BOOK 1028/171 PRICE 50 np

INSTRUCTION BOOK

Lister

LR AND SR

1-2-3 CYLINDER

AIR COOLED DIESEL ENGINES

R. A. LISTER & CO. LTD.,
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Hawker Siddeley

SPECIFY ONLY GENUINE LISTER SPARE PARTS—SEE PAGE 46

Engine No.

MAINTENANCE

Date	Hours Run	Item	Work Carried Out

INDEX

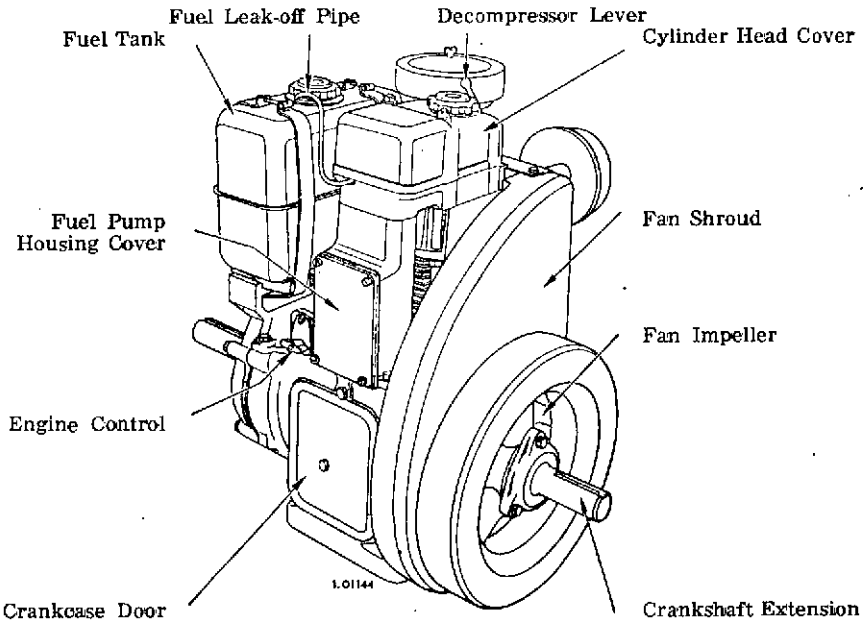


Fig. 1—Type SR1 Engine—Camshaft Side

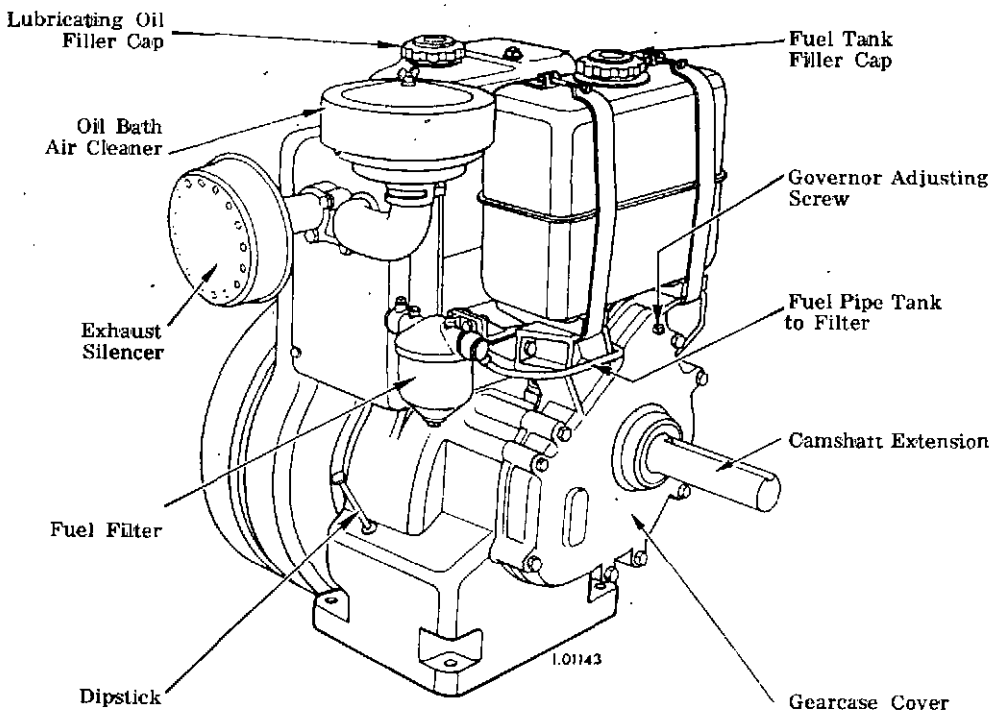


Fig. 2—Type SR- Engine—Manifold Side

TECHNICAL DATA

	LR1	LR2	SR1	SR2	SR3
MAXIMUM GROSS BHP ...	6.95	13.9	9.4	18.8	28.2
RATED BHP (BS 649: 1958) continuous 2500 rpm	5.25	10.5	7.75	15.5	23.25
2200 rpm	4.8	9.6	—	—	—
2000 rpm	4.5	9	6.5	13	19.5
1800 rpm	4	8	6	12	**18**
1500 rpm	3.3	6.6	5	10	**15**
1200 rpm	2.6	5.2	4	8	12
1000 rpm	2.1	4.2	3	6	9
750 rpm	1.5	3	—	—	—
NUMBER OF CYLINDERS	1	2	1	2	3
B.M.E.P. (1800 rpm) lbs/in.²	—	—	78.4	78.4	78.4
kg./cm.²	—	—	5.5	5.5	5.5
(2000 rpm) lbs/in.²	72	72	—	—	—
kg./cm.²	5.06	5.06	—	—	—
BORE x STROKE ins. ...	3 x 3½	3 x 3½	3½ x 3½	3½ x 3½	3½ x 3½
mm. ...	76.2 x 88.9	76.2 x 88.9	88.9 x 88.9	88.9 x 88.9	88.9 x 88.9
CYLINDER CAPACITY c.ins	24.7	49.5	33.7	67.3	101.0
c.cm.	405	811	552	1103	1655
FUEL CONSUMPTION at full load 2500 rpm	0.51	0.51	0.46	0.46	0.45
lb/bhp/hr 2200 rpm	0.5	0.5	—	—	—
subject to 5% 2000 rpm	0.49	4.49	0.45	0.45	0.44
BS tolerance 1800 rpm	0.49	4.49	0.44	0.44	0.43
1500 rpm	0.485	0.485	0.43	0.43	0.42
1200 rpm	0.5	0.5	0.435	0.435	0.425
1000 rpm	0.51	0.51	0.44	0.44	0.43
750 rpm	0.53	0.53	—	—	—
LUBRICATING OIL CONSUMPTION	Less than ¾% of full load consumption				
LUBRICATING OIL SUMP Pts.	3½	9½	3½	9½	13½†
CAPACITY (engine level) Litres	2.0	5.4	2.0	5.4	7.7
EXHAUST CONNECTION BSP ins.	1	1¼	*1¼	1¼	1½
WEIGHT Approx. Nett lbs.	222	405	250	415	475
kg.	101	184	114	189	216
STANDARD ROTATION IS CLOCKWISE LOOKING AT FLYWHEEL END On multi-cylinder engines No. 1 cylinder is at end opposite flywheel					

*With reducing socket.

†When Purolator Oil Filter is fitted capacity is 16 pts. (9 litres).

Engine Rating

The engine is rated in accordance with BS649:1958, i.e. the engine will develop its rated HP continuously including 10% overload for a period not exceeding one hour in any period of twelve hours consecutive running.

INSTALLATION OF AIR COOLED INDUSTRIAL ENGINES

The engine must be installed where a generous supply of fresh air is assured.

A portable electric light is recommended in addition to the fixed lighting.

Keep the exhaust pipe as short and straight as possible

Exhaust Pipe Diameter	LR1—2 SR1—2	SR3
Up to 20 ft.	*1¼"	1½*
Over 20 ft.	1½"	2"

The engine must be installed in a level position.

*With a 1¼"—1" reducing socket on SR1 only.

Hand Starting

Normally the engine will be hand started from the camshaft, but in cases where the final drive is from the camshaft, starting can be effected from the flywheel end through geared-up starting.

Belt Drive

Driving belts must be run as close to the engine as possible to avoid undue strain on the bearings. Where "fast" and "loose" pulleys are used the fast pulley must be driven from the side nearest the engine.

Distortion

Customers installing engines in their own equipment must ensure that **no strain is imposed on the engine feet** either by distortion during installation (feet not correctly shimmed) or by deflection of the structure during operation.

Shaft Extension at Flywheel End

This must be fitted with the keyway on top when No. 1 on T.D.C. Firing Stroke. No. 1 is the cylinder at the gearcase end.

Cooling

The engine is cooled by air. A fan impeller is secured to the flywheel. Air is drawn into the impeller and discharged through trunking and shrouding to the fins of the cylinder and cylinder head.

Arrangements must be made to ensure the cooling air it not re-circulated or restricted (see page 6-11).

Temperatures

From the aspect of engine performance, the temperature of the air entering the engine is the only criterion of ambient temperature. The power developed by the engine depends on the temperature of the combustion air, measured at the air manifold inlet (or the air cleaner), and the temperature of the cooling air is measured at the fan inlet. The higher of these two temperatures is taken as being the "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures (as defined above) up to 29.4C° (85°F) without derating. Above this temperature the rated brake horsepower must be reduced by 1% for every 2.78°C (5°F). The maximum temperature is 52°C (125°F), and if it is desired to run at higher temperatures, R. A. Lister & Co. Ltd., or their Distributors must be consulted.

COOLING AIR CONSIDERATIONS

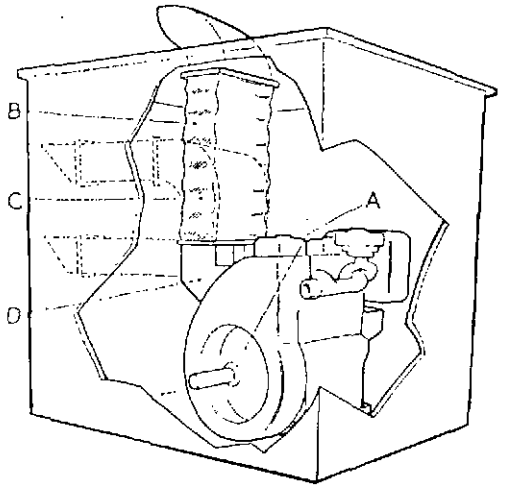


Fig. 3—Method of leading out the hot cooling air in small enclosed compartments.

A It is absolutely essential that the hot cooling air discharge does not find its way to the cooling inlet and become recirculated.

B Flexible trunking of canvas, rubberized canvas or heat resisting rubber.

C One of these alternative methods must be used if engine is flexibly mounted.

D Ducting as shown can be supplied if ordered. Ducting is fully detachable for servicing and priming fuel pump and the trunking must be attached so that it does not impair the quick removal of the ducting.

The extension of the ducting, the trunking and the cowl are to be supplied by the customer. For lengths of trunking up to 5ft. (1.5m.) the minimum inside area to be:—

30 sq.ins. (195cm²) for LR1 and SR1.
60 sq.ins. (390cm²) for LR2 and SR2.
90 sq.ins. (582cm²) for SR3.
For 5 to 10 ft (1.525 to 3.05 metres) multiply by 1.4.
For 10 to 25ft. (3.05 to 7.625 metres) multiply by 2.25.
For 25 to 50ft. (7.625 to 15.25 metres) multiply by 3.5.

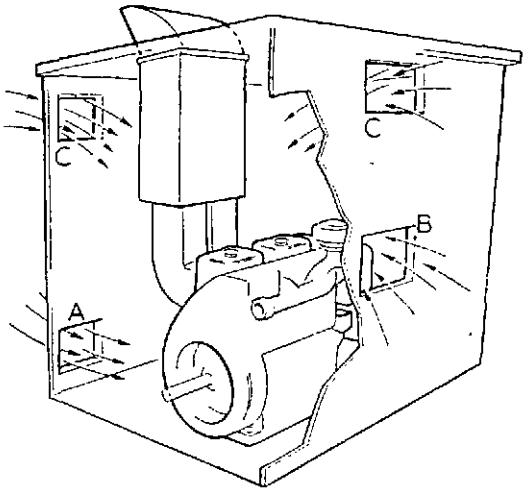


Fig. 4—Notes on Air Intakes

A One of the cooling air intake holes must be near the bottom of engine room to bring cool air in and also to strike the engine sump to assist cooling the lubricating oil.

B Another intake hole must be opposite the air filter to ensure a good supply of cool combustion air.

C One or two cooling air intake holes must be near the top of the engine room to prevent an accumulation of hot air above the engine. Generally it is not desirable to place an air intake hole opposite the engine cooling fan, because the rest of the engine room will not be ventilated (except where the ambient temperature exceeds 120°F (49°C) when it is essential for the engine to be as cool as possible under these conditions).

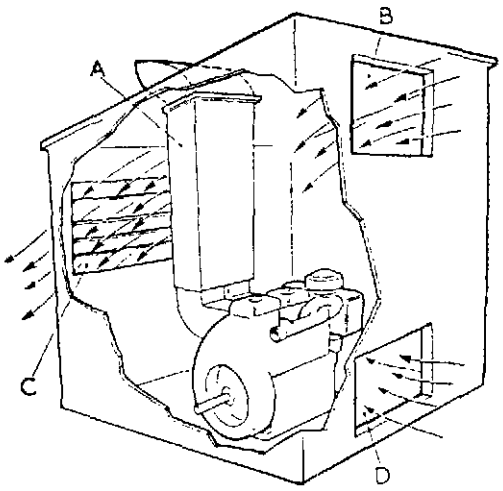


Fig. 5—Installation in moderate size engine house (10ft. x 6ft.)

A Engine ducting, trunking and cowl to be used in tropical climates, and also in other climates when a cool engine house is required.

B Window 2ft. x 2ft. (62 x 62 cm.) near the roof and opposite the main window. Capable of being fully opened.

C Large window opposite the engine air outlet, capable of being fully opened (or if louvred, slots to be 4″ (102 mm.) apart).

D Window 2ft. x 2ft. (62 x 62 cm.) near the floor and opposite main window, or in the wall nearest the engine fuel filter, capable of being fully opened.

