You want the best out of this engine. Give this handbook to the man who has to look after it.

BOOK 352/462

PRICE 10/-

Lister

DIESEL ENGINES

SL 1-2-3 CYLINDERS

INSTR OOK & PARTS LIST

R. A. LISTER & CO. LTD.,
DURSLEY, GLOUCESTERSHIRE
ENGLAND

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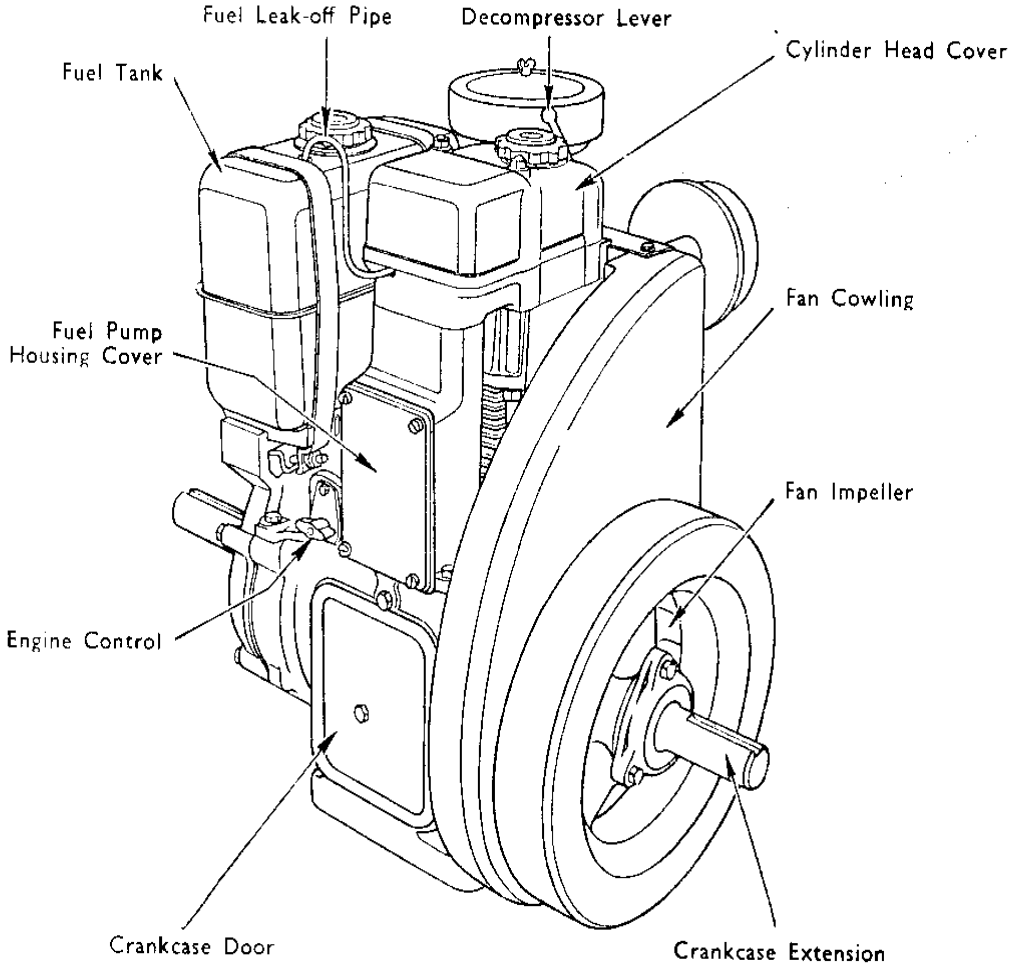


Fig. 1.—Type LD1 or SL1 Engine—Front View.

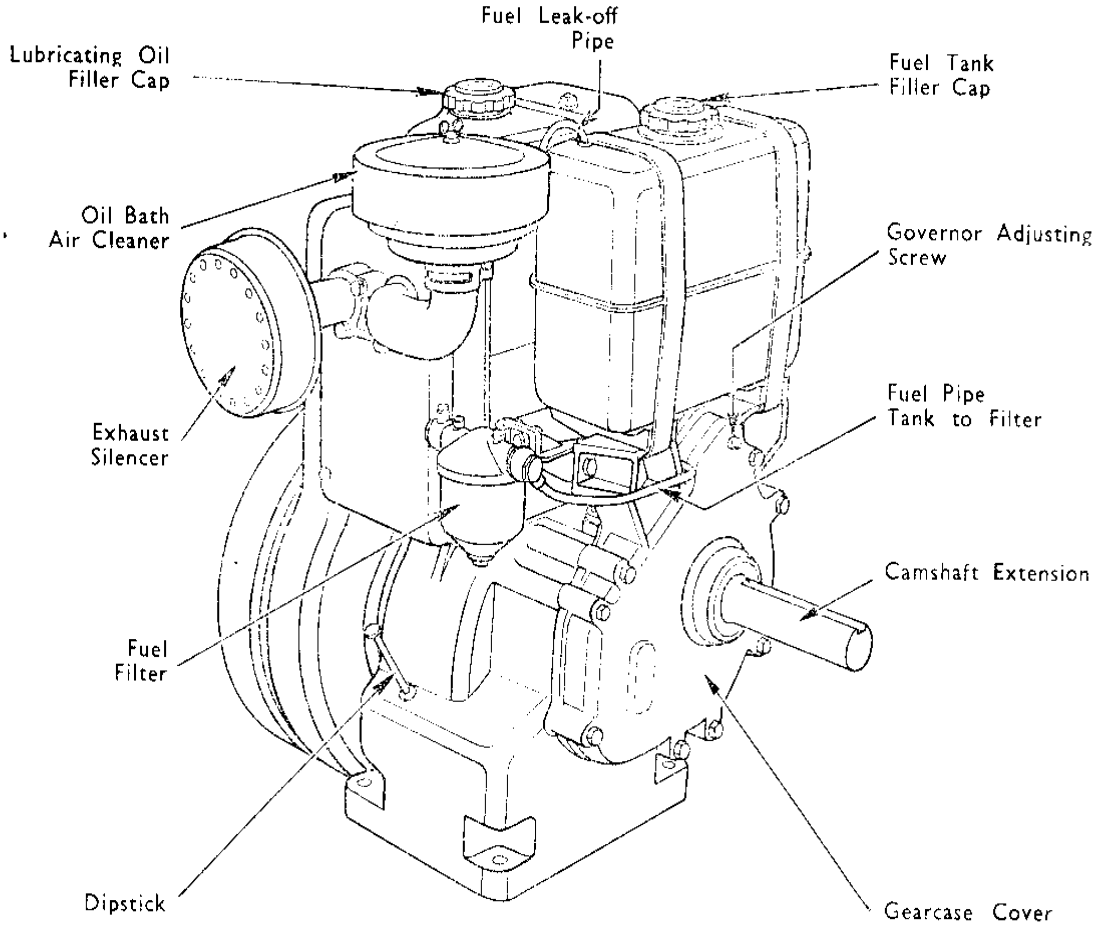


Fig. 2—Type LD1 or SL1 Engine—Back View

TECHNICAL DATA

	LD1	LD2	SL1	SL2	SL3
MAXIMUM GROSS BHP	5	10	6	12	18
B.H.P. for Automotive installation only	—	—	5.5	11.0	16.5
RATED BHP (B.S. 649/1958) 2000 Rev/min.	—	—	4.75	9.5	—
1800 Rev/min.	3½	7	4.25	8.5	12.75
1500 Rev/min.	3	6	3.6	7.2	10.8
1200 Rev/min.	2.4	4.8	2.87	5.74	8.6
1000 Rev/min.	2	4	2.4	4.8	7.2
800 Rev/min.	1.6	3.2	1.9	3.8	5.7
CYLINDER BORE x STROKE in.	3 x 3½		3 3/16 x 3½		
mm.	76.2 x 88.9		80.96 x 88.9		
SWEPT VOLUME cu. in.	24.7		27.9		
PER CYLINDER c.c.	405		458		
B.M.E.P. at 1800 R.P.M., lb/sq.in. ..	62.3		67		
FUEL CONSUMPTION on Full load in lb/hp/hr	.55	.53	.54	.53	.52
Approximate FUEL CONSUMPTION on Full Load at Maximum revolutions Pints/Hour	1.8	3.5	2.4	4.8	6.3
Litres/Hour	1	1.9	1.4	2.7	3.6
LUBRICATING OIL Consumption on Full Load at Maximum revolutions Hours/Pint	39	20.2	29.2	14.9	11.1
Hours/Litre	68	35	51	26	19.5
LUBRICATING OIL SUMP (Engine Level) Capacity—Pints	3½	9½	3½	9½	13½
See also page 19 Litres	2	5.4	2	5.4	7.7
EXHAUST CONNECTION B.S.P. ...	1"	1¼"	1"	1¼"	1½"
NETT WEIGHT OF ENGINE lb.	261	416	261	416	513
kg.	118	187	118	187	233
STANDARD ROTATION CLOCKWISE LOOKING AT FLYWHEEL END					

Engine Rating.

The Engine is rated in accordance with BSS 649/1958, i.e., the Engine will develop its rated H.P. continuously including 10% overload for a period not exceeding 1 hour in any period of 12 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	LD1 & SL1	LD2 & SL2	SL3
Up to 20 ft.	1″	1¼″	1½″
Over 20 ft.	1¼″	1½″	2″

The engine must be secured in a level position.

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 startng.

Belt Drive.

Driving belts must be run as close up 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.

Shaft Extension at Flywheel End.

This must be fitted with the keyway on top when No. 1 is on T.D.C. Firing Stroke. No. 1 is the cylinder at the fuel tank 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 is not re-circulated or restricted (See Pages 6—12).

Temperatures.

(1) The temperature rise from ambient to cooling air inlet and combustion air inlet must be kept as low as possible (5° to 10°F or 3° to 6°C.).

(2) The approximate temperature rise of a normal engine on full rated load is 63°F. (35°C.).

(3) The maximum permissible cooling air inlet and combustion air temperatures is 125°F. (52°C.).

(4) The maximum permissible cooling air outlet temperature at full load is 185°F. (85°C.). If this temperature is exceeded it can be assumed that the installation is unsatisfactory and if the engine is allowed to run it will require frequent overhauls and will not perform satisfactorily.

(5) The B.S. rating for the engine applies for ambient temperatures not exceeding 85°F. (30°C.). Above this temperature the engine must be derated by 1% for every 5°F. (2.78°C.). It follows that it is most important to ensure that the cooling and combustion air inlet temperatures are kept as near ambient temperature as possible.

COOLING AIR CONSIDERATIONS

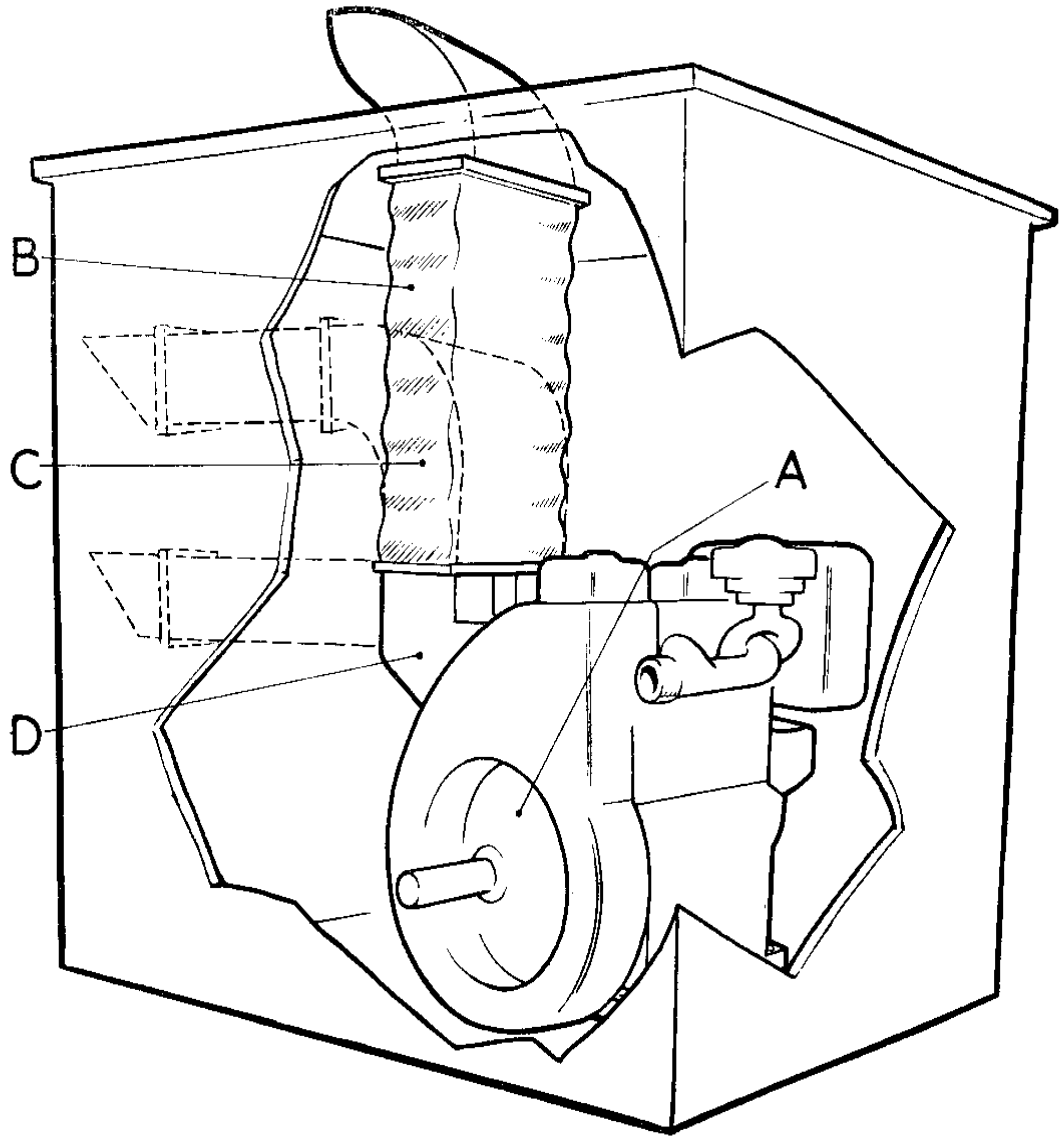


Fig. 3.—Method of leading out the hot cooling air in small enclosed compartments

A It is absolutely essential that the hot cooling air discharge does not find its way to the cooling air 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 pumps and the trunking must be attached so that it does not impair the quick removal of the ducting.
The extension on the ducting, the trunking and the cowl are to be supplied by the customer.
For lengths of trunking up to 5 ft. (1.5 m.) the minimum inside area to be :—
30 sq. ins. (194 mm.) for SL1 & LD1.
60 sq. ins. (288 mm.) for SL2 & LD2.
90 sq. ins. (582 mm.) for SL3.
For 5 to 10 ft. multiply by 1.4.
For 10 to 25 ft. multiply by 2.25.
For 25 to 50 ft. multiply by 3.5.

