workshop manual for L4 diesel engines

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Unified Threads and Engine No. Location

All threads used on the L4 Engine, except on proprietary equipment and the crankshaft are Unified Series, and American Pipe Series. The crankshaft and starting dog nut are threaded 1″ American National Fine, 14 T.P.I.

Unified threads are not interchangeable with B.S.F. and although B.S.W. have the same number of threads per inch as Unified Coarse Series, interchanging is not recommended, due to a difference in the thread form.

The engine number is stamped on the top rear, right hand side of the cylinder block, as shown in the diagram below. This number should be quoted when requesting information or ordering Parts.

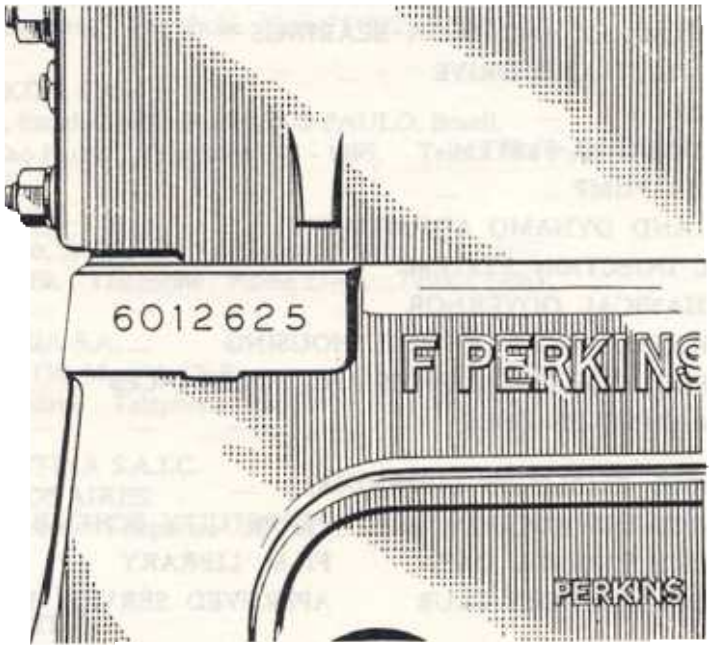

Diagram showing position of Engine No. 6012625

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 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 of 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 equipment fitted with the Perkins L4 Diesel engine and to others who are concerned with the sale and subsequent maintenance of such engines.

Perkins Engines 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. 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 time providing an effective aid to that co-operation.

Immediately this manual is received, 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 Perkins Engines Ltd. provide in order to ensure efficient service for the engines they market. Two of the others may appropriately be mentioned here.

Service Instruction is provided 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 Division of Perkins Engines Ltd., Peterborough in case of need.

ENGINE DESCRIPTION (A)

Perkins L4 Diesel engines are vertical four-stroke Power Units. They are entirely of British design and manufacture and embody 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 the 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 L4 Diesel, with which this manual is concerned, is a four cylinder unit having a bore and stroke of 4¼ in. (107.95 mm) and 4¾ in. (120.65 mm) respectively.

Cylinder Block.

The cylinder block and crankcase comprise a one-piece high duty alloy iron casting. Centrifugal cast iron wet liners are fitted, which are flanged at the top end and fitted with sealing rings at the lower end.

Cylinder Head.

The cylinder head is an alloy iron casting, secured to the cylinder block by a large number of well spaced through studs. The overhead valves are operated by push rods from flat faced tappets in the cylinder block, the rocker assembly being mounted on top of the cylinder head. The whole assembly is enclosed in a light alloy die cast cover. All valves are of special alloy steel, the inlet being larger to ensure maximum volumetric efficiency. The spherical combustion chamber is formed half in the head and half by a detachable steel cap.

Camshaft.

The low level camshaft is situated in the offside of the cylinder block and is supported by three bearings.

Crankshaft and Main Bearings.

The crankshaft is made from an alloy steel stamping, with hardened main and crankpin journals. The crankshaft runs in three pre-finished replaceable shell bearings, which are lead bronze lined and indium flashed.

Connecting Rods.

The connecting rods are of alloy steel "H" section stampings with replaceable steel shell big end bearings, which are lead bronze lined and indium flashed.

Pistons.

The pistons are flat topped. They are of light aluminium alloy with ample metal in the crown to carry off the heat of combustion. 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. The gudgeon pins are of the fully floating type.

Timing Drive.

The camshaft and fuel pump are gear driven, the timing case being a separate casting secured to the front end of the cylinder block. Provision is made for mounting a gear drive on the timing case meshing with the timing gear train, for driving a hydraulic pump or other low power auxiliary.

Lubrication.

Lubrication is high pressure force feed throughout the engine. The pump, a gear type, is secured to the cylinder block and is driven by spiral gears from the camshaft. It is fully capable of maintaining an adequate pressure at all running speeds.

Fuel Injection Equipment.

The unit type fuel pump is flange mounted on the timing case.

The atomisers are two hole type fitted in an accessible position on top of the cylinder head ; one spray is directed into the combustion chamber and the other into the cylinder, ensuring easy starting.

Cooling.

The cooling water is pump circulated by a centrifugal pump which is mounted on the front end of the cylinder block. It is driven, together with the dynamo, by a Vee belt from the engine crankshaft.

The internal water passages are arranged to give a brisk circulation of water around the combustion chamber and atomiser seating. The fan is mounted on the forward end of the water pump.

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 connected to the venturi inlet which houses the butterfly throttle valve control.

Cold Starting Equipment.

Comprises a hand pump, atomiser, priming tank, piping, induction heater and starter and heater switches. The induction heater is not in contact with the burning gases in the cylinder. It is located in the inlet venturi and is in use only during starting under very cold conditions.

Electric Starting Equipment.

A 12-volt starter is flange mounted on the flywheel housing.

Dynamo.

12-Volt ; earth return type complete with control box and fuse box. It is mounted on the off side of the cylinder block and is belt driven by a Vee-belt from the crankshaft.

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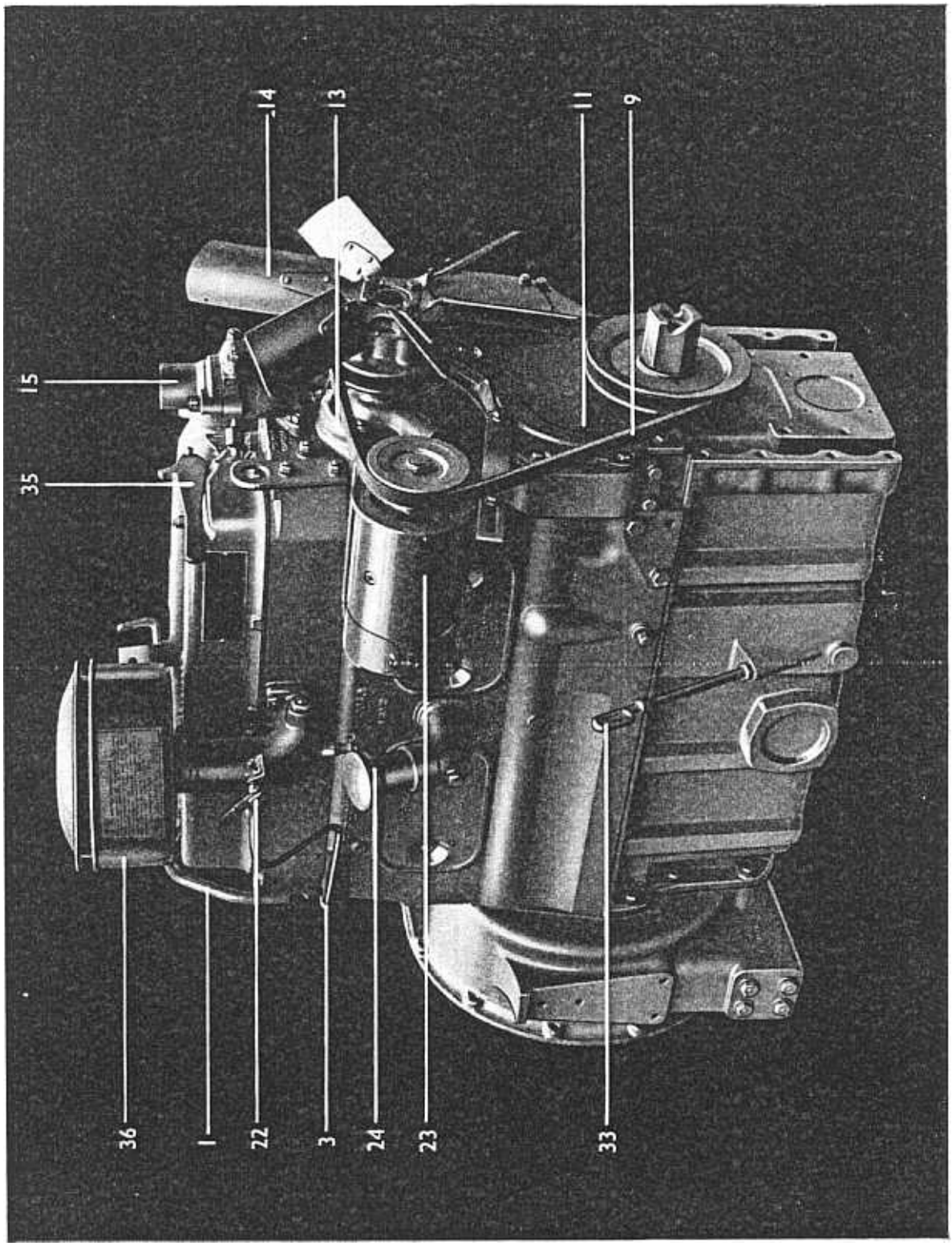
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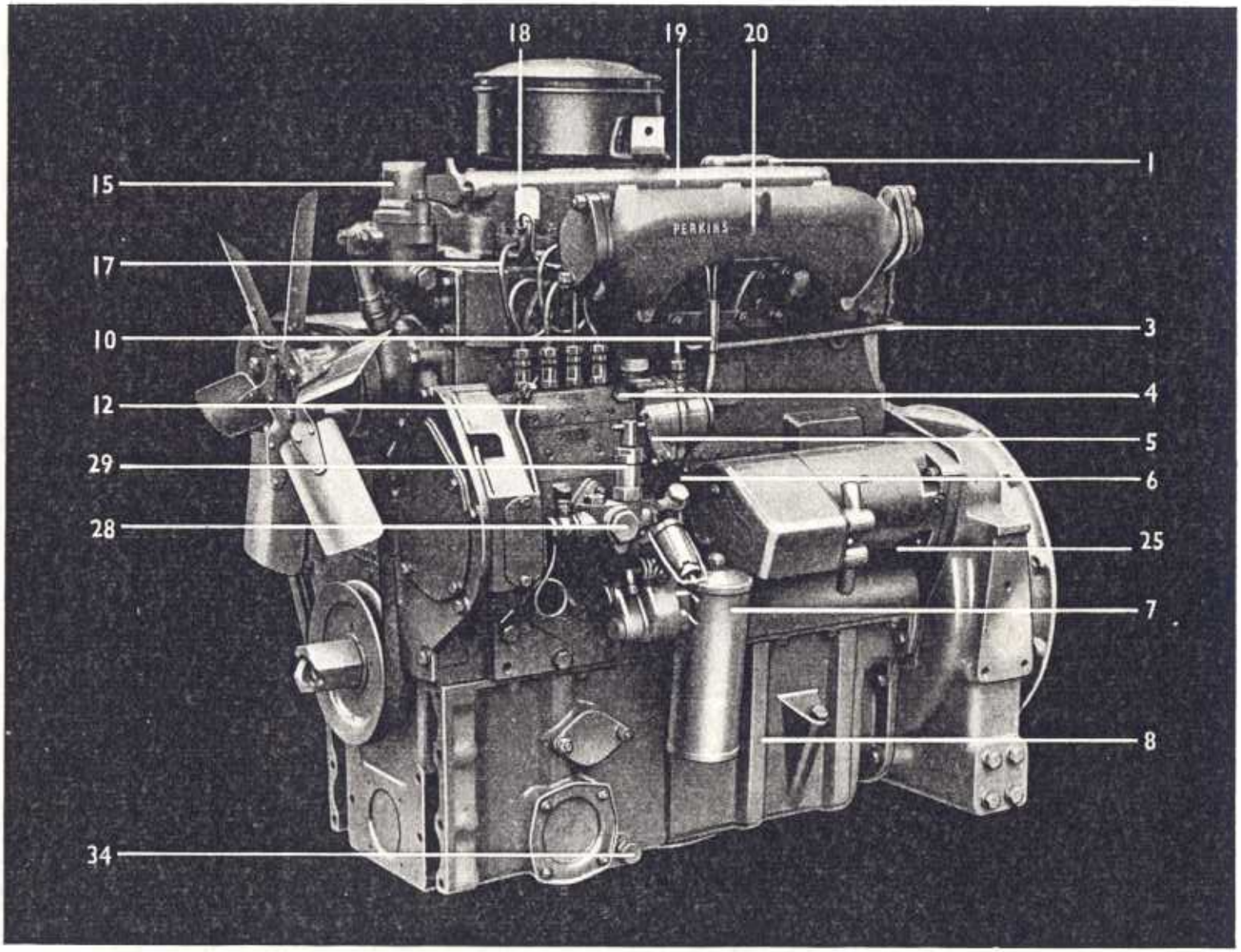
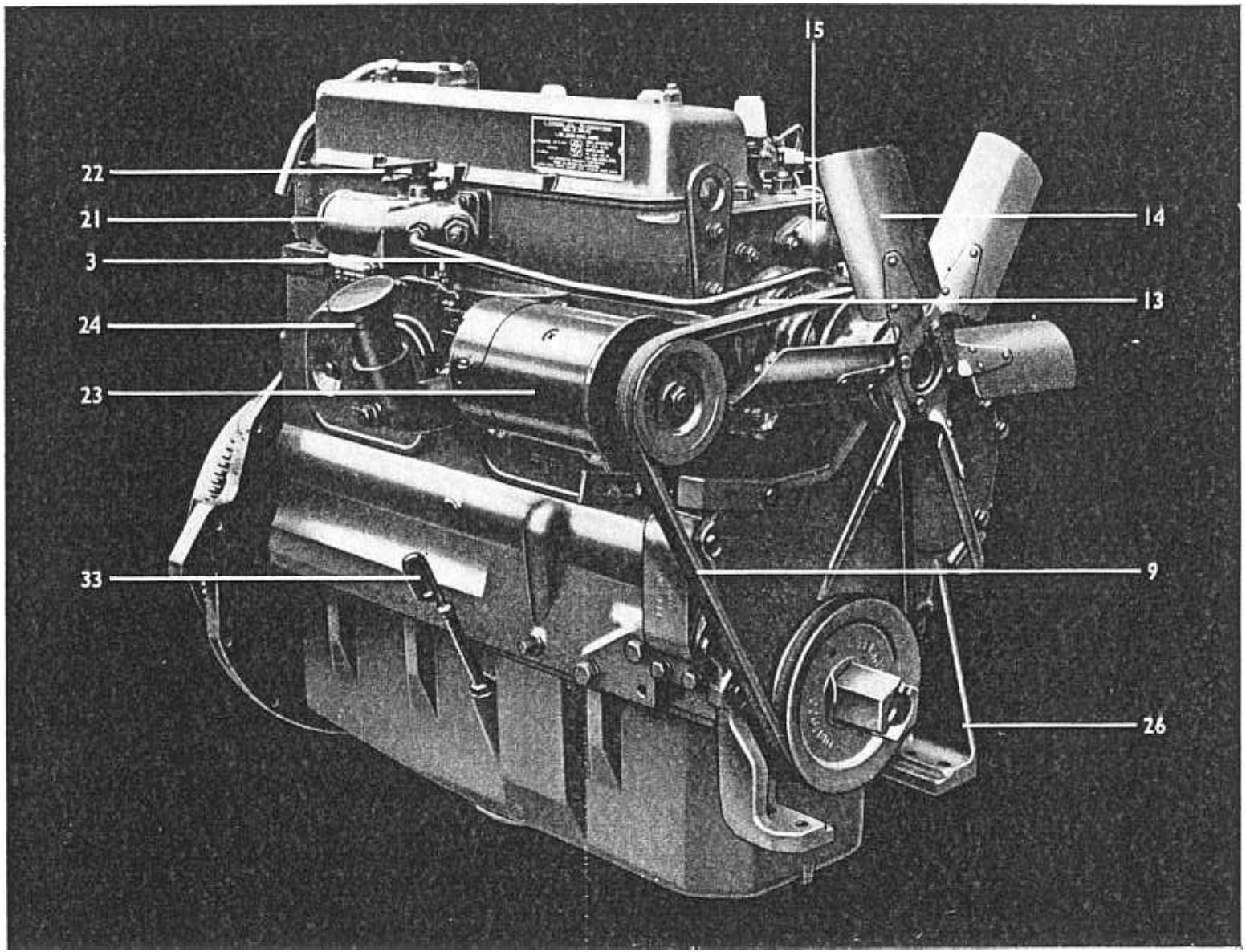


Near-side view of L4 (Industrial) engine.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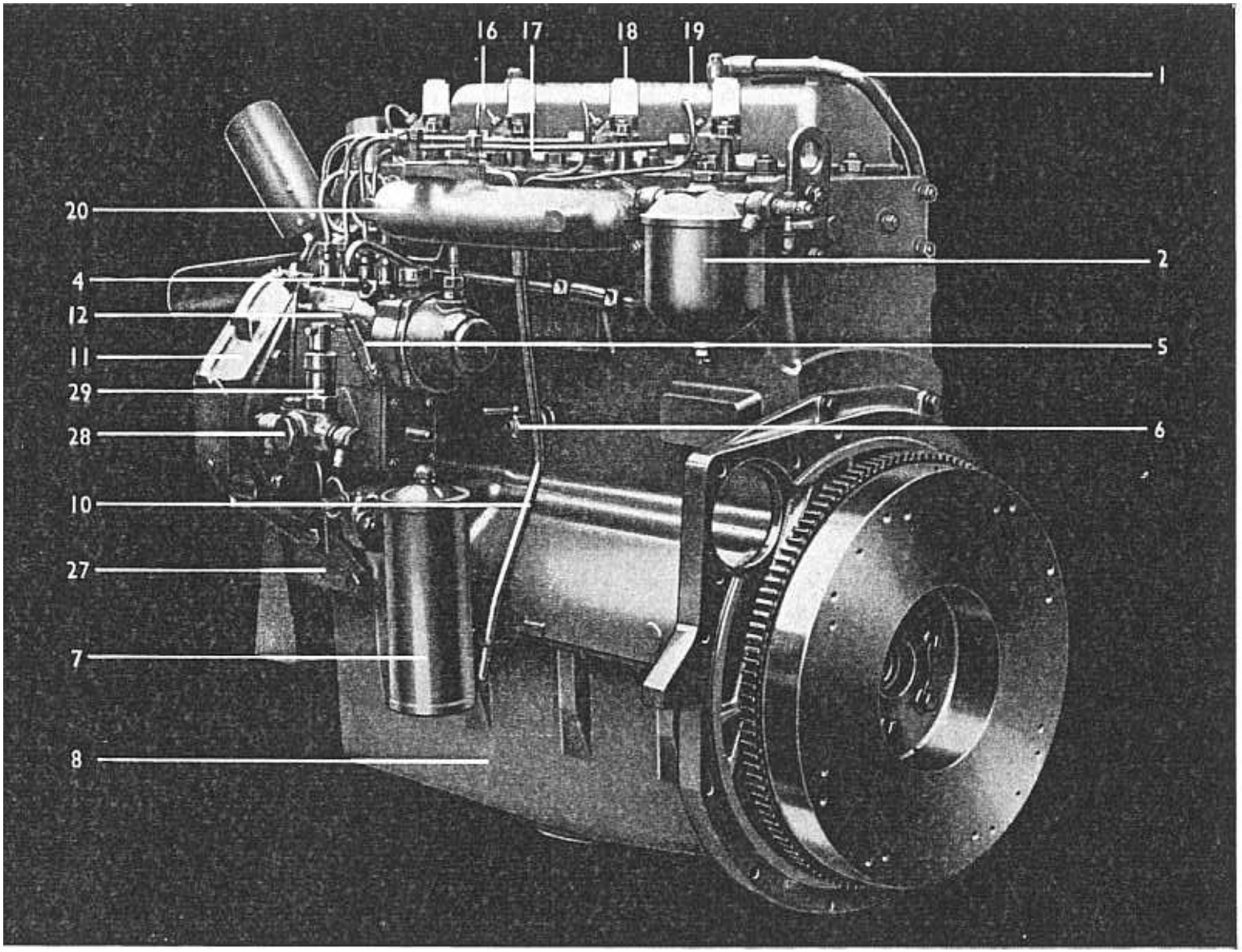
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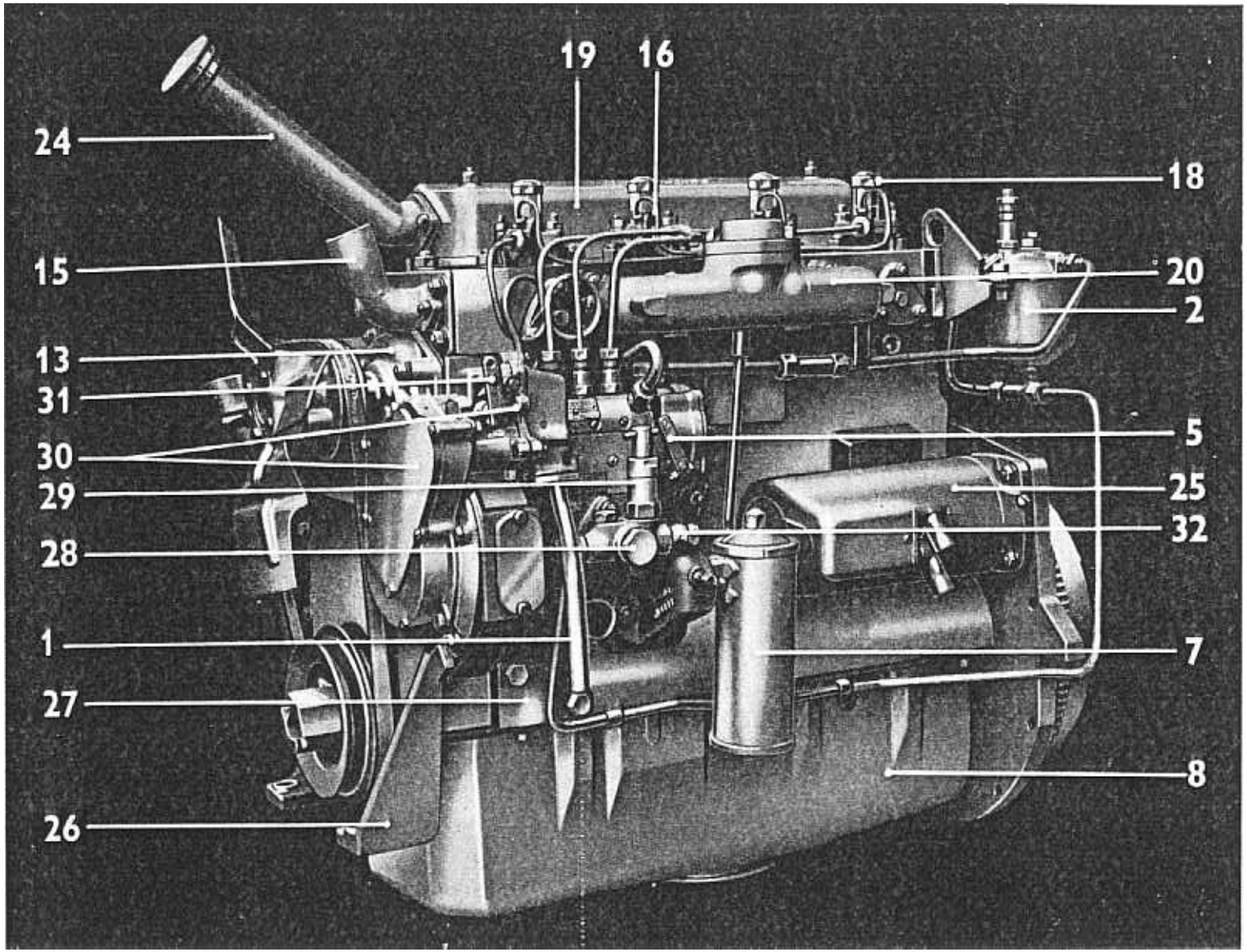
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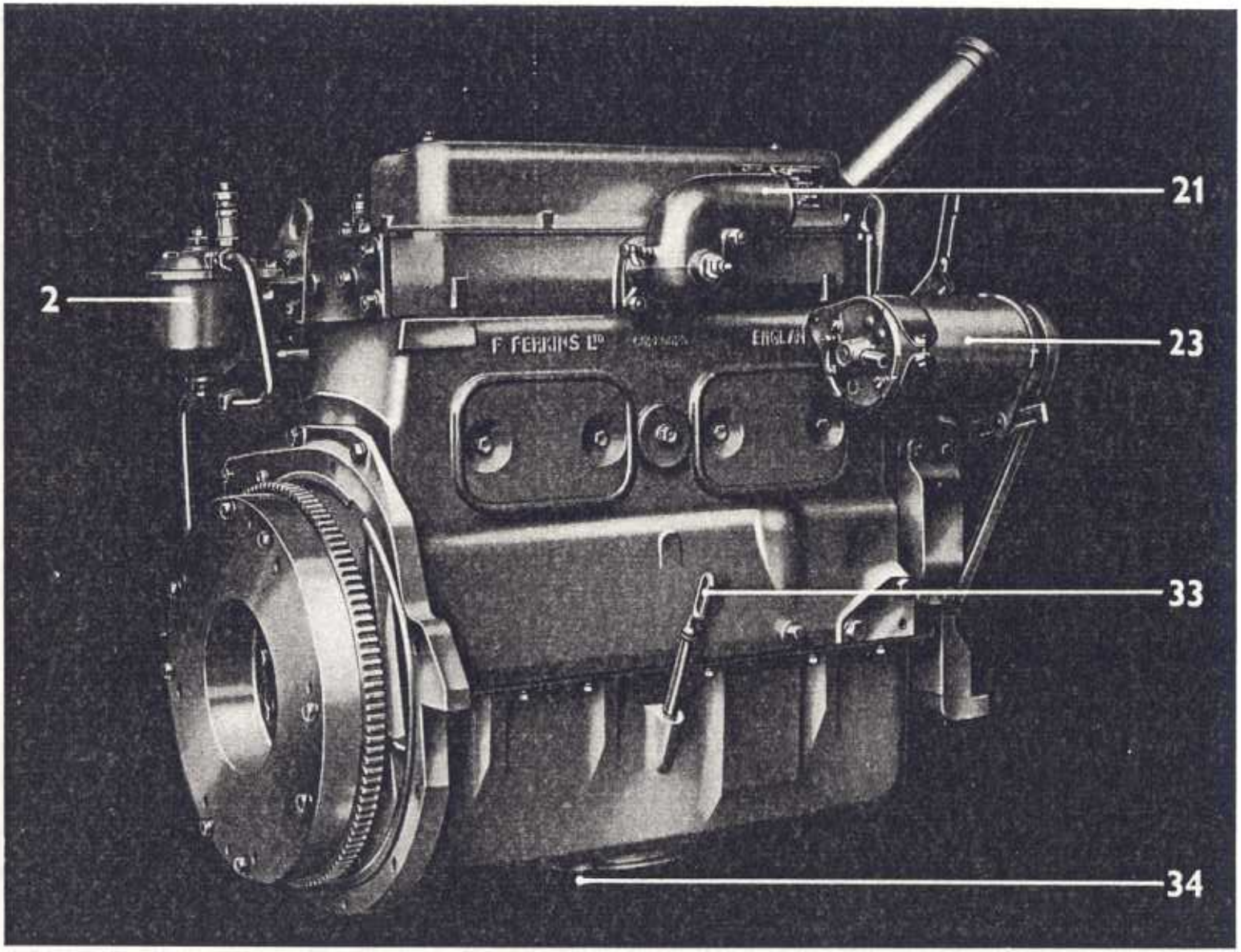


Off-side view of L4 (Combine) engine.

