



PETTERS LIMITED

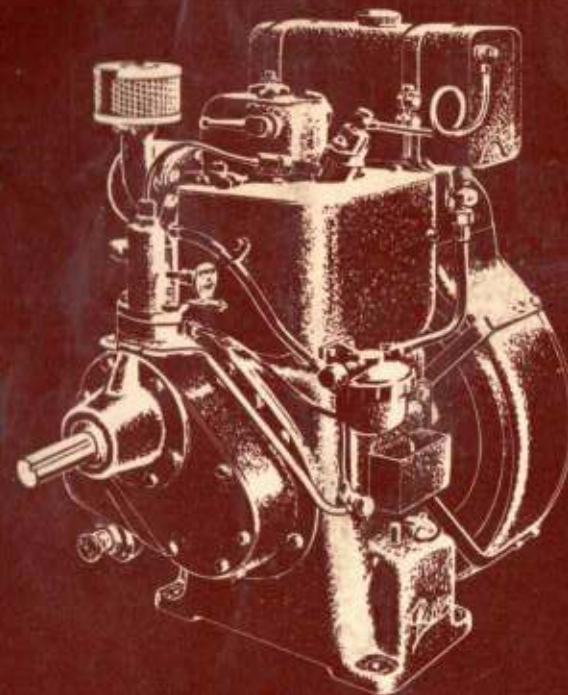
CAUSEWAY WORKS, STAINES, ENGLAND

PHONE-STAINES 1122. TELEGRAMS AND CABLES-DIESEL STAINES

A MEMBER OF THE BRUSH GROUP

PETTER

DIESEL ENGINES



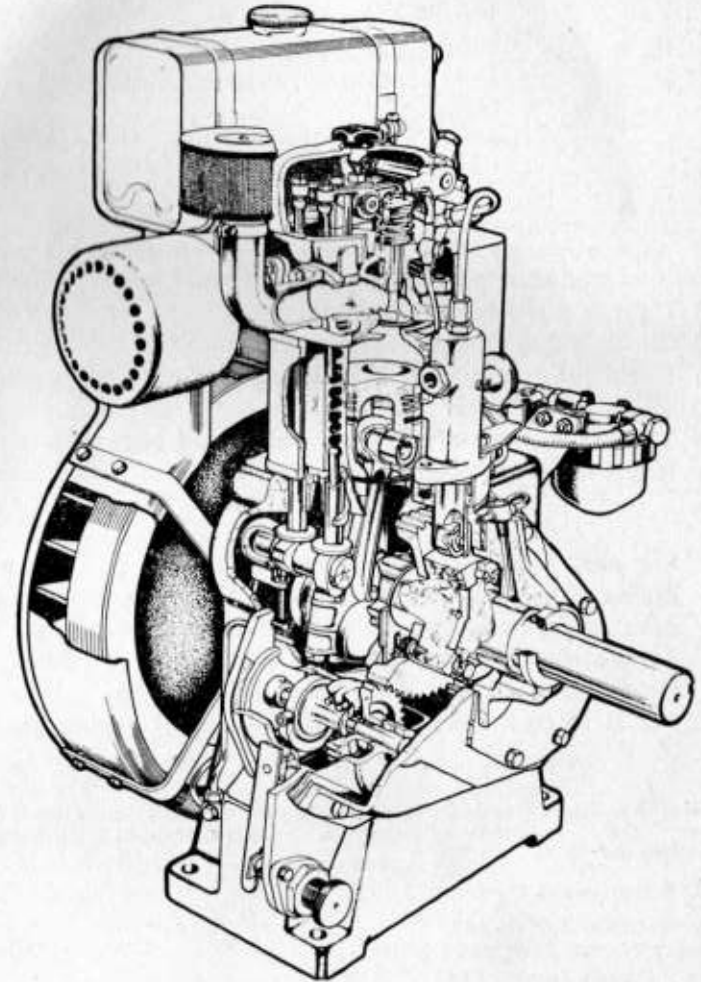
PAZ1

**OPERATORS
HANDBOOK**

PUBLICATION 2086/4

Petter Diesel Engine

TYPE PAZ I



This book should help the user to get the best results from the Engine. No Engine will run without care, but if it is given the attention described in this book, it will give good service.

Please remember . . .

- ... an Engine needs Fuel—
Keep Fuel, Tank, Filter and Piping clean.
- ... an Engine needs Lubricating Oil—
Use the correct grade of oil. Keep oil level in Sump topped up.
- ... an Engine needs Air—
Keep Air Cleaners clean and wetted with oil.
Keep Air Intakes and entire Exhaust System free of soot and any other restriction.

After approximately 20 hours initial running-in of a new or overhauled engine, the following points should receive attention—

- (a) Tighten Cylinder Head Nuts.
- (b) Check Valve Rocker Tappet clearance.
- (c) Drain lubricating oil from Sump and refill with clean oil.
- (d) Clean Fuel Filter.
- (e) Check tightness of all nuts, bolts, and keys.
- (f) If a Clutch is fitted check adjustment.

For easy reference see index on page 81.

Pour texte-précis en FRANCAIS prière de voir page 36.

Para el texto abreviado en ESPAÑOL ver página 40.

Para as instruções em PORTUGUES ver a página 44.

Gekürzter DEUTSCHER Text auf Seite 48.

Per il testo in lingua ITALIANA redasi pagina 52.

Requests for Spares and Service should be directed to **Petter McLaren Service Ltd., Burton-on-the-Wolds, Loughborough, Leicestershire.**
Tel: Wymeswold 333.

Or your nearest Service Depot at:

Petter McLaren Service Ltd. Causeway Works, Staines, Middlesex.	Staines 1122
Petter McLaren Service Ltd., 14/15 Haddon Street, Aberdeen.	Aberdeen 21217
Petter McLaren Service Ltd., Walker Square, Cowel Street, Maryhill, Glasgow.	Maryhill 3597
Petter McLaren Service Ltd., Airedale Works, Leeds 10.	Leeds 20965



technical data

Description	PAZI
	Vertical, 4 stroke cycle, compression ignition, air cooled, cold starting.
Number of Cylinders ...	1
Bore	76.2 mm (3 in.)
Stroke	76.2 mm (3 in.)
Total Volume Swept ...	348 cc (21.2 cu. in.)
Compression Ratio ...	19.5:1
Rated Power and Speed.	
B.S. 12 Hour Rating ...	1½ B.H.P. @ 1000 rev/min 2½ B.H.P. @ 1500 rev/min 3 B.H.P. @ 1800 rev/min
Fuel Injection Release Pressure	
(1000 rev/min to 1099 rev/min)	1995 lb/sq. in. (132 kg/sq. cm.) to 2205 lb/sq. in. (155 kg/sq. cm.)
Fuel Injection Release Pressure	
(1100 rev/min to 1800 rev/min)	2850 lb/sq. in. (200 kg/sq. cm.) to 3150 lb/sq. in. (221 kg/sq. cm.)
Nozzle	Bryce type HL 120. S20. B249. P3.
Nozzle Holder	Bryce type BL 52. SD. 252.
Fuel Pump	Bryce type AIAA 50/55. 179.
Bumping Clearance (between Piston and Cylinder Head)...	-.035 to -.040 in. (-.89 to -.916 mm)
Valve Tappet Clearance ...	-.010 in. (-.25 mm)
Crankshaft and Camshaft End Float... ..	-.006 to -.016 in. (-.15 to -.41 mm)
Piston Ring Gap (New) ...	-.009 to -.014 in. (-.23 to -.35 mm)
Maximum when Rings are worn	-.06 in. (1.5 mm)
Decompressor Valve Lift ...	-.015 to -.020 in. (-.03 to -.508 mm)
Main Bearing Clearance (New)	-.002 to -.0042 in. (-.05 to -.107 mm)
Fuel Injection Timing (by spill)	26° Before T.D.C. (1151 to 1800 rev/min) 23° Before T.D.C. (1000 to 1150 rev/min.)
Inlet Valve Opens	6° Before top dead centre
Inlet Valve Closes	30° After bottom dead centre
Exhaust Valve Opens ...	29° Before bottom dead centre
Exhaust Valve Closes ...	7° After top dead centre
Fuel Tank Capacity	1 gallon (4.54 litres)
Oil Sump Capacity	6¾ pints (3.8 litres)
Fuel Oil	A high grade light distillate diesel fuel in accordance with B.S. Specification No. 209/1947 Class "A".
Lubricating Oil	A fully detergent oil MUST be used. See the list of approved grades on the following page.

LUBRICATING OIL CHART

PROPRIETARY BRANDS OF LUBRICATING OIL APPROVED FOR USE WITH PETTER PAZ I ENGINE.			
Supplier	Winter	Summer	Tropical
SHELL GROUP OF COMPANIES.	Rotella Oil 10W Talona Oil 10W	Rotella Oil 20/20W Talona Oil 20	Rotella Oil 30 Talona Oil 30
MOBIL OIL CO. LTD. AND ASSOCIATED COMPANIES.	Mobiloil 10W Delvac Oil 910	Mobiloil Arctic Mobiland Diesel 20 Tractor Oil Delvac Oil 920 Gargoyle DTE Oil No. 2D	Mobiloil A. Delvac Oil 930 Gargoyle DTE Oil No. 3D
POWER PET. CO. LTD. (UK) B.P. COMPANIES (OVERSEAS)	Energol Diesel D-SAE 10W Special Energol Visco Static	Energol Diesel D-SAE 20W Special Energol Visco Static	Energol Diesel D-SAE 30 Special Energol Visco Static
ESSO MARKETERS.	Essolube HD 10 Esstic HD 10	Essolube HD 20 Esstic HD 20	Essolube HD 30 Esstic HD 30
CALTEX/TEXAS CO. REGENT OIL CO. LTD.	Caltex RPM Delo Special SAE 10W Texaco Urso Oil Heavy Duty SAE 10 Havoline Special 10W/30 Caltex RPM 10-30 Special	Caltex RPM Delo Special SAE 20W Texaco Urso Oil Heavy Duty SAE 20 Havoline Special 10W/30 Caltex RPM 10-30 Special	Caltex RPM Delo Special SAE 30 Texaco Urso Oil Heavy Duty SAE 30 Havoline Special 10W/30 Caltex RPM 10-30 Special
GULF OIL GROUP OF COMPANIES.	Brit-Gulf 10W-HD Gulflube Motor Oil HD 10W	Brit-Gulf 20/20W-HD Gulflube Motor Oil HD 20/20W	Brit-Gulf 30-HD Gulflube Motor Oil HD 30 Gulf Veritas V9 HD

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TROUBLE LOCATING CHART FOR PETTER DIESEL ENGINES

Trouble.	Reason.	Causes.	Suggested Remedy.
Engine will not start on turning the handle.	Fuel Supply Failure. Check by operating the Fuel Pump Priming Lever and listen for the characteristic "Squeak" in the Injectors.	No fuel in the tank. Fuel Cock closed. Air in the pipe line. Broken fuel pipe or leaking connection. Fuel Filter choked. Faulty Injector Nozzle. Fuel Pump Plunger sticking. Fuel Pump Tappet Plunger sticking.	Fill the tank. Open the cock. Bleed the system. Repair or replace the pipe and tighten the connection. Clean the Filter. Fit a new Nozzle. Fit a new Pump. Free and clean the Plunger.
	Poor Compression.	Valves sticking. Cylinder Head loose. Cylinder Head Gasket blown. Piston Rings stuck in the Grooves. Worn Cylinder Liner, and Piston. Valves not seating properly.	Free the Valves. Tighten all Nuts. Fit new Gasket. Check the Rings and clean the Piston. Overhaul the Engine. Check the Valve Springs. Grind if necessary. Check the Tappet Clearance.
	Incorrect lubricating oil		Drain the Sump and fill up with correct oil.
Engine lacks power with dirty Exhaust.	Faulty Fuel Supply.	Air in Fuel lines. Water in the Fuel. Faulty Injector Nozzle. Fuel Filter choked. Broken Fuel Pump Spring. Unsuitable Fuel.	"Bleed" the system. Drain the Tank and fill up with clean fuel Fit new Nozzle. Clean the Filter. Replace. Drain the Tank and fill up with correct Fuel.
	Faulty Compression.	Broken Valve Spring. Sticking Valve. Pitted Valve. Worn Main Bearing.	Replace. Free the Valve. Grind in or replace. Replace and check the lubrication.
	Out of Adjustment.	Valve Tappet clearance incorrect. Fuel Timing retarded.	Adjust. Adjust timing.
	Dirty engine.	Blocked exhaust pipe or similar.	Clean out.
		Dirty Air Filter. Faulty Piston Ring. Excessive carbon on Piston and Cylinder Head. Worn Cylinder Liner and Piston.	Clean out. Replace. Decarbonize. Overhaul the Engine.

[5]

Trouble.	Reason.	Causes.	Suggested Remedy.
Faulty Running.	Knocking.	Carbon on the Piston Crown. Injector Needle sticking. Fuel timing too far advanced. Broken Piston Ring. Slack Piston. Worn Large End Bearing. Loose Flywheel.	Decarbonize. Fit a new Nozzle. Adjust the timing. Fit a new ring. Replace. Replace and check the lubrication. Refit the key.
	Overheating.	Overload. Cooling air ducts choked. Lubricating oil failure. Excessive Valve Tappet clearance.	Reduce the load. Clean out and check for obstruction. Fill the Sump and check the system. Adjust.
	Speed surges.	Air in fuel pipes. Governor sticking.	"Bleed" the system. Free the Governor.
	Sudden Stop.	Empty Fuel Tank. Choked Injector. Fuel Pipe broken. Seized Piston.	Fill the Tank. Fit a new Nozzle. Replace or repair. Fit new Piston or in an emergency stone down.
	Heavy Vibration.	Loose holding down bolts.	Tighten up.

b

installation

1. Plant Layout.

The general layouts of the engines are shown on installation drawings, which may be obtained from Petters Ltd. Before proceeding with a new layout or installation it is advisable to consult Petters or their agents in order to obtain the best possible arrangement for the Engine.

2. Foundations.

- Details of the foundation block for fixed location are given on the installation drawings which may be obtained from Petters Ltd. or their agents and the sizes shown are for a good subsoil. With "made-up" ground, or on a poor sandy subsoil, the size of the concrete block must be increased.
- The best composition for Concrete, is one part Portland Cement, two parts of clean sharp Sand and four parts of Washed Ballast. After pouring, the concrete should be allowed to set for at least 48 hours before the engine is bolted down. In a very hot and dry climate, the block should be moistened with water during this period.
- On portable installations, it is absolutely necessary to consult Petters or their agents. When an engine is fitted for the first time, a technical engineer of Petters should be present to give advice, if necessary. An incorrectly installed Engine may give endless trouble.
- If anti-vibration Mountings are used Petters must be consulted before the engine is installed. It is vitally important that suitable Mountings are selected. A wrong choice might be dangerous.

3. Erection.

The Engine should be levelled up on the Foundation Block. Where the Engine is mounted on superstructures these should be of rigid construction and levelled before the engine is bolted down. In the case of direct driven sets, the driven unit must be lined up with the Engine and a flexible Coupling should be fitted.

4. Exhaust System.

- Standard Engines are fitted with "Pepper Pot" Silencers. If the exhaust Piping should be extended, for instance to the outside of a building, the Silencer can be fitted on the end of an iron Pipe, screwed 1 in. B.S.P.
- For better silencing, a larger Exhaust Silencer may be obtained from Petters or their agents. This is of the combined

expansion absorption type. A suitable size iron or flexible metallic exhaust Pipe should be used to connect this Silencer to the Exhaust Manifold. An outlet pipe 18 in (457 mm) long must be fitted to the Silencer.

- (c) The exhaust system should be as short as possible with a minimum of bends. A faulty system can seriously reduce the power of an Engine.
- (d) When an installation has more than 12 feet (4 metres) of exhaust Piping with two or three bends, the diameter of the Pipes must be increased to 1½" B.S.P.

5. Intake Air.

The air is taken through an oil wetted Cleaner. When the Engine is housed in a small building, good ventilation should be provided to keep the air cool and clean, and to allow plenty of air to enter. **For a Heavily Dust-Laden Atmosphere. A Heavy Duty Air Cleaner and Fuel Pump dust covers should be fitted.**

6. Cooling Air System.

- (a) The cooling air is driven over the cooling fins by a Flywheel Fan.
- (b) Care should be taken not to obstruct the air intake.
- (c) If the engine is mounted inside a housing or small building, ample openings must be provided to enable the air to circulate freely.
- (d) UNDER NO CIRCUMSTANCES SHOULD THE ENGINE BE RUN WITHOUT THE AIR COWLING IN POSITION.

C driving arrangements

- 7. The drive is always taken from 1½" dia. (38 mm) shafts with ⅜" (9.5 mm) keys, but to suit any particular installation, the power take-off can be arranged in several ways as follows:—

- (a) Mark I. Pulley or Coupling on Half Speed Shaft, starting from Flywheel end.
- (b) Mark II. Pulley or Coupling on Full Speed Shaft at gear end, starting from Flywheel end.
- (c) Mark III. Pulley or Coupling on a Clutch on Half Speed Shaft, starting from Flywheel end.
- (d) Mark IV. Pulley or Coupling on a Clutch on Full Speed Shaft, at gear end, starting from Flywheel end.
- (e) Mark V. Pulley or Coupling on Flywheel Shaft, starting from Half Speed Shaft.

8. A Drive

A drive may be taken from two Shafts at the same time, if the total power required is not more than the rated horse power of the Engine.

9. Rotation

The standard rotation is clockwise when looking at the driving shaft ends on Marks I, III and V, anticlockwise when looking at the driving shaft end of Marks II and IV Engines.

10. Standard Pulley sizes are:—

5" diameter × 4½" face.
5" diameter × 7" face.

11. Belt Drive

When plain Belt Drives are used, the Belt should be as close to the Engine as possible. With fast and loose Pulleys, the fast pulley must be nearer the Engine.

