams of Atomiser and Atomiser Body : the letters have reference in the text.

as much as 200 pounds as between one and another. With such differences between atomisers the engine cannot possibly give of its best.

If the spray is still unsatisfactory, even after brushing the carbon away from around the atomiser nozzle with the fine wire brush specially designed for the purpose and illustrated in Fig. 18, the atomiser should be placed on the atomiser holding plate already described, see Fig. 15.

Before attempting to dismantle the atomiser, the tension on the spring should be released by unscrewing the compression screw, 26. The nozzle holder cap nut, 21, Fig. 20, should be slackened with the special ring spanner provided, ET.116 (see Fig. 19). To hold the nozzle holder cap nut in the vice or to use ill-fitting "packed" or adjustable spanners or wrenches is to invite disaster.

Examine the pressure face of the nozzle holder cap nut to see it is not damaged so as to have "nipped" the atomiser nozzle in any way.

The nozzle holder cap nut should now be removed and the atomiser nozzle completely lifted from the atomiser body for examination. The surfaces "A" and "B" in Fig. 17, on the top of the atomiser nozzle should be clean and bright, free from damage, likewise the under-surface "C" of the flange, the face of the atomiser body "D" and the interior retaining shoulder of the nozzle holder cap nut. All of these must register together absolutely cleanly and squarely to form the high pressure joint between the atomiser body and nozzle.

The atomiser body should now be removed from the plate, and together with the cap nut immersed in clean paraffin and left to soak in a

suitable container. The nozzle valve should be grasped by the stalk between finger and thumb and withdrawn, carefully, for examination. The stem of the nozzle valve should be clean and bright, and free from high spots, bad scratches or dull patches, and the grooves free from dirt, metal particles or other foreign matter.

The stem and the valve seat of the nozzle valve should now be examined, and, if dirty, or "coked" cleaned until bright metal is shown.

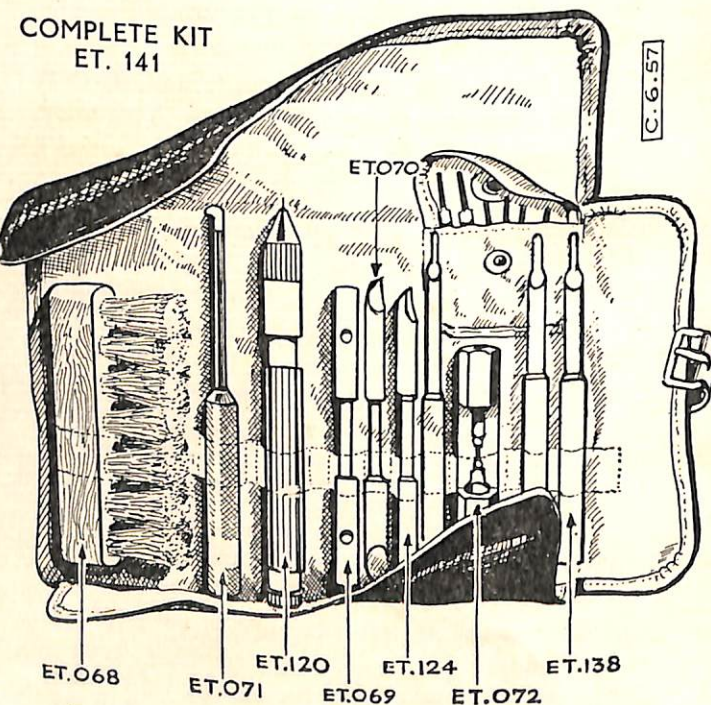


FIG. 18. Complete Kit of Tools for use when cleaning and overhauling atomisers.

Cleaning.

Assuming that the nozzle valve has been soaking and the two surfaces "A" and "B" on the top of the atomiser nozzle flange already mentioned, are clean and free from damage, the inside of the atomiser nozzle should be examined. The kit of tools shown in Figs. 18 and 19, are recommended. The three small drilled passages "G" (Fig. 17) should be explored to see that they are clear and clean, followed by examination of the valve stem bore in which the nozzle valve slides. This surface should be clean and bright and free from high spots or scratches or dull patches. The valve seating "J" (Fig. 17) should now come under observation under a strong light to ascertain whether or not it is free from dirt or carbon. If this is not so, and indeed, in any case, it is advisable to use the soft brass seat scraper No. ET.070 (see Fig. 18) to remove any carbon or particles that may be imprisoned on the seat. The gallery "H" (Fig. 17) should now be cleaned with the aid of the special soft brass scraper No. ET.071 (see Fig. 18) to ensure that it is also clean and free from dirt or carbon.

The spray holes in the atomiser nozzle end should be probed with the special tool ET.120 (see Fig. 18).

In cases where the holes cannot be cleaned by this process, the complete atomiser should be returned securely wrapped and packed as described above. Assuming that the spray holes have been cleaned satisfactorily, the atomiser nozzle can then be placed into the container to soak in paraffin or preferably assembled in the atomiser flushing tool No. ET.427 (Fig. 19) and thoroughly flushed through to ensure that all carbon particles are removed from the inside of the atomiser nozzle.

The nozzle valve should now be polished by rubbing with an absolutely clean cloth—a piece of used boiled cotton is best—upon which there is no suggestion of fluff. Particular attention should be given to the valve seat. This and the smaller cylindrical portion above it, called the "stem" and "cone" in Fig. 17, can be cleaned with the fine brass wire brush. To ensure that the stem and cone are free from any particles, the soft brass stem cleaner No. ET.072 should be applied with a rotary action, pressing the nozzle valve into the cleaning tool with the fingers.

After ensuring that the exterior of the atomiser nozzle is clean and free from carbon, the valve and atomiser nozzle may be assembled together. This should be after the two parts have been thoroughly washed in clean paraffin or fuel oil and placed together, preferably with the fingers whilst submerged in the clean oil.

The atomiser body should now receive attention : it should be washed in clean paraffin, care being taken to ensure that the highly ground face "D" (Fig. 17) is clean and free from scratches. This face must register with the atomiser nozzle flange cleanly and squarely to form a high-pressure joint and must, therefore, be handled in such a way as to avoid damage to the surface. The exterior of the atomiser body, of course, should be cleaned thoroughly from dirt and grease in the usual manner. Periodically, it is advisable to dismantle the interior of the atomiser body to examine the springs, 24 (Fig. 20), spring plate, and nozzle spindle, 22. When dismantling, the special spanners, Nos. ET.117 and ET.118 (see Fig. 19) should be applied for the removal of the nozzle holder spring cap, 25 (Fig. 20) which is revealed after the removal of the covering protection cap. The interior of the atomiser body and the parts removed should be washed carefully to remove any dirt or moisture. If the spring and the parts are in good condition, they should be re-assembled carefully, and preferably after having been slightly coated with lubricating oil.

The serviceable life of the atomiser valve spring can be considerably enhanced by careful treatment, and great care should be taken to avoid the damage likely to be caused by moisture, corrosion arising in storage, handling, or by reason of condensation owing to temperature changes in service. It is recommended that these valve springs should be inspected, cleaned and greased whenever the atomisers are removed for cleaning, whilst care should be taken in storing spares to preclude all possibility of the access of moisture.

Re-Assembly of Atomisers.

The atomiser body and atomiser nozzle may now be assembled carefully, after having immersed the pressure faces of each in clean fuel oil, to ensure that they are free from dirt. The nozzle holder cap nut, 21, should be screwed on to the body by use of the special spanner. Excessive tightening of the nozzle holder cap nut may result in con-

Fuel Injection System—continued

striction or distortion of the atomiser nozzle and its consequent failure; care should be exercised to ensure that the leverage applied is not excessive.

After cleaning, the atomiser should be tested always on the atomiser testing pump as previously described. If the pressure at which the spray breaks is not that quoted above it can be adjusted by the spring adjusting screw and lock nut, using spanner ET.119 (Fig. 19).

A perfect atomiser, when tested by pumping

fuel through it in the open air gives a short "pinging" sound as the fuel emerges from the holes, no matter how slowly the fuel be pumped. After the atomiser has been in service for some time, the "pinging" changes to a crackling sound. It is not until the atomiser sounds "dead" that its condition is likely to affect the running of the engine.

When replacing the atomiser in the cylinder head follow carefully the instructions for fitting given on page 33.

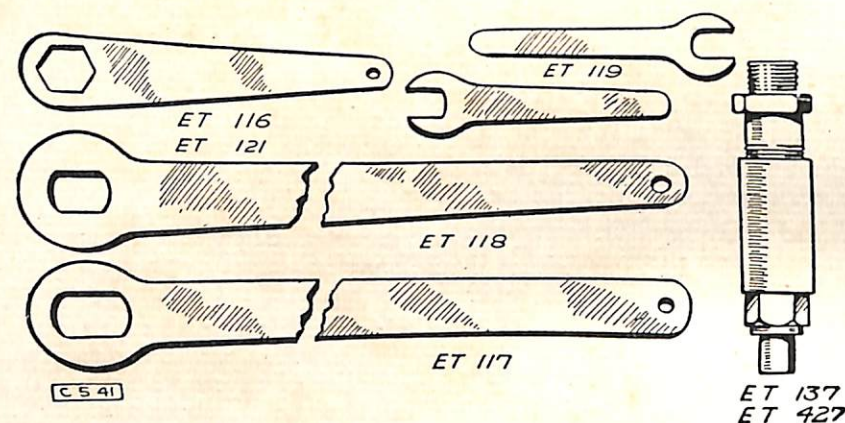
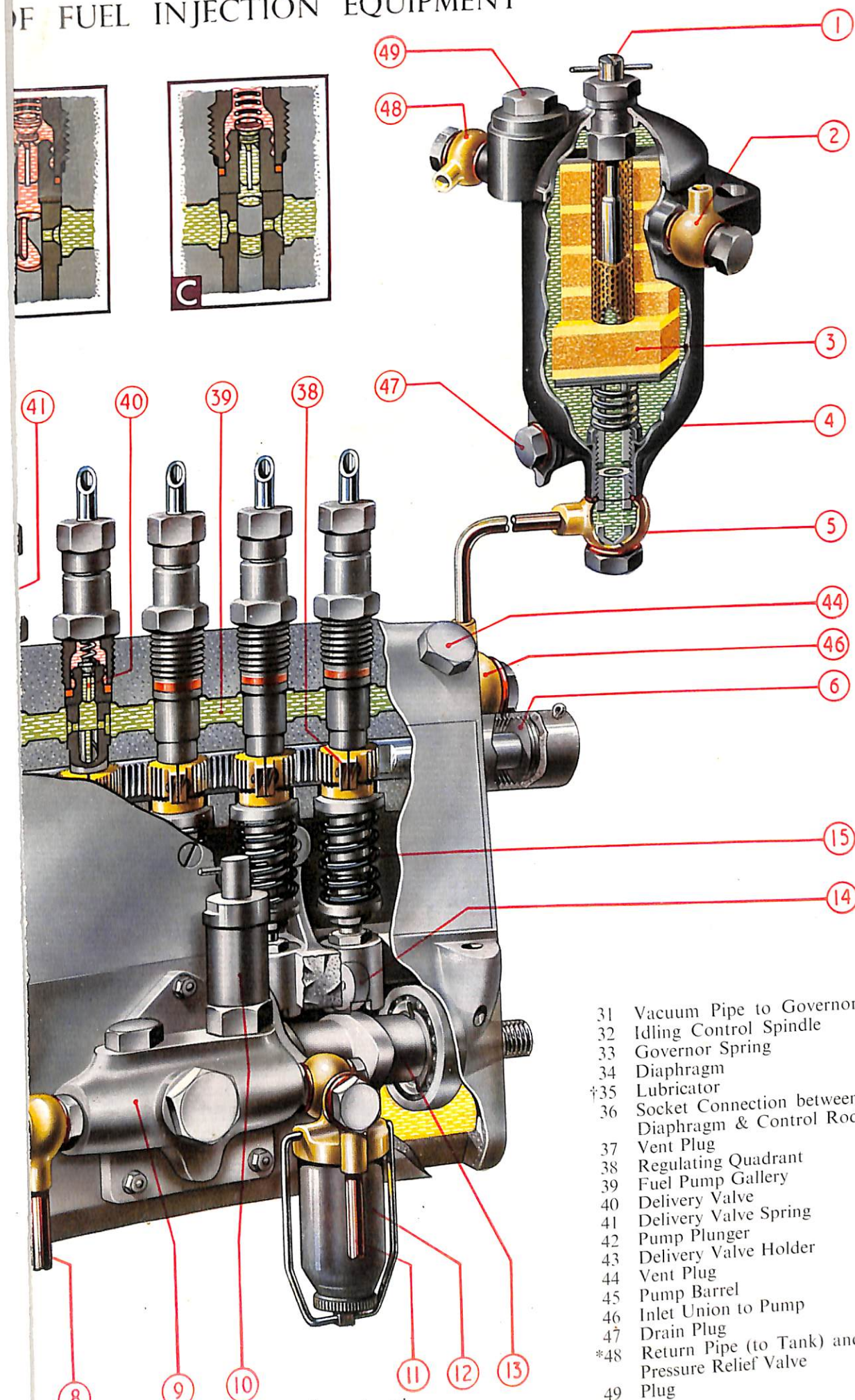


FIG. 19. Spanners and cleaning tools for use with atomisers.

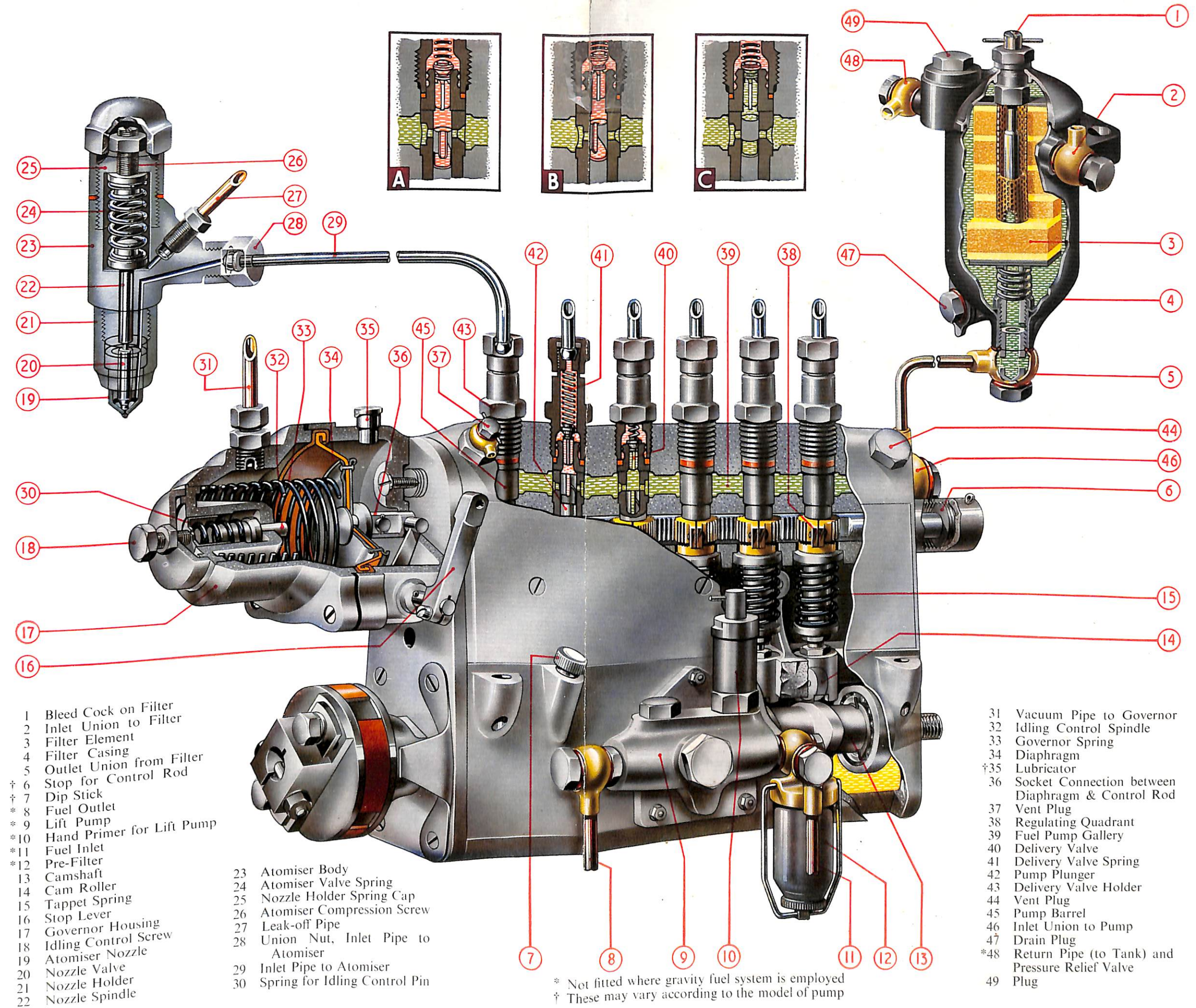
OF FUEL INJECTION EQUIPMENT



- 31 Vacuum Pipe to Governor
- 32 Idling Control Spindle
- 33 Governor Spring
- 34 Diaphragm
- 35 Lubricator
- 36 Socket Connection between Diaphragm & Control Rod
- 37 Vent Plug
- 38 Regulating Quadrant
- 39 Fuel Pump Gallery
- 40 Delivery Valve
- 41 Delivery Valve Spring
- 42 Pump Plunger
- 43 Delivery Valve Holder
- 44 Vent Plug
- 45 Pump Barrel
- 46 Inlet Union to Pump
- 47 Drain Plug
- *48 Return Pipe (to Tank) and Pressure Relief Valve
- 49 Plug

1 fitted where gravity fuel system is employed
 2 these may vary according to the model of pump

FIG. 20. GHOST DRAWING OF FUEL INJECTION EQUIPMENT



TIMING

General.

The timing or re-setting of the timing of a Perkins P4 and P6 engine can be simply and quickly carried out if the following instructions and data are borne in mind.

It is well to remember that the removal of the cylinder head does not in any way affect the timing

of the engine.

Timing Marks.

When the engine is timed at the factory certain arrow marks are stamped on the timing case and sprockets so that if for any reason the timing has to be broken (e.g. major overhaul), the engine can be easily reset to its original timing.

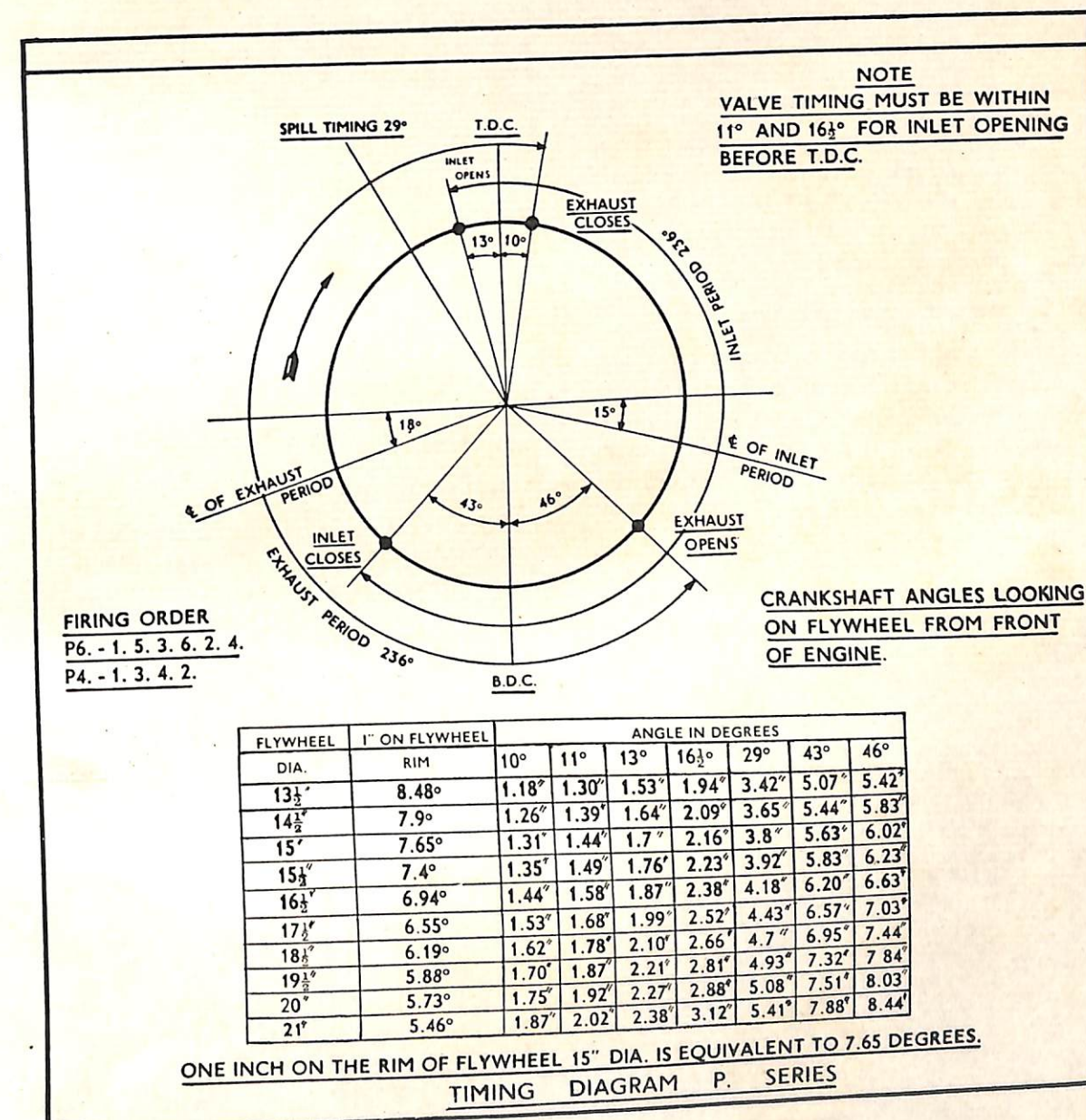


FIG. 21.

The method of marking is as follows:—

(a) **Camshaft Sprocket.**

With the timing chain in position and No. 1 piston at T.D.C. and No. 1 firing, an arrow is stamped on the outside edge of the camshaft sprocket. This arrow matches up with an arrow stamped on the timing case front face. An arrow is stamped on the inside of the camshaft sprocket which matches up with an arrow stamped on the camshaft hub. The purpose of these arrows is to show the original position of the camshaft sprocket in relation to the camshaft hub. This sprocket is adjustable for timing purposes as explained later.

(b) **Fuel Pump Drive Sprocket.**

With the engine and camshaft sprocket set as previously mentioned, an arrow is stamped on the fuel pump drive sprocket which matches up with an arrow stamped on the timing case front face.

(c) **Fuel Pump Coupling Marks.**

There are three different markings on the fuel pump coupling (See Fig. 22). The first is a scribed line stamped with the letter 'S' on the fuel pump half coupling which, when it coincides with another line on the preset plate, indicates the position of the pump when the engine is at T.D.C. firing on No. 1 cylinder.

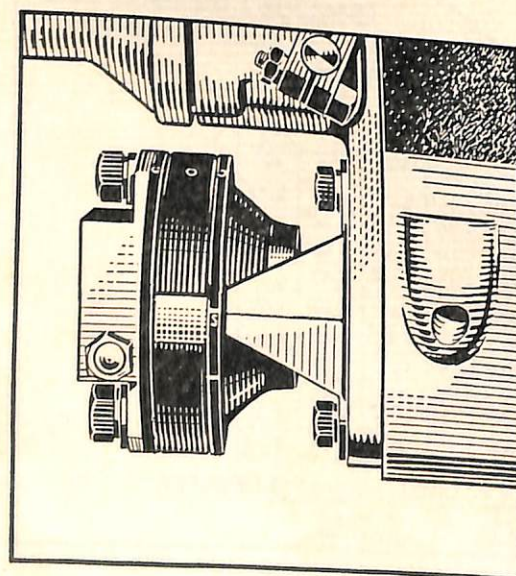


FIG. 22.

The alternate scribed line on the fuel pump half coupling denotes spill timing 29° B.T.D.C.

Certain engines have only one scribed line on the coupling (See Fig. 23) which represents the line marked with the letter 'S' as described above.

The third of the coupling marks is three noughts stamped on the fuel pump coupling; one of these noughts is on the driving flange, one on the intermediate fibre disc, and the third on the driven flange of the fuel injection pump. These three noughts should be in line across the coupling. Particular care should be taken that if the pump is removed to ensure that the three noughts are in line when the pump is replaced, otherwise the pump timing will be 180° out.

Camshaft Sprocket Adjustment—Section I.

Note the position of the sprocket in relation to the hub. If the open holes in the hub are $1\frac{1}{2}^\circ$ retarded to the corresponding holes in the sprocket as shown in Fig. 24, determine the amount of alteration the valve timing requires and proceed as follows.

All angular references are for crankshaft degrees.

(a) **To advance 3°**

Remove the three setscrews and replace them in the alternate set of tapped holes, thus moving the sprocket through $1\frac{1}{2}^\circ$ of camshaft angle.

