Lister
DIESELS

INDUSTRIAL ENGINES

L, T, H and J Ranges

Operators Handbook

027-08152

INTRODUCTION

The purpose of this handbook is to lay down operating guidelines for the engine user who should consult his local Lister-Petter Distributor for further advice and technical assistance.

Illustrations identifying the engines are given at the beginning of each Section. For operators wishing to carry out their own service and maintenance, a fully illustrated Workshop Manual covering the complete servicing of this engine can be obtained from the distributor.

Instructions and statements contained within 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.

IMPORTANT

Please write your engine type and serial number in the space below and quote on all correspondence.

Engine Number:-

IMPORTANT

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

Genuine Parts

Parts that have not been supplied by the Lister-Petter organisation cannot be relied upon for correct material, dimensions or finish.

This Company 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 PARTS

EDITION 11

CONTENTS

1. INSTALLATION INFORMATION

This installation information is intended as a general guide only. Your local Distributor should be consulted for more comprehensive information.

Installation

The engine should be bolted down to a rigid bed to ensure there is no excessive vibration and installed where a generous supply of fresh air is assured.

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.

Cooling - Air Cooled Engines

LT, LV, TR, TS and HR Ranges

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 cylinders and cylinder heads.

TL, HL and J Range

A single stage axial flow fan, belt driven from the crankshaft, delivers air through ducting to the fins of the cylinders and cylinder heads.

Cooling - Water Cooled Engines

HRW Range and JW Range

Cooling can be either by tank or radiator, in both cases a thermostat is fitted. Water circulation in each case is pump assisted, the centrifugal pump being a standard fitting.

Note: *On JWSC engines, a cooler matrix is fitted between the turbocharger and air intake.*

Belt Drive

Driving belts must be run as close to the engine as possible to avoid undue strain on the bearings.

Exhaust System

In general the exhaust pipe run should be kept as short and straight as possible. A silencer, or expansion chamber, should be fitted near the engine. The tailpipe beyond the silencer should be about 30 times the

pipe diameter in length. Bends should have radius of not less than 4 diameters at the centre line of the pipe. Where pipes must be led upwards from the engine a suitable drain cock, or drain trap with cock, should be fitted at the lowest point to prevent the condensate running into the engine.

Note: *This Company can accept no responsibility for reduced performance or damage to engines where exhausts have been restricted due to the use of unsuitable exhaust systems.*

Note: *On LT, LV, TR, TS and TL engines, the outlet of the silencer must face upwards or horizontal away from the engine, unless it is connected to a tail pipe. It is important to ensure that exhaust gases are not sucked in by the air cleaner or the cooling fan otherwise premature choking will occur.*

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 as measured at the fan inlet. The higher of these two temperatures is taken as being "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures up to 29.4°C (85°F) without derating. Above this temperature the rated brake horsepower must be reduced as listed below.

Naturally aspirated engines	2% per 5.5°C (10°F)
Turbocharged engines	3% per 5.5°C (10°F)
Turbo and charge cooled engines	5% per 5.5°C (10°F)

The maximum temperature is 52°C (125°F) and if it is desired to run at higher temperatures the local distributor must be consulted.

Hand Starting - LT, LV, TS and TR

Normally the engine will be hand started from the camshaft, but in the case of LT engines where the final drive is from the gear end, the engine can be started from the flywheel end through geared-up starting.

Rotation (looking on flywheel)

Clockwise:- LT, LV1.
Anti-Clockwise:- LT, LV, TS, TR, TL, HR/W, HL & J Range.

2. CARE OF YOUR NEW ENGINE

Before leaving the maker's works, each engine is carefully tested and inspected; this includes full load running, followed by detailed examination and tightening of nuts and unions.

When the engine is put into service, further settling of some joints will occur and the valve gear will bed down. For these reasons, if the best results are to be obtained from the engine, it is important that it should receive regular attention, particularly during the first 500 hours of its life. The same applies to an engine which has been completely overhauled.

Long periods of light or 'no load' running early in the engine's life may lead to cylinder bore glazing and high oil consumption.

Initial Attention

To ensure that the top cups of the push rods are full of oil and that the valve springs are lubricated, pour lubricating oil over the valve gear.

It is recommended that the following receive attention after the engine has run 25 hours and again after the engine has run 250 hours.

1. Adjust tappet clearances.

2. Check and tighten nuts, bolts and unions paying particular attention to the fuel system.

3. Check belt tension. It is particularly important that the tension be checked after overhaul or after new belts have been fitted. Do not overtighten.

4. Change the lubricating oil for the first time after 100 hours: thereafter:- Engines running at over 3000 rev/min - 125 hours. All other engines - 250 hours.

5. Clean the engine and keep it clean.

6. Observe the exhaust at the normal full load. The exhaust must be free from soot. A black exhaust means that the engine is overloaded or that the injection equipment is out of order. Do not allow the engine to run with a dirty exhaust without investigating the cause as this may result in an expensive breakdown.

Routine Maintenance

Following the initial attention, the normal routine maintenance must be carried out.

It is sound engineering practice to tighten bolts or nuts holding cylinder heads, sumps, covers, and doors etc. diagonally. This will ensure the

component is pulled down square, resulting in less chance of oil seepage from the joint.

Lubricating Oil

Always use oils of the correct viscosity and type. This will ensure easy starting, lowest fuel consumption, minimum wear and longer periods between overhauls.

3. SAFETY PRECAUTIONS

General

Ensure engine is securely mounted where a generous supply of fresh air is assured.

On water cooled engines ensure the radiator, heat exchanger or tank is full and no leaks are apparent.

Keep the engine clean.

On basic engines, starting shaft guards are available which in the opinion of this Company comply with the requirements of the Health and Safety at Work Act 1974 (UK). Special accessories may require special guards which must be supplied and fitted by the purchaser.

After prolonged running the stop control may become hot, it is advisable to use suitable hand protection when stopping the engine.

The lifting plates and eyes fitted to the engine are designed to lift the engine plus supplied accessories. They must not be used to lift complete assemblies such as a complete power plant.

Starting - All Engines

- Ensure the engine is free to turn without obstruction.
- Check that the level of water, fuel and lubrication oil is correct.
- Check that the fuel and oil systems are correctly primed.

Hand Start Engines

Ensure there are no burrs on the starting shaft, clean and lightly oil the shaft before fitting the handle. Do not attempt to start an engine if the starting handle is damaged or dirty and always check the arrow on the handle boss for direction of rotation.

Use the correct starting handle which has been designed for the engine, hold the handle firmly with the **THUMB ON TOP** of the grip and not around it. On HR/W and HL engines, a clutch pin (pawl) on the starting handle engages with a keyway on the starting shaft. After fitting the handle and before attempting to start the engine, turn it in the opposite direction to that required to start the engine in order to check that the

clutch pin will disengage from the keyway, and does not bind on the starting shaft.

Hand starting any diesel engine can be dangerous in the hands of inexperienced people. Engine operators must be instructed in the correct procedures before attempting to start the engine. If these conditions cannot be met electric starting should be used.

Note: *When the engine is firing it is dangerous to allow the handle to rotate on the running shaft.*

Alternator

The following points must be strictly observed when an alternator is fitted otherwise serious damage can be done.

- Never disconnect the battery whilst the alternator is running.
- Never disconnect a lead unless the alternator is stopped and all switches are in the OFF position.
- Always ensure that leads are fitted to their correct terminals.
- A short circuit or reversal of polarity will ruin the diodes or transistors.
- Never connect a battery into the system without checking that voltage and polarity are correct.
- Never flash the connection to check the current flow.
- Never experiment with adjustments or repairs to the system.

Warning

When engines that are fitted with Charge Windings are running with the system disconnected from the battery, disconnect the stator leads from the rectifier/regulator and tape them up separately.

4. FUEL

Specification

Engines must be used only with fuel oils which conform to the British Standard Specification 2869:1970 Class A1 or A2. They must be distillate, and not a residual oil or blend thereof. Vaporising oils are NOT suitable as fuels for these diesel engines.

The user is cautioned that although the engines may operate on fuels outside the above specification, such operation may well result in excessive wear and damage.

This Company can accept no responsibility for such wear or damage, which has been caused by the use of unsuitable or dirty fuels. The local supplier should be consulted if in doubt as to its suitability.

The engine should not continue to be run until all fuel is exhausted. If, however, this occurs the fuel system (if not self bleeding) will need bleeding, i.e. all air removed from the fuel system when the tank is refilled. *See Priming Fuel System in relevant engine section.*

When testing fuel injection equipment, particularly injection nozzles, there is a danger of high pressure oil penetrating the skin.

On no account allow any unprotected skin to come into contact with the spray.