12. Clutch Drives.

Engines supplied with Mark III or Mark IV drives are fitted with a hand operated Multiple-Disc Clutch in a housing which is bolted to the Gear Cover.

d

operation

13. Preparing a new or overhauled engine for starting.

- (a) Dip the oil wetted air cleaner in clean engine oil. Allow to drain and replace on engine.
- (b) Remove the Filler Cap and fill the engine Sump with Lubricating Oil, to the high level mark on the Dipstick.
- (c) Lift the Decompressor Lever on the Rocker Box and crank the engine one to two dozen times. This helps to circulate the oil before the engine is started up.
- (d) Fill the Fuel Tank with Fuel Oil.
- (e) Open the Stop Cock between the Fuel Tank and the Fuel Filter with a screwdriver, and "bleed" the fuel system as follows. (Fig. 1).
 - (i) Loosen the Vent Screws (A) on top of the Fuel Filter and keep loose, until clean fuel without any air bubbles leaks out. Tighten the Screws again.
 - (ii) Loosen the Vent Screw (B) on the top of the Fuel Pump. Slowly crank the Engine over a few times,

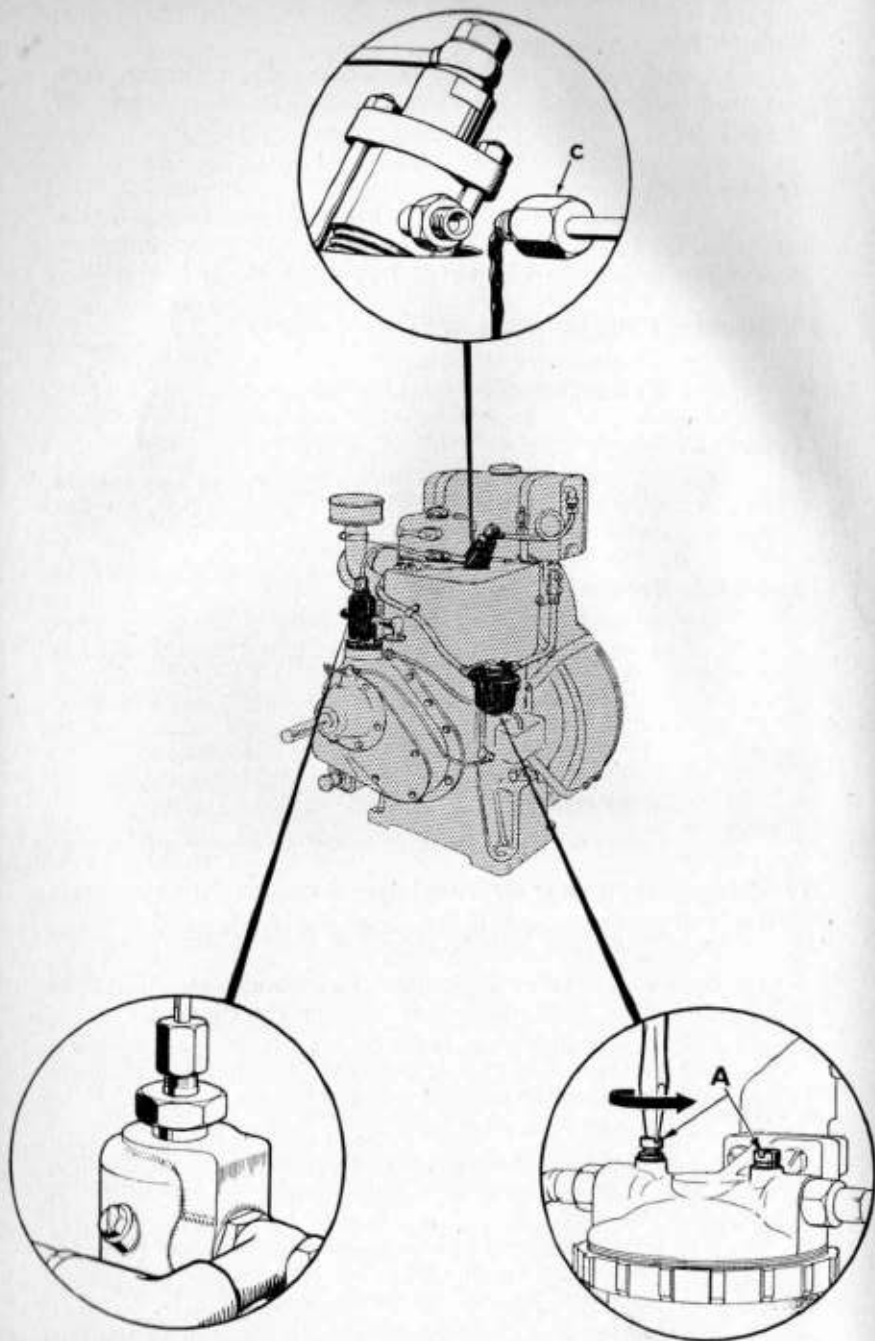


Fig. 1
[10]

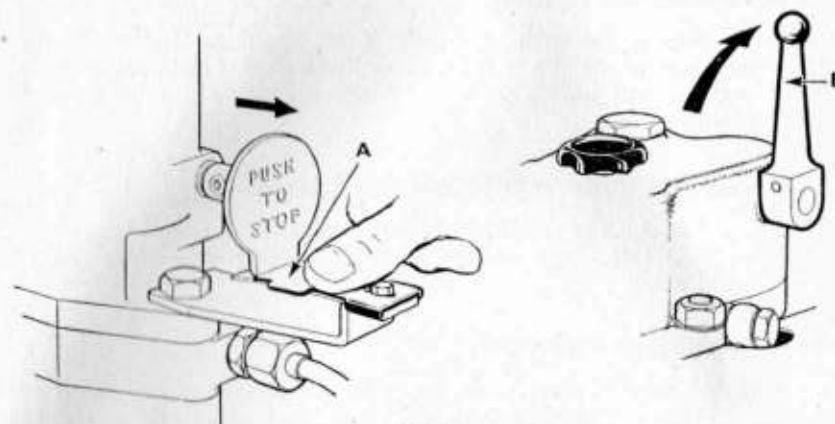


Fig. 2

until clean fuel, without air bubbles, leaks from the pump. Tighten the Screw again.

- (iii) Unscrew the Fuel Delivery Pipe Connection from the Injector, crank the Engine over until bubble free fuel leaks from the Pipe (C). Replace the Pipe Connection.
- (iv) Repeat the slowly cranking over of the engine until the Injector is heard to "squeak". This operation is called "Priming".
- (f) If a multiple-disc clutch is fitted, remove the Clutch Inspection Cover and fill Clutch Housing with $\frac{1}{2}$ pint (.3 litres) of lubricating oil.
- (g) The engine is now ready for a normal start.

14. To Start the Engine (Fig. 2).

- (a) Depress the Overload Leaf Spring (A) and allow the Fuel Pump Rack to move into its fully open position.
- (b) Lift the Decompressor Lever (B). Fit the Starting Handle and turn the engine over slowly thus "priming" it. This is unnecessary with a warm engine.
- (c) Turn the engine as fast as possible. When the Flywheel is turning at a good speed, knock down the Decompressor Lever. The engine will now fire.
- (d) If the first attempt fails, lift the Decompressor Lever and crank the engine slowly a few times before attempting to start again.
- (e) On Engine with Starting Handle on full speed shaft, it may be found easier to start the Engine without the use of the Decompressor Gear.

15. To Stop the Engine.

Run engine without load for a few minutes. Push the Stop Button towards the Fuel Pump until the Over-Load Leaf Spring engages and holds the Fuel Pump Rack in the fully closed position.

16. Starting under very Cold Conditions.

For starting conditions where ambient air temperature is -15°C . (5°F .) and under, a cold Starting Aid should be fitted.

17. Important "Don'ts".

- (a) "DON'T" Stop the engine by using the Decompressor Lever. This will lead to damaged Valve Seats and Cylinder Head Joints.
- (b) "DON'T" stop the engine by closing the fuel Stop Cock or allowing the Fuel Tank to run dry. This will let air into the Fuel Lines and it will be necessary to "bleed" and "prime" the system as described in para 13(e).

e

working cycle

18. Suction Stroke.

The Air Inlet Valve is open. The Piston moves down and draws air into the Cylinder.

19. Compression Stroke.

Both Valves are closed. The Piston moves up compressing the air and thereby heating it. Just before Top Dead Centre, a very small quantity of Fuel is injected under pressure.

20. Working Stroke.

The Fuel ignites on Top Dead Centre, due to the heat of the compressed air. The combustion of the fuel creates a rise of pressure which forces the Piston down.

21. Exhaust Stroke.

The Exhaust Valve is open. On moving up again the piston pushes the burnt gas out, thus completing the cycle.



D

head joints are
nuts if necessary
and keys.



E

Make sure that the vent hole in the
fuel tank filler cap is clear.

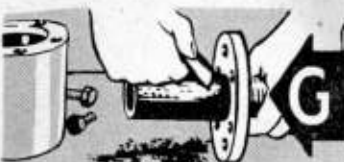


F

Clean out the air cleaner. (In very
dusty conditions this must be done
more frequently.)

180 hrs.

Keep cooling air intake free
from dust,



G

Clean the carbon deposit from the
exhaust silencer.

CKM

and obstruction.

Use only the lubricants



D

recommended

250 hrs.

in the handbook



H

Drain sump, flush with paraffin and
fill with new oil



J

Check valve clearances and adjust
if necessary.



L

Remove injectors and test spray.
If in order replace without inter-
ference.



K

Test fuel system for leaks.

f

running maintenance

22. Daily.

- Check the Lubricating Oil level on the Dipstick and top up if necessary.
- Check that the cooling air flow is unobstructed, do not allow dust, etc., to collect on the Cylinder Head or round the Fan Inlet.

23. Every 180 hours.

- Clean the Fuel Oil Filter.
- Clean the Air Cleaner (in very dusty condition this must be done more frequently).
- Ensure that Cylinder Head Joints are not leaking. Tighten nuts if necessary. Check all nuts, bolts and keys for tightness.
- Make sure that Vent Hole in Fuel Tank Filler Cap is clear.
- Clean out deposit from Exhaust Silencer.

24. Every 250 hours.

- Drain the Sump, flush out with flushing oil and refill with new oil. Clean the Oil Strainer. (If flushing oil cannot be obtained, paraffin may be used.)
- Test the fuel system for leaks.
- Remove the Injectors and test spray. If in order replace without interference.
- Check Rocker Clearance and adjust if necessary.

25. Every 500 hours.

- Replace Fuel Filter Element.

26. Every 1,000 hours.

- Remove Cylinder Head, decarbonize Piston top and insides of Inlet and Exhaust Ports.
- Examine and grind in, if necessary, the Inlet and Exhaust Valves.
- Withdraw the Pistons and carefully clean out the oil return holes. Examine Cylinder bore.

27. Every 2,000 hours.

- Examine Large End Bearings and replace if clearance is excessive.
- Wash out Lubricating Oil Pipes.
- Thoroughly clean out the Fuel Tank.

28. Decarbonizing.

A deposit of hard carbon is formed on the top of the Piston and Valve Heads after the engine has been running a considerable time. No hard and fast rule can be expressed as to when it is necessary to decarbonize. It depends entirely on the loading on the engine.

The presence of excessive carbon deposit is usually indicated by a falling off of power and a dirty exhaust.

To remove the carbon deposit proceed as follows :—

29. The Removal of the Cylinder Head.

- (a) Remove the three Setscrews which hold the Cylinder Cowl to the Flywheel Fan Casing. The Cylinder Cowl will then slide straight off.
- (b) Unscrew the Rocker Box Fixing Nut and withdraw the Rocker Box Assembly.
- (c) Disconnect the Rocker Supply Oil Pipe by unscrewing the Banjo Bolt which connects the Pipe to the Cylinder Head.
- (d) Remove the Fuel Injector with its finned Cooling Sleeve.
- (e) Disconnect the Stay between the Exhaust Manifold and the Fan Casing and remove the Air Intake and Exhaust Manifolds.
- (f) Remove the five Cylinder Head Nuts and lift off the Cylinder Head.
- (g) Remove the Cylinder Head Gasket and Push Rods.

30. To Dismantle the Cylinder Head and Rocker Box Assemblies.

- (a) Remove the Circlip from the Decompressor Shaft, slide off the Washers and Thackeray Washer.
- (b) Slacken off the Locknut, screw out the Decompressor Peg and withdraw the Decompressor Shaft.
- (c) Remove Circlip and withdraw Rocker Box Nut.
- (d) Unscrew the two Rocker Shaft Support Nuts and withdraw the Rocker Assembly. Remove the two circlips and withdraw the Rocker Shaft and extract the Rockers.
- (e) To remove the Valves, place the Cylinder Head (without the Injector) on a bench, press down the Valve Spring Cup and remove the Split Collets from the Valve Stem. The Valves and Springs can now be withdrawn.

31. Removing the Carbon Deposit (Decarbonizing).

- (a) Turn the engine Flywheel until the Piston is at the top of its stroke.

- (b) Scrape the deposit off the top of the Piston and its combustion space. An old screwdriver or some other blunt tool may be used. Do not allow any carbon dust to fall between the Piston and the Cylinder Bore.
- (c) Thoroughly clean out the Inlet and Exhaust Ports in the Cylinder Head, also the Inlet and Exhaust Manifolds.
- (d) Thoroughly clean the Valves and examine the Seats. If these show signs of pitting, they should be "ground in".
- (e) Be sure the Valve is seating properly. Leaky Valves cause loss of compression, and make starting difficult.

32. To "Grind-in" the Valves.

- (a) Place the Cylinder Head with the Valve Seat on top, on a bench and insert the Valve. Inlet and Exhaust Valves should always be returned to their original positions.
- (b) Place a very small quantity of valve grinding paste evenly round the Valve Seat, and partially rotate the Valve backwards and forwards on its Seating, by means of a screwdriver inserted in the slot in the Valve Head, at the same time exert a gentle but firm pressure on the Valve.
- (c) Every few oscillations lift the Valve off its Seating and give it half a turn, to ensure that the grinding paste is spreading evenly. The most convenient way to carry out this periodic lifting is to insert a light coil spring in the Port beneath the Valve Head. When pressure is released on the screwdriver the Valve will rise up, it can then easily be rotated into a fresh position.
- (d) It is not necessary to continue grinding the Valves once the faces of both the Valves and Seating have assumed a clean matt-surfaced appearance. A polished surface must not be expected and is quite unnecessary.
- (e) It is most important that all traces of the grinding paste are removed. Carefully wipe the Cylinder Head with a rag moistened with paraffin. Do not wash out the Valve Ports with petrol or paraffin or some of the paste may find its way into the Guides.

33. To Re-assemble the Cylinder Head.

- (a) Generally reverse the instructions given for removing and dismantling.
- (b) If the old Valves are distorted or very badly pitted replace with new ones.
- (c) If new Valves or Valve Guides are fitted the Valves must be "ground in".
- (d) When a Cylinder Head has been removed it is always a wise policy to fit a new Cylinder Head Gasket. A new Gasket

must be fitted if the old one shows any sign of damage. Due to the high compression pressure in a diesel engine a good sound Gasket is imperative.

- (e) As this engine is fitted with long through bolts from the crankcase to cylinder head it is most important that the cylinder head nuts are correctly tightened and in the right sequence when re-assembling the engine. Proceed as follows:

1. Screw down each cylinder head nut until finger tight.
2. Tighten nuts a $\frac{1}{4}$ of a turn each, working diagonally across the cylinder head.

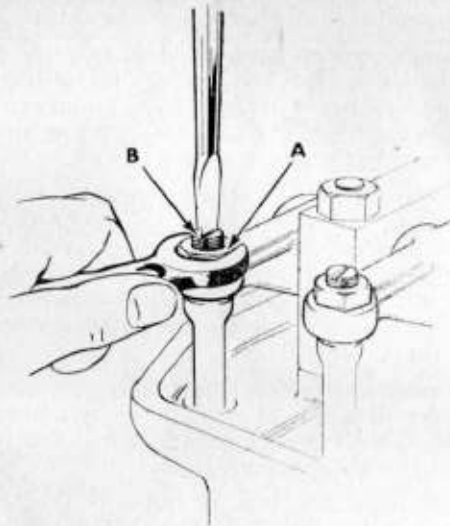


Fig. 3

34. Valve Rocker Adjustment (Fig. 3).

- (a) The clearance between the Valve Stem and the Rocker Arm should be .010" (.25 mm) when cold.
- (b) To adjust the clearance, set the engine with valves closed (Top Dead Centre of firing stroke), loosen the Locknut (A) on the Rocker Adjusting Screw (B) and turn the Rocker Adjusting Screw with a screwdriver. The gap may be measured with a standard feeler gauge. When the correct setting is obtained, ensure that the Locknut is again secure.
- (c) The Decompressor should lift the valve .015" to .020" (.381 to .508 mm) off its seat. The valve should not be lifted more

than this, otherwise it will hit the Piston causing serious damage. The setting may be obtained as follows:—

- (i) Make sure that the Rocker Box is firmly bolted down.
- (ii) Turn engine until the Cylinder is on the Compression stroke, i.e., both Valves closed.
- (iii) Turn the Decompressor Lever to a vertical position.
- (iv) Slacken Locknut and adjust Decompressor Screw until it just touches the Valve Rocker Arm. A further half turn will lower the Valve the required amount. Do not exceed this amount. This function may be operated by removing the Rocker Box Plug and Washer and inserting a box spanner, for turning the Locknut, and passing a screwdriver through the spanner for the Decompressor Screw.

NOTE.—When the Decompressor is in operation, the air in the cylinder is allowed to escape through the slightly open Exhaust Valve. Compression cannot, therefore, build up, and the engine may be turned easily and will not fire.

- (d) IMPORTANT: The Cylinder Head must be firmly bolted in position, with the nuts finally tightened before the Tappet Clearance can be adjusted. This applies also to the Rocker Box when adjusting the Decompressor lift, ALWAYS check and readjust if necessary, the Decompressor lift after removing the Rocker Box.