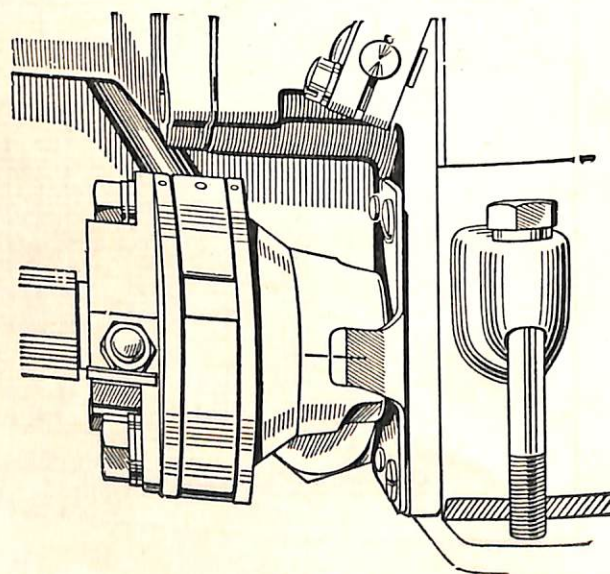
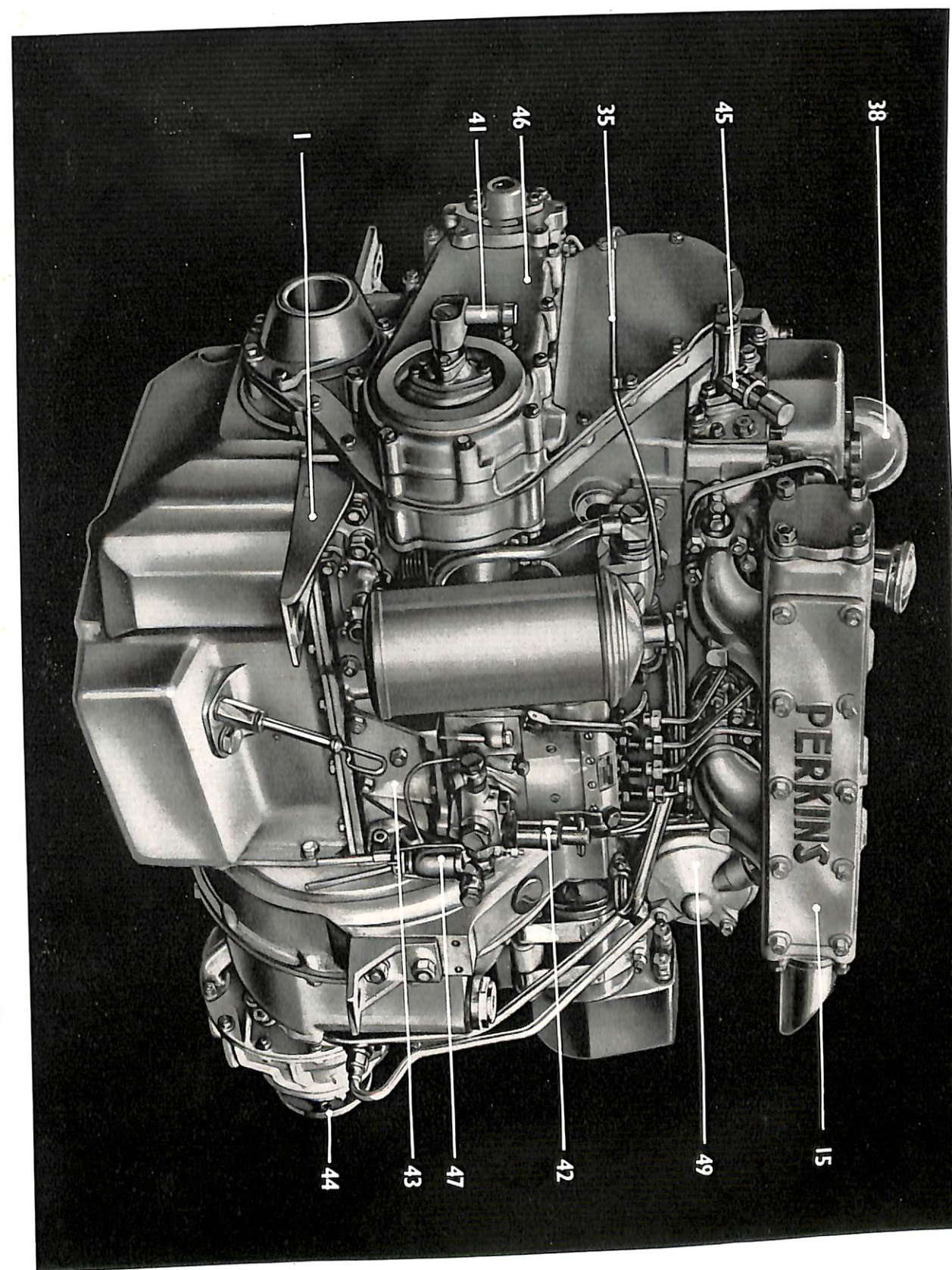
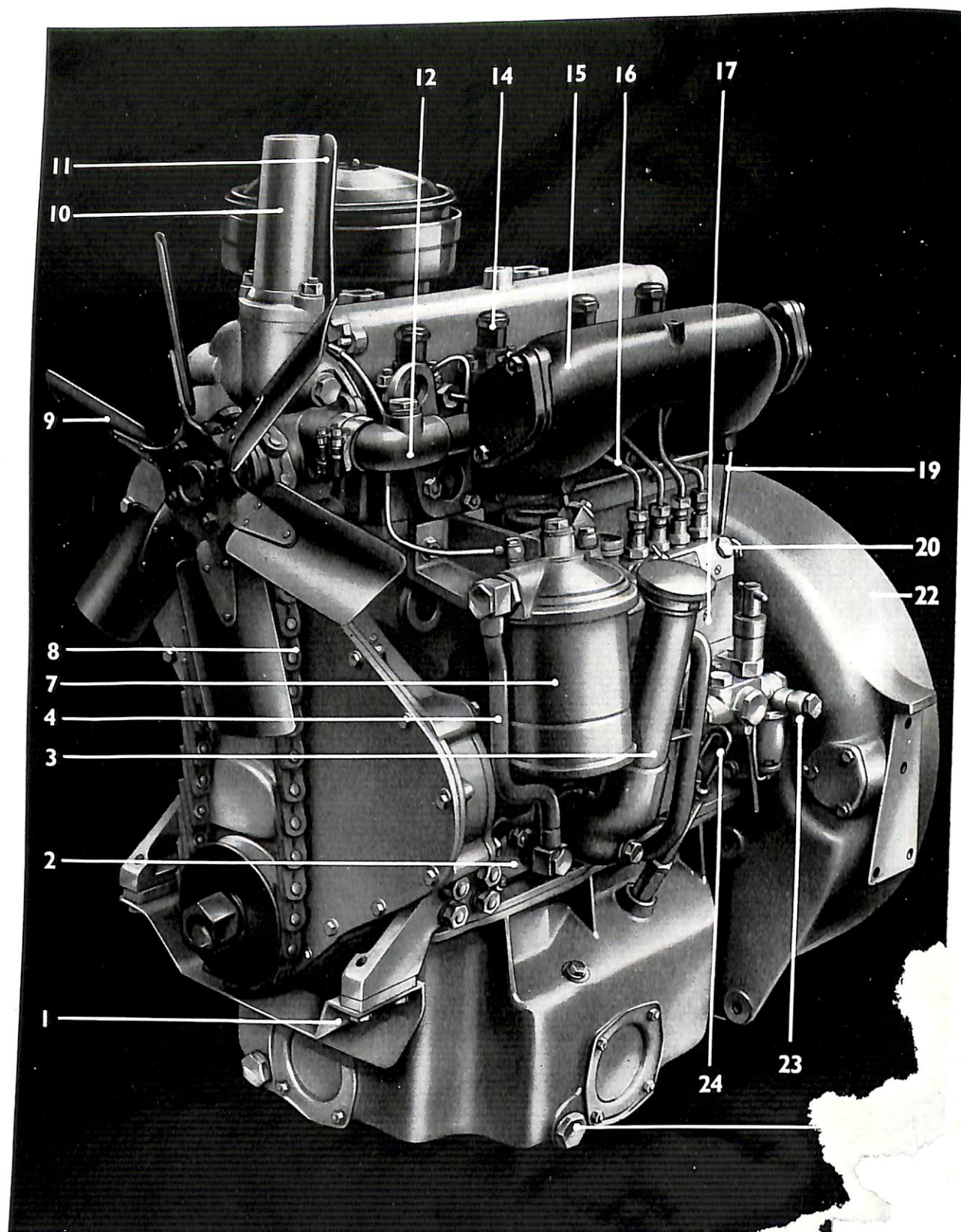


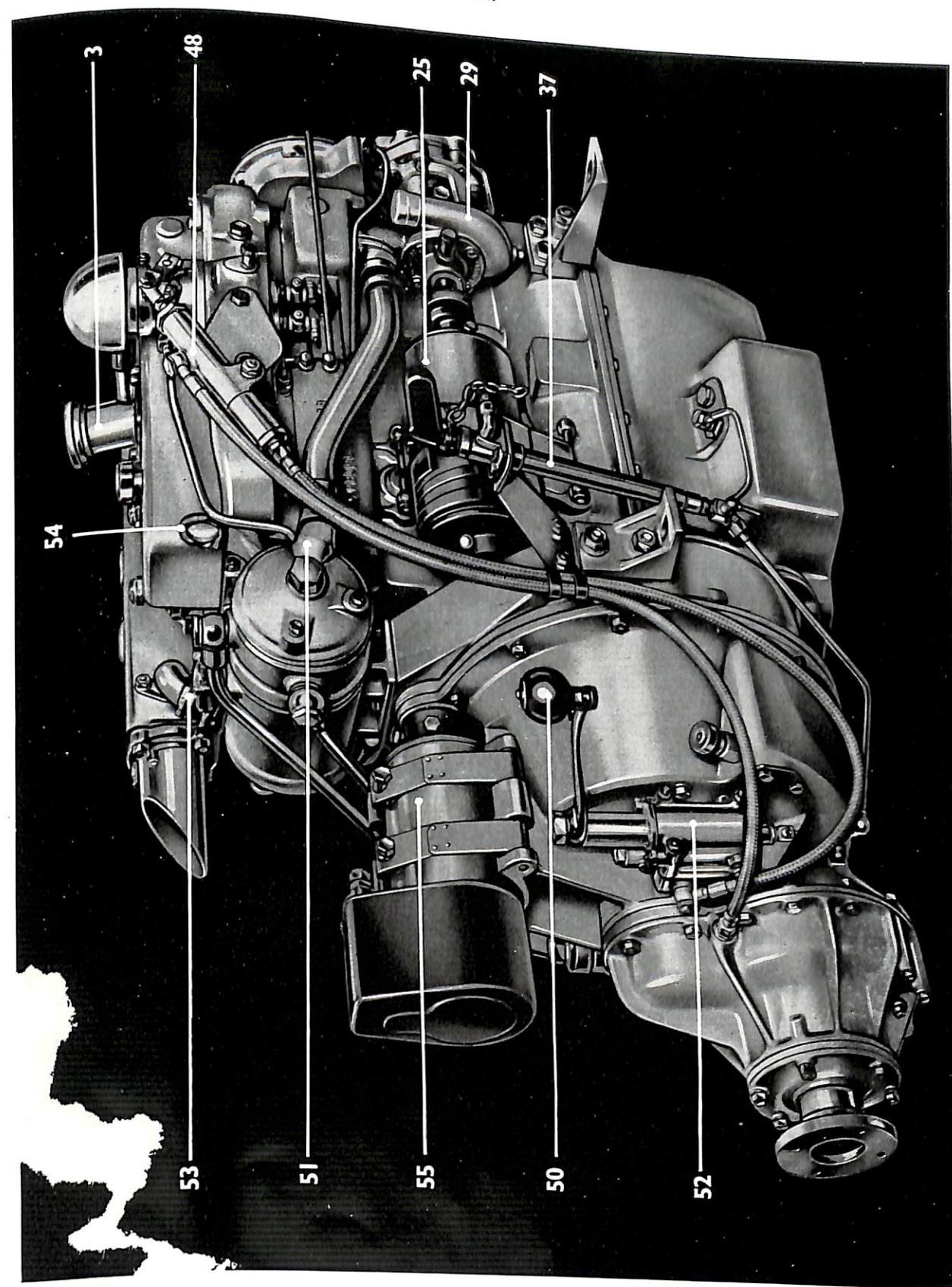
FIG. 23.

Port View of P4 Marine Engine with Hydraulically Operated Gearbox and Reverse Gears

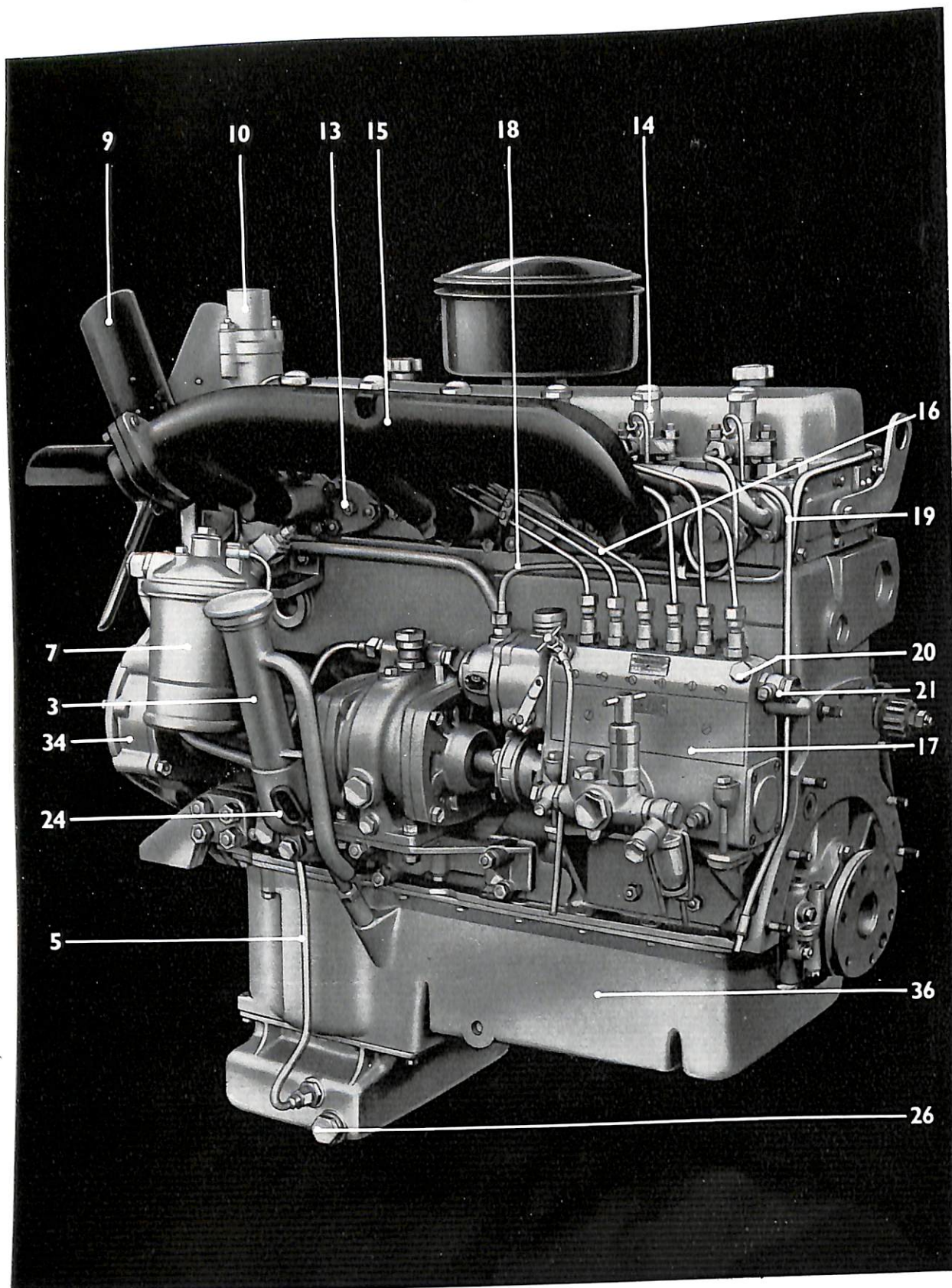




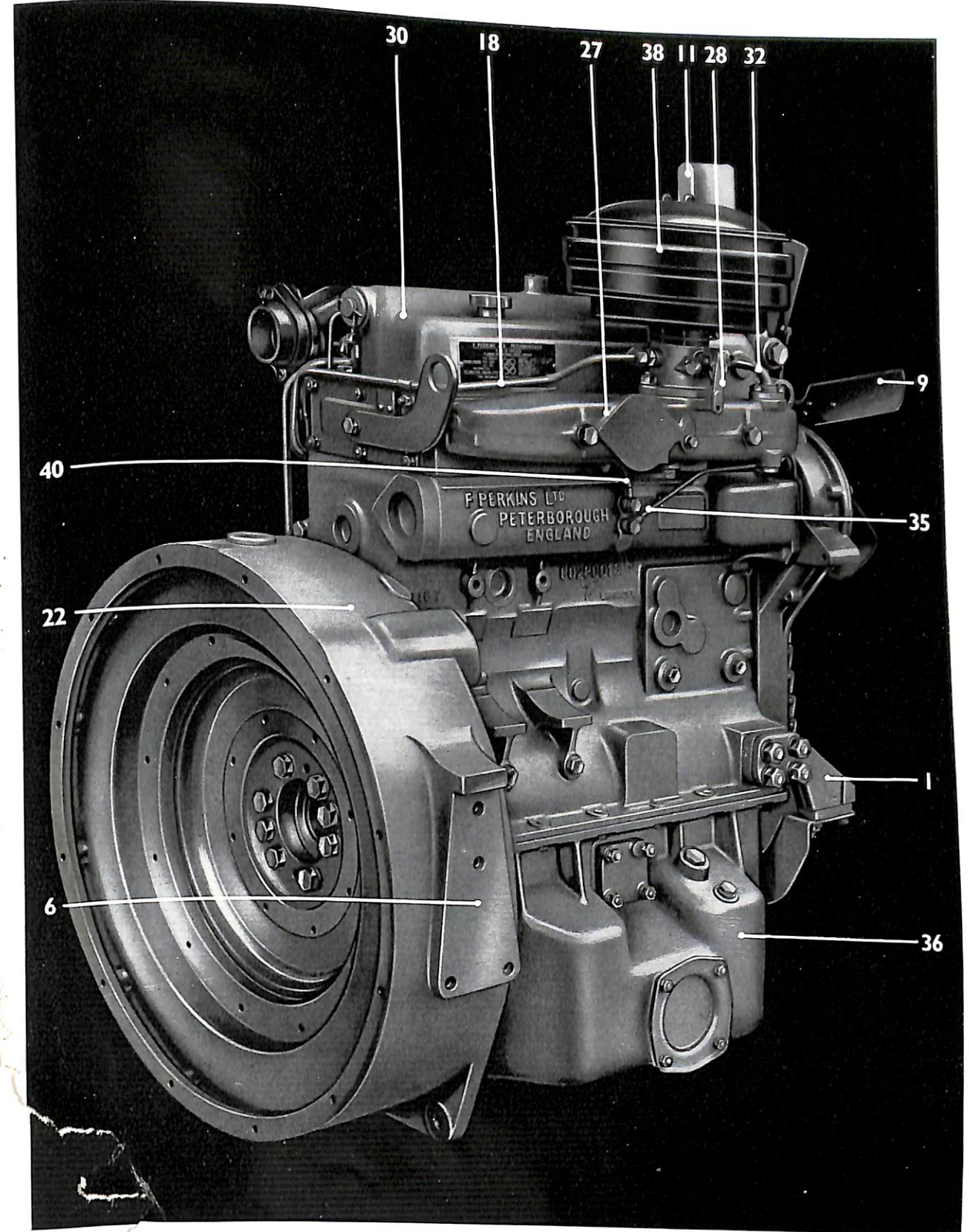
Near-Side View of P4 Industrial Engine (Bearer Mounted)



Starboard View of P4 Marine Engine with Hydraulically Operated Gearbox and Reverse Gears



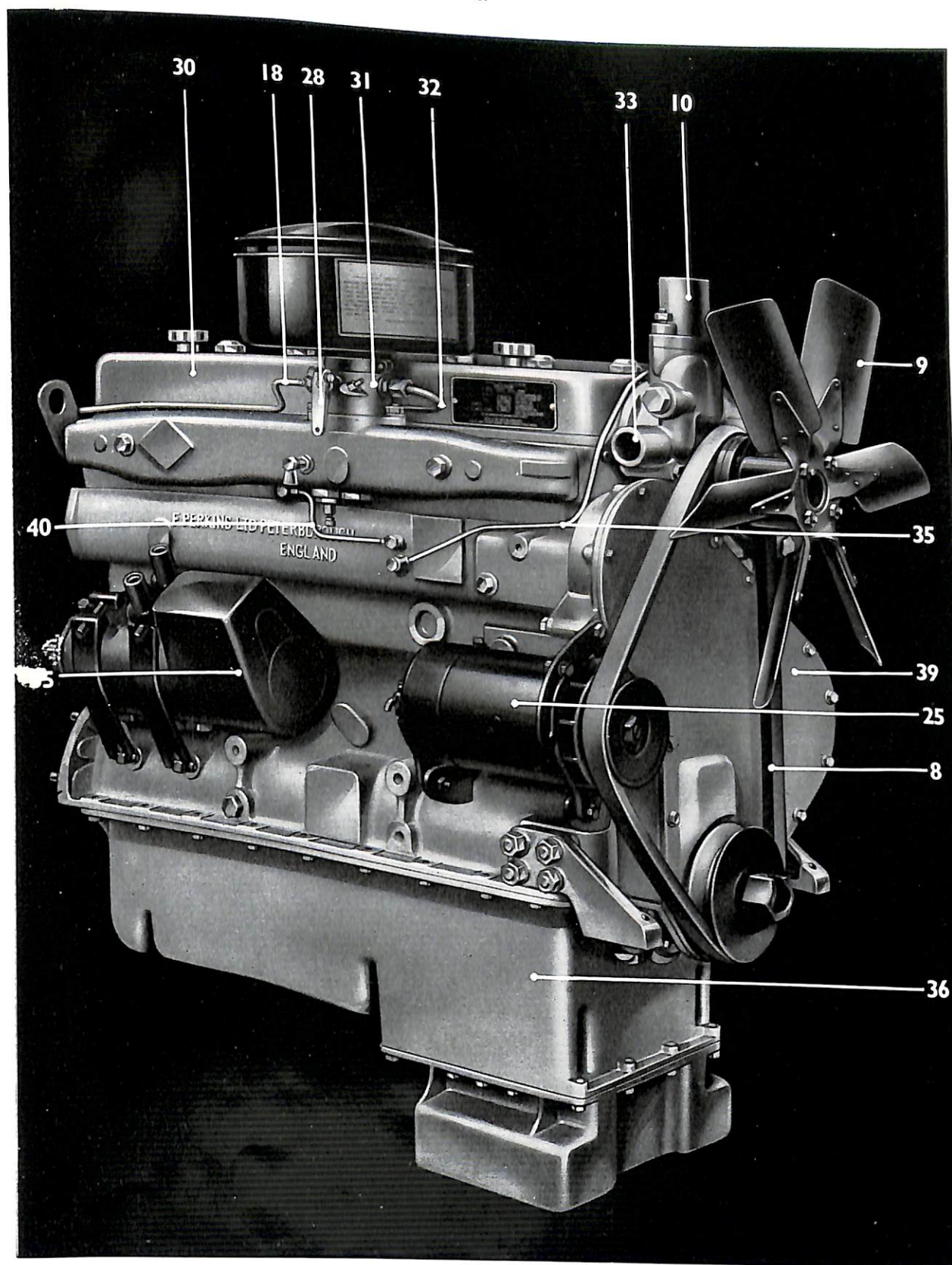
Near-Side View of P6 Vehicle Engine (Exhauster Type)



Off-Side View of P4 Industrial Engine (Bearer Mounted)

INDEX TO ENGINE PHOTOGRAPHS

- | | |
|---|---|
| 1. Front Engine Support | 29. Water Pump |
| 2. Oil Relief Valve Adaptor | 30. Cylinder Head Cover |
| 3. Oil Filler | 31. Venturi Inlet |
| 4. Main Oil Pipe from Adaptor to Filter | 32. Breather Pipe |
| 5. Oil Pipe, Exhauster to Sump | 33. Water Inlet from Radiator |
| 6. Facing for Rear Engine Support | 34. Timing Case |
| 7. Filter | 35. Oil Pipe to Camshaft Reducer |
| 8. Fan Belt | 36. Sump |
| 9. Fan | 37. Oil Sump Pump |
| 10. Water Outlet to Radiator | 38. Air Cleaner |
| 11. Decompressor Lever | 39. Timing Case Cover |
| 12. Water Manifold | 40. Oil Pipe from Camshaft Reducer to Cylinder Head |
| 13. Combustion Chamber Cap | 41. Tachometer Drive Connection |
| 14. Atomiser | 42. Hand Primer |
| 15. Exhaust Manifold | 43. Fuel Pump Bracket |
| 16. Pressure Pipes, Injection Pump to Atomisers | 44. Output Flange |
| 17. Fuel Injection Pump | 45. Water Outlet Connection |
| 18. Pipe from Venturi to Pneumatic Governor | 46. Water Pump Drive Cover |
| 19. Leak-off Pipe | 47. Pre-filter to Fuel Lift Pump |
| 20. Plug in Fuel Injection Pump | 48. Hydraulic Throttle Control |
| 21. Inlet Fuel Supply to Injection Pump | 49. Oil Cooler |
| 22. Clutch Housing | 50. Gear Change Lever |
| 23. Inlet Union for Fuel Oil | 51. Oil Cooler—Water Inlet Connection |
| 24. Dipstick | 52. Pre-selector Box |
| 25. Dynamo | 53. Oil Cooler—Water Outlet Connection |
| 26. Drain-plug in Sump | 54. Rear Lifting Eye |
| 27. Induction Manifold | 55. Starter Motor |
| 28. Butterfly Valve Lever | |



Off-Side View of P6 Vehicle Engine

PHOTOGRAPHS ENGINE

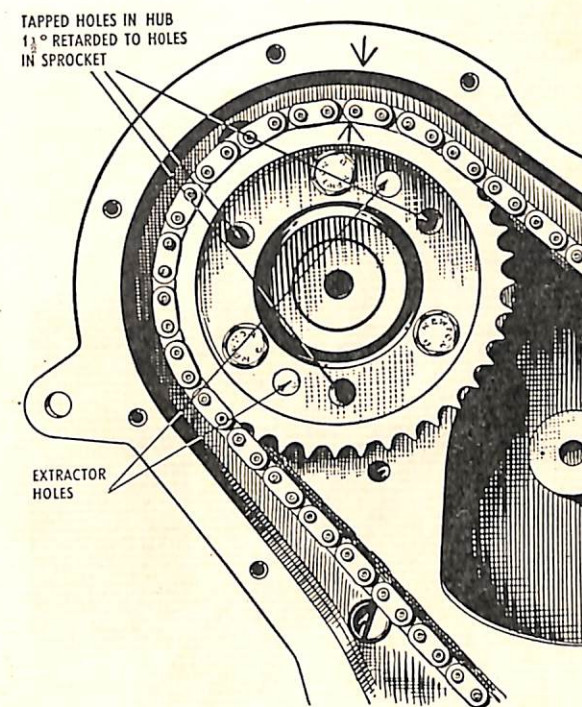


Fig. 24

(b) To advance 6°

Release the pawls in the automatic tensioner and push it as far to the left as it will go in order to release the tension on the chain. Wedge it there with a piece of wood.