CLEAN FUEL
- FREE FROM WATER -
IS OF UTMOST IMPORTANCE

5. LUBRICATION

1. The temperatures mentioned in the table are the ambient temperatures at the time when the engine is started. However, if the running ambient temperatures are much higher than the starting temperatures, a compromise must be struck and a higher viscosity oil used, provided starting is satisfactory, multigrade oils overcome the problem, provided they have a suitable specification.

2. Naturally aspirated diesel engines must be run on H.D. Diesel lubricating oils to specifications equal to or better than DEF91-43, MIL-L-2104B, MIL-L-46152A/B or API CC. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

3. API CD, Series III or MIL-L-2104C/D oils are recommended for naturally aspirated 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 fuel exceeds 0.5%.

4. **MIL-L-2104C/D, API CD or Series III oils must be used in turbocharged engines but should not be used in new or reconditioned naturally aspirated engines for the first 'fill', but may be used to advantage after the first 250 hours running.**

5. Multigrade oils must meet the specifications in paragraph 2. and 3..

6. The oil should be suitable for oil changes every 250 hours or 125 hours in engines running at over 3000 r/min without undue oxidation, with sump temperatures reaching 150°C in tropical climates under extremely severe applications, and 120°C under normal applications.

ALL ENGINES

Viscosity

The viscosity of the lubricating oil must be as follows:-

Starting Temperatures			Monograde Oils	Multigrade Oils
	°C	°F		
Below	-15	5	SAE 5W	5W/20
Between **and**	-15 4	5 39	SAE 10W	10W/30
Between **and**	4 30	39 86	SAE 20/20W	15W/40
Above	30	86	SAE 30	15W/40 20W/40

6. ROUTINE MAINTENANCE

AIR COOLED ENGINES

When new drive belts are fitted the belt tension should be checked after the first 25 hours.
Decarbonising the engine is usually carried out at 2000 hours.
Comprehensive information concerning Routine Maintenance can be found in the relevant Workshop Manual.

Daily	Check supply of fuel oil.
	With the engine stopped, check level and condition of lubricating oil.
	Clean air cleaner under very dusty conditions.
125 Hours	Clean or change the air cleaner element under moderately dusty conditions.
	Check for fuel and lubricating oil leaks, tightening nuts and fittings as necessary.
	Check serviceability of battery , if fitted.
	Change oil in engines running at over 3000 rev/min.

ALL ENGINES

250 Hours	Drain lubricating oil, flush out system, renew filter element and refill with correct type and grade of oil.
	Check drive belt tension and adjust if necessary.
	Clean the fuel injector nozzles if the exhaust is dirty.
	Renew fuel filter element if the fuel is not perfectly clean.
	On turbocharged engines change the turbocharger oil filter.
500 Hours	Renew the fuel filter element.
1000 Hours	Decarbonise if the engine shows loss of compression or blow-by past the piston, (do not disturb otherwise).
	Adjust the valve clearances, with the engine cold.
	Clean the cylinder and cylinder head fins under dusty conditions.
	Check the condition of belts; change if necessary.
	On **LT/LV engines** clean the restrictor banjo union at the top end of the lubricating oil feed pipe to each cylinder head.

ROUTINE MAINTENANCE

WATER COOLED ENGINES

When new drive belts are fitted the belt tension should be checked after the first 25 hours.
Decarbonising the engine is usually carried out at 2000 hours.
Comprehensive information concerning Routine Maintenance can be found in the relevant Workshop Manual.

Daily	Check supply of fuel oil.
	With the engine stopped, check level and condition of lubricating oil.
	Clean air cleaner under very dusty conditions.
125 Hours	Clean or change the air cleaner element under moderately dusty conditions.
	Check water level in radiator or cooling tanks.
	Check for fuel, water and lubricating oil leaks, tightening nuts and fittings as necessary.
	Check serviceability of battery , if fitted.

ALL ENGINES

250 Hours	Drain lubricating oil, flush out system, renew filter element and refill with correct type and grade of oil.
	Check drive belt tension and adjust if necessary.
	Clean the fuel injector nozzles if the exhaust is dirty.
	Renew fuel filter element if the fuel is not perfectly clean.
	On turbocharged engines change the turbocharger oil filter.
500 Hours	Renew the fuel filter element.
1000 Hours	Decarbonise if the engine shows loss of compression or blow-by past the piston, (do not disturb otherwise).
	Adjust the valve clearances, with the engine cold.
	Check the condition of belts, change if necessary.

7. SPANNER TORQUE SETTINGS

(Tolerance +5% -0)

Location	Engine Ranges	Nm	lbf.ft
Fuel Hose Clips	L Range	0.68	0.5
Governor Link Adjusting Nuts Decompressor Screw	L & T Ranges L Range	2.98	2.2
Polypropylene Flywheel Fan Injector Leak Off Banjo Screw Nylon Side Shield Retainer	LT LV TS1 L Range TR/TS1	4.06	3.0
Injector Leak Off Banjo Screw	T Range	6.10	4.5
Cold Start Oil Cup Taper Thread	L & T Ranges	7.9/14.4	5.8/10.6
Polypropylene Flywheel Fan	TS2/3	8.13	6.0
Decompressor Screw Nut	T Range	8.80	6.5
Fuel Filter To Tank Cap Screw Manifold Lower Level Nuts Fuel Pump Holding Bolts	L & T Ranges	8.80	6.5
Valve Rocker Adjusting Screw Nuts	L Range	8.80	6.5
Fuel Pump Inlet Union Nut	J Range	13.50	10.0
Camshaft Catch Pin Retaining Screw	T Range	16.20	12.0
Connecting Rod Cap Nut	L Range	24.40	18.0
Fuel Filter Adaptor (steel into aluminium)	T Range	18.97	14.0
Main Bearing Dowel Locating Plug	L Range	20.32	15.0
Injector Clamp Screw/Nut Valve Rocker Adjusting Screw Nuts Manifold Higher Level Nuts Crankshaft Balance Plate nuts	L,T & H Ranges T & H Ranges L & T Ranges LV	21.00	15.5

Spanner Torque Settings continued

Location	Engine Ranges	Nm	lbf.ft
Main Bearing Housing Screws Sump Retaining Bolts Injector Top Plug	L & T Range L & T Ranges L,T & HL Ranges	27.10	20.0
Injector Pipe Nuts Valve Rocker Screw Nuts Fuel Pump Inlet Union	All Ranges J Range J Range	28.45 33.87	21.0 25.0
Cylinder Head Nuts	L Range	40.65	30
Connecting Rod Nuts	T Range	43.36	32
Alternator Pulley Nut (not AC5R)	H & J Ranges	44.71	33.0
Injector Clamp Nuts Fuel Pump Delivery Valve Holder Alternator Pulley Nut (AC5R)	J Range L,T & H Ranges HL & J Ranges	54.20	40.0
Balance Weight Retaining Bolt	T Range	56.9	42.0
Fuel Pump Delivery Valve Holder	J Range	60.97	45.0
Cylinder Head Nuts	T Range	67.75	50.0
Shaft Extension Fan Nuts	J Range	78.59	58.0
Injector Top Cap and Locknut	H & J Ranges	88.09	65.0
Balance Weight Bolts Connecting Rod Nuts Cooling Fan Shaft Nuts	H Range H Range H Range	92.14	68.0
Cylinder Head Nuts	HR HL	108.4	80.0
Cylinder Head Nuts Flywheel Setscrews	HRW Ranges HR/W4,6 & HL	135.6	100.0
Gear End Crankshaft Drives	LV	138.21	102.0
Cylinder Head Nuts	JA	189.70	140.0
Flywheel Retaining Screw Connecting Rod Nuts	L Range J Range	196.47	145.0

Spanner Torque Settings continued

Location	Engine Ranges	Nm	lbf.ft
Cylinder Head Nuts	JW	244.90	180.0
Main Bearing Cap Nuts	H Range	271.00	200.0
Flywheel Setscrews	J Range	392.95	290.0
Main Bearing Cap Nuts	J Range	433.60	320.0
Flywheel Setscrews	HR/W2 & 3	542.00	400.0
Flywheel Retaining Nut	T Range	609.75	450.0

8. STARTING AND RUNNING FAULTS

Difficult Starting

1. Overload trip not lifted, excess fuel button not operated or control lever not in start position.
2. Unsuitable lubricating oil (too heavy).
3. Incorrect grade of fuel.
4. No fuel in tank.
5. Choked fuel filter.
6. Air lock in fuel system.
7. Injector nozzle valve stuck open.
8. Fuel pump delivery valve scored.
9. Injector loose on seat.
10. Leaking valves.
11. Sticking rings.
12. Exhaust valve sticking.
13. Worn cylinder.
14. Sticking fuel pump rack.

Knocking

1. Valve, probably exhaust, sticking in guide and touching piston.
2. Slack bearing.
3. Worn gudgeon pin or small end bearing.
4. Insufficient clearance between piston and cylinder head.
5. Injection too early.
6. Flywheel coupling or pulley loose.
7. Too much crankshaft end float.
8. Excessive carbon deposit on piston.
9. Excessive clearance between piston and cylinder.