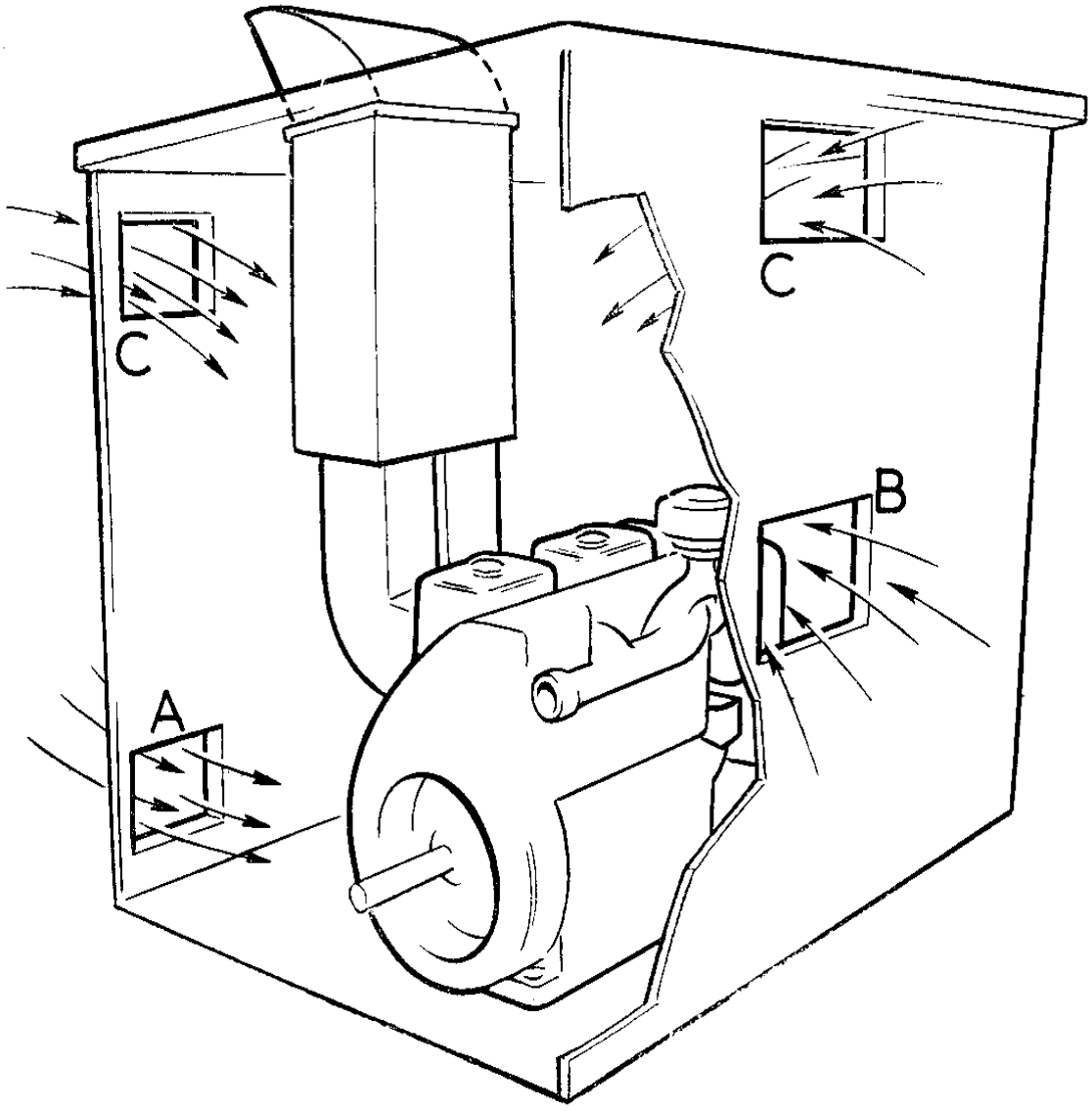


Fig. 4.—Notes on Air Intakes.

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).

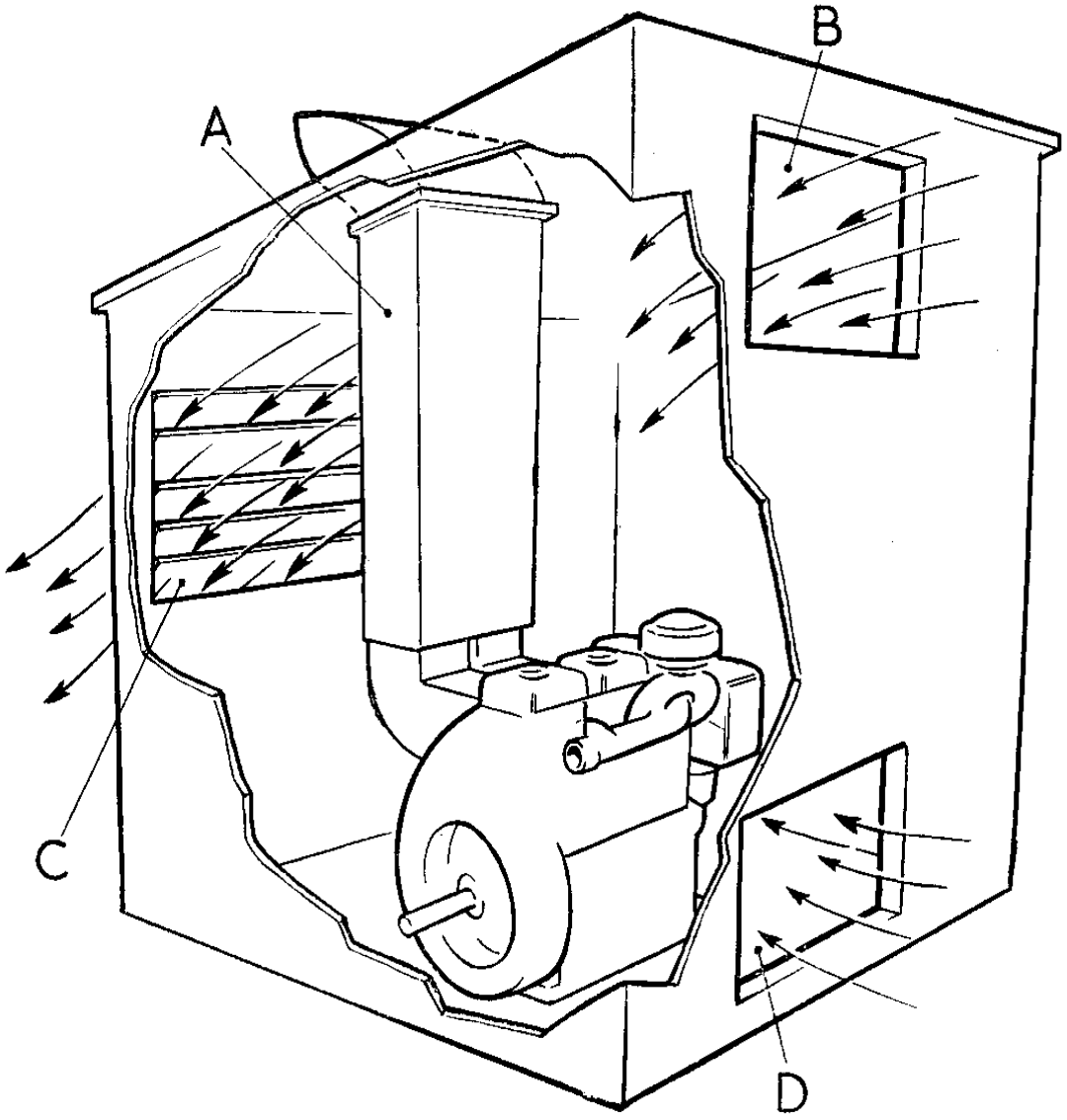


Fig. 5 -Installation in moderate size engine house (10 ft. x 6 ft.)

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 2 ft. x 2 ft. 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″ apart).

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

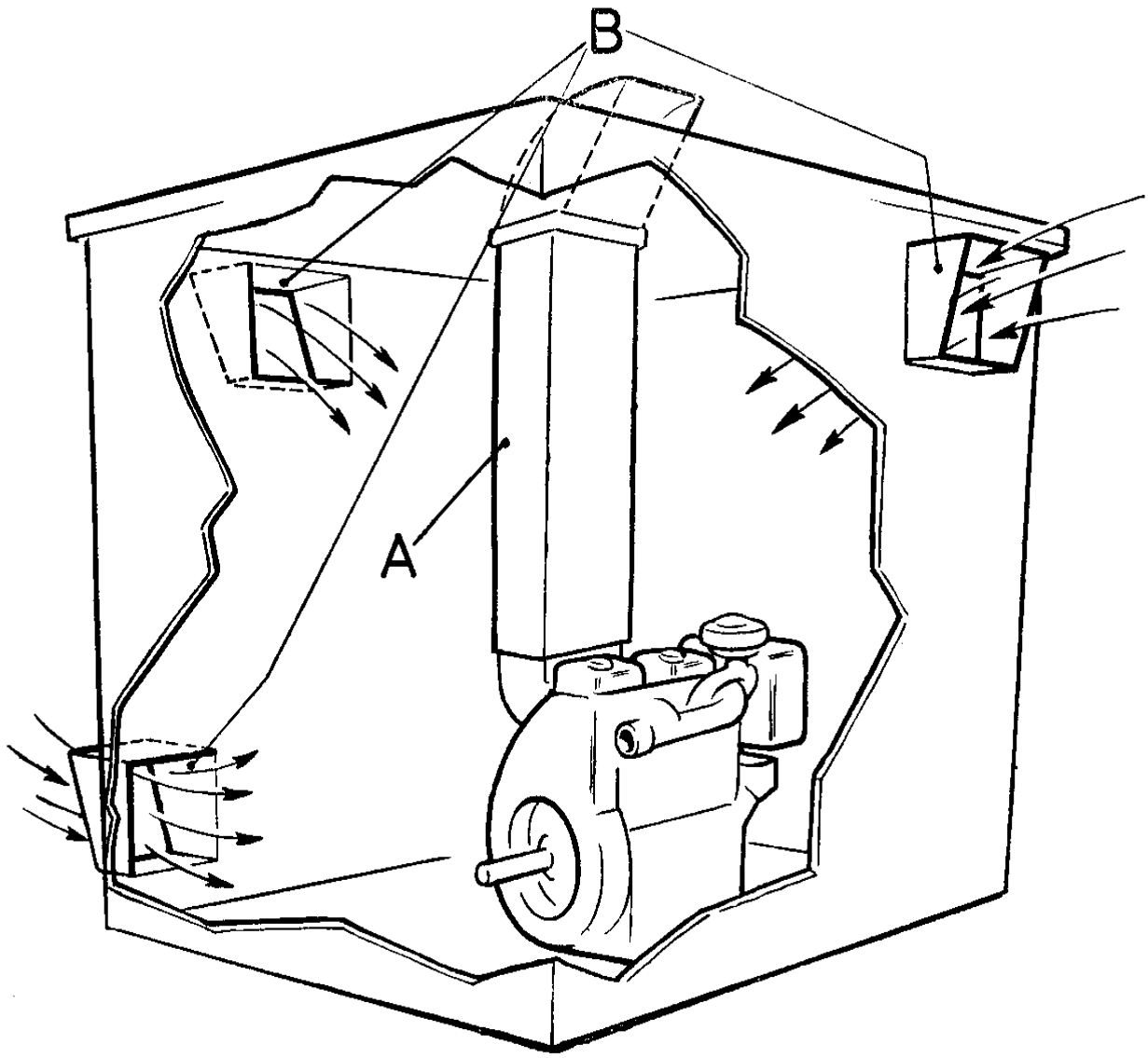


Fig. 6.—Installation in confined space where air intake holes have to be as small as possible.

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 :-
LD & SL1 3 holes each 13 sq. ins.
LD & SL2 3 holes each 26 sq. ins.
SL3 3 holes each 40 sq. ins.