Remove the setscrews and turn the sprocket one set of holes in a clockwise direction, at the same time slipping the chain back seven teeth. Place the setscrews back in the same set of tapped holes and tension the chain.

(c) To advance 9°

Proceed as in (b) but replace the setscrews in the alternate set of tapped holes.

(d) To advance 12°

Release the tension on the chain as already described.

Remove the setscrews and turn sprocket one set of holes in an anti-clockwise direction, at the same time slipping the chain forward six teeth. Place the setscrews back in the same set of tapped holes and tension the chain.

(e) To advance 15°

Proceed as in (d) above, but replace the setscrews in the alternate set of tapped holes.

Section II.

Should the relationship of the sprocket and hub show the open holes in the hub $1\frac{1}{2}^\circ$ advanced to those in the sprocket as shown in Fig. 25, proceed as follows.

(a) To advance 3°

Release the tension on the chain.

Remove the setscrews and turn the sprocket one set of holes in a clockwise direction, at the same time slipping the chain back seven teeth. Replace the setscrews in the alternate set of tapped holes and tension the chain.

(b) To advance 6°

Proceed as in (a), but place setscrews back in the original set of tapped holes.

(c) To advance 9°

Release the tension on the chain.

Remove the setscrews and turn the sprocket one set of holes in an anti-clockwise direction, at the same time slipping the chain forward six teeth. Replace the setscrews in the alternate set of tapped holes and tension the chain.

(d) To advance 12°

Proceed as in (c), but place setscrews back in the original set of tapped holes.

(e) To advance 15°

Advance the sprocket complete with the camshaft one tooth and replace setscrews in the alternate set of tapped holes.

Retarding the Timing.

It should be remembered that one tooth on the camshaft equals 18° on the flywheel.

Therefore to retard the timing, advance the timing 18° minus the degrees the engine requires retarding and retard the sprocket complete with camshaft one tooth, e.g.:

If it is required to retard the timing 12° , advance the timing 6° (18° minus 12°), and then retard the sprocket complete with camshaft one tooth.

NOTE. After making an adjustment as previously described, it is not possible to reset the valve timing using the arrow mark on the camshaft sprocket.

This should be erased when the timing is found to be correct, and restamped to coincide with the arrow mark on the timing case.

Fuel Pump Coupling Adjustment.

On the fuel pump coupling there are ten graduations, that is five graduations on either side of the neutral line. This provides a fine adjustment to obtain a perfect injection timing point; also the pump can be advanced or retarded easily should the necessity arise later. One graduation is equal to approximately 1 in. on the flywheel. If it is desired to advance or retard the injection, the two setscrews securing the graduation plate and the driving flange of the coupling should be loosened and the necessary adjustment made. Care should be taken to see that these setscrews are tightened when the adjustment has been made.

When an engine comes off the test bed at the factory a line is scribed right across the coupling to indicate the original position of the coupling.

To Reset Engine to Original Timing.

Remove rocker assembly and atomisers.

Release the pawls in the automatic tensioner and push it as far to the left as it will go, wedge it in that position with a piece of wood.

Bring No. 1 piston to T.D.C.

Turn the fuel pump drive until the arrow mark on the sprocket is in line with the arrow on the timing case. The scribed line on the fuel pump coupling marked with the letter 'S' should coincide with the line on the preset plate.

Turn camshaft until the arrow on the sprocket is in line with the arrow on the timing case.

Fit timing chain (it is advisable to wait until the valve and fuel pump timing have been checked before finally rivetting the chain).

Remove wedge from the automatic tensioner.

With the chain in its tension position, check the timing to ensure the arrows are in line at T.D.C. firing No. 1 cylinder.

Replace rocker shaft and adjust tappets to .012 in.

Replace atomisers.

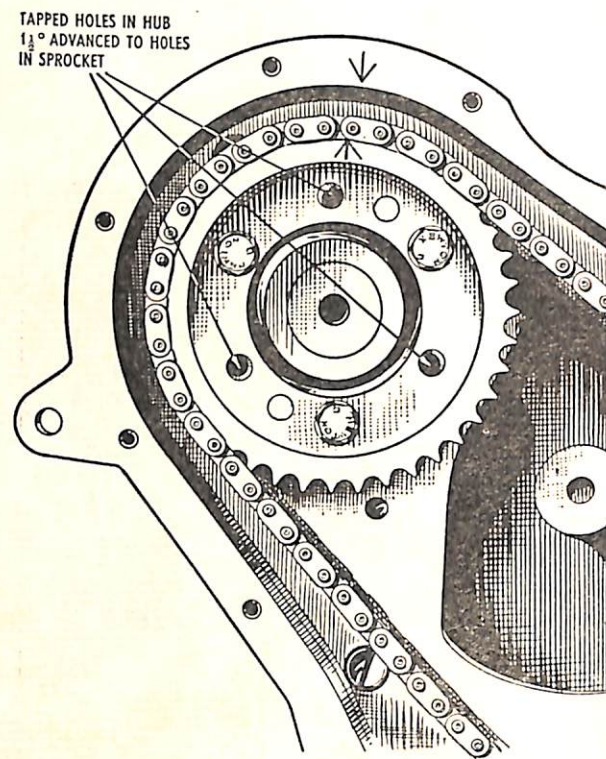


Fig. 25

Tappets should be adjusted to .010 in. with the engine warm.

Revising the Timing.

If it is necessary to revise the timing, proceed as follows.

Ensure that all old timing marks have been removed.

Remove rocker assembly and atomisers.

Release pawls in the automatic tensioner and push it as far to the left as it will go, wedge it there with a piece of wood.

Bring No. 1 piston to T.D.C. That T.D.C. on No. 1 piston has been obtained can be checked by examining the flywheel or the crankshaft at the front end where the key for the fanbelt pulley should be at the top of its periphery.

Turn camshaft until equal lift is obtained on the tappets of No. 6 cylinder.

In the case of a 4-cylinder engine, refer to No. 4 cylinder.

With the three noughts on the fuel pump coupling

in line, turn the fuel pump drive sprocket until the scribed line marked with the letter 'S' on the fuel pump coupling is in line with that on the preset plate.

Fit the timing chain (do not rivet it until final timing check has been made).

Remove wedge from automatic tensioner to tension the chain.

With No. 1 piston at T.D.C. on its compression stroke, the fuel pump coupling should now be adjusted if necessary to bring the scribed line marked with the letter 'S' on the coupling in line with that on the preset plate.

When the timing has been checked and found to be correct, rivet the chain and mark the camshaft and fuel pump drive sprockets and timing case with arrows to indicate camshaft and fuel pump positions with the engine at T.D.C. No. 1 piston on its compression stroke.

Fit rocker assembly and atomisers and adjust tappets to .010 in. with engine warm.

Check the timing as follows.

(a) Valve Timing.

Turn the engine in the normal direction of rotation until the inlet tappet on No. 1 cylinder just tightens.

When this is done with the engine cold, a .002 in. feeler should be placed between tappet and rocker to ensure that the timing is checked at a tappet clearance (.010 in.) corresponding to that which it will obtain under running conditions. Alternatively set the inlet tappet of No. 1 cylinder at .010 in. resetting to .012 in. after checking the timing. This is the point at which the inlet valve just begins to open and for good valve timing this should be 13° B.T.D.C. (See Fig. 21).

The number of degrees to an inch varies according to the flywheel size and the table of flywheel dimensions should be referred to. Valve timing

must be between 11° and 16½° for inlet opening B.T.D.C. If the timing is not within these limits, the necessary adjustments should be made on the camshaft sprocket as already described.

(b) Injection Timing.

To check the fuel pump timing, proceed as follows.

Remove No. 1 fuel injection pipe.

Feed fuel to fuel gallery of the fuel pump. The best method is by gravity feed tank with a pipe coupled to the fuel gallery.

Open the bleed screw on the fuel pump and allow the fuel to flow until it comes through free from air bubbles and then tighten the bleed screw.

Wipe all surplus fuel oil away from the open end of the delivery valve holder slowly until fuel just begins to well-up in the delivery valve holder. At this point stop turning the engine. This is the approximate point of port closure which should be 29° B.T.D.C. On a 14½ in. diameter flywheel this will be 3.74 ins. B.T.D.C.

Make any necessary adjustments to the fuel pump sprocket (one tooth equals 18°), or on the fuel pump coupling; one graduation on this coupling is approximately 1 in. on the flywheel.

When the timing is found to be correct, disconnect gravity feed tank and replace No. 1 fuel injection pipe.

Rivet the timing chain.

Bring the engine to T.D.C. No. 1 piston at the top of its compression stroke. Mark the camshaft and fuel pump drive sprockets and the timing case with arrows to indicate camshaft and fuel pump position with the engine at T.D.C. No. 1 piston on its compression stroke.

Final adjustments on the fuel pump coupling to find the perfect injection point can be made after testing the engine. This injection point may vary slightly with each individual engine.

CYLINDER HEAD MAINTENANCE



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

The Diesel engine rarely, if ever, needs the periodical decarbonising that is accepted as a matter of course with the petrol engine, insofar that in an engine operating on the Diesel cycle, carbon beyond a superficial coating does not form and accumulate in the combustion chamber and on the pistons as in the case with the petrol engine.

Owing to its higher thermal efficiency, the valves of the Diesel engine are also much more free from trouble due to overheating; that is, of course, providing the engine is reasonably maintained.

After a period, depending upon the conditions under which the engine is operated, the valves may need attention. This will become apparent by loss of compression. This is a matter of greater importance in a Diesel engine than it is in a petrol engine, so that when there is a loss of compression a top overhaul is necessary. Proceed as follows:—

PREPARATION.

Begin by assembling all the joints and other parts required, as called for in the Perkins spare parts list.

Drain all water from the cylinder head and jackets. The drain cock may be on either side of the engine.

Disconnect the exhaust pipe from the engine exhaust manifold. Uncouple external connections to cylinder head.

Cylinder Head. To remove.

- Remove the air cleaner.
- Take off cylinder head cover.
- Uncouple unions on oil pipe to rocker shaft.
- Take away nuts holding rocker shaft assembly.
- Lift off rocker shaft assembly, bringing above-named oil pipe with it.
- Remove leak-off pipes from atomisers.
- Remove pressure pipes to atomisers.
- Remove atomisers.
- Release clip holding lower end of main leak-off pipe.
- Take away leak-off pipe.

Remove the pipe between the venturi and the pneumatic governor on the fuel pump. There is a clip holding this pipe, secured by one of the

nuts at the rear end of the cylinder head. Replace this nut after freeing the clip.

Remove the pipe connecting the camshaft reducer to lubricating oil filter head.

Take off cylinder head nuts and then cylinder head complete with manifolds, venturi, etc.

To remove Valves.

Place the cylinder head with the machined face downwards on the bench. Depress the spring cap and springs by means of a valve lifter and remove the two half conical cotters. Remove the spring caps and springs, thus liberating the valve which can be taken out when the cylinder head is turned upside down.

Grinding Valves.

The valves and valve seats should be re-conditioned in the orthodox way using grinding compound or by means of specialised equipment.

The valve seat is recessed into the cylinder head and a groove is cut where the proper valve seat ends in the mitred recess in the head.

When valves have been re-conditioned several times it is possible that the valve may become masked by sinking too low in the head, and in these circumstances, the groove referred to should be re-cut accordingly.

EXAMINATION.

Examine all parts for wear, bearing in mind the following points:—

Valve Springs.

Valve springs deteriorate because of the fatigue resulting from the combined effect of heat and the normal working of the spring. After a period the spring becomes weaker and is then prone to fail. This, of course, applies to all types of engines.

A new set of springs should be fitted whenever the engine undergoes a major overhaul.

Rocker Levers and Bushes.

Wash the rocker shaft assembly thoroughly in paraffin.

Examine the rocker shaft bushes for wear. The rockers should be an easy fit on the shaft without excessive side play.

If as a result of inadequate lubrication, any rocker bushes have seized on the rocker shaft.

the rockers will have worked loose on the bushes. Each rocker should be examined for this fault. Whenever it is present new rockers and/or bushes should be fitted.

When dismantling rocker shaft assemblies make careful note of the order of assembly of the various parts, supports, distance pieces, springs and rockers, so that re-assembly may be facilitated and that left and right-hand rockers are correctly placed and come opposite their respective tappets and valves.

Valves and Guides. Valve Seatings.

There will be little wear of the valve stems or their guides provided that the lubrication of these parts has always been adequate.

The extra wear of the exhaust valves, associated with the petrol engine does not occur in the Diesel engine because the latter is cooler in operation.

Examine the valves for cracks. Check wear of valve stems and their fit in guides. If the stems are worn, fit new valves.

Number all new valves to correspond with the numbering of the old valves.

When fitting new valves take care that the clearance between the valve head and cylinder head bottom face is not less than .070 in. Check this by putting a straight edge across the face of the cylinder head bottom face and measuring the distance between the straight edge and the top of the valve.

Do not forget that the efficiency of operation of the Diesel engine depends largely on the maintenance of good compression. Contact between valves and seatings must therefore be the best possible.

When grinding in valves make certain that no signs of pitting are left on the seating. Valves should be ground in until a continuous "high mark" is present the full way round the seating, both on the valve and on the valve seating in the head.

Care should be taken to avoid unnecessary grinding away of the seat.

The maximum clearance between the valve head and cylinder head bottom face should not exceed .140 in.

VALVE GUIDES.

Examine the valve guides for wear, if necessary replace with new guides.

Clean the new guides, removing any burrs.

Smear the outer surface with clean oil, and

using a suitable press, drive home hard up to the collar.

The guides are made of cast iron and are therefore comparatively brittle. Care should be exercised as the collar approaches the cylinder head.

Tappets.

The tappets slide in holes bored in the cylinder head. The wear, under normal conditions, is negligible.

The running clearance between the top of the tappet and the rocker should be .010 in. when the engine is hot.

When adjusting this clearance, tighten tappet lock nut effectively, so that it does not slacken in service.

CYLINDER HEADS.

Wash out and thoroughly clean the water passages in the head, subsequently drying out and finally cleaning with compressed air.

If the water jacket of the cylinder head shows signs of excessive scale, a proprietary brand of descaling solution should be used.

Combustion Chamber Joints.

It is not as a rule necessary to remove the covers of the combustion chambers during top overhaul, as carbon rarely forms in these chambers.

If for any reason these covers are removed, new copper gaskets should be fitted when they are replaced.

If new copper gaskets are not available, the old ones may be used provided that they are softened before being re-fitted.

To soften these copper gaskets, heat them to a dull red heat and quench in cold water.

Again having in mind the importance of good compression for efficient operation of Diesel engines, special care is necessary when refitting these covers to ensure that there are no leakages at the joints.

Re-Assembly Cylinder Head.

Replace valves, collars and cotters taking care that the collars and valves are of the correct type.

Place combustion chamber cap gaskets in position and fit the caps.

Lightly smear water manifold inlet joints and joint for water pump with jointing compound.

Re-fit water manifold and water pump. Similarly, fit exhaust manifold, gaskets and exhaust manifold, then inlet manifold.

Replacing Cylinder Heads.

Before replacing the cylinder head, it is extremely important to ensure that the faces of the cylinder block and cylinder head are perfectly clean. It is recommended that a new gasket should be used.

When replacing the gasket take care that it is of the correct width, and fits the head, also that it is placed correctly. The gasket is marked to indicate how it should be replaced.

Cover both sides of the gasket, with a thin coating of good jointing compound.

When the under face of the cylinder head is perfectly clean, the head may be lowered into position on its studs and the nuts tightened down in the order shown in Fig. 26. The cylinder head nuts should be pulled down to the recommended torque (see page 8).

Replace the atomisers (see page 33).

The rocker shafts can now be replaced and the tappets should be adjusted to approximately .012 in.

Thoroughly clean the oil feed pipes to the rocker shaft and blow clean air through them.

Examine the unions to see that they are in good condition.

Replace these pipes, taking care to screw the unions up tightly.

Replace the hose connections to the water pump, the pipe between the venturi and the pneumatic governor, leak-off gallery, pipes, etc.

NOTE.—For fitting of fuel pipes see page 33.

STARTING THE ENGINE.

Proceed as instructed on page 10.

After warming up, the engine should be stopped and the rocker shafts removed when the cylinder head can again be tightened down, the nuts being tightened in the order shown in Fig. 26.

Re-fit the rocker shafts and re-set the tappets.

After warming up, the tappets should be finally set with clearance of .010 in. The cylinder head cover can now be replaced.

A new joint should be fitted and care should be taken to see that it is correctly placed, otherwise oil may leak away in considerable quantity, enough to starve the engine of oil if left unchecked

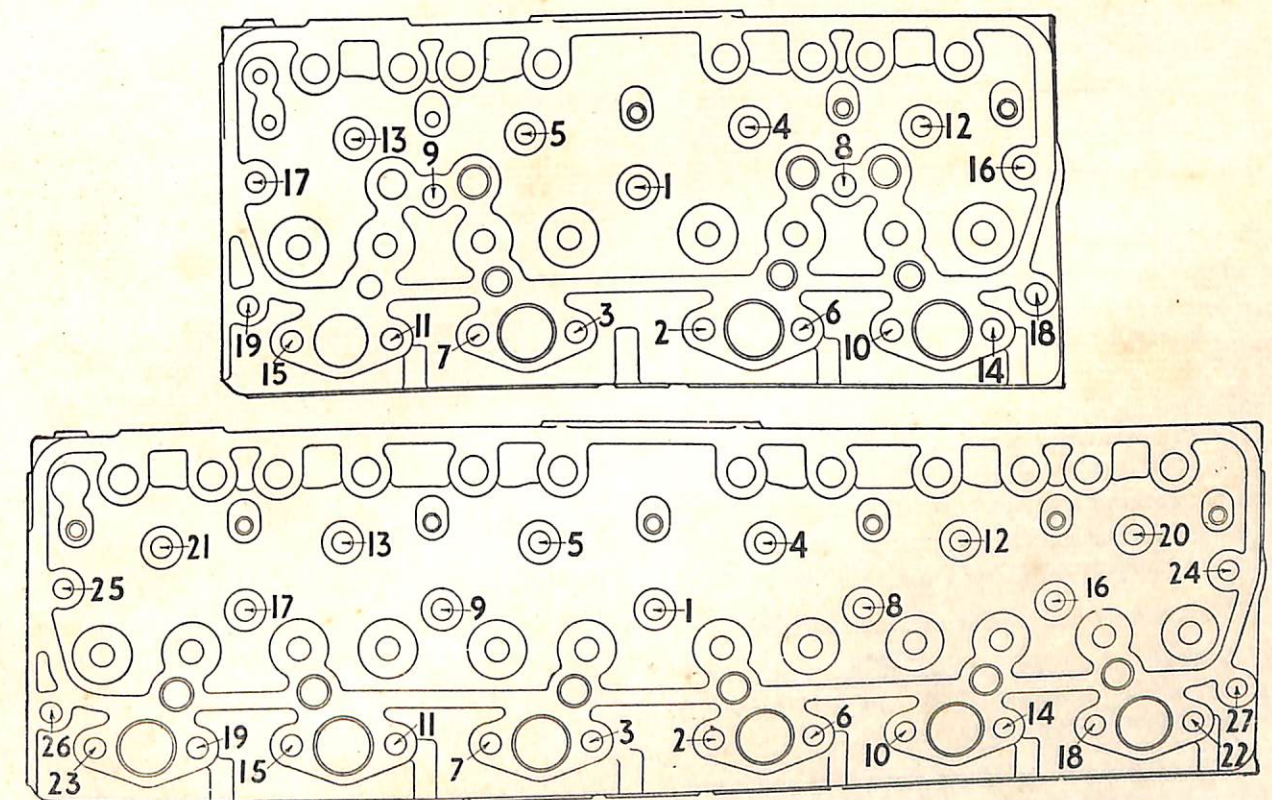


FIG. 26. Diagram showing order in which cylinder head nuts must be tightened. The upper figure is for the P4 engine; the lower one P6 engine.

SERVICING THE WATER PUMP

This Section has been issued for the guidance of Overseas Operators and Traders who are unable to take advantage of the Exchange Scheme operated by Messrs. F. Perkins Limited in Gt. Britain. It should be noted, however, that certain overseas countries are covered by Exchange Schemes operated by local companies assisted by F. Perkins Ltd., and enquiries should be made regarding such schemes before an operator starts servicing his own units.

REMOVAL OF THE WATER PUMP FROM ENGINE.

On some applications the water pump can be removed without interfering with the radiator, but on certain types the radiator must be removed.

Remove the fan, fan belt and water inlet and outlet pipe. Remove three $\frac{1}{4}$ in. Whit. setscrews from the rear of mounting plate, and slacken the clip securing the water manifold to the water pump.

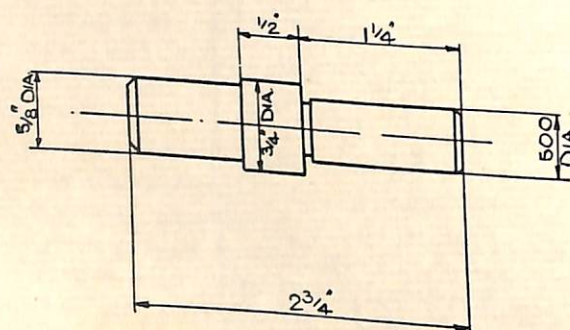


FIG. 27.

Finally remove the three $\frac{3}{8}$ in. Whit. setscrews, one on the left looking at the engine from the front can be removed completely but the remaining two must be slacked and left in position as the water pump is pulled away from the cylinder head.

It is not necessary to remove any other parts.

Remove circlip and cover plate from front pulley cover. Remove circlip and bakelite drive member from pump shaft.

With a suitable bar press the pump shaft out from the pump body complete with impellor, distance piece, spring, driving tube, and water

pump seal. Detach the pulley cover from the pulley by removing the four $\frac{5}{16}$ in. Whit. setscrews, also the felt seal and seal retainer. Remove circlip from the pulley support and press off the pulley using a suitable mandrel.

Finally remove the pulley support from the body and press out the carbon seal.

The ball and roller race can be removed if required for inspection by pressing out, using a suitable mandrel.

INSPECTION.

Inspect the pump shaft for wear and check the pulley support bushes, see page 70 for the bushes and shaft sizes as new.

If the bushes are worn remove and press new bushes in, using tool as shown (Fig. 27). By the use of this tool a true and free running fit is ensured for the pump shaft.

Carefully inspect the driving tube slots and corners of the impellor blades for wear. Inspect the spring for corrosion, tension and twisting.

If the ball or roller race require replacing always ensure that the ball race is pressed in first followed by the large and small distance piece and finally the roller race.

It is advisable that the carbon thrust pad and water pump seal should be scrapped, as it is difficult to maintain a water-tight seal after disturbing.

ASSEMBLING.

Part I.

Place on the threaded end of the pump shaft in the following sequence: Brass distance piece, shims, as required, impellor, tab washer and locking nut. Tighten locking nut and bend over tab washer. Slide on the plain end-spring, driving tube, and water pump seal. The driving tube slots must fit into the impellor blades and the arms into the grooves of the water pump seal.

Ensure that the small end of the water pump seal is nearest to the driving tube.

It is advisable to lap the face of the water pump seal before fitting.

Part II.

With a suitable jointing compound on the outer edge of the carbon thrust pad, place it on the outside aperture of the pump body, place the pulley support on the studs and tighten down evenly. With the carbon thrust pad now in position inspect for an even fit, fractures, and ensure there is no jointing compound on the face.

Press the pulley on to the pulley support and secure with a circlip. It is advisable to grease the ball and roller bearings with high melting point grease before pressing the pulley on to the pulley support.

Place the seal retainer, felt seal, and front pulley cover in position and tighten down.

Wire the four $\frac{5}{16}$ in. Whit. setscrews.

NOTE. There are two types of front pulley covers, one for a four bladed fan, the other a six bladed fan; these are interchangeable.

Part III.

Fit the plain end of the pump shaft through the carbon thrust pad and pulley support, securing in position with the bakelite driving member and small circlip.

Lightly tap the plain end of the pump shaft to test for end float. The end float is adjusted by removing or adding shims on to the threaded end of the pump shaft.

The maximum amount of end float is .030 in. This is measured between the small circlip and the bakelite driving member.