Excessive Carbon Deposits

1. Choked air filter.
2. Choked exhaust system.
3. Unsuitable fuel oil.
4. Unsuitable lubricating oil.
5. Continuous idling.
6. Defective spraying.
7. Late injection of fuel.
8. Too much side play on valve rockers.

Smoky Exhaust

Black smoke due to incomplete combustion of fuel can be caused by:-

1. Overload.
2. Choked air filter.
3. Inlet air temperature too high.
4. Defective spraying.
5. Unsuitable fuel oil or water in fuel.

Note: *Faint blue smoke is generally the result of light load. Heavy blue smoke is due to lubricating oil passing the piston rings and is attributable to stuck, worn or broken piston rings, or to worn cylinder barrel.*

Engine Stops

1. Lack of fuel.
2. Air or water in fuel system.
3. Choked fuel filter or blocked nozzle.
4. Overload.
5. Overheating.
6. Loss of compression.

Loss of Power

1. Loss of compression.
2. Incorrect tappet clearance.
3. Choked air filter.
4. Choked exhaust system.
5. Fuel injector or pump out of order.
6. Choked fuel filter.

Failure to Attain Normal Speed

1. Engine started on overload.
2. Fuel system not properly primed.
3. Insufficient fuel.
4. Injection retarded.

Loss of Oil Pressure

1. Low oil level.
2. Strainer choked.
3. Fractured pipe or leaking joint.
4. Badly worn bearings.
5. Relief valve not seating.
6. Oil pump worn or drive failed.

7. Oil cooler choked.

Note: *Lubricating oil filter element must be regularly checked.*

Overheating - Air Cooled

1. Cooling air being re-circulated.
2. Fins of cylinder head or cylinder blocked with dirt.
3. Cooling air inlet obstructed.
4. Cooling air outlet obstructed.
5. Engine cooling air used also to cool driven unit.
6. Overload.
7. Lubricating oil level too low.
8. Injection timing faulty.

Overheating - Water Cooled

1. Thermostat faulty.
2. Injection timing faulty.
3. Overload.
4. Lubricating oil, or cooling water level too low.
5. Water pump belt slipping.
6. Blockage in water cooling system.

Note: *This section is intended as a guide only. Any rectification of faults should be in accordance with the Engine Workshop Manual. When in doubt consult your local Distributor.*

9. ASSOCIATED PUBLICATIONS

Workshop Manuals

Engine	Book No
LT	027-08202
LV	027-08226
TR/TS	027-08221
TL	027-08224
HR/W2 & 3	027-08208
HR/W4,6,S6 & HL	027-08213
J Range	027-08216

Note: *Some of these Manuals are available in Spanish and French.*

Parts List

Engine	Book No
LT/LV	027-08060
TS/TR	027-08081
TL	027-08082
HR2 & 3	027-08054
HRW2 & 3	027-08055
HRW4,6 & S6	027-08053
HL	027-08062
JA/S	027-08056
JW/S	027-08057
JWSC	027-08058

When ordering replacement parts, always quote the

ENGINE NUMBER
PART NUMBER
DESCRIPTION OF PART

SECTION TWO - LT

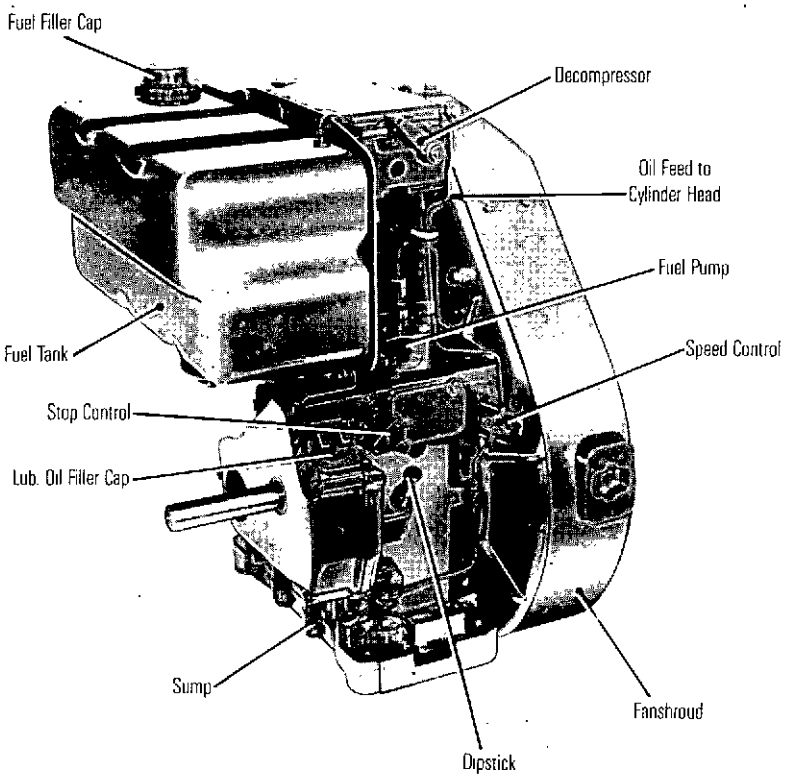


Figure 1. LT1 Air Cooled Engine

ENGINE NUMBER PLATE

The engine number plate is fitted to the manifold side air shield.

LUBRICATING OIL PRESSURE

0.7 bar (10lbf/sq.in.) minimum at 1000 rev/min.

OIL SUMP CAPACITY

LT1 - 1.3 litres; Brit. 2.3 pints; U.S 1.4 quarts

PRIMING THE FUEL SYSTEM

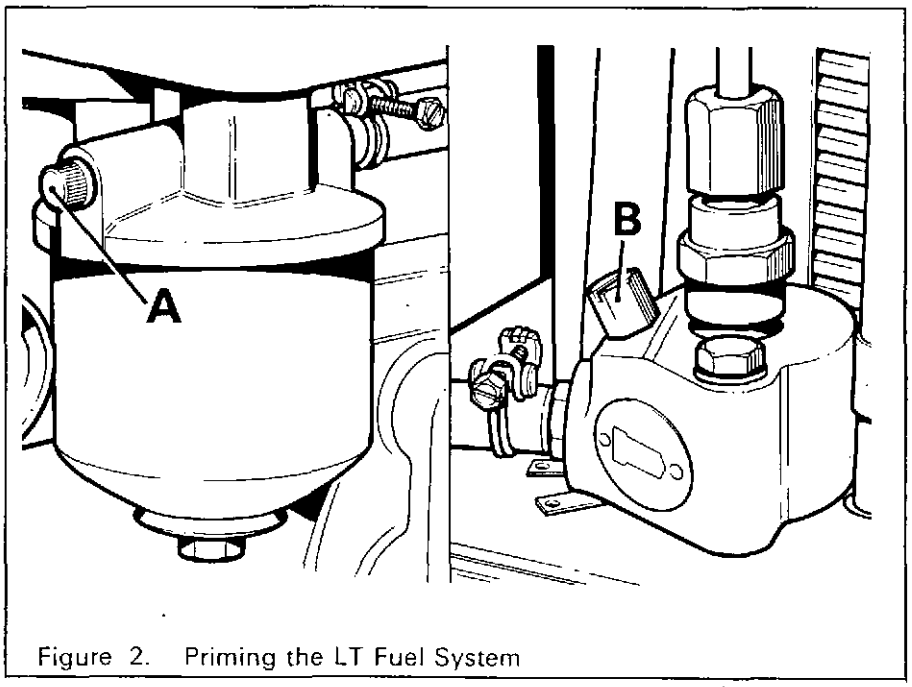


Figure 2. Priming the LT Fuel System

1. Fill the fuel tank.
2. Vent the fuel filter through bleed screw 'A' until a full air free flow of fuel is obtained. When a remote mounted fuel supply is used, the bleed screw is located on the top of the fuel filter.
3. Vent fuel at pump through bleed screw 'B' until a full air free flow of fuel is obtained.

DECOMPRESSOR ADJUSTMENT

1. Remove the cylinder head cover.
2. Turn the engine until the piston is on T.D.C. firing stroke (both valves closed).
3. Turn the decompressor screw down until the valve rocker just begins to depress the valve.
4. Turn the screw one turn clockwise (so that it travels towards the rocker).

INJECTOR PRESSURE

The injector is set on a rig to 200 atmospheres and will settle to 190 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearances for both inlet and exhaust valves set with the engine cold are:-

Up to and including 3000 r/min	
Inlet and exhaust	**0.13mm (0.005") GO** **0.18mm (0.007") NOT GO**
3600 r/min.	
Inlet valve	**0.05mm (0.002") GO** **0.10mm (0.004") NOT GO**
Exhaust valve	**0.13mm (0.005") GO** **0.18mm (0.007") NOT GO**

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is at T.D.C. on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that clearance is correct.
4. Repeat for second valve.