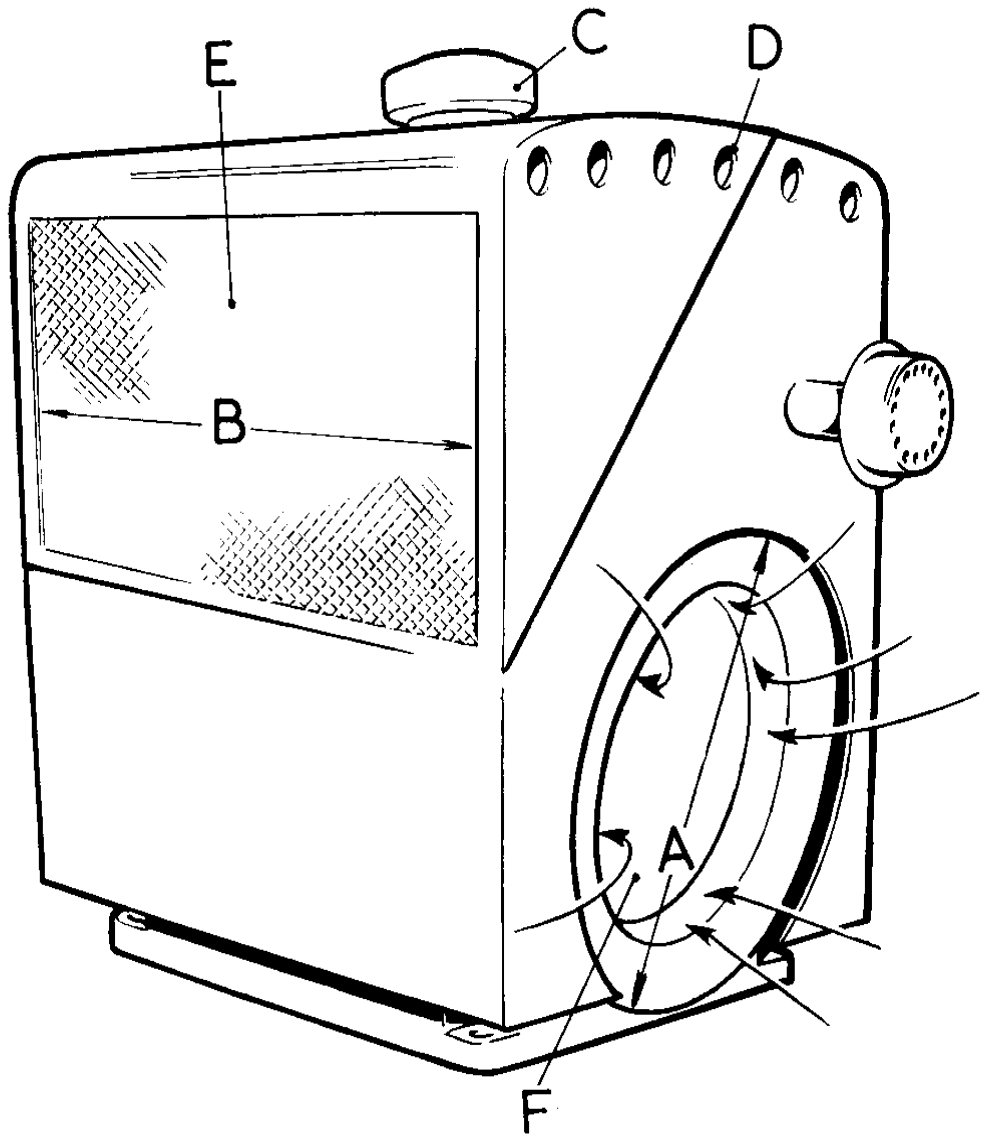


Fig. 7.—Engine installed in a housing which itself is in the open with unobstructed air all round. (2 and 3 cylinder engines only)

A 15″ minimum diameter hole opposite flywheel air intake.

B 21″ for two cylinder engine; 26″ for three cylinder engine.

C Combustion air intake brought outside.

D At least 6 ventilating holes each end 1″ dia.

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

F Flywheel air intake to be against this end.

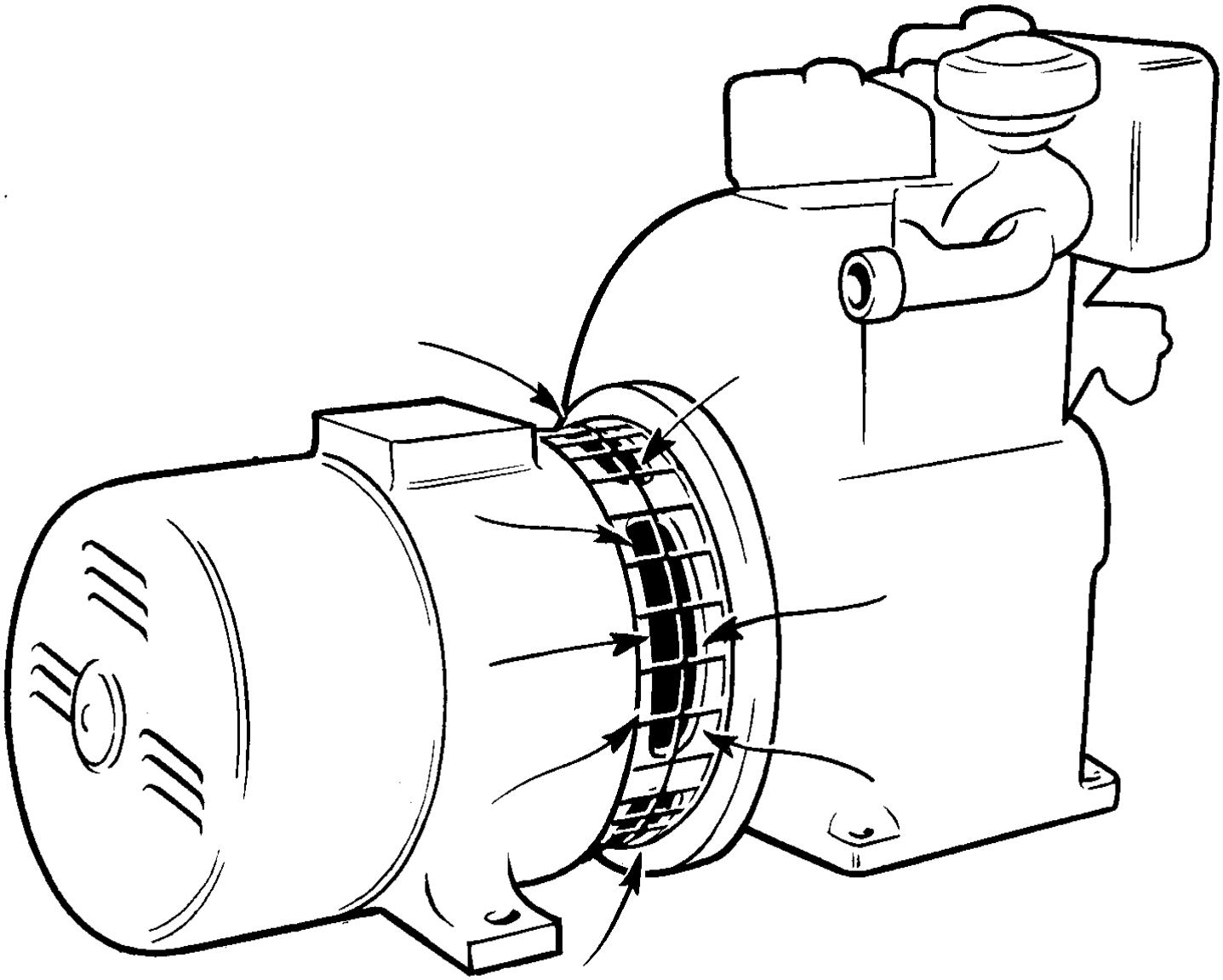


Fig. 8.—Engine close coupled to a driven machine.

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

30 sq. ins. for SL & SL1.

60 sq. ins. for SL & LD2.

90 sq. ins. for SL3.

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.

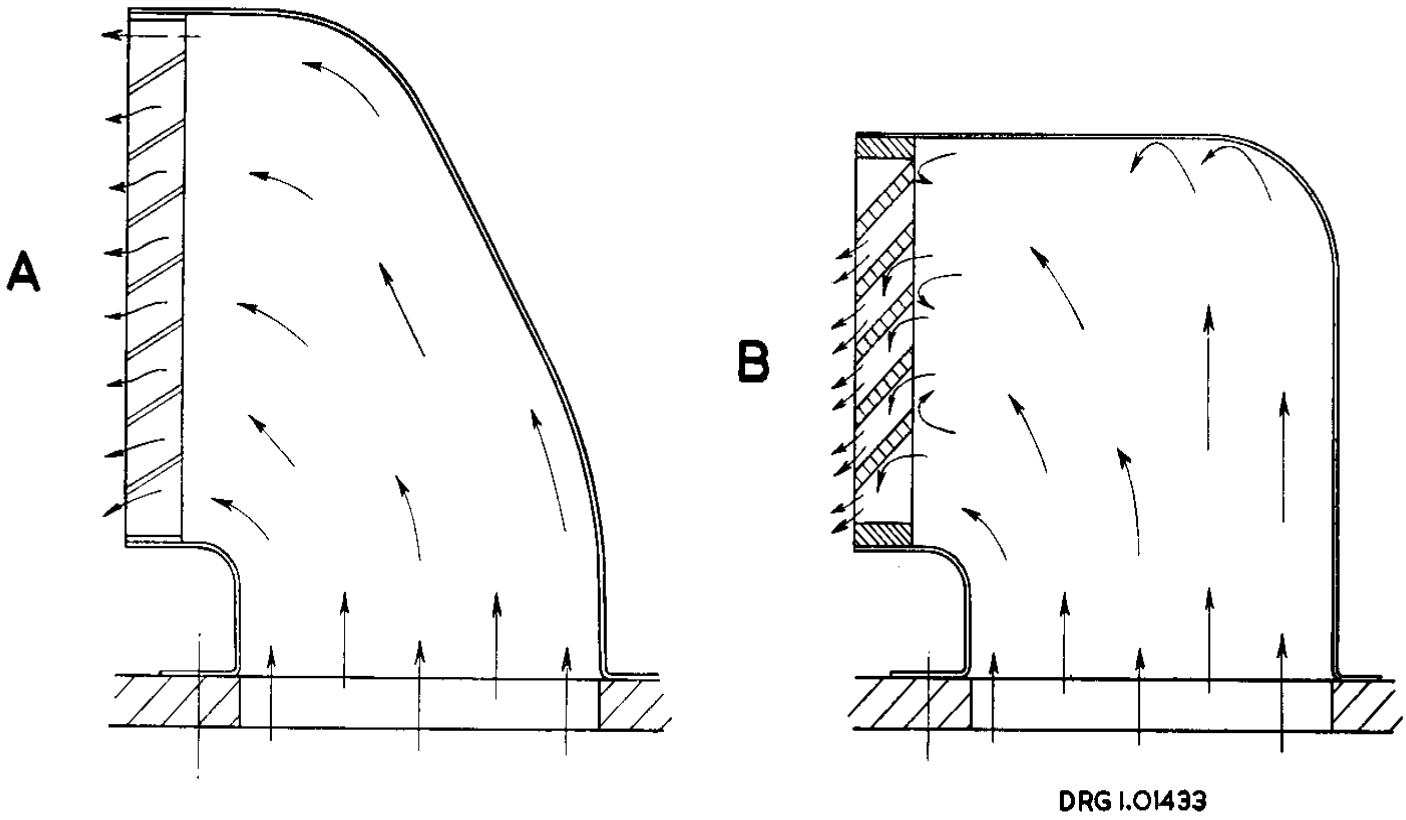


Fig. 9—Cowls.

CORRECT—

A Area through louvres or grille is at least 25 per cent greater than area of ducting.

WRONG—

B Louvres or grille obstructs air flow. Area through louvres is smaller than area of ducting.

Grilles, wire mesh or louvres placed in the air stream are obstructions and allowance must be made for them. The free flow area of these must be calculated to ensure that it is at least 25% greater than that specified for the inlet and outlet passages.

LUBRICATION

Specification

These engines must be run only on the best Heavy Duty (Detergent) Diesel Engine lubricants complying with British Standard Specification 1905/52 or U.S. Army Specification MIL-L-2104A.

Viscosity

The viscosity is to be SAE10W for starting temperatures below 85°F (38°C), Temperate Climate, and SAE20 for starting temperatures above 85°F, Tropical Climates.

Branded Oils

In order to assist engine users a list of brands of oil normally obtainable in world markets which have proved satisfactory in our engines is given on Page 21.

DO NOT MIX TWO DIFFERENT BRANDS OF OIL. THOROUGHLY DRAIN OFF THE ONE BEFORE ADDING THE OTHER.

Lubricating Oil System

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

The oil is drawn through a wire gauze strainer and ball suction valve. The suction valve and seating 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 a manifold. From the manifold the oil is distributed by two pipes pressed into the main bearing housings and a single pipe which lubricates the valve rocker gear.

The relief valve is carried into the securing plug for the oil pipes to the main bearings and incorporates a pressure reservoir which maintains oil pressure on the bearings during the suction stroke of the pump. The relief valve is set to open at 50 lbs./sq.in. and is not adjustable.

The crankcase may be drained through a drain plug at the back of the engine.