SETTINGS AND DATA (B)

Bore	4¼ in. or 107.95 mm
Stroke	4¾ in. or 120.6 mm
Number of cylinders	4
Swept volume	4.42 litres (270 cu.in)
Compression ratio	17.5 : 1
Firing order	1, 3, 4, 2
Horsepower	See below
Maximum torque	182 lbs./ft. (25.17 kg/m) at 1,000 r.p.m.
Pistons	Light Alloy
Spill timing	21 degrees B.T.C.
Atomiser Body	BKB 35S87 or BKB32S630
Atomiser Nozzle	BDL 110S6116
Injection pressure	See page T11
Valve lift	.465 in. or 11.811 mm
Valve Face and Seat Angle	45°

Oil Pressure at max. engine speed and normal working temperature 25/50 lbs: per sq: in: (1,76/3,52 kg/sq: cm)

Valve clearance .010 in. or .254 mm

When checking and adjusting valve clearances the engine should be turned to bring the respective pistons to T.D.C. on compression.

Recommended Torque Tensions	Lbs./Ft. ((kg/m)
Cylinder Head Nuts	80/85 (11.06–11.75)
Con. Rod Setscrews	100/105 (13.82–14.51)
Main Bearing Setscrews	125/130 (17.29–18.00)
Flywheel Setscrews	75 (10.37)

With reference to the Cylinder Head Nuts, these should be re-checked with the engine hot.

It will be appreciated that after overhaul or rectification work has been carried out, there will be a settling period which will allow a slight variation on the figures quoted. This is not detrimental to the performance of the engine and there is no necessity to interfere with the settings. On no account should attempts be made to increase the torque already quoted by re-tightening with a torque spanner.

SUMP CAPACITIES

Massey-Harris-Ferguson Combines	2 gallons (9.08 litres)
Massey-Harris-Ferguson 745 Tractor	2 gallons (9.08 litres)
Fordson Major Tractor	2 gallons 6 pints (12.49 litres)
Claas Combine	2 gallons (9.08 litres)
Industrial	3 gallons 3 pints (15.31 litres)

HORSE POWER

Massey-Harris-Ferguson Combines	56 b.h.p. at 1,940 r.p.m.
Massey-Harris-Ferguson 745 Tractor	50 b.h.p. at 1,500 r.p.m.
Fordson Major Tractor	45 b.h.p. at 1,500 r.p.m
Claas Combine	62 b.h.p. at 2,000 r.p.m.
Industrial	Up to 59 b.h.p. at 2,000 r.p.m.

Details of Industrial engine ratings can be obtained upon request, from the plant manufacturers or engine manufacturers.
In the case of queries on other types of application, apply to Service Division quoting the engine number.
De-rating for Altitude : Where engines are called upon to operate in rarefied atmospheres occasioned by altitude, such engines should be de-rated. For details regarding engine de-rating for altitude apply to Service Division, Perkins Engines Ltd., Peterborough, or to those Overseas Companies listed on Page II.

IMPORTANT NOTE : ALL Screw Threads used on the L4 engine, except on proprietary equipment and the crankshaft, are Unified Series and American Pipe Series.
The crankshaft and starting dog nut are threaded 1 inch American National Fine 14 T.P.I.

STARTING THE ENGINE (C)

PREPARATION FOR STARTING

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

Where a pneumatic governor is fitted, make quite sure that the connections on the pipe from the butterfly valve to the 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 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 screw on the top of the fuel pump.

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

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

Gravity Fed Systems.

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

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

Tighten the bleed screw securely whilst fuel is still issuing.

The engine is now ready for starting.

Move the speed control lever to full open position.

COLD STARTING EQUIPMENT

Method of Operation.

The small hand pump (see Fig. C.1) is constructed with inlet and outlet ports. On the upward stroke of the pump fuel is drawn through a copper pipe from the supply 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 venturi. A swirl in the atomiser causes the fuel to be sprayed into the venturi.

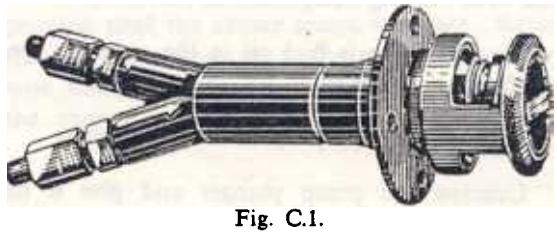


Fig. C.1.

The spray is directed on to a heater plug (see Fig. C2) which is also fitted into the venturi.

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 in easy starting.

The wiring diagram (see Fig. C3) shows all necessary details of the "Heater-Starter" switch and Heater plug connections.

Use of Equipment.

The hand pump is used in conjunction with the induction heater and "Heater-Starter" switch for starting in cold weather.

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

With some applications, in addition to the hand pump, two electric push button switches, marked " Heater " and " Starter " respectivly, are mounted on the instrument panel or somewhere conveniently near to the engine controls. These are for starting the engine.

On other applications, a starter engaging lever is provided instead of the button switch previously mentioned.

In warm weather or if the engine has been only recently stopped, open up the throttle and engage the starter motor.

If the battery is sufficiently charged to turn the starter motor quickly, the engine should start.

Cold Starting Equipment.

In cold weather, if the engine has been standing, the cold starting equipment should be used.

See that there is fuel oil in the reservoir tank (if fitted).

Turn on the supply tap to the hand pump

Unscrew the pump plunger and give it 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 throttle fully opened, engage the starter motor, at the same time giving short strokes on the hand pump.

The engine should then start.

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

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

NOTE : Always be sure that the starter pinion has stopped revolving before re-engaging the starter motor, otherwise the starter ring or pinion may be damaged.

After using the hand pump, always make sure that the plunger is screwed down and the feed tap turned off, otherwise a leakage may occur with damaging results.

Main Tank Supply.

In certain fuel systems no separate tank is fitted.

Instead the hand pump draws fuel from the final fuel filter.

Fig. C2. Plug Heater

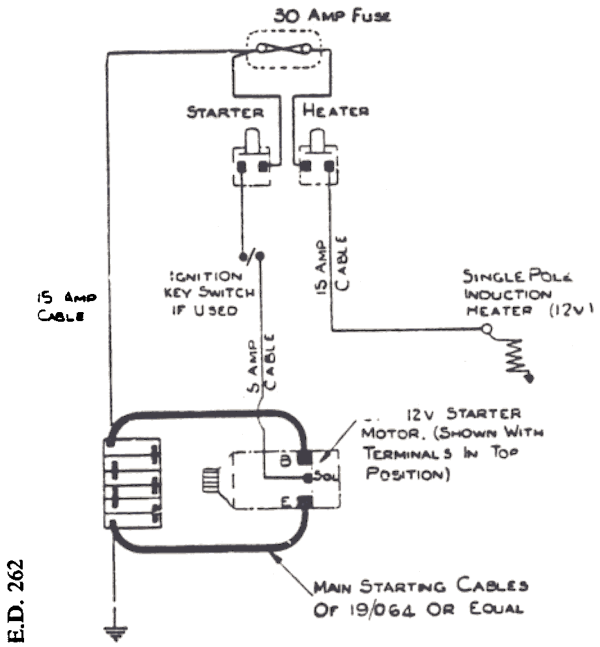


Fig. C3. Wiring Diagram

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 hand pump otherwise fuel may drain from the main tank into the engine.

Maintenance of Equipment.

Use fuel oil in the system.

Check unions, pipes, and supply tank for leaks.

Inspect every 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.

Hand Starting.

Engines not provided with electric starting equipment are fitted with a decompressor shaft in the valve cover.

The decompressor lever is positioned on the front of the valve cover. When the lever is raised, the exhaust valves are opened, thereby relieving the compression to facilitate easy turning.

To start, put the decompressor lever in the vertical position, turn the engine over smartly and drop the decompressor lever.

It should be noted that where a decompressor shaft is fitted, loss of compression in one or more cylinders may be caused by this shaft fouling one or more of the rocker levers, thus preventing closure of a valve or valves. The remedy is a new cylinder head cover joint.

If the engine is particularly cold lift the decompressor lever and turn the engine over a few times before attempting to start.

To Stop the Engine

A spring loaded stop control is located near the normal engine controls and functions by cutting off the fuel oil at the fuel injection pump.

To operate, pull the knob and hold in this position until the engine ceases to rotate. Ensure that the control returns to the run position otherwise difficulty may be experienced in restarting the engine.

FAULT FINDING (D)

DIFFICULT STARTING

No Fuel at Atomisers :—

(a) No fuel in tank.
(b) Fuel lift pump not working (Pressure fed system only).
(c) Slack connections in the fuel system.
(d) 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 quickly enough.

(Particularly in cold weather)

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

Use the cold starting equipment (if fitted). (See Section C).

Low Compression.

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

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 Section S).

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 in Section S and clean them if necessary.

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

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 the rockers should be checked.

Fuel Oil.

It is essential to use clean fuel oil free from water, dirt, or sand. The recommended specification for fuel oil is given in Section S. Providing clean fuel is used, no trouble should be experienced with the fuel system but dirty oil will lead to trouble due to 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) should be cleaned by washing in clean fuel oil, but the final filter should not need attention more than once in 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.

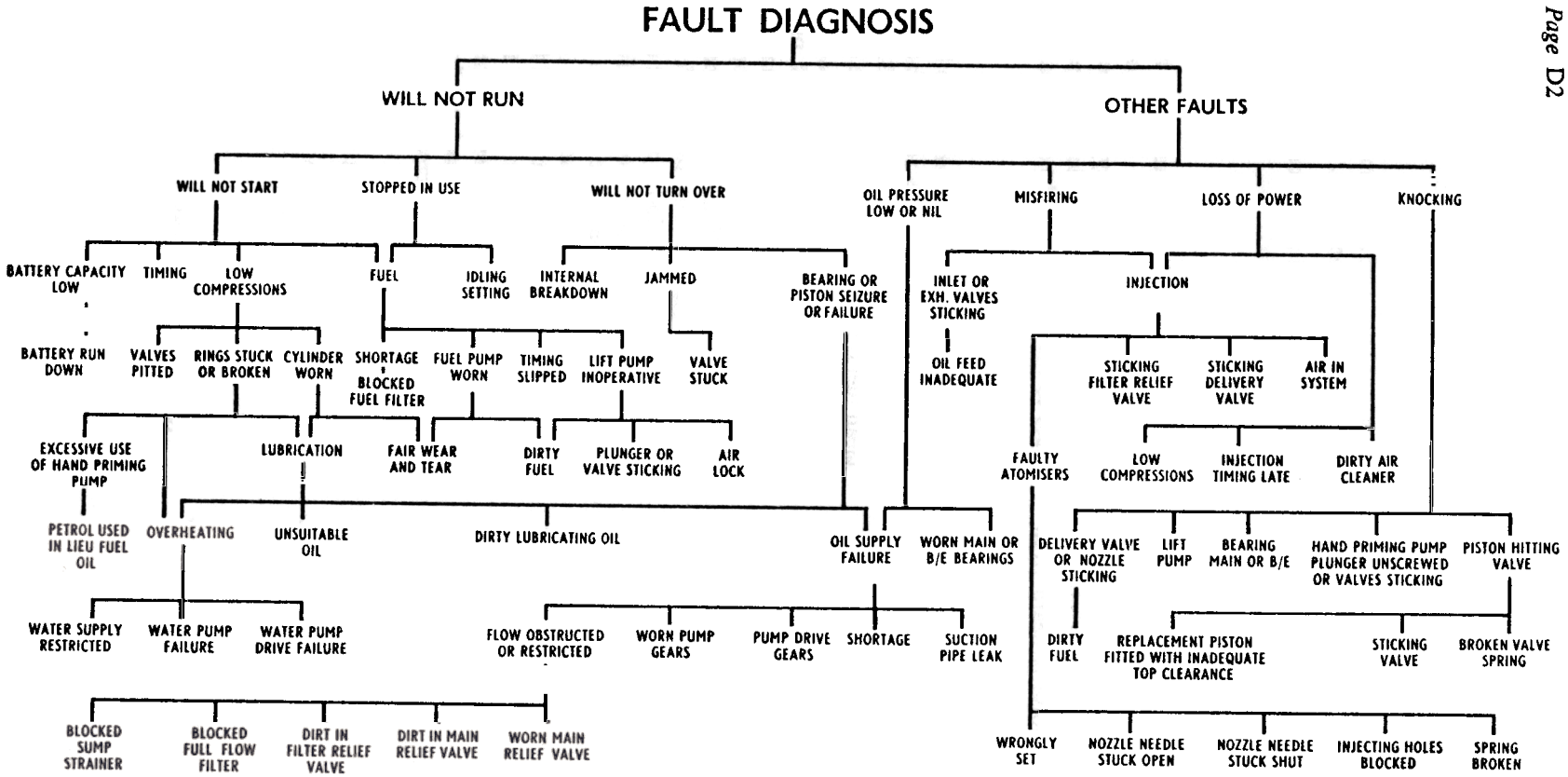
Always, after disturbing fuel line washers, replace with new washers to ensure the joints are air tight.

Air Cleaner.

In accordance with periodical attentions, Section F, clean the filtering element in paraffin, and. if of the oil bath type, dip in oil.

In those filters which need it, new engine oil should be poured into the base, up to the level mark.

FAULT DIAGNOSIS



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.

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.

DO AND DO NOT (E)

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 lubricating oil.

DO use only GENUINE PERKINS 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, Section F.

DO renew element in lubricating oil filter in accordance with periodical attentions, Section F.

DO check oil flow to rocker shaft and examine the valve springs in accordance with periodical attentions, Section F.

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 170°F. or 77°C. but where a pressurised radiator cap is fitted then the coolant temperature may be slightly higher.

DO attend immediately to fuel and lubricating oil leaks.

DO grind in valves when necessary.

DO check valve clearance from time to time (.010 in./ .25 mm.) with warm engine.

DO tighten cylinder head nuts in correct order (See Fig. H3).

DO quote engine number when ordering parts.

DO keep essential parts 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 fuel pump side of block).

DO remove pressurised radiator filler cap before draining the cooling system.

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 guess. For additional information contact suppliers of the Industrial Plant, Tractor or Engine.

DO NOT neglect the routine attentions specified in Section F.

DO NOT store fuel oil in a galvanised container.

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 or venturi seals—remember if broken your Guarantee may be void.

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

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 lubricating oil.

DO NOT subject the engine to continuous overloading.

PERIODICAL ATTENTIONS (F)

POST-DELIVERY CHECKOVER.

After a customer has taken delivery of his Perkins diesel engine, it is advisable, in his own interest, that a general check over of the engine be carried out after the first 25 hours in service.

It is also recommended that this following procedure be adopted where an engine has been laid up for a considerable period, before it is again put into service.

This check over should comprise the following points :—

1. Drain lubricating oil sump and re-fill up to the full mark on the dipstick with new clean oil (Do not overfill). When the sump is drained the sump strainer should be removed and cleaned.
2. Check and if necessary adjust slow running speed.
3. Check external nuts for tightness.
4. Check and adjust valve clearances (.010 in. .25 mm. hot).
5. Check fuel pipes from tank to fuel injection pump common chamber for leaks.
6. Check for lubricating oil leaks, and rectify if necessary.
7. Check cooling system for leaks and inspect radiator water level.
8. Check fan belt for tension.
9. Carry out road test to check general performance of engine.
10. Check engine mounting bolts for tightness.

It is also advisable to check the cylinder head studs to ascertain that they are tightened to the correct torque as given on page B.1.

Thereafter maintenance periods should be in accordance with the following instructions.

It is assumed that electrical equipment will have already been checked for such points as dynamo rate of charge, effectiveness of connections and circuits etc.

Keep Engine Clean.

DAILY

Check water in radiator.

Check oil level in sump (make sure the engine is level).

EVERY 50 HOURS

Check fan belt adjustment. (See Section R).

Clean air cleaner and renew oil (See note).

Top up batteries with distilled water.

EVERY 250 HOURS

Refill Greaser on Dynamo.

Clean water trap bowl and gauze element.

*Clean element in lubricating oil filter.

*Drain oil from sump and renew.

*Clean strainer in sump.

Unscrew drain plug on final fuel filter, replace plug when clean fuel appears.

Flush radiator with clean water.

Clean and treat the battery terminals.

*These periods should be decreased to 100 hours maximum, when engine is operating under adverse conditions.

EVERY 500 HOURS

Clean and check atomisers.

Renew felt element in lubricating oil filter.

Clean gauze trap in fuel oil filler (when fitted).

Clean strainer in lubricating oil filler.

EVERY 1,000 HOURS

Drain fuel tank, remove and clean.

Inspect commutator and brushes of dynamo.

Remove cylinder head cover.

Examine valve springs and check valve clearance.

Inspect valve rocker assembly for lubrication.

Renew 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

PRESERVATION OF LAID UP ENGINES

Where an application which is powered by a Perkins engine is to be laid up for several months it is advisable that some measure of protection be afforded the engine to ensure that it suffers no ill effect during the intervening period before operations are recommenced.

It is recommended, therefore, that the following procedure be adopted and applied immediately the unit is withdrawn from service.

1. Thoroughly clean all external parts of the engine.
2. Run the engine until well-warmed through. Stop the engine and drain lubricating oil sump.
3. Drain water from radiator and engine cylinder block.
4. Remove and clean gauze strainer in sump and full flow filter element.
5. Clean out engine breathing system.
6. After replacing filters, fill sump to correct level with clean, new lubricating oil or with a suitable preservative fluid.
7. Remove atomisers and spray into cylinder bores a ¼ pint (.14 litres) of lubricating oil divided between the cylinders.
8. Replace atomisers and turn engine slowly over compressions.
9. Remove air cleaner and any intake pipe which may be fitted between the air cleaner and venturi. Carefully seal venturi orifice with waterproofed adhesive tape or some other suitable medium.
10. Remove exhaust pipe and seal opening in manifold as in '9.'
11. Disconnect battery and store in fully charged condition. Before storing, the battery terminals should be treated to prevent corrosion.

The fuel system may either be drained and charged with a suitable preservative or alternatively, it may be left primed with normal fuel oil.

Where the latter course is taken, it should be noted that deterioration of the fuel oil may be occasioned during the months the application is idle.

If this occurs, the fuel oil may become contaminated with a wax-like substance which will quickly clog the fuel filtering arrangement once the engine is returned to service.

Therefore, before recommencing operations in respect of a unit primed with normal fuel oil which has lain idle for several months it is recommended that the fuel tank be drained and the interior of the tank thoroughly cleaned. The fuel oil drained off should be discarded as unfit for further use.

Fuel oil contained in the remainder of the fuel system should also be dispelled and the paper element in the final fuel filter renewed, following which, the system may then be re-charged with fresh, clean fuel oil.

Preparations for starting the engine should then be in accordance with the procedure detailed in Section "C".

NOTE :—

Where a preservative is used in the lubricating oil sump, this should be drained off and replaced by normal lubricant prior to re-starting the engine at the end of the storage period. In the case of a preservative being utilised to charge the fuel system this need not necessarily be drained off before returning the engine to service. Therefore, when a preservative is used in this respect the relevant manufacturers of the fluid should be contacted, seeking their guidance as to whether their product should be drained away prior to re-starting the engine.

When draining Marine engines, the end plate of the water pump should be removed to allow drainage of any water trapped between the blades of the impellor. After the pump has been drained, the impellor should be lubricated with Marfak 2HD Grease, after which the impellor should be turned to ensure penetration of the grease. When the engine is put back into service, under no circumstances should it be run with the interior of the water pump dry.

FROST

Precautions against damage by frost should be taken if the engine is to be left exposed to inclement weather either by adequately draining the water system or where this is not convenient, an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

Should it be your policy to protect engines from frost damage by adding anti-freeze to the cooling system, it is advisable that the manufacturers of the relevant mixture be contacted to ascertain whether their products are suitable for use in Perkins engines and also to ensure that their products will have no harmful effect on the cooling system generally. It is our experience that the best results are obtained from anti-freeze which conforms to British Standard 3151.

Where the use of an anti-freeze is contemplated in respect of an L4 marine engine employing a closed circuit cooling system, advice should be sought from the relevant anti-freeze manufacturers seeking assurance that their product will have no detrimental effect on the rubber impellor of the fresh water pump.

When draining the water circulating system it is not enough merely to open the radiator drain tap ; the one on the cylinder block must also be opened. This tap is located midway along the fuel pump side of the cylinder block.

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

(a) Locking of the impellor by ice due to the pump drain hole being blocked by sediment.

(b) 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 :—

(1) 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.

(2) If it is impossible to turn the pump by hand, the radiator and engine should be filled with warm water.

(3) 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.

After an anti-freeze solution has been used, the cooling system should be thoroughly flushed in accordance with the manufacturer's instructions before refilling with normal coolant.

If the foregoing action is taken, no harmful effects should be experienced, but Perkins Engines Ltd., cannot be held responsible for any frost damage or corrosion which may be incurred.

FILTERS (G)

A prime consideration in the maintenance of Diesel engines is that of cleanliness. The air and fuel oil that enters the cylinders must be scrupulously clean and so also must the lubricating oil.

In the Perkins L4 Diesel engine particular attention has been paid to the provision of means for ensuring cleanliness in respect of these.

Three filtration systems are provided : Air, Fuel Oil and Lubrication, and all that the operator needs to do is to take steps to ensure that the filters are kept in such a state that they will most effectively perform their functions.

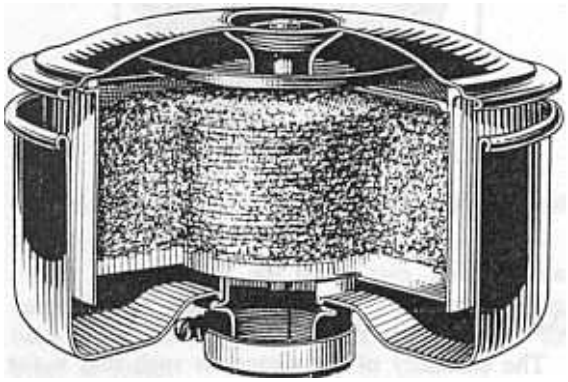


Fig. G1. Oil Bath Air Filter

AIR FILTERS

Air is filtered as it enters the inlet manifold by use of one or the other of the following filters :

1. Oil Bath type.
2. Air Maze type (Tractor type).

The system of operation of the air filters 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 extreme dusty conditions, the time limit recommended in the periodical attentions for cleaning should be decreased. (See Section F).

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

Oil Bath Type Filter.

In this type of filter the incoming air impinges upon the surface of the oil carried in a reservoir in the lower part of the filter casing.

As a result, particles of foreign matter are carried into the oil by their own momentum and are there trapped. The air then 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.

Maintenance.

Examine and replenish oil and clean in accordance with periodical attentions. Section F.

Remove top cover and lift out element. Wash in paraffin or fuel oil and allow to drain.

Empty oil from outer case and scrape out accumulated sludge. Wash outer case with paraffin or fuel oil and refill with oil to the 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 before tightening the top cover down.

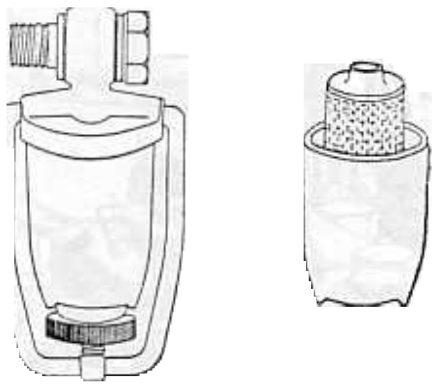


Fig. G2. Pre-filter

Air Maze type (Tractor type).

In the tractor oil bath filter the air is drawn in through the intake pipe and down through the centre of the filter to the oil bath. Here the air impinges upon the surface of the oil and particles of foreign matter are carried into the oil by their own momentum and trapped. The air then passes up the sides of the filter through the wire maze and out through the connection at the top.