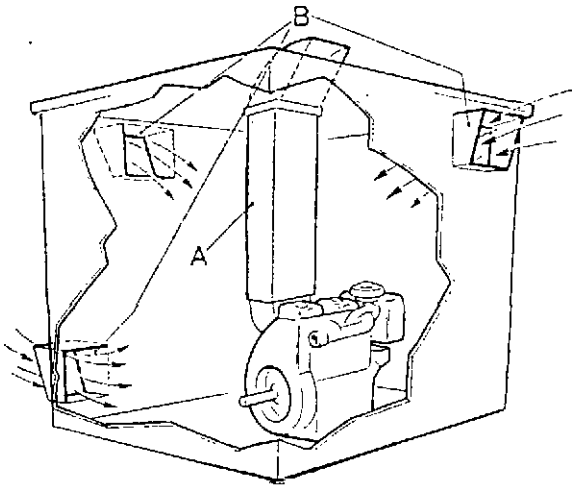


Fig. 6—Installation in confined space where air intake holes have to be as small as possible.

A Area of trunk and cowl to be as given in Fig 3.

B Air intake holes to be in positions shown and all the same size to ensure even air distribution.

Minimum area of intakes:—
LR1 and SR1 3 holes each 13 sq.ins. (84 sq.cm.).
LR2 and SR2 3 holes each 26 sq.ins. (168 sq.cm.).
SR3 3 holes each 40 sq.ins. (258 sq.cm.).

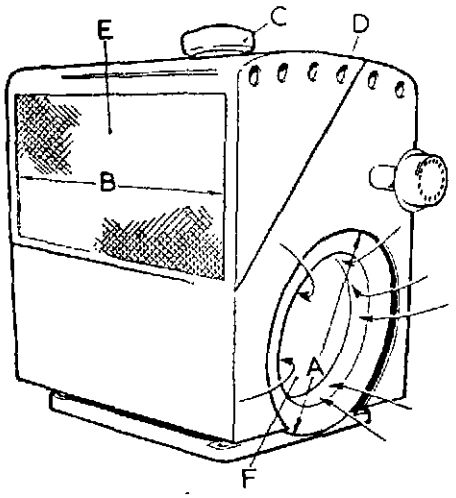


Fig. 7—Engine installed in a housing which itself is in the open but unobstructed air all round. (2 and 3 cylinder engines only).

A 15″ (381 mm.) minimum diameter hole opposite flywheel air intake

B 21″ (533.4 mm.) for two cylinder engine; 26″ (660.4 mm.) for three cylinder engine.

C Combustion air intake brought outside.

D At least 6 ventilating holes each end 1″ (25.4 mm.) dia.

E Open mesh grill opposite hot air side of engine. Free area through grill, 70 sq.ins. (450 sq.cm.) (minimum) for two cylinder engine; 105 sq.ins. (970 sq.cm.) (minimum) for three cylinder engine.

F Flywheel air intake to be against this end.

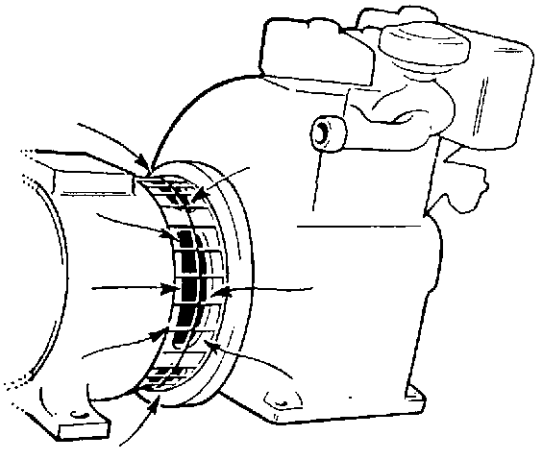


Fig. 8—Engine close coupled to a driven machine.

Air intake holes in adaptor. The absolute minimum area of the intakes must be:—

30 sq.ins. (195 sq.cm.) for LR1 and SR1.

60 sq.ins. (390 sq.cm.) for LR2 and SR2.

90 sq.ins. (582 sq.cm.) for SR3.

Larger areas are preferred. The coupling or clutch driving member at the flywheel end must not obstruct the air flow to the fan, and the areas above must be maintained at this point and through to the fan.

LUBRICATION

Specification

LR and SR engines must be run on Heavy Duty Diesel lubricating oils to specification—DEF2101C or BS1905 or MIL-L-2104A. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

MIL-L-2104B or Supplement 1 oils are recommended for engines running at a high load factor, particularly in conjunction with high ambient temperatures. They must also be used if the sulphur content of the oil exceeds 0.5%.

Series 3 oils must be used when oil changes are made at periods longer than 250 hours under the same conditions as above for MIL-L-2104B.

The oils should be suitable for oil changes every 250 hours without undue oxidisation, with sump temperatures reaching 125°C in tropical climates under extremely severe applications, and 120°C under normal applications.

Viscosity

	SR	LR
Below 0°C	SAE 10W	SAE 10W
Between 0°C and 30°C ...	SAE 20/20W	SAE 10W
Above 30°C	SAE 30	SAE 20/20W

Lubricating Oil System

Oil is supplied under pressure from a plunger pump to all crankshaft bearings and to the valve rockers.

The oil is drawn through a wire gauze strainer and ball suction valve. The suction valve assembly is screwed into the base of the crankcase. The delivery valve is carried in the bottom of a hollow plunger, the oil passing into the hollow tappet and out into the delivery manifold. From the manifold the oil is distributed through a passage in the crankcase to the bearing in the crankcase and by a pipe pressed into the bearing housing at the flywheel end and a single pipe which lubricates the valve rocker gear.

The relief valve is carried in the plug securing the oil pipes for the main bearings, and incorporates a reservoir which maintains oil pressure on the bearing during the suction stroke of the pump. The relief valve is set to open at 50 lbs./in.^{2} (3.5 kg/cm.^{2}) and is not adjustable.

On engines fitted with a lubricating oil pressure gauge a recorded pressure of 15/20 lbs./in.^{2} (1.05/1.4 kg./cm.^{2}) is adequate.

The crankcase may be drained by removing the drain plug at the back of the engine.

Before Starting or After Overhaul

Fill the engine crankcase through the oil filler to the mark "max." on the dipstick. Top up when the engine has been stopped after the initial run. See page 14.

It is recommended that the fuel system be thoroughly flushed with fuel oil and the pump control rods checked for free movement.

Lubricating Oil Sump Capacity

Engine	Dipstick Position	Dipstick Identification No.	Max. angle of inclination at which the engine may be run Flywheel Down	Flywheel Up	Approx. Oil capacity with engine level
LR1-SR1	Crankcase—hand start	1	10°	10°	3½ pints (2 litres)
	Crankcase—elec. start	9	15°	15°	3½ pints (2 litres)
	Crankcase Door	17	10°	10°	3½ pints (2 litres)
LR2-SR2	Crankcase	16	15°	15°	9½ pints (5.4 litres)
	Crankcase Door	19	15°	15°	*9½ pints 5.4 litres)
	Crankcase Door	18	15°	13°	**11½ pints (7.2 litres)
SR3	Crankcase	4	10°	10°	13½ pints (7.7 litres)
	Crankcase Door	8	15°	15°	**12 pints (7.5 litres)
	Crankcase Door	19	15°	10°	*16 pints (9 litres)

*Door with lift pump, oil filter and filler.

**Door with dipstick only.

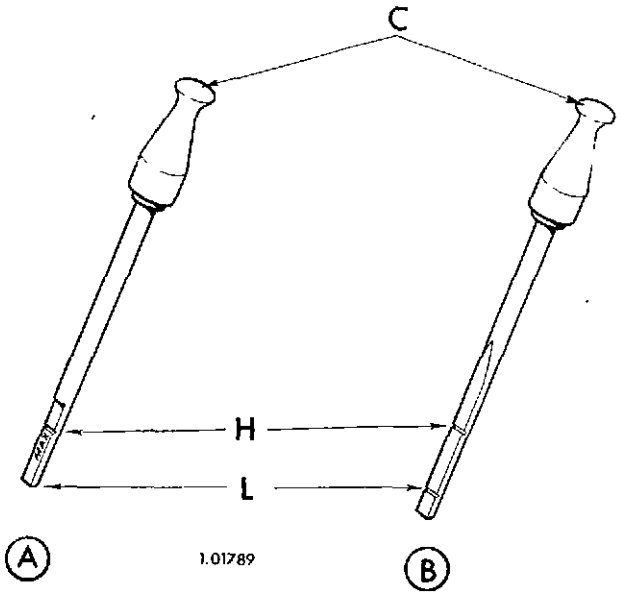
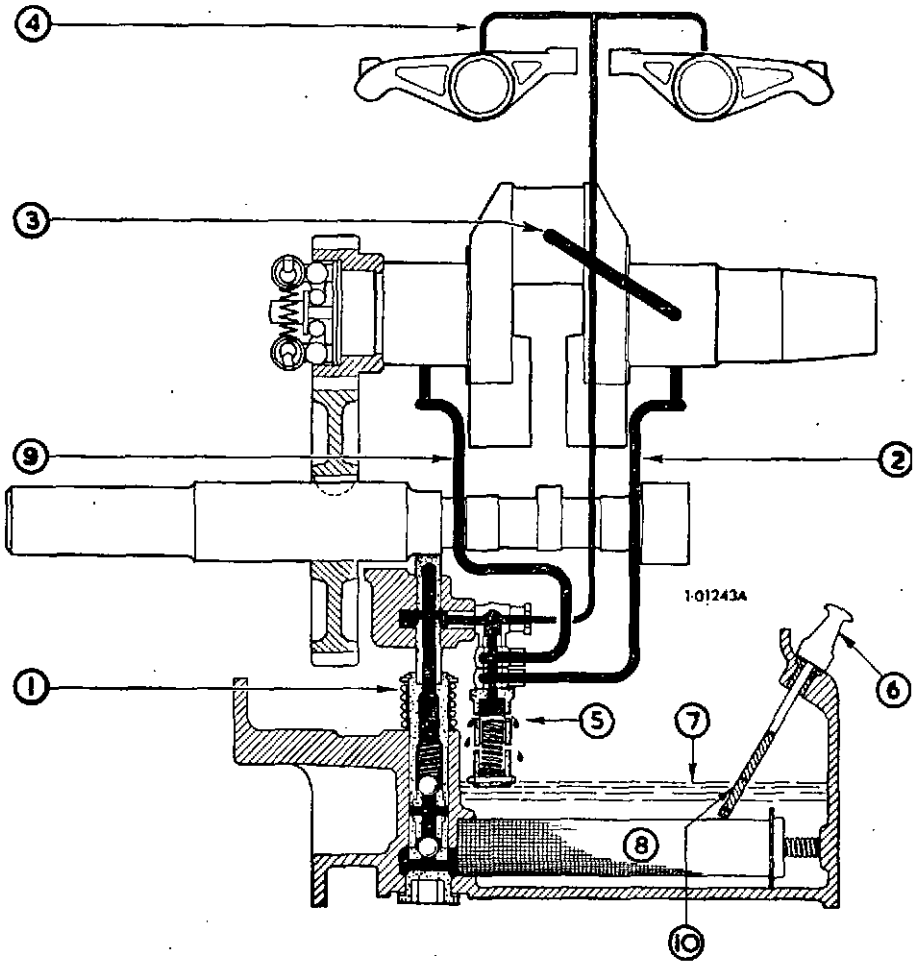


Fig. 9—Dipsticks

A—Earlier type dipstick
B—Latest type dipstick
C—Identification mark stamped here
H—High oil level
L—Low oil level

Oil Level

The correct oil level in the sump is determined by a dipstick mounted on the crankcase or the crankcase door. The illustration shows the correct oil level marks on the dipstick. These levels must not be exceeded.



1. Lubricating oil pump
2. Oil pipe to main bearings
3. Oil passage to big end bearing
4. Oil pipe to valve rockers
5. Lubricating oil relief valve
6. Lubricating oil dipstick
7. Lubricating oil level
8. Lubricating oil suction strainer
9. Oil passage to crankcase main bearing
10. Oil level—see page 14—Dipsticks

Fig. 10—Schematic diagram of Lubricating Oil System

FUEL SUPPLY

It has not been found practicable to recommend any particular fuel for universale use, but the fuel must be a distilate, and not a residual oil or a blend thereof. It should have a Specification conforming to British Standard No. 2869:1957, Class A1 or A2.

Specification Limits

ITEM	CLASS A1	CLASS A2
Viscosity, Kinematic at 37.8°C		
centistokes, Min.	1.6	1.6
centistokes, Max.	6.0	6.0
Cetane number, min.	50	45
Carbon residue, Conradson on 10% residue, % by weight, max	0.2	0.2
Distillation, recovery at 357°C % by volume, min.	90	90
Flash point, closed, Pensky-Martens, min. ...	55°C	55°C
Water content, % by volume, max.	0.05	0.05
Sediment % by weight, max.	0.01	0.01
Ash % by weight, max.	0.01	0.01
Sulphur Content, % by weight, max. ...	0.5	1.0
Copper corrosion test, max.	1	1

In some cases Summer grade oil is unsuitable for use in Winter because it becomes cloudy and rapidly clogs the fuel filters on the engine.

In general the fuel must be free from foreign matter and water otherwise excessive wear may take place, particularly in the fuel injection system. Certain fuels are unsuitable owing to the excessive temperatures, pressures, deposits and corrosion resulting from their use.

The user is cautioned that although the engine may run satisfactorily for a short time on cheap fuel excessive wear and damage will ultimately be suffered by the engine and its life materially shortened. For these reasons we can accept no responsibility for such damage or wear caused by the use of unsuitable or dirty fuels.

When in doubt as to the suitability of a fuel oil, the local dealer should be consulted.

Clean fuel is of the utmost importance in ensuring reliable performance.

Vaporising oils are unsuitable as fuel for Lister diesel engines.

Fuel Tank

Always fill the fuel tank through a fine strainer, preferably at the end of a run. If any sediment is stirred up during the process this has time to settle before the engine is used again. If cans are used avoid tipping out the last few drops.

Funnels are very difficult to keep clean in dusty conditions. Wash them before and after use and wrap them up when not required, or fill service tank direct from a small mouthed screw capped can such as a 2 gallon petrol can.

STARTING AND STOPPING

To Start Engine

(a) Check fuel and lubricating oil levels.

(b) If an oil bath air cleaner is fitted, fill the oil container with engine oil to the level marked on the air cleaner.

(c) Ensure the fuel and lubricating oil systems are primed (See pages 12 and 24).

(d) If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming level on the lift pump.