Before Starting or After Overhaul

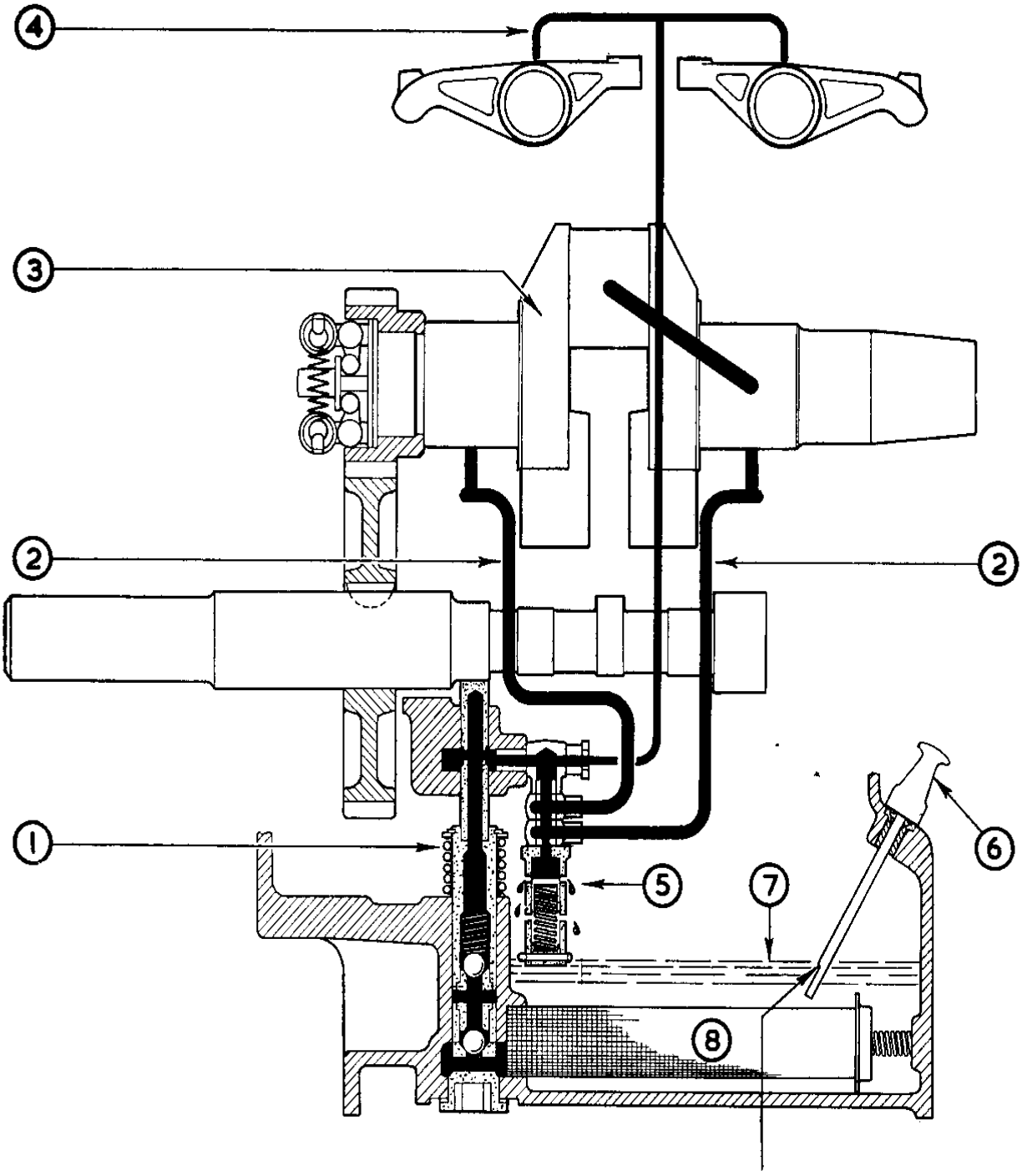
Fill the engine crankcase through the oil filler to the mark "max" on the dipstick. Top up when the engine has been stopped after the initial run.

Lubricating Oil Sump Capacity

Engine	Dipstick Position	Dipstick Identification No.	Max. angle of inclination at which engine may be run Flywheel Down	Flywheel Up	Approx. Oil capacity with engine level
LD/SL1	Crankcase	1	10°	10°	3½ pints
	Crankcase Door	17	10°	10°	3½ pints
LD/SL2	Crankcase	16	15°	15°	9½ pints
	Crankcase Door	19	15°	15°	*9½ pints
	Crankcase Door	18	15°	13°	**11⅝ pints
SL3	Crankcase	4	10°	10°	13⅜ pints
	Crankcase Door	8	15°	15°	**12 pints
	Crankcase Door	19	15°	10°	*13½ pints

*Door with Lift Pump, Oil Filter and Filler.
**Door with Dipstick only.

Remove crankcase door and turn engine fast until oil is seen to be discharged under pressure from the relief valve at each stroke of the pump.



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.

Fig. 10.—Schematic diagram of Lubricating Oil System

LIST OF OILS COMPLYING WITH B.S.S. 1905/52 or U.S.A. SPECN. MIL-L-2104A

OIL COMPANY	**Temperate Climates** SAE 10W BRAND	**Tropical Climates** SAE 20 or 20W BRAND
R. A. Lister & Co. Ltd.	Listroil L10	
Castrol Ltd.	Duesol CR 10 Castrol CR 10 Agricastrol HD10	Deusol CR 20 Castrol CR 20 Agricastrol HD 20
Alexander Duckham & Co. Ltd.	Duckhams HD 10/MIL	Duckhams HD 20/MIL Tractor Diesel 20
Edward Joy & Sons	Diesel Filtrate	Diesel Filtrate 20
Esso Petroleum Co. Ltd.	Essolube HD 10 Estor HD 10 Tro-mar HD 10	Essolube HD 20 Estor HD 20 Tro-mar HD20
Fina Petroleum Products Ltd.	Solco HD10 or 10W Solna HD10 or 10W	Solco HD20 or 20W Solna HD20 or 20W
Freedom-Valvoline Oil Co.	Valvoline VPR 206 Mil-O-2104	Valvoline VPR 306 Mil-O-2104
Germ Lubricants Ltd.	Germil 101	Germil 201
Gulf Oil (Great Britain) Ltd.	Gulflube Motor Oil HD10W Gulflube Motor Oil XHD10W Gulf Dieselube HD10W	Gulflube Motor Oil HD20/20W Gulflube Motor Oil XHD20/20W Gulf Dieselube HD20/20W
Mobil Oil Co. Ltd.	Delvac Oil 910 Mobiloil 10W (Overseas)	Delvac Oil 920 Mobiland Diesel 20
Power Petroleum Co. Ltd. (U.K.) B.P. Companies Overseas	B.P. Energol Diesel D-SAE 10W	B.P. Energol Diesel D-SAE 20W
Regent Oil Co. Ltd. Texaco/Caltex	Caltex RPM Delo Special SAE 10W Ursa Oil HD-SAE 10W	Caltex RPM Delo Special SAE 20 Ursa Oil HD-SAE 20W
Shell Group of Companies	Shell Talona Oil 10W Shell Rotella Oil 10W	Shell Talona Oil 20 Shell Rotella Oil 20/20W
Snowdon, Sons & Co.	Royal Snowdrift Apennine SAE 10	Royal Snowdrift Apennine SAE 20
Vigzol Oil Co. Ltd.	New Ace 10	New Ace 20

FUEL SUPPLY

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

	Class A
Viscosity, kinematic, at 100°F (37,8°C), centistokes, min.	1.6 (max. 7.5)
Redwood No. 1 secs. @ 100°F min.	30 (max. 45)
Saybolt Universal secs. @ 100°F min.	31 (max. 50)
Cetane number, min.	45
Carbon residue, Conradson, per cent by weight, max.	0.1
Distillation, recovery at 357°C per cent by volume, min.	90
Flash Point P.M. closed cup °F min.	130
Water content, per cent by volume, max.	0.1
Sediment, per cent by weight, max.	0.01
Ash, per cent by weight, max.	0.01
Sulphur, corrosive	Not more than slight tarnish
Sulphur content, per cent by weight, max.	1.3
Strong acid number	Nil

The purchaser must satisfy himself that his Engine is capable of dealing with the fuel at the lowest temperature to which it may be exposed.

The following fuel oils have been used with satisfaction in these Engines :--

Shell Diesolene.	Esso Diesel.
Shell Gas Oil.	Texaco 811 Diesel Gasoil.
Pratts Diesel Fuel A.	Mobil Diesel.
Essogasol.	Mobil Gasoil.

It must be understood, however, that different Fuel Oils become available in different areas and that variations in a particular brand of fuel oil may occur.

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

Vaporising Oils are unsuitable as fuel for Lister Diesel Engines.

In general, the fuel must be free from foreign matter or excessive wear will take place in the Fuel Injection system; some fuels are unsuitable owing to the excessive pressures resulting from their use or excessive carbon formation and chemical action on moving parts. 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.

Clean fuel is of the utmost importance in maintaining standard performance.

Fuel Tank

The fuel tank, capacity 1¼ gallons for Single cylinder engines or 2½ gallons for Twin cylinder engines, is carried on two cradles and secured by 2 steel straps to the front of the engine. The outlet connection projects upwards inside the tank to prevent any residue from entering the fuel system.

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.

The SL3 engine is supplied with a separately mounted fuel tank.

STARTING AND STOPPING

To Start Engine

(a) Check fuel and lubricating oil levels.

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

(c) Ensure fuel and lubricating oil systems are primed. (See Pages 35 and 19).

(d) If engine is fitted with fuel lift pump prime fuel filter by using priming lever on lift pump.

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

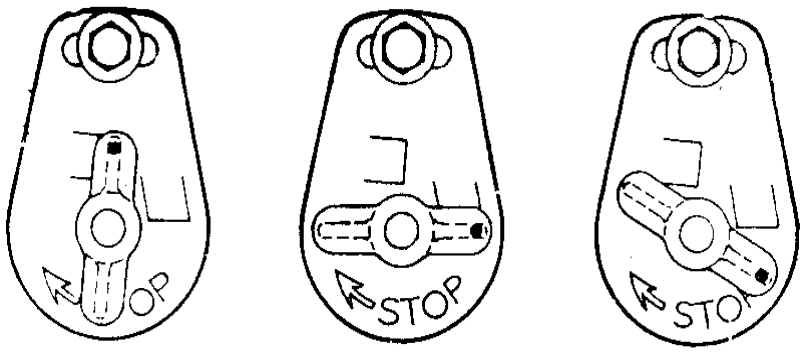
(f) Pull control lever outwards and allow it to rotate anticlockwise so that it abuts against the top stop and it is in a vertical position, see illustrations below.

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

(h) **Important.**—Turn 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 handle smartly in a clockwise direction move decompression lever(s) towards fuel tank and continue turning. Slip off starting handle when the engine fires.

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



START RUN STOP

Fig. 11.—Engine Control

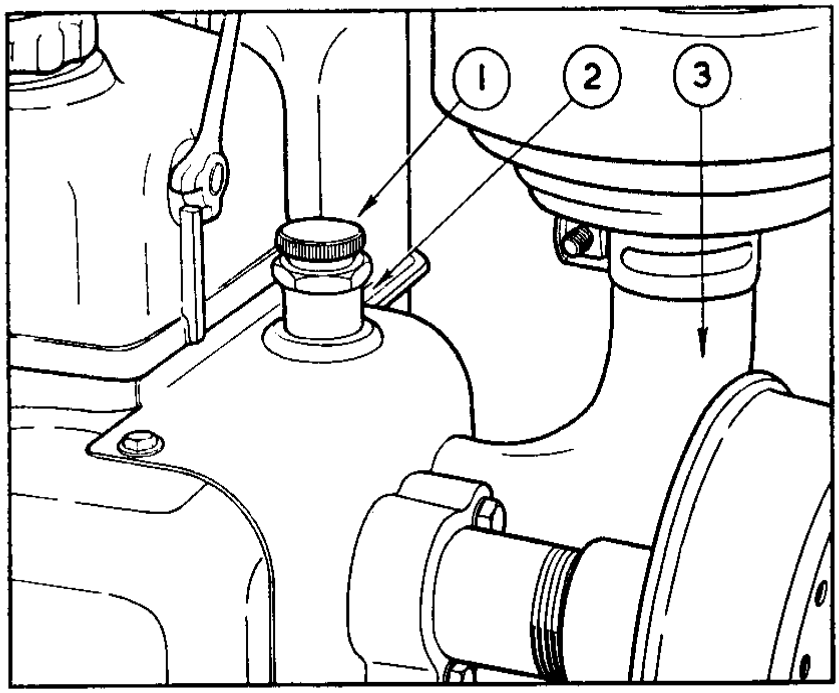
Starting Under Cold Conditions

An Oil Cup is provided, mounted on the Inlet Valve Port, 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 then follow the procedure 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 SAE 5W lubricating oil.



1.—Plunger.

2.—Oil Cup.

3.—Air Inlet.

Fig. 12.—Cold Starting Oil Injector Device.

To Stop Engine

Turn control clockwise and hold in this position until engine stops. When remote control is fitted, move lever to " 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 control as shown, a variable speed control can be fitted with a range of 800-1800 rev/min., this arrangement is illustrated on pages 40 and 42.

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 pages 55 and 56.

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 above 2½% without consulting the makers.

ROUTINE MAINTENANCE

When the Engine is in continuous use:—

Daily :

Check supply of Fuel Oil.
Check level and condition of Lubricating Oil. (Also in gearbox if fitted).
Clean Air Cleaner under very dusty conditions.
Drain moisture trap in Exhaust pipe, if fitted.

Every 100 Hours :

Clean Air Cleaner under moderately dusty conditions. Replace element if necessary.
Check for oil and fuel leaks—tighten Nuts and Fittings if necessary.
Wipe Engine and Baseplate clean.
Clean cylinder, cylinder head and injector finning under very dusty conditions.

Every 250 Hours :

Drain Oil and refill with correct grade and type.
Check injector spray and clean if necessary. Do not clean at shorter periods unless absolutely necessary.

Every 500 Hours :

Decarbonise if engine shows loss of compression, or blow by the piston. Do not disturb otherwise.
Adjust Valve clearances.
Wash Engine down with Paraffin or Fuel Oil.
Clean cylinder, cylinder head and injector finning under dusty conditions.

Every 1500 Hours :

Decarbonise.
Clean Inlet Manifold and Exhaust System.
Examine Fan Blades and Clean.
Check Free Working of Governor Linkage.
Drain and clean Fuel Tank.
Clean Fuel Filter Element. Replace if necessary.
Adjust Injector Pressure setting.
Check Fuel Pump Timing and Balancing.
Clean cylinder, cylinder head and injector finning under normal conditions.
Check lubricating oil pump valve assemblies.