35. Examination of Piston and Cylinder.

Excessive lubricating oil consumption, loss of compression and knocking are signs that the Piston may need attention.

- (a) Remove the Cylinder Head as described in Section 29.
- (b) Lift the Cylinder off the Crankcase and draw it off of the Piston.

36. The Cylinder.

- (a) The Cylinder is finished to limits of $3.000" \pm .0005"$ (76.2 mm $\pm .013$ mm) after it has worn more than .012" (.3 mm) on the diameter, it should be bored out and an oversize Piston and Rings fitted.
- (b) The Cylinder should be rebored and honed to the following sizes:—

Amount Oversize	Dimensions of Oversize Bore
.020" (.508 mm)	$3.020" \pm .0005"$ (76.708 $\pm .013$ mm)
.040" (1.016 mm)	$3.040" \pm .0005"$ (77.216 $\pm .013$ mm)

37. Maintenance of Piston.

- (a) Take out one Gudgeon Pin Circlip and push out Gudgeon Pin. This may need forcing, but care should be taken not to damage the piston.

- (b) The Piston has five Ring grooves. A chromium plated Compression Ring is placed in the top groove, followed by two plain Compression Rings. Slotted Scraper Rings are carried in the fourth and bottom groove.
- (c) The Ring gaps are .009" to .014" (.23 to .35 mm) when new. When the gaps are more than .06" (1.5 mm) the Rings should be renewed. To measure the Ring gaps, place the Cylinder horizontally on a table and remove all Rings from the Piston. Insert the bare Piston into the Cylinder with the crown facing towards the bottom end of the Cylinder. Keep the Piston crown about $\frac{1}{2}$ " (12 mm) inside the bottom edge of the Cylinder and insert the Rings one by one into that space, pushing the Rings hard up against the Piston crown to make sure they are level in the Cylinder bore. The gap can now easily be measured by inserting a feeler gauge.
- (d) Rings should be neither sloppy nor stuck fast in the groove. If the Piston is held in the hands in a horizontal position, the Rings should not fall downwards, unless the Piston is shaken. This only applies to pistons which have been cleaned free of grease and oil.
- (e) The Piston Ring grooves should be scraped quite clean from carbon deposit. The small holes in the fourth and bottom groove should receive particular attention. Their purpose is to return any excess oil, collected by the Scraper Rings back to the Engine Sump.

38. Replacing the Cylinder Assembly.

- (a) When replacing the Piston see that the hemispherical recess in the Piston crown is at the side opposite to the Camshaft.
- (b) Take care that the Ring gaps are not in line, but well distributed around the circumference of the Piston.
- (c) Take good care to replace the Shims between the Cylinder Block and Crankcase. The thickness of these Shims controls the bumping clearance, that is the clearance between the Piston and the Cylinder Head at Top Dead Centre.
- (d) Before completing assembly check bumping clearance as follows: Put four pieces of lead wire on edge of Piston, roughly over the ends of the Gudgeon Pin and at right angles to it. Bolt on Cylinder Head firmly, and rotate engine either side of Top Dead Centre, remove Cylinder Head and measure the thickness of the four pieces of lead wire. The lead wires have been flattened and should now be .035" to .040" (.89 to .916 mm).
- (e) After completing assembly check the Valve Tappet clearance and re-set the Decompressor, see Section 34.

39. Examination of Connecting Rod and Bearings.

- (a) Remove the Crankcase Inspection Cover, on the oil Filler side of the engine.
- (b) Insert one hand through the inspection aperture and grasp the large end of the Connecting Rod. Check that there is

no undue play or shake in the Bearing. The engine should be decompressed whilst doing this, and the Flywheel rocked backwards and forwards.

- (c) Check also that the Connecting Rod Bolts are tight.

40. To Remove the Connecting Rod.

- (a) Remove the Cylinder Head and Cylinder Block as described in Sections 29 and 35.
- (b) Remove the Crankcase Inspection Cover.
- (c) Bend the Tab Washers away from the Large End Nuts and remove these Nuts. The Connecting Rod/Piston Assembly can now be withdrawn.

41. To Replace the Connecting Rod.

- (a) Generally reverse the operations described in Section 40 but make quite sure that the Large End Nuts are securely locked with NEW Tab Washers before the Crankcase Inspection Cover is replaced.
- (b) After re-assembling the Cylinder Block and Cylinder Head, check the bumping clearance and adjust the valve tappet clearance. (See Sections 34 and 38).

42. Maintenance of Connecting Rod Bearings.

- (a) The Small End Bush is splash lubricated and care must be taken to ensure that when pressing in a new Bush, the oil holes in the Bush coincide with those in the connecting Rod. If a press is not available, use a suitable wood or lead driver, and drive the Bush in squarely to avoid damaging its edges.
- (b) The two half shells of the Large End Bearing must be assembled in the Connecting Rod in the same position as when supplied. The Large End Bearing is of the precision thin-wall, steel-backed type, and is sprung into position in the Connecting Rod halves.
- (c) The Bearing Shell directly under the Piston is lined with copper lead, the shell in the Connecting Rod Cap being lined with white metal. When fitting a new large End Bearing, take care to replace the two Shells correctly. The copper lead Shell is also white (due to a thin layer of lead) but will seem slightly pink when compared with the white metal shell. The half-bearing which fits in the Connecting Rod is stamped "TOP."
- (d) The Bearing Shells are precision machined to the correct dimension, and should on no account be scraped or in any way touched by a tool. When fitting, make quite sure that the inside of the Connecting Rod, the outside of the Shells and the split face of both are completely clean and free from small particles of dirt.

- (e) The outside of the Bearing Shells and the inside of the Connecting Rod bore should not be scraped or bedded, nor should shims of any description be fitted. If faces are filed, the Connecting Rod becomes useless with regard to Bearing Shell replacements.
- (f) The Connecting Rods and Caps are stamped on the outside with an identical serial number. Care should be taken that the two halves when assembled bear the same number, and that the two stamps are on the same side of the Rod.
- (g) Undersize Large End Bearing Shells from .020" (.51 mm) to .040" (1.016 mm) below standard diameter are available. (See also Section 45).

43. Main Bearings.

- (a) The two Main Bearings at the Gear end and Flywheel end are in the form of thin steel Sleeves lined with white metal. They are also of the precision type and should be driven squarely into the Bearing Housings by means of a block of wood. They are machined in such a way that they give the required fit on the Crankshaft after being driven into their Housings and should never be scraped or bedded. If they have a split this should be placed at the top, i.e. towards the Piston.
- (b) Crankshaft End Thrust from the Gear End is taken by a flange on the inner, (nearest the cylinder) end of the Flywheel end Main Bearing. Thrust from the Flywheel end is taken by a flange on the inner end of the gear end Main Bearing. The Crankshaft 'float' should be .006" to .016" (.15 to .40 mm.) and is adjustable by means of shims inserted between the Flywheel end Bearing Housing and the Crankcase. Shims of thickness .008" (.20 mm) and .015" (.38 mm) may be obtained from Petters or their Agents.
- (c) Undersized Main Bearings are available (see Section 45).

44. To Remove the Crankshaft.

- (a) Remove the Cylinder Assembly and Connecting Rod as described in Sections 35 and 40.
- (b) Disconnect the Pipe, Fuel Filter to Fuel Tank, unscrew the four Setscrews and remove the Fuel Tank.
- (c) Remove the Flywheel Fan Casing and Straps.
- (d) Withdraw the Gib Head Flywheel Key with tapered Key Drift and strip off the Flywheel. A special tool may be obtained from Petters or their Agents.
- (e) Unscrew the Pivot Pin Nut and withdraw the Pivot Pin, Fuel Pump Rack Lever, Lever Spring and Fulcrum Lever.
- (f) Disconnect the Filter to Fuel Pump Pipe unscrew the two Fuel Pump Setscrews and withdraw the Fuel Pump Assembly.

- (g) Uncouple the Oil Pipes and remove the Gear end Cover and Extension Shaft Bearing Housing Assembly. The two Hexagon Head Dowels can be levered out with a spanner on edge.
- (h) Remove the Full Speed Extension Shaft if fitted. The Crankshaft Gearwheel is keyed to the Crankshaft and held in position with a Setscrew and Retaining Plate. Remove the Setscrew and Plate and withdraw the Gear with a Simple Extractor. A special tool may be obtained from Petters or their Agents.
- (j) Remove the Setscrews holding the Flywheel end Main Bearing Housing in position.
- (k) Withdraw the Crankshaft from the Crankcase by pulling towards the Flywheel end.

45. Maintenance of Crankshaft.

- (a) Carefully examine the Bearing Journals and Crank Pin; these should have a highly polished appearance and be quite free from scratches or score markings. If there are any scratches or upon measurement, they are more than .003" (.08 mm) oval, they should be reground undersize and special undersize Bearings fitted.
- (b) The Main Bearing Journals and Crank Pin should be reground to the following sizes.

Nominal Amount undersize	Dia. of Main Bearing Journal	Dia. of Crankpin
.020" (.51 mm)	1.7280" — .0008" (43.89 — .020 mm)	1.730" — .001" (43.94 — .025 mm)
.030" (.76 mm)	1.7180" — .0008" (43.64 — .020 mm)	1.720" — .001" (43.69 — .025 mm)
.040" (1.01 mm)	1.7080" — .0008" (43.38 — .020 mm)	1.710" — .001" (43.43 — .025 mm)

- (c) Carefully clean out the oil Holes in the Crankshaft and if it has been reground, be sure that all Holes have a radiused edge.

46. To Replace the Crankshaft.

- (a) Generally reverse the instructions given for removal in Section 44.
- (b) Fit new Bearings if the old ones have excessive clearance or show signs of the metal having run.
- (c) Before completing the assembly, check the End Float, see para. 43 (b).

47. To Remove the Camshaft (Fig. 4).

- (a) Remove the Cylinder (see Section 35).
- (b) Remove the Gear end Cover (see para. 44 (g)).

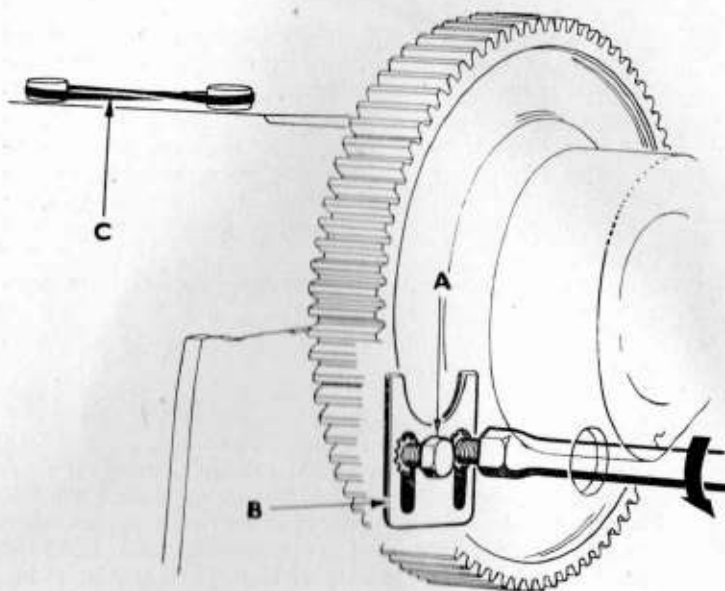


Fig. 4

- (c) Remove the Half Speed Extension Shaft, if fitted.
- (d) Rotate the Engine until one of the Holes in the Camshaft Gearwheel lines up with the Thrust Plate Setscrews (A). Slacken off these two Setscrews sufficiently to allow the Thrust Plate (B) to drop to the full extent of its Slots.
- (e) Hold the Tappets up in the "maximum lift" position; this can be done by winding a rubber band or piece of string (C) round the Shank.
- (f) Withdraw the Camshaft Assembly carefully; care should be taken to hold the Oil Pump Plunger down to its full extent otherwise the Push Rod Cap will fall off.

48. Maintenance of Camshaft.

- (a) Careful examination of the Camshaft Faces should be made; if these are damaged or chipped it will be necessary to fit a new Camshaft.
- (b) The Camshaft Gearwheel is keyed and pressed on to the Camshaft. These are machined as an assembly and therefore component parts cannot be ordered separately.

49. To Replace the Camshaft and Time the Engine (Fig. 5).

- (a) Generally reverse the instructions given for removal in Section 47.

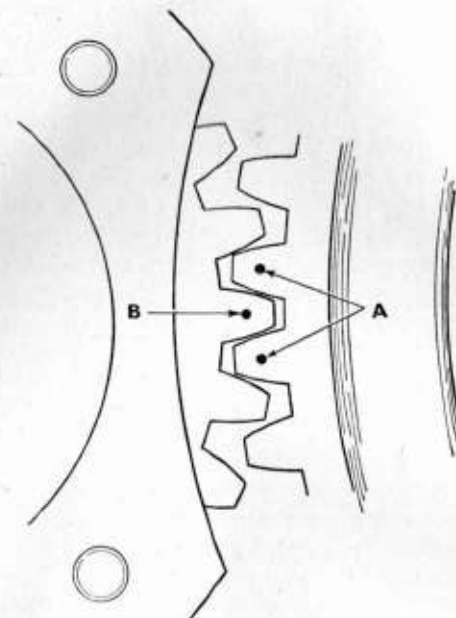


Fig. 5

- (b) Insert the Camshaft Assembly from the Gear End.
- (c) To time the Engine correctly, mesh the two Teeth marked with dots on the Camshaft Gearwheel, (A) either side of Tooth marked with a dot on the Crankshaft Gearwheel (B).
- (d) Push Camshaft Thrust Plate back into position and tighten the two Setscrews.
- (e) Free the Tappets and after complete assembly, check the Tappet clearances (see Section 34).

50. The Governor (Fig. 6).

- (a) The Governor is housed in a mounting attached to the Gear end Cover Plate.
- (b) The Governor Weights are fitted to the Governor Gearwheel. The action of these Weights moves the Governor Sleeve along the Governor Spindle and Controls the Yoke.
- (c) The Yoke is fixed to the Yoke Spindle by a Woodruff Key and locked with a Grub Screw. The Governor Lever is pressed on to the Spindle and clamped there by a Socket Headed Cap Screw.
- (d) One end the Lever is attached to the Fuel Pump Rack by means of a Fulcrum Lever, Pivot Pin and a Fuel Pump Rack Lever; this controls the amount of fuel to the engine. The

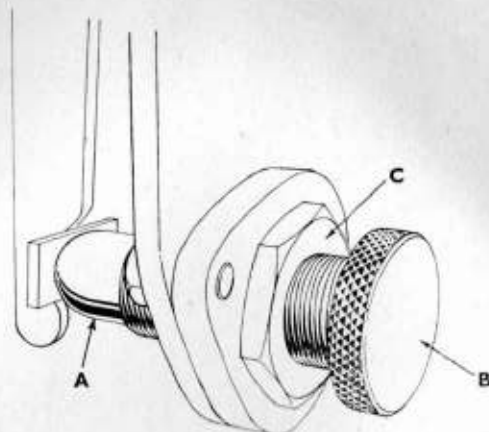


Fig. 6

other end of the Lever bears on the Speeder Spring Plunger (A), which compresses into the Adjusting Screw (B).

- (e) To Adjust the Speed of the Engine:
 - (i) Loosen Locknut (C).
 - (ii) To increase the Engine speed—screw Adjusting Screw Inwards.
 - (iii) To decrease the Engine speed—screw the Adjusting screw outwards.
 - (iv) When the correct setting is obtained, again tighten Locknut (C).

51. To Dismantle the Governor.

- (a) Remove the Governor Assembly as one unit from the Gear End Cover Plate by unscrewing the three Setscrews.
- (b) Unscrew the two screws which hold the Governor Housing Cover to the Governor Housing and remove the Cover.
- (c) Remove the Socket Head Cap Screw from the Yoke and withdraw the Yoke Spindle sufficiently to expose the Woodruff Key in the cut-away portion of the Yoke. Remove the Key and pull out the Yoke Spindle. Extract the Yoke and slide the Sleeve from the Governor Spindle, withdraw the Governor Spindle complete with Gearwheel and Weights, from the Governor Housing.

52. To Re-assemble the Governor and Time the Engine.

- (a) Generally reverse the instructions given for dismantling in Section 51.
- (b) Replace the Governor Assembly without the Governor Lever by bolting it to the Gear end Cover Plate.
- (c) Twist Governor Lever Spindle clockwise as far as it will go, then assemble Governor Lever on Spindle with pinch boss

on inside. Set Governor Lever Spindle so that pump rack position gives a dimension of $\frac{3}{32}$ " from boss of pump to flat on rack on right hand side of pump viewed from the gear end of the engine. Tighten Allen Capscrew to lock lever to spindle, try lever mechanism for freedom of action.

- (d) Retime the Injector timing as described in Section 61.

53. Variable Speed. (Fig. 7).

- (a) The Variable Speed Control Gear, which is cable operated, is mounted on a bracket attached to the Gear Cover.
- (b) The centrifugal forces on the Governor Weight are transmitted by a sliding sleeve on the Governor Shaft, through a lever assembly. These forces are balanced by an adjustable Speeder Spring (A) on the Control Gear. Movement of the Control Lever, i.e. pulling cable, will increase the engine speed.
- (c) To adjust the Variable Speed Control. Set the Control Lever to the fully closed position and tighten or slacken the adjusting nut (B) until the correct idling speed is obtained.