(e) Move the decompressor lever(s) over towards the flywheel.

(f) Pull the control lever outwards and allow it to rotate anticlockwise so that it abuts against the top stop and is in a vertical position. See illustration below.

Note: On engines fitted with speed control the control lever should be set at "Fast". See pages 40 and 42.

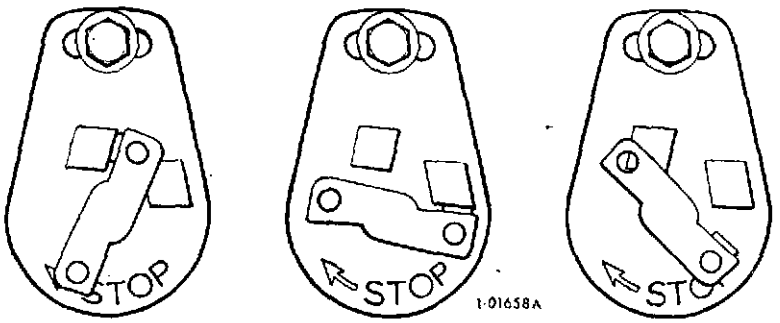
(g) Lightly oil the end of the camshaft extension and fit the starting handle. It is recommended that this shaft always be used for starting the engine.

(h) **Important.**—Turn the engine slowly from 3 to 20 turns on the camshaft according to the temperature and period of standing unused, in order to prime the combustion chamber(s) and the lubricating oil system.

(j) Turn the handle smartly in a clockwise direction and whilst still turning, move the decompressor lever(s) toward the fuel tank. Slip off the starting handle when the engine fires.

(k) As soon as the engine reaches normal speed, **turn the control lever clockwise to the horizontal position so that it abuts against the horizontal stop**—THIS IS MOST IMPORTANT.

or (l) When speed control is fitted reduce speed as required.



START RUN STOP

Fig 11—Engine Control

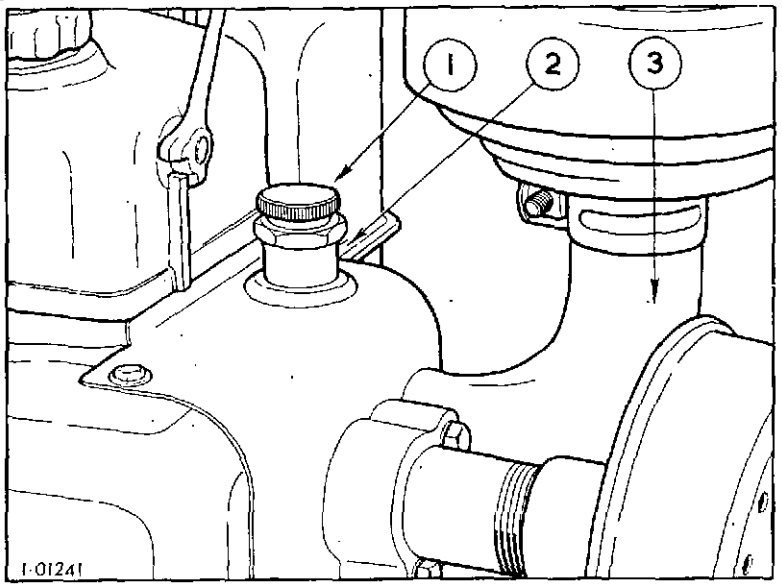
Starting Under Cold Conditions—Standard on LR engines; Optional extra on SR engines

An oil cup, mounted on the inlet valve port, is provided to assist starting under frosty conditions and should be used as follows:—

For starting under normal frosty conditions the cup should be half filled with SAE10W lubricating oil, the plunger pressed to the bottom of its stroke and the engine turned at least 5 complete revolutions with the exhaust valve decompressed. The engine should then be started in the usual way.

For starting under extremely frosty conditions the cup should be completely filled with a mixture of 50% fuel oil and 50% SAE10W lubricating oil and the procedure then followed for normal frosty conditions.

The fuel and lubricating oil must be suitable for the temperature at which the engine has to be started—they must have a pour point lower than this temperature. For temperatures below 0°F it is permissible to dilute the SAE10W lubricating oil with up to 25% fuel oil, and to run and top up the sump with this mixture, or use SAE5W lubricating oil.



1.—Plunger 2.—Oil Cup 3.—Air Inlet

Fig. 12—Cold Starting Oil Injector Device—standard on LR engines; optional extra on SR engines

To Stop Engine

Turn the control level clockwise and fix it in the clip. When remote control is fitted, move lever to the "Stop" position.

Remote Stopping Control

Remote control of the stopping lever is available if required, consisting of a hand lever and Bowden cable. The control can be mounted on a panel together with variable speed lever, ammeter, electric starter push button and voltage control unit, should variable speed gear and/or electric starting be fitted. For cold starting the engine control (Fig. 11) must be set by hand to the start position.

Variable Speed Control

On all engines in place of the standard fixed speed control, a variable speed control can be fitted with a range of 750 to maximum rpm. This arrangement is illustrated on page 40.

Electric Starting

Electric starting is available and can be operated by either direct or remote control; diagrams of the electric circuit for both these methods of control are shown on page 55.

Speed Adjustment

A slight adjustment of speed may be made by turning the screwed rod which projects through the gearcase. Turn anti-clockwise to increase speed, clockwise to decrease. Secure the locknut.

Do not increase speed more than 2½% without consulting R. A. Lister & Co. Ltd.

ROUTINE MAINTENANCE

When the engine is in daily use:—

Daily:

Check supply of fuel oil.
Check the level and condition of lubricating oil (also in gearbox if fitted)
Clean the air cleaner under very dusty conditions.
Drain the moisture trap in the exhaust pipe if fitted.

Every 100 Hours:

Clean the air cleaner under moderately dusty conditions. Renew the element if necessary.
Check for oil and fuel leaks—tighten nuts and fittings if necessary.
Wipe the engine and baseplate clean.
Clean the cylinder, cylinder head and injector finning under very dusty conditions.

Every 250 Hours:

Drain the lubricating oil and refill with the correct grade and type.
Renew the lubricating oil filter element (if fitted).
Clean the fuel injector nozzle if the exhaust is dirty.

Every 500 Hours:

Decarbonise if the engine shows loss of compression, or blow-by past the piston. Do not disturb otherwise.
Adjust valve clearances.
Wash the engine down with paraffin or fuel oil.
Clean the cylinder, cylinder head and injector finning under dusty conditions.

Every 1500 Hours:

Decarbonise.
Clean the inlet manifold and exhaust system.
Examine the fan blades and clean.
Check for free working of the governor linkage.
Drain and clean the fuel tank.
Renew the fuel filter element.
Clean the fuel injector nozzle and adjust the pressure settings.
Check the fuel pump timing and balancing.
Clean the cylinder, cylinder head and injector finning under normal conditions.
Check the lubricating oil pump valve assemblies.

Every 5000 Hours:

Check the big ends and main bearings.

A reasonable amount of time spent in checking over the details as described in the foregoing is the user's best insurance against loss of valuable time and costly repairs.

JOINTING COMPOUNDS

The following is a list of suitable jointing compounds and where they they should be used.

Joint Description	Jointing compound to be used	Instruction for applying compound
Valve gear cover	Hylomar SQ32M	Coat valve gear cover jointing face and stick joint to it.
Fuel pump housing door and cast crankcase door	Hylomar SQ32M	Coat door jointing face and stick joint to it.
Fuel pump housing to crankcase. Flat joint	Hylomar SQ32M	Coat housing on jointing face, stick joint to it and coat joint.
Fuel pump housing rubber joint ring	Bostik 772	Coat Housing groove and stick joint to it.
Crankcase door (Pressed steel)	Bostik 772	Coat door groove and stick joint to it.
Gear case cover	Wellseal	Coat gear case on joint face, stick joint to it and coat joint.
Crankshaft bearing housing shims	Wellseal	Coat all joint surfaces on one side—tighten bolts and re-tighten after about 10 mins.
Bottom of cylinders	Hylomar SQ32M	Coat cylinder on jointing face, stick joint to it and coat joint.
Camshaft cover in crankcase	Hylomar SQ32M	Apply a little compound to ring recess in cover.
Oil seals	Hylomar SQ32M	Apply a little compound to outside diameter of seal.
Oil pump suction plug	Hylomar SQ32M	Coat plug threads and both sides of joint.
Leak off connection at leak off manifold	Hylomar SQ32M	Coat threads lightly before screwing connection.
Fuel pump housing to crankcase. Rubber cord joint	Hylomar SQ32M	Coat groove in fuel pump housing and stick cord to it.
Cylinder head nuts and washers, and top thread of cylinder studs	Wellseal	Dip nuts and washers, and coat stud threads and area of cylinder head or rocker bracket in contact with washers.

MAINTENANCE

Note: Every effort must be made to maintain the engine in a clean condition and oil leaks must be dealt with as soon as they occur. With a new or overhauled engine the joints settle during the first few hours running and their tightness must subsequently be checked. This includes the following:

Gear train end cover joint.
Cylinder head cover joint
Lubricating oil pipe joints
Injector pipe nuts
Fuel pump element locating screw.
All unions in the fuel system.
Fuel pump housing cover joints

A table showing recommended jointing compounds and how to use them is given on page 21. For assembly use SAE10W heavy duty detergent lubricating oil with 5% concentrated colloidal graphite added. All bearing surfaces must be well lubricated including the cups of the push rods and the valve stems.

Where torque spanners are available the following tightening torques must be maintained:

Size	Torque lb.ft.	Kg.m	Component
$\frac{1}{4}$" UNF	10	1.38	
$\frac{5}{16}$" UNF	15	2.07	Injector clamp nuts. Big end nuts.
$\frac{3}{8}$" UNF	32	4.4	Balance weight setscrews.
$\frac{7}{16}$" UNF	50	6.9	Cylinder head holding down nuts.
$\frac{1}{2}$" UNF	68	9.4	
$\frac{3}{4}$" UNF	200	27.6	Flywheel crankshaft setscrew.
	65	9.0	Injector cap nut and locknut.

Note: The above torque settings must not be applied to unsupported components such as centre bolts in crankcase doors, or, in the case of studs or screws in aluminium parts, unless a thread insert is fitted which has a length of thread engagement of $1\frac{1}{2}$ times the thread diameter.

Oil Bath Air Cleaner

It is recommended that the element be cleaned at least every 1000 hours, even when operating in substantially dust-free conditions; under less favourable conditions more frequent cleaning will be necessary—even daily.

After dismantling the filter the element should be thoroughly washed in paraffin or fuel oil and the filter bowl cleaned out. On re-assembly, the filter must be filled with oil up to the mark using the same grade of oil as for the engine.

Paper Type Air Cleaners

The element in this type of cleaner should not be cleaned but should be renewed.

Breather

A crankcase breather, in the form of a copper pipe, is screwed into the top of each cylinder head and connects with the inlet port. Vapour is drawn into the inlet manifold and a partial vacuum thus maintained in the crankcase which prevents oil leakage through joints and bearings.

Fuel Filter

The fuel filter is an essential part of a diesel engine. It must not be removed from the engine or used without a filter element.

Clean or renew the filter element every 1,500 hours—more frequently if the fuel is known to be dirty for any reason. The element may be washed in

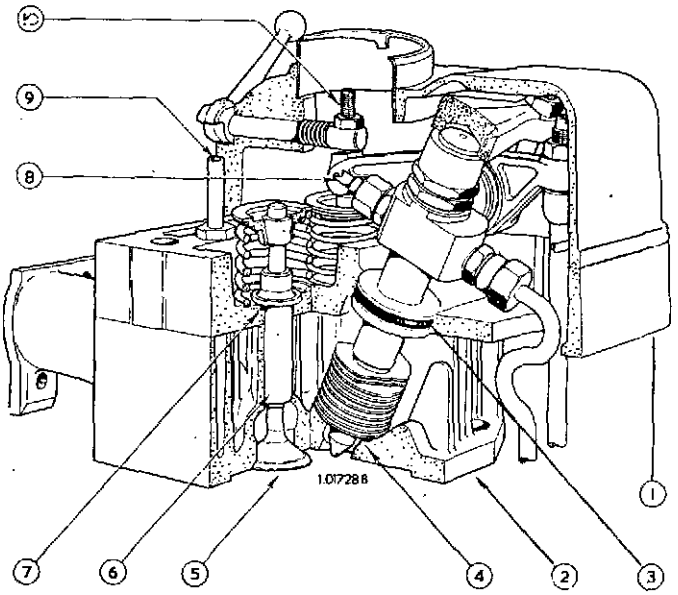


Fig. 13.—Cylinder Head—SR

1. Cylinder head—top plate.
2. Cylinder head.
3. Injector sleeve oil seal ring.
4. Washer for injector sleeve.
5. Inlet Valve.
6. Inlet valve guide.
7. Valve guide oil seal ring.
8. Fuel leak-off pipe.
9. Breather.
10. Decompressor screw.

clean paraffin or fuel oil, taking care not to allow dirt to reach the inside of the element or delivery pipes. Clean the inside of the filter bowl.

After carefully re-assembling the filter, the fuel should be turned on and all air bled from the system by slackening the two bleed screws on top of the filter body, and the single bleed screw in the outlet banjo. After all air has been displaced, tighten the vent screws securely.

To Remove Cylinder Head

Remove:—

(a) Cylinder head cover.
(b) Fuel pump housing door.
(c) Lubricating oil pipe to valve rockers.
(d) Fuel leak-off pipe.
(e) Fuel pipe—fuel pump to injector.
(f) Fuel injector.
(g) Inlet and exhaust manifold.
(h) Oil starting reservoir (if fitted).
(j) Air shroud at back of cylinder.
(k) Four holding down nuts and washers and lift off head.

Valve Guides

The cylinder head is in two parts (an upper and lower). The valve guides are a press fit in the lower half only and hold the two parts together. The inlet valve guide is jointed on a rubber ring under the collar at the top. The two parts should not be separated unless it is necessary to replace components.

The exhaust valve guide is recessed at the lower end. Inlet and exhaust valve guides must therefore not be intermixed.

To Replace Cylinder Head

Examine cylinder head gasket—renew if damaged. The thin shims should be fitted nearest to the cylinder head and the thick gasket nearest to the cylinder. Care must be taken to ensure that the shims are not trapped by the spigot. They may be stuck to the cylinder head with clean grease.

Replace cylinder head and pull down the four nuts evenly. Tighten to a torque of 50 lb.ft. (6.9 kg.m.).