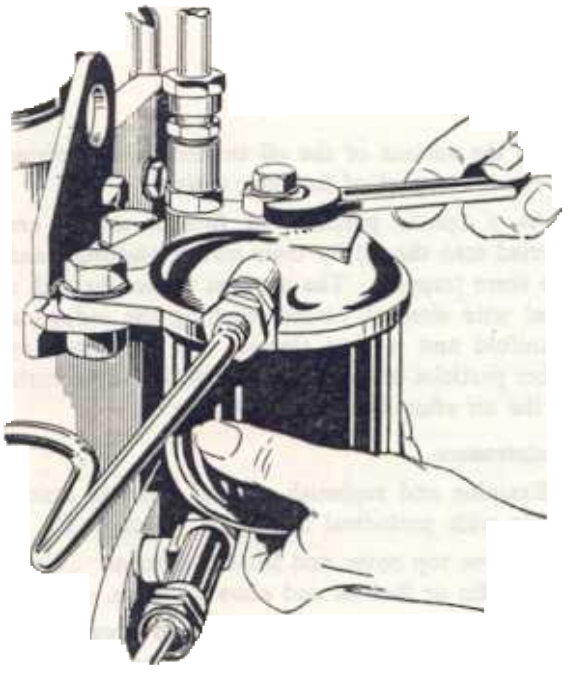


Fig. G3

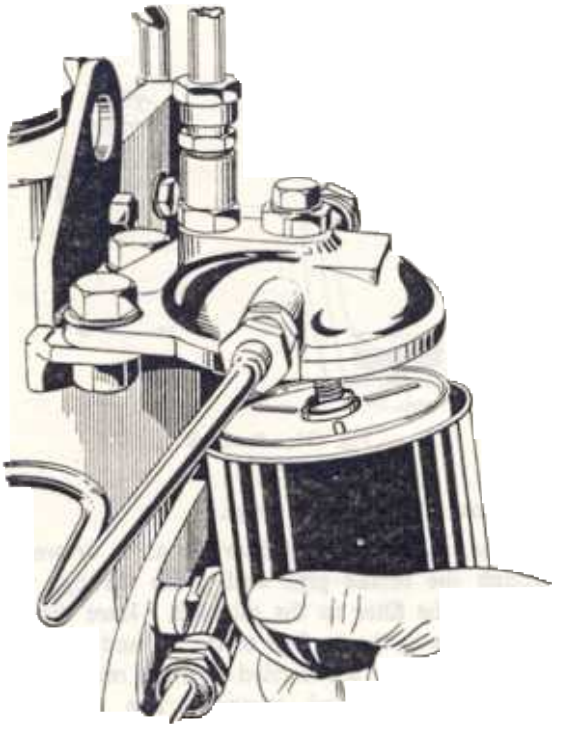


Fig. G4.

Maintenance.

Examine, replenish oil and clean in accordance with periodical attentions. Section F.

Remove oil container and empty out the oil.

Scrape out all accumulated sludge and thoroughly wash in paraffin or fuel oil.

Inspect the wire gauze and if necessary remove filter body from installation and wash in paraffin or fuel oil. Allow to drain before re-assembly.

Refill oil container to the level indicated (do not overfill) and re-assemble to filter.

Fig. G5.

IMPORTANT NOTE

The efficiency of the cleaner is such that if the cleaning of the filter is not carried out at appropriate intervals, engine performance will be seriously affected, because the presence of impurities in 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 clogging of the filter is the cause.

FUEL OIL FILTERS

Of all the factors on which satisfactory operation of a Diesel engine depends, cleanliness of 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 L4 engine is provided by the following filters, reading from the tank to the pump.

(1) Water Trap.

(2) Pre-filter.

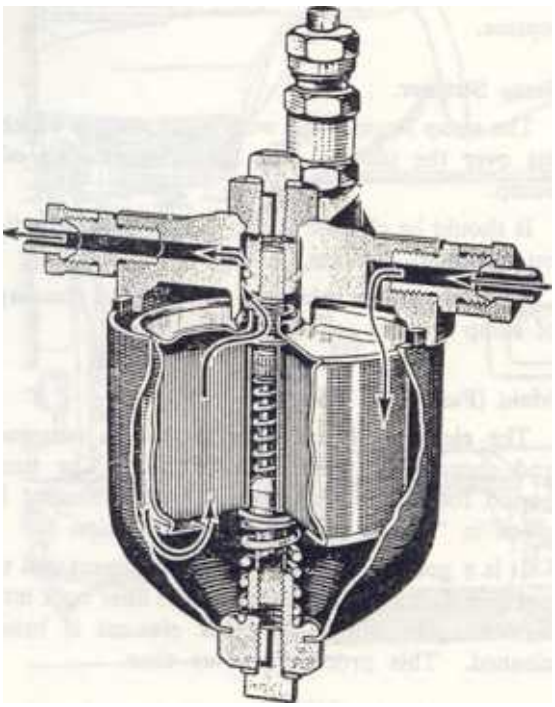


Fig. G6. Fuel Filter in section showing fuel flow through element

The arrangement of these two filters varies according to application. On some applications both filters are fitted, on others either one or the other is fitted.

(3) Paper element type filter.

Water Trap.

This filter varies according to application.

The gauze strainer is contained in an easily removable bowl and should be cleaned in accordance with periodical attentions. Section F.

Pre-filter.

This unit's main purpose is to protect the fuel lift pump. It has a comparatively coarse element. (See Fig. G.2).

This element is contained in an easily removable bowl and should be cleaned in accordance with periodical attentions. Section F.

To remove element for cleaning, unscrew knurled nut at the bottom of the bowl. Swing the stirrup clear and remove filter bowl.

Remove element and wash in paraffin or clean fuel oil. Clean out and wash filter bowl in clean paraffin or fuel oil.

When re-assembling, 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.

Paper Element Filter.

It is not possible to clean the paper element in this filter.

It should be renewed every 1,000 hours. Every 250 hours unscrew the drain plug at the bottom of the filter bowl and allow fuel to flow through 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 (See Figs. G3 and G4).

Remove the dirty element and throw away. (Fig. G5).

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

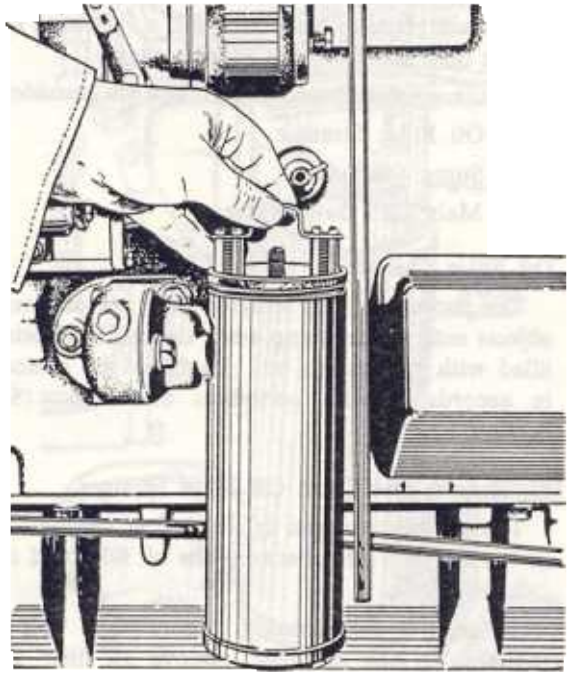


Fig. G7

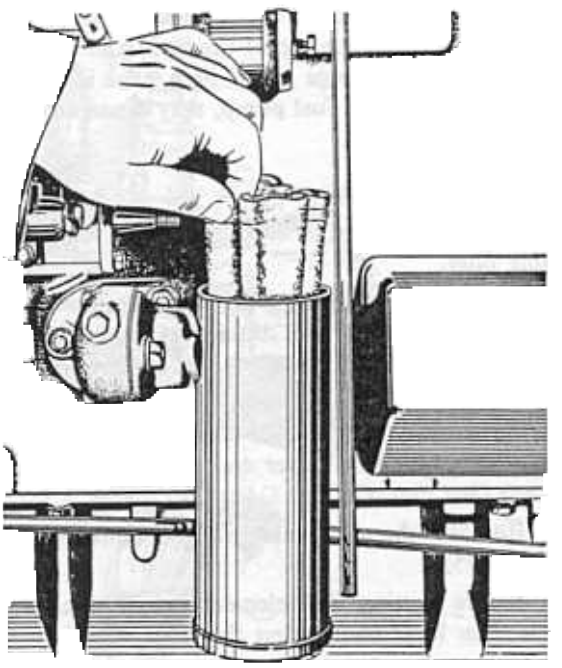


Fig. G8.

that it is always clean in use, is hardly second to the importance of cleanliness in respect of fuel oil.

It is imperative, therefore, that lubricating oil filters are not neglected. Moreover, if the periodical attentions 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 provided.

1. Oil Filler Strainer.
2. Sump Strainer.
3. Main (full flow) Filter.

Oil Filler Strainer.

The purpose of this strainer is to prevent large objects entering the sump when the engine is being filled with lubricating oil. It should be cleaned in accordance with periodical attentions. (See Section F).

To Remove and Clean Oil Filler Strainer.

The oil filler strainer is situated at the bottom of the oil filler tube, between the oil filler and the cylinder block.

To remove for cleaning, unscrew the bolt at the base of the oil filler, remove oil filler and strainer.

Wash strainer in clean paraffin or fuel oil and replace.

Sump Strainer.

The sump strainer is a wire gauze strainer which fits over the suction pipe to the lubricating oil pump.

It should be cleaned in accordance with periodical attentions (Section F).

For instructions regarding removal and cleaning of sump strainer see Section P.

Main (Full Flow) Filter.

The element of this filter should be removed and thoroughly washed in paraffin. The time period for cleaning and renewing the element is given in " Periodical Attentions " Section F.

It is a good plan to have a spare element and to put this element in the filter and the filter back into service again whilst the other element is being cleaned. This procedure saves time.

Fig. G9.

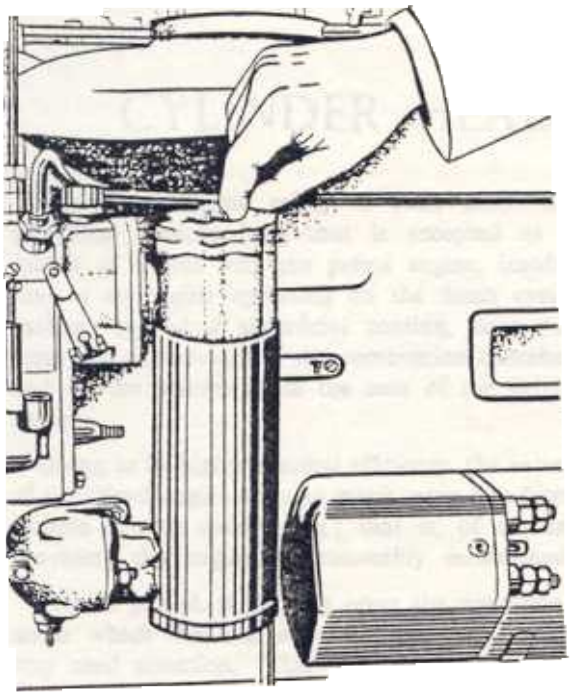


Fig. G10.

To Remove and Clean Element.

Unscrew nut on cover and remove cover.

Remove by-pass valve assembly (See Fig. G7).

Remove element (See Fig. G8).

Clean element in paraffin and allow to dry before replacing (See Fig. G9).

Remove drain plug at base of filter casing and clean filter casing with paraffin.

To re-assemble, reverse order of procedure. Ensure that the felt sealing ring around the by-pass valve piston and the rubber sealing washer are in good condition.

NOTE – On certain applications, the lubricating oil filter is fitted as shown in Figs. G.10 and 11.

To remove and clean the element of this filter :

(1) Unscrew bolt and remove top cover.

(2) Remove spring and element pressure plate.

(3) Remove element.

(4) Clean element in paraffin or fuel oil. Allow to dry before replacing.

(5) Remove by-pass valve assembly. This is best effected by means of a piece of wire bent to form a hook at one end.

(6) Remove drain plug at base of filter casing and clean filter casing with paraffin.

(7) Re-assemble filter unit in reverse order to dismantling.

It should be noted that the by-pass valve assembly should always be replaced in a position adjacent to where the filter is mounted to the cylinder block.

CAUTION

If the filter element is not cleaned as recommended, the flow of oil through the filter is restricted. This does not, however, prevent oil passing to the engine, for when restriction takes place, the by-pass valve opens and permits unfiltered oil to continue to flow round the engine. The consequence of this need not be described. Do not, therefore, omit to clean the element as prescribed.

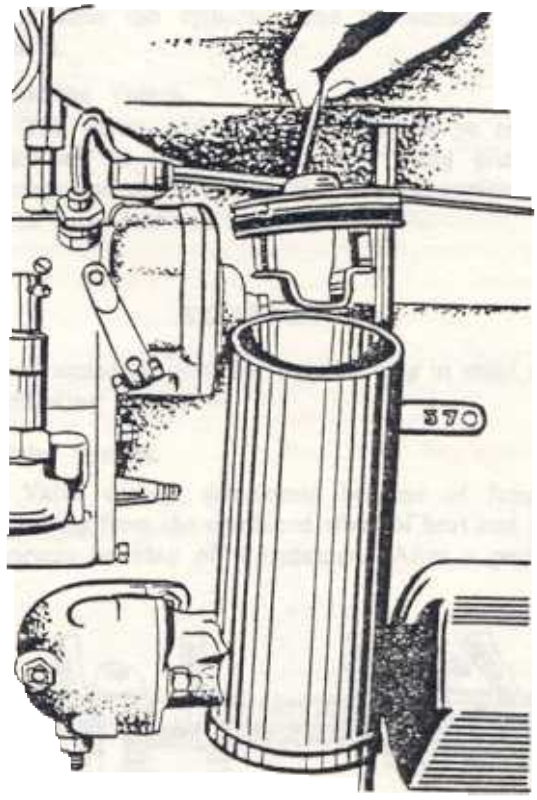


Fig. G11.

CYLINDER HEAD MAINTENANCE (H)

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 of 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, in which case a top overhaul may be necessary.

Preparation.

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

Drain all water from the radiator and cylinder block. The drain cock for the cylinder block is on the fuel pump side of the engine. Disconnect the exhaust pipe from the engine exhaust manifold. Uncouple external connections to the cylinder head.

Cylinder Head. To Remove.

Remove the air cleaner.

Take off cylinder head cover.

Uncouple union on oil pipe to rocker assembly.

Remove nuts holding rocker shaft assembly.

Remove retaining plates and lift off rocker assembly, bringing above named oil pipe with it.

Remove push rods.

Remove leak off pipes to atomisers.

Remove pressure pipes to atomisers.

Remove atomisers.

Remove main leak off pipe.

Uncouple union on pipe connecting the venturi and the pneumatic governor (where fitted).

Take off cylinder head nuts and remove cylinder head complete with exhaust manifold and venturi.

To Remove Valves.

All valves are numbered consecutively from 1 to 8, commencing from the front of the engine. The cylinder head is marked with corresponding numbers opposite the valve seats, see Fig. H.2.

Compress the spring cap and springs with a valve spring compressor and remove the split-cone collets. 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 reconditioned in the orthodox way, using grinding compound or by means of specialised equipment. The valve seat and face angle is 45°.

EXAMINATION.

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

Valve Springs.

Valve springs deteriorate because of fatigue resulting from the combined effect of heat and the normal working of the springs. After a period

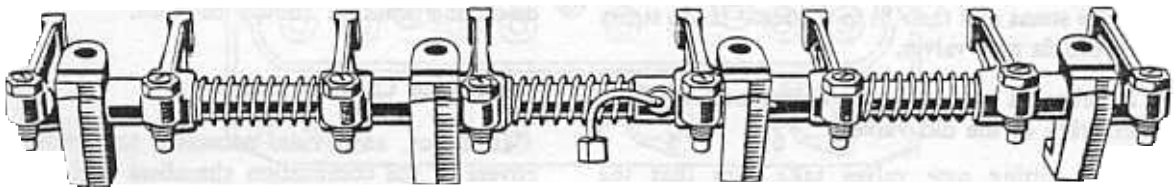


Fig. H1. Showing Rocker Shaft Assembly

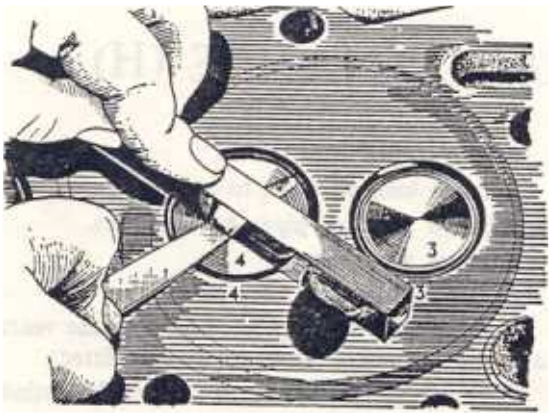


Fig. H2. Checking Valve Head Clearance and method of marking valves

the spring becomes weak and is then prone to failure. 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 assembly thoroughly in paraffin. Examine the rocker lever 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. Should this have occurred it will be advisable to fit new rockers and/or bushes.

Should it be necessary to dismantle the rocker shaft assembly re-assemble as shown in Fig. H.1.

Valves and Valve Seats.

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

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 the cylinder head bottom face is not less than .057 ins. (1.45 mm) inlet and .053 ins. (1.35 mm) exhaust. Maximum clearance should not exceed .140 ins. (3.56 mm) inlet and exhaust. Check this by putting a straight edge across the bottom face of the cylinder head and measuring the distance between the straight edge and the valve head as illustrated in Fig. H.2.

The efficiency of a diesel engine depends largely on the maintenance of good compression therefore, when grinding in valves, make certain that no signs of pitting are left on the seatings. 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. At the same time care should be taken to avoid unnecessary grinding away of the seat.

Valve Guides.

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

To remove old guides : press out, or use a suitable drift.

To fit new guides : clean and remove any burrs.

Smear the outer surface with clean oil, and using a suitable press, drive home hard up to the collar. Care should be exercised as the collar approaches the cylinder head as the guides are made of cast iron and therefore comparatively brittle.

Cylinder Head.

Remove exhaust manifold and clean off any carbon deposit formed in the cylinder head.

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 de-scaling solution should be used.

Combustion Chamber Joints.

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

Should it be necessary to remove these covers new copper joints should be fitted when they are replaced.

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

To soften the joints heat them to a dull red heat and quench in cold water.

Special care is necessary when refitting these covers to ensure that there are no leaks at the joints otherwise there will be a loss of compression and the efficiency of the engine will be impaired.

Re-assembly Cylinder Head.

Replace valves, valve springs, collars and collets.

Replace combustion chamber caps and joints.

Fit exhaust manifold gaskets and exhaust manifold.

Replacing Cylinder Head.

Before replacing cylinder head it is extremely important to ensure that the cylinder block and cylinder head faces are perfectly clean.

When replacing the cylinder head a new gasket should be used. Cover both sides with a thin coating of good jointing compound and before placing over the cylinder head studs ensure that the gasket is correctly positioned. The gasket is marked to indicate how it should be replaced.

Having placed the gasket in position ensure that the cylinder head face is perfectly clean and place in position over the cylinder head studs.

To tighten the cylinder head nuts, a torque wrench should be used, set to the tension given in Section B, and pulled down in the order marked in Fig. H.3.

With the push rods in position replace the rocker shaft assembly. Examine the oil pipe union and ensure that it is in good condition. Connect union to cylinder head.

Where necessary, re-connect the pipe from the pneumatic governor to the venturi.

Replace atomisers (See Section S).

Replace leak off pipes and cold starting equipment.

For fitting of fuel pipes see Section S.

Valve Clearance.

Valve clearances should be set to .010 in. (.25 mm)

When adjusting valve clearances the engine should be turned to bring the respective pistons to T.D.C. on compression.

To adjust, slacken the lock nut and with a .010 in. (.25 mm) feeler gauge between the top of the valve stem and the rocker lever face, turn the adjusting screw by means of a screwdriver until the correct clearance is obtained. Tighten the lock-nut.

STARTING THE ENGINE

Proceed as instructed in Section C.

After warming up, the engine should be shut down and the cylinder head nuts again tightened with a torque wrench, set to the tension given in Section B. The nuts should be tightened in the order shown in Fig. H.3.

Re-set valve clearance to .010 in. (.25 mm).

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 positioned

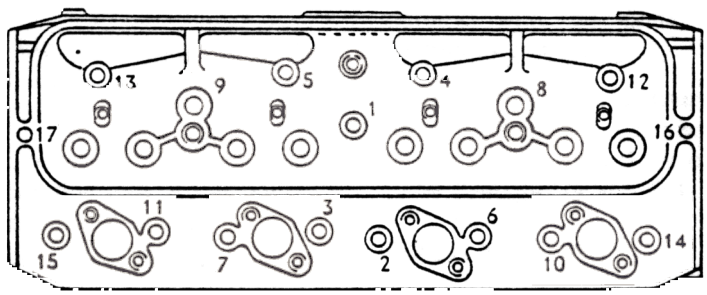


Fig. H3. Diagram showing order in which cylinder head nuts must be tightened

PISTONS & CONNECTING RODS (J)

The pistons are of light alloy, with fully floating gudgeon pins, which work in the bush fitted to the connecting rod small end. The gudgeon pins are held in position by means of circlips.

The pistons are fitted with three compression rings, and two oil control or scraper rings. The top compression ring is a plain compression ring, the second a chrome plated compression ring and the third is composed of four laminated rings. (See fig. J.2).

The fourth and fifth rings are slotted scrapers.

Pistons are numbered from 1 to 4 commencing with No. 1 at the front of the engine.

Each connecting rod and cap are also numbered 1 and 1, 2 and 2, etc. (See fig. J.1).

The connecting rod and cap mating faces are serrated to ensure correct positioning and should on no account be filed.

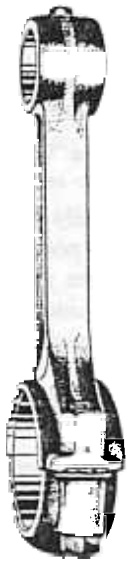


Fig. J.1. Showing marking of connecing rods.

To Remove Pistons and Connecting Rod Assemblies.

Remove cylinder head assembly (see Section H).

Remove sump (see Sect. P).

Remove lubricating oil pump (see Section P).

Turn engine until two connecting rods are at bottom centre, then remove setscrews and locking washers.

Remove caps and bearing shells.

Push piston and connecting rod out of the top of the cylinders.

Turn engine until remaining connecting rods are at bottom centre, then repeat removal operations.

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

Keep each piston and connecting rod assembly separate, each to each as marked.

To Remove Gudgeon Pins.

Remove circlips from the piston, using long nosed pliers.

To remove the gudgeon pins, warm the pistons in liquid to a temperature of 100°F.—120°F. (38°—49°C.). The pins can then be pushed out.

To Fit Small End Bushes.

Remove piston and connecting rod from engine.

Remove gudgeon pins (see above).

The small end bushes are a press fit into the connecting rods.

Press out old bush with suitable press

Remove any sharp edges around small end parent bore.

Press in new bush, ensure that oil hole in bush coincides with hole in top of connecting rod. Ream out new bush to suit gudgeon pin (see Section V) and check for parallelism.

To Assemble Piston and Connecting Rod.

Insert gudgeon pin into position, to do this it may be necessary to heat piston in liquid to a temperature of 100°—120°F. (38°—49°C.). The gudgeon pin can then be pushed easily into position.

If original pistons are being used they must be re-assembled to the same connecting rods, e.g. piston stamped 1 must go with connecting rod stamped with the figure 1. For markings of connecting rod see fig. J.1.

Fit circlips, check to ensure that they fit correctly into the grooves in the piston. It is advisable to fit new circlips even if the old ones do not appear to be damaged or strained.

Fittings New Rings.

Pistons and rings must be thoroughly washed to remove any oil or grease which may be present.

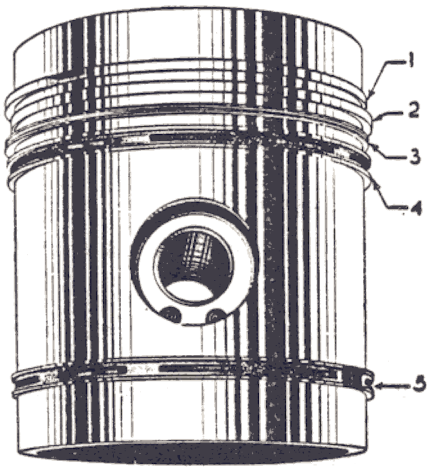


Fig. J.2. Showing arrangement of piston rings.

1. Plain compression ring. 3. Laminated compression ring.
2. Chrome plated compression ring. 4. and 5. Slotted scraper ring.

NOTE. In the case of combine engines, the chrome plated compression ring is omitted and replaced by a plain compression ring of the same type as fitted in No. 1 ring groove.

Check rings for correct gap which must be within the limits given in Section V.

Fit the rings to the piston in the order shown in fig. J.2. The gaps of the two compression and scraper rings must be arranged so that they are equally spaced around the piston and not in line with one another.

When fitting a chrome plated compression ring, care should be taken to ensure that it is fitted correctly. The ring is suitably marked to indicate how it should be replaced.

When fitting the third laminated compression ring, care should be taken that the four laminations are correctly assembled to the piston.

To assemble to piston, proceed as follows:—
Examine the laminations and it will be observed that the free ends of the ring are not cut square to the circumference but slope away either to the right or left, depending on which way up the ring is turned.

Fit the first segment to the piston so that when held horizontally in the palm of the hand and radially compressed, the ring ends point downwards. Position this ring at the bottom of the groove with the gap over the gudgeon pin bore.

Fit the second segment on the top of the first, so that when held compressed as described above, the ring ends point upwards. Position the gap at 180° to the first segment gap.

The third segment should be fitted on the top of the second so that when compressed as described, the ring ends point downwards. Position the gap immediately above that of the first segment.

Fit the fourth segment on top of the third so that when held and compressed, the ring ends point upwards. Position the gap above that of the second segment.

When the four laminations are fitted to the piston check that they are fitted correctly. If fitted correctly there will appear a circumferential gap between the bottom two laminations and the top two laminations as illustrated in fig. J.3.

When fitting new rings to original pistons, clean out piston ring grooves using the old ring from the appropriate groove for this.

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

The piston should be examined carefully for bruising of the ring grooves and to ensure that the rings move freely in their grooves.

NOTE. When fitting new rings to worn cylinder liners, the ring gaps should be checked at a bore diameter of 4.250 in. (108 mm.).

To Fit Piston and Connecting Rod to Cylinder Block.