Every 5000 Hours :

Check Big End 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.

MAINTENANCE

Breather

The crankcase breather, in the form of a copper pipe, is screwed into the top of each cylinder head and connects with the inlet port.

The oil laden vapour is drawn into the Inlet Port and a partial vacuum maintained in the crankcase. This prevents the Lubricating Oil from working out through the joints and bearings.

Fuel Filter

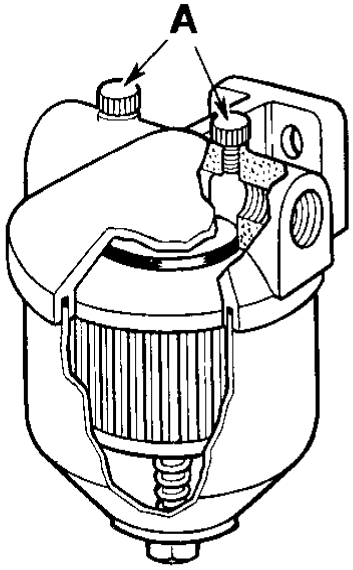
The fuel filter is an essential component of a Diesel Engine and it must not be removed or used without a filter element.

Clean or renew the element every 1,500 hours if clean fuel is used, if fuel is known to be dirty for any reason attend to filter more often.

The element may be washed in clean paraffin or fuel oil, taking care to prevent dirt reaching the inside of the element or delivery pipes. Clean inside the Bowl.

Assemble carefully and prime fuel system by slackening the two vent screws 'A' shown in the illustration below and one vent screw in the outlet banjo until all air is removed. Tighten the vent screws securely.

If the engine runs erratically it should be further primed at the fuel pump inlet union(s) which is (are) accessible after removing the fuel pump housing cover.



A—Vent Screws.

Fig. 13.—Fuel Filter

Air Cleaner

An oil bath type of cleaner must be cleaned according to the amount of foreign matter in the air.

Dismantle and wash in paraffin. Dry thoroughly before reassembling.

The oil level must be maintained up to the mark.

Air Cleaner—Dry Type (Paper element)—Cleaning Instructions

Unscrew knurled nut and remove shroud.

LIFT OFF ELEMENT TAKING CARE THAT DUST DOES NOT DROP INTO INTAKE ORIFICE.

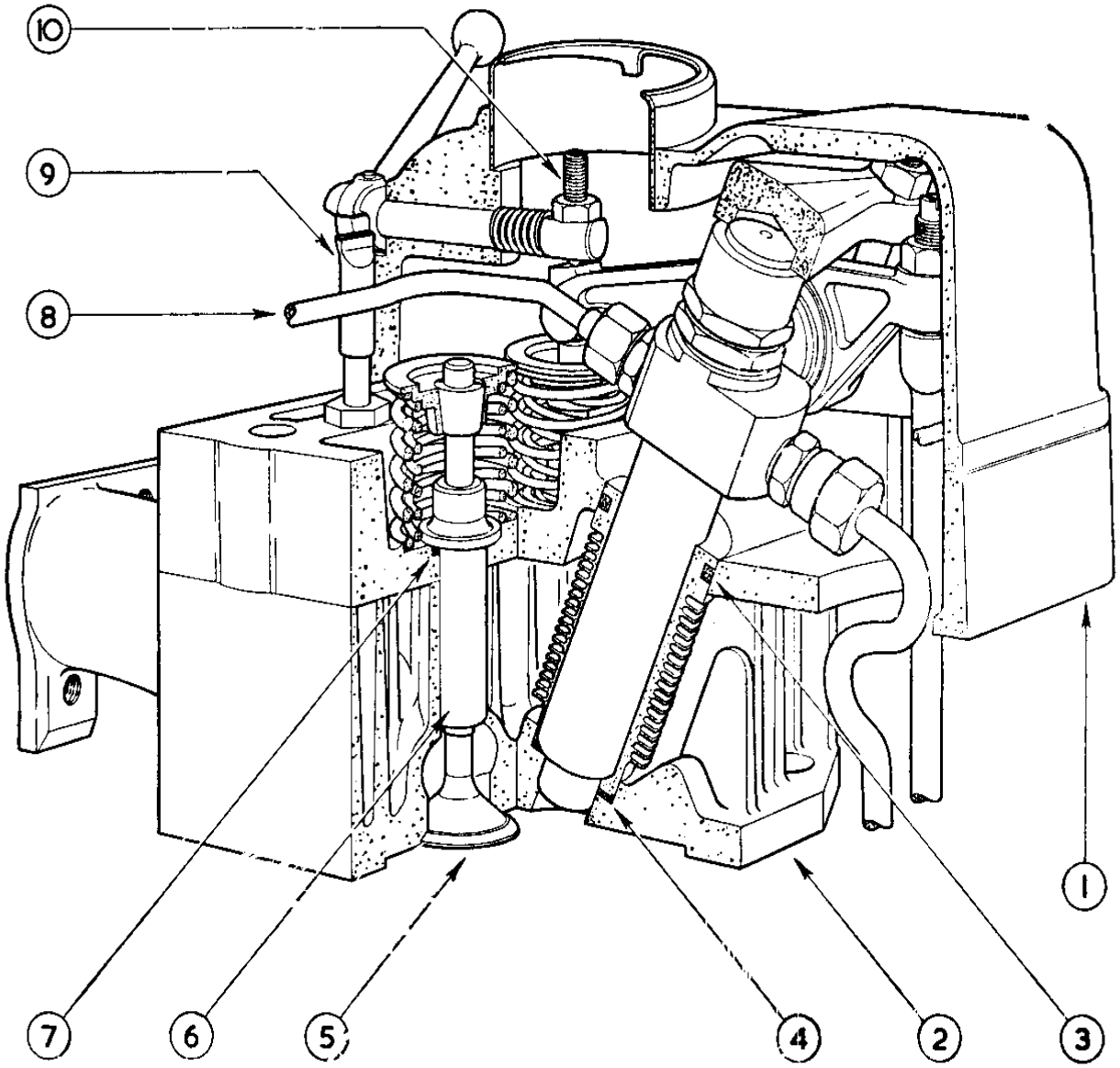
Tap Element on palm of hand to dislodge the bulk of the caked dust, then blow compressed air, at a nozzle pressure not exceeding 100 lb/sq.in., through the Element from inside to out. This should be done in a hosing motion along the length of each pleat in turn.

It is important that the tapping should not be too severe since damage to the plastic end seals could allow contaminated air to by-pass the Element.

After cleaning hold the Element to a light and inspect each pleat in turn for rupture, a hole in the paper would render the whole Element ineffective.

Clean neck and inside of shroud with a damp cloth and reassemble.

Tighten knurled nut until shroud cannot be rotated.



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.

Fig. 14.—Cylinder Head

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.
(j) Air shroud at back of cylinder.
(k) 4 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.

Injector Sleeve.

This need not be removed from the Cylinder Head unless it is necessary to separate the two parts. It may, however, lift out with the injector, in which case the carbon must be brushed from the projecting part of the injector with a wire brush, care being taken not to damage the pintle valve which projects through the end of the injector, and then push the injector out of the sleeve. Be careful to replace injector sleeve washer (No. 4, Fig. 14). There is no washer between the injector and its sleeve.

To Replace Cylinder Head.

Examine Cylinder Head Gasket—renew if damaged.

Replace Cylinder Head and pull down the 4 nuts evenly. Tighten to a torque of 40 lb. ft. This is very tightly with a spanner about 7″ long.

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

Note :—The inlet and exhaust flanges of all cylinder heads must be lined up with a straight edge before finally tightening down to avoid distortion when fitting the manifolds.

To Check Cylinder Head Clearance.

Place a piece of lead wire .048″ x 1″ on top of piston clear of valve recesses and combustion chamber in the top of the piston.

Tighten down Cylinder Head and turn piston past T.D.C.

Remove Cylinder Head and measure thickness of lead. This should be between .030″ (.76 mm.) and .033″ (.84 mm.) and may be adjusted by copper shims .003″ (0.75 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 Gudgeon Pin, immerse Piston in hot water, remove Spring Circlip and Gudgeon Pin may be pushed out.

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

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 in its own groove.

Measure the gap between the ends of the new ring when placed in the bottom of the cylinder. This should be between .008″ and .020″ (.20/.50 mm.).

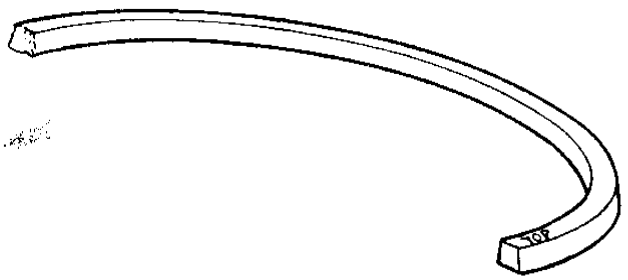


Fig. 15.—Piston Ring.

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 large end of the taper at 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 .005" (.127 mm.) measured with a feeler pushed between the two.

Oil and place piston and connecting rod in cylinder block. Place one copper joint at base of cylinder block.

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

Turn piston with wording 'CAMSHAFTSIDE' towards camshaft (fuel pump housing).

Turn crankshaft to T.D.C., lower into position Cylinder complete with Piston and Connecting Rod, and when the Connecting Rod Bolts have passed over the crankpin, turn crank towards door as Piston is pressed down.

Assemble Big End Bearing according to the identification marks and secure with the self locking nuts. Correct tightening torque is 12 lb. **ft.**

Connecting Rod Big End Bearings.

Big End Bearings are copper-lead lined 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 becauseof 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 Bearings.

Engines are built with steel backed, split bush main bearings with separate thrust washers. The top half is whitemetal lined and the bottom half copper lead lined. When re-assembling an engine, care must be taken that the 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 end of bearing is 1/16" below Housing on inside edge.

Valve Adjustment.

Valves should be retained in their respective guides when decarbonising.

Valve clearance must be set to .002" (.05) mm..) Cold for both Inlet and Exhaust Valves, above 1200 rev/min. Below 1200 rev/min. Inlet .002". Exhaust .006".

To adjust, turn the Piston to T.D.C. firing stroke. Remove cylinder head cover. Slacken locknut on adjusting screw and turn screw until correct clearance is obtained. Tighten locknut.

The Valve rocker operates directly on to the valve stem.

Inlet Valve	Opens	10° B.T.D.C.
	Closes	30° A.B.D.C.
Exhaust Valve	Opens	30° B.B.D.C.
	Closes	10° A.T.D.C.

Valve heads must be between .015" and .020" (0.38– 0.5 mm.) under the face of the cylinder head.

The width of Valve Seats must be .064"—.083" (1.63—2.1 mm.). This width can be obtained by increasing the depth of the recess in the head using Tool No. 317-86.

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). (Do not remove.)
(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 Piston to TDC firing stroke.

Move decompressor lever over towards Flywheel.

Slacken locknut and turn decompressor screw down until exhaust valve touches the piston. Turn screw back $\frac{1}{2}$ turn and tighten locknut.

When no filler is provided in the cylinder head cover the decompressor should be adjusted so that when the cover is tightened down in position, the eccentric just touches the valve rocker when operated. The adjusting screw should then be screwed down a further $\frac{3}{4}$ 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 2 Turns before loosening the Flywheel on the taper.

Air Cooling Fan (LD1 or SL1 with standard aluminium shroud).

To ensure that the fan has side clearance inside the fan cowling the latter is positioned axially by means of joint or shims between the bearing housing and the fan cowl so that there is between .040″ and .090″ (1.0—2.25 mm.) clearance between the side of flywheel and the fan cowling.

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.

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.

Camshaft.

The camshaft is carried in porous bronze bushes. One bush is pressed into the end cover and the remainder into the crankcase.

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

To Remove Camshaft.

(a) Remove fuel pump cover.
(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) 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 Time Camshaft.

The camshaft is timed by matching the letters 'O' on the camshaft gearwheel and the crankshaft pinion.

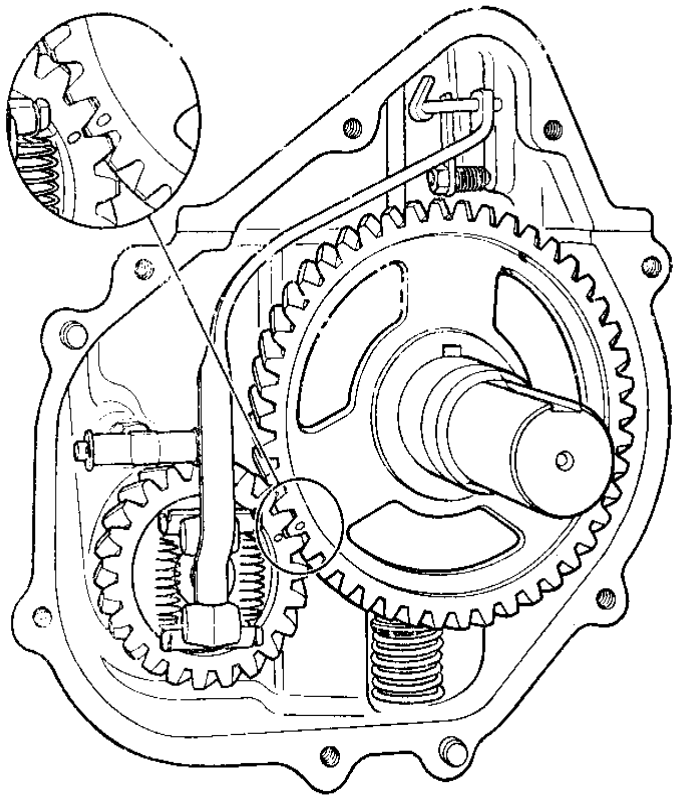


Fig. 16.—Camshaft Timing.

Governor.