It is essential that these nuts be tightened before securing the injector.

Note:— The inlet and exhaust flanges of all cylinder heads on multi-cylinder engines must be lined up with a straight edge, or alternatively fit a manifold, before finally tightening down to avoid distortion when fitting the manifolds.

To Check Cylinder Head Clearance

Place two pieces of lead wire 0.048″ x $\frac{1}{8}$″ (1.042 x 3.175 mm.) on top of the piston clear of valve recesses and the combustion chamber in the top of the piston. Space widely apart and immediately over the gudgeon pin.

Tighten down the cylinder head and turn the piston past T.D.C.

Remove the cylinder head and measure the thickness of lead. This should be between 0.035″ (0.89 mm.) and 0.038″ (0.97 mm.) for SR engines and 0.025″ (0.63 mm.) to 0.028″ (0.71 mm.) for LR engines, this may be adjusted

by shims 0.003″ (0.075 mm.) thick, placed between the cylinder head and the gasket. Only one joint must be used between the crankcase and the cylinder barrel.

To Remove Piston

(a) Remove cylinder head.
(b) Remove air guide plates at sides of cylinder.
(c) Remove crankcase door.
(d) Disconnect connecting rod big end bearing.
(e) Lift off cylinder complete with piston and connecting rod, after having marked the camshaft side of the barrel with chalk.

Withdraw piston from cylinder.

To remove the gudgeon pin remove one spring circlip, and the gudgeon pin may then be pushed out.

Piston rings may be removed by inserting thin metal strips between the ring and the piston and casing off the ring, but it is recommended that a ring expanding tool, as made for car engines, be used when available.

To Replace Piston Rings

Clean piston ring grooves, oil holes and rings carefully.

Roll each ring (except the top one which is taper sided) round its own groove.

When fitting new rings, measure the gap between the ends when the ring is inserted squarely in the bottom of the cylinder. The gap should be between 0.012″ and 0.016″ (0.305-0.406 mm.) for the top ring and between 0.008″ and 0.012″ (0.203-0.305 mm.) for the compression and scraper rings.

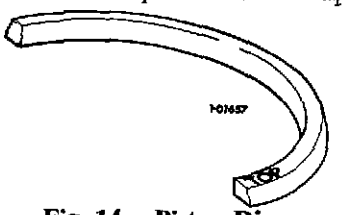


Fig. 14.—Piston Ring

The top ring is taper sided and chromium plated.

The second and third rings have tapered faces against the cylinder. These should be fitted with the larger diameter of the taper on the bottom. New rings are marked "Top" on the top side.

To Replace Piston and Connecting Rod

Always check the clearance between the piston skirt and the cylinder which must not be less than 0.005″ (0.127 mm.) measured with a feeler pushed between the two.

Oil the piston and connecting rod and assemble into the cylinder block. Place one copper joint at the base of the cylinder block.

Turn the cylinder block so that the flats on the fins are towards the flywheel and fuel tank ends respectively, and the side marked with chalk is towards the camshaft.

Turn the piston to that the wording 'CAMSHAFT SIDE' is towards the camshaft (fuel pump housing).

Turn the crankshaft to T.D.C., lower into position the cylinder complete with piston and connecting rod, and when the connecting rod bolts have passed over the crankpin, turn the crank towards the door whilst the piston is being pressed down.

Assemble the big end bearing according to the identification marks and secure with the self locking nuts. Correct tightening torque is 15 lb.ft. (2.07 kg.m.).

Connecting Rod Big End Bearings

Big end bearings are precision finished, and require no fitting; under no circumstances should they be scraped or touched up in any way.

If the big end has been dismantled because of failure of the metal, the oil passage in the crankshaft must also be examined for obstruction and fragments of metal. After cleaning out, it is advisable to crank the engine over by hand to see that oil reaches the bearing and to flush out the oil passage.

Main Bearing—see also pages 50-52

Engines are built with steel backed, split bush main bearings with separate thrust washers. When reassembling an engine, care must be taken that thrust washers are correctly positioned. The centre main bearing housing is located in the crankcase by means of a plain hollow dowel tapped at one end. Care should be taken to ensure that this is fitted with the tapped end outwards to assist removal. If new bearings are fitted, ensure that the oil holes are in line with the holes in the bearing housing, and that the bearing is pressed in so that the inner edge is $\frac{1}{16}$" from the inner face of the bearing housing.

Valve Adjustment

LR—valve clearances are:— up to 1200 r.p.m.—Inlet 0.002" (0.05mm.) GO—0.004" (0.10 mm.) NOT GO. Exhaust 0.006" (0.15 mm.) GO 0.008" (0.20 mm.) NOT GO—cold. Over 1200 r.p.m.—Inlet and Exhaust 0.002" (0.05 mm.) GO—0.004" (0.10 mm.) NOT GO.

SR—valve clearance, when aluminium push rods are fitted, must be set to 0.014" (0.35 mm.) GO, 0.016" (0.41 mm.) NOT GO on both inlet and exhaust valves. When steel push rods are fitted the clearance, both inlet and exhaust is 0.008" (0.20 mm.) GO, 0.010" (0.25 mm.) NOT GO. This can be done with the engine either hot or cold.

To adjust, remove the cylinder head cover and turn the piston to the T.D.C. position firing stroke (both valves closed). Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained. Tighten the locknut whilst restraining the adjusting screw, and re-check to ensure that the clearance is correct.

	S.R.	L.R.
Inlet Valve Opens	25° B.T.D.C.	10° B.T.D.C.
Closes	35° A.B.D.C	30° A.B.D.C.
Exhaust Valve Opens	40° B.B.D.C.	30° B.B.D.C.
Closes	20° A.T.D.C.	10° A.T.D.C.

On LR engines both valve heads should be between 0.015" to 0.020" (0.38—0.50 mm.) below the surface of the cylinder head.

On SR engines inlet valve head is between 0.035″—0.045″ (0.89—1.14 mm.) below the face of the cylinder head. Corresponding figures of exhaust valves are 0.015″—0.025″ (0.38—0.64 mm.).

The width of valve seats on both LR and SR engines must be 0.064″—0.083″ (1.63—2.1 mm.). The width can be obtained by increasing the depth of the recess in the head using tool No. 317-00086.

Decarbonising

Decarbonise after about 1500 hours.

(a) Remove cylinder head(s).
(b) Remove piston(s) and rings.

All parts must be thoroughly cleaned and washed in paraffin.

Special care must be taken with regard to:—

(a) Recess in exhaust valve guide(s).
(b) Valve ports.
(c) Piston rings and grooves.
(d) Combustion chamber(s) in top of the piston(s).
(e) Fins must be cleaned on cylinder(s), cylinder head(s) and injector sleeve(s). **This is very important.**
(f) The inside of the piston(s).
(g) Regrind valve seats if not in perfect condition.
(h) Clean out exhaust piping and silencer.

To Adjust Decompressor

For engines provided with an oil filler hole in each cylinder head cover, access to the decompressors is through these holes.

Turn the piston to T.D.C., firing stroke.

Move the decompressor lever over towards the flywheel.

Slacken the locknut and turn the decompressor screw down until the exhaust valve touches the piston.

Turn the screw back $\frac{1}{2}$ turn and tighten the locknut.

When no filler is provided in the cylinder head cover the decompressor should be adjusted to that when the cover is tightened down in position, the adjusting screw just touches the valve rocker when operated. The adjusting screw should then be screwed down $\frac{3}{4}$ turn and locked in position.

Flywheel

The flywheel is mounted on a taper. A withdrawing tool is required to remove it. Do not slacken the nut more than two turns before loosening the flywheel on the taper. On reassembling tighten the retaining setscrew to a final torque of 200 lb.ft. (27.6kg.m).

Cooling Air Fan

Engines with sheet metal fan shrouds. The fan shroud is secured by four set screws, which also retain the main bearing housing in position. To ensure correct crankshaft end float, metal shims are inserted between the main bearing housing and the crankcase. To ensure correct axial location of the cooling fan in the fan shroud, further shims may be inserted between the fan shroud

and the main bearing housing so that there is between 0.040" and 0.090" (1.0—2.25 mm.) clearance between the side of the flywheel and the fan shroud.

All engines with cast fan shrouds: During initial assembly, the fan shroud is secured in position by means of the four centre setscrews, and the resultant gaps then gauged between the four bosses at the back of the fan shroud and the corresponding bosses on the end of the crankcase. The centre setscrews are then slackened, and long shims of corresponding gauged thickness are inserted transversely across the top bosses and across the bottom bosses. **Great care must be taken when stripping the engine down to note the position of all shims and to replace them as originally fitted.** This is particularly important when close coupled driven units are involved as incorrect shimming will cause distortion of the fan shroud and eccentric support of the driven unit in relation to the engine flywheel.

To Remove Fuel Pump

(a) Drain fuel at fuel filter.
(b) Remove fuel pipe to injector.
(c) Disconnect fuel supply pipe.
(d) Release governor adjusting spring.
(e) Disconnect governor link.
(f) Remove fuel pump clamp setscrew and clamp. Lift out pump, taking care of adjusting shims below pump body.

Check the tightness of the element locating screw.

When refitting the fuel pump, use two spanners to tighten the fuel delivery connection to prevent the pump being twisted on its seating. The pump racks **must** move freely, otherwise erratic running or hunting will occur.

Camshaft

The camshaft is carried in porous bronze bushes. One bush is pressed into the end cover and the remainder into the crankcase. See pages 53-54.

The camshaft is extended beyond the cover and is the same diameter as the crankshaft extension providing a second position for power take off at half the engine speed.

To Remove Camshaft

(a) Remove fuel pump housing door.
(b) Disconnect governor adjusting spring.
(c) Disconnect fuel pipe(s)—filter to pump(s) and drain fuel.
(d) Remove fuel pump(s) and tappet(s).
(e) Remove set screws in gear end cover.
(f) Turn camshaft keyway to bottom.
(g) Remove crankcase door.
(h) Slacken the lubricating oil pump plug $\frac{1}{16}$", or remove, in order to compress lubricating oil pump return spring until pump tappet is below level of camshaft bearing.
(i) Remove gear end cover.
(j) Hold up tappets and slide out camshaft—collect tappets.

To Replace End Cover

(a) Clean joint faces, fit new joint with sealing compound both sides.
(b) Fit end cover. **NOTE: Care must be taken not to damage oil seal.**
(c) Hook speeder spring onto governor link.
(d) Fit seven setscrews and copper washers in end cover.
(e) Fit swivel union screw and joints to connect fuel pipe to filter.
(f) Fill tank with fuel.
(g) Bleed fuel system at all points.
(h) Replace fuel pump housing door.
(j) Start engine.
(k) Adjust speeder spring screw to required speed and tighten lock-nut.

To Time Camshaft

The camshaft is timed by matching the letters 'O' on the camshaft gear-wheel and the crankshaft pinion.

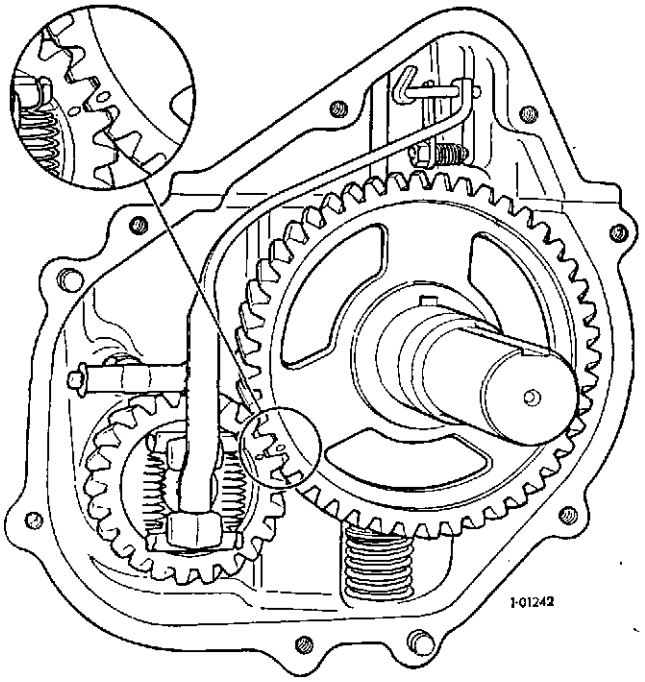


Fig. 15.—Camshaft Timing

Governor

The engine governor is carried within the crankshaft pinion at the gear-case end of the engine.

The governor lever operating the fuel pump(s) is carried on a fulcrum bearing secured to the crankcase above the pinion. This bearing, fitted so that the centre line of the bearing is approximately $\frac{3}{4}''$ from the facing on the

crankcase, is adjusted in accordance with the instructions given under "Setting Fuel Pump" (page 35), and secured with a lock nut.

The lever is curved to pass over the camshaft gearwheel and is joined to the fuel pump by a link arm.

CARE MUST BE TAKEN AT ALL TIMES TO PREVENT ANY FOREIGN MATTER ENTERING THE CRANKCASE.

Lubricating Oil Pump

The plunger type pump is cam operated from the camshaft and the suction valve, being below the level of the oil, should require little attention.

At times of major overhaul, however, the pump should be dismantled for inspection.

Check that the plugs retaining the suction and delivery ball valves are solidly locked in position.

Under no circumstances dismantle these valve assemblies.

When reassembling the pump ensure that the hollow end of the pump tappet is to the bottom.

To Remove Lubricating Oil Pump

(a) Compress pump return spring to relieve pressure on the circlip.

(b) Remove circlip.

(c) Release pump spring.

(d) Remove suction valve assembly from bottom of crankcase.

The pump plunger and tappet may now be pushed out.

Remove the spring and carrier ring from the crankcase.

The suction strainer is held in place by a spring end cap in front of the crankcase.

Main Bearing Housing

To remove:—

(a) Remove flywheel.

(b) Remove air and exhaust manifold(s).

(c) Remove air shroud at back of cylinder(s).

(d) Remove fan shroud.

(e) Remove crankcase door.

(f) Remove lubricating oil relief valve and oil pipe to main bearing in housing.

The housing may now be removed from the crankcase.

Before replacing, ensure that the main bearing bush is in its correct position — lubricating oil holes in line.

Crankshaft end play must be between 0.005″ and 0.009″ (0.12/0.21 mm.). This can be adjusted by **metal** shims of 0.005″/0.010″ (0.127—0.254 mm.) thickness between the housing and crankcase. No paper joints must be used. The metal shims must be joined with clean jointing compound on both sides.