WARNING.

If the circlip on the pump shaft is tight against the driving member it will have a tendency to spring off, which will obviously cause the pump shaft and impellor to slide back, causing the water pump to cease functioning.

Finally replace cover plate and circlip into the front pulley cover.

Lubricate the two nipples in the front pulley cover.

The water pump can be checked for water leaks under running conditions.

Fig. 28 shows the pump in cross section.

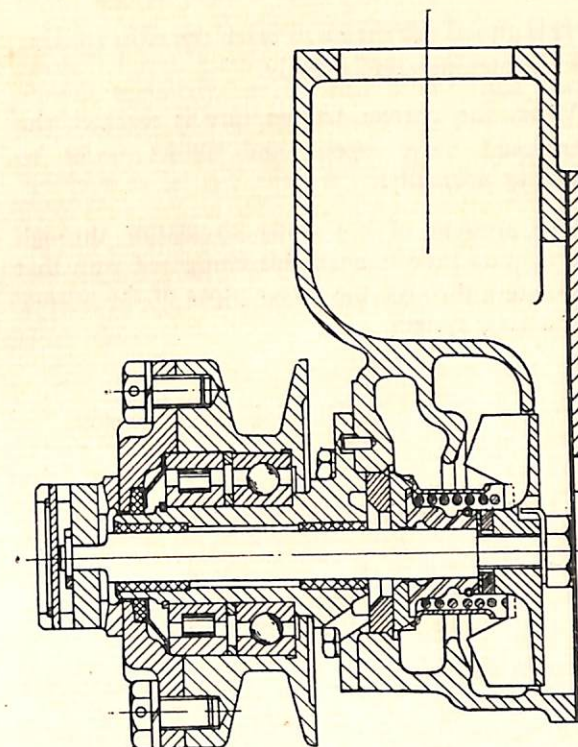


FIG. 28.

AUTOMATIC TEMPERATURE CONTROL

For controlling the water circulation on P6 and P4 engines the water pump body has been modified to receive a thermostat. The working parts remain the same but the body modification consists of:—

- Larger water outlet to radiator to allow for fitting of a thermostat.
- Internal by-pass tube.
- Two tapped bosses, one $\frac{3}{8}$ in. B.S.P. for the thermometer connection, the other $\frac{1}{2}$ in. B.S.P. for the return pipe connection from cab heater.

The method of removing the old pump and the fitting of the new pump is the same as described on Page 48.

For a. b. c. (See Fig. 29).

THERMOSTAT OPERATION

When cold, the thermostat closes a valve and restricts the flow of water into the radiator, therefore the water must flow through the by-pass tube so as to allow the water to circulate without passing through the radiator.

This allows the engine to reach the most efficient working temperature quickly.

When the correct temperature is reached, the thermostat valve opens and allows water to circulate normally.

The amount of hot water circulating through the by-pass tube is negligible compared with that circulating through the larger pipes of the normal circulating system.

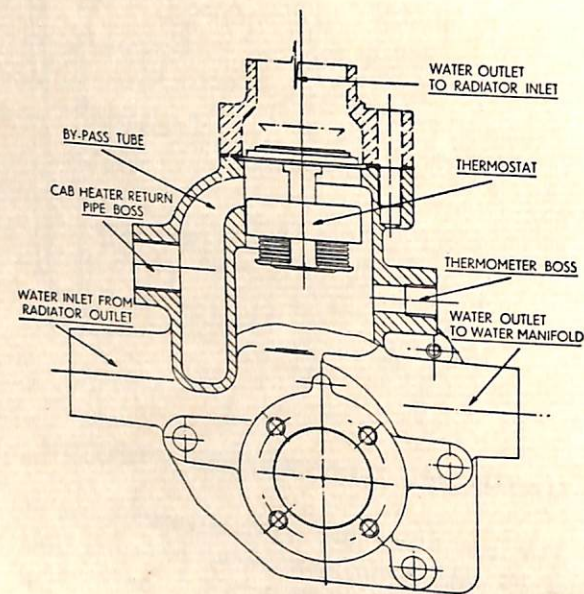


FIG. 29.

SPECIAL FROST PRECAUTIONS

When the engine is started from cold, there is no circulation of water through the radiator while the thermostat valve is closed. The fan is drawing cold air through the radiator therefore the water in the radiator can easily freeze before the thermostat valve opens and allows the water to circulate normally.

Under these conditions the radiator should be masked until the correct temperature is reached, and the water is circulating through the entire system.

CAB HEATER

If a cab heater is required, the water manifold is provided with a connection to allow for the installing of the outlet pipe to the cab heater.

A modified water pump complete with thermostat as explained is necessary for the efficient working of the heater equipment.

The return pipe from the cab heater is connected to the tapped $\frac{1}{2}$ in. B.S.P. boss on the water pump body.

The outlet pipe to the cab heater is connected to the tapped $\frac{1}{2}$ in. B.S.P. boss on the water manifold elbow.

Both the boss on the water pump and manifold are plugged, the conversion parts for cab heater being supplied by the vehicle manufacturer.

THERMOSTAT CONTROL TO THERMO-SYPHON SYSTEM

If the thermostatic controlled water system is not required, remove the thermostat and fit sleeve (Pt. No. 0900043), this cuts off the water supply to the by-pass tube.

Note. Engines not requiring a thermostat, but manufactured with the thermostat type water pump, are fitted with a sleeve (Pt. No. 0900043) described above.

THE HIGH CAPACITY WATER PUMP

An improved impellor has been incorporated in the Mk. III water pump to increase the flow rate of water, without altering the basic design of the water pump.

The new type impellor consists of six blades on both the front and the rear faces of the centre plate (see fig. 30) as against the four blades on the front face of the centre plate, as on the previous type impellor (see fig. 31).

The advantages of the double six bladed impellor are :—

- The flow rate into the water jacket of the engine is increased.
- The water outlet is now impellor assisted thermo-syphon.

Previously the flow of water depended on the four bladed impellor driving the coolant into the water jacket and a thermo-syphon outlet.

Water Pump Mounting Back Plate.

To assist the efficiency of the rear blades on the impellor, it has been found necessary to reduce the hole in the back plate to $1\frac{1}{4}$ inches and the setscrews above this hole have been replaced by countersunk screws (see fig. 33).

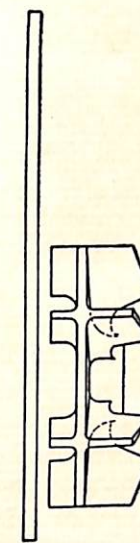


FIG. 30.



FIG. 31.

Interchangeability.

To replace existing impellor and backplate it is necessary to remove the cylinder head and water pump.

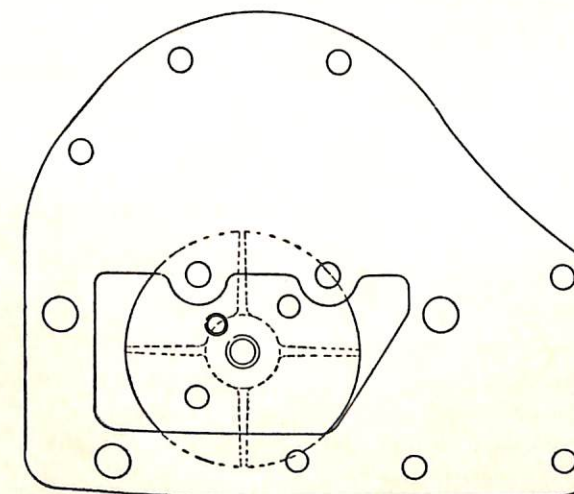


FIG. 32.

Replacing the Back Plate.

Remove back plate Pt. No. 0940245 (see fig. 32), from the cylinder head and replace with back plate Pt. No. 0940271 (see fig. 33), bearing in mind the information given in the previous paragraph, regarding the screws.

It is advisable to clean the front of the cylinder head and use a new joint, lightly smeared with jointing compound at the rear of the back plate, before tightening the plate in position.

Assembling the Six Bladed Impellor and Driving Tube.

Remove the circlip and cover plate from the front pulley cover of the water pump. Remove the circlip and bakelite drive member from the pump shaft.

With a suitable bar, press the pump shaft out from the pump body complete with impellor, distance piece, spring, driving tube, and water pump seal.

Unlock the tab washer and unscrew the locking nut, remove the four bladed impellor and driving tube.

Place in position the new driving tube Pt. No. 0900058, then the six bladed impellor, lock in position with the securing nut and tab washer.

Ensure that the six slots in the driving tube are resting correctly on the blades of the impellor, also that the arms of the driving tube fit into the grooves of the water pump seal.

Assemble the pump shaft to the pump body and secure with the bakelite drive member and circlip. Finally replace the cover plate and circlip.

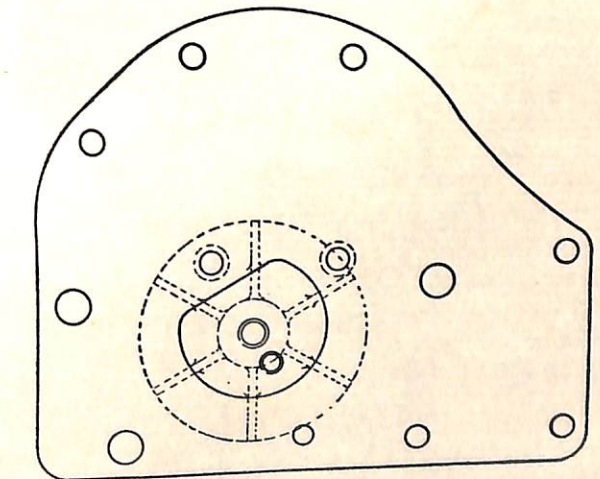


FIG. 33.

FAN & DYNAMO BELT ADJUSTMENT

Incorrect adjustment of the fan and dynamo belt can result in the fraying of the belt and eventual failure. To ensure the belt is correctly adjusted it should be checked every 50 hours or 1,000 miles. Tight adjustment will tend to overload the bearings in the dynamo and water pump which consequently may result in damage to these components. If the adjustment is too slack, belt slip will occur. This could result in overheating of the engine due to the reduced efficiency of the water pump and the inability of the fan to draw cool air through the radiator.

The output of the dynamo would also be considerably reduced.

Method of Checking Correct Adjustment.

Press the fan belt with the thumb at the centre point between the water pump pulley and the crankshaft pulley in a sideways direction (see fig. 34). Check the amount of movement of the fan belt which should be $\frac{3}{4}$ in. if correctly adjusted.

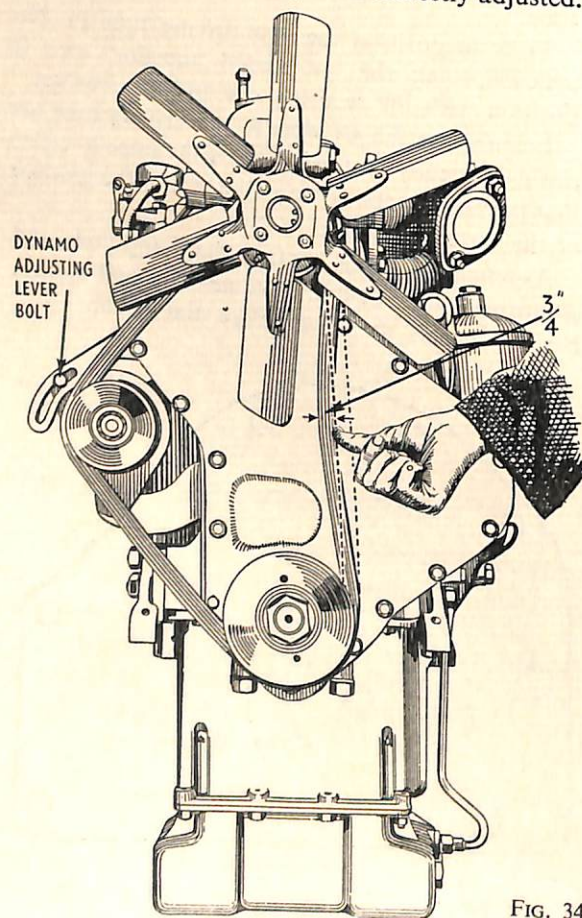


FIG. 34.

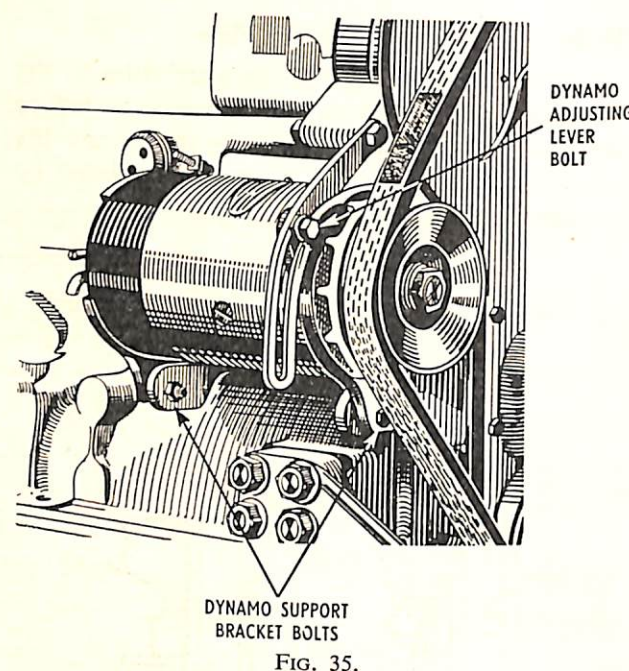


FIG. 35.

Method of Adjustment.

1. Standard Fan Pulley Arrangements.

Unscrew the dynamo adjusting lever bolt and dynamo support bracket bolts (see fig. 35). The dynamo can then be moved inwards towards the engine to slacken the belt or in an outwards direction to tighten it. When the position of the dynamo provides correct tension of the belt, tighten dynamo adjusting lever bolt and support bracket bolts.

2. Low positioned Fans.

Some types of Tractor engines are fitted with a low positioned fan. This necessitates an extra belt drive from the crankshaft to the fan pulley which is situated on the Timing Case Front Cover. To adjust this belt slacken the nut of the locking pin in the fan pulley support bracket. The fan pulley can then be moved to obtain correct adjustment.

WARNING: After slackening the nut of the locking pin *do not* attempt to use force on this pin or damage will result.

New Belts.

In the event of a new belt being fitted it is advisable to check the adjustment again after a few hours running to ensure no initial stretching has occurred. Should this have developed re-adjust as already described.

MAJOR OVERHAUL

PERPETUITY

Attention is called to the Perkins Perpetuity Plan under which an engine in need of overhaul can be replaced by one reconditioned by F. Perkins Ltd. The replacement scheme is of unique type, offering several special advantages. A booklet describing it can be obtained on request.

DISMANTLING THE ENGINE

Remove the cylinder head as described in the Section on Cylinder Head Maintenance on Page 45.

Remove cylinder head studs.

Lift gasket off cylinder block.

Remove oil pipe leading from the delivery side of oil pump to lubricating oil filter. Remove oil pipe, which connects the lubricating oil filter to the main oil pressure rail.

Remove pipe between lubricating oil filter head and auxiliary drive housing.

Remove the lubricating oil filter.

Remove the fuel pump. This is held by four setscrews, all accessible from above, and two dowelling setscrews accessible from below the bracket.

On exhaustor type engines remove exhaustor.

Do not remove the exhaustor and fuel pump bracket as difficulty may be experienced in re-aligning on replacement.

Remove the dynamo.

Remove the starter motor.

Remove the starter bracket (if fitted).

Remove clutch.

Take off flywheel.

Remove clutch housing and, if fitted, rear engine support plate.

Take off the timing case cover.

Remove the plug at the back of the top of the timing case.

Note for future reference, the markings on the camshaft sprocket, auxiliary drive sprocket and timing case. See Section on timing, page 39.

Examine the timing chain and find the master link; it is the link the pins of which have been hand-riveted. Turn the crankshaft until that link is exactly opposite the hole in the back of the timing case from which the plug has been removed.

Take out the link, being careful not to lose the intermediate plates. Keep the old link as it is useful as a guide when re-assembling the chain with a new link.

Wind off the chain, being careful when doing so to keep it taut so that it does not become wedged under the crankshaft sprocket.

The camshaft and its sprocket will pull straight out. Take care not to chip the cams.

Now prepare to remove the auxiliary drive.

Commence by removing the triangular top cover over the oil pump drive, bringing with it the spiral gear and the upper shaft of the oil pump drive.

Next lift out the intermediate pump-drive spindle. This is best effected by use of a pair of long nosed pliers. See Fig. 36.

Now take off the auxiliary drive assembly. This is held by four setscrews, two of which have their heads inside the timing case and are locked by shakeproof washers, and two are outside.

The auto-tensioner should be removed next.

First, remove the pawl holder which is held by two setscrews which are wired. Take care that the pawls are not lost. When this is taken away the sprocket with its spring will come off its bracket which should next be removed. It is held by two countersunk screws, which are locked in position by shakeproof washers.

Next remove the lower part of the timing case which is held by two $\frac{5}{16}$ in. nuts and four setscrews.

Now take off the upper part of the timing case. It is held by 14 setscrews, locked by shakeproof washers. This timing case is located on the front of the cylinder block by two dowels.

There is a joint between the timing case and the cylinder block.

Remove the oil relief valve, this is a push fit.

Remove dipstick.

Turn engine on side, if not in a swivel stand.

Remove the sump well and oil strainer.

Remove sump.

Remove suction pipe which is fitted to the lubricating oil pump and supported by a bracket to the main bearing cap.

The oil pump may now be removed. It is secured to the cylinder block by setscrews which are locked by shakeproof washers.

Having removed these setscrews the pump will come away.

Connecting Rods and Main Bearings

Next remove the connecting rods.

Begin by taking out the split pins.

Each connecting rod cap, connecting rod and bearing shell is marked 1 and 1, 2 and 2, 3 and 3, etc.

The connecting rods should be dealt with in the following order:—

In the case of the P6 engine:—Nos. 1 and 6 together, Nos. 2 and 5 together and Nos. 3 and 4 together.

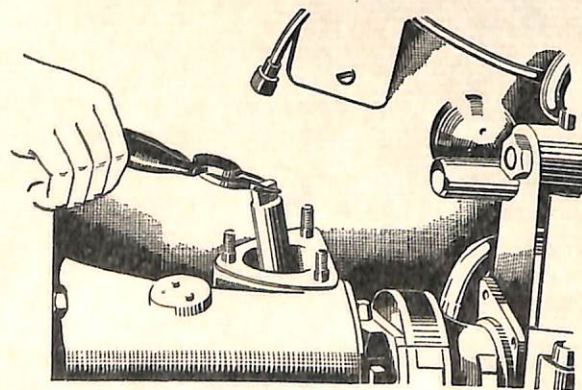


FIG. 36.

In the case of the P4 engine:—Nos. 1 and 4 together and Nos. 2 and 3 together.

The cylinder head gasket must be removed before the pistons are pushed out.

If there are carbon ridges in the cylinder bores, remove them, using a scraper for the purpose.

After removing the bolts, the cap of the connecting rods with the half shells can be taken away and the corresponding pistons pushed out of the top of the cylinders, complete.

Keep all pistons, connecting rods, caps, bearing shells, bolts and nuts together, each to each, as marked.

The main bearing bolts are secured by tab washers. The caps are numbered consecutively, starting from the front. It is most important that each cap goes back to the bearing from which it is taken as all the bearings are bored with the caps in position.

The gudgeon pins which can next be removed are fully floating: they are held in place by circlips. The circlips when removed should be scrapped so that they are not used a second time. If the pins are tight in the pistons, warm the latter in oil, at a temperature of 100 to 120 deg. Fah.: which will free the pins. In the case of cast-iron pistons the gudgeon pin should be tapped out with a brass drift.

Crankshaft.

Inspect the crankshaft journals and crank pins for scoring, ovality and wear. When regrinding is necessary the crankshaft should be reground to $-.010$ ins., $-.020$ ins., or $-.030$ ins., the limits being the same as for a standard crankshaft (see page 68).

If the crankshaft requires to be re-ground below $-.030$ in., it is recommended that a new crankshaft is fitted.

Examination for Wear.

After dismantling, all parts must be thoroughly cleansed by washing in paraffin or some other process.

Examination for wear of all parts listed on pages 66—70 should now be carried out.

As the efficient running of the engine is particularly dependent on good compression, cylinder bores which are worn to the extent—whereby engine performance is affected should be re-lined, or re-bored $+.030$ in. oversize. It is most important to take care that the true alignment of the bores relative to the crankshaft axis be maintained.

Other points of importance in this connection will emerge from the following instructions for re-assembly.

RE-ASSEMBLING.

Cylinder Block.

Remove the plugs at each end of the main oil pressure rail.

Thoroughly clean the cylinder block and flush out all water ways.

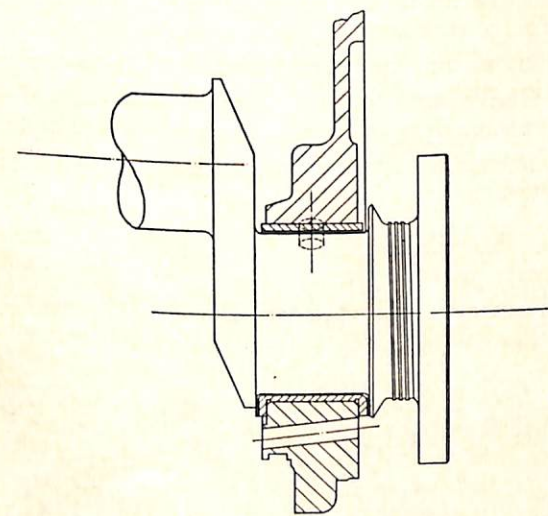
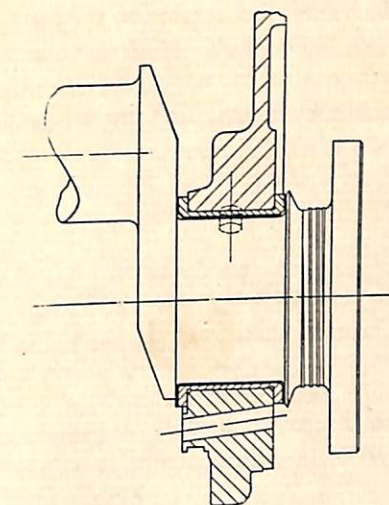
Clean out all oil ways formed in the casting, especially the main pressure oil-way and the camshaft chamber.

The top face of the block must be examined for signs of erosion such as can be caused by a faulty gasket or failure to keep the cylinder head nuts tight.

Check that the face of the cylinder block is perfectly plane, using for this purpose either a surface plate or straight edge.

Check cylinder head studs for damage or "stretch." Affected studs must be scrapped.

Re-fit studs and pull up tightly.

FIG. 37.
NEW TYPE BEARINGFIG. 38.
OLD TYPE BEARING

Main Bearings.

Prepare now to fit the main bearing shells.

When fitting replacement main bearing shells it is preferable to bore them "in line." In that way correct crankshaft alignment is ensured.

If it is impossible, in the circumstances prevailing to arrange for boring "in line" the shells may be bedded direct to the crankshaft, or to a mandrel.

In either event, prepare by bedding the shells into the cylinder block and bearing caps, the top halves of the shells into the cylinder block, the lower halves into the bearing caps.

It is important when performing this operation to mate the caps to the bearing housings and the two half shells each to its fellow. The bearing housing and caps are numbered, the half-bearing shells must be numbered to correspond.

Main Bearing Clearances.

The "running" clearance between the bearings and crankshaft journals is $.003$ to $.0045$ inches. It is, therefore, advisable when using a mandrel to obtain one which is $.002$ in. to $.0025$ in. larger in diameter than the crankshaft. When a mandrel is used it should, of course, reach from end to end of the cylinder block.

In the absence of a suitable mandrel use the crankshaft, bearing in mind the necessary running clearance which is required. The marking may

be obtained upon the top halves of the main bearings when the cylinder block is inverted, the lower halves can only be accurately fitted by setting the block upright and then rotating the crankshaft to obtain a marking.

End Float.

The end float of the crankshaft is measured between the crank cheek and the flange of the rear main bearing shell, and should be .00125 in. to .00425 in.

To ensure correct end float, equal amount of metal should be machined off the two faces of the shell.

Reference has already been made to the importance of correct alignment of the crankshaft axis in relation to the cylinder bores. This should be checked progressively as bearings are bedded. When the fitting of the bearings is completed a final check should be made as follows:—

Lay a straight edge across the bottom face of the cylinder block (the sump flange). Check the distance from the straight edge to the front crank bearing and also to the rear crank bearing. The difference between these two distances must not exceed .006 inches.

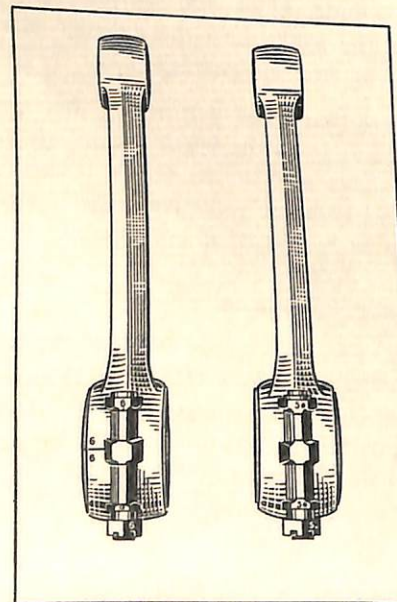


FIG. 39.
Showing the markings on the connecting rods.

Modified Main Bearings.

A modified bearing is now fitted to the top halves of the centre and rear main bearings on all "P" Series engines.

The flanges on the top half of the rear main bearing have been removed, but the bottom half remains the same to allow for adjustment of the crankshaft end float. (See figs. 37 and 38).