The engine speed governor is attached to the pinion end of the crankshaft and secures the pinion to the shaft.

The governor weight carrier plate is fitted into a recess in the crankshaft pinion and is secured by two setscrews.

The governor lever operating the fuel pump(s) is carried in a fulcrum bearing secured to the crankcase above the pinion. This bearing, fitted so that the centre line of the bearing is approx. $\frac{3}{4}$" 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(s) by a link arm.

To Replace End Cover.

Clean joint faces, fit new joint with sealing compound both sides.
Fit end cover. **NOTE : Care must be taken not to damage oil seal.**
Hook speeder spring onto governor link.
Fit seven bolts and copper washers in end cover.
Fit banjo bolt and washers to connect fuel pipe to filter.
Fill tank with fuel.
Bleed fuel system at all points.
Replace fuel pump housing door.
Start engine.
Adjust speeder spring screw to required speed and tighten lock-nut.

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 sweated 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.
Pump plunger and tappet may now be pushed out.
Remove 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 impeller trunking.

(e) Remove crankcase door.

(f) Remove lubricating oil relief valve and oil pipes to main bearings.

The Housing may now be removed from the crankcase.

Before replacing see the main bearing bush is in correct position—lubricating oil holes in line.

Crankshaft end play must be between .005″ and .009″ (0.12/0.21 mm.). This can be adjusted by **metal shims** of .005″/.010″ (0.127—0.254 mm.) thickness between housing and crankcase. No paper joints must be used but the metal shims must be joined with clean jointing compound on both sides.

When replacing the fan cowling the vertical edge must be in line with the face of the inlet and exhaust port flange on the cylinder head.

To Remove Crankshaft.

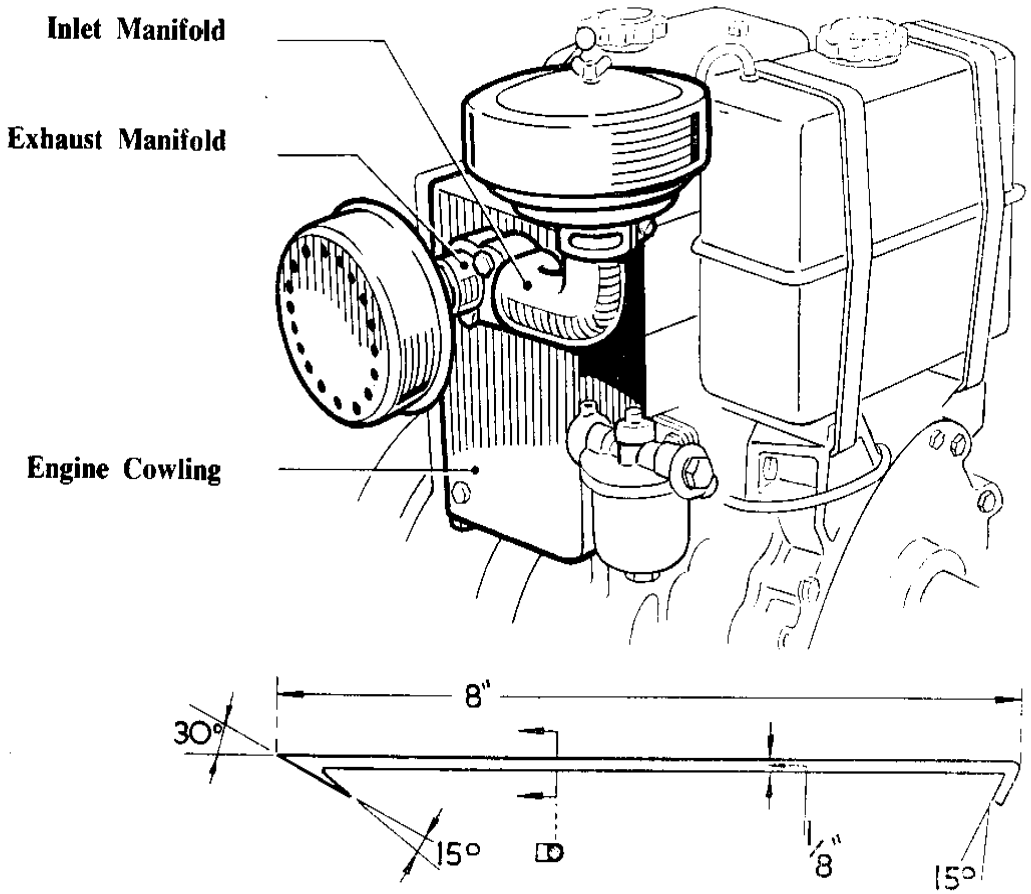
(a) Remove piston(s) and connecting rod(s).
(b) Remove gear end cover.
(c) Remove governor and control rod.
(d) Remove crankshaft pinion (shrunk and keyed to crankshaft, to replace heat in boiling water).
(e) Remove main bearing housing and centre bearing locating dowel (using a $\frac{1}{4}$" UNF bolt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

Replace in the reverse order for 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.

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.



Engine fin rake (Cleaning Tool 367/16170)

Fig. 17.—Cleaning Cooling Fins

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 periods.

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 piston 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.

Engines installed in agricultural machinery such as balers normally require cleaning at the end of the season, although if conditions are very dusty, cleaning may become necessary twice a season.

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 on page 33. 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 sleeve fins it is necessary to withdraw the injector sleeve from the cylinder head, after removing the injector.

Laying-up Procedure.

The following routine should be carried out when it is known that the engine will not be required for some weeks.

1. Replace fuel in tank with a small supply of Shell Fusus Oil A or equivalent.
2. Drain lubricating oil from sump and refill with Shell Ensis 453 oil or equivalent.
3. Run the engine for a period to circulate the Ensis oil through the system and to ensure the Fusus Oil 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 Fusus oil should be left in the fuel system.
5. Seal all openings on the engine with tape.
6. Remove batteries and store fully charged, with terminals coated with Vaseline (petroleum jelly). (Electric start engines).
7. Grease all external bright parts and control linkage, etc.
8. Tie labels on the engine clearly stating its condition.

FUEL EQUIPMENT

These engines can be overloaded without the user realising it, because even a fraction of a horse power is a big proportion of the total engine output. If a smoky exhaust is noticed in an engine the first thing to check is the setting of the overload stop.

The directions of how to adjust the overload stop are given on page 37.

The injectors are most unlikely to be the cause of smoky exhausts in LD/SL engines and should only be disturbed after the overload stop has been properly set, 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 avalaible 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 in the leaflet "Let me Breathe".

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 washer 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.

To Prime Fuel System.

(i) Fill fuel tank.

(ii) Vent fuel filter (See Page 26).

(iii) Vent fuel pipe at fuel pump(s). Turn engine as for starting, i.e., 3 to 20 times until injector(s) 'creak(s)' and then attempt to start the engine. If the engine fails to start, a more detailed method of priming must be used as follows :—

(a) Remove cylinder head cover(s).

(b) Remove fuel injector pipe(s).

(c) Remove delivery valve holder and spring on each pump in turn and slightly raise delivery valve until fuel free from air flows. (At least $\frac{1}{4}$ pint fuel must be allowed to flow.)

(d) Replace delivery valve spring and holder and tighten down each pump in turn.

(e) Connect fuel injector pipe(s) to pump(s). Do not twist the pumps on their seatings.

(f) Set control to start position.

(g) Turn engine until fuel free from air flows from injector pipe(s). Secure pipe(s) to injector(s) and continue turning engine until injector(s) 'creak(s)'.

With the Engine Control in the Run position, and a .027" (0.69 mm.) feeler inserted as shown at Item 6, Fig. 19, the calibration mark on the Fuel Pump rack must be against the Fuel Pump Body. This setting can be obtained by an adjustment of the quadrant on the Engine Control (Item 3, Fig. 19) but the works setting must not be altered unless a new fuel pump is fitted.

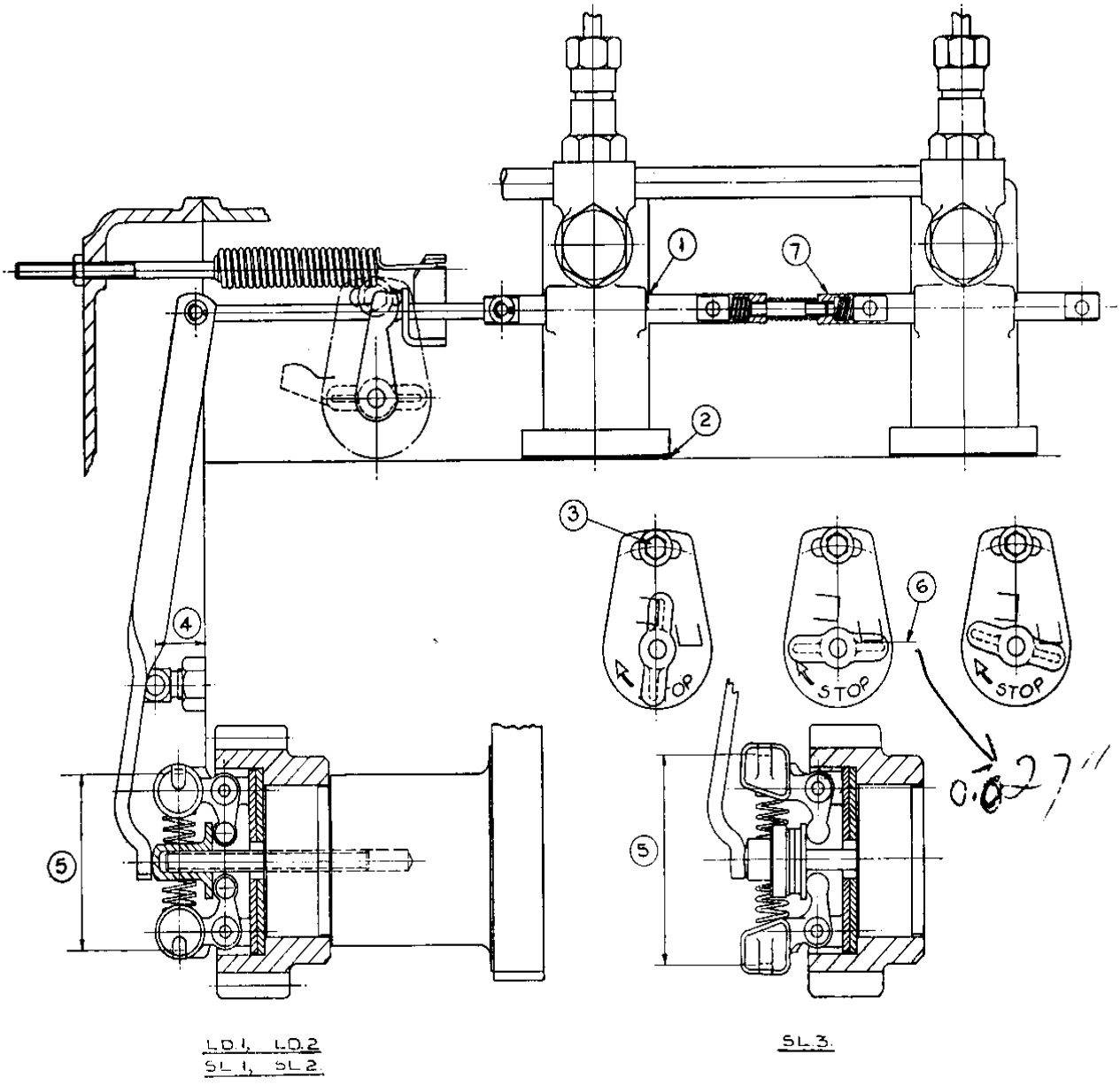


Fig. 19.—Setting Fuel Pump.

SETTING FUEL PUMP

1. Calibration mark on Fuel Pump Rack, to be against side of Fuel Pump Body.

2. Fuel Pump Shims, for setting pump timing see Page 38.

3. Engine control Quadrant adjusting screw.

4. Governor Lever Fulcrum Bearing Adjustment, to be set to give (1) and (5).

5. Governor Weight Setting—Distance between Spring Grooves; LD & SL 1 and 2=2 3/16"; SL3=2 9/16".

6. Feeler $\frac{1}{8}$" wide and of a thickness equal to the overload setting figures given below. Quadrant to be adjusted to this clearance on lever, when fuel pump rack is in position (1) using screw (3).

Condition	Thickness of Overload Setting Shim
(a) Engines operating in temperate climates and at sea level	0.027" (0.686 mm.)
(b) Engine operating in temperate climates and at sea level, but driving a load which controls its speed because the loading torque is greater than the engine torque, for instance, an engine driving an excessively large centrifugal water pump	0.025" (0.635 mm.)
(c) Engines operating at altitudes up to 5,000 feet or in tropical climates approx.	0.022" (0.559 mm.)

7. To set Fuel Pumps for multi-cylinder engines adjust No. 1 Pump and Governor as notes (1) to (6), then line up other Pump calibration marks against side of fuel pump body by removing pin of shackle (7) and rotating it.

Note.—The linkage between pumps must be adjusted so that the calibration marks for all pumps are simultaneously against the respective pump bodies. The fuel pump racks **must** move freely after this adjustment has been made.

To Time Fuel Pump.

(a) Set control to start position.
(b) Turn flywheel to firing position—On LD1 and SL1 engines, this is when mark ⌐ on the flywheel is opposite the centre mark on the fan shroud and both valves are closed. On LD2, SL2 and SL3 engines the firing position is when the mark ⌐ is opposite the arrow over the window on the side of the fan shroud near the fuel pumps, and both valves are closed (see illustrations).

A table is given below showing the injection timing for all these engines.
(c) Disconnect fuel injector pipe at pump and injector.
(d) Remove delivery valve holder, delivery valve and spring. If fuel flows from pump turn crankshaft forward until flow ceases.
(e) Replace delivery valve holder without valve and spring and lightly tighten.
(f) Turn crankshaft backwards until fuel commences to flow then turn in direction of rotation until flow ceases. Blow fuel from top of 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 trunking. If it is not, the shims below the pump body must be adjusted.