To Remove Crankshaft

(a) Remove piston(s) and connecting rod(s).
(b) Remove gear end cover.
(c) Remove governor and control rod.
(d) Remove crankshaft pinion (shrunk and keyed to crankshaft; to replace, heat in boiling water).
(e) Remove main bearing housing and centre bearing locating dowel (using a $\frac{1}{4}$" UNF bolt screwed into end).
(f) Withdraw crankshaft through the housing bore.
Replace in the reverse order to removing.

Oil Seals

The crankcase is sealed at the crankshaft by screw type oil seals and felt rings, and the camshaft is sealed in the end cover with a Gits seal. Screw type seals must be concentric with the shaft, the maximum permissible variation of gap being 0.003" (0.075 mm.).

There is a ring type oil thrower on the flywheel end of the crankshaft and care must be taken to guide this ring over the end of the crankshaft when fitting the main bearing housing.

Cleaning of Cooling Fins

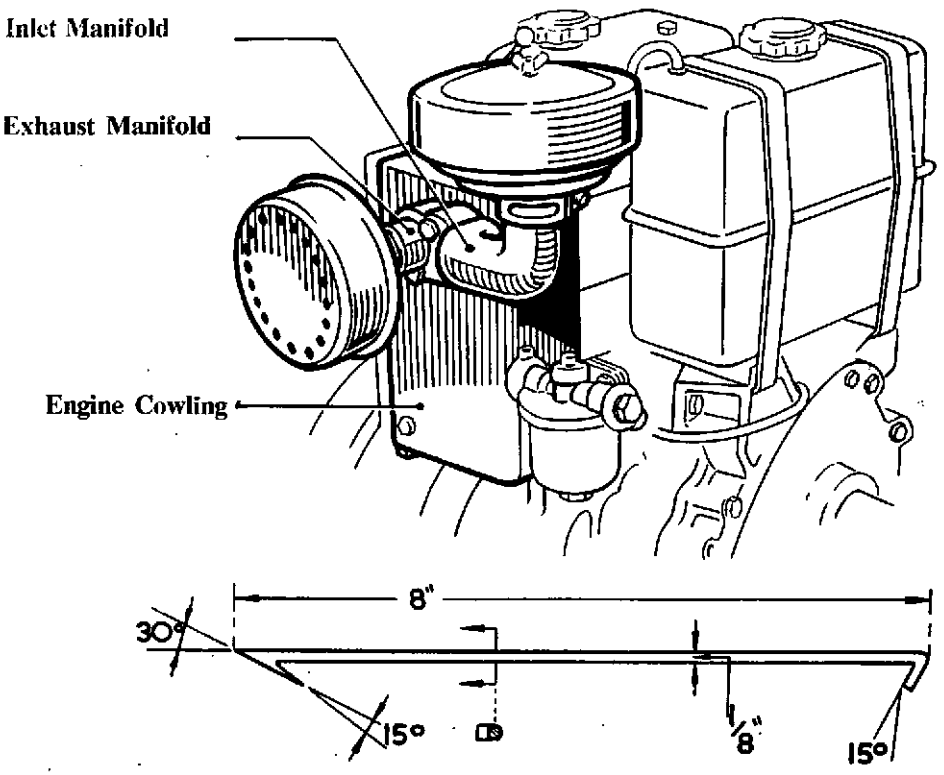
Under normal conditions the cylinder, cylinder head and injector cooling fins require cleaning at intervals of 1500 hours or even longer, but if the engine runs in a very dusty atmosphere, particularly if there is vegetable fibre, fluff, or similar matter in the air, cleaning may become necessary at 100 hour intervals. **Regular cleaning in exceptionally dusty conditions is essential if overheating is to be avoided.**

In dusty conditions it is also particularly important to **eliminate oil leaks, so keeping the cooling fins dry and clean.**

The engine has ample cooling capacity, and therefore cleaning is not so important if the average load is light, but if the load is heavy, serious overheating can occur and this will damage the engine although the pistons may not seize. Damage due to overheating may show itself as fuel injection trouble, stuck exhaust valves, with corresponding valve gear troubles, poor starting and scuffed piston rings and pistons.

To clean the fins it is necessary to remove the cooling air cowling (item 36, plate 1) and in order to do this the inlet and exhaust manifolds must be taken down. In many cases the inlet and exhaust manifold joint becomes damaged during this operation and a new joint must be fitted. The cleaning is effected with a special hooked wire tool, part no. 367-16170, the dimensional illustration of which is shown overleaf. This tool is of special design to draw the deposits between the fins towards the operator and makes the cleaning operation speedy and effective.

To clean the injector fins it is necessary to withdraw the injector from the cylinder head.



Engine fin rake (Cleaning Tool 367-16170)

Fig. 16—Cleaning Cooling Fins.

Laying-up Procedure

The following routine should be carried out when it is known that the engine will not be required for some months:—

1. Replace fuel in tank with a small supply of calibration fluid or equivalent.
2. Drain lubricating oil from sump and refill with Shell Ensis 20 or equivalent.
3. Run the engine for a period to circulate the Ensis oil through the system and to ensure the calibration fluid is passed through the fuel pumps and injectors.
4. Stop the engine and drain off the Ensis lubricating oil from the sump, after which the crankshaft should NOT be turned until the engine is again required for service. The calibration fluid should be left in the fuel system.

5. Seal all openings on the engine with tape.
6. Remove batteries, when applicable, and store fully charged with the terminals coated with vaseline (petroleum jelly).
7. Grease all external bright parts and control linkage, etc.
8. Tie labels on the engine clearly stating what steps have been taken to inhibit the engine during storage, as above.

If the above is not carried out then the engine should be run about 15 minutes once a month.

FUEL EQUIPMENT

Engines of low horsepower can be overloaded without the user realising it, because even a fraction of a horsepower is a big proportion of the total engine output. If a smokey exhaust is noticed in an engine the first thing to check is the setting of the overload stop.

The directions for how to adjust the overload stop are given on page 35.

The injectors are most unlikely to be the cause of smoky exhaust in LR or SR engines and should only be disturbed after the overload stop has been properly set and if the exhaust is still unsatisfactory. The injection timing of the engine may produce a smoky exhaust if more than $\frac{1}{4}$" (6 mm.) out on the flywheel.

Overheating of the engine and of the combustion air reduces the weight of air available for combustion, produces a darker exhaust as well as a loss of power and can cause serious damage, so this matter must receive immediate attention. Full information on cooling problems arising from the installation of air cooled engines is given on pages 6 to 11.

IMPORTANT

When priming or checking the fuel pump timing, care must be taken to prevent the overflow of fuel passing into the crankcase.

Always fit a NEW joint when a joint has been broken.

Special care must be taken to see there is no leakage from the joints of the fuel pipe connection to the pump(s).

When tightening or loosening the fuel pump delivery connection, use two spanners to prevent the pump from twisting on its seating and causing misalignment and possibly jamming of the fuel pump rack.

When refitting the fuel pipe from pump to injector the connection to the injector must be tightened before the connection to the fuel pump.

This procedure will ensure that there is no leakage from these joints.

It is most important that all fuel joints are tight and leakproof.

To Prime Fuel System

(i) Fill fuel tank.

(ii) Vent fuel filter (see page 24).

(iii) Vent fuel pipe at fuel pump(s). Turn engine as for starting, i.e. 3 to 20 times until the injector(s) can be heard to inject and then attempt to

start the engine. If the engine fails to start, prime the injection pipes as follows:—

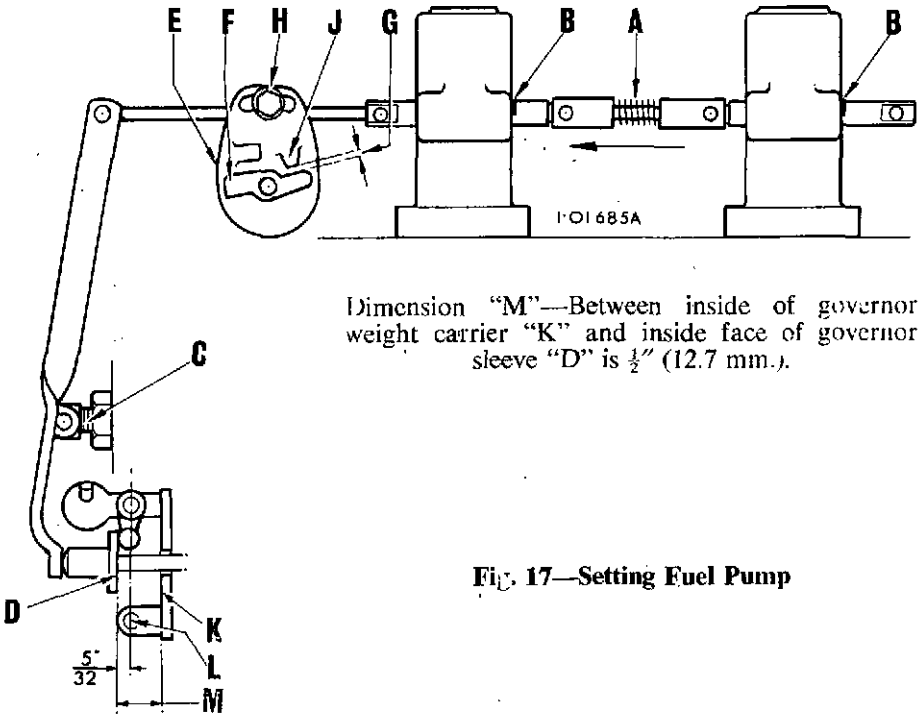
(a) Remove cylinder head cover(s).

(b) Undo injection pipe at injector two turns only.

(c) Set control to start position.

(d) Turn engine until free from air flows from injector pipe(s). Retighten injector pipe nut and continue turning engine until injector(s) are heard to inject.

When self-venting pumps are fitted it should not be necessary to carry out the above procedure except when putting the engine into commission.



Dimension "M"—Between inside of governor weight carrier "K" and inside face of governor sleeve "D" is $\frac{1}{2}$" (12.7 mm.).

Fig. 17—Setting Fuel Pump

KEY :

A—Fuel pump linkage
B—Calibration mark
C—Fulcrum
D—Governor sleeve
E—Control lever locating plate
F—Control lever
G—Setting clearance—see page 35.
H—Locating plate setscrew
J—Control lever stop
K—Governor weight carrier
L—Distance between inner face of governor sleeve and centre line of fulcrum—5/32" (3.97 mm.)
M—Dimension between outside face of governor weight carrier and inside face of governor sleeve—$\frac{1}{2}$" (12.7 mm.).

SETTING OF FUEL PUMPS and GOVERNOR WEIGHTS

1. On multi-cylinder engines, adjust linkage "A" so that all the calibration marks "B" accurately coincide with the sides of the fuel pumps within 0.005" (0.127 mm.). The fuel pump racks must move freely after this adjustment.
2. Adjust fulcrum "C" so that when the calibration marks "B" are against the sides of the fuel pumps the distance "M" between the inside of the governor weight carrier "K" and the inside face of the governor sleeve "D" ½" (12.7 mm.). This is the same for both constant speed and variable speed engines.
3. Insert a shim of the thickness given in the table below at "G" between the stop "J" and control lever "F". Rotate the locating plate "E" so that, with the shim in position, the calibration marks "B" are against the pump sides. The full width of each calibration mark must be visible. Lock locating plate "E" with screw "H" when this condition is attained. The corresponding movement of the pump rack in the direction of the arrow is also given in table below.

Engine Type and Speed	Thickness of Shim used at "G"	Movement of Rack corresponding to thickness of shim at "G"
LR1 @ 750 rpm	0.032/0.036 in. 0.8/0.9 mm.	0.102/0.114 in. 2.59/2.9 mm.
LR1 @ 1000 rpm	0.023/0.027 in. 0.58/0.68 mm.	0.074/0.086 in. 1.89/2.18 mm.
LR1 at all other speeds LR2 at all speeds SR1-2-3 at all speeds Except when driving centrifugal pumps	0.015/0.017 in. 0.38/0.43 mm.	0.046/0.052 in. 1.17/1.32 mm.
All LR and SR engines driving centrifugal pumps	0.010/0.012 in. 0.254/0.30 mm.	0.031/0.037 in. 0.79/0.94 mm.

4. The lower settings are acceptable provided the engines carry the normal load but the higher ones must not be exceeded.

To Time Fuel Pump

(a) Set the control lever to the "start" position.

(b) Turn the flywheel to the firing position. On LR1 and SR1 engines, this is when the mark ⌐ on the flywheel is opposite the top centre mark on the fan shroud and both valves are closed. On LR2, SR2 and SR3 engines the firing position is when the mark ⌐ is opposite the arrow at the back of the fan shroud near the fuel pumps, and both valves are closed (see illustration). A table is given on page 37 showing the injection timing.

(c) Disconnect the fuel injector pipe at the pump and injector.

(d) Remove the delivery valve holder, delivery valve and spring. If fuel flows from the pump turn the crankshaft forward until flow ceases.

(e) Replace the delivery valve holder without the valve and spring and slightly tighten.

(f) Turn the crankshaft backwards until fuel commences to flow and turn in direction of rotation until flow ceases. Blow fuel from the top of the holder to make sure flow has ceased. At this position the firing mark on the rim of the flywheel should be opposite the centre mark on the fan shroud. If it is not, the shims below the pump body must be adjusted.

Remove shims to advance.

Add shims to retard.

Shims 0.005″ and 0.010″ thick to a total of approximately 0.035″ are normally inserted below the fuel pump.

One shim 0.005″ (0.127 mm.) thick is equivalent to a timing adjustment of $\frac{3}{16}$″ (4.75 mm.) measured round the **rim** of a flywheel 14″ (35.6 cm.) diameter, or 13/64″ (5.16 cm.) for a flywheel 15″ (38 cm.) diameter.