When fitting the rear main bearing always ensure that the relief grooves on the butt faces lead towards the inside of the crankcase.

The centre top half main bearing now contains relief grooves on one side only making it identical with the top rear main bearing. These two bearings are supplied under one part number which is Part No. 0050116.

The flangeless top half rear main bearing is interchangeable with the previous flanged type on the old type of cylinder block, but on the latest type of cylinder block the flangeless bearing must be fitted.

Cover, Crankshaft Rear End Seal.

The housing consists of two halves, bolted together around the crankshaft oil return thread and lined up to give the correct gap. The lining up operation is carried out by the use of a gauge (See Fig. 40), and the sequence of operation is as follows:

The two halves of the housing, bolted together, are offered up to the gauge diameter marked Z. The face of the housing is then coated with jointing compound and the joint is fitted. The gauge is then inserted into the two rear main bearings and the housing secured by six setscrews and Shake-proof washers. Ensure that the gauge is capable of rotation.

The through bolts on the housing are then removed and the rear mains are dismantled leaving one half of the housing on the block; the other coming away with the rear main bearing cap.

If the housing has worn through contact with the oil return thread, it is possible to file the butt faces of the two halves, and then re-machine or scrape to the right dimensions to give a .00275 in. concentric air gap round the oil return thread on the crankshaft.

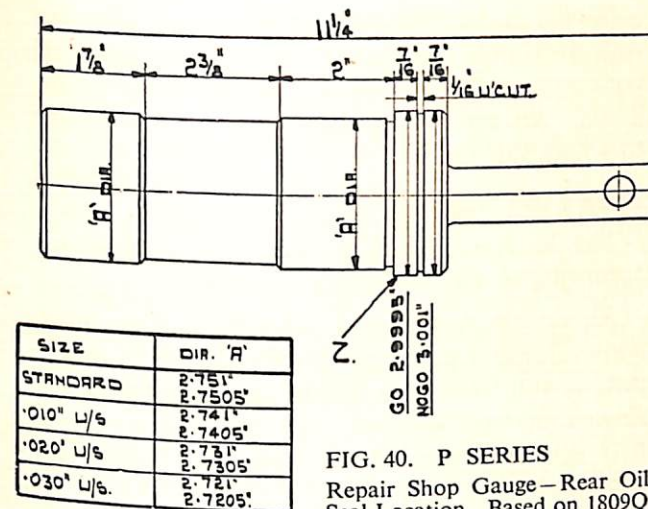


FIG. 40. P SERIES
Repair Shop Gauge—Rear Oil
Seal Location. Based on 1809Q

Finally, after fitting a new or reconditioned rear end oil seal housing, assemble crankshaft in the ordinary way.

The through bolts securing the two halves of the oil seal housing together should finally be pinned.

Main Bearing Caps.

The bearing caps may now be finally tightened down and the cap setscrews locked securely by means of the tab washers. New tab washers must always be used when the bearings are removed for any reason whatever.

NOTE:—As the front and rear main bearings are exposed, i.e., not covered by the sump, care should be taken when re-assembling, to ensure that no oil leakage can take place. A light coating of jointing compound should be smeared on the faces of the main bearing caps.

In no case should setscrews other than those supplied by the manufacturer be used as they are all of special heat-treated high-grade steel.

Connecting Rods.

The big end bearings and small end bushes should be carefully washed, cleaned and examined.

The gudgeon pin should be a free working fit in the small end bush (See page 69).

The beddings of the bearings on the crankshaft pins should be checked, and any high or low spots noted.

The surface of the bearings should be further examined for any signs of "picking up" or the embedding into the metal of foreign material.

On no account must connecting rod caps be filed as there is not sufficient metal in the bearings to allow that.

If the connecting rod caps have been filed and, at a later date, it is desired to fit new bearings, the connecting rods will have to be scrapped because the rods are not interchangeable.

If the bearings are satisfactory and the surfaces not unduly scored or marked, they may be used again.

All connecting rods and caps, as well as their bolts and nuts are plainly marked with a number corresponding to their position in the engine, see Fig. 39. The numbers on cap, rod, bearing, nuts and bolts coincide.

On the one side of the rod are numbers with dots (thus 2.) on the other side just numbers (thus 2). That side with the dots is on the camshaft side of the engine.

The original connecting rod bearing shells are also numbered and care should be taken to see that the shells are assembled with the numbers in the correct position, as described above. New bearing shells must be numbered as those which they replace.

Bearing shells, caps and rods must be scrupulously clean before assembly.

Before fitting big end bearing shells to the crankshaft they should be assembled and the connecting rod caps bolted in place, so that the following can be checked.

- (1) That the bolts are a good fit and do not distort the bearing shell.
- (2) That the shells have the correct "nip" of .004 in. to .008 in. in the rod.

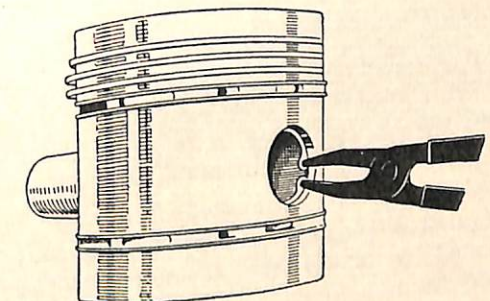


FIG. 41.
Showing arrangement of piston rings, also method of
removing circlips.

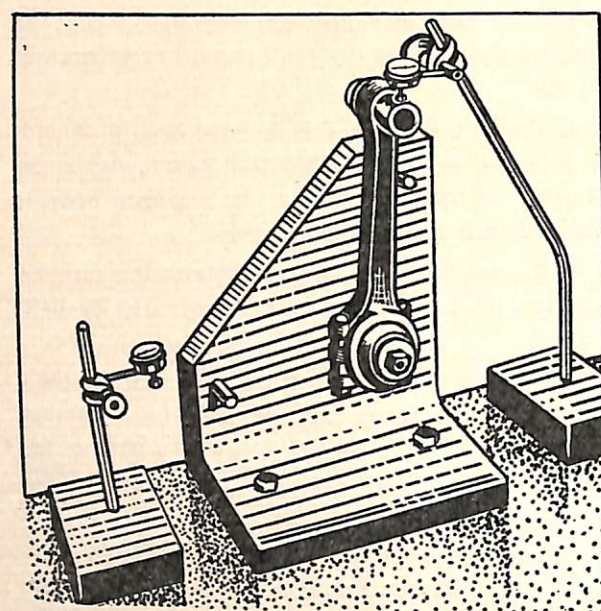


FIG. 42.
Checking alignment of connecting rod (vertical).

- (3) That the faces of the rod and cap are meeting squarely when the nuts are tightened.
- (4) That the gudgeon pins are in alignment with the big end bearings: this should be checked in two directions as shown in Figs. 42 and 43.

When this has been done dismantle the rod^s again and fit the bearing shells to the crank pins, taking care that a good marking is obtained.

For information concerning clearances between connecting rod big-end shells and crank pins, see pages 68 and 69.

The connecting rod bolts must be examined carefully for damaged threads or "stretch." Doubtful ones must be scrapped. All connecting rod nuts and bolts should be renewed during a major overhaul. In no case should bolts be used other than those supplied by the manufacturer as they are all of special heat-treated high-grade steel.

When re-fitting bearings to connecting rods and caps take care that the dowels are not preventing the bearing shells from seating properly in the connecting rod caps. They must bed well down.

In the case of pre-finished thin wall type bearings as fitted on later engines, these are not positioned by dowels and therefore the above remarks do not apply.

Fit each connecting rod to its appropriate crank pin, bearing in mind the marking as described above.

Should it be necessary to replace a connecting rod, it should be noted that the weights of connecting rods in engine sets must balance within 2 oz. All connecting rods are made up in sets to within this limit.

Pistons and Rings.

The arrangement of pistons and rings varies according to the application as follows:

All vehicle, marine and industrial engines rated above 1,500 r.p.m. are fitted with light alloy pistons and have two $\frac{3}{32}$ in. plain compression rings, four steel segment rings in one groove and two scrapers, one above and one below the gudgeon pin.

Industrial engines rated below 1,500 r.p.m. and all Tractor engines are fitted with cast iron pistons have two $\frac{1}{8}$ in. plain compression rings, four steel segment rings in one groove, a laminated type with four spring loaded laminations above the gudgeon pin and a scraper ring below that pin.

The exception is the P4(TA) engine which is fitted with light alloy pistons and has two $\frac{3}{32}$ in. plain compression rings, four steel segment rings in one groove, a laminated type with four spring loaded laminations above the gudgeon pin and a scraper ring below.

Fitting new Rings.

Pistons should be thoroughly washed and the rings examined for any tendency to stick in their grooves. Wear is most likely to occur in Nos. 1 and 2 pressure ring grooves. In addition, however,

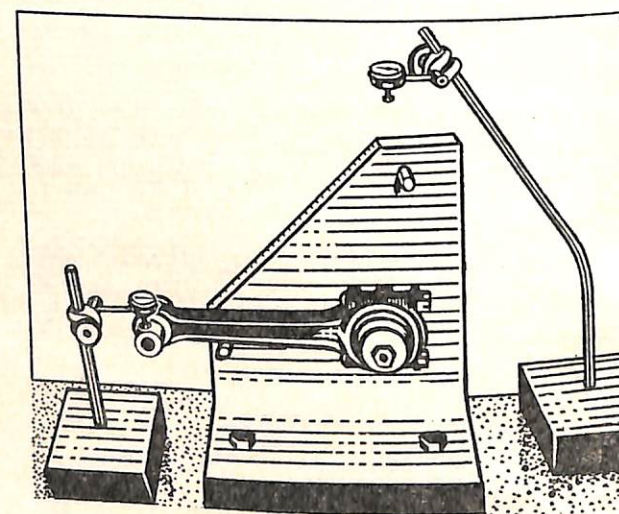


FIG. 43.
Checking alignment of connecting rod (horizontal).

the piston skirt should be examined and if there is any scoring the piston must not be used again.

Examine the piston carefully for bruising of the ring grooves and ensure that the rings move freely in their grooves.

The correct ring gap in the cylinder bore is quoted on pages 67 and 68.

Make certain that the ring gaps are equally spaced round the piston. The gaps in the laminated ring should be at 180 deg. and over the gudgeon pin bosses.

When preparing to assemble the gudgeon pin, piston and connecting rod, warm the piston in oil at a temperature of 100 to 120 degrees F.

Whilst it is still warm insert the gudgeon pin.

The pistons are numbered consecutively, No. 1 being that belonging to the cylinder nearest the timing case. They must be replaced accordingly.

Each piston must be assembled on its connecting rod so that the recess in the piston crown is on the side opposite to that on which are the numbers with dots on the rods. That side of the rod, i.e., with dots is on the same side as the camshaft.

This procedure ensures that the recesses in the pistons come beneath the atomisers, which is essential.

When assembling gudgeon pins and pistons, new circlips must invariably be fitted.

Ensure that the circlips are fitted correctly and bedding in their grooves in the piston bosses.

Fitting new Pistons.

See also paragraph "Fitting new rings," on page 58.

It is important when fitting pistons to check the distance from the crown of the piston to the face of the cylinder block.

When the crank is at top dead centre the crown of the piston must not be above the top face of the cylinder block face, and not more than .010 ins. below block face. For best performance, the distance should be maintained between .000 ins. and .005 ins. This must always be checked when assembling new pistons. The method is shown in Fig. 44. If the piston stands higher than this the crown must be reduced accordingly; if lower, that piston should be rejected.

The pistons and connection rods may now be fitted in the cylinder.

It is first, of course, necessary to remove the connecting rod caps.

Insert the pistons in the cylinders from the top dealing with them in the following order:—
In case of the P6 engine: 1 and 6, 2 and 5, 3 and 4.
In case of the P4 engine: 1 and 4, then 2 and 3.

Take care not to damage the rings. Should the piston accidentally drop partly into the bore and is held suspended by a piston ring it must be taken out again, and the ring examined to see if it is cracked or broken.

Having fitted all pistons in their respective cylinders, the connecting rod caps on their rods, the nuts of the connecting rod bolts should be tightened down to the recommended torque (see page 8). Put split pins in connecting rod cap bolts. The split pins should be so fitted that all heads are towards the front of the engine.

Rotate the crankshaft by hand and note that all parts move freely.

Fitting Timing Case.

Fit new joint using jointing compound.

Fit first the upper part and then the lower part of the timing case.

Be careful to tighten the setscrews holding the timing case using shakeproof washers.

AUTO-TENSIONER

It is advisable to assemble the auto-tensioner before fitting to the engine, to test for free movement of the sprocket and guide, also that the ratchet plates and plungers are working correctly.

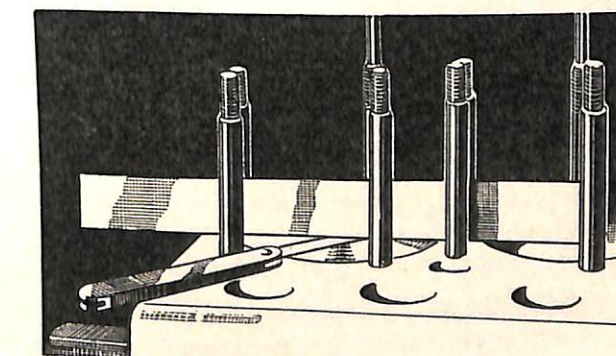


FIG. 44.
Checking distance from crown of piston to face of cylinder block.

To assemble the auto-tensioner, first place the base of the body support tight in a vice and slide on the sprocket and guide.

Screw in position to the guide, the two ratchet plates, the teeth pointing to the left.

Screw the plunger retaining housing plate complete with the two plungers and springs, to the body support, the plunger teeth pointing to the right.

Slide the sprocket and guide to the right and place the tensioner spring between the body support and the inside of the guide.

With the plungers depressed, slide the sprocket and guide to the left, testing the free movement of the guide by allowing the tensioner spring to re-assert itself.

Lock the two setscrews on each ratchet plate with wire.

Remove the plunger retaining housing plate and tensioner spring.

Fit the body support to the engine and secure in position using countersunk setscrews and shakeproof washers.

Place on the body support the sprocket and guide complete with ratchet plates.

Insert the tensioner spring in the same position as described above.

Screw the plunger retaining housing plate complete with plunger and springs to the body support and lock the setscrews with wire.

LUBRICATING OIL PUMP

To dismantle the oil pump remove the setscrews holding the bottom cover to the pump body. Remove the bottom cover. Idler gear and driver gear with shaft can now be removed.

Check bushes, shaft and gears for wear. The gears are in pairs and if one is worn, both gears must be replaced by a new pair.

The gear housing is dowelled to the pump body and can only be fitted one way to line up with the setscrew positions in the pump body.

Re-assemble the pump, bearing in mind that there are one or more thin paper joints between the gear housing and the pump body and between the gear housing and bottom cover.

Check the oil pump to see that it turns freely, using a hacksaw blade engaging in the driving dog of the pump shaft.

Use shakeproof washers with the setscrews holding the bottom cover to the pump body.

The oil pump, with joint, is secured to the bottom face of the cylinder block by setscrews and shakeproof washers. If shakeproof washers are not used, the setscrews must be wired.

FUEL AND OIL PUMP DRIVE

To dismantle, remove triangular cover holding the oil pump drive shaft, steel gear and ball race. (These parts will come away as one assembly).

Remove end cover and oil seal.

Remove circlip located just above bronze gear.

Remove the fuel pump drive shaft and sprocket, by pressing the shaft through the bronze gear.

Having dismantled the drive, check all bushes and shafts and pay particular attention to the bronze gear. If this is worn, a new pair of gears should be fitted.

To re-assemble proceed as follows :—

Fit new bushes if required.

Fit fuel pump drive shaft and sprocket into the drive housing.

Fit distance piece over the fuel pump drive shaft and press on bronze gear, ensuring first that the Woodruff key is in position.

Fit circlip.

Fit drive housing end cover joint, end cover and oil seal. The oil seal is a press fit into the end cover. Make sure that the end cover sits flush against the face of the drive housing.

There should be an end float of .007 to .010 in. in the drive. This may be checked with feeler gauges between the flange of the fuel pump drive bush and the fuel pump drive sprocket.

To assemble the oil pump drive components proceed as follows :—

Press steel gear onto oil pump drive shaft.

Press oil pump drive bearing into its housing.

Press shaft and gear into oil pump drive bearing.

Fit oil pump drive assembly and joint complete to the fuel pump drive. Tighten down with three nuts. Rotate the fuel pump drive sprocket; it should turn quite freely, without binding in any place.

Fitting and Aligning of Fuel and Oil Pump Drive to Engine.

It is most important to ensure that the vertical oil pump drive is correctly aligned with the oil pump.

To effect this alignment, proceed as follows :—

Bolt the body of the lubricating oil pump without gears, shaft, etc., but with the pump bushes to correct size, to the engine block.

Fit oil pump drive sleeve, spring, collar and packing joints (1 large and 1 small).

Remove oil pump drive assembly from fuel pump drive before fitting the drive to timing case, in order that the mandrel used for alignment may be inserted.

Do not tighten the four setscrews holding the fuel pump drive to the timing case until the mandrel is in place. A rocker shaft may conveniently be used as a mandrel.

Fit mandrel (rocker shaft) down the lubricating oil pump drive bush until it engages with the uppermost bush of the lubricating oil pump body; if a long mandrel is used, it can be engaged with both lubricating oil pump body bushes.

With the mandrel in position, tighten the four setscrews holding the fuel pump drive in position. Two of these setscrews are located through the timing case and screw into the fuel pump drive and two are located through the fuel pump drive and screw into the timing case. The two setscrews on the inside of the timing case are shorter than those on the outside and are fitted with shakeproof washers.

The mandrel should turn freely with the fuel pump drive tightened down.

Having aligned the vertical lubricating oil pump drive, the mandrel may be removed, also the lubricating oil pump body. This may be built up and fitted to the block, as previously described.

Before replacing the lubricating oil pump drive assembly in the fuel pump drive, ensure that the intermediate spindle taking the drive from the lubricating oil pump drive shaft to the lubricating oil pump, is fitted.

The lubricating oil pump drive assembly with joint may now be fitted to the fuel pump drive and tightened down with the three nuts.

Replace oil relief valve.

Re-fit joint and oil relief valve cover in position and tighten the three nuts holding cover to the block.

CAMSHAFT

Refit camshaft hub if this has been removed. It is a press fit on the end of the camshaft.

It will be noted that the sprocket is bolted to this flanged hub. The bolt holes are so spaced that by turning the sprocket rim on the hub and using a fresh set of holes a slight difference in timing is achieved.

Small arrow marks are stamped on the camshaft sprocket and hub. When the arrow marks are in line this denotes the original setting (see page 40).

If difficulty in timing occurs, it may be necessary to remove the sprocket, turn it one or more set of holes, and re-attach.

Replace camshaft.

On the latest type camshaft, the sprocket hub is cast integral with the camshaft. The sprocket is secured by three setscrews and by removing these setscrews and placing them in the alternate set of holes and/or turning the sprocket rim on the hub one set of holes, a difference in valve timing in multiples of 3 deg. is achieved. (See page 40).

Re-fitting Auxiliaries.

In the case of exhaustor type engines, it is advisable to fit the exhaustor at this stage and check the alignment as recommended in the Exhaustor Section of this Manual.

With the three "O's" on the coupling in line, fit the fuel pump.

Providing the exhaustor and fuel pump brackets have not been disturbed, no difficulty should be experienced regarding the alignment.

Refit cylinder head (See Page 45).

Wear in the timing chain is inevitable, but comparatively slow. There is no need to renew the chain until its total length has increased by half a link.

If worn to that extent the chain should be renewed.

With the pawls depressed slide the sprocket and guide to left and wedge in position by placing a piece of wood between the body support and the guide.

Set No. 1 piston to T.D.C. and align the arrow marks on the camshaft and fuel pump drive sprockets with the arrow marks on the timing case (see page 40).

Replace the chain, being careful not to disturb the sprockets. The best way is to lay one end on the auto-tensioner and place it round camshaft sprocket, round the fuel pump drive sprocket, crankshaft sprocket, and back to the auto-tensioner.

Insert the old link, comprising plate and two rivets, from the front.

When the rivets are through the front rollers insert one thick link between the front and middle rollers.

Press the link further in until the rivets are into the middle rollers, then insert the second thick link.

Press the link right home.

Release the chain tensioner by removing the wedge.

Do not force the chain tensioner, as in so doing undue strain would be placed on the pump drive bearings.

Now turn the engine until the old link comes exactly above the camshaft sprocket. Insert new link from behind, using the old link as a guide, i.e., push the old link out with the new one.

Press the new link right home until the rivet heads protrude at the front of the chain.

Turn the engine backwards until the link is as near as possible to the chain tensioner sprocket, without being on it.

Wedge the link, for riveting, by inserting the tappet spanner between the back of the link and the timing case. Make sure that the link is fully home in the chain and that the chain is rigidly supported by the spanner.

Place the medium thick link over the two protruding ends of the rivets.

Close the links up tightly.

After completing this operation the accuracy of the timing should be checked. The chain should then be riveted securely in position.

Check the valve timing as instructed on page 43.

Now check the fuel pump as instructed on page 43.

Replacing the Sump.

Put the cork strip over the front and rear end crankshaft bearing caps using jointing compound to make the joints.

Put joint and jointing compound on face of sump, taking care that all surfaces are clean.

Place sump in position and screw all setscrews lightly home.

Tighten all setscrews.

Replace the oil strainer, taking care that it registers on the suction pipe.

Replace the separate sump well (where fitted).

Fit the oil filler body, ensuring the gauze strainer is sandwiched between body and cylinder block.

Replace the timing case cover.

Set the adjustment of the tappets to .012 ins.

Replace oil pipes to rocker shaft.

Replace cylinder head cover.

Replace dynamo.

When replacing the starter motor and no distance piece or oil seal is used, the following should be checked :—

With the flywheel in position, the starter pinion should be approximately $\frac{1}{8}$ in. from the flywheel teeth.

Replace auxiliary oil pipes and ventilation pipes.

Replace pipe between venturi and pneumatic governor on the fuel pump.

If care has been taken, when handling the venturi and fuel pump and care has been taken not to disturb the adjustment to these components they may be replaced with the certainty that the engine will function as before.

In the event of disturbance, or of a new fuel pump being required, arrangements should be made for the fuel delivery of the pump to be set by an authorised Agent, so that the engine speed and control will be as they were previously.

In either event a request should be made for the setting to be carried out and the type of the engine must be stated.

Replace water pump, fan and fan belt.

Starting the Engine.

Proceed in accordance with the instructions given on page 10.

ALIGNMENT OF THE CLUTCH HOUSING AND FLYWHEEL

It is most important that the clutch housing be correctly aligned with the crankshaft. Misalignment may give rise to difficulty in changing gear, etc. If the housing has been removed, as is necessary for a complete overhaul, the greatest care must be taken on replacement to ensure accuracy of alignment. The appropriate procedure is as follows :—

See that the face of both the rear of the cylinder block and clutch housing are perfectly clean and free from burrs.

Turn the crankshaft and check that this hole is truly central. The housing should be adjusted until the bored hole is central.

For convenience in turning the engine it is advisable to release (but not remove) the nuts holding the atomisers in place.

The hole in the clutch housing should be truly central with the crankshaft within the limits of plus or minus two-and-a-half thousandths-of-an-inch.

Alignment of the Clutch Housing Face.

With the base of the "clock" gauge still bolted to the crankshaft flange, adjust the "clock" so as to set the needle against the vertical machined face on the clutch housing, and, again turning the crankshaft, check that this face is perpendicular to the crankshaft axis (see fig. 45).

This facing should be within plus or minus two-and-a-half thousandths-of-an-inch of being truly at right angles to the crankshaft axis.

This degree of accuracy should prevail in any position of the indicator clock.

All adjustments to bring the clutch housing within the limits must be on the clutch housing and under NO CONDITIONS must the rear of the cylinder block be interfered with.

When the housing is properly aligned to the above limits, tighten the eight securing nuts evenly.

Ream the three $\frac{3}{8}$ in. dowel holes and fit the correct length and size dowels.

Fitting Flywheel and Checking Alignment.

With the flywheel and crankshaft flange perfectly clean and free from burrs, place the flywheel on the crankshaft flange.

Insert the eight setscrews complete with flat washers into the flywheel holes and tighten evenly.

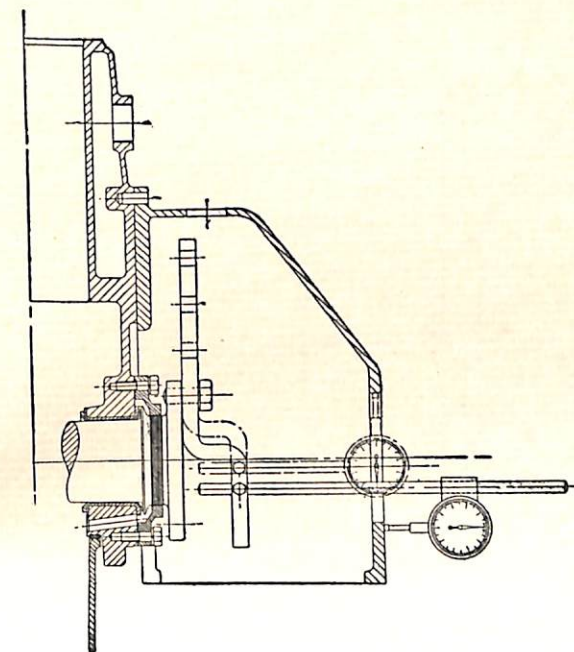


FIG. 45.

Set the housing on to the rear face of the cylinder block and tighten but not overtight so as to allow adjustment.

Alignment of the Clutch Housing Bore.