Remove shims to advance.

Add shims to retard.

Shims of .005″ and .010″ to a total of about .035″ are below the fuel pump.
0.005″ (.125 mm.) Shim is equal to 3/16″ (4.76 mm.) on rim of 14″ (35.5 cm.) Flywheel and 13/64″ (5.16 mm.) on a 15″ Flywheel.

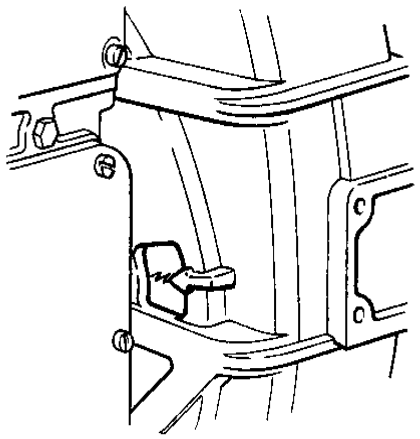


Fig. 20.—Fuel Pump Timing

*On SL2 and SL3 & LD2 engines the mark ⌐ is on the **side** of the flywheel—These figures which are measured on the flywheel **rim,** or periphery are given for guidance only.

FUEL INJECTION TIMINGS

Engine	B.T.D.C. Timing Degrees	Diameter of Flywheel	Distance Measured on Flywheel Rim
LD1	28	14″ (35.6 cm.) 16″ (40.6 cm.)	3.42″ (8.8 cm.) 3.91″ (9.9 cm.)
SL1	30	14″ (35.6 cm.) 16″ (40.6 cm.)	3.66″ (9.3 cm.) 4.2″ (11.2 cm.)
LD2, SL2 & SL3	30	15″ (38.1 cm.)	3.93″ (10.0 cm.)*

Fuel Injector (Pintle Nozzle Type)

The fuel injector, located in the cylinder head, fits into a finned aluminium alloy sleeve. The sleeve is jointed at the bottom on an asbestos joint ring and at the top by a rubber ring which fits into a groove. See Fig. 14.

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 12 lb. ft. torque ensuring that the clamp is level and bears evenly on the injector. The steel fuel pipe from the pump to the injector **must not** be tightened until the clamp is correctly secured.

There is no joint between the injector and the sleeve.

FUEL INJECTOR TESTING INSTRUCTIONS

Injectors. Testing Instructions.

LD & SL 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 finely atomised fuel is delivered, the bulk of the fuel going through after the needle has lifted a fixed amount. This feature gives a good combustion and quietness.

It is strongly recommended that the nozzle is not 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 it should be inspected every 250 hours and the instructions given below must be followed.

Due 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. This setting is higher than the normal one of 150 atmospheres and is to allow for the inevitable fall in pressure during the 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 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 150 atmospheres and noting the time the pressure takes to drop from 120 to 70 atmospheres. This time must be between 15 secs. and 70 secs. (Alternatively measure the time between 150 and 100 atmospheres which must be 10 secs. to 45 secs.) 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* (Part Number 317/92). Set the overload stop to the running position (external lever horizontal) turn the engine from the camshaft at about 60 r.p.m. camshaft speed and observe the spray in the usual way. To test a nozzle remove the injector from the cylinder head and turn so that it sprays into the air **away** from the operator (the spray can easily penetrate the skin). A perfect spray is in the form of a fine mist and shows no signs 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.

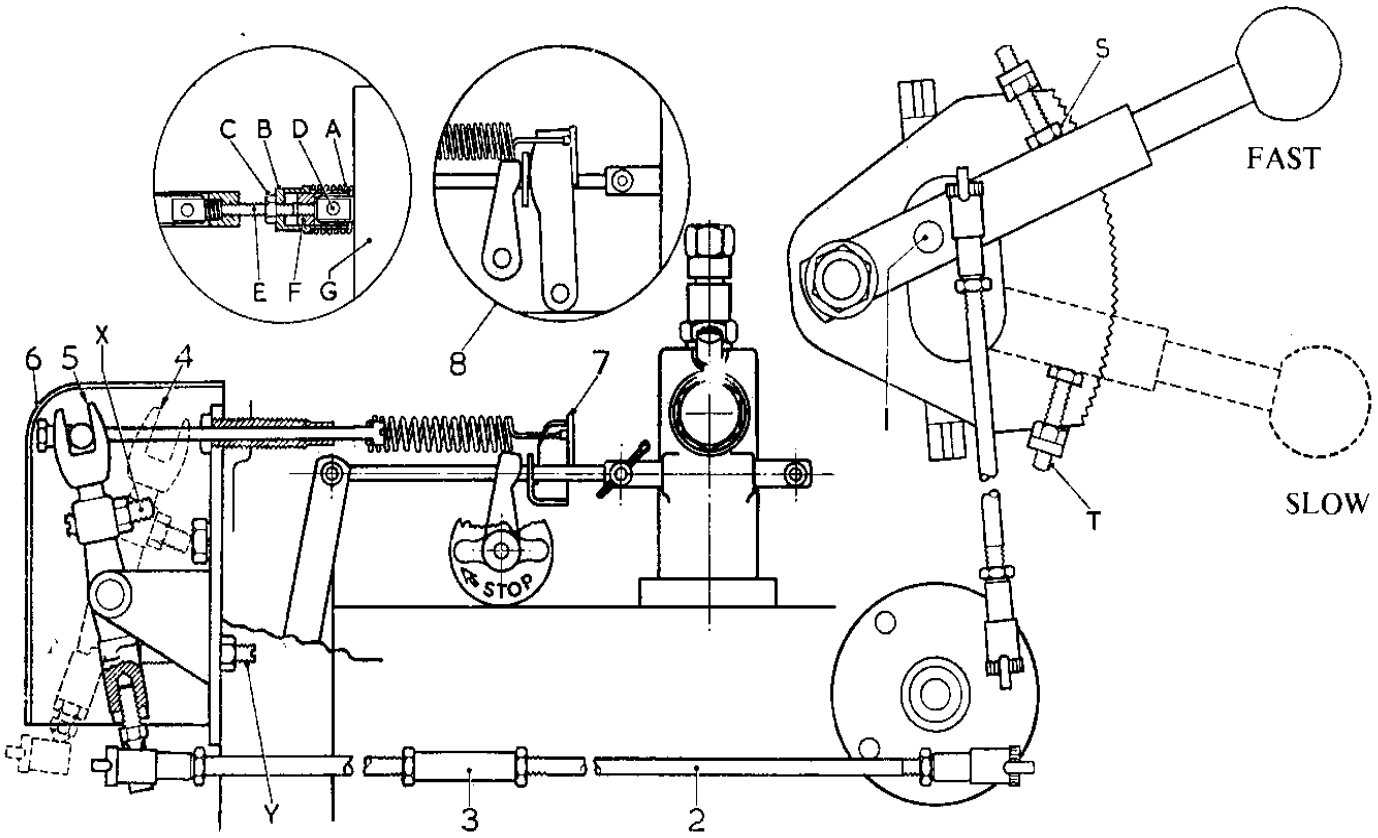


Fig. 18.—Arrangement of LD & SL Rod Operated Variable Speed Control

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

1. Alternative position for connecting rod.

2. For flexibly mounted engines 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 LD1/2 and SL1/2 engines.

8. Fuel pump linkage for SL3 engine.

Instructions for Adjusting Speed Control

LD/SL1 engines only. With the control lever in the "Slow" position—engine in neutral adjust screw 'X' until the idling speed is 650 rev./min. (approx.) and tighten nut.

LD/SL2 and SL3 engines. The device consists of an idling 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 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.

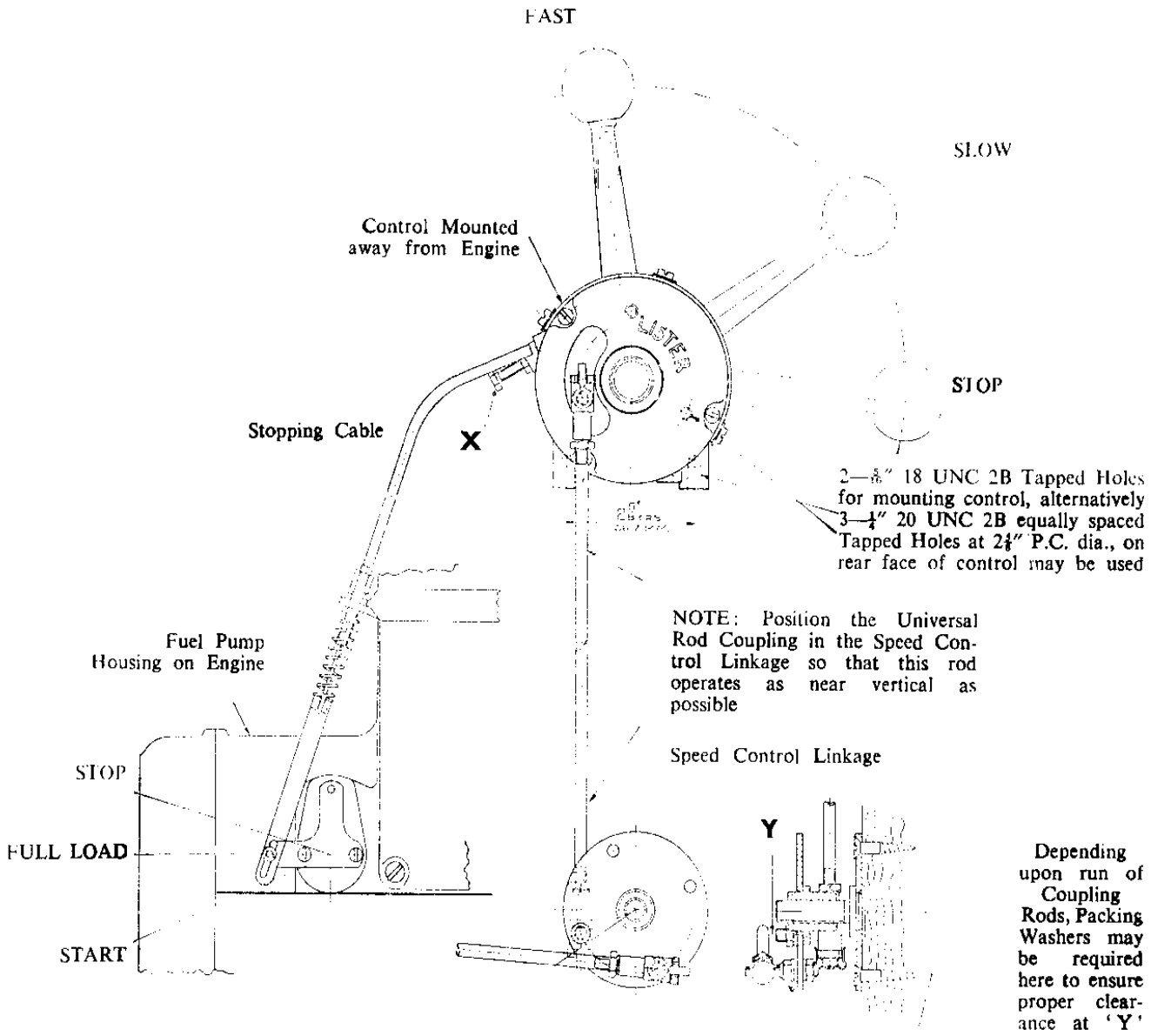
The speed control on the engine has an idling adjusting screw which should now be adjusted so that the main speeder spring just begins to increase the engine speed, and then screwed anti-clockwise one turn. The speeder spring must not exert any force when the engine is idling.

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 and tighten 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.



Arrangement of Single Lever Speed and Stop Control

ADJUSTMENT

Engine idling at 650 r.p.m.: Adjust connecting rod to hand control so that the hand lever is in bottom notch of ratchet in the speed sector.

Engine at full speed 1800 r.p.m.: With hand lever held in the full speed position, set adjustable stop X so that it just touches the hand lever. Tighten 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 above 2½% without consulting makers.

GOVERNOR WEIGHTS & SPRINGS — CONSTANT SPEED

BSS 649 : 1958 Class A (Clause 5)

SINGLE & TWIN CYLINDER ENGINES—

ENGINE Speed r.p.m.	WEIGHTS 2 off		WEIGHT SPRING 2 off		SPEEDER SPRING 1 off	
	Part No.	Type	Part No.	Colour	Part No.	Colour
750-850	201-10730	Plain	201-10821	Green	201-10901	Blue
850-1000	201-10730	Plain	201-10821	Green	201-10903	Yellow
*1100-1300	201-10730	Plain	201-10821	Green	201-10900	Red
1400-1700	201-10730	Plain	201-10820	Red	201-10900	Red
1700-1800	201-12960	Drilled	201-10820	Red	201-10900	Red
2000	201-10735	Milled	201-10820	Red	201-10900	Red

THREE CYLINDER ENGINE—

*1150-1300	351-11500	Plain	201-10820	Red	201-10903	Yellow
1500	351-11500	Plain	203-10822	Yellow	203-10901	Green
1800	351-11501	Drilled	203-10822	Yellow	203-10901	Green

*See Page 29—Valve Adjustment.

GOVERNOR WEIGHTS & SPRINGS — VARIABLE SPEED

BSS 649 : 1958 Class B

Engine Type	Rev/min. Range	Governor Weight			Speeder Spring			Idling Spring	
		Part No.	Type	No. per Set	Part No.	Colour	No. per Set	Part No.	No. per Set
LD1 &	600-1800	201-10733	Milled	2	201-10900	Red	1		
SL1	700-2000	201-10732	Milled	2	201-10900	Red	1		
LD2 &	600-1800	201-10733	Milled	2	201-10900	Red	1	204-21491	1
SL2	700-2000	201-10732	Milled	2	201-10900	Red	1	204-21491	1
SL3	600-1800	354-21561	Milled	2	203-10903	White	1	204-21491	1

INSTRUCTIONS FOR CHANGING SPEEDS OF LD & SL ENGINES

FIXED SPEED

Note : Before starting consult table on page 43 to check which of the Governor Weights and Springs are to be changed.