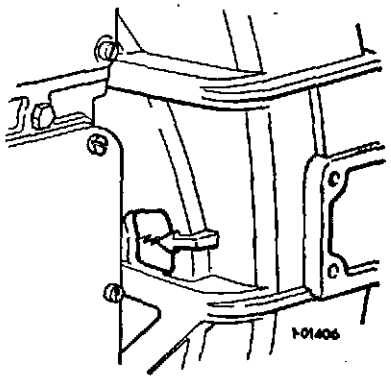


Fig. 18—Fuel Pump Timing

FUEL INJECTION TIMING

Engine	B.T.D.C. Timing Degrees	Diameter of Flywheel	Distance Measured on Flywheel Rim
LR1 up to 1200 rpm	24	14″ (35.6 cm.)	2.92″ (7.4 cm.)†
		16″ (4.06 cm.)	3.65″ (8.5 cm.)†
LR2 up to 1200 rpm	24	15″ (38.1 cm.)	3.15″ (8.0 cm.)†
LR1 over 1200 rpm	28	14″ (35.6 cm.)	3.42″ (8.8 cm.)†
		16″ (40.6 cm.)	3.91″ (9.9 cm.)
LR2 over 1200 rpm	28	15″ (38.1 cm.)	3.66″ (9.4 cm.)
SR1	25	14″ (35.6 cm.)	3.05″ (7.7 cm.)
		16″ (40.6 cm.)	3.49″ (8.8 cm.)
SR2 & SR3	25	15″ (38.1 cm.)	3.27″ (8.3 cm.)*

*On LR2—SR2—SR3 engines the mark ⌐ is on the **side** of the flywheel; the above figures, which are measured on the flywheel **rim** or periphery, are given for guidance only.

Note: On close coupled single cylinder engines there is a hole in the adaptor supplied by R. A. Lister & Co. Ltd. at T.D.C.

Where adaptors other than above are fitted they should also have a hole in this position in order to observe the flywheel timing mark.

†These settings refer to camshafts quoted on page 60 of Spare Parts List in Book 1028PL.

FUEL INJECTOR TESTING INSTRUCTIONS

Fuel Injector—LR Engines

LR engines are fitted with single hole, pintle type, injector nozzles, this being the most reliable type of nozzle known as it is almost impossible to block the hole completely.

The pintle nozzles used are of the delay type and this means that the profile of the pintle is such that on the first part of the needle lift, a relatively small proportion of fine atomised fuel is delivered, the bulk of the fuel going through after the needle has lifted a fixed amount. This feature gives good combustion and quiet operation.

It is strongly recommended that the nozzle should not be cleaned unless it is absolutely necessary. It is customary for a nozzle to run for 1,000 hours or more without cleaning, but under adverse conditions is should be inspected every 50 hours and the instructions given below must be followed.

Testing Fuel Injector—LR Egines

Owing to the above mentioned features it is not possible to test these nozzles for spray in the ordinary hand pump as in most cases good nozzles will appear defective. The correct way to check nozzles is as follows:—

(a) Check the "bursting" pressure with an ordinary hand test pump and if necessary set the injector to 160 atmospheres (165.4 kg/cm²). This setting is higher than the normal one of 155/140 atmospheres (160/145 kg/cm²) and is to allow for the inevitable fall in pressure during running of the engine.

(b) While the injector is still connected to the hand pump check the tightness of the seating by drying the nozzle and applying a pressure of about 100 atmospheres (103.3 kg/cm²) when no leakage whatever should appear from the nozzle hole. At this stage the back leak past the lapped portion of the needle must be checked by bringing the pressure up to 160 atmospheres (165.4 kg/cm²) and noting the time the pressure takes to drop from 150 to 100 atmospheres (155 to 103.3 kg/cm²). This time should be between 10 and 55 seconds. When an injector is working in an engine the leak off should be between 1% and 5% of the engine fuel consumption per cylinder.

(c) Check the spray by connecting the injector externally to the engine fuel pump by means of a special pipe.* The nozzle must point away from the operator as the spray can easily penetrate the skin. Set the overload stop to the running position (external lever horizontal), turn the camshaft at about 60 rpm and observe the spray in the usual way. A perfect spray is in the form of a fine mist and shows no sign of being "streaky" or "dribbling".

A nozzle must only be cleaned with the necessary special tools and by a qualified service engineer.

Note: *This can be made from a genuine spare pipe (correct length, bore and outside diameter) reversed and slightly set to allow the injector to be connected externally through the fuel pump housing door. After the pipe is bent, it **must never** be used for anything but test purposes, it is

impossible to straighten it again to a sufficient degree of accuracy to give a satisfactory fit in the engine.

The section on fitting a new injector on page 40 (SR engines) applies to LR engines also.

Fuel Injector—SR Engines

The fuel injectors are fitted in the cylinder heads and have cooling fins on the nozzle cap nut—these must be kept clean.

The injectors are jointed on reinforced asbestos joint rings in the cylinder heads and are fitted with rubber sealing rings on the upper part of the barrel.

Each injector is secured by a clamp which fits over two studs screwed into the valve rocker bracket. The clamp nuts must be tightened evenly to 15 lb.ft. (2.07 kg.m.) torque ensuring that the clamp is level and bears evenly in the injector. The steel fuel pipe from the pump to the injector **must not** be tightened until the clamp is correctly secured.

The injector nozzle has three spray holes each 0.0098″ diameter (0.25 mm.). The setting pressure of the injector spring is 200 atmospheres; this allows for settling to the normal pressure of 190 atmospheres. When tested on a hand pump the back leakage time should be 10 to 55 seconds for a drop from 150 to 100 atmospheres (155 to 103.3 kg/cm^2).

The injection equipment, and pipes and unions between the fuel filter and the fuel pump, and between the fuel pump and the injector must be absolutely clean; one particle of dirt can easily block one hole in the nozzle and produce a dirty exhaust. Every care is taken before the engine leaves the works to ensure that this equipment is scrupulously clean, and after the engine is run on test these injectors are checked and replaced if necessary, as sometimes particles of dirt get dislodged from the system when all the equipment is new. Therefore it is recommended that great care be taken not to introduce dirt into the system in any subsequent dismantling done after the engine leaves the works. This applies to the fuel pump, the fuel injector and all the pipes and unions between the fuel filter and the fuel pump and between the fuel pump and the injector.

Testing Fuel Injector

To check if the injector spray is in good condition the injector is removed from the engine and reconnected to the fuel injection pump externally so that the spray can be observed directed **away** from the operator. This requires removing the injection pipe and using a spare one (the standard injection pipe must never be bent for this purpose as otherwise it will be impossible to refit it). The camshaft is turned at about 60 rev/min and after a few turns the nozzle will begin to function and the sprays can be observed. These should be in the form of a very fine mist, not streaky or dribbly. All three sprays should have the same appearance and the same length of penetration in the air. If one spray is shorter or weaker than the others this means that the corresponding hole is partially blocked and best results will not be obtained.

If one hole is totally blocked or the nozzle dribbles it must be replaced or sent to be cleaned and reclaimed by an accredited Service Depot.

If the nozzle only is replaced the injector spring pressure must be reset

and this cannot be done without a special test rig consisting of a hand operated fuel pump and a pressure gauge. This rig is normally carried by Service Engineers but if it is not available it become necessary to replace the complete injector by a new one or a serviced one which has a clean nozzle and has been properly set to the correct pressure; in this case the complete faulty injector should be sent to the Service Depot or returned to the Lister Works or Agents for reconditioning.

When fitting a new injector the following instructions must be observed:—

1. The injector nozzle cap nut and the injector spring lock nut and outer cap must be dead tight (65 lb.ft. (9.0 kg.m.) torque).
2. The reinforced asbestos joint between the cylinder head and the injector finned nut must be carefully placed in position ensuring that it is properly located in the recess and undamaged. Both the seatings in the cylinder head and the injector finned nut must be clean and smooth. Blowing at this joint causes over-heating of the injector and sticking of the nozzle valve.
3. The rubber joint on the upper part of the injector barrel is used to prevent lubricating oil escaping from the valve gear compartment into the air stream. The ring has to be examined for cuts or other damage and renewed if necessary.
4. If it is intended to remove the nozzle, or before re assembling into the engine if the nozzle is not being removed, the finned cap nut must be thoroughly cleaned and all dirt removed from the recess between the fins.
5. The injector clamp nuts must be tightened to 15 lb.ft. (2.07 kg.m.) torque.

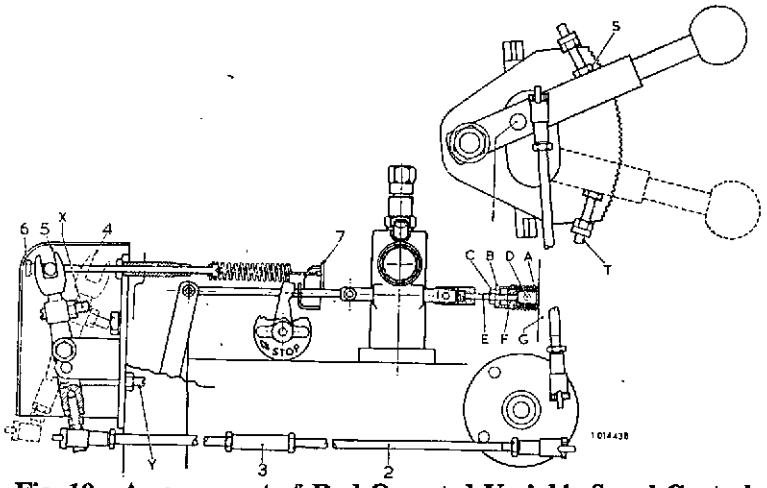


Fig. 19—Arrangement of Rod Operated Variable Speed Control

Cable operated arrangement is supplied as standard, rod operated as an alternative.

1. Alternative position for connecting rod.
2. For flexibly mounted engine, this connecting rod must lie in a plane close to the horizontal and must not be less than 10″ (254 mm.) long. Where it is necessary to carry the rod upwards fit universal rod coupling as above. Further rod couplings may be fitted as required.
3. Muff coupling for extending rods if required.
4. Idling position.
5. Full speed position.
6. Cover—not supplied with raised hand starting.
7. Fuel pump linkage for LR1—2 and SR1—2 engines.
8. Fuel pump linkage for SR3 engine.

Note: On LR1 and 2 and SR1 and 2 the **upper hole** in the bracket and the lever are used. On SR3 it is the **lower holes** in both bracket and lever which are used.

Instructions for Adjusting Speed control

LR1 & SR1 engines only. With the control lever in the "Slow" position—engine in neutral—adjust screw 'X' until the idling speed is 650 rpm and tighten nut.

LR2, SR2 & SR3 engines. The idling device consists of a spring "A" which is mounted over the left hand shackle "F" of the flywheel end fuel pump and exerts a force on the fuel pump rack by abutting against the pump body.

The fuel pump shackle "F" is fitted with a link stud "E" which has a long thread on which is screwed the idling spring adjusting sleeve "B". This sleeve when rotated controls the spring force and is locked in position by the lock nut "C".

To adjust the idling spring "A" the main speeder spring at the gear end of the engine is completely slackened and the adjusting sleeve "B" is rotated in the desired direction, until a steady idling of about one third of the rated engine speed is obtained, and then locked by the nut "C". Care must be taken, with earlier type engines, that the shackle pin "D" is at least partially covered by the adjusting sleeve "B" as otherwise the pin is not located sideways and will fall out.

The speed control on the engine has an idling adjusting screw "X" which should now be adjusted so that the main speeder spring just begins to increase the engine speed, and then screwed anti-clockwise one turn. The speeder spring must not exert any force when the engine is idling.

All engines. With control lever still held in "Slow" position adjust screw "T" until it just touches the operating lever and lock the nut.

All engines. Push the control lever in the direction of "Fast" and adjust screw "Y" until full revolutions are obtained on load and tighten the locknut.

All engines. With control lever still held in "Fast" position adjust screw "S" until it just touches the operating lever and lock the nut.

N.B.—Ensure that the ratchet is engaged between two teeth in the "Fast" position. Adjust the length of the connecting rod or cable to suit.

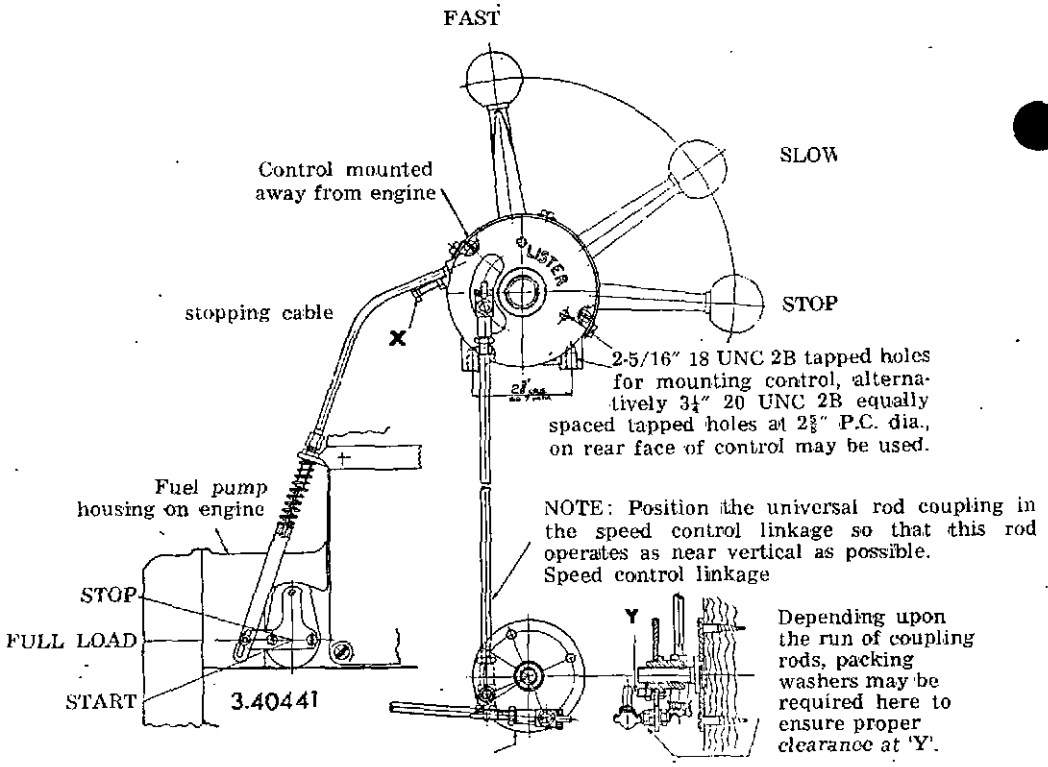


Fig. 20—Arrangement of Single Lever Speed and Stop Control

ADJUSTMENT

Engine idling at 700/850 rpm: Adjust the connecting rod to the hand control so that the hand lever is in the bottom notch of the ratchet in the speed sector.

Engine at full speed 2000/2500 rpm: With the hand lever held in the full speed position (on load), set adjustable stop "X" so that it just touches the hand lever. Tighten the lock nut.