Secure the base of a "clock" gauge to the flange of the crankshaft.

Set the needle of the gauge to the interior of the bored hole in the clutch housing (see fig. 45).

Secure the base of the "clock" gauge to the clutch housing. With the flywheel at top centre, set the needle of the gauge on the periphery at T.D.C. (see fig. 46).

Turn the crankshaft and check the clock, the flywheel should run truly within limits of plus or minus two-and-a-half thousandths-of-an-inch.

With the base of the "clock" gauge still bolted to the clutch housing, adjust the clock so as to

set the needle against the vertical machined face of the flywheel (see fig. 46).

Again turn the crankshaft and check the clock, the flywheel should be within the limits of plus or minus two-and-a-half thousandths-of-an-inch at right angles to the crankshaft axis.

When the flywheel has been checked for the correct limits, lockwire in pairs the setscrews.

Finally grease the spigot ball race if fitted.

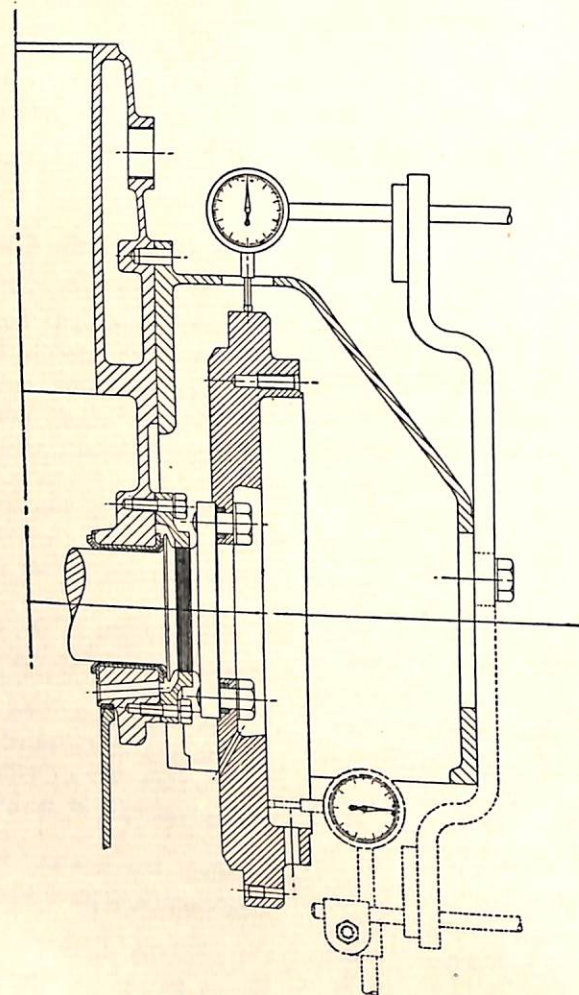


FIG 46.

SCHEDULE OF CLEARANCES AND TOLERANCES

1. The data regarding clearances and tolerances is given as a guide for personnel engaged upon major overhauls.
2. The figures in the column "Permissible Dimensions" are the drawing sizes to which the parts are made. These dimensions are given in limit form and represent the minimum and maximum sizes to which parts may be accepted when new, as, for example, $\frac{1.298}{1.2985}$ quoted for a shaft diameter.
3. The difference between the minimum and maximum dimensions quoted in para. 2 is known as the manufacturing tolerance. This tolerance is necessary as an aid to manufacture and its numerical value is an expression of the accuracy of the design, it may also be considered as a numerical expression of the desired quality of workmanship. For the example referred to in para. 2 the tolerance is 0.0005.
4. If, when carrying out a major overhaul it is found that a bush and corresponding shaft have worn and that the majority of wear has taken place in the bush it may be necessary to renew the bush only. Similarly, if the majority of wear has taken place on the shaft it might only be necessary to renew the shaft.
5. During the overhaul of worn components personal initiative must be exercised at all times. It is obviously un-economical to return worn parts to service with an expectation of life which may involve labour costs again at an early date.
6. Further information can be obtained on request from the Service Department, F. Perkins Ltd., Queen Street, Peterborough, England.

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

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS. (ENGINE TYPE P SERIES).

BORING, BIG END AND MAIN BEARINGS.

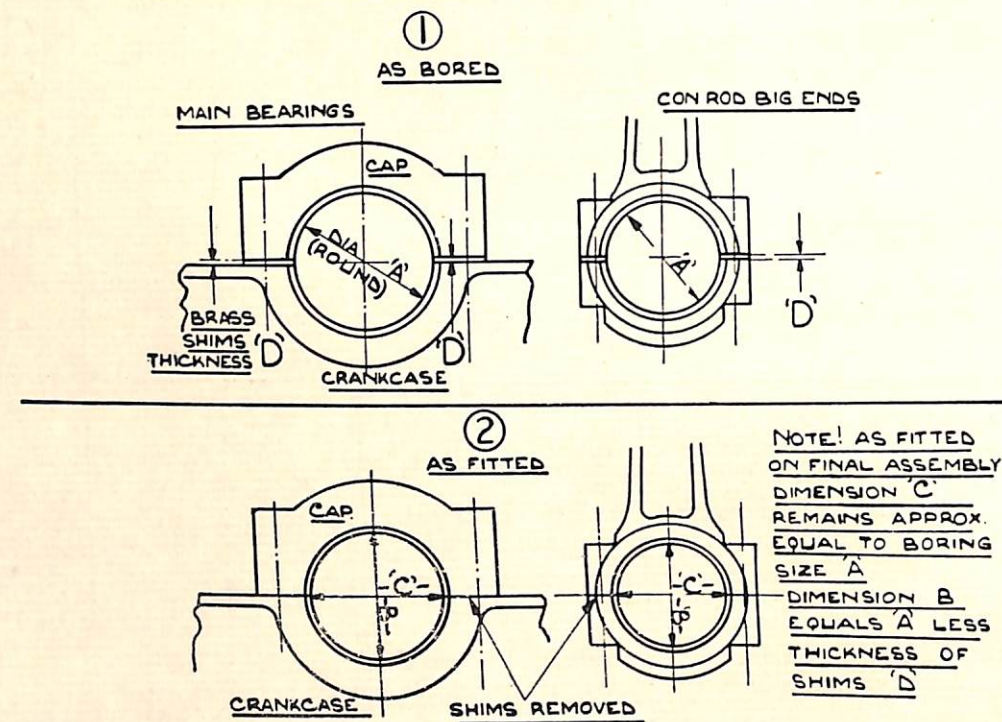


Fig. 47

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION		PERMISSIBLE CLEARANCE		REMARKS	
		inches	mm.	inches	mm.		
0640003	CYLINDER BLOCK (cont.)						
	Piston (Scraper ring groove) (width)	.252	6.4	} .002 .004	.0508 .1016		
0640004	Ring, Scraper (width)	.253	6.426				
		.249	6.324				
		.250	6.35				
	Gap			.009 .013	.2286 .3302		
0050026/7 P6 0260010 P4 0260009	CRANKSHAFT AND CON- NECTING ROD					Measured along axis of rod. Does not apply with thin wall pre-finished bearings. See alternative type connecting rod.	
	Bearing, Connecting Rod, Big End (Finished bore)	2.25225	57.207	} .00325	.0825		
		2.25325	57.232				
		Crankshaft, Crankpins (Dia.)	2.2485	57.112	} .00475		.1206
			2.249	57.125			

NOTE :—When fitting Piston Rings to a worn cylinder, ring gaps should be checked at *bottom* of cylinder.

NOTE:—When fitting Piston Rings to a worn cylinder, ring gaps should be checked at bottom of cylinder.

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS. (ENGINE TYPE P SERIES).

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION		PERMISSIBLE CLEARANCE		REMARKS
		inches	mm.	inches	mm.	
0260010 0260009	CRANKSHAFT AND CONNECTING RODS (cont.) Crankshaft, Crankpins (Width)	1.562	39.675	.0095 .013	.2413 .3302	Standard Crankshafts only. Does not apply with thin wall pre-finished bearings. NOTE: Bushes reamed to suit individual pins.
		1.5635	39.713			
		1.5505	39.383			
0050009	Bearing, Connecting Rod, big end (Width)	1.5525	39.433	.001	.0254	Bushes provided with reaming allowance.
0610516	Bush, Connecting Rod, small end (Bore Dia.)	See Remarks				
0210001/4	Pin, Gudgeon (Dia.)	1.24975	31.743	.001	.0254	Alignment measured between mandrels through large and small end bores. See fig. 48.
		1.250	31.75			
0050116 0050117	Rod, Connecting, alignment between small and large end bearing bores. (Parallelism) Ditto. (Twist)	1.873	47.574	.00125 .00425	.0317 .1079	
		1.872	47.549			
P6 0260010 P4 0260009	P6 Bearing, No. 7, Main (Width) P4 " No. 5, " (")	1.87425	47.606	.00125 .00425	.0317 .1079	
		1.87625	47.657			
0050023/22 0050020/21	Crankshaft, No. 7, Journal (Width) " No. 5, " (")	2.7555	69.983	.0035 .005	.0889 .1270	Bored with brass shims in position. Removed on final assembly. Shim thickness D—.00275" .0698 mm. .00325" .0825 mm. (see fig. 47)
		2.7565	69.996			
0050025 0050116 0050116 0050117	Bearings, Main, Boring dia., 'A' (see fig. 47)	2.7525	69.901	.0035 .005	.0889 .1270	
		2.7535	69.926			
P6 0260010 P4 0260009	Do. Finished size 'B' (see fig. 47), measured vertically	2.7485	69.812	.0035 .005	.0889 .1270	
		2.749	69.824			
0240005	Crankshaft, Main Journals (Dia.)	3.001	76.225	.0055 .009	.1397 .2286	
		2.9995	76.187			
	Cover, Crankshaft, rear end	2.994	76.047	.0055 .009	.1397 .2286	
		2.992	75.997			
0210007	CRANKSHAFT AND CONNECTING ROD Rod, Connecting, Parent Bore Dia. (for thin wall pre-finished bearings)	2.3955	60.846			Measured in position
		2.3950	60.833			
0050118	Bearing, thin wall pre-finished, Connecting Rod, Big End, Bore Dia.	2.251	57.175			
		2.252	57.200			
0210007	Rod, Connecting, Parent Bore Dia. (for small end bush)	1.37475	34.917			Bushes provided with reaming allowance.
		1.37620	34.955			
0050119	Bush, Connecting Rod, Small end, Bore Dia.	1.2505	31.763			
		1.2515	31.788			

**SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN
OVERHAULING ENGINES TO FACTORY STANDARDS. (ENGINE TYPE P SERIES).**

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION		PERMISSIBLE CLEARANCE		REMARKS	
		inches	mm.	inches	mm.		
CYLINDER HEAD AND VALVE GEAR							
0050016	Bush, Rocker Lever (Bore Dia.)	.6245	15.862	.00075 .0035	.0195 .0889	New clearance of valve face below cyl. head face .070" or 1.778 mm. Exh. and Inl. Seat should not be re-cut unless essential when clearance must not exceed .140" or 3.048 mm. Exh. and Inlet.	
P6 0750144 P4 0750143	Shaft, Rocker (Dia.)	.62575	15.894				
		.62225	15.805				
		.62375	15.843				
0420002	Guide, Valve (Bore Dia.)	.314	7.972	.002 .004	.0508 .1016		
0910001/2	Valves, Inlet and Exhaust (Stem Dia.)	.315	8.00				
		.311	7.895				
		.312	7.925				
0860007	Tappet, Valve (Shank Dia.)	.62225	15.805	.00075 .0035	0.195 .0889		
	Hole in Cylinder Head for Tappet (Dia.)	.62375	15.843				
		.6245	15.862				
		.62575	15.894				
0780007	Spring, Valve, Inner (Free length)	1.365	34.67				
0780006	Spring, Valve, Outer (Free length)	1.405	35.68				
		1.803	45.80				
		1.783	45.29				
WATER PUMP							
0750007	Shaft, Water Pump	.498	12.649	.0019 .0034	.049 .086	Large and small end Connecting Rod Bores must be square and parallel with each other within the limits of plus or minus .005" measured 5" each side of the axis of the rod on test mandrel as shewn in Fig. 48.	
0050017	Bush, Water Pump Support Shaft	.499	12.674				
		.5009	12.722				
		.5014	12.735				

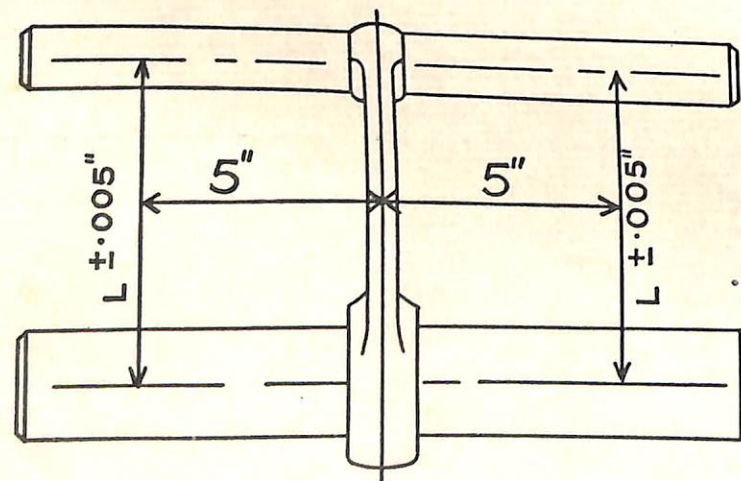


FIG. 48

NOTE :—The Manufacturers reserve the right to alter this Specification without notice.

FILTERS

A prime consideration in the maintenance of Diesel engines is that of cleanliness. The air and fuel oil which enters the cylinders must be scrupulously clean and so also must the lubricating oil.

In Perkins Diesels particular attention has been paid to the provision of means for ensuring cleanliness in respect of these. Filters are provided and all that the operator needs to do is to take steps to ensure that those filters are kept in such a state that they will most effectively perform their functions.

dusty conditions, the time limit recommended in the periodical attentions for cleaning should be decreased.

The correct maintenance of the air cleaner will greatly assist in reducing bore wear, thereby extending the life of the engine.

When fitting the air filter to the venturi, see that the slots in the base of the filter body are blanked by the venturi, also that the securing clip is square and tight.

OIL BATH FILTER.

In the oil bath filter the incoming air impinges upon the surface of oil carried in a reservoir in the lower part of the filter casing. (See Fig. 49). As the result of this, particles of foreign matter are carried into the oil by their own momentum and there trapped. The air next passes through a steel wire element before reaching the induction manifold and in that element are deposited any other particles of foreign matter which still remain in the air after its contact with the oil.

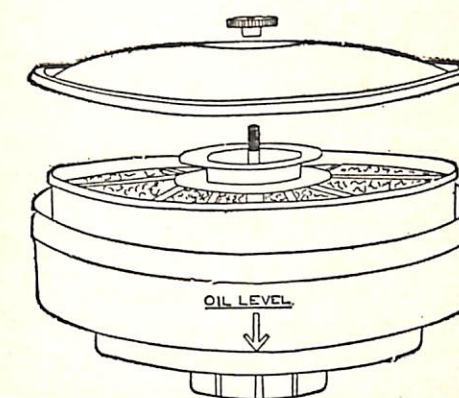


FIG. 49.

AIR FILTERS

In this section the question of air filtration is considered, the filters supplied with the engine are described, and instruction given as to how to maintain those filters and keep the filtration to a high level of efficiency.

Air is filtered as it enters the inlet manifold by use of one or the other of the following filters.

1. Oil Bath type filter.
2. Dry type filter.
3. Tractor type.

The system of operation of the oil bath filters and the dry filter varies considerably, but either types will afford a high measure of protection to the engine, if properly maintained.

The time for cleaning the air cleaner depends on operating conditions, therefore, under extremely

Maintenance.

The method of maintaining the two types of oil bath filters is the same.

Examine and replenish oil and clean in accordance with periodical attentions. Pages 17-20.

Remove top cover and lift out element, wash in paraffin or fuel oil and allow to drain. Empty oil out of outer case and scrape out accumulated sludge, wash outer case with paraffin or fuel oil and refill with oil to level indicated (do not overfill). Replace element and top cover, care to be taken to see that the joint ring is in good condition and is sealing, also that the felt washer beneath the steel washer is in position before tightening the top cover down.

DRY TYPE FILTER

The filtering element in this is of felt. It is of the shape shown in Fig. 50, which is a partial sectional view of the filter. The feature of this component is the comparatively large surface

area of the element and the advantage is that the air, in passing through the element, travels at a relatively low speed, in consequence of which any particles of dirt in the air are either deposited on or stopped by its surface.

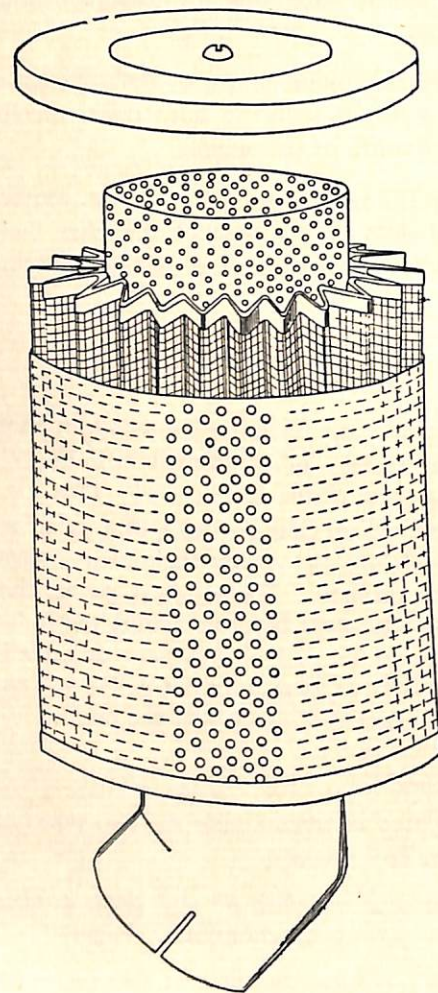


FIG. 50. Dry Type Air Filter.

Maintenance.

In accordance with periodical attentions (See pages 17-20) the cleaner should be dismantled and the element opened up and washed in paraffin. Before replacing the element it should be allowed to dry out. As this operation takes time it is recommended that a spare element be held so that as the one is taken out for attention the other can be put in and no time lost.

TRACTOR FILTER.

Manufacturers Instruction books should be consulted for information regarding the maintenance of air cleaners fitted to tractor engines.

Due to conditions under which the tractor usually operates the air cleaner should be cleaned and oil replenished at least every 50 hours.

Important Note.

The efficiency of the cleaner is such that if the cleaning of the element is not carried out at appropriate intervals, engine performance will be seriously affected, because the presence of impurities on the cleaner will restrict the air passage. In the event of engine performance being below par, it is a good plan first to check up on the cleaner to ascertain if, as a matter of fact, clogging of the filter is the cause.

The choice of filter, and indeed the necessity for offering alternatives, is determined by the need for satisfying the requirements of the various applications of the Perkins P Series engines. The oil bath type air cleaner must of necessity be mounted level, which circumstance, combined with its relatively large size, and the effect of swan neck bends on the engine governing, has precluded its use in some of these applications.

The above filters will be found entirely satisfactory for all normal operations. In the event of vehicles operating under abnormal conditions, certain types of heavy duty air cleaners can be obtained through F. Perkins Ltd., if in the application in question there is provided sufficient space to accommodate the special filters, which, as a rule are larger than above described.

FUEL OIL FILTERS

Of all the factors on which satisfactory operation of a Diesel engine depends, cleanliness of the fuel oil is the most important. The efficient operation and length of life of the fuel pump elements and of the atomisers, depends, first, on the use of clean fuel oil; second, the provision of suitable filters; third, attention to these filters.

Protection for the Perkins engine is provided by the following filters, reading from the tank to the fuel pump.

(1) Pre-Filter.

In most cases this is mounted on the fuel pump unit but on tractor engines the type varies according to application.

(2) Intermediate Filter.

This is used on vehicle, marine, and certain industrial engines, but not on tractors.

(3) Final Filter. Three types are used:

Felt element type for vehicle, marine and industrial.

On later type tractors a composite felt and cloth element type is used, which is also of a larger capacity than the original vehicle type.

On some applications a paper element type filter is fitted.

Pre-Filter.

The main purpose of this filter is to protect the fuel lift pump. It has a comparatively coarse element.

This element is contained in an easily removable bowl and should be cleaned in accordance with periodical attentions (See pages 17-20).

When re-assembling after cleaning, take care that a good joint is made between the top of the bowl and the filter body, as any leakage of air here, that is, on the suction side of the fuel pump, may cause air locks in the fuel system.

Intermediate Filter.

This filter contains a star-shaped felt element which should be washed in paraffin or clean fuel oil (see pages 17-20).

In order to save time and allow particularly for thorough cleaning of the element, it is advisable to keep a spare one in stock which may be put into service, thus saving time which might be lost waiting for the used element to be cleaned and replaced.

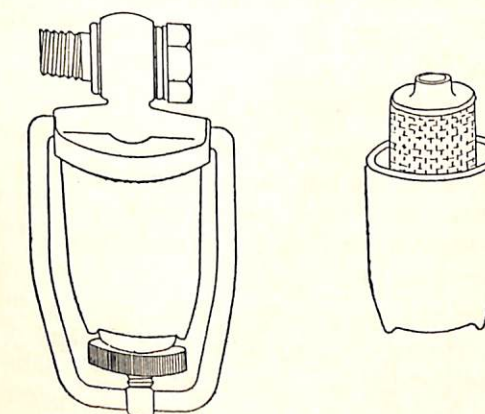


FIG. 51. Pre-Filter.

Final Filter. (Felt element type).

This filter provides final protection for the fuel pump. The element is of fine felt pads in compression. As the outlet branch of this filter leads straight to the fuel pump, it is not recommended that orthodox washing of the element in paraffin be carried out. Approximately every 20,000 miles or 1,000 hours a new element should be fitted.

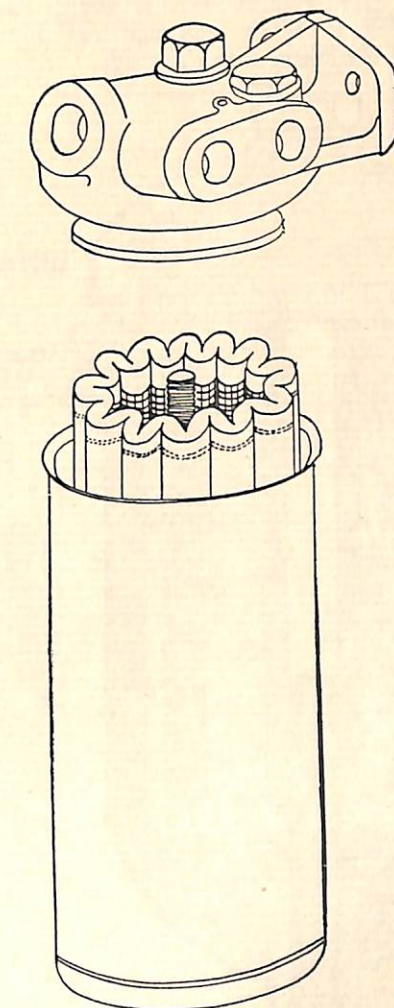


FIG. 52.

COMPOSITE FILTER.

Combined Cloth and Felt Element Type.

The fuel filter element as fitted on later type tractor engines, is of an improved type, consisting of a finely woven cloth pleated to a cylindrical form over a wire cage and fastened at the bottom. The felt element which is retained inside the cage, comprises a series of felt pads built up on a perforated support tube.

This element provides a safeguard and greater efficiency because of the composite element employed, and giving, in effect, if properly maintained, permanent protection to the injection equipment.

Operation.

The fuel oil passes from the outside of the fabric to the inside, through the felt pads to the perforated tube which is connected to the fuel outlet at the bottom of the filter body. Any impurities are therefore deposited on the outer surface of the fabric. (See Fig. 53).

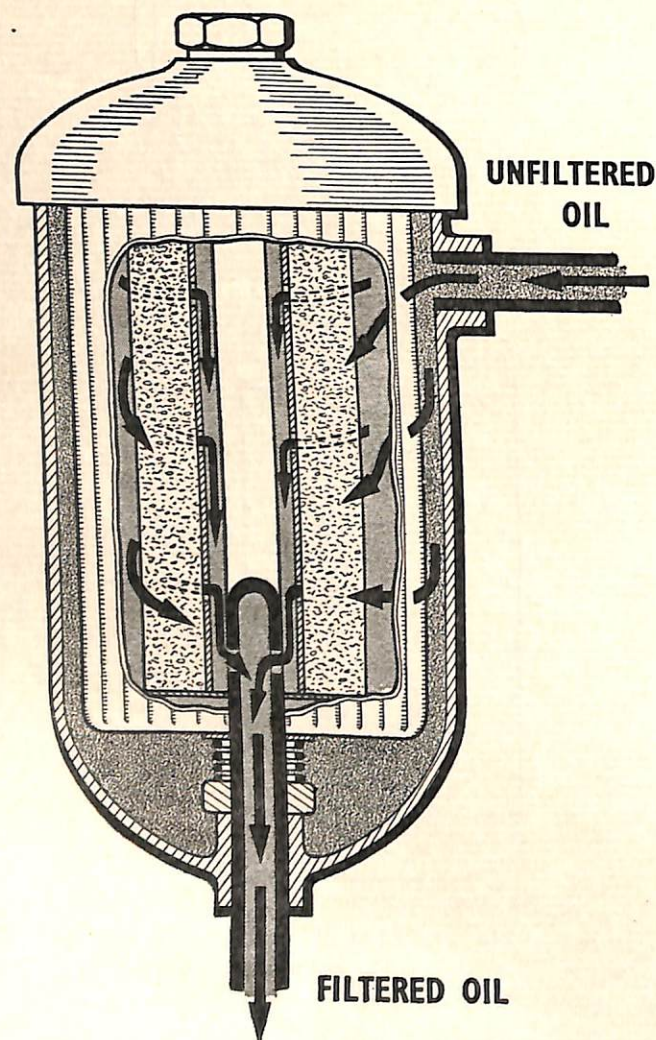


FIG. 53.