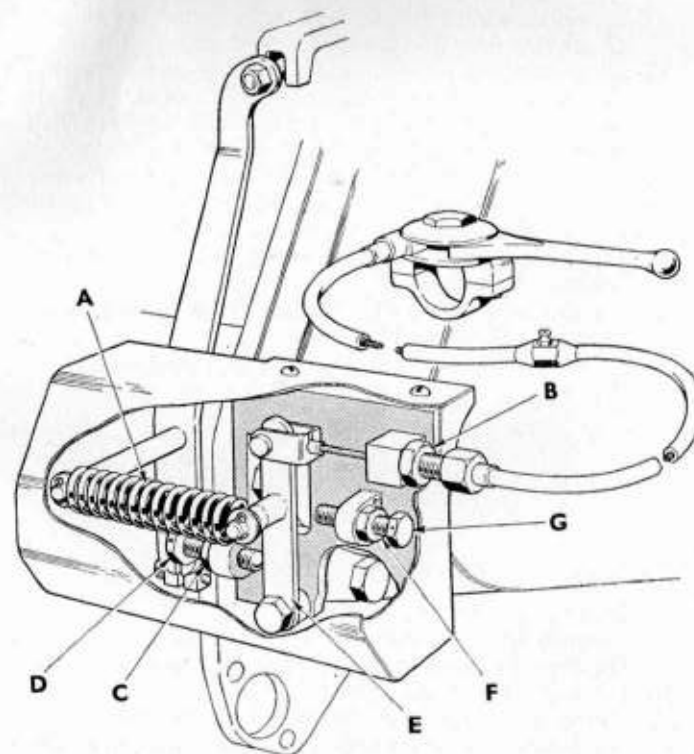


Fig. 7.

tained (approx. 1000 r.p.m.). Loosen the Stop Screw locknut (C) and screw in the Stop Screw (D) until it just touches the lever (E). Tighten the locknut again, and replace seal with new locking wire.

- (d) Having set the idling speed correctly move the Control Lever into the fully open position, slacken off the Stop Screw Locknut (F) and set the Stop Screw (G) until the appropriate Maximum Speed is obtained. Tighten the locknut again, and replace seal with new locking wire.
- (e) Re-check the idling speed setting once more and if required re-adjust.

54. The Lubricating Oil System (Fig. 8).

- (a) The Engine oil pressure system is as follows :—
 - (b) The Plunger type Pump (A) is submerged in oil in the Crankcase at the Flywheel end of the Engine. The Pump is operated by a Push Rod (B) off a Cam on the Camshaft.
 - (c) The oil is drawn through a gauze Strainer (C) fitted to the Pump Suction Branch and is delivered through a drilled Oil-way in the Crankcase to the external Delivery Pipe (D).
 - (d) A non-adjustable Relief Valve is incorporated in the Pump to prevent excessive pressures when the Engine is cold.
 - (e) Oil under pressure reaches the Main, and Extension Shaft Bearing through the external Delivery Pipe. The Large End Bearing is lubricated through a drilled hole (E) in the Crankshaft from the Flywheel End Main Bearing.
 - (f) The external Delivery Pipe (F) supplies the Rocker Gear through the Restrictor Banjo (G), return being via the Push Rod compartment in the Cylinder Block.
 - (g) The Cylinders, Small End Bearing and Camshaft are splash lubricated.
 - (h) The governor gear is lubricated by oil passing through the restrictor (K) from pipe (H).
- To adjust the oil flow through the Restrictor.
- (i) Loosen the Locknut.
 - (ii) Screw home the Adjuster.
 - (iii) Screw out the Adjuster $\frac{1}{2}$ a turn.
 - (iv) Tighten the Locknut making sure not to move the Adjuster.

55. To Dismantle the Lubricating Oil Pump.

- (a) Remove Lubricating Oil Filter.
- (b) Remove Filter Carrier.
- (c) Depress the Plunger and remove the Push Rod and Cap.
- (d) Lift out Plunger and Spring.
- (e) Unscrew the setscrews holding the Retaining Flange to the crankcase, thus releasing the Flange. The Pump Body can now be gently levered out.

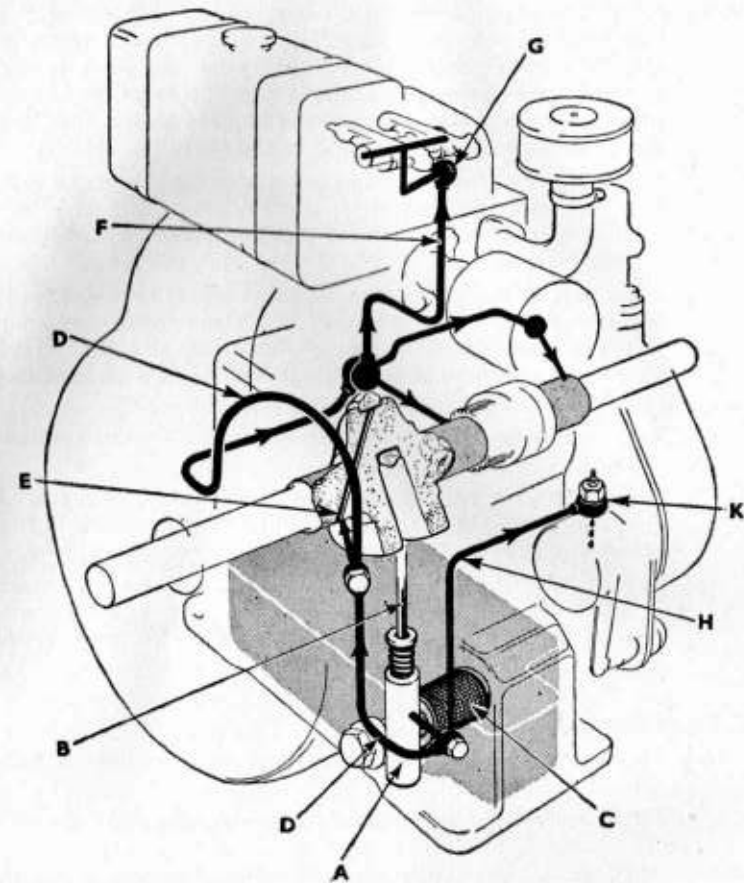


Fig. 8

- (f) Unscrew the Plunger into three parts, taking care not to damage the Springs on the Delivery and Relief ball Valves; these Springs and balls must be returned to their original position.
- (g) To reassemble Lubricating Oil Pump generally reverse the instructions for dismantling.

56. Fuel Oil System.

- (a) Fuel Oil from the Tank flows through a Filter to the Injection Pump mounted on the top of the Gear End Cover. Fuel under high pressure is supplied from the Pump through a steel Pipe to the Injector at the side of the Head, remote from the Manifold side.

- (b) A small amount of fuel is always leaking back along the Needle of the Injector Nozzle. This fuel is returned direct to the Tank by a copper Pipe. When the Fuel Tank is not mounted in a convenient position, this fuel is collected in a small Container, which should be emptied daily. This fuel should be filtered and returned to the tank.
- (c) The quantity of fuel injected during each cycle is very small. The Fuel Injection Equipment is manufactured to very fine limits and it requires extreme care and absolute cleanliness in handling.
- (d) If any part of the fuel system, even a Pipe, is removed from the engine, it should be placed in a clean metal container which is filled with clean fuel oil. No filing, grinding, scraping or sawing should be carried out within a few yards of dismantled Fuel Injection Equipment.
- (e) Replace the Equipment wet, no rag, cloth or waste should touch it.
- (f) Unless the user has been trained in the care and repair of Fuel Injection Equipment, he should not dismantle it in any other way than as described in the following paragraphs.
- (g) Faulty Fuel Pumps and Injectors should be returned to Petters or their agents for repair and replacement. Users are advised to keep a Nozzle in their spares kit so that they can replace a faulty Nozzle immediately.

57. Fuel Pump.

- (a) To remove the Fuel Pump Assembly from the engine, proceed as follows :—
 - (i) Close the Fuel Cock and Disconnect the Pipe connections.
 - (ii) Unscrew the two Fuel Pump holding setscrews and lift off Fuel Pump.
- (b) The Fuel Pump should not be dismantled and is not likely to require any attention.

58. To Test a Fuel Injector.

- (a) Disconnect the Pipe connections to the Pump and Leak-off.
- (b) Remove the two Nuts on the Injector Flange and carefully lever out the Injector Assembly.
- (c) Slide the Finned Aluminium Cooling Sleeve off the Nozzle Holder Body, be careful not to damage the cooling fins.
- (d) Connect the High pressure Pipe up again in such a way that the Nozzle points away from the engine.
- (e) Lift the Decompressor Lever and crank over the Engine. The fuel should squirt out suddenly in two fine mist sprays, which should just as suddenly stop. If the Nozzle does not

spray, or if it gives solid squirts of fuel, or if it dribbles after the sprays have stopped, it should be replaced. BE CAREFUL to see that the Injector spray is not directed to an exposed part of the body. The force behind the spray will cause it to penetrate the skin.

59. To Fit a Fuel Injector.

- (a) Slide on the Aluminium Sleeve and push the complete assembly into position by hand. DO NOT USE FORCE.
- (b) This finned nozzle sleeve acts as a gas seal and A COPPER WASHER MUST NOT BE USED. DO NOT UNDER ANY CIRCUMSTANCES ATTEMPT TO RUN THE ENGINE WITHOUT THIS COOLING SLEEVE.
- (c) Tighten the two Nuts on the flange mounting quite evenly. The Injector should not bind on one edge.
- (d) Connect up the fuel pipes and 'bleed' the engine, see para. 13 (e).

50. To Clean a Fuel Injector.

- (a) It is necessary to release the spring pressure on the Needle before removing the Nozzle from the Nozzle Holder Body. Remove the Cap Nut and Upper Nut from the top of the Holder Body. Do not touch the spring adjusting Screw and Locknut fitted to the Upper Nut as this is set to give the correct injection pressure. The Nozzle Nut may now be removed and the Nozzle lifted off.
- (b) To fit a Nozzle to the Nozzle Holder it is necessary to hold the Nozzle hard against the pressure face with the fingers, in the position determined by the Dowels, and tighten up the Nozzle Nut with the Nozzle held firmly in this position. It is absolutely essential that the spring pressure is released as described in (a) above, otherwise the Nozzle will not seat squarely on the Dowels.
- (c) To reassemble the Nozzle Holder, wash all the parts in clean paraffin or fuel oil and brush off any dirt or carbon from the parts. HAVING CLEANED OFF ALL DIRT AND CARBON, WASH EACH PART THOROUGHLY IMMEDIATELY BEFORE FITTING IN PLACE. The Nozzle Holder Spring should be greased. Screw home the Upper Nut with the Adjusting Screw untouched and fit the Cap Nut and Sealing Washer.
- (d) To clean a Nozzle remove the Needle from the Nozzle, and wash both Nozzle and Needle in clean fuel oil. It is advisable to leave these parts overnight in a bath of clean fuel oil. After this treatment, carbon may be scraped off the Nozzle Body with a piece of clean wood or brass, or preferably with a special brass wire brush obtainable from Messrs. Bryce Berger Ltd., or their agents.

- (e) Every Nozzle Body and Needle are "mated". The Needle should, therefore, never be put into another Nozzle Body.
- (f) The Nozzle Spring has been adjusted to one of the pressure ranges shown on the Technical Data Sheet. If the spring setting is altered it will be necessary to test the injector on a test outfit and re-adjust to give the correct injection pressure.

61. Injection Timing.

Before attempting to time the Injection be sure that the Fuel Line is 'bled' up to the Pump.

- (a) Close the Fuel Cock.
- (b) Remove the steel Pipe from the Pump to the Injector, and unscrew the steel Union Body on top of the Pump, which carries the Injector Pipe. Lift out the Delivery Valve which is then lying open on top of the Pump and put it in clean fuel oil. Do not disturb the Delivery Valve Seat.
- (c) Replace the top fitting of the Fuel Pump but leave out the Delivery Valve.
- (d) Turn the Flywheel until it is about $\frac{1}{2}$ of a turn before T.D.C. of the Cylinder.
- (e) See that the Fuel Tank is quite full and open the Fuel Cock next to the Fuel Tank.
- (f) Turn the Flywheel slowly in the normal running direction until the flow of fuel from the Pump stops. Find by repeated trial the exact Flywheel position at which this happens. (Do not use the Starting Handle, but turn the Flywheel by hand).
- (g) When the Flywheel is in the exact position where the fuel flow stops, the Pointer on the Crankcase should point to a position of 26° before T.D.C. for 1151 to 1800 R.P.M. Engine or 23° before T.D.C. for 1000 to 1150 R.P.M. Engine. This is shown by the marked line on the outer edge of the Flywheel.
- (h) If the Pointer shows an incorrect position on the Flywheel, shims of required thickness should be placed between the Tappet Guide and the Fuel Pump Boss on the Gear End Cover, until the correct reading is obtained.
- (j) When the spill point is correctly adjusted, turn off the Fuel Cock and reassemble the Fuel Injection Equipment, including the Pump Delivery Valve. 'Bleed' the engine as described in para. 13 (e).

62. Fuel.

- (a) To make sure that the Injection Equipment can work properly, the fuel must always be clean.
- (b) Barrels of fuel should be allowed to settle before use. Sludge or water at the bottom of the barrel should not be used. A

"cheap" fuel may be very expensive in the long run, due to increased repair costs on the engine.

- (c) Any funnels or cans used for fuel oil should not be used for anything else, and should be kept absolutely clean, nor should they be used while wetted by water.
- (d) Occasionally the Fuel Tank should be removed from the engine and flushed with petrol or paraffin, to remove the sludge from the bottom of the Tank.
- (e) The fuel used should be high grade light diesel fuel, gas oil or D.E.R.V. fuel. It should comply with B.S. Specification 209/1947 Class "A" which is as follows :—

Cetane number, 45 Min.

Viscosity Redwood No. 1 at 100°F ., 31 to 45 secs.

Conradson Carbon (by weight). 0.1% max.

Distillation % by volume recovered at 350°C ., 85.

Flashpoint (closed) $^\circ\text{F}$., 150.

Calorific Value, gross, 19000 B.T.U's/lb.

Water % by volume, 0.1.

Ash % by weight, 0.01.

Sediment % by weight, 0.01.

Sulphur % by weight, 1.5.

Acidity, inorganic, Nil.

Corrosion, copper strip at 212°F ., Negative.

63. To Clean the Cooper Fuel Filter.

- (a) Close the Fuel Cock.
- (b) Unscrew the ribbed locking ring holding the Filter Bowl and withdraw Filter Bowl.
- (c) Remove the Element complete by unscrewing the long Setscrew in the bottom of the element.
- (d) Wash Element in clean petrol, fuel oil, paraffin or trichlorethylene (cleaning fluid).
- (e) Thoroughly clean out the Filter Bowl.
- (f) The Filter Element Assembly should be replaced when a large mount of dirt deposit is visible. Replacement Elements may be obtained from "Petters" or their agents.
- (g) Re-assemble the Filter.
- (h) "Bleed" the fuel system as described in Section 13 (e).

64. Air Cleaner.

- (a) An oil wetted Air Cleaner is fitted to the Air Intake Manifold and should be removed every 180 hours and thoroughly washed in paraffin or petrol.
- (b) After washing, it should be allowed to drain and then dipped into a bath of clean Engine oil; again it should be allowed to drain before being refitted to the Engine.

65. Clutch.

A multi-plate Clutch can be fitted to the Gear end for either full or half speed drive.

- (a) To Adjust the Clutch:
 - (i) Remove the Inspection Cover.
 - (ii) Slacken off the Locking Screw in the Adjusting Ring and turn the Ring until the correct adjustment is obtained. Final adjustment can only be obtained by trial with the load applied. Correct adjustment is such that with the Engine running, the load is taken when a steady strong pull on the Lever just makes the "overcentre" action operate.
 - (iii) After adjustment, tighten the Locking Screw.

DO NOT OVER ADJUST THIS MECHANISM AS THIS CAN CAUSE SERIOUS DAMAGE TO THE CLUTCH.
- (b) To Remove the Clutch from the Engine:
 - (i) Remove the Inspection Cover.
 - (ii) Remove the Split Pin on the Yoke Shaft and remove the Pinch Bolts on the Clutch Yoke. Withdraw the Hand Lever and Yoke Shaft, leaving the Clutch Yoke in the Clutch Housing.
 - (iii) Slacken off Adjusting Ring.
 - (iv) Remove the Setscrews holding the Clutch Housing to the Gear end Cover and withdraw the Clutch Assembly.
- (c) To Remove the Driving Plates.
 - (i) Remove the countersunk screws attaching the Hub Plate to the Hub and remove Hub Plate.
 - (ii) Withdraw Driving Plates and Toggles.
- (d) To Remove the Driving Shaft:
 - (i) Remove Oil Seal and Housing.
 - (ii) Extract the Main Bearing out Circlip and press out the Driving Shaft (i.e. plus Sliding Sleeve, Hub and Adjusting Ring) from the Clutch Housing.

Note: The Hub is keyed to the Driving Shaft.

- (iii) Clutch Plates should be refitted in the same order and position as when dismantled.
- (iv) The Clutch Yoke must be replaced with the pinch bolt bosses facing the Engine.
- (v) For lubricating purposes, $\frac{1}{2}$ pint (.3 litres) of Engine lubricating oil should be poured into the Clutch Housing for initial starting. When the Engine is running the Clutch is lubricated by an oil mist and spray from the Restrictor (Painted Red) which is pressure fed from the Engine and should pass 45 cc. to 65 cc. of oil per $\frac{1}{4}$ hr.
- (vi) This is a positive acting industrial type clutch and must on no account be slipped when operated. The lever should be smartly engaged and disengaged.

66. Speed-up Gear.

This unit consists principally of a Driving Gear keyed to a Crankshaft Extension and provided with a plain end Bearing pressure lubricated by the Oil Pump. The Driving Gear meshes with a Pinion Keyed to the "Power Take-off Shaft" which is fitted with an oil bath lubricated Pilot Roller Bearing and Main Ball Bearing. The ratio of Power Take-off Shaft speed to Crankshaft speed is 1.61 : 1. An alternative ratio of 1.86 : 1 is also available.

Dismantling.