All connecting rods and caps are plainly marked with a number corresponding to their position in the engine. For method of marking see Fig. J.1. These numbers are stamped on that side of the connecting rods and caps which are machined to take the locating lips of the bearings.

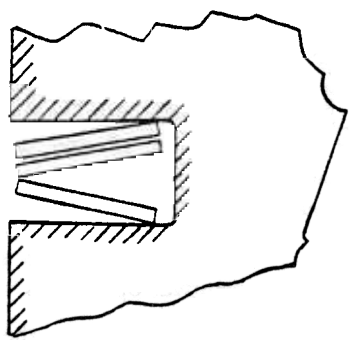


Fig. J.3. Showing how the laminated compression ring should be fitted into its groove.

When fitting pistons and connecting rods to cylinder block and crankshaft, ensure that the side of the connecting rod which is stamped with the number goes to the camshaft side of the engine.

Insert the pistons and connecting rods into the cylinder bores from the top, ensuring that piston and rod stamped No. 1 are fitted into No. 1 cylinder bore and No. 2 into No. 2 cylinder bore and so on counting from the front of the engine. When fitting assemblies, deal with them in the order 1 and 4 then 2 and 3. Turn the crankshaft until the appropriate crankpins are at B.D.C.

To minimise the possibility of breaking piston rings, it is advisable to use a piston ring guide. 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.

Pull the connecting rod to the crankpin and insert the half bearing.

Fit cap and cap half bearing.

NOTE. When replacing connecting rod setscrews, new locking washers must always be used.

The top and bottom half-shells are not interchangeable with each other, due to the locating lips of the two half-bearings being offset in relation to one another.

Tighten connecting rod setscrews, using a torque wrench set to the tension given in Section B.

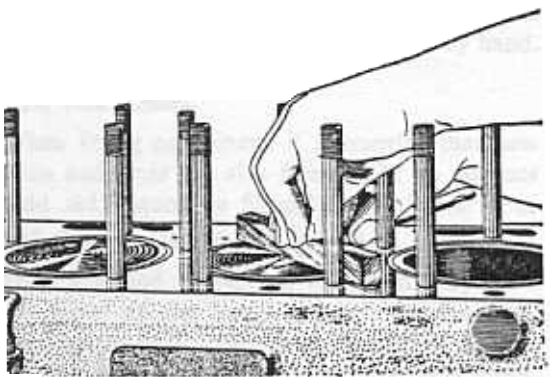


Fig. J4. Checking distance between straight edge and cylinder block face.

Fitting New Pistons.

It is important, when fitting new 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 be .007 to .012 in. (.178 to .305 mm.) above the face of the cylinder block. If the piston stands higher than this then the crown must be reduced by taking the necessary amount off in a lathe. If the piston height is below the minimum figure quoted above, that piston must be rejected if a first class performance is required.

To take this measurement the piston assembly and connecting rod must be fitted to the cylinder block and crankshaft as previously described.

When assembled turn crankshaft to bring piston to T.D.C. and place a straight edge across the top of the piston and with a set of feeler gauges, measure the distance between the straight edge and the top face of the cylinder block. (See Fig. J.4).

Connecting Rod Weights.

The finished weight of connecting rods in engine sets should balance within two ounces.

In order to effect this, rods are batched as follows :

Code No.	*Minimum weight*	*Maximum weight*
12	4 lb. 10 oz. (2.10 kg.)	4 lb. 12 oz. (2.15 kg.)
13	4 lb. 12 oz. (2.15 kg.)	4 lb. 14 oz. (2.21 kg.)
14	4 lb. 14 oz. (2.21 kg.)	5 lb. (2.27 kg.)

It is necessary, therefore, when ordering spares for an individual engine that the appropriate code number of the connecting rod set be quoted.

This code number can be found etched either on Nos. 1 or 4 connecting rod on the machined shoulder which is adjacent to the fuel pump side of the engine.

On spare rods, however, the code number is present on each rod.

CYLINDER LINERS (K)

The liners fitted to Perkins L4 engines are centrifugal cast iron wet liners. They are flanged at the top and rubber type sealing rings are fitted at the bottom. see Fig. K.1.

Under normal circumstances the liner would only need to be renewed during a major overhaul, but should it be necessary to remove the liner for any other reason this can be carried out without removal of the crankshaft.

If at any time the cylinder liners are removed, and these same liners are to be refitted, then before removing the liners from the cylinder block, ensure they are suitably marked so that they may be refitted to their original parent bore and in the same position in that bore, that is, thrust side of the liner to the thrust side of the cylinder block.

To Remove Liners.

Remove cylinder head (See Section H).

Remove Sump (See Section P).

Remove oil pump (See Section P).

Disconnect connecting rods and remove pistons (See Section J).

Remove liner using a suitable liner removing tool.

When the rubber sealing rings have cleared the bottom landing, the liner can be removed by hand.

To Fit New Liners.

When fitting new liners, it is essential that new pistons and rings are also fitted. On no account should old pistons be fitted to new liners. For fitting of new pistons see Section J

Over a period of service, corrosion may have taken place at the inner ends of the landings. This corrosion and any burrs which may be present should be removed with a scraper or emery cloth.

Fit the rubber sealing rings in the grooves provided in the lower diameter of the liner. (See Fig. K.1). Care should be taken not to stretch these rings as they are not elastic and if stretched will not return to their former size.

In order to facilitate the fitting of the liners when the two rings have been placed in position on the liner, smear them with soft soap or soapy water.

Place liner in position and press home by hand ensuring that the rubber sealing rings remain in their respective grooves.

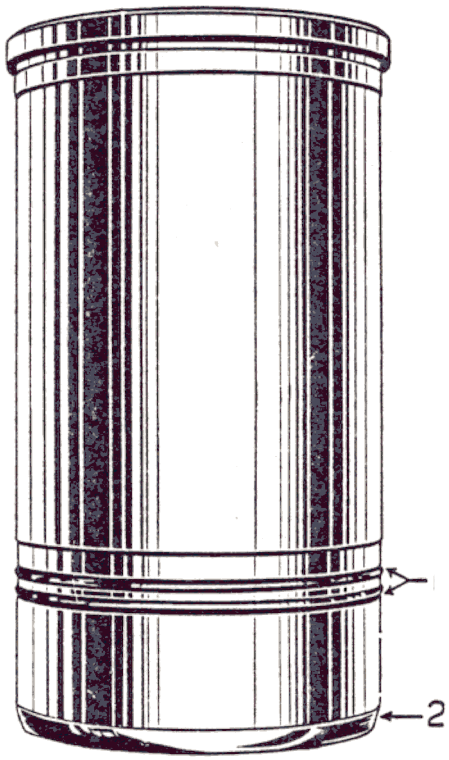


Fig. K1. Showing cylinder liner and sealing rings.
1. Sealing Rings 2. Leading Edge

The liners are a push fit and no force is required but should a liner require more pressure than can be applied by the fingers, place a suitable piece of wood across the top flange and press home.

After fitting the liners the cylinder block should be water tested to a pressure of 20 – 25 lbs. per sq. in. (1.4 – 1.76 kg/sq.cm).

Re-assemble engine as required and to instructions given for the various components.

CRANKSHAFT & MAIN BEARINGS (L)

CRANKSHAFT AND MAIN BEARINGS

The crankshaft runs in three pre-finished replaceable shell bearings, which are lead bronze lined and indium flashed.

To Remove Crankshaft.

Remove cylinder head (See Section H).
Remove sump (See Section P).
Remove lubricating oil pump (See Section P.)
Remove pistons and connecting rods (See Section J).
Take off timing case front cover and remove idler gear.
Remove timing case bottom cover.
Remove starter motor.
Remove flywheel and assembly.
Remove the crankshaft rear end seal.
Remove main bearing caps and half bearings.
Lift out crankshaft.

Crankshaft Regrinding.

Examination for Wear.

Before proceeding to regrind the Crankshaft, the following points should be checked to ensure it is suitable for further grinding.

The Crankshaft should be crack-detected and then demagnetised in order to remove any polarisation which may be present.

The main journal and crankpin diameters should be checked for ovality and measured to ascertain the next appropriate size to which the Crankshaft can be reground, i.e. –.010″ (–.25 mm), –.020″ (–.51 mm), –.030″ (–.76 mm) from Standard. If the crankshaft requires regrinding below –.030″ (–.76 mm), it is recommended that new crankshaft be fitted.

It should be noted, however, that in the home market, an exchange scheme is in operation whereby reconditioned Crankshafts are available at a certain cost, providing the Crankshaft being exchanged is not damaged and is suitable for regrinding to a limit of –.030″ (–.76 mm).

Regrinding.

All the necessary information required for regrinding the Crankshaft is given under ' Crankshaft Data '. All limits listed thereunder must be adhered to and the main journals and Crankpin must be free from grinding marks.

After regrinding, the sharp corners on the oil ways should be removed and the Crankshaft crack-detected again and demagnetised.

NOTE :—It is important that the RADII on the main journals and Crankpins are maintained. If these are neglected, a fatigue fracture is liable to occur.

CRANKSHAFT DATA

Description	*Dimensions*	*Remarks*
Main Journal Diameter		
STD.	2.99825/2.999 ins. (76.16/76.17 mm)	Surface finish not to exceed 16 micro ins. (.4 microns).
–.010 in. (–.25 mm)	2.98825/2.989 ins. (75.90/75.92 mm)	
–.020 in. (–.51 mm)	2.97825/2.979 ins. 75.65/75.67 mm)	
–.030 in. (–.76 mm)	2.96825/2.969 ins. 75.39/75.41 mm)	
Main Journal Radii		
	$\frac{1}{8}$ in. $^{-0}_{+.015}$ in. (3.18/3.56 mm)	Must be maintained.
Rear Main Journal Width		
STD.	2.0625/2.0635 ins. (52.39/52.41 mm)	Not to exceed 2.0785″ (52.79 mm) after regrind.
Crankpin Diameter		
STD.	2.74825/2.749 ins. (69.81/69.82 mm)	Surface finish not to exceed 16 micro ins. (.4 microns)
–.010 in. (–.25 mm)	2.73825/2.739 ins. (69.55/69.57 mm)	
–.020 in. (–.51 mm)	2.72825/2.729 ins. (69.30/69.32 mm)	
–.030 in. (–.76 mm)	2.71825/2.719 ins.) (69.04/69.06 mm)	
Crankpin Radii		
	$\frac{3}{16}$ in. $^{-0}_{+.015}$ in. (4.76/5.13 mm)	This must be maintained.
Crankpin Width		
STD.	1.780/1.785 ins. (45.21/45.34 mm)	Not to exceed 1.80″ (45.72 mm) after regrind.

Should the Crankshaft rear flange need re-grinding, the rear $\frac{3}{8}$ in. (9.52 mm) of the flange width must **not** be ground. The remaining portion of the flange width may be ground to a minimum diameter of 5.238 in. (133.05 mm). Surface finish not to exceed 16 micro ins. (.4 microns).

To Fit New Main Bearings and Thrust Washers.

The main bearings being of the pre-finished strip type, the fitting of these should present no difficulty.

To prevent errors occurring in fitting top and bottom half bearings, the locating lips, and the recesses in the caps and bearing housings, are offset in relation to one another.

The bearing caps and crankcase are numbered 1—3. No. 1 being at the front of the engine.

To avoid the caps being inadvertently assembled to the crankcase the wrong way round the locating dowels and dowel holes are also offset.

Under normal circumstances by the time the main bearings require to be renewed, the crankshaft will need to be removed for regrinding. However, if for any reason one or more of the bearings should have to be renewed or removed for inspection, this can be carried out on Nos. 1 and 2 bearings without the necessity of removing the crankshaft from the engine.

Proceed as follows :—

Remove sump (See Section P).

Take off the cap of the bearing in question.

Slacken remaining bearing cap setscrews one or two turns.

Remove the lower half of the bearing from the bearing cap.

With a suitable piece of wood push out the top half of the bearing by rotating it on the crankshaft, applying the tool to the side opposite the locating lip. The locating lips are on the camshaft side of the engine.

Inspect the bearing shells and if they require renewing insert a new half bearing in the top, inserting plain end first. Fit new half bearing to cap. Do not remove more than one bearing at a time.

Replace cap and tighten setscrews lightly before proceeding to next bearing.

Having replaced the bearings and caps pull down the setscrews with a torque wrench set to the tension given in Section B.

The thrust washers fit in the recesses provided on either side of the rear main bearing housing and should be assembled with the flat steel side to the bearing housing. The end float of the crankshaft is measured between the crank cheek and the thrust washers. This measurement should be between .0085 and .0155 in. (.22 and .39 mm). If greater or smaller than this amount fit new thrust washers or oversize thrust washers if necessary.

Crankshaft Rear End Seal.

On early engines, this seal consisted of a housing and rubber seal.

When removed it should be inspected for cracks or scratches on the bearing surface. If this surface is damaged in any way a new seal should be fitted.

To fit a new seal proceed as follows :—

Remove old seal by pressing it out of the housing.

Lightly smear the outer edge of the new seal with soft soap.

Place seal in position and press in by hand as far as it will go, this should be approximately halfway in. Pressing in halfway by hand ensures that the seal is centralised.

Press in with a press until the bevelled edge or the seal is level with the outer face of the housing.

MODIFIED CRANKSHAFT AND REAR OIL SEAL

Later L4 engines incorporate a crankshaft and rear oil seal of modified design. Neither of these components are individually interchangeable with their earlier counterparts so that if the latest type crankshaft is to be fitted to an engine previously utilising an unmodified crankshaft, a modified rear oil seal must also be fitted.

The modification to the crankshaft affects that part of the shaft around which the rear oil seal is fitted. Whereas, previously, this portion of the shaft had a nominal diameter of $5\frac{1}{4}$ in. (133.4 mm). the equivalent nominal dimension in the case of the modified shaft is $3\frac{1}{8}$ in. (79.38 mm). Furthermore the modified crankshaft has a shallow spiral oil groove machined to a depth of .004/.008 in. (.10 to .20 mm) in that section upon which the rear seal bears.

With the advent of this latest type crankshaft, the bore of the modified rear oil seal is machined

to accommodate a rubber cored asbestos strip. This strip consists of two sections, one for each of the two half-housings which now compose the seal cover. The strip itself forms a positive seal with the rear end of the crankshaft.

When fitting the seal with the crankshaft in position, the following procedure should be adopted :

1. Set up a half housing in a vice with the seal recess uppermost.
2. Settle approximately 1 in. (25.4 mm) of the strip at each end into the ends of the groove, ensuring that each end of the strip projects .010/.020 in. (.25/.51 mm) beyond the half housing joint face. Allow the middle of the seal to bulge out of the groove during this operation.
3. With the finger or thumb, press the remainder of the strip into the groove working from the centre. Then use any convenient round bar to further bed the strip by rolling and pressing its inner diameter. This procedure takes advantage of the friction between the strip and the groove at the ends to compact the rope, whilst ensuring that the projections of the end faces of the rope remain as set. Fit same to other half housing in similar manner
5. Remove all traces of the old joint from the cylinder block rear face and fit new joint treated with a suitable jointing compound.
6. Lightly paint the faces of the two housings with a suitable jointing compound.
7. Spread a film of graphited grease over the exposed inner diameter surface of the strip
8. Assemble the half housings around the rear of the crankshaft and fasten together by the two setscrews.
9. Swivel the complete seal housing on the shaft to bed in the strips and to establish that the assembly turns easily on the shaft.
10. Bolt the seal housing in position on the block and rear main bearing cap and finally tighten with setscrews.

Replacing Crankshaft.

Ensure that all oilways are clear (See Lubricating Diagram Fig. P.2).

Check main bearing setscrews for stretch or damage to threads. Affected setscrews must be scrapped.

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

Clean bearing housings and place top half bearings in position.

Place crankshaft in position.

Fit lower halves of bearings to bearing caps and place in position. Ensure that the thrust washers on No. 3 bearing are fitted correctly.

Place tab washers in position and tighten setscrews.

For final tightening of the setscrews a torque wrench should be used, set to the tension given in Section B.

Lock setscrews in position by means of the tab washers.

Fit crankshaft rear end oil seal as previously described.

Re-assemble engine as required and to the instructions given for the various operations.

It is important that new locking washers of the correct type are fitted when setscrews have been removed.

CAMSHAFT AND DRIVE (M)

To Remove Camshaft.

Remove cylinder head (See Section H).

Remove timing case front cover.

Remove sump (See Section P).

Remove lubricating oil pump (See Section P)

Remove timing case 'Power Take Off' facing cover.

Note timing marks (See Section N.1.)

Remove idler gear.

If engine is in a swivel stand, turn engine completely over. If not, lay engine over at an angle. This will prevent the tappets dropping out when the camshaft is removed.

Remove camshaft.

To Remove Camshaft Gear.

To remove camshaft gear from camshaft remove the three setscrews in the centre of the gear. The gear can now be removed from the camshaft.

To Replace Camshaft Gear.

The three clearance holes drilled at equal angles are the holes for attaching the gear to the camshaft. The three slotted holes are for use with the fuel pump.

When fitting a replacement gear to the camshaft, turn the camshaft until No. 1 cam is upright. It will be observed that a tapped hole on the camshaft hub is also at the top, in line with No. 1 cam. Look at the gear and it will be noticed that one of the holes in the gear has the letter " D " adjacent to it.

Place the gear on the hub with these two holes in line

Replace setscrews and plain washers, finally lock setscrews with locking wire.

To Replace Camshaft.

See that tappets are in position.

Replace camshaft.

Replace idler gear but do not lock idler gear retaining setscrew.

Reset timing (See Section N).

Re-assemble engine as required and to the instructions given for the various operations.

To Remove Fuel Pump.

Remove fuel injection pipe lines from atomisers and fuel pump.

Disconnect fuel supply lines.

Remove the setscrews holding the fuel pump to the timing case and remove fuel pump.

To remove the fuel pump gear remove the three setscrews securing the gear to the fuel pump adaptor.

To Replace Fuel Pump.

If the gear has been removed from the fuel pump re-fit gear or, if necessary, fit replacement gear.

The three slotted holes in the gear are for fitting the gear to the fuel pump adaptor.

Fit fuel pump to timing case.

Time fuel pump in conjunction with the engine as given in Section N.

Replace atomisers.

Connect-up fuel supply lines.

Replace fuel injection pipes.

When fitting a new or replacement fuel pump, remove the pump inspection cover and pour sufficient engine oil into the spring chamber until oil comes out of the overflow. Refit the inspection cover.

TIMING (N

NOTE.— When checking and adjusting valve clearances the engine should be turned to bring the respective pistons to T.D.C. on compression.

The timing or resetting of the timing on the Perkins L4 engine can be simply and expediently carried out if the following instructions are followed.

It is well to remember that if the cylinder head has been removed it does not, in any way, affect the timing of the engine.

MARKINGS.

The timing gears are marked as shown in Fig. N.1 so that, if for any reason the timing has to be broken, the engine can easily be re-set to its original timing.

There are two different markings on the fuel pump adaptor. One is a scribed line marked with the letter " S " which should coincide with the scribed line on the pointer of the fuel pump, when the engine is set at T.D.C. firing on No. 1 cylinder (See Fig. N.2).

The alternative scribed line on the fuel pump adaptor denotes spill timing, 21° B.T.C. In the case of L4 engines fitted to the Marshall Crawler Tractor, the spill timing is 24° B.T.D.C.

To obtain access to the fuel pump markings it is necessary to remove the inspection plate situated on the left hand side of the timing case.

To Re-set Engine to its Original Timing.

Remove atomisers.

Bring Nos. 1 and 4 pistons to the top. That T.D.C. has been obtained can be checked by examining the flywheel or the front end of the crankshaft, where the key of the fan belt pulley should be at the top of its periphery.

Set fuel pump gear with scribed line " S " on the fuel pump adaptor in line with the scribed line on the pointer of the fuel pump.

Rotate camshaft to bring inlet and exhaust valves of No. 4 cylinder to rocking position.

With the crankshaft set as described above place idler gear in position, ensuring that the timing marks line up correctly. Replace idler gear set-screw, tighten and lock with tab washer.

VALVE TIMING

If for any reason a new camshaft gear has been fitted it may be necessary to re-time the engine. Fit replacement gear as instructed in Section L and proceed as follows :—

Bring Nos. 1 and 4 pistons to T.D.C. That T.D.C. has been obtained on Nos. 1 and 4 pistons can be checked by examining the flywheel, or the crankshaft at the front end where the key for the fan belt pulley should be at the top of its periphery.

Remove idler gear.

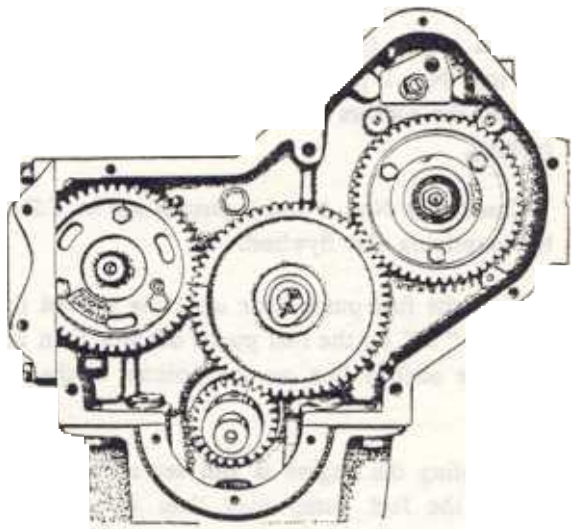


Fig. N1. Showing timing gear markings

Turn camshaft until equal lift is obtained on the tappets of No. 4 cylinder.

Turn fuel pump gear until scribed line marked with the letter " S " on the fuel pump adaptor is in line with the scribed line on the pointer on the fuel pump.

Place the idler gear in position.

Replace push rods and rocker shaft assembly. Check valve and injection timing. If found to be correct, tighten idler gear retaining setscrew and lock with tab washer. For setting valve clearances and checking valve timing see method " To Check Timing."

INJECTION TIMING.

If the fuel pump has been removed, or a replacement pump is to be fitted it will be necessary to time the fuel pump in conjunction with the engine.

Proceed as follows :—

Remove atomisers.

Remove valve cover.

Turn engine to bring Nos. 1 and 4 pistons to the top, No. 1 piston being on the compression stroke, the rockers of No. 4 cylinder being just rocking.

Check that Nos. 1 and 4 pistons are at T.D.C. by examining the flywheel.

Turn the fuel pump gear until the scribed line marked " S " on the fuel pump adaptor is in line with the scribed line on the pointer of the fuel pump

Providing the engine is still set as mentioned above, the fuel pump may then be placed in position and the securing setscrews tightened.

Turn the engine through two revolutions of the crankshaft and check the fuel pump timing according to instructions for checking injection timing.

TO CHECK TIMING.

To check timing proceed as follows

(a) Valve Timing.

Remove valve cover.

Remove atomisers.

Turn engine until equal lift is obtained on the tappets of No. 4 cylinder. In this position, set the clearance on No. 1 inlet valve to .025 in. (.64mm)

Turn engine in the normal direction of rotation until the inlet push rod of No. 1 cylinder just begins to tighten. This is the point at which the inlet valve begins to open.

Check through the inspection hole in the flywheel housing that the flywheel T.D.C. mark is central within the inspection hole. If the T.D.C. mark on the flywheel is within plus or minus 3° of T.D.C. position, then the valve timing is correct.

Having checked the valve timing, the valve clearances should be re-set to .010 in. (.25 mm) with engine warm. When checking and adjusting valve clearances the engine should be turned to bring the respective pistons to T.D.C. on compression.

(b) Injection Timing.

To check the fuel pump timing proceed as follows :—

Remove atomisers.

Remove valve cover.

Remove the inspection plate on the side of the timing case.

Turn the engine in the normal direction of rotation and bring Nos. 1 and 4 pistons to the top, No. 1 piston being on the compression stroke, the rockers of No. 4 cylinder being just rocking.

Check that Nos. 1 and 4 pistons are at T.D.C. by examining the flywheel.

Check through the inspection hole that the scribed line marked " S " on the fuel pump adaptor is in line with the scribed line on the pointer of the fuel pump (See Fig. N.2).

Should the scribed lines mentioned above not coincide, adjustment can be made by slackening the three setscrews in the centre of the fuel pump gear, then turning the fuel pump adaptor in the direction required.

To obtain access to the setscrews remove the plate on the front of the timing case cover.

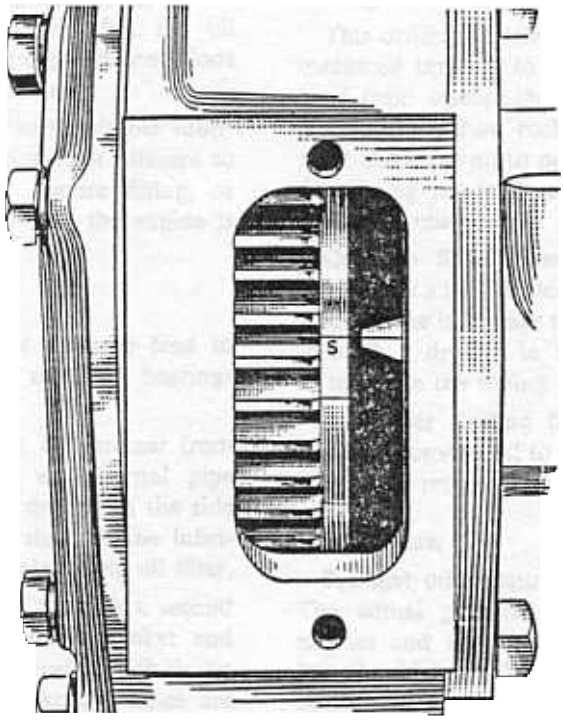


Fig. N2. Diagram showing fuel pump gear and scribed lines

LUBRICATING SYSTEM (P)

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 that the engine is level.

Oil Circulation.

The system of lubrication is pressure feed to main and big end bearings, to camshaft bearings and to valve rocker assembly.

The pump draws oil through the strainer from the sump and delivers it by an external pipe inside the crankcase through a drilling in the side of the cylinder block ; thence through the lubricating oil filter bracket to the lubricating oil filter.

From the filter it is delivered through a second drilling in the lubricating oil filter bracket and cylinder block to the pressure rail which is an internal passage within the crankcase ; holes are drilled which lead from the pressure rail to the crankshaft main bearings and holes drilled in the crankshaft carry oil to the big end bearings. Surplus oil returns to the sump.