STARTING AND STOPPING

Before running engines with the charge windings disconnected from the battery, disconnect the leads from the rectifier/regulator unit and tape up separately.

Before Starting

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc. if fitted - with the correct grade of lubricating oil to the correct level on the dipstick.
3. Ensure there is an adequate supply of fuel and the fuel system is primed.
4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.

Cold Starting Below -10°C(14°F)

A cup and plunger may be fitted on the combustion air intake port. To operate, withdraw the plunger and fill one third of the cup with the same type of lubricating oil as used in the engine. Replace the plunger and inject the oil just before starting. The device must not be used more than three times in succession. The engine should be turned 20 revolutions with the fuel on after injecting the oil before attempting to start.

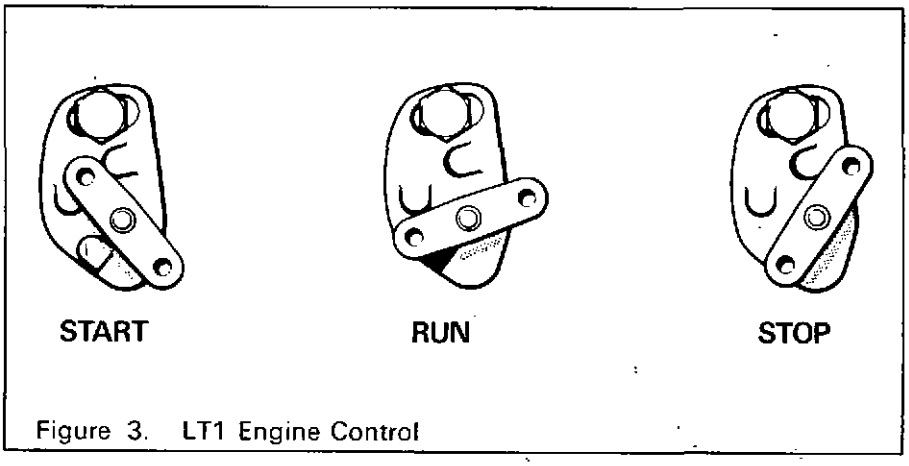


Figure 3. LT1 Engine Control

- **Hand Start**

1. Read the Safety Precautions in Section One
2. Check the engine is free to turn without obstruction.
3. Pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.
4. If a variable speed control lever is fitted, move it to the 'FAST' position.
5. Move the decompressor lever towards the flywheel, lightly oil the end of starting shaft and fit a correct and fully serviceable starting handle.
6. Turn the engine slowly from 3 to 20 turns according to the temperature and period of standing unused in order to prime combustion chamber and lubricating oil system.
7. Crank the engine really fast and when sufficient speed is obtained, *move decompressor lever towards fuel tank (or gear end) and* continue to crank until the engine fires, retain a firm grip on starting handle and remove it from the shaft.
8. Turn the control lever to the 'RUN' position, abutting against the middle catch.
9. When a speed control is fitted, reduce the speed as required

Electric Starting with Starter Button

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Press the starter button and release it immediately the engine fires.
7. Turn the control lever to the 'RUN' position, abutting against the middle catch.
8. When a speed control is fitted, reduce the speed as required

Electric Starting with Key Switch

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.

5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Turn the key switch in a clockwise direction and hold it at position 3 until the engine fires and then release it immediately.
7. Turn the control lever to the 'RUN' position, abutting against the middle catch.
8. When a speed control is fitted, reduce the speed as required

Switch Positions

1. Warning light on - No charge.
2. Cold start (not used).
3. Energise starter.

To Stop Engine

Move the control lever anti-clockwise to the 'STOP' position and hold it there until the engine comes to rest.
After prolonged running the engine control may become hot, it is advisable to use suitable hand protection.

After the engine has stopped ensure the electric start switch, if fitted, is switched off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVER OR VALVE DAMAGE MAY OCCUR

SECTION THREE - LV

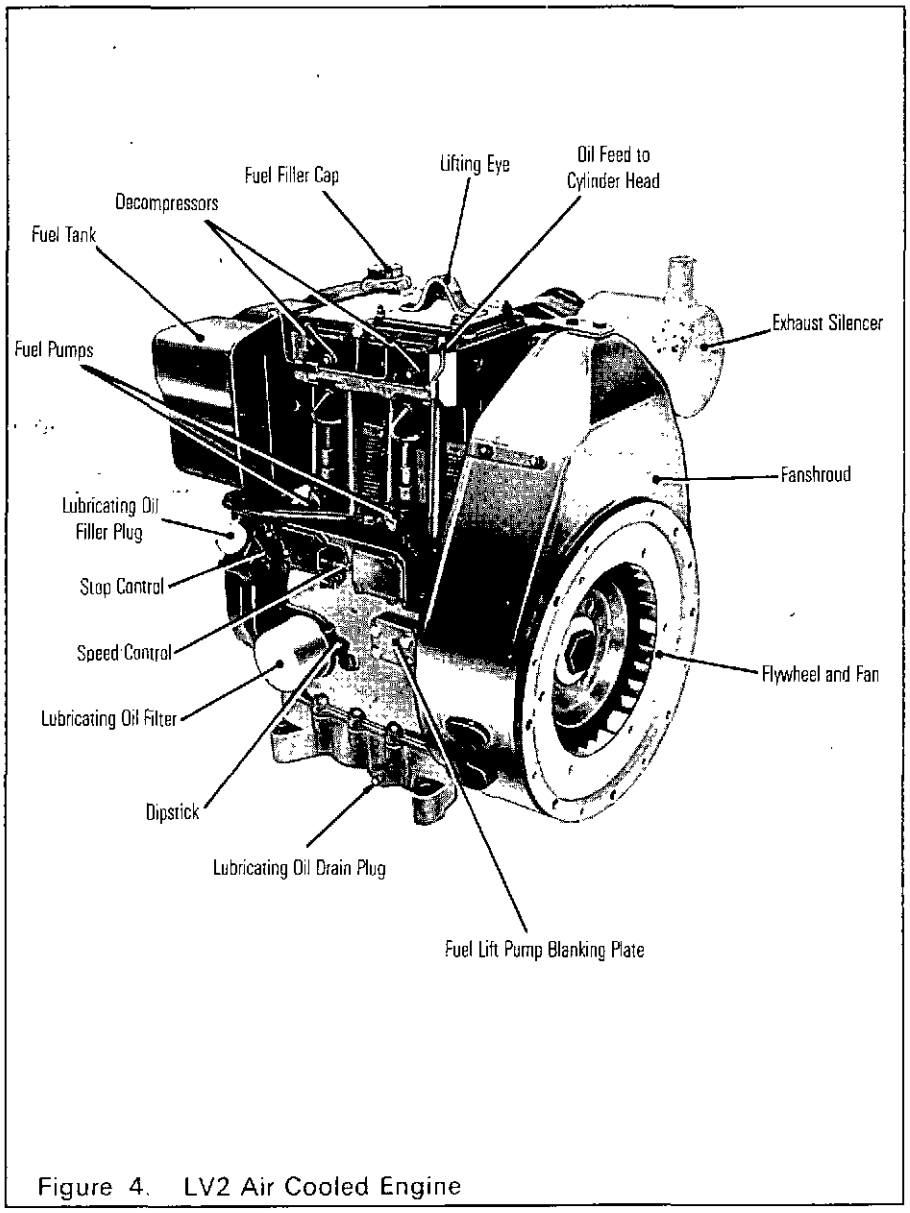


Figure 4. LV2 Air Cooled Engine

ENGINE NUMBER PLATE

The engine number plate is fitted to the manifold side air shield.

LUBRICATING OIL PRESSURE

0.7 bar (10 lbf/sq.in.)minimum at 1000 rev/min.

OIL SUMP CAPACITY

LV1 - 1.3 litres; Brit. 2.3 pints; U.S. 1.4 quarts
LV2 - 3.58 litres; Brit. 6.3 pints; U.S. 3.8 quarts

PRIMING THE FUEL SYSTEM

LV1 engines are fitted with a self venting system as standard and the LV2 may have a self venting system fitted as an optional extra. When fitted priming is not normally necessary.