- (a) Remove the Lubricating Oil Pipe and drain the oil by removing the plug at the back of the Speed up Gear.
- (b) Remove the eight Bolts that secure the two Halves of the Gear Housing. The hexagon head Dowels may be removed with a Spanner on edge.
- (c) Draw off the outer half of the Gear Housing complete with the Power take-off Shaft and the Driven Gear Assembly. Care should be taken not to damage the Inner Ring of the Pilot Bearing which is then exposed on the end of the Power Take-off Shaft.
- (d) Remove the four Setscrews from the Oil Seal Housing and draw this assembly off the Shaft. Take great care not to damage the Oil Seal Assembly.
- (e) Remove the small Locking Screw from the Main Locknut. Remove this Locknut. The Power Take-off Shaft can now be withdrawn from the Bearing. On the 1.86 : 1 ratio speed up gear it will be necessary to release the Circlip on the inner end of the Power Take-off Shaft to remove the inner ring of the Pilot Bearing and Driven Gear.
- (f) To expose the crankshaft gear wheel loosen the small locking Screw from the Main Locknut on the Driving Shaft. Remove the Locknut and withdraw the Driving Gear. The Driving Shaft is then removed by unscrewing the four set-

screws attaching the Driving Shaft to the Crankshaft Gear-wheel.

- (g) To re-assemble the Speed-up Gear generally reverse the instructions for dismantling.

IMPORTANT : All parts should be well oiled before re-assembly.

67. Protection and Preservation.

The following notes are intended to help users to obtain the maximum useful working life from their engine.

- (a) A Cover for the Engine.

If the engine is in the open and not being used, it should be covered with a tarpaulin.

In tropical climates it is an advantage to have a permanent awning to provide protection from the heat of the sun.

- (b) Routine Running.

An engine not required for daily use should be run for about five minutes once a week in order to ensure internal parts remain lubricated. At the same time external bright parts should be cleaned with an oily rag and external mechanism lubricated. The starting handle—an often neglected accessory—should receive special attention, and the starting shaft kept clean.

- (c) Engine Required for Periodic or Seasonal Use.

If an engine is to remain idle for a period exceeding one month, corrosion of the working parts may take place, and result in serious damage to the engine. The following procedure of preservation is recommended and may be performed without any special tools. The type of preservative oil to be used may be determined by applying to local lubricating oil headquarters. In the following description, suitable oils marketed by Shell-Mex & B.P. Ltd., are used as examples:—

- (i) Drain the engine crankcase of oil. This should be done after running the engine; when the engine will be warm. If the engine contains a large amount of sludge the crankcase may be flushed with paraffin, but the engine must not be run with paraffin in the crankcase.

- (ii) The engine should be allowed to remain until cool, when the crankcase should be filled with Shell Ensic 20 oil. This should be done without delay if the engine has been flushed. Drain the fuel tank and fill with sufficient Shell Fusus "A" oil to run the engine for five minutes. The Fusus oil will provide protection for the fuel injection equipment and is used as a fuel.

The air cleaner, depending on its design, should be washed or filled with Shell Ensic 20 oil.

The engine should run (on light load if possible) for about five minutes.

The Ensic oil will provide a protective film inside the engine.

- (iii) Shut down engine. The crankshaft should not be turned after running.

- (iv) All openings, such as air cleaner inlet, exhaust silencer, holes, manifold inlet and outlets should be sealed to prevent the entrance of moisture.

It may be convenient to remove the air cleaner.

The engine should be re-preserved once every six months, when it will only be necessary to run the engine for five minutes. Make sure that all seals affixed to the engine to prevent entrance of moisture are removed before attempting to start the engine.

Any preserved engine is ready for starting. It should be cranked over a number of times to expel surplus oil from the cylinders. Although it is desirable to fill the crankcase with an approved grade of oil the engine may be run for a short period on Shell Ensic 20 oil.

Additional protection can be obtained by coating external bright parts.

- (d) Stock Engines.

Prior to despatch all engines are protected internally with Shell Ensic 20 oil.

It should be pointed out that the only satisfactory method of preservation is to run the engine—as described in Section (c)—to ensure the preserving oil reaches all parts of the engine. If however, this is not possible, the engine should not be disturbed.

WHEN ORDERING SPARE PARTS, STATE THE ENGINE TYPE AND SERIAL NUMBER, THE PARTS LIST SECTION AND REFERENCE NUMBER, AND THE QUANTITY REQUIRED. FOR FUEL INJECTION EQUIPMENT STATE ALSO THE TYPE NUMBER STAMPED ON THE INJECTORS AND PUMPS.

Parts list

THIS ENGINE IS FITTED WITH BRYCE BERGER FUEL INJECTION EQUIPMENT. ON NO ACCOUNT SHOULD ANY OTHER MAKE OF FUEL INJECTION EQUIPMENT BE FITTED WITHOUT FIRST CONSULTING PETTERS LTD.

In addition to Petters Ltd., or the agents of Associated British Oil Engines Ltd., Fuel Injection Equipment may be obtained direct from the makers—Bryce Berger Ltd., Ironbarks Works, Staines, England.

A

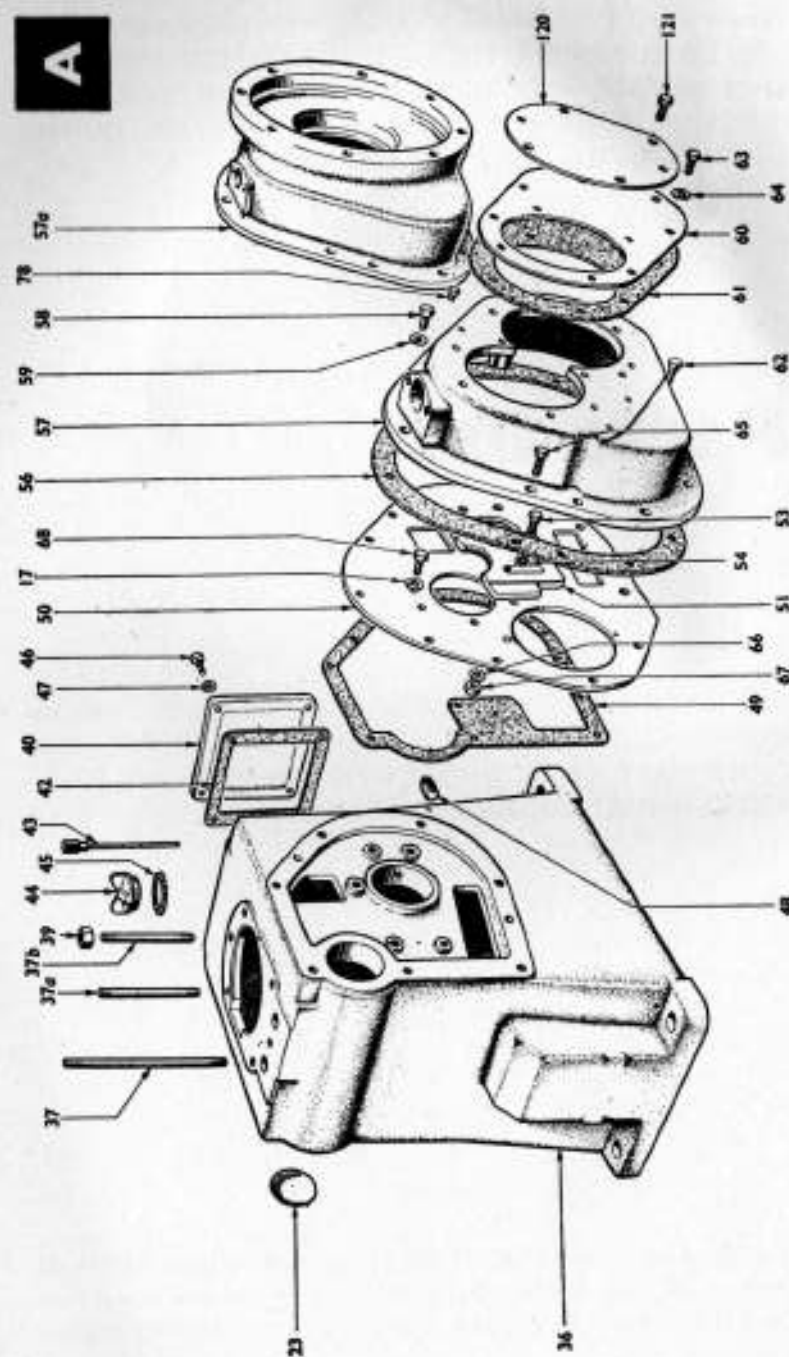
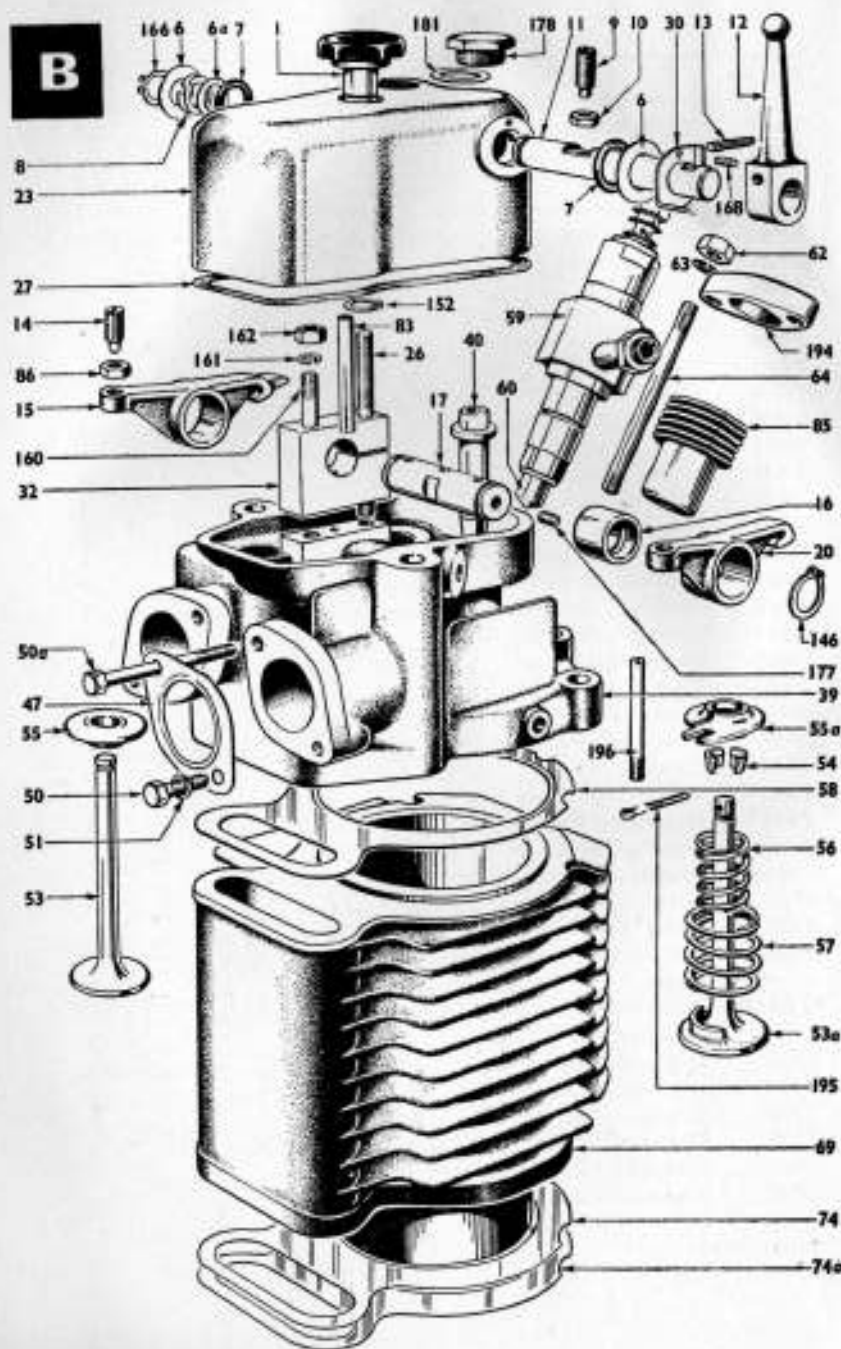


PLATE A

Ref. No.	Description	PAZI
TA17	Spring Washer—Gear Cover Plate, $\frac{1}{8}$ "	5
TA23	Core Plug	1
PA36	Crankcase	1
ZPA37	Stud—Cylinder Head (Long)	2
ZPA37a	Stud—Cylinder Head (Short)	2
ZPA37b	Stud—Cylinder Head (Rear)	1
TA39	Nut	5
ZPA40	Cover—Crankcase Inspection	1
TA42	Joint—Inspection Cover	1
TA43	Dipstick	1
TA44	Cap—Oil Filler	1
TA45	Joint—Oil Filler Cap	1
TA46	Set screw—Inspection Cover, $\frac{1}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	4
TA47	Spring Washer, $\frac{1}{8}$ "	4
TA48	Plug—Crankcase Drain	1
TA49	Joint—Gear Cover Plate	1
PA50	Plate—Gear Cover	1
TA51	Plate—Camshaft Thrust	1
*TA53	Set screw—Camshaft Thrust Plate, $\frac{1}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	2
TA54	Shakeproof Washer, $\frac{1}{8}$ "	2
TA56	Joint—Gear Cover	1
ZPA57	Cover—Gear	1
ZPA57a	Cover—Gear (S.A.E. No. 6 Bellhousing)	1
JA58	Set screw—Gear Cover, $\frac{1}{8}$ " B.S.F. \times 1" long	8
TA59	Spring Washer, $\frac{1}{8}$ "	8
PA60	Cover—Gear Cover	1
PA61	Joint—Gear Cover Cover	1
TA62	Dowel—Gear Cover	2
*JA62a	Dowel—Gear Cover (S.A.E. No. 6 Bellhousing)	2
JA63	Set screw—Gear Cover Cover, $\frac{1}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	4
JA64	Spring Washer, $\frac{1}{8}$ "	4
PA65	Bolt—Gear Cover and Governor Housing, $\frac{1}{8}$ " B.S.F. \times $1\frac{1}{2}$ " long	2
*ZPA65	Bolt—Gear Cover and Governor Housing, $\frac{1}{8}$ " B.S.F. \times $1\frac{1}{2}$ " long (Variable Speed)	2
JA66	Spring Washer, $\frac{1}{8}$ "	2
TA67	Nut—Gear Cover Plate, $\frac{1}{8}$ " B.S.F.	5
TA68	Set screw—Gear Cover Plate, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long	5
JA78	Plug—Gear Cover ($\frac{1}{8}$ " B.S.F. \times $\frac{1}{2}$ " long Set screw)	2
PA120	Plate—Gear Cover Blanking	1
PA121	Set screw—Blanking Plate, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long	6