A seal prevents oil leaking from the rear end of the crankshaft.

The small end bushes are lubricated by splash and lubricating oil mist.

A passage from the centre main bearing conveys oil to the centre camshaft bearing which is also in open communication with the top face of the cylinder block by means of a vertical drilling.

In conjunction with the centre camshaft journal, this latter drilling serves to provide oil at a reduced pressure to the top face of the cylinder block and thence to the rocker assembly.

The camshaft journal contains two drilled passages and when, as in Fig. P.2, these drillings are in line with the feed from the centre main bearing, oil flows to the top face of the cylinder block. Since these drillings coincide but momentarily for every revolution of the camshaft, only a reduced quantity of oil is delivered to the drilling leading to the top face of the cylinder block.

This drilling matches up with a vertical passage machined through to the top face of the cylinder head from whence the oil is taken by an external pipe to the hollow rocker shaft. Drillings in this shaft allow the oil to pass to the rockers, the overflow being returned to the sump by way of the push rod chamber.

Oil also flows from the front main bearing bracket via a hole drilled in the front of the cylinder block to the idler gear spigot from which it escapes through a drilling in the boss of the idler gear to lubricate the timing gears.

A further drilling from No. 1 Main Bearing Housing conveys oil to the front camshaft bearing, surplus oil returning to the sump.

Oil Pressure.

See that oil pressure is registered on the gauge. The actual pressure may vary with individual engines and under different operating conditions but should be 25/50 lbs. per sq.in. (1,76/3,52 kg/sq.cm) at working temperature and maximum engine speed.

If the oil pressure, as registered on the gauge, is below normal check the following in the order given below.

(1) Dipstick. Ensure that there is sufficient oil in the sump.

(2) Oil pressure gauge. Check for accuracy with master gauge.

(3) Lubricating oil filter. May be choked, clean or re-new element (see periodical attentions Section F).

(4) Sump strainer. This may be choked, remove, clean and replace (for removal instructions see Page P.2).

(5) Lubricating oil pump. Ensure that suction and delivery pipe unions are tight.

(6) Oil pressure relief valve. Foreign matter may be preventing the valve from closing. For cleaning instructions Page P.3.

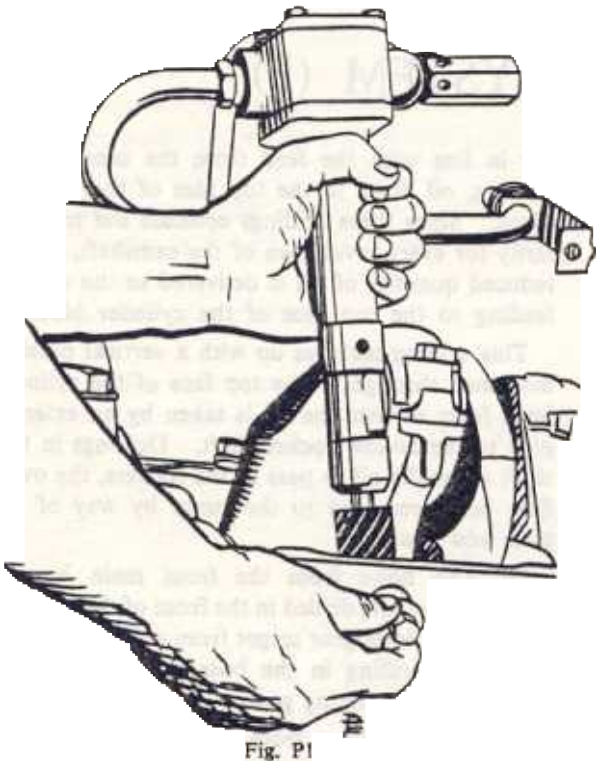


Fig. P1

The Oil Pressure Relief Valve.

The oil pressure relief valve which is incorporated in the pump prevents the pressure becoming excessive as might otherwise happen when the engine is cold.

When the predetermined pressure is exceeded the valve opens against the spring 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.

On early engines the oil pressure relief valve housing was integral with the bottom cover of the lubricating oil pump and to obtain access to the valve for cleaning, see Page P.3.

As from Engine No. 6032453, however, lubricating oil pumps incorporate a detachable pressure relief valve which is screwed into the outlet side of the pump body, (See Fig. P.1). The action of this valve is identical to that described above, and cleaning instructions are given on page P.3.

When to Renew the Oil.

The oil in the sump must be drained in accordance with periodical attentions Section F and replaced by new oil of a specification suitable for the climate in which the engine is operated (See Appendix).

General.

Particular care must be taken to wipe off any water which may have splashed onto the engine at any time, since water, which may find its way into the sump from the exterior, will tend to form sludge.

Failure to change the oil at the 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, see Section F.

To Remove, Clean and Replace Sump Strainer.

Drain oil into a suitable receptacle after removing the drain plug. Remove setscrews holding sump strainer cover. This cover is situated near the drain plug.

Drop cover and strainer will come away with cover.

Wash and clean strainer in clean fuel oil or paraffin.

To re-assemble, reverse the order of operations. Ensure that the oil pump suction pipe enters the hole provided in the strainer.

If reasonable care is taken when removing and replacing sump strainer cover, the joint will not require renewing every time the strainer is removed.

To Remove Sump.

Remove drain plug and drain off oil.

Remove dipstick.

Remove sump strainer (as above).

Remove all setscrews securing sump to crankcase and lower sump.

Remove all traces of old joints and sump cork strip from timing case bottom cover and rear main bearing cap.

To Replace Sump.

Assemble new joints and cork strips.

Lightly smear crankcase faces with a thin coating of jointing compound and place joints in position ensuring all holes line up.

When placing joints in position it is important

that the mitred ends go right up into the recesses of the timing case bottom cover and rear main bearing cap.

Cut cork joints to required length and lightly coat one face and the two sides with jointing compound and place in position.

To facilitate assembly of the sump, screw two guide studs into the crankcase, one on each side.

The studs will position the sump accurately and prevent displacement of the joints.

Place the sump in position and insert the screws

Remove guide studs.

When all the setscrews have been inserted tighten evenly all round. Do not overtighten setscrews.

Replace sump strainer and cover plate as previously described.

To Remove and Refit Oil Pump.

Remove sump and sump strainer (see previous headings).

Disconnect oil pump delivery pipe from the crankcase union.

Remove setscrew from centre main bearing cap thus releasing the oil suction pipe.

Unscrew the lubricating oil pump locating setscrew. This screw is situated outside the cylinder block (See Fig. P.1).

The oil pump may now be removed (See Fig. P.1).

To refit, reverse the above order of operations.

To Remove and Clean Oil Pressure Relief Valve.

With engines prior to No. 6032453, the oil pressure relief valve forms part of the oil pump bottom cover. The breaking pressure is set and adjusted at the factory and unless special test equipment is available no attempt should be made to dismantle the oil pressure relief valve.

To obtain access to the relief valve for cleaning proceed as follows :—

Remove sump and sump strainer.

Remove lubricating oil pump from engine.

Remove the setscrews securing the bottom cover and remove bottom cover.

Wash the valve in clean fuel oil and blow the valve dry with compressed air.

See that the ball and ball seat are perfectly clean and bedding correctly.

Re-assemble bottom cover to pump using a new bottom cover joint.

When re-assembling bottom cover to pump, note the warning given on page P.4.

On engines subsequent to No. 6032453, the lubricating oil pump relief valve may be removed and cleaned without dismantling the pump from the engine.

After the sump has been removed, break locking wire, and unscrew the relief valve assembly from the side of the oil pump body. Thereafter cleaning of the valve assembly should be in accordance with instructions detailed below.

To Dismantle the Oil Pump.

Remove pump from engine (See above).

Remove locking wire from suction and delivery pipe banjo bolts and remove pipes. In the case of engines subsequent to No. 6032453, it will be necessary to remove the relief valve assembly in order to release the delivery or outlet pipe.

Remove the setscrews securing the bottom cover and gear housing.

The idler gear can now be removed.

Press off spiral driving gear.

The drive shaft and gear can now be removed. To remove gear from shaft use suitable press.

To remove the idler gear shaft, withdraw the split pin first ; the shaft can then be pressed out. Unless a replacement shaft is to be fitted it is not necessary to remove this shaft and pin.

The cleaning of the pressure relief valve has been dealt with under a previous heading.

Inspection.

All the parts of the pump should be cleaned and inspected for wear. The fit of the shaft in the pump body should be carefully checked. The shaft should work easily without lateral movement in the bushes fitted in the body. If the bushes are worn they should be replaced.

If the oil pump gears show signs of wear they should be renewed.

To Re-assemble the Oil Pump.

Press drive shaft gear on to shaft The end of the shaft should be flush with the bottom face of the gear.

Assemble gear and shaft to pump body.

Assemble idler gear, pump housing and joint to body ; secure by using setscrews with suitable distance pieces.

Check that there is clearance between housing and gears.

Place bottom cover joint on bottom face of housing and with a straight edge and feeler gauge, check the clearance between the straight edge and face of gears. This clearance should be .002 in. to .006 in. (.051 to . 152 mm). It is important that this clearance does not exceed .006 in. (.152 mm) otherwise the pump output will be insufficient and the lubricating system adversely affected.

New joints should be used when carrying out the above test.

Remove setscrews, pump housing and idler gear.

Using a suitable press, press the spiral driving gear on to the shaft. The shaft end should be just level with the top face of the spiral gear.

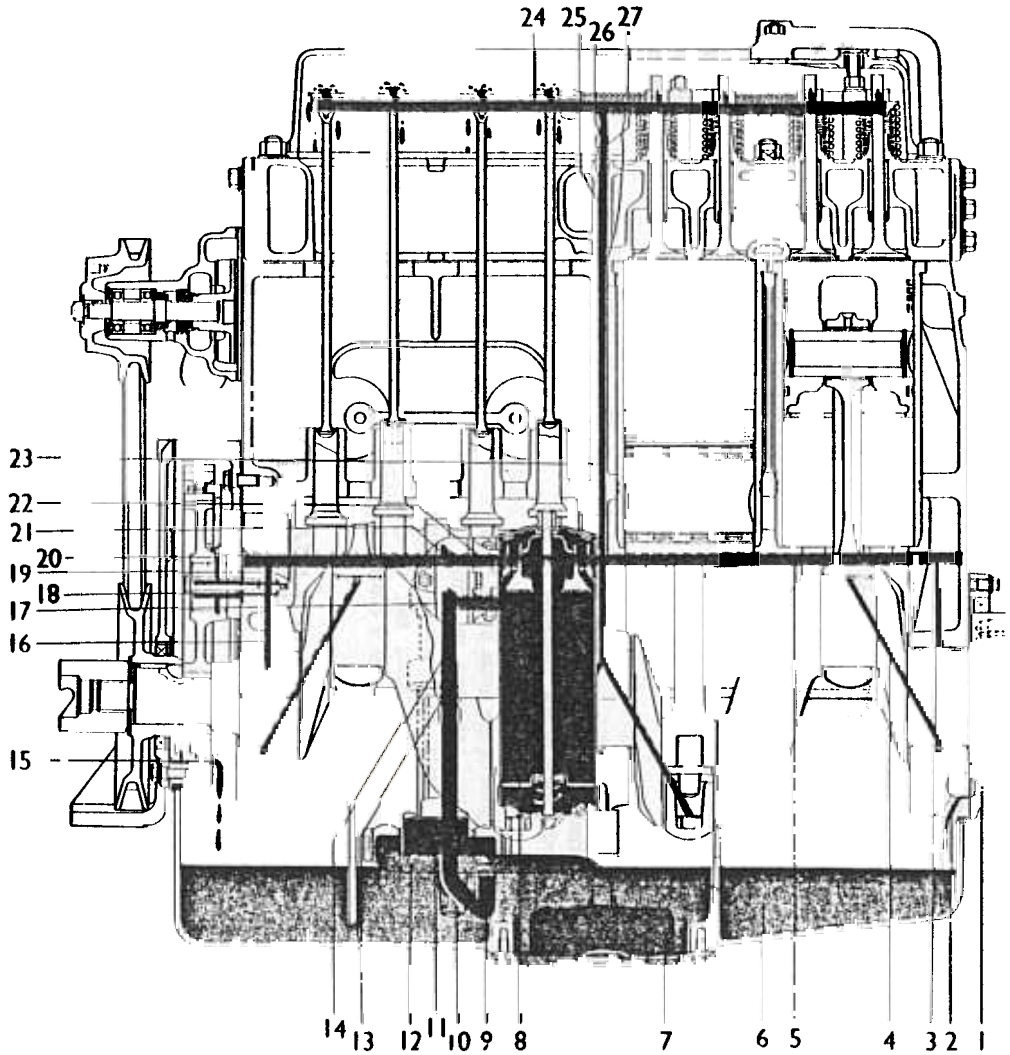
Assemble housing, joints, idler gear and bottom cover to pump body, using new Shakeproof washers for the securing setscrews.

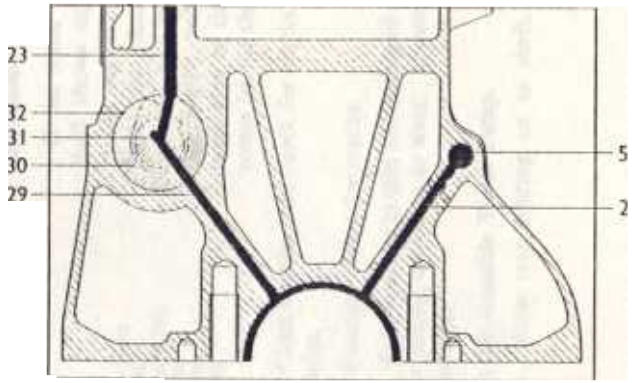
WARNING :—WHERE APPLICABLE, WHEN RE-ASSEMBLING BOTTOM COVER CARE MUST BE TAKEN TO ENSURE THAT THE COVER IS ASSEMBLED WITH THE OIL RELIEF VALVE ON THE DELIVERY SIDE OF THE PUMP.

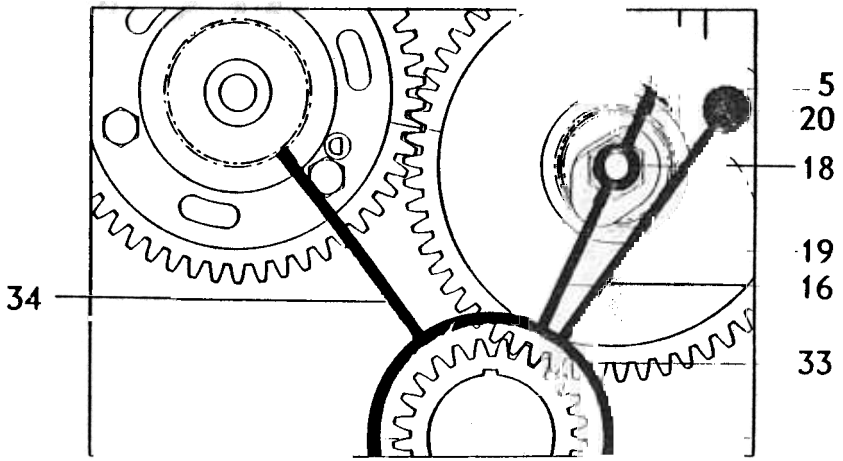
Replace suction and delivery pipes and lock banjo bolts with locking wire.

Re-assemble pump to engine.

FIG P2 LUBRICATING DIAGRAM







1. Oil Seal.
2. Oil Return Passage to Sump.
3. Oil Ways in Crankcase Webs.
4. Oil Ways in Crankshaft.
5. Pressure Rail.
6. Sump.
7. Sump Strainer.
8. Oil Filter.
9. Oil Pump Delivery Pipe.
10. Relief Valve Housing. (Engines prior to No. 6032453)
11. Oil Pump.
12. Oil Pump Suction Pipe.
13. Union—Oil Delivery Pipe to Crankcase.
14. Oil Way in Crankcase leading to Adaptor.
15. Oil Return from Timing Case.
16. Oil Way—No. 1 Main Bearing to Idler Gear in Timing Case.
17. Oil Way—Crankcase to Adaptor —Delivery to Filter.
18. Oil Way—Idler Gear Spigot.
19. Oil Way—Pressure Rail to No. 1 Main Bearing.
20. Oil Hole—Idler Gear Outlet.
21. Oil Pressure Gauge Connection.
22. Oil Filter Outlet—through Adaptor to Pressure Rail.
23. Oil Way—Centre Camshaft Bearing to Top Face of Cylinder Block.
24. Rocker Shaft.
25. Oil Way through Cylinder Head, Continuation of 23.
26. Oil Pipe—Cylinder Head to Rocker Shaft.
27. Outlet Connection—Cylinder Head.
28. Oil Way—Pressure Rail to oil groove Centre Main Bearing housing.
29. Oil Way—Centre Main Bearing to Centre Camshaft Bearing.
30. Camshaft.
31. Drilling in Centre Camshaft Journal.
32. Centre Camshaft Bearing.
33. Oil groove No. 1 Main Bearing housing.
34. Oil way—No. 1 Main Bearing housing to front Camshaft Bearing.

WATER PUMP (Q)

The cooling water is circulated by a centrifugal type pump mounted on the front end of the cylinder block and driven by a Vee belt from the engine crankshaft. Provision is made for fitting a fan on the front of the water pump pulley.

The pump does not require greasing as the bearings are treated with a special grease before assembly.

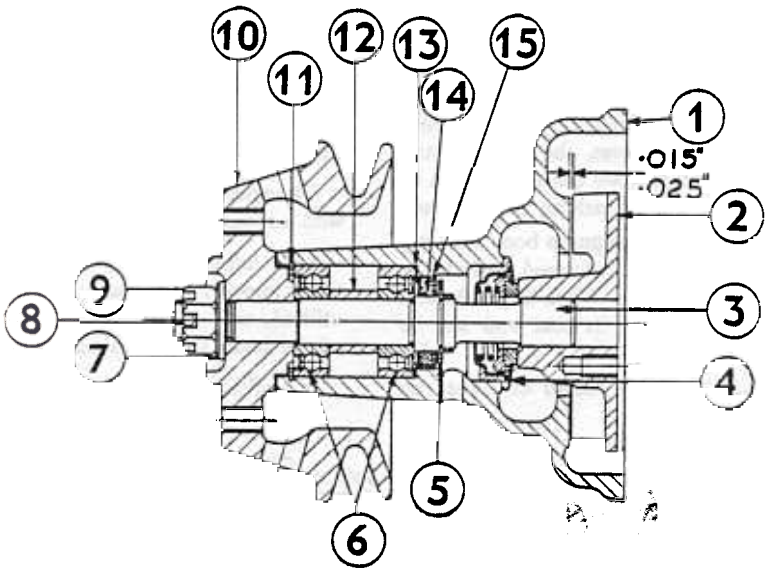


Fig. Q.1. Water Pump in Section

1. Body
2. Impeller
3. Shaft
4. Rear Seal
5. Thrower
6. Bearings
7. Plain Washer
8. Split Pin
9. Slotted Nut
10. Pulley
11. Circlip
12. Distance Piece
13. Front Seal Retaining Plate
14. Front Seal
15. Front Seal Housing

To Remove and Refit Water Pump.

Slacken dynamo securing screws and remove fan belt.

Remove fan.

Unscrew nuts securing water pump to cylinder block and remove water pump.

To refit pump to cylinder block is a reversal of the above procedure.

When re-assembling to cylinder block a new joint should be used to ensure that a watertight joint is made.

To Dismantle Water Pump.

Remove split pin from slotted nut securing water pump pulley, and remove nut and washer.

Remove water pump pulley.

Remove impeller from shaft.

Remove front bearing retaining circlip using long nose pliers for the purpose.

Remove rear seal.

Using a suitable press, press the shaft out of the body from the impeller end leaving the thrower loose in the body. These can now be removed from the body.

Remove the front seal and flanges. The two bearings and distance piece will still be on the water pump shaft. These can be removed by means of a suitable press.

Inspection.

If the water pump drive shaft shows signs of wear in the region of the bearings, the shaft must be renewed, as a worn shaft in this region will allow the inner race of the bearing to rotate on the shaft.

Clean impeller and check for cracks and broken blades.

Examine casing for cracks.

Wash bearings in thin lubricating oil and examine for pitting, corrosion or wear. If necessary renew bearings.

To Re-Assemble Water Pump.

1. Press rear bearing on to shaft, fit bearing

distance piece and then press on front bearing. Ensure that each bearing end cover faces outwards towards the ends of the shaft.

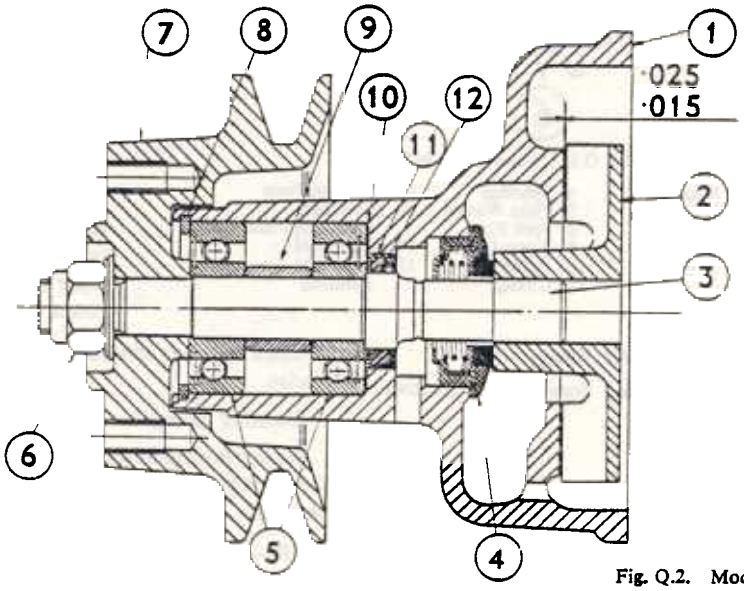
2. The front seal retaining plate should then be placed in position against the back face of the rear bearing. This retaining plate is 'dished' and when positioned, the centre of the plate must not be in contact with the rear bearing.
3. Fit the felt seal and seal housing, so that these bear on the retaining plate.
4. Press the water pump thrower on to the shaft so that the thrower flange faces towards the rear bearing.
5. The whole of the foregoing assembly should then be pressed into the water pump body from the front end, and the circlip securely positioned in the recess forward of the front bearing. Before pressing the assembly into the pump body, however, the bearings and the space between the two bearings should be half filled with a high melting point grease.
6. Fit the rear seal into the pump body ensuring that the carbon face is positioned towards the rear of the pump body. When fitted, the seal must rest squarely on its seat and not be canted in any way.
7. At this stage the shaft should be turned by hand to ensure that there is no undue resistance to rotation.
8. Press on the pulley making certain that no rearward axial movement of the shaft is incurred.
9. The impeller should now be pressed on to the shaft. With the impeller fitted, care should be taken to ensure that a clearance of .015—.025 in. (.38 to .64 mm) is maintained between the inner edge of the impeller vanes and the water pump body. As a guide to obtaining a correct clearance in this respect, the impeller should be so positioned as to allow a straight edge to simultaneously touch the back face of the pump body and the two raised extractor hole faces in the rear of the impeller.
10. Refit plain washer and slotted nut and secure with a new split pin.

Modified Water Pump

L4 engines subsequent to No. 6036233, are fitted with a modified water pump.

This latest assembly (Fig. Q.2) incorporates larger impeller shaft bearings than those previously utilised, and, accordingly, the interior dimensions of the body have been amended.

In addition the dimensioning of the latest water



1. Body
2. Impeller
3. Shaft
4. Rear Seal
5. Bearings
6. Self Locking Nut
7. Pulley
8. Circlip
9. Distance Piece
10. Front Seal Retaining Plate
11. Fro t eal Housing
12. Front Seal

Fig. Q.2. Modified Water Pump in Section

pump body and pulley result in a very limited clearance between these components so that the labyrinth sealing effect obtained offers increased restriction to the passage of dust to the water pump front bearing.

Since the width of the pump bearings have been increased, a shorter distance piece is now fitted between the bearings, and the increased bearing diameter necessitates the use of a larger front bearing retaining circlip.

A modification to the impeller shaft dispenses with the thrower flange previously fitted at the rear of the front seal and self-locking nut replaces the retaining slotted nut and split pin previously fitted to retain the water pump pulley.

The process of dismantling and reassembly of the water pump as detailed previously is applicable to the latest type pump with the exception of those remarks in respect of the thrower flange and slotted pulley retaining nut and split pin.

FAN AND DYNAMO BELT ADJUSTMENT (R)

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. 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.

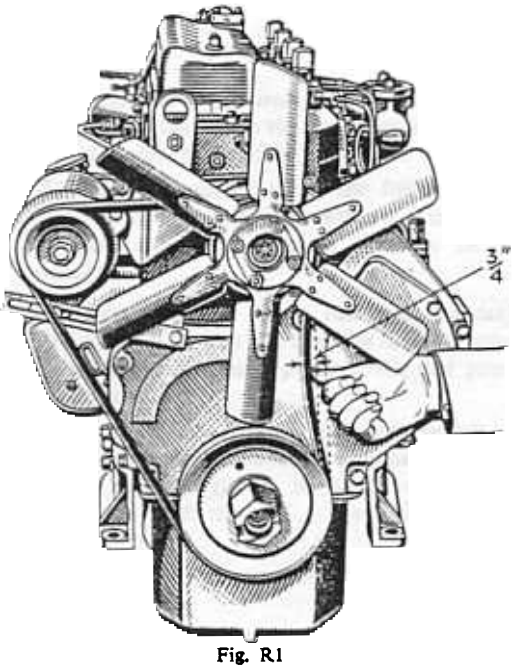


Fig. R1

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 reduced.

Method of Checking Correct Adjustment.

Press the fan belt with the thumb at the centre point between the water pump and the crankshaft pulley in a sideways direction (See Fig. R.1). Check the amount of movement of the fan belt which should be ½ in. (19.05 mm) if correctly adjusted.

Method of Adjustment.

Unscrew the dynamo adjusting lever setscrew, the setscrew securing adjusting lever to timing case and dynamo support bracket bolts. The dynamo can then be moved inwards towards the engine to slacken the belt and in an outwards direction to tighten it. When the belt is tensioned correctly, tighten dynamo adjusting lever setscrew, the setscrew securing adjusting lever to timing case, and support bracket bolts.