Remove screws from Fuel Pump Housing Door.

Unhook speeder spring from Governor Link.

Remove banjo bolt at filter connecting the pipe to the pump.

Drain fuel tank.

Remove seven bolts securing end cover.

Remove end cover complete with tank and filter.

To Change Governor Weight Springs Only

Unhook governor weight springs.

Fit new springs (consult table).

To Change Speeder Spring

Remove speed adjusting screw from end cover.

Remove spring and fit new speeder spring.

Fit screw into cover and replace lock-nut.

To Change Governor Weight

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

Remove governor lever.

IMPORTANT NOTE : DO NOT TOUCH THE GOVERNOR LEVER FULCRUM.

Remove governor thrust sleeve.

Remove two bolts securing the governor weight carrier.

Remove carrier and weights.

Remove pins, fit new governor weights and replace pins.

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

Re-fit carrier complete with weights and pins and secure by means of two bolts.

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

Fit governor weight springs (consult table).

Replace 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.

(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) Too much 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 period 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 26.)

(b) Overload.

(c) Overheating, due to shortage of lubricating oil.

(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 injection system. Fuel injector or fuel pump out of order.

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.

DIRECT DRIVE CLUTCH

Direct Drive Clutch.

The clutch fitted to either the crankshaft or camshaft is of the single plate type. 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.

All parts are lubricated on assembly (Shell Alvania Grease No. 2) or other equivalent high melting point grease and a grease nipple is provided for the clutch cross shaft.

Adjustment

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 screw driver and when dis-engaged from the 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.

IMPORTANT

Unified threads conforming to International Standard are used where applicable.

A Locking piece for adjusting ring
B Driving member
C Clutch plate
D Adjusting ring
E Lubricator for cross shaft

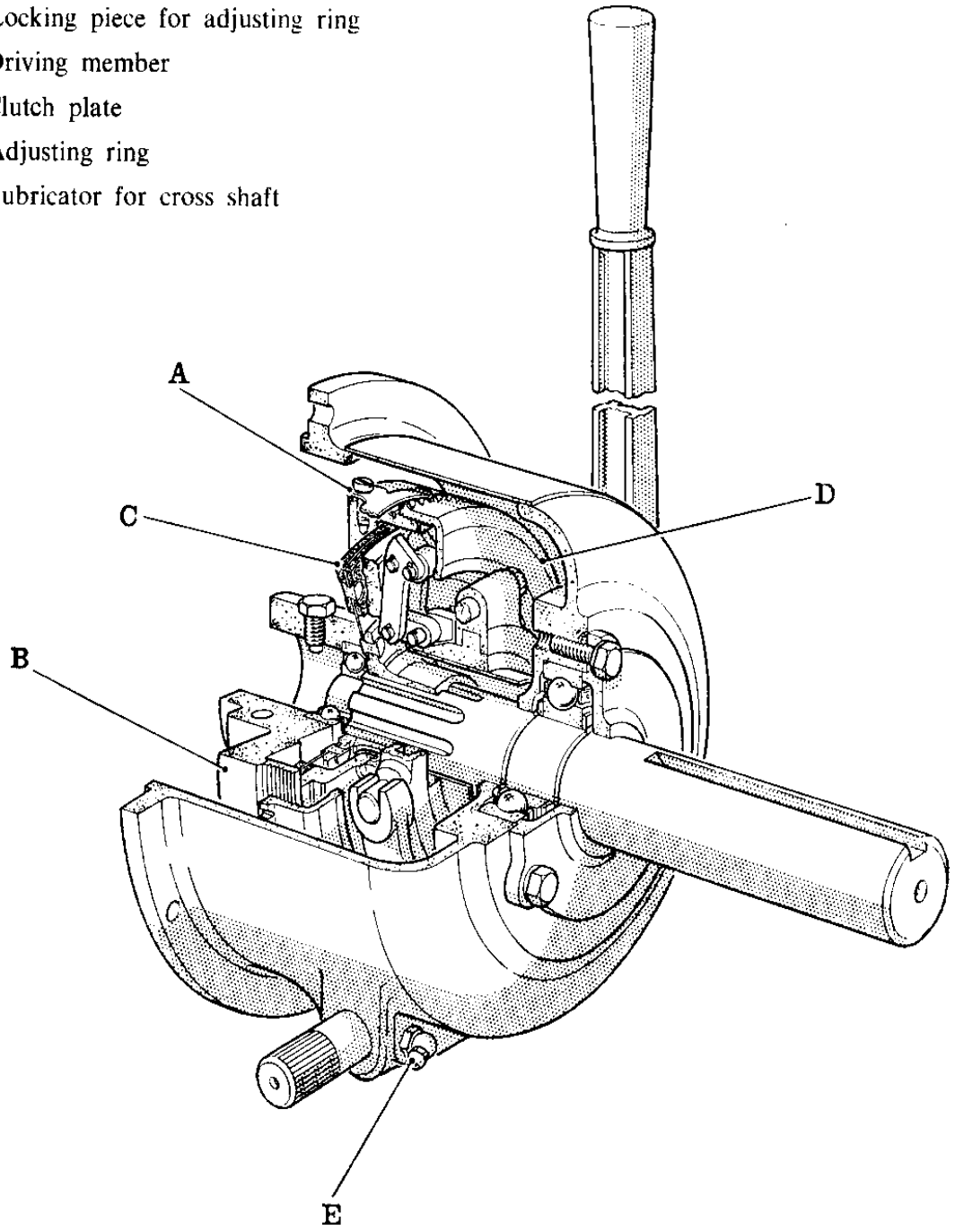
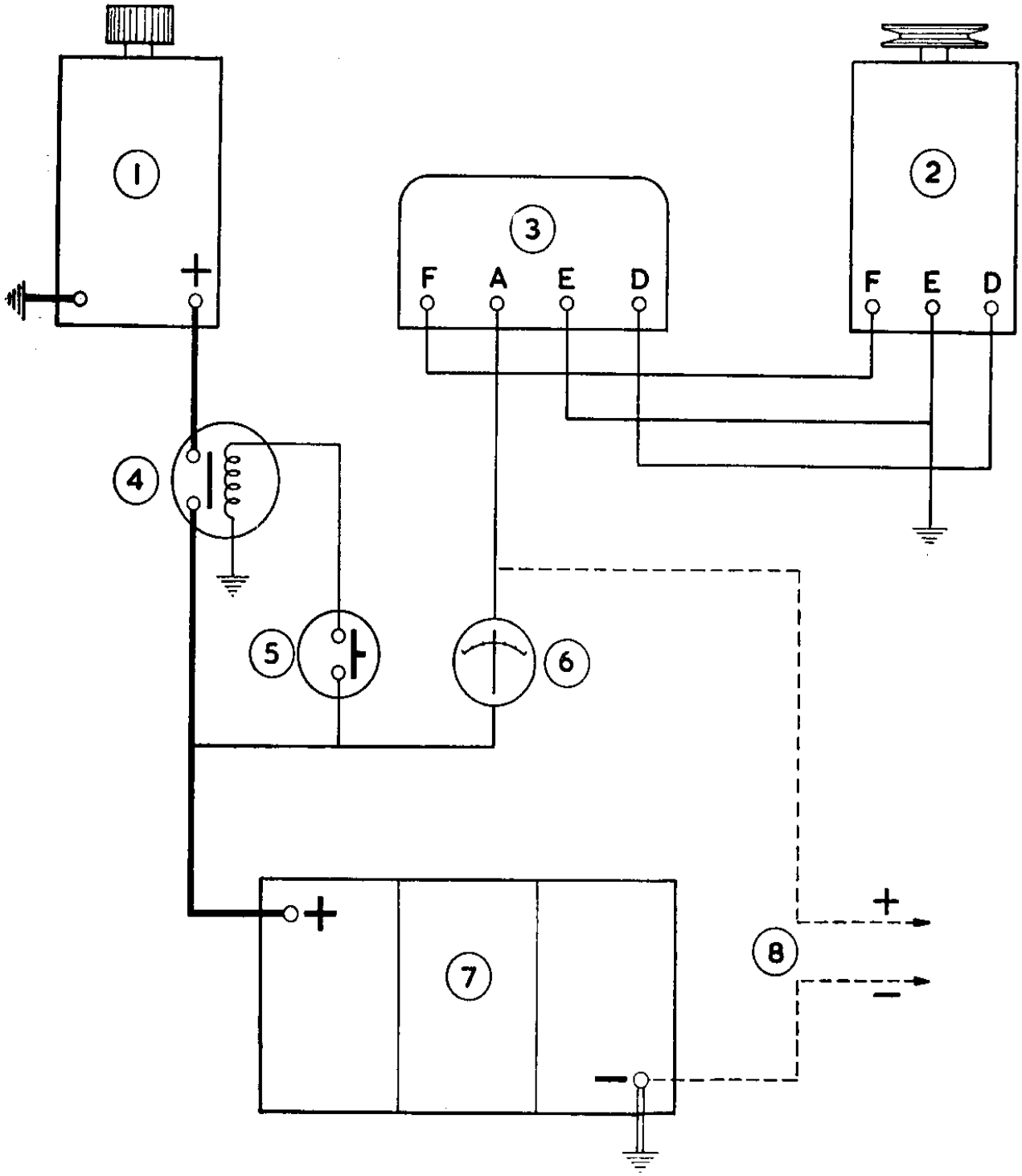
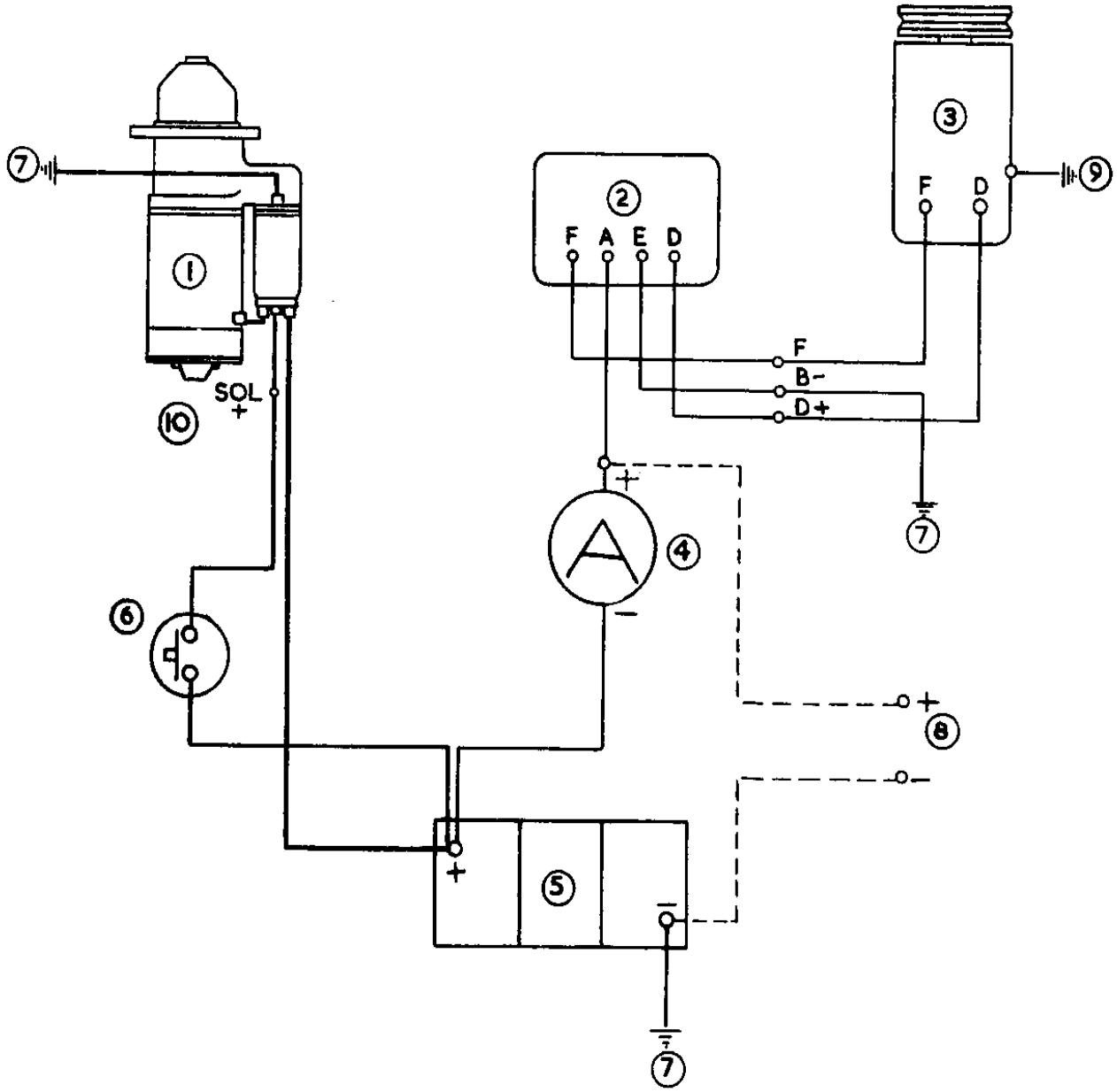


Fig. 21. Clutch for LD and SL Engines



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

LD1 & SL1 12v. Electric Starting Equipment — Wiring Diagram ED.6105



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

LD2, SL2 & SL3 12v. Electric Starting Equipment — Wiring Diagram ED. 6838