* Not illustrated

B

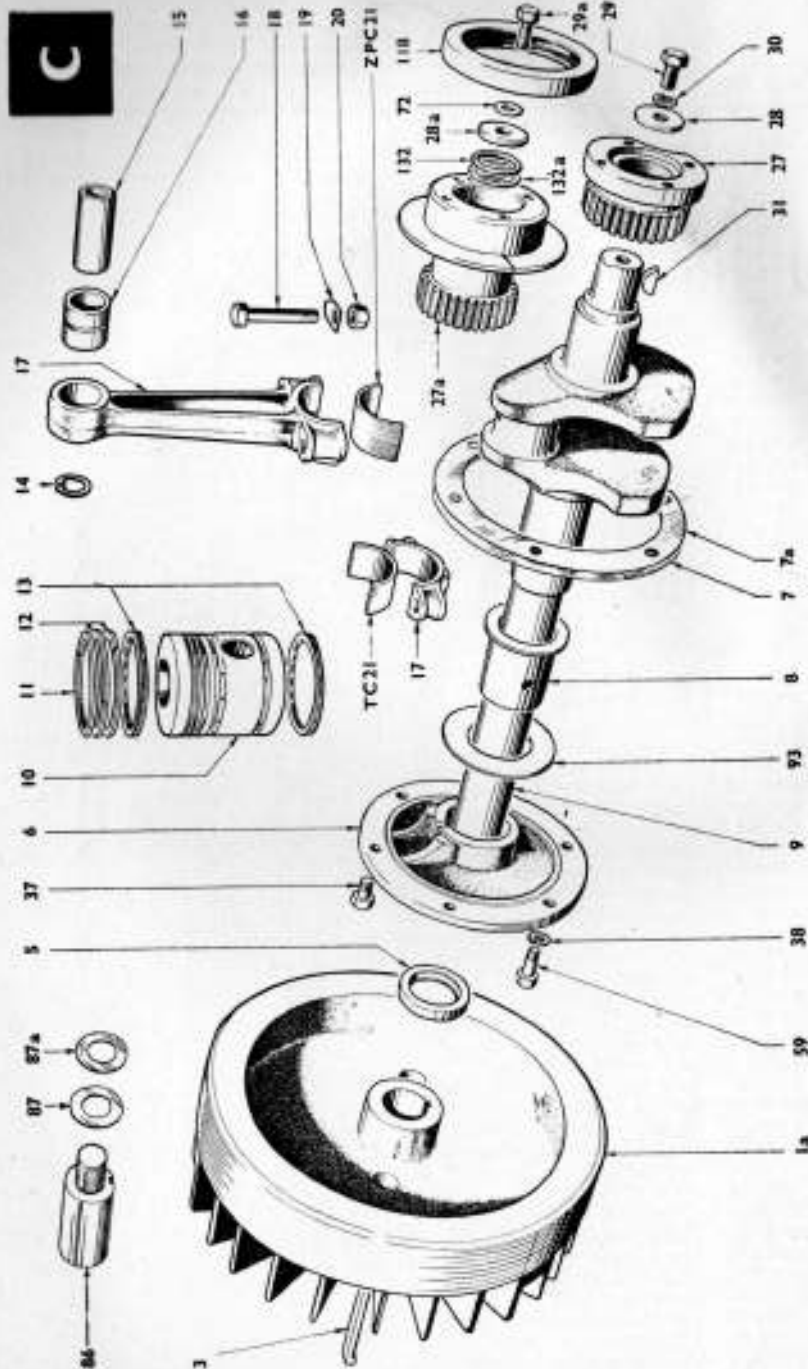


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PLATE B

Ref. No.	Description	PAZI
ZPB1	Nut—Rocker Box	1
ZPB6	Washer—Decompressor Shaft, $\frac{1}{8}$ "	1
ZPB6a	Washer—Decompressor Shaft	1
ZPB7	Oil Seal—Decompressor Shaft	2
ZPB8	Thackery Washer—Decompressor Shaft	1
ZPB9	Screw—Decompressor Adjusting	1
ZPB10	Locknut—Decompressor Adjusting Screw, $\frac{1}{4}$ " B.S.F.	1
ZPB11	Shaft—Decompressor	1
ZPB12	Lever—Decompressor	1
JB13	Cotter Pin—Decompressor Lever, $\frac{1}{16}$ "	1
ZPB14	Screw—Valve Rocker Adjusting	2
ZPB15	Rocker—Exhaust Valve	1
ZPB16	Bush—Valve Rocker	2
ZPB17	Shaft—Valve Rocker	1
ZPB20	Rocker—Inlet Valve	1
ZPB23	Rocker Box	1
ZPB26	Stud—Rocker Box and Rocker Shaft Support	1
ZPB27	Joint—Rocker Box	1
ZPB30	Washer—Decompressor Shaft	1
ZPB32	Support—Rocker Shaft	1
ZPB39	Cylinder Head	1
ZPB40	Guide—Valve	2
JB47	Gasket—Exhaust and Inlet Manifolds	2
JB50	Bolt—Exhaust and Inlet Manifolds, $\frac{1}{8}$ " B.S.F. $\times \frac{3}{4}$ " long	4
JB50a	Bolt—Inlet Manifold (Heavy Duty Air Cleaner) $\frac{1}{8}$ " B.S.F. $\times 2\frac{1}{2}$ " long	1
JB51	Spring Washer, $\frac{1}{8}$ "	4
ZPB53	Valve—Exhaust	1
ZPB53a	Valve—Inlet	1
TB54	Collet—Valve	2 prs.
ZPB55	Cup—Exhaust Valve	1
ZPB55a	Cup—Inlet Valve	1
ZPB56	Spring—Valve (Inner)	2
ZPB57	Spring—Valve (Outer)	2
ZPB58	Gasket—Cylinder Head	1
ZPB59	Injector—Fuel	1
ZPB60	Nozzle—Fuel Injector	1
JB62	Nut—Fuel Injector, $\frac{1}{8}$ "	2
JB63	Spring Washer, $\frac{1}{8}$ "	2
ZPB64	Stud—Fuel Injector, $\frac{1}{8}$ " B.S.F. $\times 4$ " long	2
ZPB69	Cylinder	1
ZPB74	Joint—Cylinder (0-015" thick)	As reqd.
ZPB74a	Joint—Cylinder (0-005" thick)	As reqd.
ZPB83	Tube—Breather	1
AJB85	Sleeve—Fuel Injector	1
ZPB86	Locknut—Valve Rocker Adjusting Screw	2
ZPB146	Circlip—Rocker Shaft	2
ZPB152	Circlip—Rocker Box Nut	1
ZPB160	Stud—Rocker Shaft Support, $\frac{1}{8}$ " B.S.F. $\times 2\frac{1}{2}$ " long	1
ZPB161	Spring Washer, $\frac{1}{8}$ "	2
ZPB162	Nut, $\frac{1}{8}$ " B.S.F.	2
ZPB166	Circlip—Decompressor Shaft	1
ZPB168	Mills Pin—Decompressor Shaft Washer	1
ZPB177	Grub Screw—Rocker Shaft	1
ZPB178	Plug—Rocker Box	1
ZPB181	Joint Washer, $\frac{3}{4}$ "	1
ZPB194	Flange—Fuel Injector Locating	1
ZPB195	Split Pin—Inlet Valve Cup, $\frac{1}{8}$ " $\times \frac{1}{4}$ " long	1
ZPB196	Pin—Inlet Valve Locating	1

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PLATE C

Ref. No.	Description	PAZI
ZPC1a	Flywheel	1
PC3	Key—Flywheel, $\frac{3}{8}'' \times \frac{11}{16}'' \times 2\frac{1}{2}''$ long	1
TC5	Oil Seal	1
PC6	Housing—Main Bearing	1
TC7	Shim—Main Bearing Housing (0-008" thick)	As reqd.
TC7a	Shim—Main Bearing Housing (0-015" thick)	As reqd.
PC8	Bearing—Main	2
ZPC9	Crankshaft	1
ZPC10	Piston Assembly, complete with Rings, Pin and Circlip	1
ZPC11	Ring—Compression (Chromium Plated)	1
ZPC12	Ring—Compression (Plain)	2
ZPC13	Ring—Scraper (Slotted)	2
ZPC14	Circlip—Gudgeon Pin	2
ZPC15	Gudgeon Pin	1
ZPC16	Bush—Small End	1
ZPC17	Connecting Rod Assembly, complete with Small End Bush, Large End Bearing and Bolts	1
TC18	Bolt—Large End	2
TC19	Tabwasher	2
TC20	Nut, $\frac{3}{8}''$ B.S.F.	2
TC21	Bearing—Large End (Bottom)	1
ZPC21	Bearing—Large End (Top)	1
PC27	Gearwheel—Crankshaft	1
PC27a	Gearwheel and Oil Thrower (S.A.E. No. 6 Bellhousing)	1
TC28	Plate—Gearwheel Retaining	1
PC28a	Plate—Gearwheel Retaining (S.A.E. No. 6 Bellhousing)	1
TC29	Setscrew—Retaining Plate, $\frac{3}{16}''$ B.S.F. $\times \frac{1}{2}''$ long	1
PC29a	Setscrew—Retaining Plate, $\frac{1}{8}''$ B.S.F. $\times \frac{1}{2}''$ long (S.A.E. No. 6 Bellhousing)	1
TC30	Spring Washer, $\frac{3}{16}''$	1
TC31	Key—Crankshaft Gearwheel (Woodruff)	1
TC37	Setscrew—Main Bearing Housing, $\frac{3}{16}''$ B.S.F. $\times \frac{1}{2}''$ long	2
PC38	Spring Washer, $\frac{3}{16}''$	6
TC59	Bolt—Main Bearing Housing and Fan Cowling, $\frac{1}{2}''$ B.S.F. $\times 1\frac{1}{8}''$ long	4
PC72	Joint Washer, $\frac{1}{2}''$ (S.A.E. No. 6 Bellhousing)	1
PC86	Shaft—Starting Extension	1
TC87	Shim—Starting Extension Shaft (0-010" thick)	As reqd.
TC87a	Shim—Starting Extension Shaft (0-030" thick)	As reqd.
TC93	Ring—Oil Retaining	1
JC118	Oil Seal (S.A.E. No. 6 Bellhousing)	1
PC132	Ring—Sealing (S.A.E. No. 6 Bellhousing)	1
PC132a	Ring—Sealing (S.A.E. No. 6 Bellhousing)	1

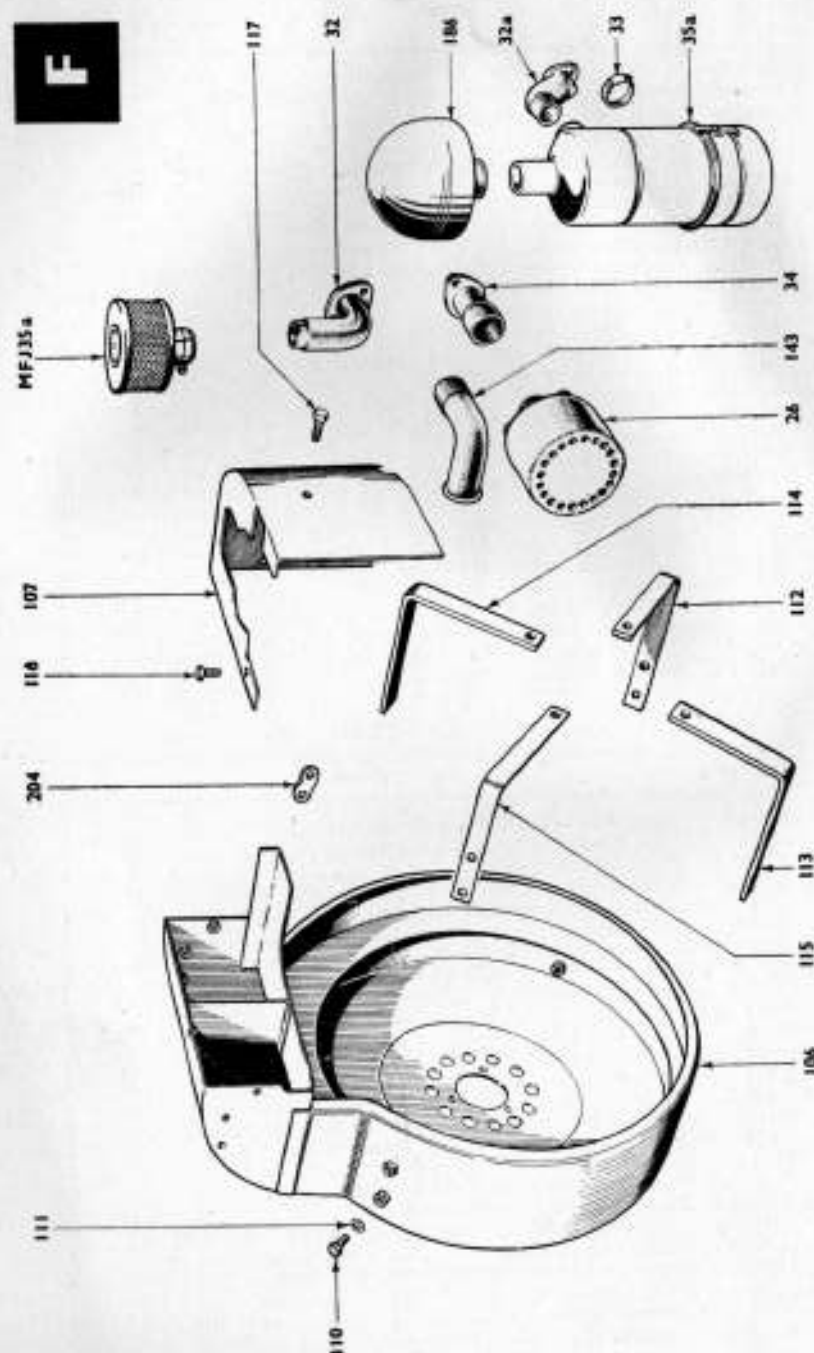
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Ref. No.	Description	PAZI
PD120	Bolt—Flange, $\frac{1}{2}$ " B.S.F. \times $\frac{3}{4}$ " long	2
PD121	Spring Washer, $\frac{1}{8}$ "	2
PD122	Screw—Speeder Spring Adjusting	1
PD123	Locknut	1
PD124	Plunger—Speeder Spring	1
ZPD125	Spring—Speeder (1151 to 1500 rev/min)	1
ZPD125a	Spring—Speeder (1000 to 1150 rev/min)	1
PD125a	Spring—Speeder (1501 to 1800 rev/min)	1
PD126	Pin—Governor Thrust Sleeve	2
PD127	Sleeve—Governor Thrust	1
PD128	Split Pin—Thrust Sleeve Pin, $\frac{3}{32}$ " \times $\frac{3}{8}$ " long	2
PD129	Grub Screw—Yoke	1
PD137	Screw—Governor Housing	1
PD138	Shakeproof Washer, 2 B.A.	1
PD148	Circlip—Governor Spindle	1
PD166	Spring—Variable Speed	1
PD179	Key—Yoke (Woodruff)	1
ZPD180a	Screw—Lever Adjusting (Variable Speed)	2
ZPD181	Locknut—Adjusting Screw, $\frac{3}{4}$ " B.S.F.	2
ZPD197	Spring Washer—Governor Housing Cover, $\frac{1}{16}$ "	2
ZPD218	Cover—Variable Speed	1
ZPD219	Screw—Variable Speed Cover, 2 B.A. \times $\frac{1}{4}$ " long	2
ZPD246	Set screw—Flywheel Pointer	2
ZPD247	Spring Washer, $\frac{1}{8}$ "	2
ZPD296	Cover—Governor Housing	1
JD297	Seal—Adjusting Screw	1
JD298	Wire—Adjusting Screw Locking	1

PLATE E

Ref. No.	Description	PAZI
PE1a	Banjo Bolt—Main Bearing (Flywheel end)	1
*JE4	Joint Washer—Clutch Oil Restrictor, $\frac{3}{8}$ "	1
ZPE5	Pipe—Injector Leak-off	1
ZPE5a	Pipe—Injector Leak-off (For use with engine having separately mounted Fuel Tank)	1
ZPE7	Tank—Fuel	1
ZPE8	Bracket—Fuel Tank	2
ZPE9	Setscrew—Fuel Tank Bracket, $\frac{1}{4}$ " B.S.F. \times $\frac{1}{2}$ " long	4
ZPE10	Spring Washer, $\frac{1}{4}$ "	2
PE11	Strap—Fuel Tank	2
TE12	Cap—Fuel Tank	2
PE16	Screw—Tank Strap	2
PE17	Washer, $\frac{1}{4}$ "	2
ZPE20	Adaptor—Fuel Pump	1
CJE21	Pipe—Fuel (Flexible) (Filter to Pump)	1
TE22	Joint Washer—Flexible Fuel Pipes and Tap, $\frac{1}{2}$ "	5
JE31	Tap—Fuel Tank	1
JE32	Pipe—Fuel (Flexible) (Tank to Filter)	1
ZPE34	Pipe—Fuel (Pump to Injector)	1
ZPE34a	Pipe—Fuel (Pump to Injector) (1000 to 1150 rev/min)	1
ZPE36	Bracket—Fuel Filter	1
JE37a	Bolt—Fuel Filter Bracket, 2 B.A. \times $\frac{3}{8}$ " long	2
JE38	Nut, 2 B.A.	2
JE39	Spring Washer, 2 B.A.	2
ZPE39a	Washer, $\frac{1}{2}$ "	2

• Not illustrated



Ref. No.	Description	PAZI
PE44	Pipe—Oil (Gear End Bearing to Extension Shaft Bearing Mk. V) ...	1
PE44a	Pipe—Oil (Gear End Bearing to Extension Shaft Bearing Mk. II) ...	1
PE44d	Pipe—Oil (Gear End Bearing to Speed Increasing Gear) ...	1
PE44e	Pipe—Oil (Gear End Bearing to Clutch Mk. IV) ...	1
JE45	Clip—Oil Pipe ...	1
ZPE46	Clip—Oil Pipe ...	1
JE53	Banjo Bolt—Oil and Leak-off Pipes, $\frac{1}{8}$ " B.S.P. ...	2
ZPE53c	Banjo Bolt—Oil Pipe, $\frac{3}{8}$ " B.S.P. ...	1
JE54	Joint Washer, $\frac{3}{8}$ " ...	3
ZPE55	Pipe—Oil (Gear End Main Bearing to Rockers) ...	1
ZPE60	Pipe—Fuel Pump Drain ...	1
JE61	Joint Washer—Pipe Banjos, $\frac{3}{8}$ " ...	11
JE62	Container ...	1
* ZPE62a	Container (For use with engine having separately mounted Fuel Tank) ...	1
JE64	Filter—Fuel (For details see separate list) ...	1
PE67	Pipe—Oil (Pump to Main Bearings) ...	1
PE70	Pipe—Oil (Pump to Governor Housing) ...	1
ZPE95	Setcrew—Filter Bracket, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long ...	2
VPE97	Spring Washer, $\frac{3}{8}$ " ...	2
MJE118	Seal—Oil Pipe, PE67, and Banjo Bolt, PE1a ...	2
MJE119	Union Nut—Seal ...	2
CPE123	Banjo Bolt—Fuel Filter, $\frac{1}{8}$ " B.S.P. ...	1
VPE141	Union—Fuel Pump Drain ...	1
PE148	Boss—Fuel Tank Strap ...	2
PE149	Boss—Fuel Tank Strap ...	2
ZPE189	Restrictor (Governor, Rocker and Clutch) ...	3
ZPE191	Banjo Bolt—Restrictor ...	3
ZPE192	Locknut—Restrictor ...	3
ZPE193	Joint Washer—Restrictor, $\frac{1}{2}$ " (Governor and Rocker) ...	2

PLATE F

Ref. No.	Description	PAZI
JF26	Silencer—Exhaust ...	1
JF32	Manifold—Inlet ...	1
JF32a	Manifold—Inlet (Heavy Duty Air Cleaner) ...	1
JF33	Clip (Heavy Duty Air Cleaner) ...	1
JF34	Manifold—Exhaust ...	1
JF35a	Air Cleaner (Heavy Duty) ...	1
MJF35a	Air Cleaner ...	1
ZPF106	Cowling—Fan ...	1
* ZPF106a	Cowling—Fan (Reverse Rotation) ...	1
ZPF107	Cowling—Cylinder ...	1
PFI10	Setcrew—Fan Cowling Straps, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long ...	8
PFI11	Spring Washer, $\frac{1}{2}$ " ...	11
PFI12	Strap—Fan Cowling ...	1
PFI13	Strap—Fan Cowling ...	1
PFI14	Strap—Fan Cowling ...	1
PFI15	Strap—Fan Cowling ...	1
PFI16	Setcrew—Cylinder Cowling, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long ...	2
ZPF117	Setcrew—Cylinder Cowling, $\frac{1}{8}$ " B.S.F. \times $\frac{3}{8}$ " long ...	1
JF143	Elbow—Exhaust (Heavy Duty Air Cleaner) ...	1
JF186	Pre-Cleaner (Heavy Duty Air Cleaner) ...	1
ZPF204	Bracket—Cowling ...	1