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.

Dynamo Bracket Locating Screw.

This locating screw is adjustable when in position in the rear arm of the dynamo support bracket, and should always be tight against the rear dynamo lug before the support bracket nuts and bolts are tightened.

FUEL INJECTION SYSTEM (S)

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 paper element type filter, the fuel pump and the atomisers.

On certain installations the fuel system is gravity fed, and therefore no fuel lift pump is fitted. The filter system in these applications consists of a water trap and a paper element type 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 :

British Standard 2869 (1957) Class A.

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-returned plunger type. It is driven by one of the cams on the camshaft of the fuel pump, on the side of which it is fitted. It is shown in Fig. S.1.

A hand primer is fitted, Fig. S.1, 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 S.6.

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.

When fitting a new or replacement fuel pump, remove the pump inspection cover and pour sufficient engine oil into the spring chamber until oil comes out of the oil overflow. Refit the inspection cover.

Thereafter, check the oil level and top up with fresh oil when necessary every 100 hours or as often as is necessary to maintain the correct level. The outside of the pump should be cleaned before removing the inspection cover to ensure dirt does not enter the pump.

Refer now to Fig. S.11, the sectional drawing of the fuel pump.

Oil is supplied from the lift pump through the fuel inlet connection, 25, and entirely fills the fuel pump gallery, 23. That is a tubular passage running the full length of the fuel pump and closed at the end opposite to the inlet by the vent plug. This fuel pump gallery is connected through small ports with all the pump barrels, 19.

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, 20, 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, 21, into the pipe leading to the atomiser.

Fig. S.2 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 groove is the means of varying the quantity of fuel delivered per stroke. (See below).

The first sketch in Fig. S.3, 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, 23, of the pump (Fig. S.11). 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 direct driven 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 and that in the gallery via (a) the vertical groove, (b) the annular groove, (c) the port in the pump barrel. (See Fig. S.2).

That is the position shown in the second sketch of Fig. S.2.

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

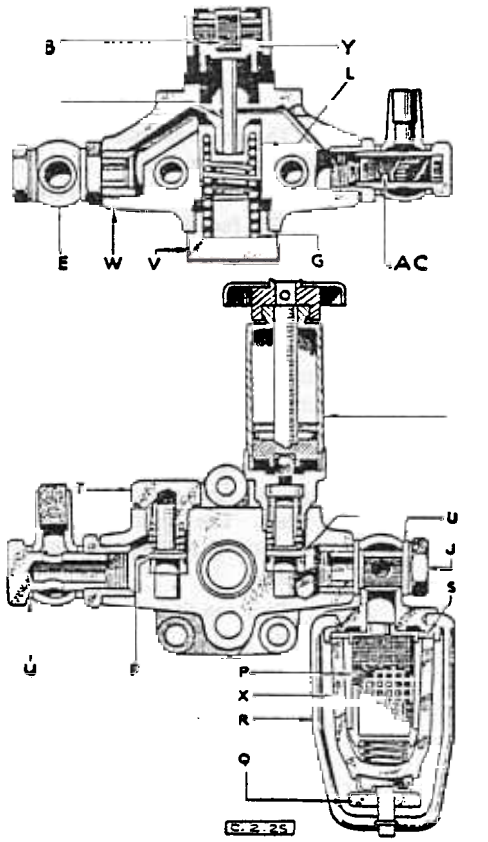


FIG. S1. FUEL LIFT PUMP.

(The preliminary filter is not always supplied).

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

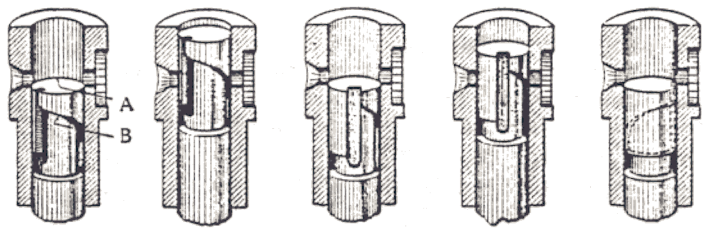


FIG. S2. Barrel, with Plunger in Various Positions.

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.

In the first and second sketches of Fig. S.2, 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.

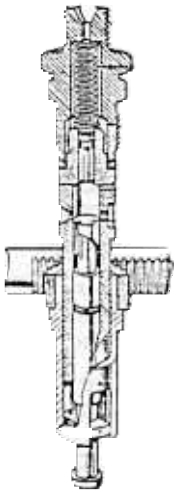


FIG. S3. Pump element shown in section.

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 lesser 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. S.3). 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. S.11). 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, 21, 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. S.4 shows a delivery valve. It is at one and the same time 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. S.4, the valve is shown closed.

This valve has a high lift, so that, as shown in Fig. S.4 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 :—

So 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. S.4.

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.

A steel peg is used to centralise the upper end or the valve spring and also to reduce the capacity of the holder, thereby improving injection control.

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 system, 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, 29, connects this venturi passage with a governor casing which is mounted on the fuel pump. See Fig. S.11.

Reference to the drawing of the pneumatic governor, Fig. S.11, will enable its operation to be understood.

The important element is the flexible leather diaphragm, 28, which divides the space inside the governor casing into two compartments, one of which, that on the right, is airtight.

This airtight compartment is in communication with the venturi by means of a pipe, 29. The vacuum in the venturi is thus communicated to the airtight compartment and the right-hand side of the diaphragm.

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

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

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

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 S.3.

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

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

Now here is a point of the very greatest im portance.

Any leaks in the joints of the pipe, 29, 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.

If the pipe, 29, were to become detached, or 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 are tight.

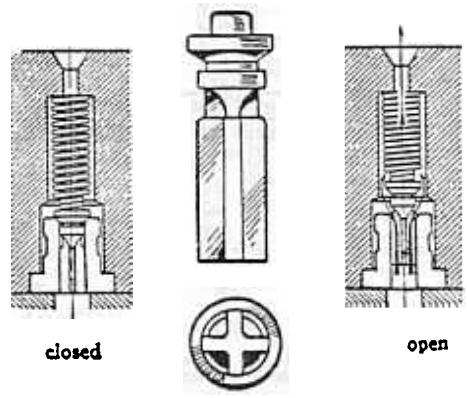


FIG. S4. Delivery Valve.

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 airtight chamber is at a maximum and the diaphragm together with the fuel pump control rod, is as far to the right 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 right of the pneumatic governor is provided. Refer again to Fig. S.11.

The idling control spindle, 33, which is under the control of a small strong spring, 32, contacts the centre of the diaphragm when the latter is in the extreme right 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, 34, is moved clockwise, carrying the control rack with it and turning the pump plunger into the position shown in the fifth sketch of Fig. S.2, the "no fuel" position tion.

Atomisers.

After leaving the fuel pump the fuel passes through short steel pipes, 35, 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, 45, with its valve, 44, and the atomiser body, 41.

The atomiser nozzle and nozzle valves are the important parts. They are shown in Fig. S.8.

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. S.11. The nozzle is held in place by the nozzle holder cap nut, 43. 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, 36, 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, 42, surmounted by the valve spring, 40, and washer, on the top of which bears the compression screw, 38. 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, 37, 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 Section G.

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. S.1. 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 authorised 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 airtight.
(b) Inlet or outlet valves leaking.	Valves F. & H.	Treat as for (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 the top of 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 bubbles 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. S.11.

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 in Section G.
	(d) Air in pump.	Air vent filter and pump as described on page S6.
	(e) Delivery Valve, 21.	Clean and inspect. If worn or damaged, replace both valve and seating.
	(f) Pump plunger, 20.	Return the pump intact to the nearest service station or to Perkins Engines Ltd.
Pump does not deliver fuel uniformly.	(g) Air in pump.	Air vent filter and pump as described on page S6.
	(h) Delivery valve spring, 22.	Replace if broken.
	(j) Delivery valve.	If damaged on face or guide replace.
	(k) Tappet spring, 15	See (f) above.
	(l) Pump plunger, 20.	See (f) above.
	(m) Fuel inlet pipes or filter elements.	Proceed as (c)
	(n) Fuel lift pump.	This pump may not be operating efficiently. See instructions on page S6.
	(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, 21	
	(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, 24.	If moved, due to screw being loose, proceed as in (f)

4. Maximum Speed of engine too high.

Possible Cause.	Location.	Condition or suggested remedy for correct working.
Control rod has jammed.	(a) Pump plunger, 20.	Proceed as in (f)
	(b) Control rod	Proceed as in (f)

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.

(a) Remove vacuum pipe.

(b) Move the stop lever into " stop " position.

(c) Place a finger over the diaphragm housing union in order to seal it.

(d) Release the stop lever.

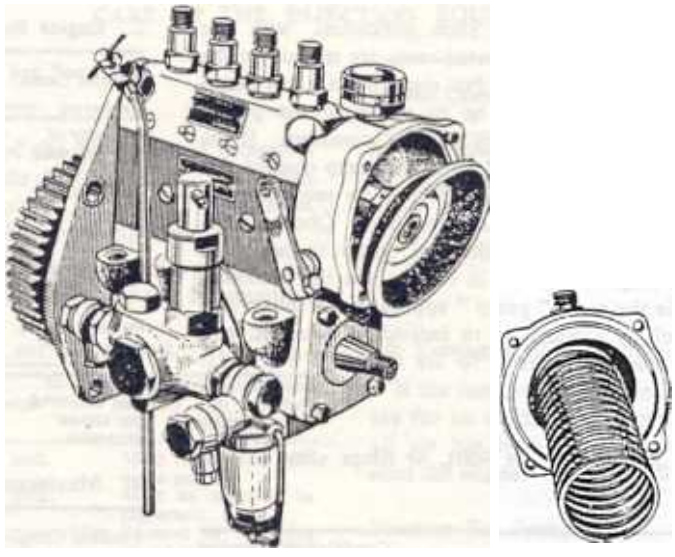


FIG. S5. Removing diaphragm from pneumatic governor.

(e) 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 by an authorised agent. 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.

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. S.5.

Great care must be exercised in this operation.

For preference, use a piece of sheet metal about ¾ in. (19.0 mm.) 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 for any reason.

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

This 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 brass nipples which will be found on each end of these pipes.

If the union nuts have at any time been over-tightened 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 thousand 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 1/64 in. (.40 mm) of the latter protruding.

Hold the pipe in the 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 brass 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

previously, 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 maintenance, Section F. It is no use taking atomisers out for attention unless the equipment described on page S.11 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 an 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.

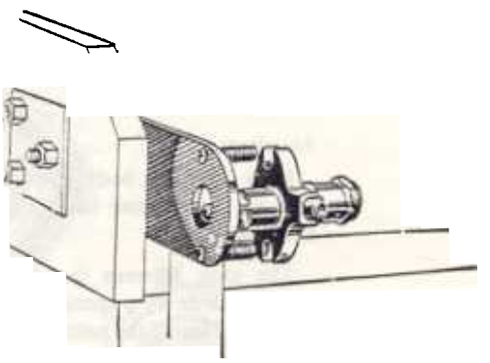


FIG. S6. Showing plate for holding Atomiser while is being dismantled.

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. S.9). 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.

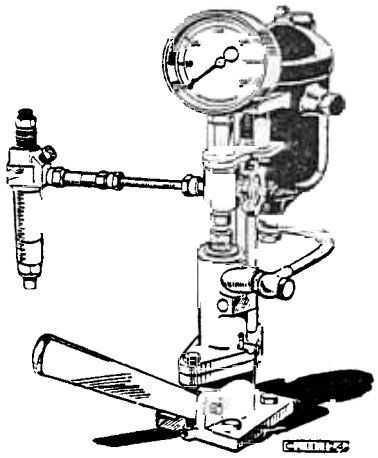


FIG. S7. Atomiser Testing Pump.

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.

A plate, made up as shown in Fig. S.6, should be secured to the bench. Its purpose is to hold the atomiser securely whilst various maintenance operations are proceeding.

An atomiser testing pump No. ET.122A (Fig. S.7) 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 pressure which is 120 atmospheres.

The only exception is in the case of atomisers fitted to L4 Engines installed in Marshall Crawler Tractors where the setting is 160 atmospheres.

Atomisers set at 120 atmospheres have white painted caps and the caps of atomisers set at 160 atmospheres are painted silver.

An alternative means of identification is a tab washer fitted under the atomiser cap nut bearing the letter " J " for 120 atmospheres, or the letter " V " for 160 atmospheres.

L4 atomisers supplied under the Perpetuity Scheme have green painted caps with white or silver on the top or a tab washer under the atomiser cap nut signifying the setting and type.

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 (75 mm) 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

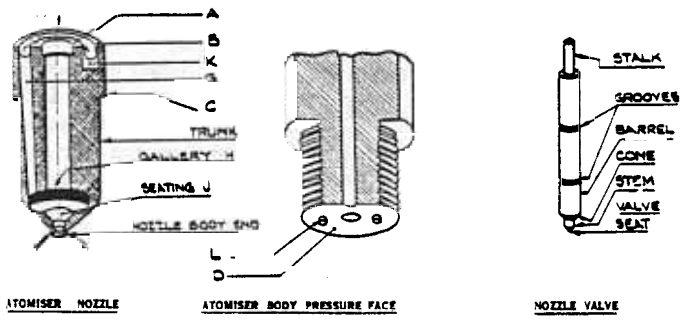


FIG. S8. Diagrams of Atomiser and Atomiser Body reference in the text. the letters have

upon to work in the engine more slowly than 250 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.

Atomisers are set to operate at the pressures described previously before leaving the works. If a new atomiser nozzle is fitted to an atomiser body it is 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. 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 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. S.9, the atomiser should be placed on the atomiser holding plate already described, see Fig. S.6.

Before attempting to dismantle the atomiser, the tension on the spring should be released by unscrewing the compression screw 38. The nozzle holder cap nut, 43, Fig. S.11, should be slackened with the special ring spanner provided, ET116 (see Fig. S.10). 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. S8, 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.

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. S9 and S10, are recommended. The three small drilled passages " G " (Fig. S8), should be explored to see that they are clear and clean, followed by an 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. S8) 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. ET070 (see Fig. S9) to remove any carbon or particles that may be imprisoned on the seat. The gallery " H " (Fig. S8) should now be cleaned with the aid of the special soft brass scraper No. ET071 (see Fig. S9) 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 ET120 (see Fig. S9).

In cases where the holes cannot be cleaned by this process, the complete atomiser should be returned securely wrapped and packed as described

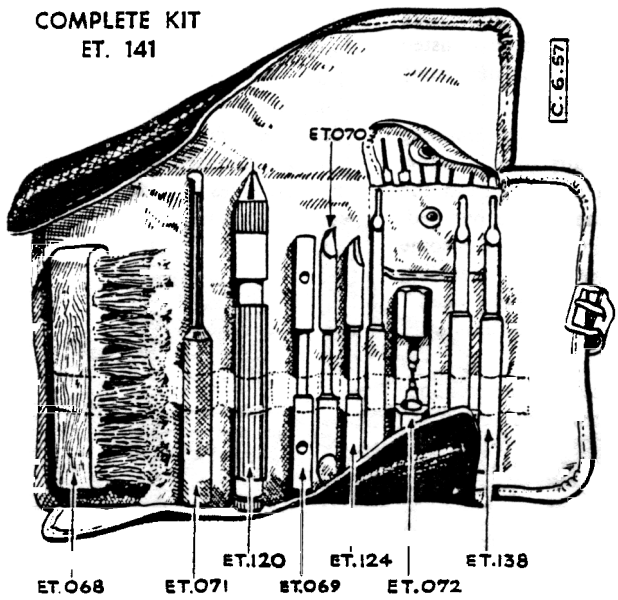


FIG. S9. Complete Kit of Tools for use when cleaning and overhauling atomisers.

above. Assuming that the spray holes have been cleaned satisfactorily, the atomiser nozzle can then be placed in the container to soak in paraffin or preferably assembled in the atomiser flushing tool No. ET427 (Fig. S10) 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. S8, 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. ET072 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. S8) 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, 40 (Fig. S11), spring plate, and nozzle spindle, 42. When dismantling, the special spanners, Nos. ET117 and ET118 (see Fig. S10) should be applied for the removal of the nozzle holder spring cap, 39 (Fig. S11) 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 perferably 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, 43, should be screwed on to the body by use of the special spanner. Excessive tightening of the nozzle holder cap nut may result in constriction 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 ET119 (Fig. S10).

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 S9.

MODIFIED ATOMISERS

As from Engine No. 6012782 a modified atomiser was introduced on L4 engines, the two main differences from the previous type being the auxiliary leak-off pipe connection and the atomiser adjusting screw (see Fig. S.12).

The auxiliary leak-off pipe connection is now on the side of the atomiser body fixing flange whereas previously it was situated just above the inlet pipe union nut. This of course necessitates a new type auxiliary leak-off pipe.

The atomiser adjusting screw now screws directly into the atomiser body and also comprises the atomiser valve spring cap.

Interchangeability.

The modified atomiser is interchangeable with the previous type providing a new type auxiliary leak-off pipe is fitted. To ensure this, new type leak-off pipes are automatically supplied with all Spares and Reconditioned atomisers of the modified type. Previous type Reconditioned atomisers are also supplied with the previous type auxiliary leak-off pipes in order to effect interchangeability with engines incorporating the later type atomisers.

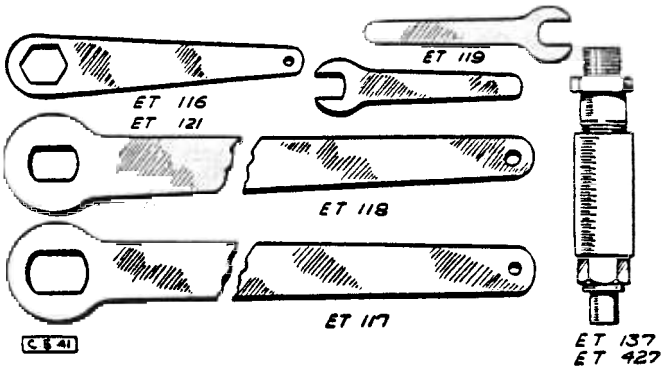


Fig. S10. Spanners and cleaning tools for use with atomisers.

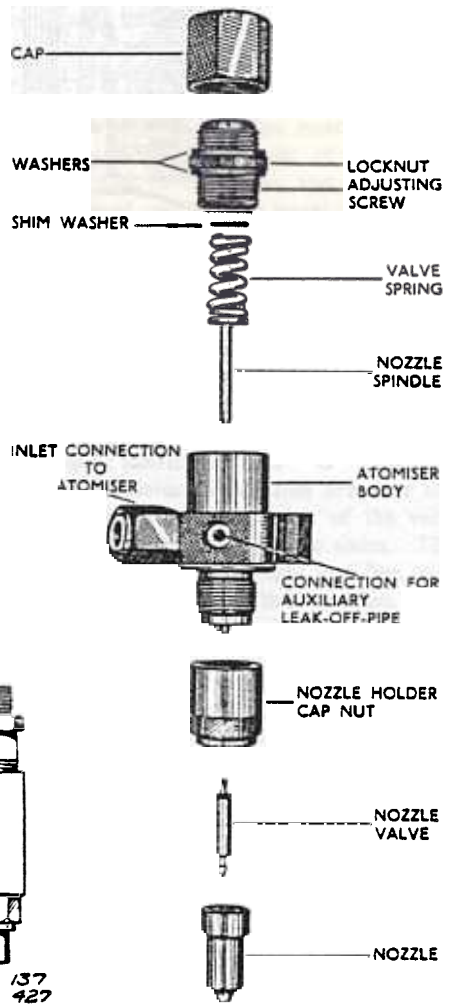
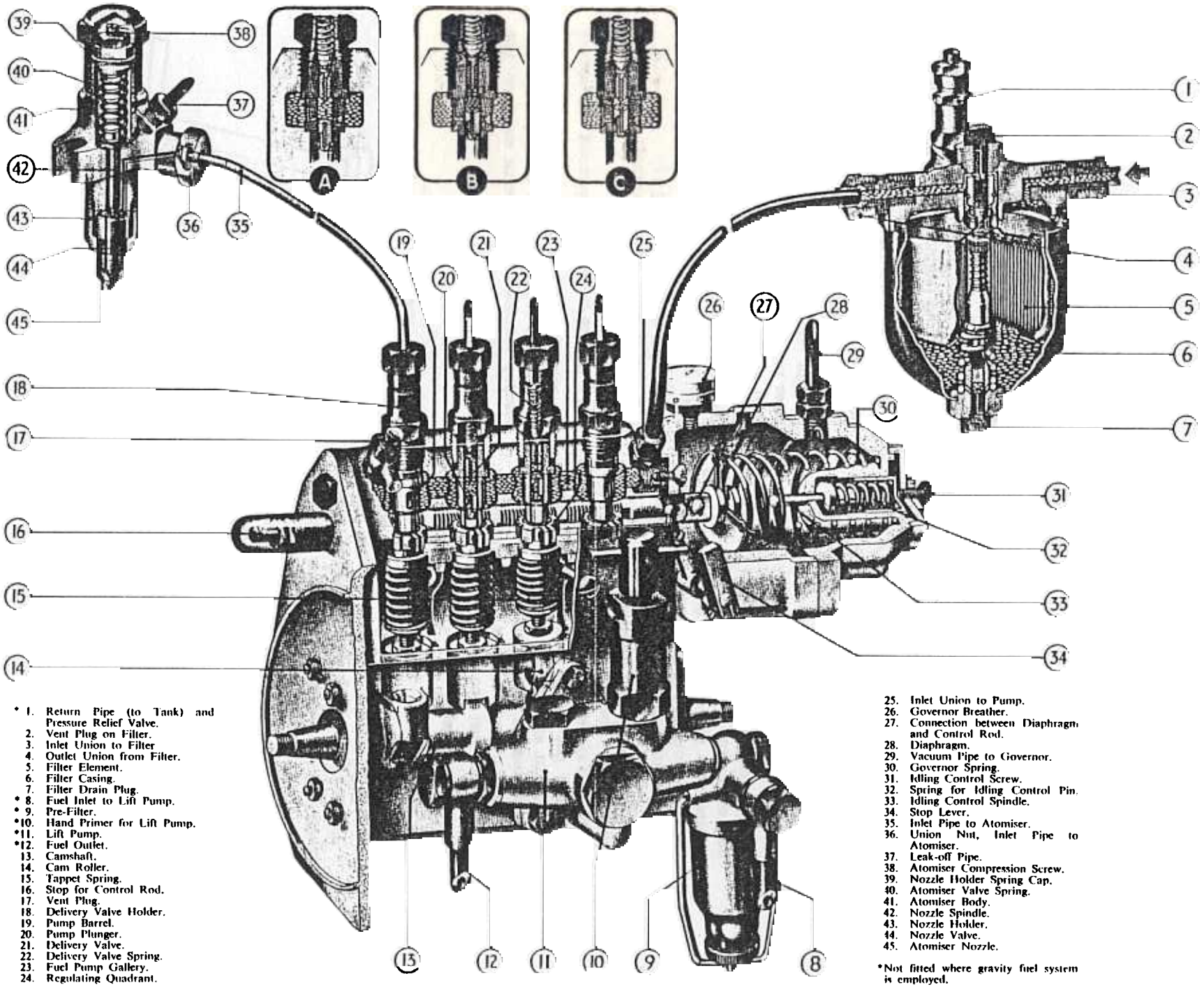


Fig. S12. Diagram of Modified Atomiser

FIG. S1 GHOST DRAWING OF FUEL INJECTION EQUIPMENT



* 1. Return Pipe (to Tank) and Pressure Relief Valve.
2. Vent Plug on Filter.
3. Inlet Union to Filter
4. Outlet Union from Filter.
5. Filter Element.
6. Filter Casing.
7. Filter Drain Plug.
* 8. Fuel Inlet to Lift Pump.
* 9. Pre-Filter.
*10. Hand Primer for Lift Pump.
*11. Lift Pump.
*12. Fuel Outlet.
13. Camshaft.
14. Cam Roller.
15. Tappet Spring.
16. Stop for Control Rod.
17. Vent Plug.
18. Delivery Valve Holder.
19. Pump Barrel.
20. Pump Plunger.
21. Delivery Valve.
22. Delivery Valve Spring.
23. Fuel Pump Gallery.
24. Regulating Quadrant.
25. Inlet Union to Pump.
26. Governor Breather.
27. Connection between Diaphragm and Control Rod.
28. Diaphragm.
29. Vacuum Pipe to Governor.
30. Governor Spring.
31. Idling Control Screw.
32. Spring for Idling Control Pin.
33. Idling Control Spindle.
34. Stop Lever.
35. Inlet Pipe to Atomiser.
36. Union Nut, Inlet Pipe to Atomiser.
37. Leak-off Pipe.
38. Atomiser Compression Screw.
39. Nozzle Holder Spring Cap.
40. Atomiser Valve Spring.
41. Atomiser Body.
42. Nozzle Spindle.
43. Nozzle Holder.
44. Nozzle Valve.
45. Atomiser Nozzle.

*Not fitted where gravity fuel system is employed.

MECHANICAL GOVERNOR (T)

Certain L4 engines are equipped with a mechanical governor in place of the pneumatic governor. This governor is set and adjusted before the engine leaves the factory and no further adjustment should be necessary.

Any settings and adjustments which may be necessary, as when the engine has undergone a major overhaul or the fuel pump has been removed, should only be carried out by trained personnel.

Instructions for adjusting Mechanical Governor.

To carry out the following instructions it will be necessary to remove the cover, situated at the front of the governor, and the governor housing rear cover.

Preliminary Settings.

1. Ensure that the governor weights move freely when operated with the finger. If they are stiff it is probably due to distortion set up in the weight carrier when holding screws are tightened. To correct this it will be necessary to remove carrier plate and see that the rear face is clean and free from dirt. See also that the front of the fuel pump gear is clean and free from dirt.

2. Hold the stop control lever on the fuel pump in the stop position and screw in the idling spring control screw until the spring is coil bound, *i.e.*, until adjustment of the screw just begins to move the stop control lever. When this position is reached, unscrew adjusting screw one turn. The idling spring control screw is situated at the rear of the fuel pump (See Fig. T.3).