Stopping control: Adjust cable so that the engine stops when the hand lever is at the limit of its travel in the stopping sector.

Speed Adjustment

A slight adjustment of speed may be made by turning the screwed rod which projects through the gear case. Turn anti-clockwise to increase speed, clockwise to decrease. Secure locknut.

Do not increase speed by more than 2½% without consulting R. A. Lister & Co. Ltd.

GOVERNOR WEIGHTS & SPRINGS—CONSTANT SPEED

BS 649 : 1958 Class A

SINGLE & TWIN CYLINDER ENGINES

ENGINE	GOVERNOR WEIGHTS 2 off		WEIGHT SPRING 2 off		SPEEDER SPRING 1 off	
Speed rpm	Part No.	Indent No.	Part No.	Colour	Part No.	Colour
750-850 LR	572-11380	2	201-10821	Green	201-10901	Blue
850-1000 LR	572-11380	2	201-10821	Green	201-10903	Yellow
1000 SR	572-11380	2	201-10821	Green	201-10903	Yellow
*1100-1300 LR & SR	572-11380	2	201-10821	Green	201-10900	Red
1400-1690 LR & SR	572-11380	2	201-10820	Red	201-10900	Red
1700-1800 LR & SR	572-11640	11	201-10820	Red	201-10900	Red
2000-2500 LR1 & 2/SR1 & 2	572-11590	6	201-10820	Red	201-10900	Red

THREE CYLINDER ENGINE—SR only

1000	354-28351		201-10820	Red	201-10903	Yellow
*1150-1300	572-11391	3	201-10820	Red	201-10903	Yellow
1500	572-11391	3	203-10824	White	203-10904	Black
1800	572-11380	2	203-10824	White	203-10904	Black
2000	572-11380	2	203-10824	White	203-10904	Black
2200-2500	572-11580	5	203-10824	White	203-10904	Black

* See page 26—Valve clearances.

GOVERNOR WEIGHTS & SPRINGS—VARIABLE SPEED

BS 649 : 1958 Class B

Engine Type	Rev./min. Range	Governor Weights 2 off		Speeder Spring 1 off		Idling Spring 1 off
		Part No.	Indent No.	Part No.	Colour	Part No.
LR1-SR1	700-2200	572-11663	16	201-10900	Red	—
	850-2500	572-11661	14	201-10900	Red	—
LR2-SR2	700-2200	572-11663	16	201-10900	Red	204-21491
	850-2500	572-11661	14	201-10900	Red	204-21491
SR3	700-2000	572-11665	18	201-10900	Red	204-21491
	850-2500	572-11665	18	201-10900	Red	204-21491

INSTRUCTIONS FOR CHANGING SPEED OF ENGINES

Note: Before starting consult the table on page 43 to check which of the governor weights and springs are to be changed.

Unhook the speeder spring from the governor link.

Remove the end cover complete with tank and filter.

Disconnect fuel piping and drain the fuel tank.

Remove seven setscrews securing end cover.

Remove end cover complete with tank and filter.

To Change Governor Weight Springs Only

Unhook the governor weight springs.

Fit new springs (consult table).

To Change Speeder Spring

Remove the speed adjusting screw from the end cover.

Remove the existing spring and fit the new speeder spring.

Re-fit the adjusting screw into the end cover and tighten the lock-nut after final adjustment of speed.

To Change Governor Weight

Remove split pins and washers from the governor lever fulcrum pin, and from the outer end only of the link to the governor.

Remove the governor lever.

IMPORTANT NOTE: DO NOT ALTER THE GOVERNOR LEVER FULCRUM SETTING.

Remove the governor thrust sleeve.

Remove the two setscrews securing the governor weight carrier.

Remove the carrier and weights.

Remove the governor weight fulcrum pins, fit new governor weights and replace the pins.

NOTE: Brass governor weights must be fitted with steel boots. If necessary use boots from the weights being removed.

Replace the governor sleeve, ensuring that it is perfectly clean.

Refit the carrier complete with weights and pins and secure by means of the two setscrews.

Fit the correct governor weight springs (consult table).

Replace the governor lever and fit washers and split pins.

STARTING AND RUNNING FAULTS

Essentials for Easy Starting

(a) Engine to turn easily when decompressed if not it may be due to:—
unsuitable lubricating oil (too heavy)
incorrect decompressor clearance
tight bearing
load not disconnected from engine

(b) Injector creak must be heard (or felt). If not, it may be due to:—
no fuel in tank
air lock in system
injector nozzle valve stuck open
fuel pump delivery valve scored

(c) Good compression, if not, it may be due to:—
worn cylinder
piston rings carboned in grooves
leaking inlet or exhaust valve
injector loose on seat

(d) Fuel pump rack(s) to be free

(e) Control must be vertical to give extra fuel for starting

Knocking, this may be caused by:—

(a) Valve, probably exhaust, sticking in guide and touching piston—clean stems and guides

(b) Slack bearing—fit new bearing, if crankshaft is not worn

(c) Insufficient clearance between the piston and cylinder head—check and adjust

(d) Injection too early—check and adjust

(e) Flywheel loose on shaft

(f) Excessive crankshaft end play

(g) Excessive carbon deposit on piston

Carbon Deposit, excessive deposit may be due to:—

(a) Choked exhaust system — dismantle and clean

(b) Long periods of idling

(c) Unsuitable fuel oil.

(d) Unsuitable lubricating oil

(e) Injector not spraying correctly—clean nozzle

(f) Late injection of fuel — check timing

Smoky Exhaust—Black smoke due to incomplete combustion of fuel caused by:—

(a) Overload, causing an excessive quantity of fuel to be injected

(b) Choked air intake

(c) Poor atomisation due to a choked injector nozzle

(d) Unsuitable fuel

Note: Blue smoke, when faint, is generally the result of light load. Heavy blue smoke is caused by lubricating oil passing the piston rings, due to either stuck piston rings or a worn cylinder.

Engine Stops—This may be due to:—

(a) Lack of Fuel—air or water in fuel system. Fuel system choked (See Page 24).

(b) Overload

(c) Overheating, due to shortage of lubricating oil or recirculation of cooling air

(d) Loss of compression

(e) Dirt in injector or fuel system

Loss of Power—This may be due to:—

(a) Loss of compression

(b) Incorrect tappet clearance

(c) Choked exhaust pipe
(d) Fuel injector or fuel pump out of order. Air in the fuel system
(e) Choked fuel filter

Failure to Obtain Normal Speed

(a) Engine started under overload
(b) Fuel system not primed properly
(c) Insufficient fuel
(d) Injection retarded

Loss of Oil Pressure

(a) Oil level below mark on dipstick
(b) Strainer choked
(c) Fractured pipe or leaking joint
(d) Badly worn or run out bearing
(e) Relief valve not seating due to dirt, or worn out
(f) Oil pump plunger and valves, worn or dirty

LISTER DIRECT DRIVE CLUTCH

Direct Drive Clutch (Lister)

The clutch, fitted to either the crankshaft or camshaft, is of the multi plate type running in oil. It is toggle operated and is therefore self locking in either the engaged or disengaged position. Tension should be felt throughout the movement of the lever to engage the clutch and it should be released on completion of the movement.

The clutch housing is filled to the level of the side plug with light engine oil (SAE 10). The capacity is approximately $\frac{5}{8}$ imp. pint. An even lighter grade of oil may be used in cold weather to reduce oil drag of driven shaft.

Adjustment—see Fig. 21

The clutch plates are held between pressure plates when fully engaged. It is essential there should be no slip when fully engaged. If the full power is not being transmitted, the clutch should be adjusted as follows:—

(1) Stop the engine.
(2) Remove the inspection cover on top of the clutch casing.
(3) With the lever in the "neutral" position, revolve the clutch until the adjusting plunger "C" is accessible.
(4) Pull plunger "C" out of engagement and rotate adjusting ring clockwise 1 to 3 holes, re-engage plunger "C" and then check "feel" of the clutch operating lever. Alter the adjustment until the full power is transmitted without slip.
(5) Do not adjust more tightly than is necessary to transmit the full power without slip.
(6) Ensure the clutch runs freely in the "neutral" position.

Reduction Gear

Where reduction gears are fitted, fill the gear case to the maximum mark on the dipstick with the same grade of lubricating oil as used in the engine sump.

Adjustment of Rockford Clutch—Optional Fitting

The clutch plate is held between two pressure plates when fully engaged. It is essential there should be no slip when fully engaged. If the full power is not being transmitted, the clutch should be adjusted as follows:—

(1) Stop the engine.
(2) Remove inspection cover on top of clutch casing.
(3) With the lever in the "neutral" position, revolve the clutch until the adjusting ring locking plate is accessible.
(4) Slacken the locking plate screw with a screwdriver and when dis-engaged from these serrations turn the adjusting ring clockwise. Re-secure the locking plate.
(5) Do not adjust more tightly than is necessary to transmit the full power without slip.
(6) Ensure the clutch runs freely in the "neutral" position.

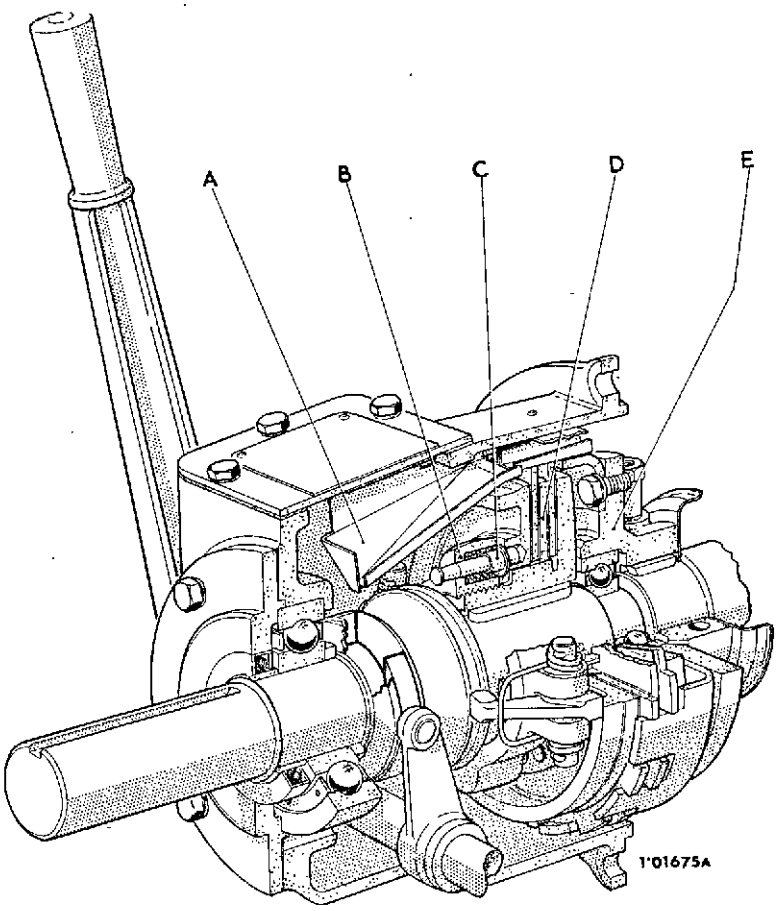


Fig. 21.—Lister Clutch

A—Lubricating oil return trough.
B—Clutch adjusting ring.
C—Clutch adjusting plunger.
D—Clutch plates.
E—Clutch driving member.

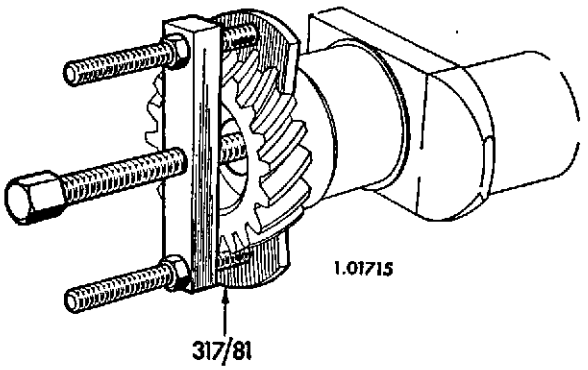


Fig. 22A.—Pinion Withdrawal Tool

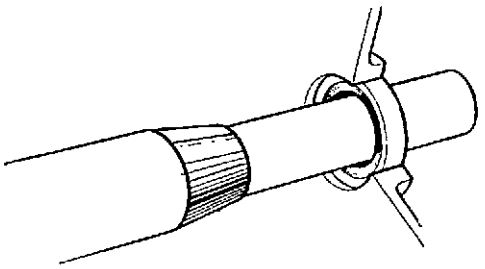


Fig. 22B—Tapered Sleeve

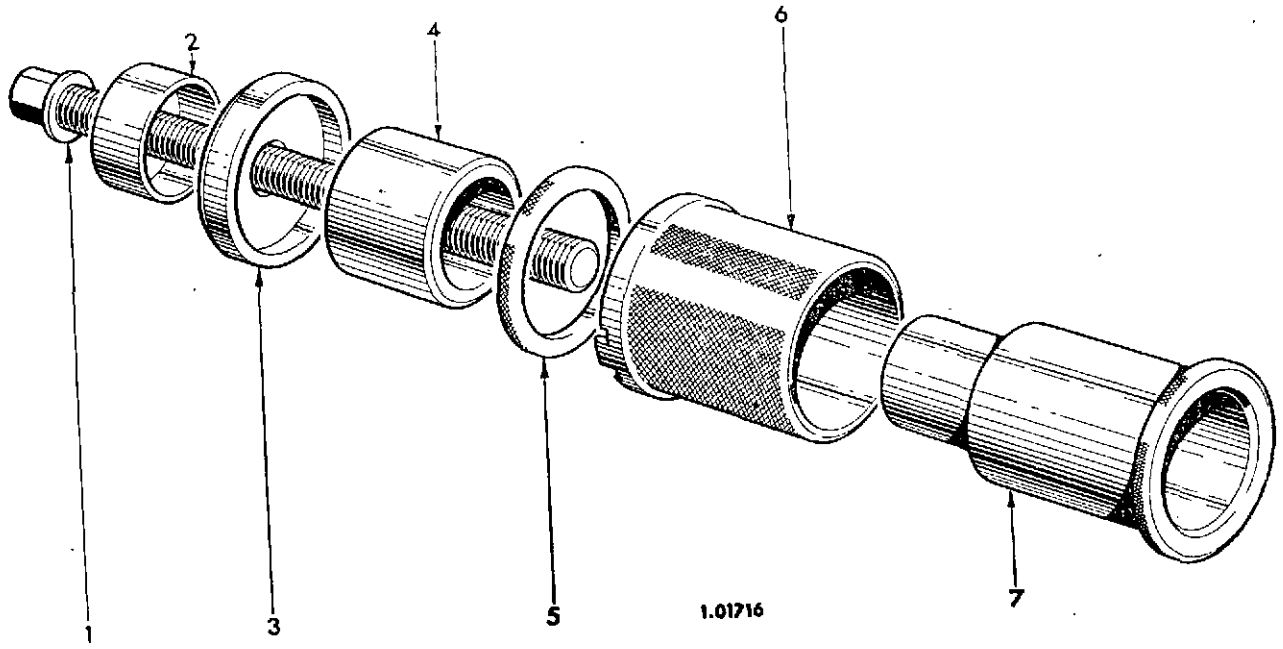


Fig. 22C—Main Bearing Tool Complete—Part No. 317-00084

KEY

1. Drawbolt
2. Small Spacer
3. Large Spacer
4. Locating Ring
5. Spacer Ring
6. Sleeve
7. Plug

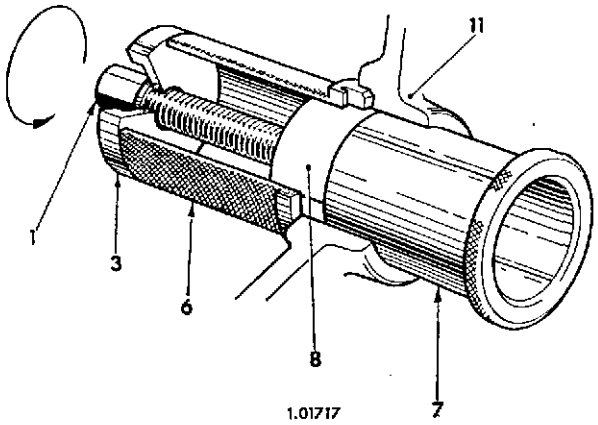


Fig. 23A—Main Bearing Bush Removal

To remove main bearing shells from the crankcase Figure 23A

(1) Enter the plug (7) with bearing locating ring (4) into bearing (8).