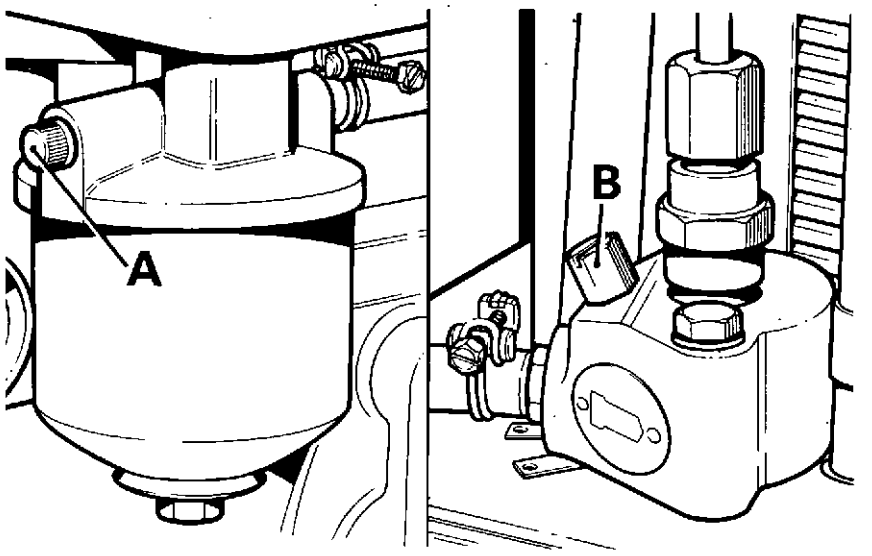


Figure 5. Priming the LV Fuel System

1. Fill the fuel tank.
2. Vent the fuel filter through the bleed screw 'A' until a full air free flow of fuel is obtained.

3. Vent fuel at the pump through the bleed screw 'B', starting with the pump nearest the filter until all the air is expelled. When a remote mounted fuel supply is used the bleed screw is located on the top of the fuel filter.

DECOMPRESSOR ADJUSTMENT

1. Remove the cylinder head cover.
2. Turn the engine until the piston is on T.D.C. firing stroke with both valves closed.
3. Turn the decompressor screw down until the valve rocker just begins to depress the valve.
4. Turn the screw one turn clockwise (so that it travels towards the rocker).

INJECTOR PRESSURE

The injector is set on a rig to 200 atmospheres and will settle to 190 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust valves set with the engine cold is:-

Up to and including 3000 rev/min	
Inlet and Exhaust	**0.13mm (0.005") GO**
	0.18mm (0.007") NOT GO
3600 rev/min	
Inlet valve	**0.05mm (0.002") GO**
	0.10mm (0.004") NOT GO
Exhaust valve	**0.13mm (0.005") GO**
	0.18mm (0.007") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke with both valves closed.
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that the clearance is correct.
4. Repeat for all remaining valves.

STARTING AND STOPPING

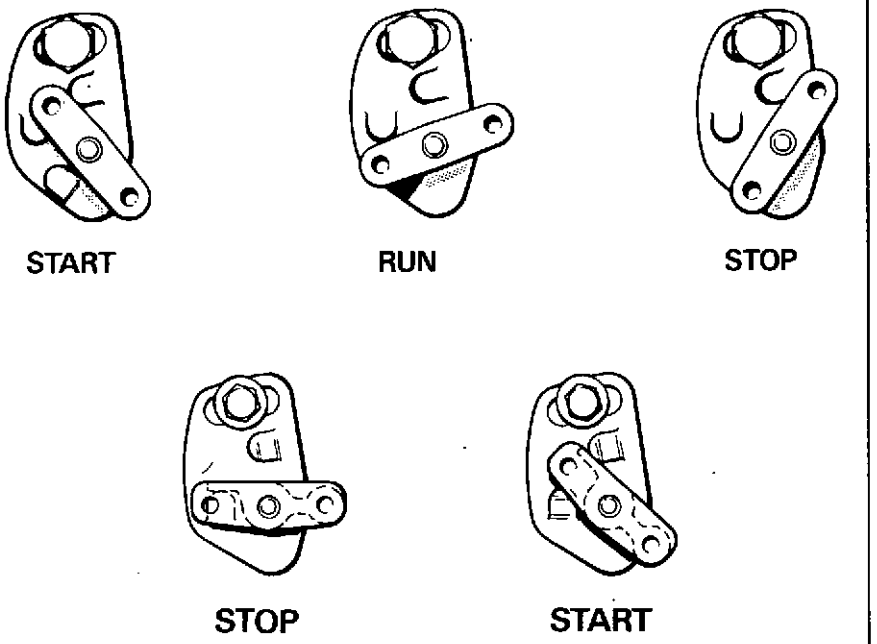


Figure 6. Engine Controls - LV1 at the top and LV2 at the bottom

Before Starting

Before running engines with the charge windings disconnected from the battery, disconnect the leads from the rectifier/regulator unit and tape up separately.

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc. if fitted - with the correct grade of lubricating oil to the correct level on the dipstick.

3. Ensure there is an adequate supply of fuel and the fuel system is primed.
4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.

Cold Starting Below -10°C(14°F)

A cup and plunger may be fitted on the combustion air intake port. To operate, withdraw the plunger and fill one third of the cup with the same type of lubricating oil as used in the engine. Replace the plunger and inject the oil just before starting. The device must not be used more than three times in succession. The engine should be turned 20 revolutions with the fuel on after injecting the oil before attempting to start.

Hand Start

1. Read the Safety Precautions in Section One
2. Check the engine is free to turn without obstruction.
3. On LV1 engines pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.
4. If a variable speed control lever is fitted, move it to the 'FAST' position.
5. Move the decompressor lever towards the flywheel, lightly oil the end of starting shaft and fit a correct and fully serviceable starting handle.
6. Turn the engine slowly from 3 to 20 turns according to the temperature and period of standing unused in order to prime combustion chamber and lubricating oil system.
7. Crank the engine really fast and when sufficient speed is obtained, move decompressor lever towards fuel tank (or gear end) and continue to crank until the engine fires, retain a firm grip on starting handle and remove it from the shaft.
8. On LV1 engines turn the control lever to the 'RUN' position, abutting against the middle catch.
9. When a speed control is fitted, reduce the speed as required

Electric Starting with Starter Button

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. On LV1 engines pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.

5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Press the starter button and release it immediately the engine fires.
7. On LV1 engines turn the control lever to the 'RUN' position, abutting against the middle catch.
8. *When a speed control is fitted, reduce the speed as required*

Electric Starting with Key Switch

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. On LV1 engines pull the control lever outward over the middle catch and turn it clockwise to an almost vertical position; this allows extra fuel for starting.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Turn the key switch in a clockwise direction and hold it at position 3 until the engine fires and then release it immediately.
7. On LV1 engines turn the control lever to the 'RUN' position, abutting against the middle catch.
8. When a speed control is fitted, reduce the speed as required

Switch Positions

1. Warning light on - No charge.
2. Cold start (not used).
3. Energise starter.

To Stop Engine

Move the control lever anti-clockwise to the 'STOP' position and hold it there until the engine comes to rest.
After prolonged running the engine control may become hot, it is advisable to use suitable hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is switched off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVER(S) OR VALVE DAMAGE MAY OCCUR

SECTION FOUR - TR/TS

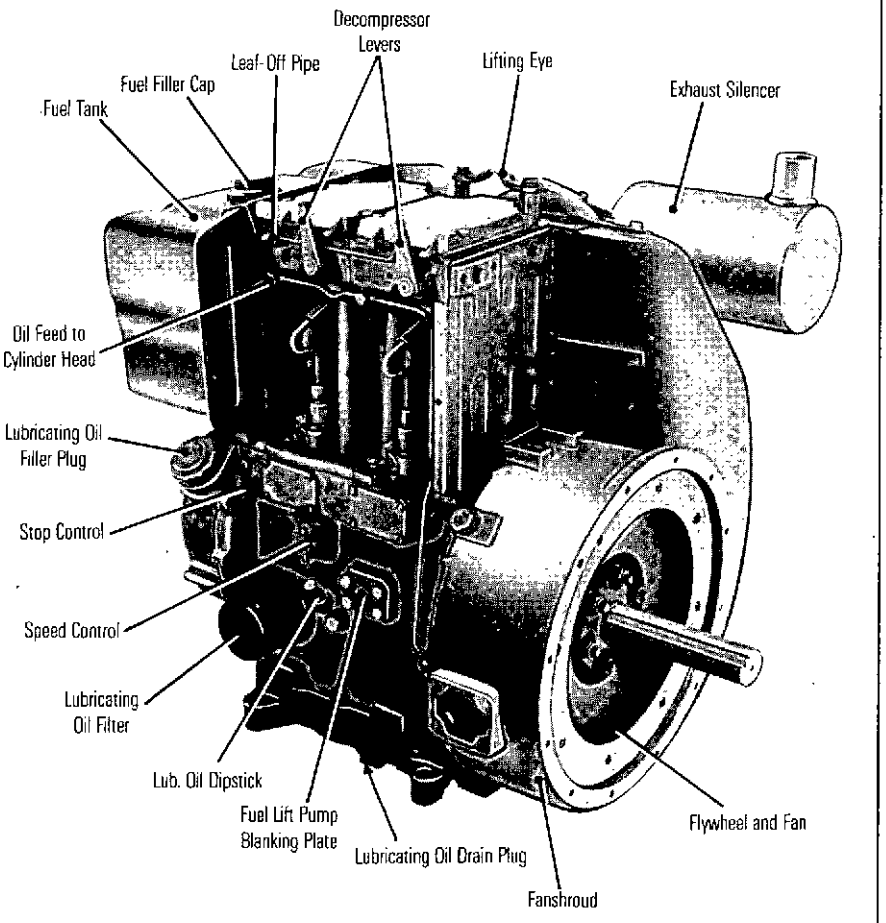


Figure 7. TS2 Air Cooled Engine

ENGINE NUMBER PLATE

The engine number plate is fitted to the right hand top corner of the cowling on the manifold side of the engine.