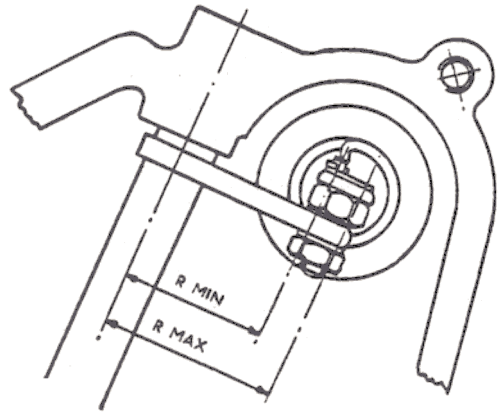


FIG. T1

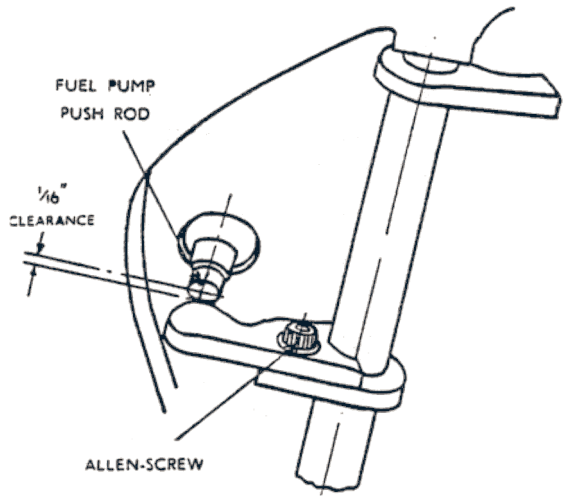


FIG. T2

3. Reduce tension on mainspring with control lever in full speed position.

4. Set eccentric spring anchorage to innermost position (R. Min. See Fig. T.1).

5. Place governor lever in the idle position, press toes of forked lever on to sleeve thrust race and adjust fuel pump actuating lever until this is clear of fuel pump push rod by $\frac{1}{16}$ in. (1.59 mm) when fuel pump control rod is at maximum fuel position (See Fig. T.2).

Allen key 5/32 in. across flats is required to unlock and lock fuel pump actuating lever.

See that, by moving the weights to the outermost position, the fuel pump control rod moves to the point of no fuel (within $\frac{1}{16}$ in. (1.59 mm) of total control rod movement).

Test Bed Procedure.

A. Start engine and warm up to 160°F. (71°C.), water and oil.

B. Set engine to rated load and speed. It will be necessary to increase the main spring tension

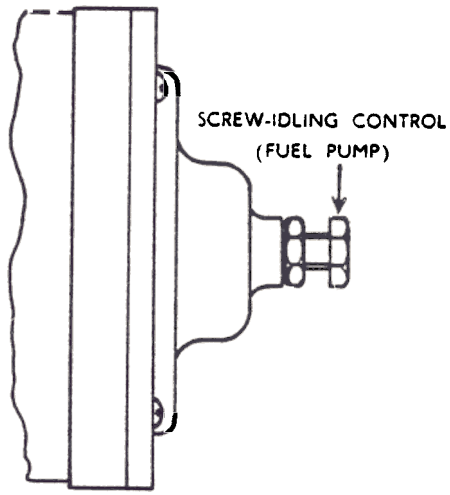


FIG. T3

until full load can just be obtained at the appropriate speed. Main spring tension adjustment is carried out by alteration of the governor spring control lever adjusting screw (See Fig. T.4).

C. *Gradually* remove load, note sustained overrun speed. If this is satisfactory, regain load and try a sudden removal to check stability of the governor.

Greater stability may be obtained by increasing the effective radius R of the spring lever by rotating the spring anchorage. Eccentric adjustment between R. Min and R. Max being obtainable (see Fig. T.1).

D. Having obtained satisfactory governing, set lever to idling position and check light load idling speed. Adjust as necessary on the idling stop screw (Fig. T.4). If it is not possible to reduce idling speed to the required r.p.m. by adjustment of the idling stop screw, it will be necessary to slightly reduce the load in the idling spring.

This can be obtained by screwing out the fuel pump idling spring control screw at the rear of the fuel pump (See Fig. T.3).

WARNING. In no circumstances should any attempt be made to *increase* idling speed with the idling spring control screw.

E. Finally re-check governing from full load, three-quarter and half load to no load to ensure the governor is stable throughout its range.

Field Procedure.

The preliminary settings are as already described and should be carried out, then proceed as follows.

1. Start engine and warm up to 160°F. (71°C.).

2. Set lever to running position and check maximum no load r.p.m. Such inertia load as is available, should then be applied and removed in rapid succession to check the stability of the governor. Any necessary correction should be made as described in Test Bed Procedure, paragraph C.

3. Carry out operation D in Test Bed Procedure.

4. Finally re-check maximum no load r.p.m. and idling r.p.m.

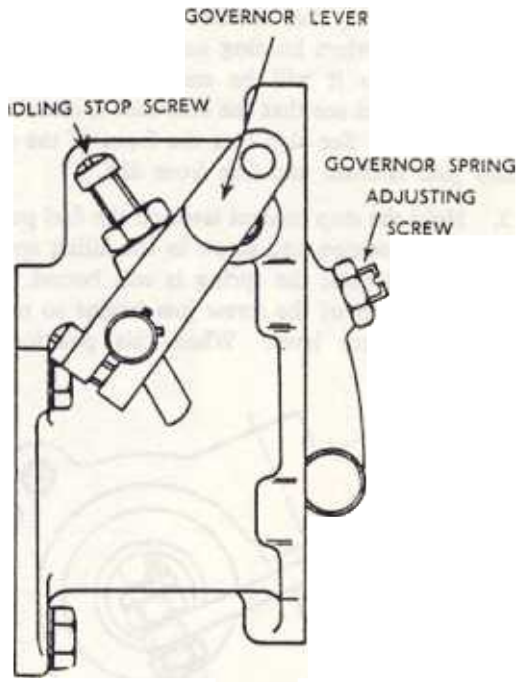


FIG. T4

FLYWHEEL AND FLYWHEEL HOUSING (U)

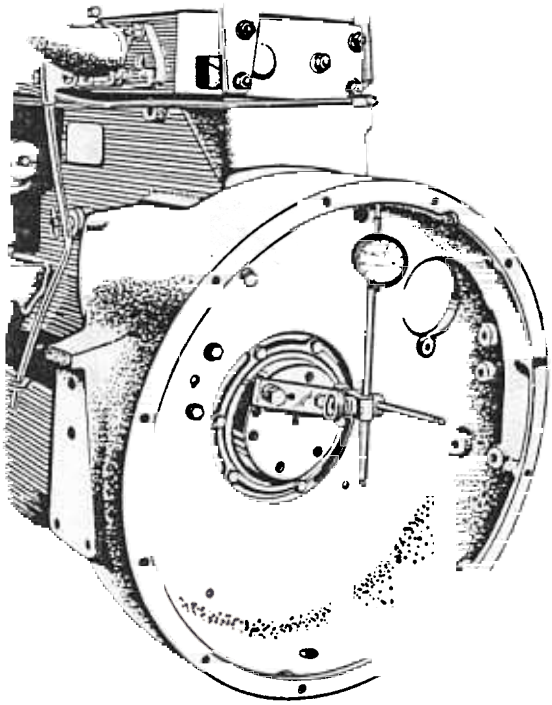


Fig. U1

It is most important that the flywheel housing be correctly aligned with the crankshaft, therefore if a housing has been removed the greatest care must be taken on replacement to ensure accuracy of alignment.

For convenience in turning the engine it is advisable to release (but not remove) the nuts holding the atomisers in place when carrying out alignment of flywheel and flywheel housing.

To Remove Flywheel.

Remove the locking wire from the set screws which secure the flywheel to the crankshaft flange.

Turn the engine to bring one setscrew to the top.

Remove this setscrew and screw in a stud in its place as a temporary measure, to prevent the flywheel from dropping.

Remove remainder of setscrews.

Remove flywheel.

To Remove Flywheel Housing.

Remove flywheel.

Removal of nuts and spring washers from the studs securing the flywheel housing to the cylinder block, or back plate (if fitted) will enable the flywheel housing to be removed.

To Refit Flywheel Housing.

Before fitting or refitting flywheel housing ensure that the mating faces of the cylinder block, or back plate (when fitted) and housing are perfectly clean and free from burrs.

Put the housing on to the studs, replace spring washers and nuts. Tighten nuts evenly, do not overtighten so as to allow adjustment.

Alignment of Flywheel Housing Bore.

Secure the base of an indicator stand to the flange of the crankshaft.

Set the needle of the gauge to the interior of the bored hole in the flywheel housing. (See fig. U1).

Turn the crankshaft and check that this hole is central. The housing is adjusted until the bored hole is central with the crankshaft within the following limits (total indicator reading).

Diameter of Housing Bore	Max. Allowance (T.I.R.)
Up to 14¼ in	0.006 in
(362 mm)	(0,15 mm)
14¼ to 20⅛ in	0.008 in
(362 to 511 mm)	(0,20 mm)
20⅛ to 25½ in	0.010 in
(511 to 648 mm)	(0,25 mm)
25½ to 31 in	0.012 in
(648 to 787 mm)	(0,30 mm)

Alignment of Flywheel Housing Face.

With the base of the indicator stand still secured

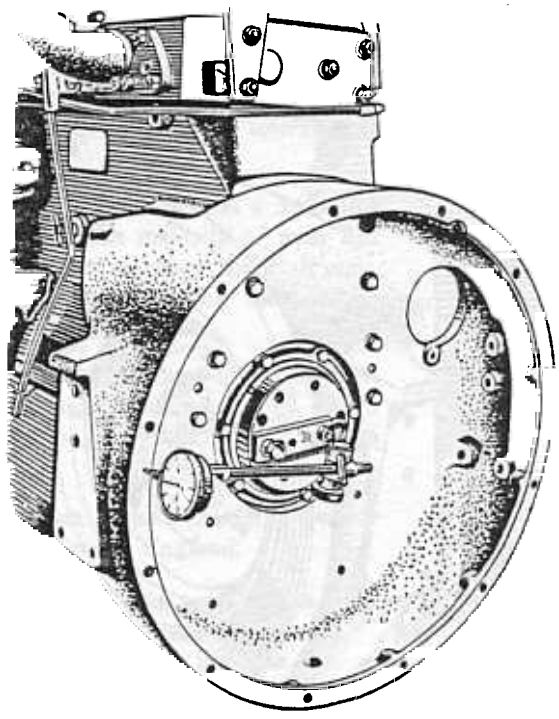


Fig. U2

to the crankshaft flange, adjust to set the needle of the indicator against the vertical machined face on the flywheel housing. (See fig. U2).

Turn crankshaft and check that this face is at right angles to the crankshaft axis. This facing must be within the following limits (total indicator reading) of being at true right angles to the crankshaft.

Diameter of Housing Bore	Max. Allowance (T.I.R.)
Up to 14¼ in (362 mm)	0.006 in (0,15 mm)
14¼ to 20⅛ in (362 to 511 mm)	0.008 in (0,20 mm)
20⅛ to 25½ in (511 to 648 mm)	0.010 in (0,25 mm)
25½ to 31 in (648 to 787 mm)	0.012 in (0,30 mm)

All adjustments to bring the flywheel housing within the limits specified must be on the flywheel housing and under NO CONDITIONS must the rear of the cylinder block or adaptor plate be interfered with.

When the housing is aligned to the above limits tighten the securing nuts evenly.

Ream the two dowel holes and fit the correct length and size of dowels.

To Refit Flywheel.

The flywheel should be replaced in the reverse order to when removing but the following must also be carried out :

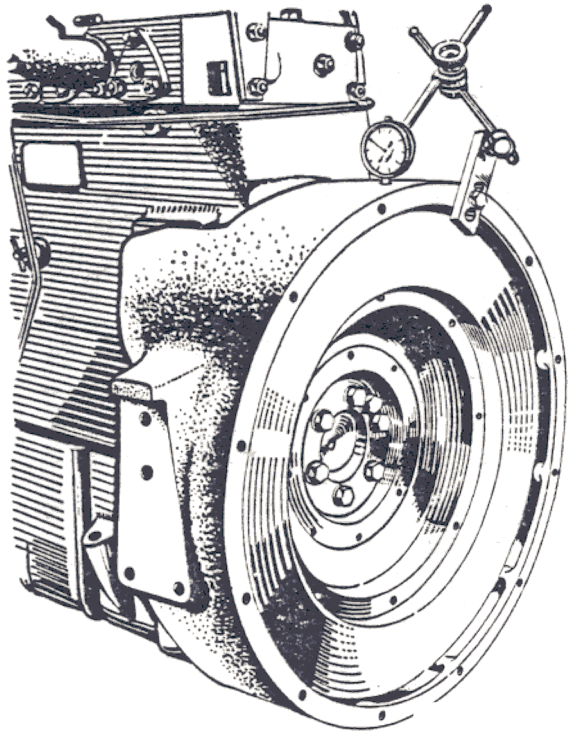


Fig. U3

See that the flywheel face and crankshaft flange are perfectly clean and free from burrs before fitting the flywheel.

When replacing the setscrews tighten evenly, and for final tightening, a torque wrench should be used, set to the tension recommended in Section B.

Checking Alignment of Flywheel.

When the flywheel has been removed, it is necessary to check the alignment on replacement.

Replace flywheel as mentioned above.

Secure the base of a dial indicator stand to the flywheel housing.

With the flywheel at top centre set the needle of the indicator on the flywheel periphery at T.D.C. (see Fig. U.3).

Turn the crankshaft and check the clock. The flywheel should run true within .012 in. (.31 mm) (total indicator reading).

With the base of the indicator stand still bolted to the flywheel housing, adjust to bring the indicator needle against the vertical machined face of the flywheel. (See fig. U4.)

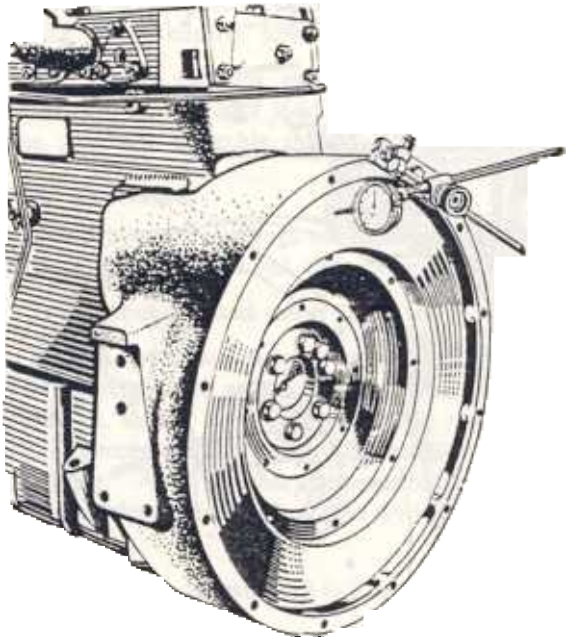


Fig. U4

Again turn the crankshaft and check the clock. The flywheel should be within 0.001 in. per inch (0,02 mm. per 25 mm.) of radius from the centre of flywheel to indicator needle.

When the flywheel has been checked for the correct limits, lock the setscrews with wire.

SCHEDULE OF CLEARANCES & TOLERANCES (V)

All threads used on the L4 Engine except on proprietary equipment and the crankshaft are Unified Series, and American Pipe Series. The crankshaft and starting dog nut are threaded 1 inch American National Fine of 14 T.P.I.

The new threads are not interchangeable with B.S.F. and although B.S.W. have the same number of threads per inch as the Unified Coarse Series, interchanging is not recommended, due to a difference in thread form.

The data regarding clearances and tolerances are 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, $\frac{.4985}{.499}$ 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 uneconomical 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 Division, Perkins Engines Ltd., Peterborough, England.

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS (ENGINE TYPE L4)

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION inches	PERMISSIBLE DIMENSION mm.	PERMISSIBLE CLEARANCE inches	PERMISSIBLE CLEARANCE mm.	REMARKS
	OIL PUMP					
0440452	Gear Housing (Dia. of pocket)	1.339	34.011			
		1.341	34.061	.006	.152	
0410120	Gears (Internal, Idler and Driver) (Dia. over teeth)	1.331	33.807	.010	.254	
		1.333	33.858			
	Ditto (Length of gears)	1.495	37.973			
		1.497	38.024	.001	.025	
0440452 0490455	Housing (Depth of Gear Pocket) c/w Joints	1.498	38.049	.006	.152	
		1.501	38.125			
0050131	Bush. Oil Pump gear (Bore Dia.)	.502	12.751			
		.503	12.776	.0005	.0127	
0750265	Shaft, Oil Pump gear (Dia.)	.5010	12.725	.002	.051	
		.5015	12.738			
0750264	Shaft (Internal, Idler) (Dia.)	.4985	12.662			
		.499	12.675	.00075	.019	
0410120	Gear (Internal, Idler) (Hole Dia.)	.49975	12.694	.00175	.044	
		.50025	12.706			
	CAMSHAFT					
0140014	Camshaft. No. 1 Journal Dia.	2.0565	52.235			Journal tapered .001 in. (.0254 mm)
		2.0575	52.261	.002	.051	
0050215	Bush, No. 1 Camshaft Bearing Bore Dia.	2.0595	52.311	.005	.127	
		2.0615	52.362			
	No. 2 Journal Dia.	2.0465	51.981			
		2.0475	52.007	.004	.102	
	No. 2 Bore for Shaft in Cylinder Block	2.0515	52.108	.007	.178	
		2.0535	52.159			
	No. 3 Journal Dia.	2.0365	51.727			
		2.0375	51.753	.004	.102	
	No. 3 Bore for Shaft in Cylinder Block	2.0415	51.854	.007	.178	
		2.0435	51.905			
0995195	Spigot, Idler Gear (Dia.)	1.497	38.024			
		1.498	38.049	.001	.025	
0050127	Bush, Idler Gear (Bore)	1.499	38.075	.003	.076	
		1.500	38.100			

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS (ENGINE TYPE L4)

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION inches	PERMISSIBLE DIMENSION mm.	PERMISSIBLE CLEARANCE inches	PERMISSIBLE CLEARANCE mm.	REMARKS
	CAMSHAFT (cont.)					
	Cam Lift	.304 .312	7.721 7.925			
	CYLINDER BLOCK					
0280073	Cylinder Block (for Camshaft bores see Camshaft Assembly).	13.772	349.810			
	Height of Block between top and bottom faces	13.777	349.937			
0530015	Bore of Cylinder Liner	4.250 4.251	107.950 107.975			
0630041	Piston (Height of Crown above face of cylinder block)	.007 .012	.178 .305			Measured with crank and piston at T.D.C.
	Comp. Ring Grooves (Width)	.127 .128	3.226 3.251	.002 .004	.051 .102	
0640064 0640025	Compression Ring (Width)	.124 .125	3.150 3.175			
0640064	Chrome Plated Compression Ring Gap			.017 .022	.432 .559	Gap dimensions are given for a bore diameter of 4.250 in. (107.95 mm)
0640025	Plain Compression Ring Gap			.012 .017	.305 .432	
0630061	Comp. Ring Groove (Width)	.127 .128	3.226 3.251			
0640033	Comp. Ring—Laminated (Width) (4 per piston)	.026 .027	.660 .686			
0630041	Piston (Scraper ring groove) (width)	.2525 .2535	6.414 6.439	.0025	.064	
0640026	Ring, Scraper (width)	.249 .250	6.325 6.350	.0045	.114	
	Gap			.012 .017	.305 .432	
	CRANKSHAFT AND CONNECTING ROD					
	Weight Connecting Rods (Sets)	See	Remarks			Weights of Rods in engine sets must balance within two ounces
0210009	Rod, Connecting Big End (Bore)	2.916 2.917	74.006 74.092			

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS (ENGINE TYPE L4)

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION inches	PERMISSIBLE DIMENSION mm.	PERMISSIBLE CLEARANCE inches	PERMISSIBLE CLEARANCE mm.	REMARKS
	CRANKSHAFT AND CONNECTING RODS (cont.)					
0050129 0050194	Bearing, Connecting Rod Big End (Bore)	2.7515 2.753	69.888 69.926	.0025	.063	Measured in position
0260063	Crankshaft Crankpins (Dia.)	2.74825 2.749	69.806 69.825	.00475	.121	
0050128	Bush, Connecting Rod, small end (Bore)	1.4382 1.43925	36.530 36.557	.0004	.010	NOTE : Bushes reamed to suit individual pins. Bushes provided with reaming allowance
0610621	Pin, Gudgeon (Dia.)	1.4375 1.4378	36.513 36.520	.00175	.044	
	Rod, Connecting, alignment between small and large end bearing bores. (Parallelism) Ditto. (Twist)					Alignment measured between mandrels through large and small end bores. See fig. 1
0280073	Housings, Main Bearings (Bore)	3.166 3.167	80.416 80.442			
0050195 0050126	Bearings, Main (Bore)	3.0015 3.003	76.238 76.276	.0025	.063	Measured in position
0260017	Crankshaft, Main Journals (Dia.)	2.9983 2.999	76.156 76.175	.00475	.121	
	Crankshaft, Main Journal No. 1 (Length)	1.9225 1.9525	48.832 49.594			
	Crankshaft, Main Journal No. 2 (length)	2.0313 2.0363	51.594 51.722			Standard Crankshafts Only.
	Crankshaft, Main Journal No. 3 (length)	2.0625 2.0635	52.388 52.413			
	Crankshaft End Float	.0085 .0155	.216 .394			
0920709	Thrust Washers, Standard (Width)	.091 .093	2.311 2.362			
0920709A	Thrust Washers, Oversize (Width)	.0985 .1005	2.502 2.553			
	CYLINDER HEAD AND VALVE GEAR					
0050132	Bush, Rocker Lever (Bore Dia.)	.6245 .62575	15.863 15.894	.00075	.020	
0750166	Shaft, Rocker (Dia.)	.62225 .62375	15.805 15.843	.0035	.089	

SCHEDULE OF BUILDING CLEARANCES AND TOLERANCES TO BE ADHERED TO WHEN OVERHAULING ENGINES TO FACTORY STANDARDS (ENGINE TYPE L4)

Part No.	DESCRIPTION	PERMISSIBLE DIMENSION inches	PERMISSIBLE DIMENSION mm.	PERMISSIBLE CLEARANCE inches	PERMISSIBLE CLEARANCE mm.	REMARKS
	CYLINDER HEAD AND VALVE GEAR (cont.)					
0420013	Guide, Valve (Bore Dia.) — —	.376	9.550			Clearance of Valve Head (new) below Cyl. Head Face :— Inlet, .057 in. to .070 in. or 1.448 mm. to 1.778 mm. Exhaust, .053 in. to .065 in. or 1.346 mm. to 1.651 mm.
		.3775	9.589	.0015	.037	
0910030 0910029	Valves, Inlet and Exhaust (Stem Dia.) — — — —	.3735	9.487	.004	.102	
		.3745	9.512			
0860009	Tappet, Valve (Shank Dia.)	.7475	18.987			Seat should not be recut unless essential when clearance should not exceed .140 in. or 3.556 mm.
		.7485	19.012	.001	.025	
	Hole in Cylinder Block for Tappet (Dia.) — — — —	.7495	19.037	.00325	.082	
		.75075	19.069			

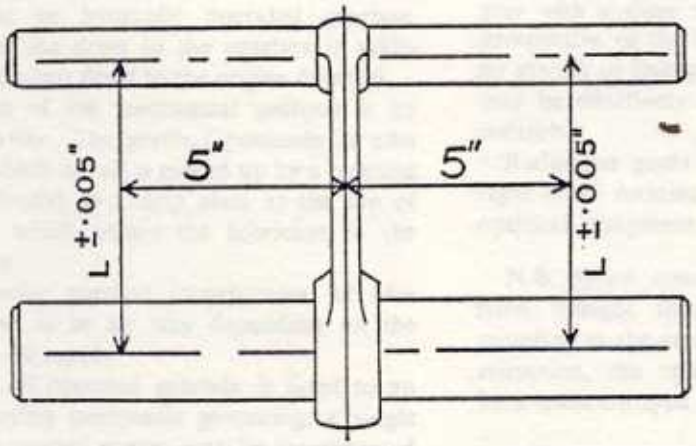


FIG. VI

Large and small end Conn. Rod Bores must be square and parallel with each other within the limits of plus or minus .005 in. (.127 mm) measured 5 in. (127 mm) each side of the axis of the rod on test mandrel as shown in Fig. 1. When checking alignment with gudgeon pin bush fitted the limit plus or minus .005 in. (.127 mm) is reduced to plus or minus 0015 in. (.038 mm)

L4 MARINE ENGINES (W)

Settings and Data.

Maximum Rating– 58 B.H.P. at 2,000 r.p.m.

Sump Capacity – 3 gallons (13.6 litres).

Engine Types.

There are two principal types of L4 Marine engine, one type having pneumatic governing and the other having mechanical governing.

The standard pneumatic governing is set for variable speed which is controlled by a lever from the air intake venturi.

The mechanically governed engine is virtually identical to its pneumatic governed counterpart, the one main difference being the mechanical governor incorporated in the timing gear housing. This governor also is of variable speed and is controlled by a lever on the side of the governor housing forward of the fuel injection pump.

Gearboxes.

The L4 Marine engine may be fitted with either a mechanical or hydraulic operated gearbox. In both cases the drive to the gearbox is taken from an input shaft fitted to the engine flywheel.

Lubrication of the mechanical gearbox is by means of gravity. The gearbox possesses its own sump from which the oil is picked up by a rotating disc and delivered to a drip plate at the top of the gearbox which passes the lubricant to the working parts.

The hydraulic gearbox incorporates its own oil pump and is in no way dependent on the engine for its oil supply.

Where an oil operated gearbox is fitted to an engine employing pneumatic governing, a single lever throttle control system may be incorporated linking the gearbox to the engine throttle. By this means gearbox engagement is determined by movement of the throttle lever. With the engine idling, initial movement of the throttle lever effects complete engagement of the gearbox without increasing engine speed. Engine r.p.m. may then be increased by further opening of the throttle control lever beyond a predetermined point.

Thus the engine cannot be speeded in neutral gear, thereby eliminating the risk of damage when the gearbox is engaged. When changing from ahead to astern or vice versa, the engine throttle must pass through the idling position, thus enabling an easy gear change to be attained.