Servicing the Filter.

It is realised that the servicing of the filter represents expense in both time and money, but it is only a fraction of the cost of fuel pump overhauls, therefore the importance of correctly servicing the filter cannot be over-emphasized.

Loss of power, fuel pump element wear, can result from the following :—

- (a) Neglect to clean the filter.
- (b) Failure to renew the cloth at the correct interval.
- (c) Faulty fitting of the cloth to the wire cage.
- (d) Using inferior material.

The fabric is specially prepared therefore on no account should any other type fabric be fitted.

Periodical Attention.

Every 250 hours unscrew drain plug on fuel filter (See Fig. 55), replace plug when clean fuel appears.

In servicing the filter, the dirty fabric should not be cleaned, but under normal conditions renewed every 500 hours. Operating under dusty conditions renew every 200 hours, but more often if found necessary.

Replacing Filter Cloth.

- (1) Clean exterior of filter body with cloth to remove all dust and dirt. (See Fig. 54).
- (2) Unscrew the drain plug at the bottom of the filter body so as to allow sediment or water trapped in the filter to drain out. (See Fig. 55).
- (3) Remove the centre top nut and detach the cover.
- (4) Remove filter element by handle.
- (5) Unscrew nut and remove washer. Cut twine holding cloth to the cage and remove dirty cloth.
- (6) Throw dirty filter cloth in waste bin. DO NOT attempt to wash filter cloth. (See Fig. 56).
- (7) Clean inside the filter body.
- (8) With clean hands, fit new cloth. Remove wrapping and cut cloth (unless already cut) across the folded corner with scissors to make a small hole in the centre of cloth. (See Fig. 57).
- (9) Open the cloth and place on the cage with the perforated tube protruding through the hole. Place on the washer and tighten down the securing nut complete with handle. (See Figs. 58 and 59).



Fig. 54

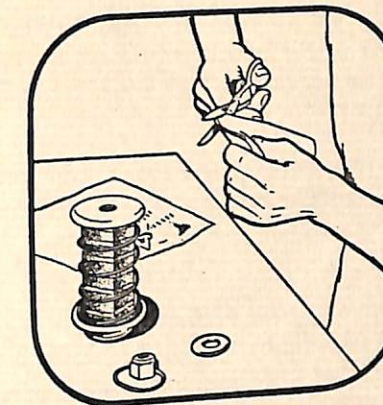


Fig. 57

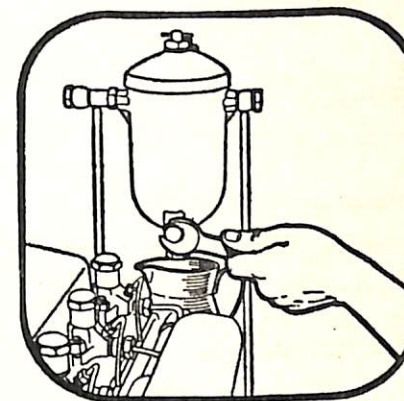


Fig. 55

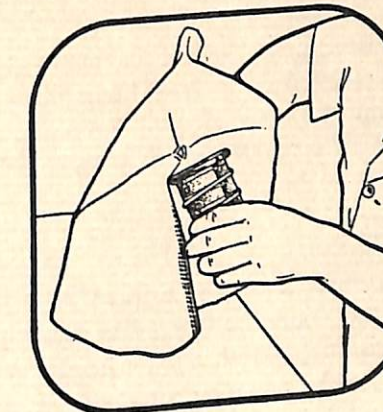


Fig. 58

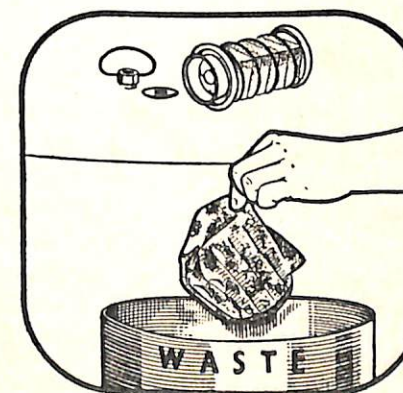


Fig. 56

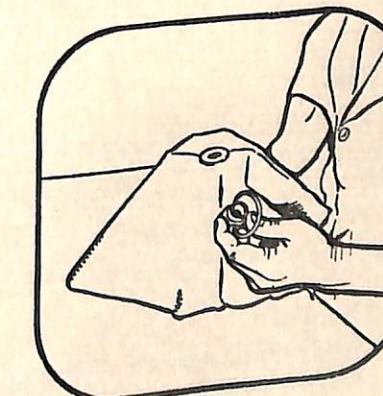


Fig. 59

- (10) Pleat the cloth round the cage, tucking in the cloth at the bottom of the cage. Pleats should be about half inch wide. (See Figs. 60 and 61).
- (11) Make two turns round the bottom of the cage with twine provided and secure pleated cloth in position with a firm knot. (See Fig. 62).
- (12) Pull out the ends of the cloth which were tucked into the bottom of the cage and trim off clear of the cage joint with scissors. (See Fig. 63).
- (13) Paint round the neck of the cage with water-glass to seal the twine and ensure that the pleated cloth is oil tight. (See Fig. 64).
- (14) Replace the filter element and tighten top cover in position.

The felt element should not be removed for cleaning but renewed every 1,000 hours, therefore when replacing the cloth element, particular care should be taken to ensure the felt element is kept clean.

FABRIC FILTER.

Certain Tractors have an extra fabric filter fitted before the composite type. The fabric filter element consists of a cloth only, whereas in the composite filter the complete element consists of felt pads covered by a cloth. The method of replacing the cloth is the same as described on Pages 74 and 76.

Under worst conditions of service, renew the cloth every 50 hours (or one week) of running.

Under normally "good" conditions of service, renew the cloth every 250 hours (or four weeks) of running.

PAPER FILTER.

It is not possible to clean the paper element in this filter. It should be renewed every 20,000 miles or 1,000 hours. Every 5,000 miles or 250 hours, unscrew the drain plug at the bottom of the filter bowl and allow fuel to flow until clean fuel oil appears.

Replace drain plug.

To remove the element, unscrew the larger nut in the centre of the cover and drop the filter bowl clear.

Remove the element.

Before putting new element in position, clean the filter bowl and inspect the relief valve.

Ensure that the rubber joints are in good condition, if not replace by new.

LUBRICATING OIL FILTERS.

The importance of using clean lubricating oil in the first place, and providing means to ensure that it is always clean in use, is hardly second to the importance of cleanliness in respect of the fuel.

It is imperative, therefore, that lubricating oil filters be not neglected. Moreover, if the periodical attentions herein recommended are carried out and the correct grade of clean oil used, a very long life can be obtained from the Perkins engine.

To ensure cleanliness, three filters are incorporated.

- (1) Oil Filler Strainer.
- (2) Sump Strainer.
- (3) Main (full flow) Filter.

The purpose of the oil filler strainer is to prevent large objects entering the sump when the engine is being filled with lubricating oil. Clean in accordance with Periodical Attentions, pages 17-20.

The sump strainer consists of a perforated gauze wire container which fits over the suction pipe to the oil pump. After a time there may be tendency for sludge to collect and restrict the supply of oil to the pump. This strainer should therefore be dropped and thoroughly washed with fuel oil in accordance with periodical attentions (See pages 17-20).

Main (Full Flow) Filter.

This filter contains a star-shaped element housed in a brass cage. The flow of lubricating oil through this filter is from the centre outwards. This is the reason why the element is in a brass cage. The element should be cleaned in accordance with periodical attentions (See pages 17-20).

In this connection it is important to note that the element must be dismantled and opened out before it is washed.



Fig. 60

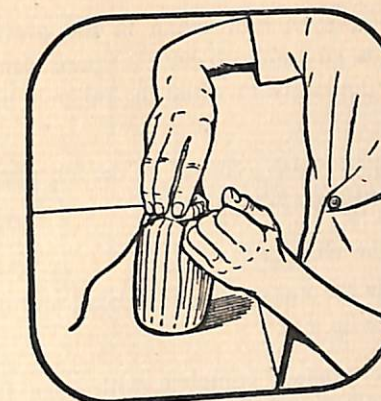


Fig. 62

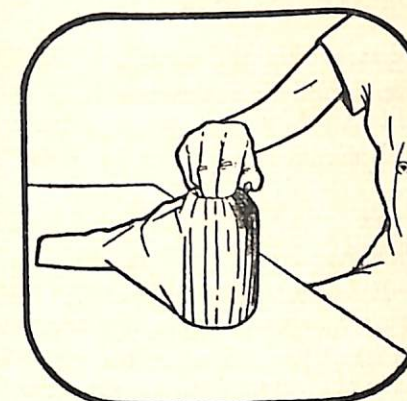


Fig. 61

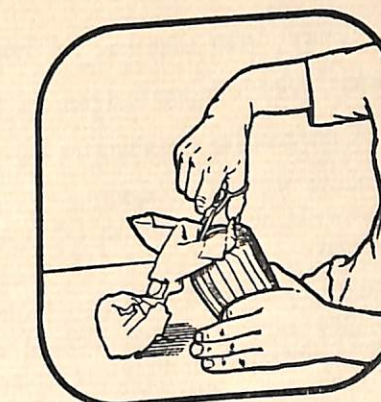


Fig. 63

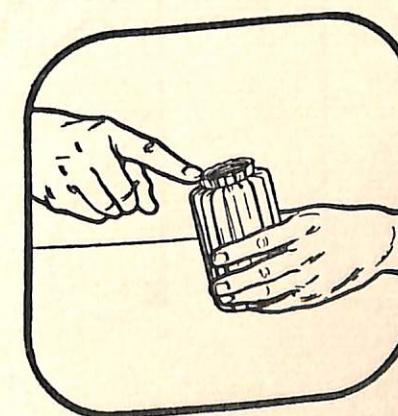


Fig. 64

In this case, even more than in the previous examples, it is advisable to have a spare element available for replacement while the other is being cleaned.

For time period for renewal of the felt portion of the element (See pages 17-20).

To remove the element :

- (a) Unscrew the nut on the filter head and drop case (see fig. 65).
- (b) Remove element complete with cage from filter bowl, care being taken not to damage the cork sealing washer (see fig. 66).
- (c) Unscrew knurled nut from centre support (see fig. 67).
- (d) Remove bottom cover plate from cage (see fig. 68).
- (e) Remove element from cage (see fig. 69).
- (f) Slide off metal clip from element (see fig. 70).
- (g) Spread out element for cleaning (see fig. 71).
- (h) An alternative method of securing the element together is by using staples in place of the metal clip.

To clean an element of this type without removing the staples, stretch element out, clean with paraffin and refold before replacing in cage (see figs. 72 and 73). Ensure that the cage is perfectly clean before replacing element.

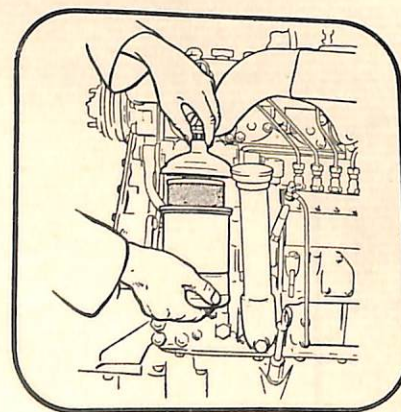


FIG. 65



FIG. 66

- (i) Replace felt pad on top cover plate (see fig. 74).
- (j) Replace felt pad to bottom cover plate before replacing cage and element complete (see fig. 75).
- (k) Before replacing into the filter bowl, ensure that the bowl is clean.

LUBRICATING OIL FILTER JOINTS.

There are two joints in the lubricating oil filter. The first is a rubber joint between the filter head and the filter bowl ; it fits in a recess in the filter head.

The second is a cork joint between the filter head and the top cover of the filter element cage.

When dismantling the filter for cleaning purposes, care should be taken not to damage these joints. If it is found that either of these joints is damaged, it should be replaced by a new joint.

Spare Element.

It cannot be too frequently emphasised that in all filters, whatever the type, a spare unit should be kept at hand for use when the element in use requires cleaning. This simplifies " periodic attentions " when the vehicle is in dock and saves time.

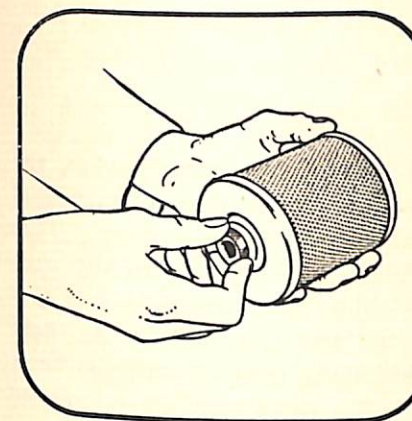


FIG. 67.

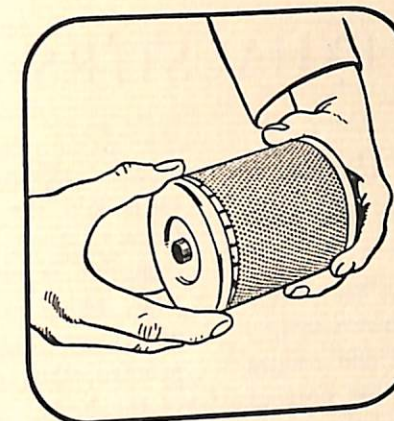


FIG. 68

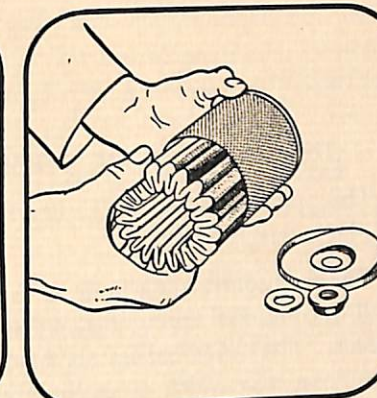


FIG. 69.

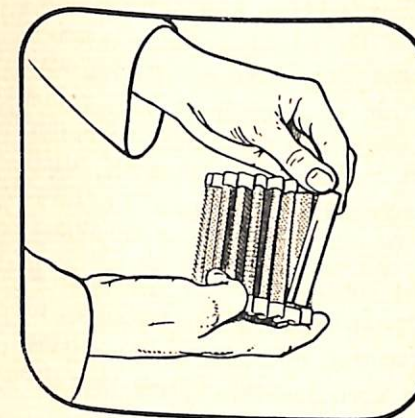


FIG. 70.

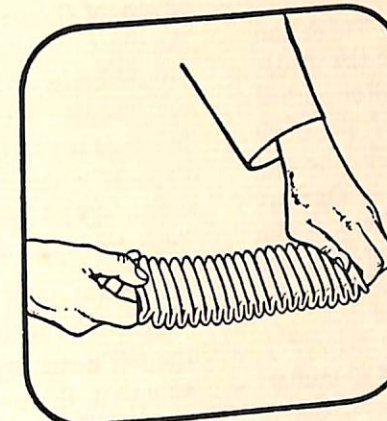


FIG. 71.

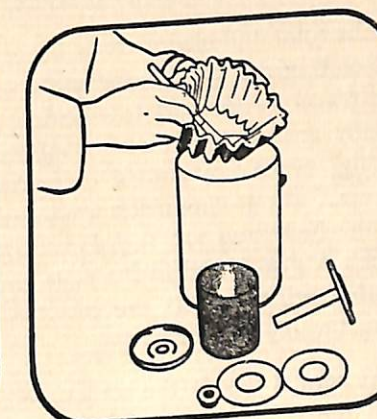


FIG. 72.

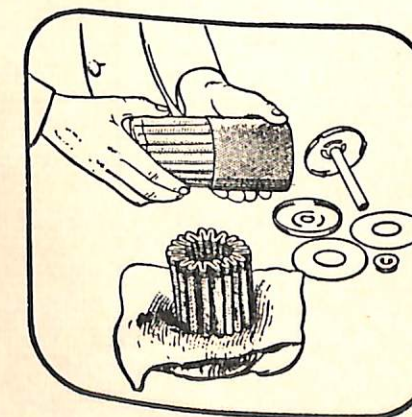


FIG. 73.

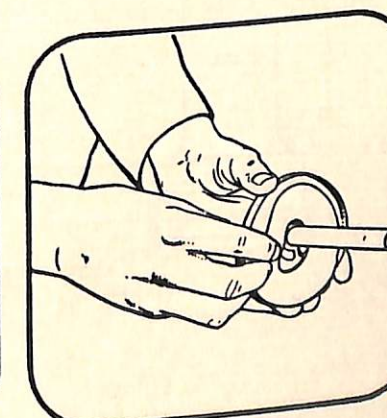


FIG. 74.

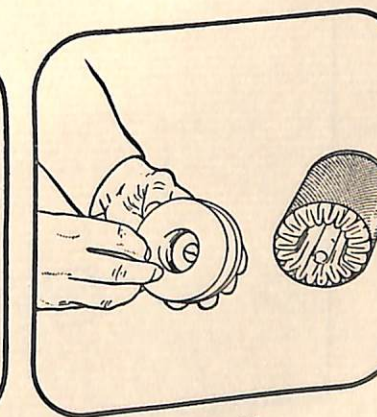


FIG. 75.

EXHAUSTERS

DESCRIPTION OF OPERATION.

The machines fitted by F. Perkins Limited are of the rotary type.

The main parts are a body, a rotor, heavy duty ball bearings and spring loaded piston ring sealing plates. The rotor carries six blades and rotates about an axis which is eccentric to the bore of the body. The spaces between the blades, rotor and body thus increase and decrease as rotation occurs. The inlet port is situated on the side where the spaces are increasing and the exhaust or outlet port on the side where they are decreasing. Air is thus drawn in at a low pressure and expelled at a higher (atmospheric) pressure.

The rotor and blades are of the same length and the ends of the working spaces between the blades are sealed by the cast iron sealing plates pushed axially against the rotor by means of six small springs which are housed in pockets in the end covers. The sealing plates are located in the bore of the body and are sealed radially by a piston ring. A peg riveted to the plate and fitted in one of the spring pockets prevents the sealing plates from turning with the rotor.

At normal speeds, the blades are kept in contact with the body bore by centrifugal force, but at

engine "tick-over" speed, particularly when the oil is cold, the blades have insufficient centrifugal force to keep them in their true motion. This condition is overcome by the action of the cam rings, which contact the inside edges of the blades and force them to move out radially in their grooves, thus maintaining contact with the bore of the body. The cam rings are "push" fit in the sealing plates.

Ball races which are located in each end cover, and large enough to take a certain amount of end thrust, are mounted on the rotor shaft and held in position by hardened steel collars.

During operation, the pressure inside the end covers of the machine is below atmospheric, since the mean pressure of the working spaces is below atmospheric. On the other hand, at starting with the vacuum reservoir at atmospheric and for a few seconds until a sufficient vacuum is generated there is a tendency to blow oil out at the shaft ends. For these reasons double seals are fitted back to back and run on hardened shaft collars.

The oil used for lubricating the exhausters is engine oil and is drawn from the engine sump to the exhauster by vacuum, returning to the engine sump via the outlet port, and thus lubricating the moving parts of the exhauster.

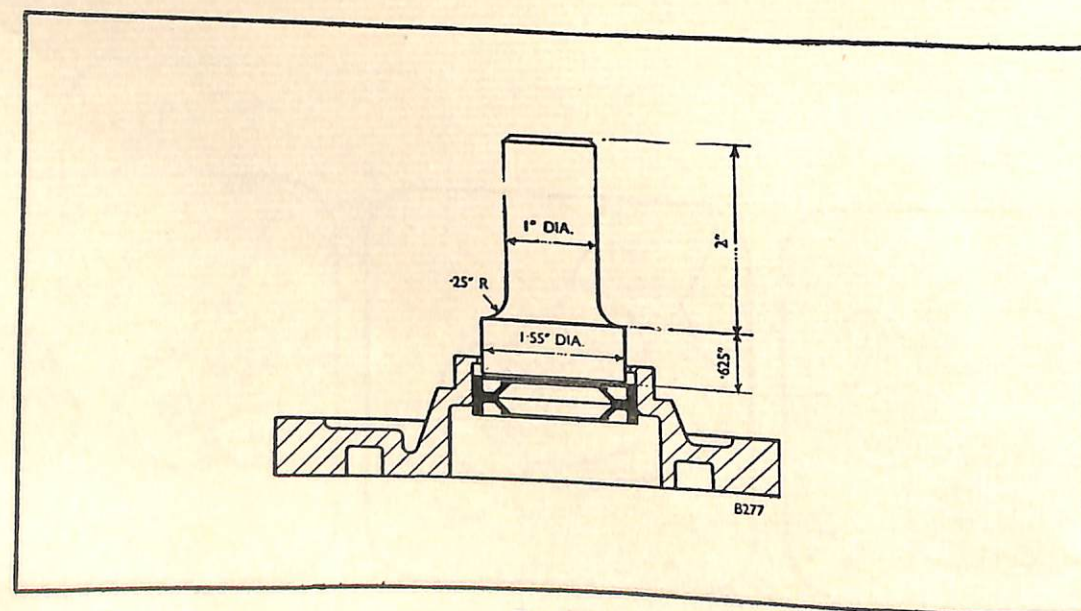


FIG. 76.

The oil connection is located on the body, in the form of a banjo connection for $\frac{3}{8}$ in. o/d pipe.

An exhaustor in good condition will easily generate a vacuum to within an inch of the barometric height but prolonged running at such a vacuum tends to create unnecessary heat in the machine. Furthermore is it not normally desirable to employ such a high vacuum for braking purposes since time is taken to attain the last few inches of the working range, which is normally between 20" and 25" of mercury. To overcome this, the machine is fitted with a snifter valve which is factory set to admit air at 25" of mercury. This valve consists of a ball, spring loaded on a seat, and is fitted in the top cover of the block.

When the vacuum in the reservoir is greater than

the vacuum generated by the exhauster, due to slowing down of the engine r.p.m., the non-return valve seats, and prevents leakage of vacuum from the system.

DISMANTLING INSTRUCTIONS.

1. Remove couplings and keys from shaft ends.
2. Remove four end cover bolts and ease off end covers. With the end cover will come the oil seals, seal back plates and springs.
3. To remove seals from end covers use a punch as shown in Fig. 76.
4. Withdraw rotor, sealing plates, bearings, cam rings, blades and shaft collars from body in one assembly.
5. Remove blades from rotor.
6. Remove sealing plates.

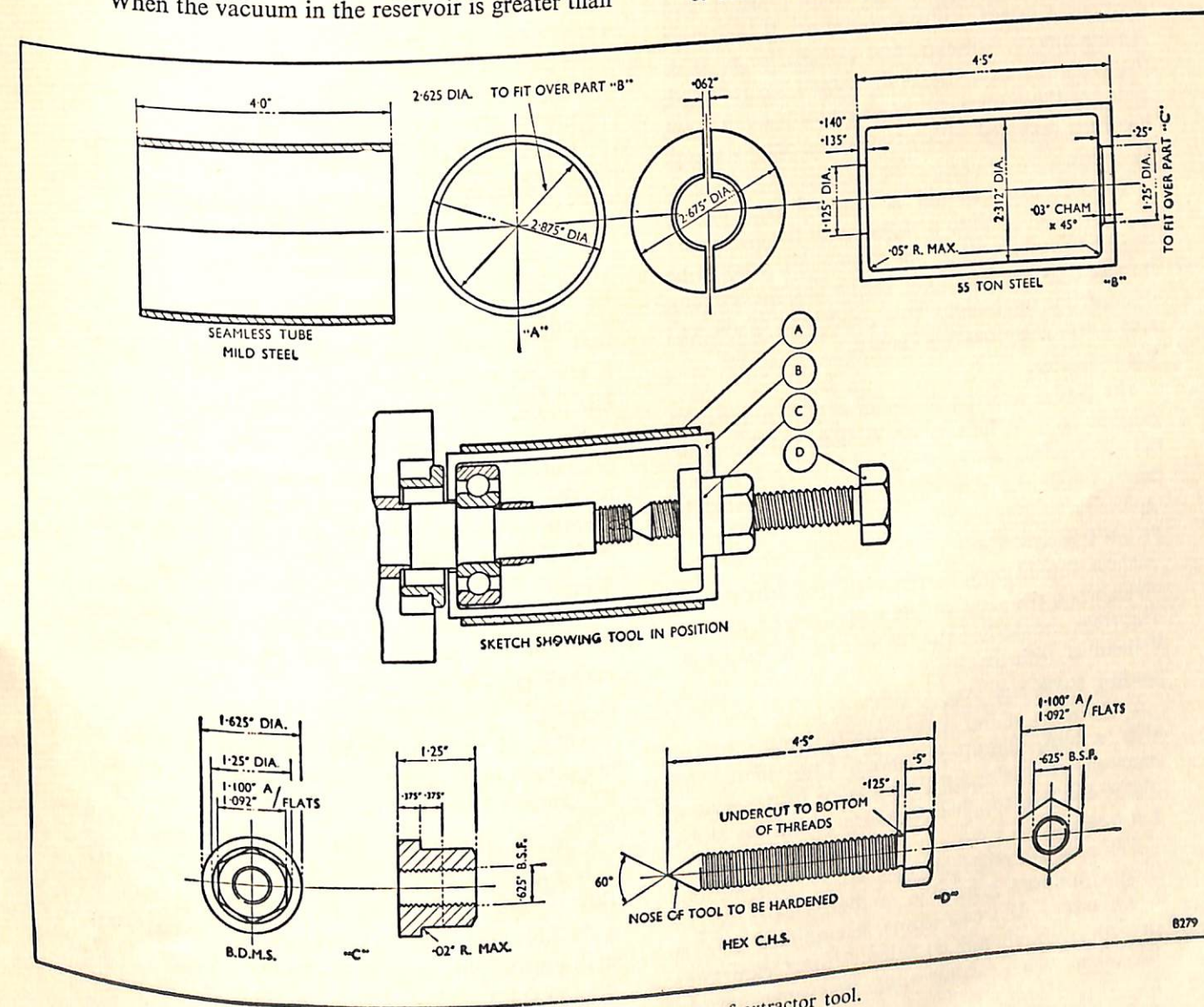


FIG. 77. Details and assembly of extractor tool.