* Not Illustrated

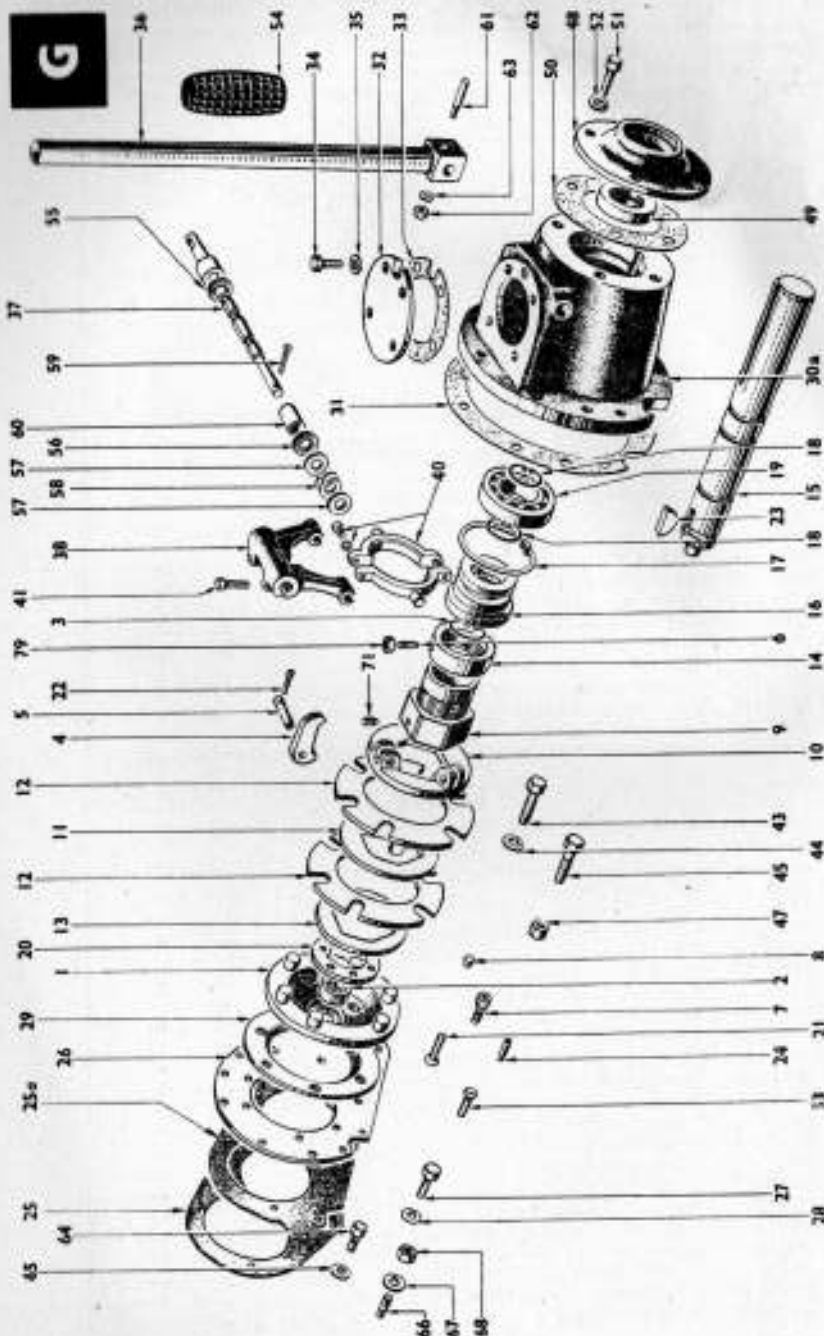
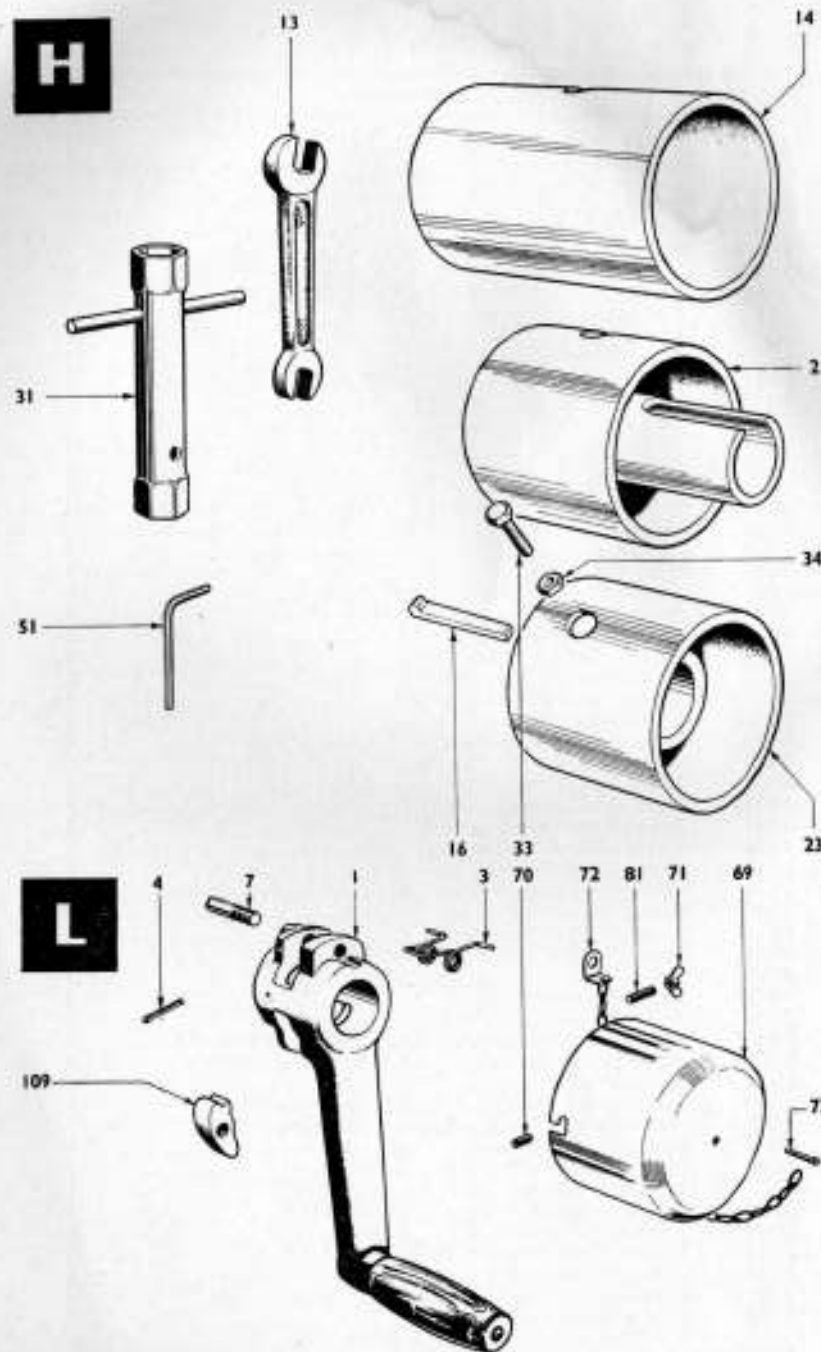


PLATE G

Ref. No.	Description	PAZI
JG1	Flange—Clutch Driving	1
JG2	Bearing—Roller	1
JG3	Circlip—Sliding Sleeve	1
JG4	Toggle	3
JG5	Pin—Toggle	3
JG6	Screw—Adjusting Ring Locking	1
JG7	Screw—Driving Flange, $\frac{3}{8}$ " B.S.F. \times $\frac{1}{2}$ " long (Mk. IV)	4
*ZPG7a	Screw—Driving Flange, $\frac{3}{8}$ " B.S.F. \times $\frac{1}{2}$ " long (Mk. III)	4
JG8	Seal—Driving Flange Screw	4
JG9	Hub—Clutch	1
JG10	Plate—Outer	1
JG11	Plate—Driven	1
JG12	Plate—Driving	2
JG13	Plate—Inner	1
JG14	Ring—Adjusting	1
JG15	Shaft—Clutch	1
JG16	Sleeve—Sliding	1
JG17	Circlip—Clutch Housing	1
JG18	Circlip—Ball Bearing	2
JG19	Bearing—Ball	1
JG20	Plate—Hub Back	1
JG21	Screw—Hub Back Plate, $\frac{3}{8}$ " B.S.F. \times $\frac{3}{8}$ " long	6
JG22	Split Pin—Toggle Pin, $\frac{3}{8}$ " \times $\frac{3}{8}$ " long	6
JG23	Key—Clutch Hub (Woodruff)	1
JG24	Dowel—Driving Flange	1
PG25	Joint—Adaptor Plate (Mk. IV)	1
PG25a	Joint—Adaptor Plate (Mk. III)	1
ZPG26	Plate—Adaptor	1
PG27	Set screw—Adaptor Plate, $\frac{3}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	4
JG28	Spring Washer, $\frac{3}{8}$ "	4
JG29	Plate—Spigot	1
JG30a	Housing—Clutch	1
JG31	Joint—Clutch Housing	1
JG32	Cover—Clutch Housing	1
JG33	Joint—Clutch Housing Cover	1
JG34	Set screw—Clutch Housing Cover, $\frac{3}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	4
JG35	Spring Washer, $\frac{3}{8}$ "	4
JG36	Lever—Clutch Operating	1
JG37	Shaft—Yoke	1
JG38	Yoke	1
JG40	Thrust Ring Assembly	1
JG41	Bolt—Yoke, $\frac{1}{2}$ " B.S.F. \times 1" long	2
PG43	Bolt—Clutch Housing, $\frac{1}{2}$ " B.S.F. \times $1\frac{1}{2}$ " long (Mk. IV)	2
PG43	Bolt—Clutch Housing, $\frac{1}{2}$ " B.S.F. \times 1" long (Mk. III)	4
JG44	Spring Washer, $\frac{3}{8}$ "	8
JG45	Bolt—Clutch Housing, $\frac{1}{2}$ " B.S.F. \times $\frac{7}{8}$ " long (Mk. III)	4
JG45	Bolt—Clutch Housing, $\frac{1}{2}$ " B.S.F. \times $\frac{7}{8}$ " long (Mk. IV)	1
JG47	Nut, $\frac{3}{8}$ " B.S.F. (Mk. III)	4
JG47	Nut, $\frac{3}{8}$ " B.S.F. (Mk. IV)	1
JG48	Housing—Oil Seal	1
JG49	Oil Seal—Clutch Shaft	1
JG50	Joint—Oil Seal Housing	1
JG51	Bolt—Oil Seal Housing, $\frac{3}{8}$ " B.S.F. \times $1\frac{1}{2}$ " long	5
JG52	Spring Washer, $\frac{3}{8}$ "	5
JG53	Screw—Spigot Plate, $\frac{3}{8}$ " B.S.F. \times $\frac{3}{8}$ " long	4
JG54	Grip—Clutch Operating Lever	1

* Not illustrated

H

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PLATE G contd.

Ref. No.	Description	PAZI
JG55	Washer—Yoke Shaft Sealing (Lever end) ...	1
JG56	Washer—Yoke Shaft Sealing ...	1
JG57	Washer—Yoke Shaft, $\frac{1}{8}$ " ...	2
JG58	Thackerary Washer—Yoke Shaft, $\frac{1}{8}$ " ...	1
JG59	Split Pin—Yoke Shaft, $\frac{3}{32}$ " \times $\frac{3}{4}$ " long ...	1
JG60	Bush—Yoke Shaft ...	1
JG61	Cotter Pin—Operating Lever ...	1
JG62	Nut, $\frac{1}{4}$ " B.S.F. ...	1
JG63	Washer, $\frac{1}{2}$ " ...	1
JG64	Plug—Gear Cover ($\frac{1}{16}$ " B.S.F. \times $\frac{1}{2}$ " long Setscrew) (Mk. IV) ...	2
PG65	Joint Washer, $\frac{1}{8}$ " ...	2
PG66	Stud—Adaptor Plate ...	1
PG67	Spring Washer, $\frac{1}{8}$ " ...	1
PG68	Nut, $\frac{1}{8}$ " B.S.F. ...	1
JG71	Grubscrew—Clutch Hub ...	1
JG79	Nut—Adjusting Ring Locking Screw, $\frac{1}{2}$ " B.S.F. ...	1

PLATE H

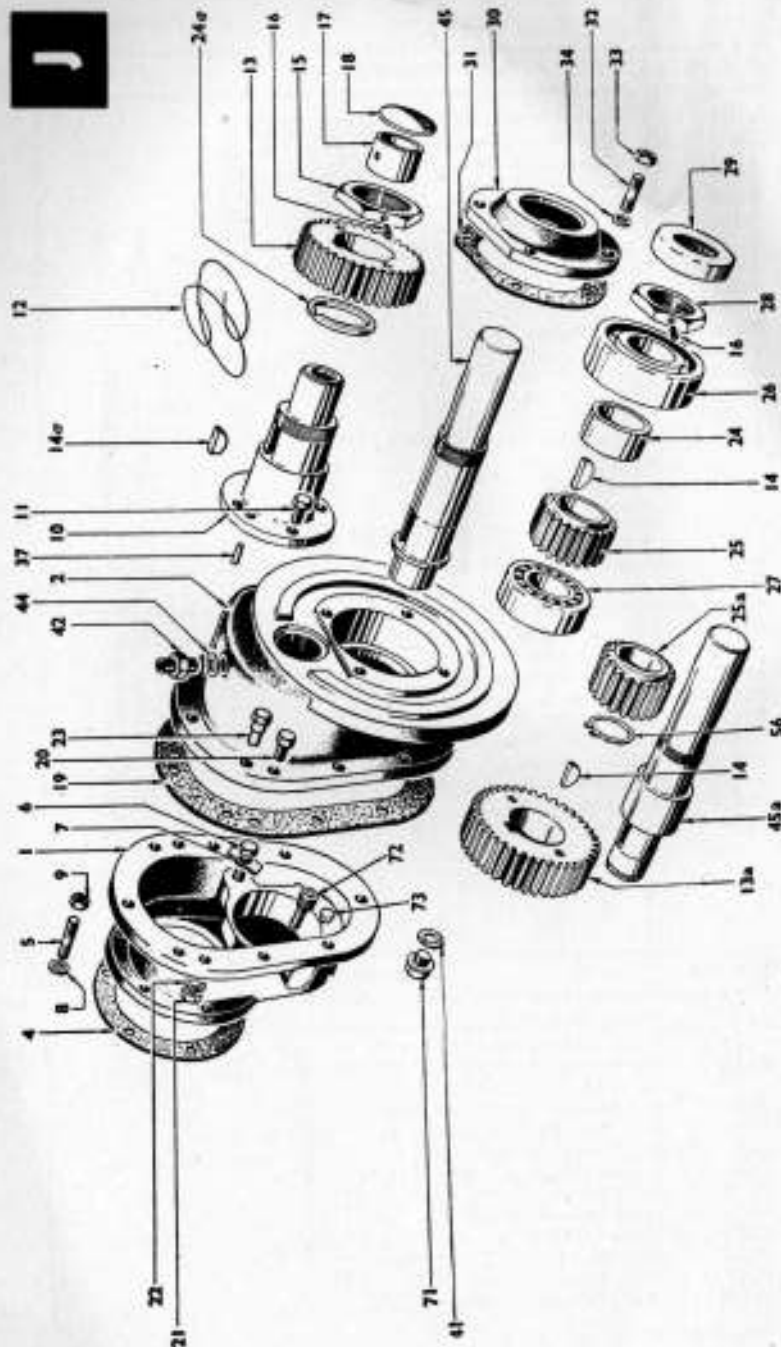
Ref. No.	Description	PAZI
PH2	Pulley—5" diameter \times $4\frac{1}{2}$ " face (Mk. V and Drive and Start at Flywheel End) ...	1
JH13	Spanner—Open Ended, $\frac{5}{8}$ " \times $\frac{1}{4}$ " ...	1
PH14	Pulley—5" diameter \times 7" face ...	1
TH16	Key—Pulley, $\frac{3}{8}$ " \times $\frac{1}{2}$ " \times $2\frac{1}{2}$ " ...	1
TH23	Pulley—5" diameter \times $4\frac{1}{2}$ " face (Mks. I, II, III and IV) ...	1
JH31	Spanner—Box, $\frac{5}{8}$ " \times $\frac{1}{2}$ " (With Tommy Bar) ...	1
TH33	Setscrew—Pulley, $\frac{1}{8}$ " B.S.F. \times $\frac{1}{4}$ " long ...	1
TH34	Locknut, $\frac{3}{8}$ " B.S.F. ...	1
JH51	Wrench—Allen Screw ...	1

PLATE L

Ref. No.	Description	PAZI
PL1	Starting Handle Assembly, complete with Spring, Pawl and Pin (Clockwise) ...	1
*PL1a	Starting Handle Assembly, complete with Spring, Pawl and Pin (Anti-clockwise) ...	1
JL3	Spring—Starting Handle Pawl ...	1
JL4	Split Pin—Starting Handle, $\frac{3}{32}$ " \times $1\frac{1}{8}$ " long ...	1
JL7	Pin—Starting Handle Pawl ...	1
PL69	Guard—Starting Extension Shaft ...	1
PL70	Grub Screw—Guard, 2 B.A. \times $\frac{3}{8}$ " long ...	1
PL71	Wing Nut—Guard, 2 B.A. ...	1
PL72	Chain—Guard ...	1
PL73	Split Pin—Guard, $\frac{1}{8}$ " \times $\frac{3}{4}$ " long ...	1
PL81	Grub Screw—Guard, 2 B.A. \times 1" long ...	1
JL109	Pawl—Starting Handle ...	1