In conjunction with this control system, provision may be made for the fitting of a cable to the throttle so that the throttle may be partly opened to assist easy starting.

When an oil operated gearbox is fitted, an oil cooler must be fitted in order to cool the gearbox oil. The mounting for this cooler is on the top of the gearbox.

An inter-locking control may also be used in the case of a pneumatically governed engine fitted with a mechanical gearbox.

The system employed ensures that the engine throttle is automatically returned to idling when the gear lever enters the neutral position. An ample measure of protection is thus afforded the gearbox, inasmuch as when engaging or changing gears, the engine throttle must always be in or pass through the idling position. However with engines utilising mechanical governing, irrespective of the type of gearbox fitted, there is no system of linkage offered whereby the gearbox may be effectively coupled to the engine throttle controls.

Reduction gears of 2 : 1 and 3 : 1 for left or right hand rotation propellors, may be fitted as optional equipment.

N.B. When converting a mechanical gearbox from straight through drive to 2 : 1 or 3 : 1 coupling at the rear of the box must be replaced reduction, the split type ball race behind the by a standard type of ball race.

Gearbox and Input Shaft Removal.

Both types of gearbox may be removed in the following manner :—

Disconnect propellor shaft.

Remove 12 setscrews and washers located around gearbox periphery.

Withdraw gearbox from input shaft.

The input shaft which is affixed to the engine flywheel may be removed as follows :—

Cut locking wire.

Remove eight securing setscrews and washers.

Replacing Input Shaft and Gearbox.

First ensure that the flywheel housing and flywheel are correctly aligned (See Section U).

Using the eight setscrews complete with washers, fit the input shaft to the engine flywheel and tighten evenly.

Secure the base of a clock gauge securely to the flywheel housing and adjust the clock so as to set the needle on the outside diameter of the input shaft, and check that the shaft is central. The limit in respect of input shaft concentricity is set at .003 in. (.076 mm) total indicator reading.

With satisfactory alignment attained, the securing setscrews should then be wired together.

The gearbox may then be eased into position on the input shaft. With the mechanical gearbox, care should be taken to ensure that the key on the input shaft is in line with the keyway in the gearbox bearing. Secure the gearbox to the flywheel housing by means of the 12 setscrews and washers and refit propellor shaft.

Locating Ring—Mechanical Gearbox.

A modified bevel locating ring locking plate has been incorporated in mechanical gearboxes for fitment to L4 marine engines.

This latest locking plate is thicker in section than the original type and of different specification material and has been incorporated to eliminate any possibility of bending or failure of the plate in service.

With the advent of this modification, the locking medium whereby this plate is secured, was altered so that now two holes $\frac{5}{16}$ in. B.S.F. by $\frac{9}{16}$ in. (14.29 mm) deep are drilled and tapped in the locating ring and pinion cage to accommodate two Allen grubscrews $\frac{5}{16}$ in. B.S.F. by $\frac{1}{2}$ in. (12.70 mm) long.

It should be noted that after assembly, the edges of the slots accommodating the bevel ring locating plates should be peened over as also should the drillings into which are fitted the grubscrews.

Details of these modifications are illustrated in Figure W.1 illustration and it is recommended that all gears sent in for service be similarly modified when necessary.

Electrical Equipment.

With the L4 Marine engine, a 12-volt earth return system is employed as standard equipment. A 12 or 24-volt insulating return system may be fitted as optional extra. The dynamo is located on the starboard side of the engine. The starter motor is flange mounted on the port side of the engine, the starter pinion engaging with the starter ring on the flywheel at the aft end of the engine.

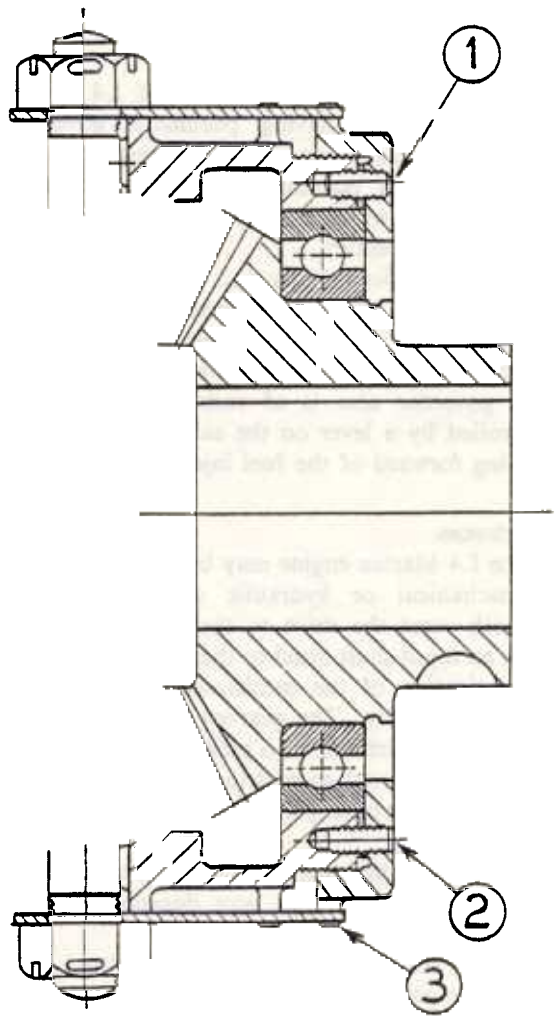


Fig. W1.

1 and 2. From the 1/8" Diameter Pilot holes in bevel locating Ring, drill two holes 17/64" Diameter to a depth of 3/8" in bevel wheel casing and tap 5/16" B.S.F. to a depth of 1/4" in bevel wheel casing to accommodate two Allen Screws 5/16" B.S.F. × 1/2" in length. These two holes must not be drilled and tapped until the bevel locating ring has been locked in position with locking plates and slots peened over.

3. Bevel locating ring locking slots peened over locking plates.

Water Circulation.

The engine may be so arranged as to accommodate any one of the following three types of cooling system.

Direct Cooling System.

With this type of circulation, a water pump embodying a rubber impeller is used. Direct suction of sea water is effected by this pump, the coolant entering the engine at the forward end of the cylinder block. The cooling water leaves the engine at the forward end of the cylinder head and is then delivered to the cooling jacket surrounding the exhaust manifold. An outlet connection fitted to the rear end of the exhaust manifold jacket enables the water to be finally led overboard.

A lubricating oil cooler for engines utilising this system of cooling is obtainable as an optional extra, and when incorporated in the cooling system, is fitted to the front end of the engine sump on the suction side of the water pump.

Keel Cooling System.

The water pump which is of the rubber impeller type, draws up cooling water from pipes running along the keel of the craft. Prior to reaching the water pump, the coolant passes through the lubricating oil cooler which is fitted as standard equipment to engines employing this type of cooling system. The coolant then enters the engine at the forward end of the cylinder block and is expelled at the forward end of the cylinder head. From the cylinder head the water is discharged back into the keel pipes via the exhaust manifold cooling jacket. It will be observed that this is a closed circuit type of cooling system, the water in the keel pipes being cooled by the water through which the craft passes.

With this type of cooling system, a thermostat is fitted as optional extra.

Information regarding dimensions of Keel Pipes may be obtained on request from Service Division, Perkins Engines Limited, Peterborough.

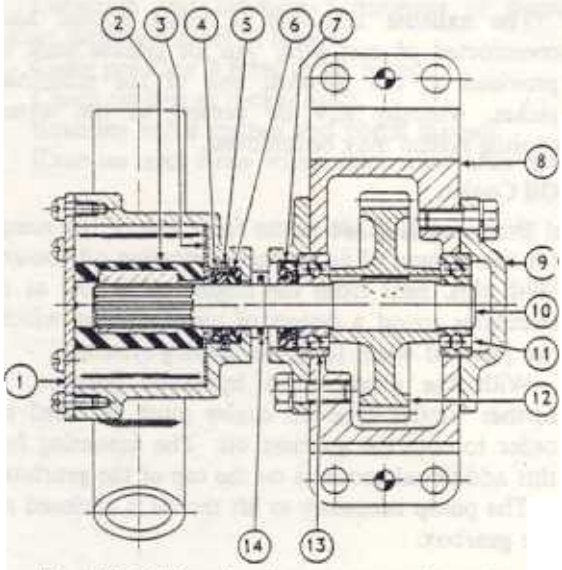


Fig. W.2. Rubber impeller water pump in section.

1. End Cover.
2. Impeller.
3. Wear-plate.
4. Seal.
5. Rubber ring.
6. Distance pieces.
7. Seal.
8. Gear Housing.
9. Bearing end cover.
10. Impellor driving shaft.
11. Bearing.
12. Gear wheel.
13. Bearing.
14. Slinger.

Indirect Cooling System (Heat Exchanger).

This type of cooling system utilised in conjunction with a heat exchanger, incorporates two separate water pumps, viz. the rubber impeller and centrifugal types.

The rubber impeller type pump is used to circulate sea water through the heat exchanger which is affixed to the front of the cylinder head. Overboard discharge is taken through the exhaust manifold cooling jacket. The lubricating oil cooler which is standard equipment with indirectly cooled engines is fitted to the front end of the engine sump and is on the suction side of the sea water pump.

Circulation of the closed fresh water system is effected by means of the centrifugal pump which is belt driven from the crankshaft pulley. Water is drawn from the heat exchanger and enters the cylinder block at the rear of the water pump. After circulation through the engine, the water is expelled from the front of the cylinder head back into the heat exchanger.

The top part of the heat exchanger forms a header tank for the fresh water and a pressure type filler cap with overflow pipes is provided. The valve in the cap operates between 3¼ and 4¼-lbs./sq. in. (.23—.30 kg/sq. cm.) A thermostat is supplied as standard for this type of cooling system.

Water Pumps.

From the foregoing it will be apparent that all L4 Marine engines, irrespective of application, incorporate the rubber impeller type of water pump, while those engines utilising indirect (heat

exchanger) cooling also incorporate a water pump of the centrifugal variety.

Centrifugal Type Water Pump.

Since the centrifugal type water pump employed on those Marine engines incorporating indirect (heat exchanger) cooling systems is identical with that pump fitted to L4 engines in general, maintenance instructions for this type of pump may be obtained by referring to Section Q.

Rubber Impeller Type.

This type of pump is gear driven inasmuch as a gear wheel attached to the impeller driving shaft is in constant mesh with the engine camshaft gear wheel, the pump itself being located on the starboard side of the engine directly below the dynamo.

Removal and Dismantling.

First disconnect water inlet and outlet hose connections. The pump may then be detached by removing the setscrews that secure it to the engine timing case.

To dismantle the pump, proceed as follows :—

Remove rear end cover.
Remove impeller.
Remove wearplate.

With the front bearing cover removed, a suitable press may be used to press out the impeller shaft together with the front bearing, leaving the driving gear wheel loose in its housing.

The cam in the impeller housing may then be detached by removing the single securing setscrew.

Remove rubber seal in impeller housing.
Remove rubber " O " ring.
Remove distance-pieces.

The driving gear wheel housing and impeller shaft rear bearing may then be removed from the pump body.

Finally remove front rubber seal.

To reassemble the water pump, the reverse order of the above procedure should be adopted, care being taken when replacing the rubber impeller that the blades all lay in the same direction relative to the rotation of the pump, i.e. blades trailing.

When reassembling, ensure that the rubber impeller is coated with a layer of water resisting grease. It should also be noted that, if necessary, the impeller may be dismantled without removing the water pump.

When replacing the cam fitted in the impeller housing, be certain to treat the entire top surface, rear face and securing setscrew hole with a suitable jointing compound. NOTE : This cam will go into place one way only.

With the assembled pump fitted to the engine, backlash between the pump and camshaft gears should be .003 in. to .009 in. (.08 to .23 mm). To achieve this in production, two joints may have been fitted between the pump gear wheel housing and the engine timing case. Should this be so, ensure that both joints (or two new joints) are replaced when refitting the pump.

If the engine is to be withdrawn from service for any length of time it will be necessary to effect lubrication of the rubber impeller at the commencement of the storage period. This may be achieved by removing the end cover (Item 1, Fig. W.2) and placing glycerine between the vanes if the impeller (Item 2, Fig. W.2).

Exhaust Manifold.

The exhaust manifold is water cooled and constructed of cast iron. An air release cock is provided at the forward end of the manifold jacket, whereby any air present in the water cooling system may be removed.

Oil Cooler.

Provision is made at the front end of the sump for the fitment of an engine lubricating oil cooler. With this, heat from the engine oil is lost as it circulates round a system of tubes through which are pumped water from the cooling system.

With the fitting of a hydraulic gearbox, a further similar type oil cooler must be fitted in order to cool the gearbox oil. The mounting for this additional cooler is on the top of the gearbox.

The pump necessary to lift the oil is enclosed in the gearbox.

Sump Oil Pump (Hand Operated).

On the majority of marine installations it is impossible to gain access to the sump drain plug which is situated on the bottom of the sump. Therefore, in order to facilitate the draining of the engine oil, a hand pump may be provided This pump when used must be fitted remote from the engine. Drainage of the sump is effected by operation of the pump after attaching a length of suitable piping to the inlet side of the pump and placing the free end of the pipe into the sump via the dipstick orifice.

PERIODICAL ATTENTIONS

L4 MARINE ENGINES

DAILY

Check oil level in sump and gearbox.

Check cooling water circulation.

Check lubricating oil pressure.

Check water level in header tank of heat exchanger when fitted.

EVERY 50 HOURS

Clean gearbox oil filter (hydraulic type gearbox only).

Check, and if necessary, top up batteries with distilled water.

EVERY 100 HOURS

Check oil level in reduction gearbox where fitted.

Lubricate and examine adjustment of single lever throttle control (if fitted).

Clean pre-filter if fitted to lift pump.

Check oil flow to rocker shaft.

Examine valve springs and check tappets.

Examine and clean water inlet weed trap and strainer (when fitted).

Examine engine holding down bolts.

Drain oil from sump and fill with new lubricant.

Clean felt element in lubricating oil filter.

Unscrew drain plug on final fuel filter, replace when clean fuel appears.

EVERY 500 HOURS

Clean and check atomisers.

Renew felt element in lubricating oil filter.

Clean gauze trap in lubricating filter body.

EVERY 1,000 HOURS

When fitted, examine heat exchanger for scale formation and de-scale if necessary.

Inspect commutators and brushes of dynamo and starter motor.

Renew element in Final Fuel Filter.

Whenever Engine is removed from Boat.

Clean sump strainer.

Clean out fuel tank.

For preservation of laid up engines see page F.2.

APPROVED SERVICE TOOLS

Available from V. L. Churchill & Co. Ltd., Daventry, Northamptonshire, England.

PD 1C Valve Guide Remover and Replacer
Engine Type : All
With this tool, all valve guides can be removed and replaced provided puller bars are available.

PD 1C-1 Puller Bars
Engine Type : All
Two bars are supplied for use with PD 1C to suit $\frac{5}{16}$ in and $\frac{1}{2}$ in i/d valve guide bores.

PD 1C-2 Valve Guide Replacing Stop
Engine Type : 4.99 4.107 4.108
When the valve guide is replaced using one of these stops, it will ensure that the guide protrudes the correct amount above the top face of the cylinder head.

PD 1C-3 Valve Guide Replacing Stop
Engine Type : 6.354 4.236
Remarks : See PD 1C-2

PD 1C-4 Valve Guide Replacing Stop
Engine Type :
P3 P3.144 B3.152 3.152 4.192 4.203
P4 P6 6.288 6.305
Remarks : See PD 1C-2

38 U3 Piston Assembly Ring
Engine Type : All
This is an expandable piston assembly ring for Std. and oversize pistons on all engine types.

PD 37 Flywheel Runout Gauge
Engine Type : All
With this tool, a check can speedily be made on the alignment of the flywheel, flywheel housing or back plate.

PD 41B Piston Height and Valve Depth Gauge
Engine Type : All
For checking piston heights and valve depths.

PD 155A Small Adjustable Puller
Engine Type : All
Can be used with suitable adaptors to remove water pump pulley, oil pump drive gears and camshaft gear.

PD 155A-1 Small Adjustable Puller Adaptors
Engine Type :
R6 P3.144 3.152 B3.152 4.192 4.203
Removes water pump pulley only on
6.305 L4 4.270 4.99 4.107 4.108
Removes water pump pulley and camshaft gear on
6.354

PD 155A-2 Small Adjustable Puller Adaptors
Engine Type : P3 P4 P6
To remove low position water pump pulley.

PD 155A-4 Small Adjustable Puller Adaptor
Engine Type :
P3.144 3.152 B3.152 4.192 4.203
Removal of oil pump gear.

No. 3 Tension Wrench
Engine Type : All
$\frac{1}{2}$ in square drive 25 to 170 lbf ft.

PD 150 Cylinder Liner Remover and Replacer
Engine Type :
6.354 4.236 3.152 D3.152 4.203 D4.203
6.305

PD 150-1 Cylinder Liner Remover/Replacer Pads
Engine Type :
6.354 4.236 3.152 D3.152 4.203 D4.203
6.305
For use with PD 150.

316X Valve Seat Cutter Handle
Engine Type : All
This tool is required for the operation of all cutters and pilots.

316-10 Valve Seat Cutter Pilot
Engine Type :
P3 P3.144 3.152 B3.152 4.107 4.99 4.108
4.192 4.203 P4 P6 6.288 6.305
This pilot is suitable for all guides that have a nominal $\frac{5}{16}$ in i/d bore.

316-12 Valve Seat Cutter Pilot
Engine Type :
L4 4.270 R6 F340 S6 4.236 6.354
This pilot is suitable for all guides having a nominal $\frac{1}{2}$ in i/d bore.

316-125 Valve Seat Cutter Pilot
Engine Type : 4.236 (0.015 in oversize)
This pilot is for valve bores which have been reamed 0.015 in oversize.

316-13 Valve Seat Cutter Pilot
Engine Type : 4.236 (0.030 in oversize)
This pilot is for valve bores which have been reamed 0.030 in oversize.

PD 137 Valve Bore Reamer (0.015 in oversize)
Engine Type : 4.236
This reamer is only suitable for guideless cylinder heads.

PD 138 Valve Bore Reamer (0.030 in oversize)
Engine Type : 4.236
This reamer is only suitable for guideless cylinder heads.

PD 317-23 Valve Seat Cutter Exhaust
PD 317-26 Valve Seat Cutter Inlet
317-G22 Glaze Breaker Exhaust
317-G25 Glaze Breaker Inlet
Engine Type :
P3 P3.144 B3.152 3.152 4.192 4.203 P4 P6 6.288 6.305
The above cutters have been designed to cut seats to the correct angle and at the same time reduce seat width. It is strongly recommended that the glaze breakers be used first as this will greatly reduce the chattering of the cutters.

PD 317-25 Valve Seat Cutter Exhaust
PD 317-29 Valve Seat Cutter Inlet
317-G30 Glaze Breaker Exhaust and Inlet
Engine Type :
L4 4.270 R6 F340
Remarks : See PD 317-23

317-30 Valve Seat Cutter Exhaust and Inlet
317G-30 Glaze Breaker Exhaust and Inlet
Engine Type :
6.354 4.236 D4.203 D3.152
Remarks : See PD 317-23

PD 317-18 Valve Seat Cutter Exhaust
PD 317-22 Valve Seat Cutter Inlet
317-G19 Glaze Breaker Exhaust and Inlet
Engine Type :
4.99 4.107 4.108
Remarks : See PD 317-23

FC9900 Atomiser Tester
Engine Type : All
This is a portable tester fitted with a paper filter element.

7066 Circlip Pliers
Engine Type : All
Two types of points are available. $\frac{1}{2}$ in shaft size. $\frac{1}{2}$ in — 1 in "B" shaft size 1 in — 3 in.

355 Connecting Rod Alignment Jig
Engine Type : All
Enables a quick check to be made on the alignment of connecting rods — various adaptors are required as follows :—

336 Multi-Purpose Con. Rod Arbor
Engine Type : All
Required with the above tool.

PD 336-1 Adaptor
Engine Type :
P3 P3.144 B3.152 3.152 4.192 4.203 P4 P6 6.288 6.305
This adaptor is fitted into the big end bore when checking alignment. (Thin wall bearings only).

PD 336-3 Adaptor
Engine Type : L4 4.270
Remarks : See PD 336-1

PD 336-5 Adaptor
Engine Type : 4.99 4.107
Remarks : See PD 336-1

PD 336-6 Adaptor
Engine Type : 6.354 4.236
Remarks : See PD 336-1

6118 Valve Spring Compressor
Engine Type : All
This valve spring compressor has been designed to remove valve springs without removing the cylinder head, providing the adaptors are available.

PD 6118-1 Valve Spring Compressor Adaptor
Engine Type : 4.99 4.107 4.108
The adaptor is fitted to the rocker shaft securing studs.

PD 6118-2 Valve Spring Compressor Adaptor
Engine Type :
P3 P4 P6 6.288 6.305 S6
Remarks : See PD 6118-1

PD 6118-3 Valve Spring Compressor Adaptor
Engine Type :
P3.144 B3.152 3.152 4.192 4.203 L4 4.270 R6 F340
Remarks : See PD 6118-1

PD 6118-4 Valve Spring Compressor Adaptor
Engine Type : 6.354 4.236
Remarks : See PD 6118-1

PD 130 Fuel Pump Allen Screw Wrench
Engine Type : 4.192 4.203 4.99 4.107 4.108
Used to remove the Allen Screw securing the fuel injection pump.

6000C Compression Tester
Engine Type : See adaptor details
Used for testing cylinder compressions when using the following adaptors.

6000C-3 Compression Tester Adaptor
Engine Type :
P3 P6 P3.144 B3.152 3.152 P4 4.192 4.203 6.288 6.305 L4 R6 F340
This adaptor replaces the atomiser for compression testing.

6000C-4 Compression Tester Adaptor
Engine Type : 6.354 4.270 4.236
Remarks : See 6000C-3

6000C-9 Compression Tester Adaptor
Engine Type : 4.99 4.107 4.108
Remarks : See 6000C-3

6400 Crankshaft Fillet Radii Rolling Tool
Engine Types :
P4 4.192 4.203 P6 6.288 6.305 4.270
For cold rolling of fillet radii on certain crankshaft main journals.

6400-1 Adaptor Set
For use with the above.

APPROVED LUBRICATING OILS

Normal Working Temperature S.A.E. Designation	0°F to 30°F (-18°C to -1°C) 10W	30°F to 80°F (-1°C to 27°C) 20/20W	80°F or over (27°C or over) 30
Esso Petroleum Co. Ltd. Imperial Oil Ltd.	Essolube HDX 10W Estor HDX 10W AL 1783 10W	Essofleet HDX 20 Essolube HDX 20 Estor HDX 20 AL 1783 20/20W	Essofleet HDX 30 Essolube HDX 30 Estor HDX 30 AL 1783 30
Shell Mex	Shell Rotella T 10W Shell Rotella S 10W	Shell Rotella T 20/20W Shell Rotella S 20/20W	Shell Rotella T 30 Shell Rotella S 30
B. P. Ltd.	B.P. DS1 - 10W B.P. Vanellus 10W B.P. Vanellus 10W/30 B.P. Tractor Oil Universal S1	B.P. DS1 - 20W B.P. Vanellus 20W B.P. Vanellus 10W/30 B.P. Tractor Oil Universal 20W/30 B.P. Tractor Oil Universal S1	B.P. DS1 - 30 B.P. Vanellus 30 B.P. Vanellus 10W/30 B.P. Tractor Oil Universal 20W/30 B.P. Tractor Oil Universal S1
Alexander Duckham & Co. Ltd.	Fleetol HDX 10W	Fleetol HDX 20	Fleetol HDX 30
Regent Oil Company Ltd. Caltex / Texaco	Super RPM DELO Special 10 Ursa Oil S-1 SAE 10W RPM DELO Multi-Service 10W	Super RPM DELO Special 20 Ursa Oil S-1 SAE 20-20W RPM DELO Multi-Service 20/20W	Super RPM DELO Special 30 Ursa Oil S-1 SAE 30 RPM DELO Multi-Service 30
Mobil Oil Company Ltd.	Delvac 1110 Delvac Special 10W/30	Delvac 1120 Delvac Special 10W/30	Delvac 1130 Delvac Special 10W/30
Amoco (U.K.) Ltd. formerly (Vigzol Oil Co. Ltd.)	New Ace 10W American S1 Motor Oil 10W	New Ace 20 American S1 Motor Oil 20	New Ace 30 American S1 Motor Oil 30
Castrol Ltd.	Castrol CR 10 Deusol CR1 10 Deusol CRT 10	Castrol CR 20 Deusol CR1 20 Deusol CRT 20	Castrol CR 30 Deusol CR1 30 Deusol CTR 30
Germ Lubricants Ltd.	Germol D10/S1 Super Germol 10	Germol D20 / S1B Super Germol 20	Germol D30 / S1B Super Germol 30
Gulf Oil Group of Companies and British American Oil Company	Gulflube Motor Oil HD10W B-A Peerless Heavy Duty Motor Oil 10W B-A Dieselube Super Duty Motor Oil 10W	Gulflube Motor Oil HD20/20W B-A Peerless Heavy Duty Motor Oil 20-20W B-A Dieselube Super Duty Motor Oil 20-20W	Gulflube Motor Oil HD 30 B-A Peerless Heavy Duty Motor Oil 30 B-A Dieselube Super Duty Motor Oil 30

And other reputable detergent oils to approved specification including : Any lubricating oils which have passed Approval Tests for the U.S. Ordnance Specification MIL-L-2104A, with 1% sulphur fuel endorsement or Defence Specification DEF 2101 D in their S.A.E. 10 and 30 grades, with a viscosity index of 80 minimum shall be deemed equally acceptable.

The lubricating oils listed above are at least Supplement 1 Detergent Heavy Duty Oils.

NOTE : Where normally aspirated engines operate satisfactorily on normal Detergent Heavy Duty Oils conforming to the U.S. Ordnance Specification MIL-L-2104A or British Ministry Tests DEF 2101 B, then these oils, if preferred, may continue to be used.

Supplement 1 oils are the minimum requirement for turbocharged engines.

Where conditions of service warrant (*e.g.* continuous heavy load operation) then 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 alteration without notice