ONLY IF IT IS REALLY NECESSARY MUST THE FOLLOWING DISMANTLING OF THE ROTOR BE CARRIED OUT.

7. To remove bearings, cam rings and shaft collars, an extractor tool is necessary, and is illustrated in Fig. 77. The claws of the extractor should be inserted between the bearings and cam ring. On screwing the bolt up against the rotor shaft end, the ball race and shaft collar will then be extracted together. The cam rings can then be removed from the rotor.

INSPECTION OF DISMANTLED PARTS.

Body.

After a long period in service, the bore of the body may show markings in the form of lines or ripples running longitudinally and coinciding with the end of the port openings. This is usual, and if of slight extent, will do no harm. If the ripple is pronounced, however, and extends for most of the circumference, the body should be replaced. This condition may also be caused if the exhaustor has been operated without adequate supply of oil.

Bearings.

Worn bearings should be replaced immediately. If a premature failure is experienced the cause may be due to end thrust on the rotor shaft, this can be imposed by swollen fibre in the flexible coupling or coupling mal-alignment. Shortage of oil will also cause early bearing failure.

Rotor Blades.

The blades wear on the outer edge, but a certain amount of wear here is permissible; if, however, the inner edges are appreciably "stepped" where they contact the cam ring, the blades should be replaced.

Piston Rings.

These should only be removed from the sealing plates when the rings or the plates need replacing. The rings should last the lifetime of the exhaustor if handled with care.

Sealing Plate and Peg.

If the faces of the sealing plates become scored after a long period of service, they should be renewed. Locating pegs are riveted to the sealing plates and are supplied together as an assembly.

Oil Seals.

Oil seals are adversely affected by dirty oil and dirty conditions generally, as the particles of grit cause wear. If troublesome, a complete new set of four seals should be fitted. Great care must be taken when withdrawing and replacing the

shaft seals as the delicate sealing edges are easily damaged. The seal guide must always be used during this operation.

Snifter Valve.

If necessary, the snifter valve can be resealed by tapping the ball on its seat, using a brass drift.

Vacuum Reservoir Non-Return Valve.

The non-return valve is rubber-seated, and a new rubber disc can be fitted if necessary. The metal

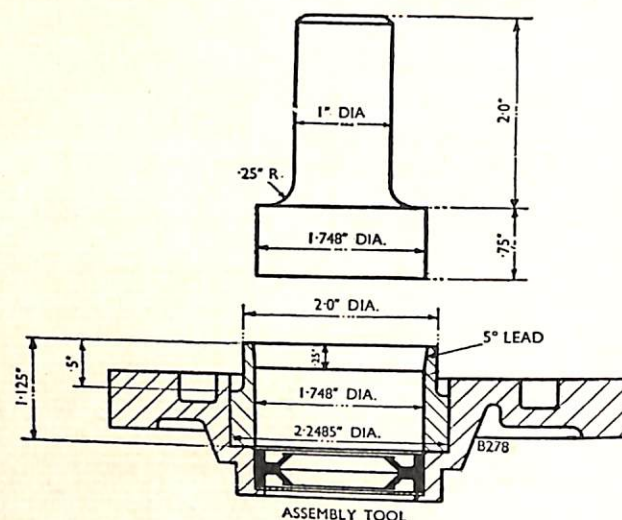


FIG. 78.

part of the valve seat should be lightly skimmed if any pitting is apparent.

Oil Filter.

This may be fitted either at the bottom of the oil suction pipe in the sump or in the control block on the top of the exhaustor body and should be cleaned periodically to ensure a good flow of oil. Renew if necessary.

Joints.

It is advisable to fit new joints whenever the exhaustor has been dismantled, to obviate the risk of leakage.

General.

All parts not specifically mentioned should be inspected for damage or deterioration and renewed if necessary.

ASSEMBLING AN EXHAUSTER.

1. The seals should be fitted in the end covers. Fig. 78 illustrates the correct method of assembly.
2. Slide cam rings on rotor and replace bearings, making certain they butt against the shoulder on the rotor shaft. Drive on shaft collars up to bearings. Check bearings for "tightness." Fit

piston rings into grooves in sealing plates, ensuring they seat below bore dia. Pass sealing plates over bearings and locate them on the cam ring spigot. Replace blades in rotor slots and check for freedom of movement.

3. Slide rotor assembly into body.

4. Replace sealing plate springs in pockets of end covers, using grease to hold them in position.

5. Smear end cover joints with grease and "stick" them on covers in their correct position.

6. Place the large seal back plates in end cover making certain they drop to the bottom of the ball race seats.

7. With the rotor in position in the body, the end covers should be slipped over the shaft ends and pushed home, taking care that the sealing plate peg fits in one of the sealing plate springs. During this operation a protecting sleeve as shown in Fig. 79 must be used to prevent the seal edges being damaged by the seal collars.

8. Replace end cover bolts and tighten. Check rotor to ensure free rotation.

9. Replace keys and couplings.

10. The snifter valve is assembled and set to operate at a pressure of 25 inches of mercury, in the following manner:—

- (a) Replace spring with its larger diameter coil to the inside of the body.
- (b) Drop in steel ball.
- (c) Screw in valve seat.
- (d) Connect exhaustor to vacuum reservoir, which should be equipped with a reliable gauge.
- (e) Run the exhaustor at 200 r.p.m. and allow vacuum gauge to settle at a steady reading. If the vacuum is too low, it is necessary to fit new parts to the valve and reseat as required for efficient operation.

Where the snifter pipe is cast integral with the exhaustor body, access to the snifter valve may be had by removal of a plug located low down on the exhaustor body. When replacing the snifter valve in this case, ensure that the ball is replaced first and then the tapered spring; the narrow end of the tapered spring should be against the ball valve. Ensure also that the washer is replaced in good condition when replacing plug.

END THRUST.

All the following points are of great importance for trouble free running, but it is desired to emphasise that to function effectively, the Rotary Exhaustor must have its rotor revolving freely and centrally between the spring loaded end plates.

If the rotor is displaced endwise, one of the sealing plates is lifted away from the end of the body and leak paths round the faces of the sealing plates are brought into existence. These leak paths will cause a loss of vacuum.

The first and most important service attention, therefore, is to see that when assembled on the engine, there is not the least end thrust on the rotor shaft. The couplings should be designed and assembled with about .030 in. clearance in an axial direction and it should be checked that this clearance is still there if for any reason the exhaustor performance is unsatisfactory. This check can be made by levering with a screwdriver or small chisel ended bar at the coupling ends and in doing this, care should be taken to avoid damage to the shaft oil seals.

With the modified B.350 exhaustor which has the control block situated on the top of the exhaustor body, heavier type bearings are incorporated, therefore the clearance referred to above is no longer necessary.

Causes of end thrust include:—

- (a) Swelling of flexible couplings due to impregnation by fuel oil. Certain types of flexible couplings after having been in service for a time may get oil on the fibre insert, causing it to swell and imposing a thrust upon the exhaustor shaft. If this condition is found to

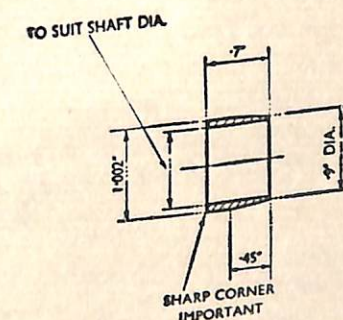


FIG. 79.

exist, the insert should be renewed immediately, or, if this is not possible, it is necessary to reduce the width of the coupling by say 2 m/m. at the same time ensuring that the coupling ends as fixed on the exhaustor rotor are free to move axially in the fibre portion of the coupling.

(b) **Difficulties arising during transit of Exhauster.**

A similar condition sometimes occurs when exhausters have been packed for transport and the full weight of the exhauster may have rested upon one end of the shaft. This causes the rotor to be forced to the opposite end inside the housing and when unpacked may remain in this position owing to the fact that the shaft races are new and may be a little stiff in their housings. If this occurs both ends of the shaft should be lightly

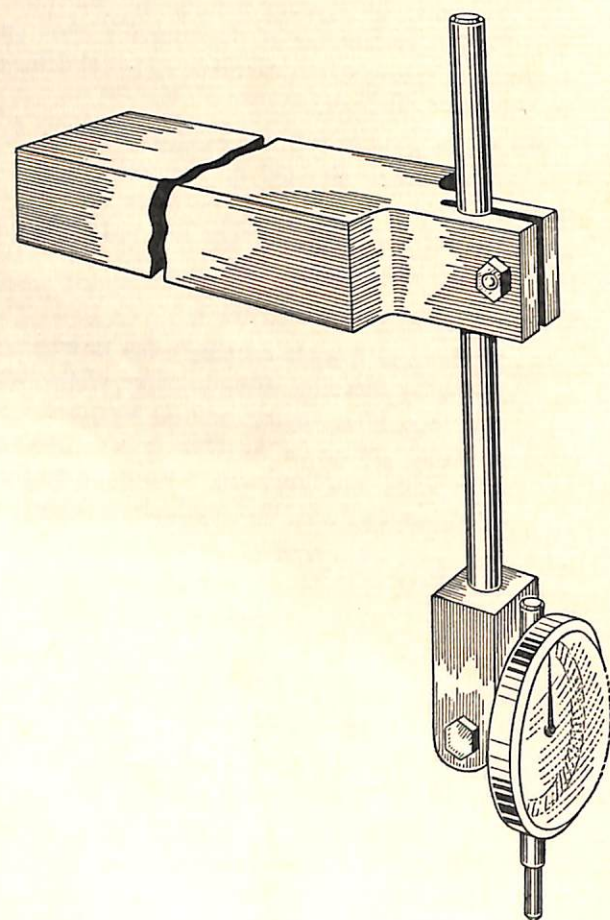


FIG. 80.

tapped with a piece of wood until the rotor centralises itself.

Correct alignment of Exhauster Drive. Special care should also be taken when mounting the exhauster to see that there is no mal-alignment as this will cause severe loading of the ball bearings and wear of driving couplings. This initial fitting is most important in the case of the base-mounted exhauster adopted by F. Perkins Ltd.

A satisfactory method of checking for alignment in this case is by running the engine at approximately 400 r.p.m. (idling speed) then slack off the four bolts at the base of the exhauster. These bolts are used for fixing the unit to the engine platform and as the holes in the base of the exhausters have clearance, the unit can be moved to either side, or endwise, and shims fitted if necessary to obtain the correct position. For maximum generating figures an endwise clearance in each direction is essential. The fixing bolts should then be finally tightened. If at any time the platform is disturbed in relation to the cylinder block it will be necessary to check the alignment.

The alignment of the exhauster platform is carried out at Peterborough by means of a very accurate jig of special design. For the normal workshop, however, the dial gauge and stand as shown in Fig. 80 is quite satisfactory if used with care.

PROCEDURE FOR USE OF GAUGE.

Remove the coupling halves from the exhauster shaft and fuel pump drive shaft.

With cylinder head removed and with the base of the jig flat on the top face of the cylinder block set the gauge from the fuel pump drive shaft.

Take the readings from each end of the exhauster shaft and adjust the exhauster platform as necessary to give equal readings.

NOTE.—This must be done with the joint in position between exhauster and platform.

When the platform has been lined up the exhauster can be lined up in relation to the fuel pump as above, by slacking off the four holding bolts.

P. SERIES MARINE

This section has been prepared for the purpose of explaining the variations in component parts used on the P Series Marine Engine as against other P Series engines.

Gearbox Adaptor and Gearbox.

The drive to the gearbox is taken from an input adaptor from the engine flywheel.

The gearbox incorporates its own oil pump and sump and is in no way dependent on the engine for its oil supply; the only remote connection being that the gearbox oil is cooled by the oil cooler but in a separate chamber. The oil is pumped up to this chamber and returned by another pipe to the gearbox.

The engine has a hydraulic throttle fitted which connects the gearbox to the engine throttle. This throttle arrangement prevents the engine being speeded in neutral gear and risking damage to the gearbox.

Provision is made however for the fitting of a cable to the throttle in order that it may be opened in neutral gear to effect easy starting.

For further information regarding the gearbox, reduction gear, and interlocking gear, contact the Service Department, F. Perkins Ltd., Peterborough.

Replacing Input Coupling and Gearbox

With the flywheel housing correctly aligned (see page 63) and the crankshaft flange, flywheel and gearbox input coupling perfectly clean and free from burrs, place the flywheel and input coupling on the crankshaft flange.

Insert the setscrews complete with flat washers into the coupling and flywheel holes and tighten evenly.

Care should be taken when tightening the setscrews that the outer diameter of the coupling is not damaged as any burrs here may impair the efficiency of the oil seal which is fitted in the gearbox to prevent the gearbox oil reaching the flywheel.

Secure the base of a "clock" gauge to the flywheel housing and check the alignment of the flywheel (see page 63).

With the "clock" gauge still bolted to the flywheel housing, adjust the clock so as to set the needle on the outside diameter of the gearbox input coupling.

Turn the crankshaft and check that the coupling is truly central.

When it has been ascertained that the flywheel and gearbox coupling are within the limits of plus or minus two-and-a-half-thousandths of an inch, wire the securing setscrews in pairs.

Now ease the gearbox into position and finally secure by means of the nuts and washers.

Electrical Equipment.

A 24-volt system is employed. The dynamo is mounted on the starboard side of the engine being driven in tandem with the water pump.

The starter motor is of the axial type and is mounted on the top of the gearbox, the starter dog engaging with the starter ring on the flywheel at the aft end of the engine.

Water Pump.

The cooling water is circulated by a pump of the roller type which is mounted on the starboard side of the engine. The water pump can be removed without disturbing the water pump drive, but the dynamo must be removed.

The only maintenance required is the greasing of the two seals which should be lubricated daily. Two grease cups are fitted for this purpose and should be kept filled. Sometimes the pump is unsatisfactory and the cause is found to be due to the grease cups not being filled and the pump in consequence drawing in air.

The pump must be primed when first fitted. Afterwards it is not necessary to prime unless the engine has been standing for long periods.

Removal and Dismantling.

To remove the pump it is necessary first to remove the dynamo which is coupled in tandem to it. Next remove the water inlet and outlet hoses. The pump is then detached by removing the nuts and spring washers securing it to the rear of the timing case front cover.

To dismantle the pump, remove the two couplings from each end of the rotor shaft. Unscrew the setscrews which secure the end cover plate to the body of the pump. Remove the end cover plate and withdraw the shaft and rotor.

Servicing.

After considerable service some slight wear on the end of the body may occur. This is overcome by facing a little off the face of the body to allow the cover to go up tighter against the rotor.

Replace rotors if unduly worn. This can be caused by sand or other abrasive matter entering the pump.

Re-assemble in reverse order to dismantling, taking care that a new joint is fitted between the end cover plate and the pump body.

The Water Pump Drive.

The water pump is driven by a double roller chain from a sprocket connected to the auxiliary drive. This drive is enclosed in the water pump drive cover which fastens on the front of the timing case cover. In order to lubricate the chain, an oil feed is taken from the bottom connection of the oil reducing system on the camshaft housing. Provision is made for the excess oil to escape by means of a small hole through the timing case front cover into the timing case and so back to the sump.

Chain whip is taken up by a steel damper pad which is tensioned by a coil spring.

Dismantling the Drive.

Begin by draining all water from the engine. The drain cock may be on either side of the cylinder block. Unscrew the oil pipe union on top of the drive cover and the two nuts securing the tachometer drive connection and remove the tachometer drive.

The water pump drive cover can then be removed by removing the setscrews and spring washers which secure it to the timing case front cover.

To slacken the tension of the chain, unhook the spring underneath the chain damper pad. The chain can now be removed by withdrawing the connecting link which is secured by a spring clip.

The removal of the water pump sprocket and shaft necessitates the removal of the dynamo and water pump. Remove the half coupling on the rear of the water pump sprocket shaft, withdraw the shaft and press off the sprocket.

The removal of the auxiliary drive sprocket and shaft necessitates the removal of the timing case front cover. This can be removed by unscrewing the setscrews securing it to the timing case.

Withdraw the auxiliary driving sprocket by using a suitable extractor. Two tapped holes are provided in the sprocket for this purpose. The sprocket shaft can then be removed from the other side of the timing case front cover.

Re-assembling.

Replace the auxiliary sprocket drive shaft with the coupling end to the inside of the timing case front cover. Press the auxiliary driving sprocket on the shaft in a relative position to the Woodruff key. Ensure that the shaft is free to rotate in bush.

Fit a new joint on the face of the timing case and replace timing case front cover ensuring the auxiliary drive coupling is correctly connected.

Press the water pump sprocket on to the drive shaft in a relative position to the Woodruff key and fit the shaft in the bush in the timing case front cover. Ensure that the longer end of the shaft is towards the rear for coupling to the water pump.

Replace the chain and connect with the coupling link with the open end of the spring clip trailing. The chain rotates in a clockwise direction. Hook up the spring to the steel damper pad in order to tension the chain.

Fit a new joint and replace the water pump drive cover, positioning it by means of the two dowels provided. Secure with setscrews and spring washers.

Finally connect the tachometer drive and oil feed connection.

The water pump and dynamo are replaced in reverse order to when removed.

Exhaust Manifold.

The exhaust manifold is water cooled and is constructed of sea water resisting alloy. The

water enters the manifold at the exhaust outlet end from the oil cooler, passes through the inner casing and out at the forward end into the water manifold.

Oil Cooler.

The oil cooler is mounted on the gearbox adaptor. It is divided into two chambers, one smaller than the other. Two sets of tubes run horizontally from end to end of the cooler. The cooling water runs through the centre of these tubes and the lubricating oil round the outside of these tubes.

The same water flow feeds both chambers, but the engine oil is cooled in the larger chamber and the gearbox oil in the smaller. The oils are prevented from mixing by means of a neoprene joint between the two chambers. There is also a neoprene joint at each end of the cooler to prevent the water from leaking into the oil.

The cooling chamber for the engine oil is the larger of the two, in order to deal with the higher temperatures reached by the engine oil.

Sump Oil Pump (Hand Operated).

A hand pump is provided to facilitate the draining of the lubricating oil from the engine or gearbox sump as on the majority of marine installations, it is not possible to gain access to the drain plug which is situated at the bottom of the sump.

A two way tap is provided for switching from engine sump to gearbox sump.

Lubricating Oil Filler Body.

This is mounted on the top of the cylinder head cover in an easily accessible position. When filling, the oil flows through the cylinder head into the camshaft chamber and an external pipe carries it to the crankcase, and so to the sump.

NOTE :—The information contained in this leaflet is correct at the date of publication, but due to continuous developments the Manufacturers reserve the right to alter this specification without notice.

F. PERKINS LIMITED
Service Department

Revised January, 1954

Lubricating Oil Specifications

ADDITIONAL

SERVICE

DATA

F. PERKINS LIMITED

Service Department

Revised January, 1954

Lubricating Oil Specifications

QUEEN STREET, PETERBOROUGH

Telephone 3241





F. Perkins Ltd. High Speed Diesel

EXAMPLES OF SERVICE FACILITIES

1 School of Instruction

AT PETERBOROUGH

Apply for Syllabus and leading particulars of the Course.

2 Perkins Mobile Diesel Instruction School

Apply for Mobile School Handbook.

3 Film Units

For Information apply to Service Department.

4 Perkins Perpetuity Plan

FULLY GUARANTEED Factory Replacement
Engines and Parts at Pre-determined Charges.
Apply for Perpetuity Handbook.



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

Enquire at your local Motor Trader or direct to F. Perkins Ltd., Service Department, Queen Street, Peterborough for further information.



P SERIES LUBRICATING OIL SPECIFICATIONS S SERIES

Normal Working Temperature	—20°F. to 30°F.	30°F. to 80°F.	80°F. or over
S.A.E. Designation	10W	20W or 20	30
Esso Petroleum Co. Ltd.	Essolube 10 (P) Essolube HD. 10 (HD) Esstic 42 Esstic HD. 10 (HD)	Essolube 20 (P) Essolube HD. 20 (HD) Esstic 50 Esstic HD. 20 (HD)	Essolube 30 (P) Essolube HD. 30 (HD) Esstic 65 Esstic HD. 30 (HD)
Imperial Oil Ltd.	Marvelube Heavy Duty 10W (HD)	Marvelube Heavy Duty 20—20W (HD)	Marvelube Heavy Duty 30 (HD)
Shell Group of Companies	Talpa 10 Rotella 10 (HD) Tractor 10	Shell Dervoil Light Talpa 20 Rotella 20 (HD) Tractor 20	Talpa 30 Rotella 30 (HD) Tractor 30
Alexander Duckham & Co. Ltd.	Duckhams SD. 10	Duckhams SD. 20	Duckhams SD. 30
Regent Oil Co. Ltd. Texaco/Caltex	R.P.M. Delo S.A.E. 10 (HD) Ursa X 10** (HD)	R.P.M. Delo S.A.E. 20 (HD) Ursa X 20** (HD)	R.P.M. Delo S.A.E. 30 (HD) Ursa X 30** (HD)
Vacuum Oil Co. Ltd.	Mobiloil Arctic Special (P) Delyvac 910 (HD) Mobiland Tractor 610	Mobiloil Arctic (P) Mobiland Diesel 20 (HD) Sovac 320 Delyvac 920 (HD) Mobiland Tractor 620	Mobiloil A (P) Mobiland Diesel 30 (HD) Sovac 330 Delyvac 930 (HD) Mobiland Tractor 630
Vigzol Oil Co. Ltd.	Vitaflm A. 10 (HD)	Vitaflm A. 20 (HD)	Vitaflm A. 30 (HD)
C. C. Wakefield & Co.	Castrol CR. 10 (HD) Deusol CR. 10 (HD) Agricastro HD. 10 (HD) Deusol FP Light (U.K. Only) Castrol Z (Overseas Only)	Castrol CR. 20 (HD) Deusol CR. 20 (HD) Agricastro HD. 20 (HD) Deusol FP	Castrol CR. 30 (HD) Deusol CR. 30 (HD) Agricastro HD. 30 (HD) Deusol FP Heavy
Germ Lubricants Ltd.	Germol D10 (HD) Germ Motoil EL Germ Tractor Oil EL	Germol D20 (HD) Germ Motoil L Germ Tractor Oil L	Germol D30 (HD) Germ Motoil M Germ Tractor Oil M
British American Oil Co.	Peerless Heavy Duty 10W (HD)	Peerless Heavy Duty 20—20W (HD)	Peerless Heavy Duty 30 (HD)

And other reputable brands to approved specification including : Any lubricating oils which have passed Approval Tests for the U.S. Ordnance Specification MIL-0-2104 in their S.A.E. 10 and 30 grades shall be deemed equally acceptable.

Special Note : Alternative grades are listed above which include both straight mineral oils free from additives and oils containing detergent or other additives. Under normal operating conditions perfectly satisfactory results are obtained from Perkins engines with non-additive oils but where operating conditions demand the additive oils quoted above may be used. It is absolutely essential when changing over from a straight oil to an oil containing detergent additives to comply with the following procedure if serious damage due to the cleansing effect of the detergent oil is to be avoided.

When fully detergent or "HD" oils are to be used, care must be taken to ensure that they are not mixed, either inside or outside the engine, with oils of other grades.

Take the following steps to remove all traces of the previous lubricant :—

1. Drain all existing oil whilst the engine is hot.
2. Fill the sump to just over the danger mark on the dipstick with new oil ; run the engine for 10 minutes at 1,000 r.p.m.
3. Drain sump and clean filter.

Oils marked with letters (HD) are fully detergent.

Oils marked with letter (P) are of premium grade, having an anti-oxidant and/or a mild detergent quality.

Where conditions of service warrant (e.g., continuous heavy load operation) the grades shown in the right hand column may be used in lieu of those shown in the first and centre columns.

The above Specifications are subject to alterations without notice.

4. Fill sump with the new oil ; run the engine for one day only.
5. Drain sump, fit new filter element and re-fill sump with new oil.
6. Carry on with normal routine operation.

F. Perkins Ltd. - Overseas Companies

CANADA

F. PERKINS (Canada) LTD.
237/239 McRae Drive
Leaside
TORONTO, 17
Ontario, Canada

Cables : Perkoil, Toronto
Telephone : Mohawk 4348/9

SOUTH AFRICA

F. PERKINS (S.A.) (Pty.) LTD.
P.O. Box 9951
156 Main Reef Road
JOHANNESBURG
South Africa

Cables : Saperk, Johannesburg
Telephone : Johannesburg 24-3087

FRANCE

F. PERKINS S.A.
2 rue Catulle-Mendes
PARIS, 17e.
France

Cables : Perkoil, Paris
Telephone : GALvani 86-05

AUSTRALIA

PERKINS DIESEL (Overseas) PTY. LTD.
Princes Highway, Dandenong
MELBOURNE
Victoria, Australia

Cables : Diesel, Dandenong
(Victoria, Australia)
Telephone : Dandenong 1277/8

Perkins Parts



for

Perkins Products