LUBRICATING OIL PRESSURE

1.8 bar (26.1 lbf/sq.in.)

OIL SUMP CAPACITY

TR/TS1 - 2.85 litres; Brit. 5.0 pints; U.S. 3.0 quarts
TR/TS2 - 4.3 litres; Brit. 7.6 pints; U.S. 4.6 quarts
TR/TS3 - 6.5 litres; Brit. 11.4 pints; U.S. 6.8 quarts

These figures include the filter.

PRIMING THE FUEL SYSTEM

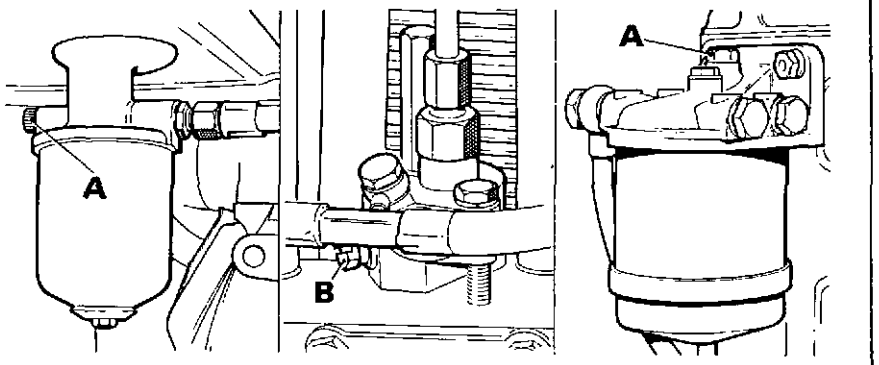


Figure 8. Priming the Fuel System

1. Fill fuel tank.
2. Vent fuel at the filter through the bleed screw 'A' until a full air free flow of fuel is obtained. When a remote mounted fuel supply is used, the bleed screw is located on the top of the fuel filter.

3. Vent the fuel filter through bleed screw 'B', starting with the pump nearest the filter.

Note: *If the engine is fitted with a self priming fuel systems it should never be necessary to prime the fuel system.*

DECOMPRESSOR ADJUSTMENT

1. Remove cylinder head cover.
2. Turn the engine until the piston is on T.D.C. firing stroke (both valves closed).
3. Turn the decompressor screw down until the valve rocker just begins to depress the valve.
4. Turn the screw one turn clockwise (so that it travels towards the rocker) and re-tighten the locknut.

INJECTOR SETTING PRESSURE

The injector is set on a rig to 200 atmospheres and will settle to 190 atmospheres when working in the engine.

VALVE CLEARANCE

The clearance for both the inlet and exhaust valves, set with the engine cold is:-

0.15mm (0.006") GO
0.20mm (0.008") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that the clearance is correct.
4. Repeat for all remaining valves.

STARTING AND STOPPING

Before running engines with the charge windings disconnected from the battery remove the leads from the rectifier/regulator unit and tape them up separately.

These engines are fitted with automatic excess fuel selection. If the engine stops other than by the operation of the engine control, the control must be turned to the 'STOP' position and then released in order to select excess fuel.

Before Starting

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc. if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed. If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming lever on the lift pump.
4. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.

Cold Starting Below -10°C(14°F)

A cup and plunger may be fitted on each combustion air intake port. To operate, withdraw the plunger and fill one third of the cup with the same type of lubricating oil as used in the engine. Replace the plunger and inject the oil just before starting. The device must not be used more than three times in succession. The engine should be turned 20 revolutions with the fuel on after injecting the oil before attempting to start.

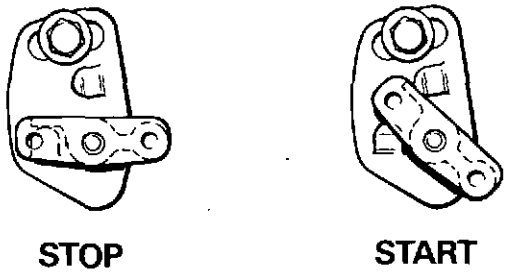


Figure 9. Engine Control

Hand Start

1. Read the Safety Precautions in Section One
2. Check the engine is free to turn without obstruction.
3. Check that the engine control lever is in the start position.
4. If a variable speed control lever is fitted; move it to the 'FAST' position.
5. Move the decompressor lever towards the flywheel, lightly oil the end of starting shaft and fit a correct and fully serviceable starting handle.

6. Turn the engine slowly from 3 to 20 turns according to the temperature and period of standing unused in order to prime combustion chamber and lubricating oil system.
7. Crank the engine really fast and when sufficient speed is obtained, move decompressor lever towards fuel tank (or gear end) and continue to crank until the engine fires, retain a firm grip on starting handle and remove it from the shaft.
8. When a speed control is fitted, reduce the speed as required

Electric Starting with Starter Button

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Check that the engine control lever is in the start position.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Press the starter button and release it immediately the engine fires.
7. When a speed control is fitted, reduce the speed as required

Electric Starting with Key Switch

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Check that the engine control lever is in the start position.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Turn the key switch in a clockwise direction and hold it at position 3 until the engine fires and then release it immediately.
7. When a speed control is fitted, reduce the speed as required

Switch Positions

1. Warning light on - No charge.
2. Cold start (not used).
3. Energise starter.

To Stop Engine

Move the control lever anti-clockwise to the 'STOP' position and hold it there until the engine comes to rest.
After prolonged running the engine control may become hot, it is advisable to use suitable hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is switched off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVER(S) OR VALVE DAMAGE MAY OCCUR

SECTION FIVE - TL

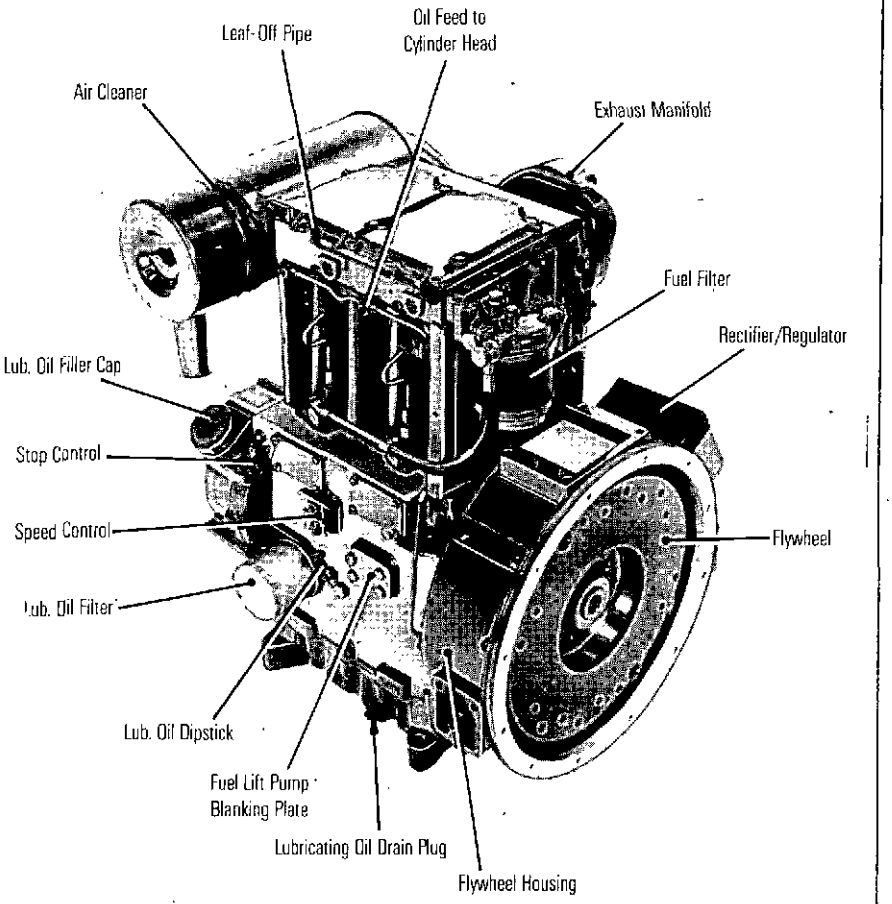


Figure 10. - TL2 Air Cooled Engine

ENGINE NUMBER PLATE

The engine serial number plate is fitted to the right hand top corner of the air cowling on the manifold side of the engine.