* Not Illustrated

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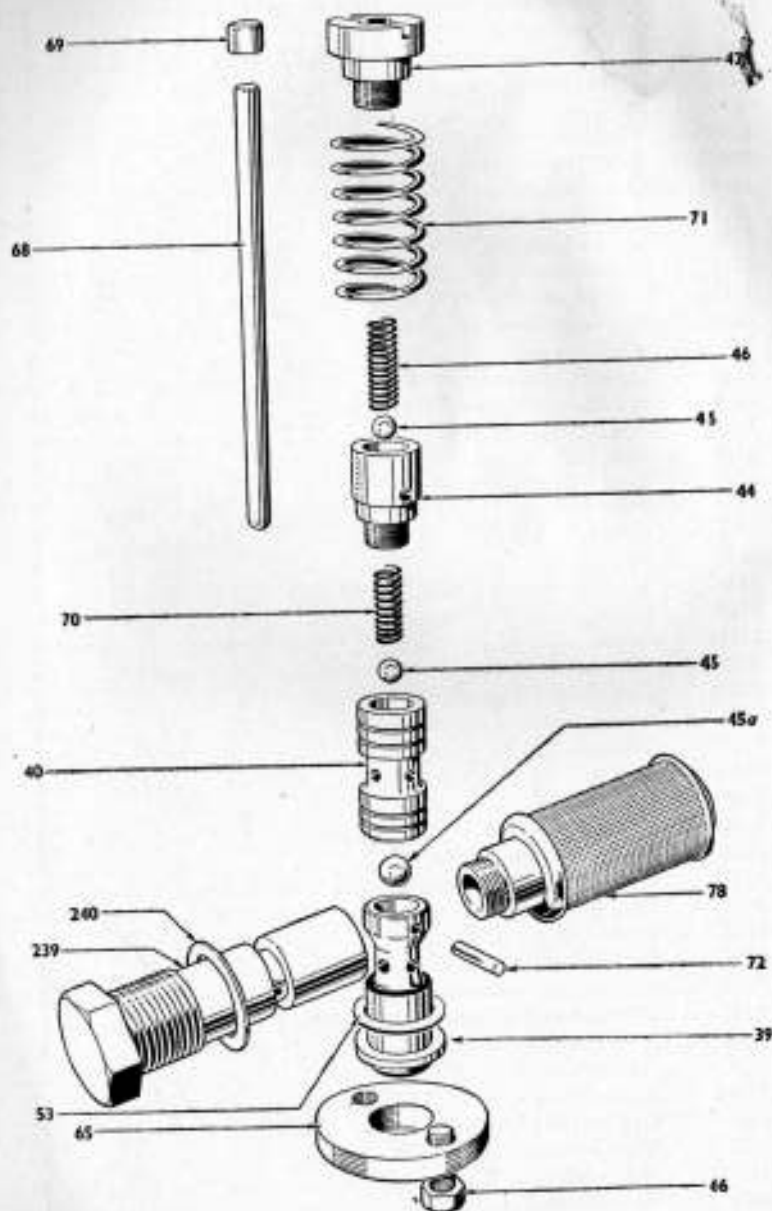
[74]

PLATE J

Ref. No.	Description	PAZI
JJ1	Housing—Speed Increasing Gear (Engine half) ...	1
JJ2	Housing—Speed Increasing Gear (Power take-off half) ...	1
JJ4	Joint—Housing (Engine half) ...	1
JJ5	Stud—Housing (Engine half), $\frac{1}{8}$ " B.S.F. \times $1\frac{1}{4}$ " long	4
JJ6	Bolt—Housing (Engine half), $\frac{1}{4}$ " B.S.F. \times 2" long	1
JJ7	Tabwasher ...	1
JJ8	Washer—Housing Stud, $\frac{3}{8}$ " ...	4
JJ9	Nut—Housing Stud, $\frac{1}{8}$ " B.S.F. ...	4
JJ10	Shaft—Crankshaft Extension ...	1
JJ11	Setscrew—Extension Shaft ...	4
JJ12	Wire—Extension Shaft Setscrew Locking ...	1
JJ13	Gearwheel—Driving (1-61:1 Ratio) ...	1
JJ13a	Gearwheel—Driving (1-86:1 Ratio) ...	1
JJ14	Key—Gearwheel (Woodruff) ...	1
PJ14a	Key—Gearwheel (Woodruff) ...	1
JJ15	Locknut—Driving Gearwheel ...	1
JJ16	Screw—Locking (For JJ15 and JJ28) ...	2
JJ17	Bush—Extension Shaft ...	1
JJ18	Core Plug ...	1
JJ19	Joint—Housing (Power take-off half) ...	1
JJ20	Bolt—Housing (Power take-off half), $\frac{1}{8}$ " B.S.F. \times 1" long	8
JJ21	Nut, $\frac{1}{8}$ " B.S.F. ...	8
JJ22	Washer, $\frac{1}{8}$ " ...	8
JJ23	Dowel—Housing (Power take-off half) ...	4
JJ24	Collar ...	1
JJ24a	Collar ...	1
JJ25	Gearwheel—Driven (1-61:1 Ratio) ...	1
JJ25a	Gearwheel—Driven (1-86:1 Ratio) ...	1
JJ26	Bearing—Ball ...	1
JJ27	Bearing—Roller ...	1
JJ28	Locknut—Ball Bearing ...	1
JJ29	Oil Seal ...	1
JJ30	Housing—Oil Seal ...	1
JJ31	Joint—Oil Seal Housing ...	1
JJ32	Stud—Oil Seal Housing, $\frac{1}{8}$ " B.S.F. \times $1\frac{1}{4}$ " long	4
JJ33	Nut, $\frac{1}{8}$ " B.S.F. ...	4
JJ34	Washer, $\frac{1}{8}$ " ...	4
JJ37	Dowel—Extension Shaft ...	1
PJ41	Joint Washer—Housing Plug, $\frac{1}{4}$ " ...	1
PJ42	Union—Housing (Power take-off half), $\frac{1}{8}$ " B.S.F. ...	1
JJ44	Joint Washer—Union, $\frac{3}{8}$ " ...	1
JJ45	Shaft—Power Take-off (1-61:1 Ratio) ...	1
JJ45a	Shaft—Power Take-off (1-86:1 Ratio) ...	1
JJ56	Circlip (1-86:1 Ratio) ...	1
PJ71	Plug—Housing (Engine half) ...	1
JJ72	Screw—Housing (Engine half) ...	1
JJ73	Seal—Housing Screw ...	1

[75]

K



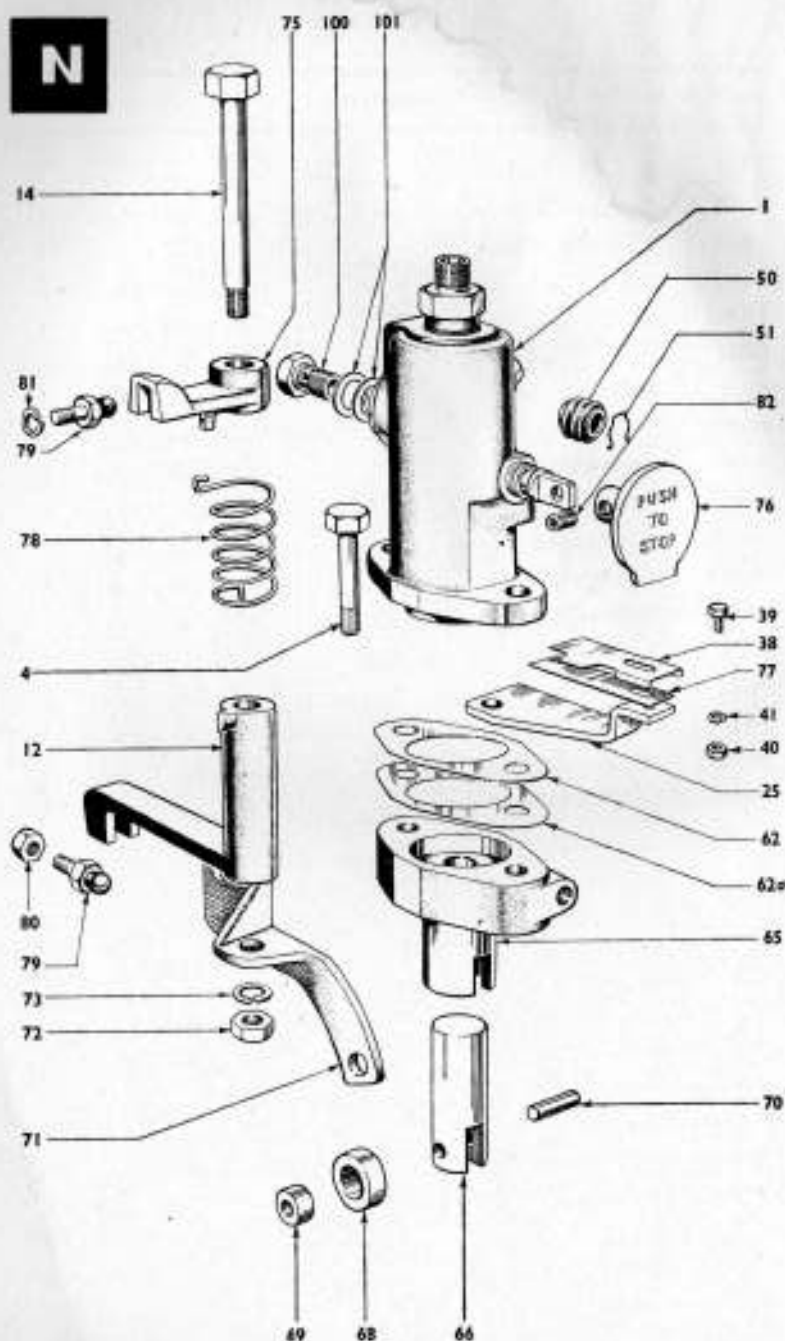
[76]

PLATE K

Ref. No.	Description	PAZI
PK39	Body—Oil Pump	1
PK40	Plunger—Oil Pump	1
PK44	Body—Relief Valve	1
PK45	Ball, $\frac{1}{8}$ "	2
PK45a	Ball, $\frac{1}{8}$ "	1
PK46	Spring—Relief Valve	1
PK47	Screw—Plunger	1
PK53	Joint—Pump Body	1
PK65	Flange—Oil Pump	1
PK66	Setscrew—Oil Pump Flange, $\frac{3}{8}$ " B.S.F. \times $\frac{1}{2}$ " long	2
PK68	Push Rod—Oil Pump	1
PK69	Cap—Push Rod	1
PK70	Spring—Delivery Valve	1
PK71	Spring—Return	1
PK72	Pin—Ball Retaining	1
PK78	Strainer—Oil Pump	1
PK239	Adaptor—Oil Pump Strainer	1
PK240	Joint Washer—Adaptor, 1"	1

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N

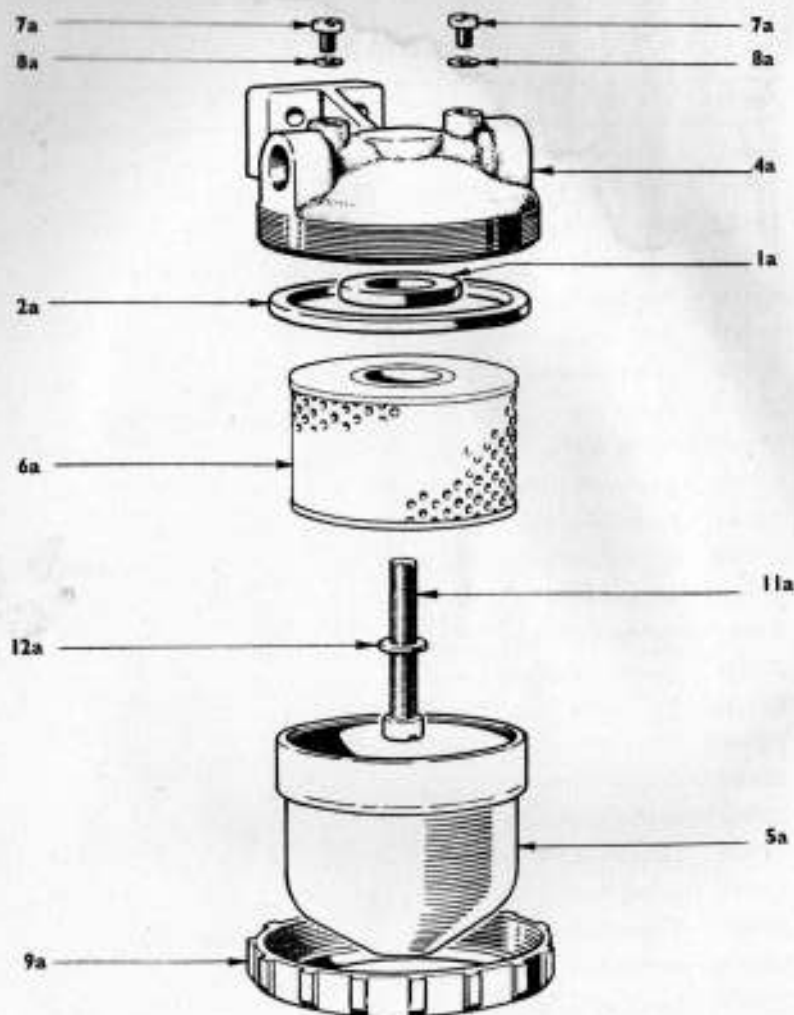


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PLATE N

Ref. No.	Description	PAZI
ZPN1	Pump—Fuel Injection	1
ZPN4	Bolt—Fuel Pump, $\frac{3}{8}$ " B.S.F. \times $1\frac{1}{2}$ " long	2
ZPN12	Lever—Fulcrum	1
ZPN14	Pin—Pivot	1
ZPN25	Bracket—Stop Control	1
ZPN38	Adjuster—Overload	1
ZPN39	Screw—Overload Adjuster, 4 B.A. \times $\frac{3}{8}$ " long	1
ZPN40	Nut, 4 B.A.	1
ZPN41	Spring Washer, 4 B.A.	1
ZPN50	Circlip—Fuel Pump Rack Cover	2
ZPN51	Cover—Fuel Pump Rack	2
ZPN62	Shim—Fuel Pump (0.002" thick)	As reqd.
ZPN62a	Shim—Fuel Pump (0.005" thick)	As reqd.
ZPN65	Guide—Fuel Pump Tappet	1
ZPN66	Tappet—Fuel Pump	1
ZPN68	Roller—Fuel Pump Tappet (Outer)	1
ZPN69	Roller—Fuel Pump Tappet (Inner)	1
ZPN70	Spindle—Roller	1
ZPN71	Bracket—Pivot Pin	1
ZPN72	Nut—Pivot Pin, $\frac{1}{2}$ " B.S.F.	1
ZPN73	Spring Washer, $\frac{1}{2}$ "	1
ZPN75	Lever—Fuel Pump Rack	1
ZPN76	Stop Button	1
ZPN77	Spring—Stop Button	1
ZPN78	Spring—Fuel Pump Rack Lever	1
ZPN79	Pin—Fuel Pump Rack	2
ZPN80	Locknut—Rack Pin, 2 B.A.	2
ZPN81	Spring Washer, 2 B.A.	2
ZPN82	Grub Screw—Stop Button	1
ZPN100	Banjo Bolt—Fuel Pump Inlet	1
ZPN101	Joint Washer	2

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FUEL FILTER JE64

Ref. No.	Description	PAZI
JE64/1a	Joint Washer—Element	1
JE64/2a	Joint—Body	1
JE64/4a	Head	1
JE64/5a	Body	1
JE64/6a	Element	1
JE64/7a	Screw—Bleed	2
JE64/8a	Washer—Bleed Screw	2
JE64/9a	Nut—Clamp	1
JE64/11a	Bolt	1
JE64/12a	Washer	1

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PAZI RUNNING MAINTENANCE CHART



Check the lubricating oil level on the dipstick and top up if necessary.



Check that there is no obstruction of the cooling air supply; no dust, etc., allowed to collect on cylinder head and cylinder or round the fan inlet.



Clean the fuel oil filter.



Check if the cylinder head joints are leaking; tighten the nuts if necessary. Check all nuts, bolts and keys.



Make sure that the vent hole in the fuel tank filler cap is clear.



Clean out the air cleaner. (In very dusty conditions this must be done more frequently.)



Thoroughly clean out the fuel tank.



Wash out the lubricating oil pipes.



Replace large end bearings if clearance is excessive.



Remove cylinder head, decarbonize piston top and insides of inlet and exhaust ports.



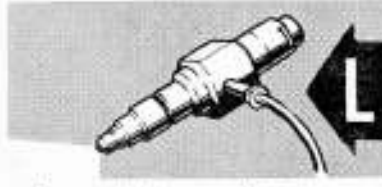
Examine and grind in, if necessary, the inlet and exhaust valves.



Examine cylinder bore. Carefully clean out oil return holes in piston.



Replace the fuel filter element



Remove injectors and test spray. If in order replace without interference.



Test fuel system for leaks.

daily

This chart has been

designed to help you

its correct application

will ensure maximum

service from your

Petter engine

1000hrs

180hrs

Keep cooling air intake free

from dust,

and obstruction.

Use only the lubricants

recommended

in the handbook.

250hrs

500hrs

f

running maintenance

22. Daily.

- Check the Lubricating Oil level on the Dipstick and top up if necessary.
- Check that the cooling air flow is unobstructed, do not allow dust, etc., to collect on the Cylinder Head or round the Fan Inlet.

23. Every 180 hours.

- Clean the Fuel Oil Filter.
- Clean the Air Cleaner (in very dusty condition this must be done more frequently).
- Ensure that Cylinder Head Joints are not leaking. Tighten nuts if necessary. Check all nuts, bolts and keys for tightness.
- Make sure that Vent Hole in Fuel Tank Filler Cap is clear.
- Clean out deposit from Exhaust Silencer.

24. Every 250 hours.

- Drain the Sump, flush out with flushing oil and refill with new oil. Clean the Oil Strainer. (If flushing oil cannot be obtained, paraffin may be used.)
- Test the fuel system for leaks.
- Remove the Injectors and test spray. If in order replace without interference.
- Check Rocker Clearance and adjust if necessary.

25. Every 500 hours.

- Replace Fuel Filter Element.

26. Every 1,000 hours.

- Remove Cylinder Head, decarbonize Piston top and insides of Inlet and Exhaust Ports.
- Examine and grind in, if necessary, the Inlet and Exhaust Valves.
- Withdraw the Pistons and carefully clean out the oil return holes. Examine Cylinder bore.

27. Every 2,000 hours.

- Examine Large End Bearings and replace if clearance is excessive.
- Wash out Lubricating Oil Pipes.
- Thoroughly clean out the Fuel Tank.