(2) Fit sleeve (6) in position with lug in groove in crankcase (11).

(3) Fit large spacer (3) with its recessed face outwards, and the drawbolt (1).

(4) Tighten the drawbolt and continue tightening until the shells (8) have been drawn into the wide section of the sleeve (6).

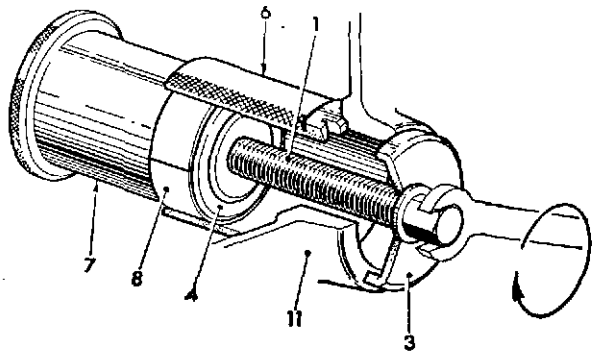


Fig. 23B—Main Bearing Bush Fitting

To fit the main bearing shells to the crankcase Figure 23B

(1) Remove sleeve (6) from the tool and turn the face with the locating lug downwards. Slide the two halves of the new bearing (8) into the top of the sleeve (6) with the locating tag of the bearing upwards.

(2) Reverse the sleeve (6) so that its locating lug is now upwards and slide it, complete with bearing (8), over the bearing locating ring (4) on the plug (7) and press down firmly by hand as far as possible ensuring *that the widest diameter of the plug is actually entering the sleeve.*

(3) Insert the tool with the bearing and sleeve into the crankcase (11), ensure that the lug on the sleeve (6) enters the groove in the crankcase.

(4) Fit the large spacer (3) and drawbolt (1), the plain face of the spacer *(3) should be outwards, draw up bolt and continue tightening until* the plug meets the sleeve.

NOTE:—Main bearings in housings can be removed and fitted with this tool if the housing is carefully held in a vice.

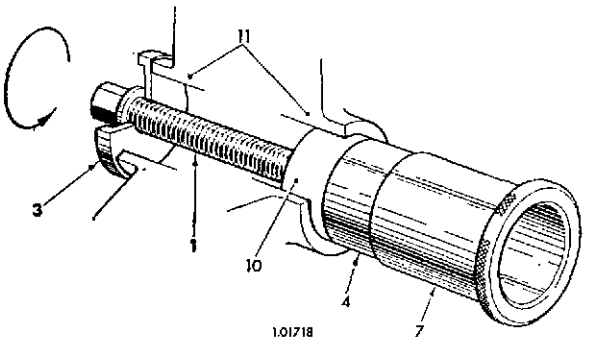


Fig. 24A.—Camshaft Plain Bush Removal

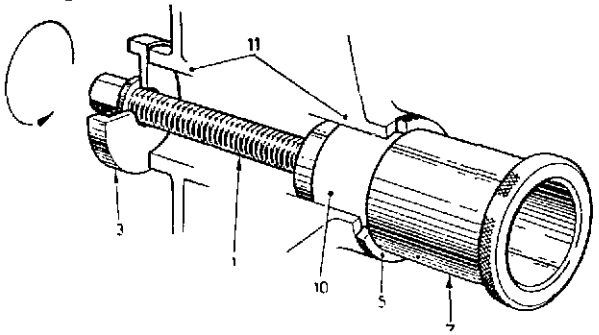


Fig. 24B.—Camshaft Plain Bush Fitting

Figure 24A—To remove camshaft bush (plain)

(1) Place plug (7) with sleeve (4) in position as sketch.

(2) Fit draw bolt (1) and spacer (3), with recessed face of spacer outwards, tighten draw bolt and continue tightening until bush (10) is withdrawn. Care must be taken to ensure that the plug (7) and sleeve (4) are accurately positioned and will not foul the crankcase when the draw bolt is tightened.

Figure 24B—To insert camshaft bush (plain).

(1) Place the spacer ring (5) on the plug (7).

(2) Place bush (10 on plug 7)—note the sleeve (4) is not required.

(3) Insert plug with bush in crankcase and fit large spacer (3) and drawbolt (1). Tighten drawbolt until bush is drawn into position.

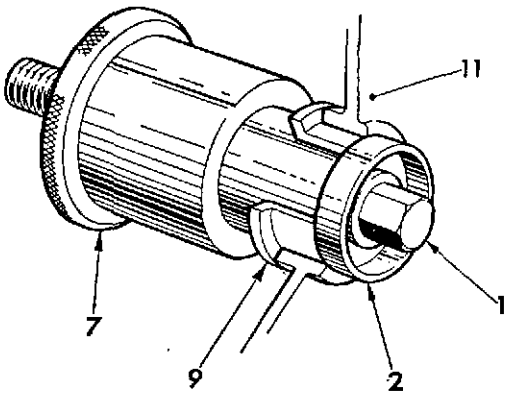


Fig 25A.—Camshaft Flanged Bush Removal

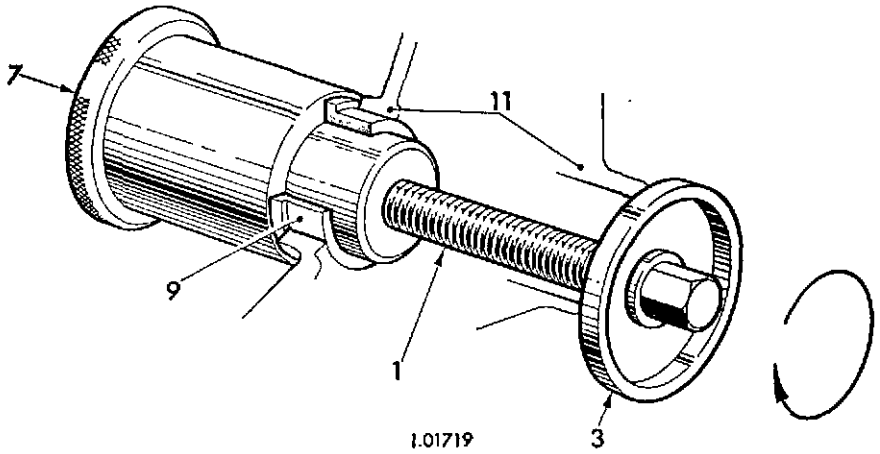


Fig. 25B.—Camshaft Flanged Bush Fitting

Figure 25A—To remove camshaft bush (flanged)

(1) Insert plug (7) into bush (9).

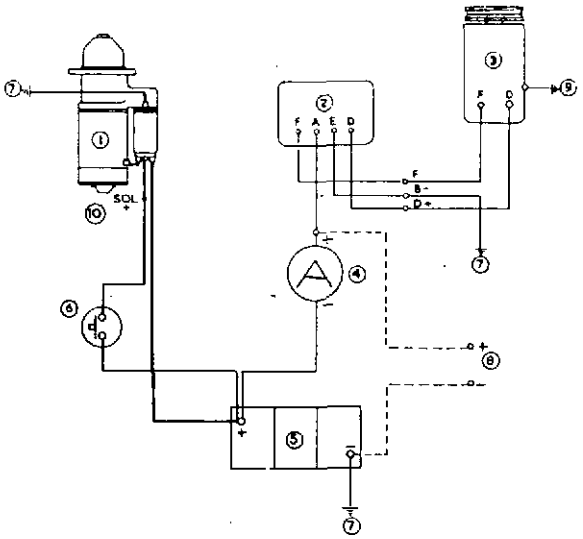
(2) Fit small spacer (2), with recessed face outwards, fit drawbolt (1) and tighten, then with a drift on the bolt head, tap the bush out.

Figure 25B—To fit camshaft bush (flanged)

(1) Place bush (9) on plug (7) as in sketch.

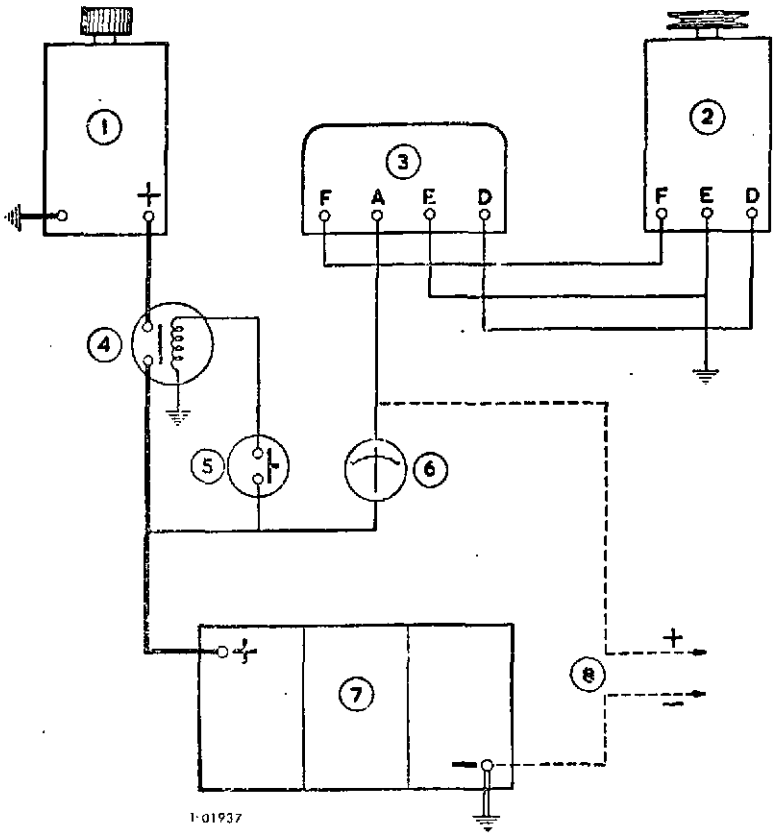
(2) Fit large spacer (3)—with recessed face outwards—and drawbolt (1).

(3) Tighten drawbolt and continue tightening until bush (9) is drawn into place.



1. Starter Motor.
2. Controller Unit.
3. Dynamo.
4. Ammeter.
5. Battery.
6. Starter Push Button.
7. Engine Earth.
8. Light—do not exceed 10 amps.
9. Dynamo Frame Earth.
10. Solenoid.

LR2—SR2 & SR3 12v. Electric Starting Equipment—Wiring Diagram
ED.6838



1. Starter Motor.
2. Dynamo.
3. Cut-out and Controller Unit.
4. Starter Solenoid.
5. Push Button.
6. Ammeter.
7. Battery.
8. Lighting Circuit.

LR and SR1 12v. Electric Starting Equipment—Wiring Diagram ED.6105

IMPORTANT

When purchasing parts or giving instructions for repairs customers should, in their own interest, always specify :

GENUINE LISTER PARTS

Parts that have not been supplied by the Lister organisation cannot be relied upon for correct material, dimensions or finish. R. A. LISTER & CO. LTD. cannot therefore be responsible for any damage arising from the use of such parts and the guarantee will be invalidated.

In your own interest, therefore, specify

GENUINE LISTER PARTS

IMPORTANT

SPARE PARTS — DIRECTIONS FOR ORDERING

See also page 98 in Book 1028PL

1. Always quote the **Engine No., Part No. and Description of Part** when ordering spare parts. The engine number will be found on the plate on the fuel pump housing door and stamped on the flywheel rim.
2. The engine components have been divided into convenient groups and illustrated. DO NOT quote illustration number when ordering.
3. Standard rotation is clockwise when looking on flywheel end.
4. Unified threads are used where applicable throughout the engine.
5. Undersize/Oversize parts, crankshaft, main bearings and connecting rod big end bearings may be obtained 0.010″, 0.020″ and 0.040″ undersize. Pistons and piston rings may be obtained 0.010″, 0.020″ and 0.040″ oversize.

WHEN USING THIS INSTRUCTION MANUAL PLEASE NOTE THE FOLLOWING:—

1. Instructions and statements contained in this book are given with our best intentions and are correct at the time of going to press. They are subject at any time to alteration.
2. The illustrations are subject to modification and must not be taken as representative of any individual specification.

INDEX

TO

LIST OF PARTS AND ACCESSORIES

BOOK 1028PL

ACCESSORIES AND SPECIAL SPARE PARTS

MAINTENANCE

Date	Hours Run	Item	Work Carried Out

Printed in England

B. 15M. 2/71