LUBRICATING OIL PRESSURE:

2.0 bar (29.0 lbf/sq.in.)
0.7 bar (10.0 lbf/sq.in.) at 1000 rev/min.

OIL CAPACITIES

TL2 - 4.3 litres; 7.6 Brit pints; 4.6 U.S. quarts.
TL3 - 6.5 litres; 11.4 Brit.pints; 6.8 U.S.quarts.

Note: *These figures include the filter.*

PRIMING THE FUEL SYSTEM

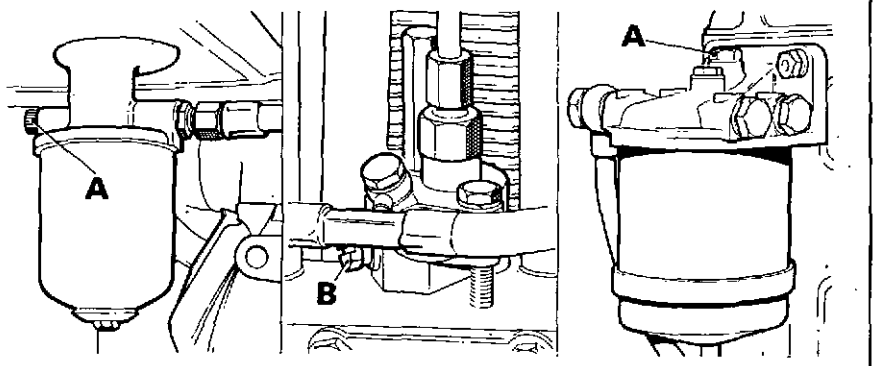


Figure 11. Priming the Fuel System

1. Slacken the bleed screw 'A' on top of the filter body and vent the filter until a full air free flow of fuel is obtained.
2. Tighten the bleed screw.
3. Vent the fuel at each pump in turn through the bleed screw 'B', starting with the pump nearest the filter. Re-tighten each pump in turn when all air has been displaced from it.

Note: *On engines that are fitted with self priming fuel systems it should never be necessary to prime the system.*

DECOMPRESSOR ADJUSTMENT

Note: *Decompressor levers are not fitted as standard on TL engines.*

1. Remove the cylinder head cover.
2. Turn the engine until the piston is on TDC firing stroke (both valves closed).
3. Slacken the locknut and turn the decompressor screw down until the valve rocker just begins to depress the valve.
4. Turn the screw one complete turn clockwise (so that it travels towards the rocker) and re-tighten the locknut.

INJECTOR PRESSURE

The injectors are set on a rig to 200 atmospheres and will settle to 190 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust valves set with the engine cold is:-

0.15mm (0.006") GO
0.20mm (0.008") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is at T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure the clearance is correct.
4. Repeat for the remaining valves.

STARTING AND STOPPING

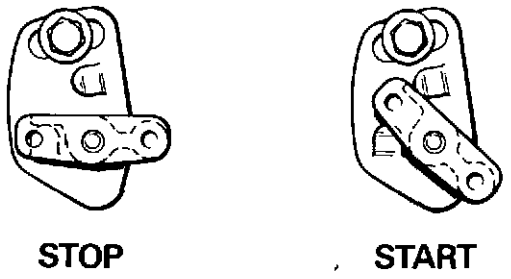


Figure 12. Engine Control

Before Starting

TL engines have electric starting fitted as standard and are fitted with automatic excess fuel selection. If the engine stops other than by the operation of the engine control, the control must be turned to the 'STOP' position and released in order to select excess fuel.
Before running engines with the charge windings disconnected from the battery, disconnect the leads from the rectifier/regulator unit and tape them up separately.

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc., if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed. If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming lever on the lift pump.
4. Ensure air cleaner is firmly attached and all joints are properly sealed.
5. Ensure batteries are filled to correct level, charged and connected.

Electric Starting with Starter Button

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Check that the engine control lever is in the start position.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.

6. Press the starter button and release it immediately the engine fires.
7. When a speed control is fitted, reduce the speed as required

Electric Starting with Key Switch

1. Read the Safety Precautions in Section One
2. Check that the decompressor lever is towards the gear end.
3. Check the engine is free to turn without obstruction.
4. Check that the engine control lever is in the start position.
5. If a variable speed control lever is fitted, move it to the 'FAST' position.
6. Turn the key switch in a clockwise direction and hold it at position 3 until the engine fires and then release it immediately.
7. When a speed control is fitted, reduce the speed as required

Switch Positions

1. Warning light on - No charge.
2. Cold start (not used).
3. Energise starter.

To Stop Engine

Move the control lever anti-clockwise to the 'STOP' position and hold it there until the engine comes to rest.
After prolonged running the engine control may become hot, it is advisable to use suitable hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is switched off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVERS IF (FITTED) OR VALVE DAMAGE MAY OCCUR

SECTION SIX - HR/W2 & 3

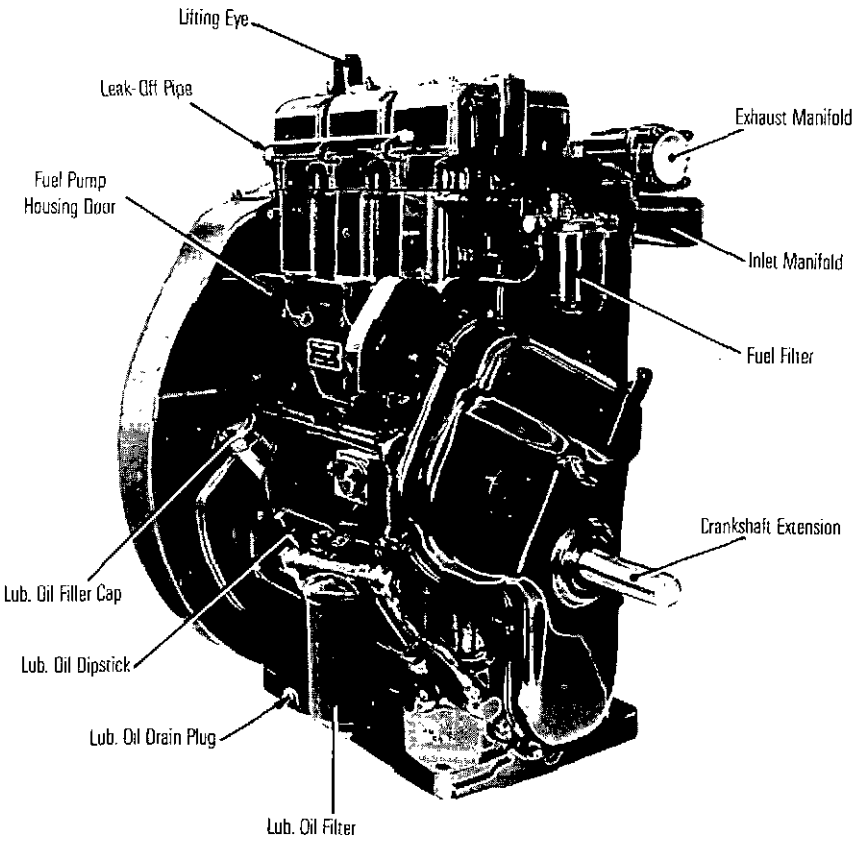


Figure 13. HR3 Air Cooled Engine

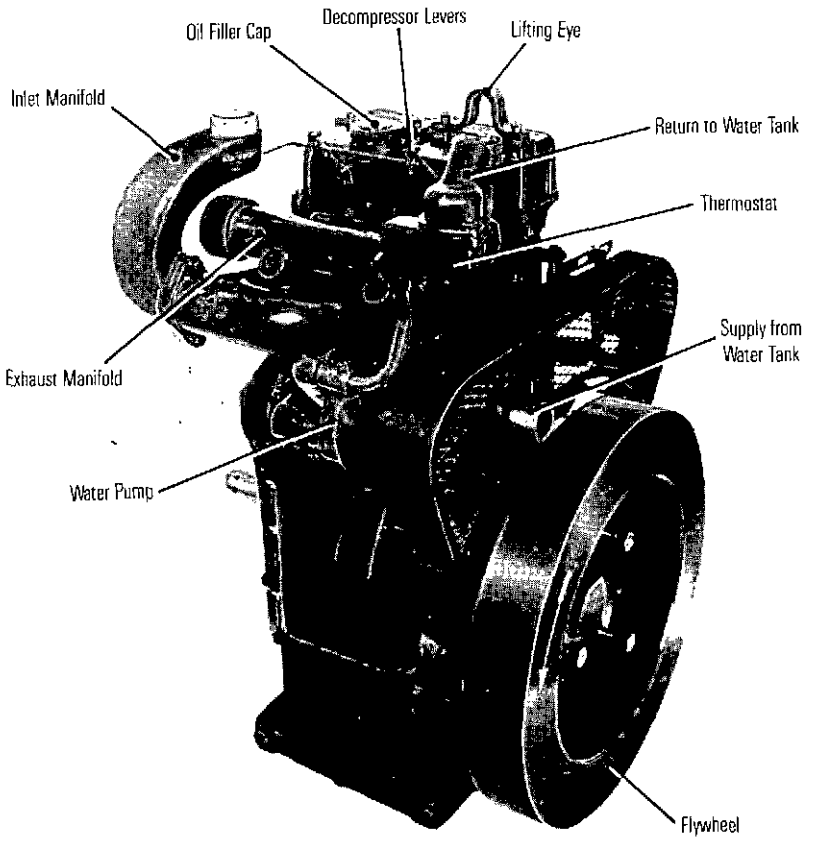


Figure 14. HRW2 Water Cooled Engine

ENGINE NUMBER PLATE

The engine serial number plate is fitted to the fuel pump housing door.

LUBRICATING OIL PRESSURE:

2.1-3.1 bar (30-45lbf/sq.in.)

OIL SUMP CAPACITIES

HR/W2 - 10.8 litres; Brit.19 pints; U.S.11.4 quarts.
HR/W3 - 14.8 litres; Brit.26 pints; U.S.15.6 quarts.

PRIMING THE FUEL SYSTEM

When carrying out this operation care should be taken to prevent a large overflow of fuel into the crankcase. On completion, ensure all joints are serviceable or renewed and all bleed screws and connections are tightened firmly.

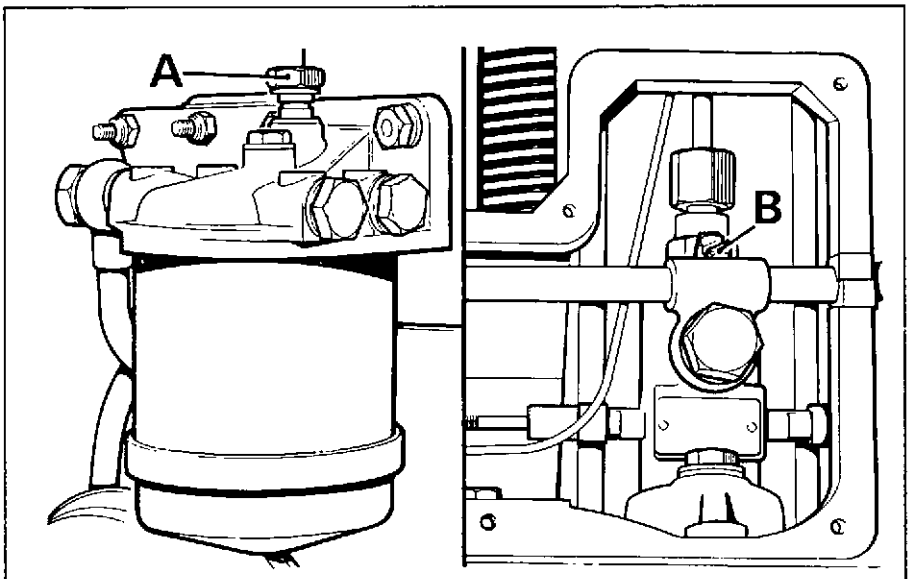


Figure 15. Priming the Fuel System

1. Fill the fuel tank or connect the fuel supply.
2. Remove the fuel pump housing door.
3. Slacken the bleed screw 'A' on top of the filter body and vent the filter until a full air free flow of fuel is obtained.
4. Tighten the bleed screw.

5. Vent the fuel at each pump in turn through the bleed screw 'B', starting with the pump nearest the filter.
6. Tighten each pump in turn when all air has been displaced from it.

DECOMPRESSOR ADJUSTMENT

1. Access to the decompressors is through the oil filler holes in the cylinder head covers.
2. Turn the engine until the piston is on T.D.C. firing stroke with both valves closed.
3. Move the decompressor lever towards the flywheel.
4. Slacken the locknut and turn the decompressor screw down until it just touches the valve rocker.
5. Turn the screw a further three quarters of a turn and tighten the locknut.
6. Repeat for the remaining cylinders.

INJECTOR PRESSURE

The injectors are set on a rig to 180 atmospheres and will settle to 170 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust valves set with the engine cold is:-

Air Cooled Engines (HR)

0.05mm (0.002") GO
0.10mm (0.004") NOT GO

Water Cooled Engines (HRW)

0.38mm (0.015") GO
0.43mm (0.017") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting scr w and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that the clearance is correct.
4. Repeat for the remaining valves.

STARTING AND STOPPING

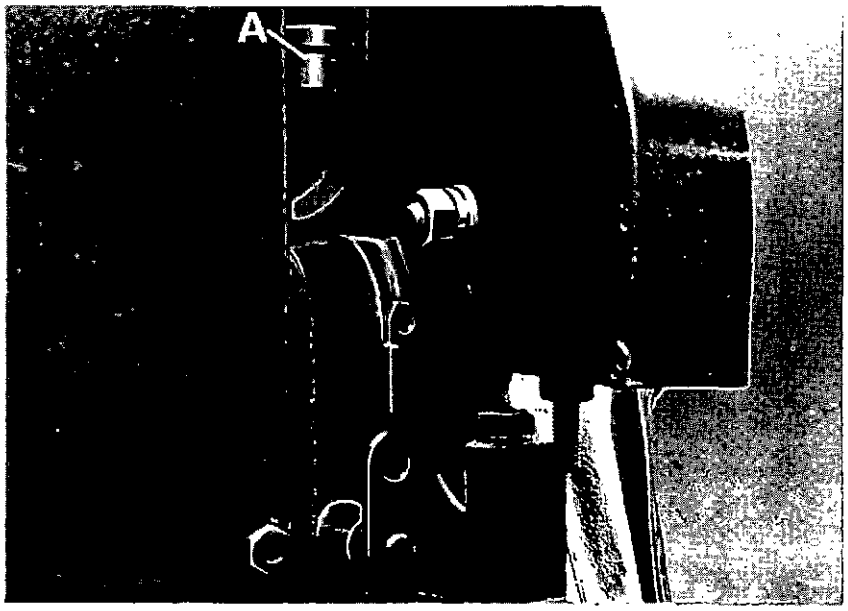


Figure 16. Engine Control

Before Starting

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc., if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed. If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming lever on the lift pump.
4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.
6. On water cooled engines fill the radiator, heat exchanger or cooling tanks to the correct level. Cooling tanks must have the top pipe covered at all times. Radiators should be filled to within 25mm (1") of the bottom of the filler opening.

Hand Starting

1. Check the engine is free to turn without obstruction.
2. In cold weather only, lift the overload stop 'A' to allow the pumps to deliver excess fuel, this allows extra fuel for starting and will be reset as the engine runs up to speed.
3. If a variable speed control is fitted, move it to the 'FAST' position.
4. Move the decompressor levers towards the gear end, lightly oil the end of the starting shaft and fit a correct and fully serviceable handle.
5. Turn the engine slowly from 3 - 10 turns according to the temperature and period of standing unused in order to prime the combustion chamber and lubricating oil system.
6. Crank the engine and when sufficient speed is obtained, move decompressor levers towards the flywheel, continue to crank until the engine fires. Retain a firm grip on starting handle and remove it from the shaft.
7. When a speed control is fitted, reduce the speed as required.

Electric Starting

1. Check the engine is free to turn without obstruction.
2. In cold weather only, lift the overload stop 'A' to allow the pumps to deliver excess fuel, this allows extra fuel for starting and will be reset as the engine runs up to speed.
3. If a variable speed control is fitted, move it to the 'FAST' position.
4. Check the decompressor levers are towards the gear end,
5. Press the starter button and release it immediately the engine fires.
6. When a speed control is fitted, reduce the speed as required.

Electric Starting with Key Switch

1. Check the engine is free to turn without obstruction.
2. In cold weather only, lift the overload stop 'A' to allow the pumps to deliver excess fuel, this allows extra fuel for starting and will be reset as the engine runs up to speed.
3. If a variable speed control is fitted, move it to the 'FAST' position.
4. Check the decompressor levers are towards the gear end,
5. When a speed control is fitted, reduce the speed as required.
6. Turn the switch in clockwise direction to position 3 and release it immediately the engine fires.
7. When a speed control is fitted, reduce the speed as required.

Switch Positions

1. Warning light on - No charge.
2. Cold start (not used)
3. Energise starter

To Stop Engine

Move the control lever anti-clockwise towards the flywheel and hold in this position until the engine stops.
After prolonged running the stop control may become hot, and it is advisable to use hand protection.

After the engine has stopped ensure the electric start switch, if fitted, is switched off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVERS OR VALVE DAMAGE MAY OCCUR

SECTION SEVEN - HRW4-6 & S6

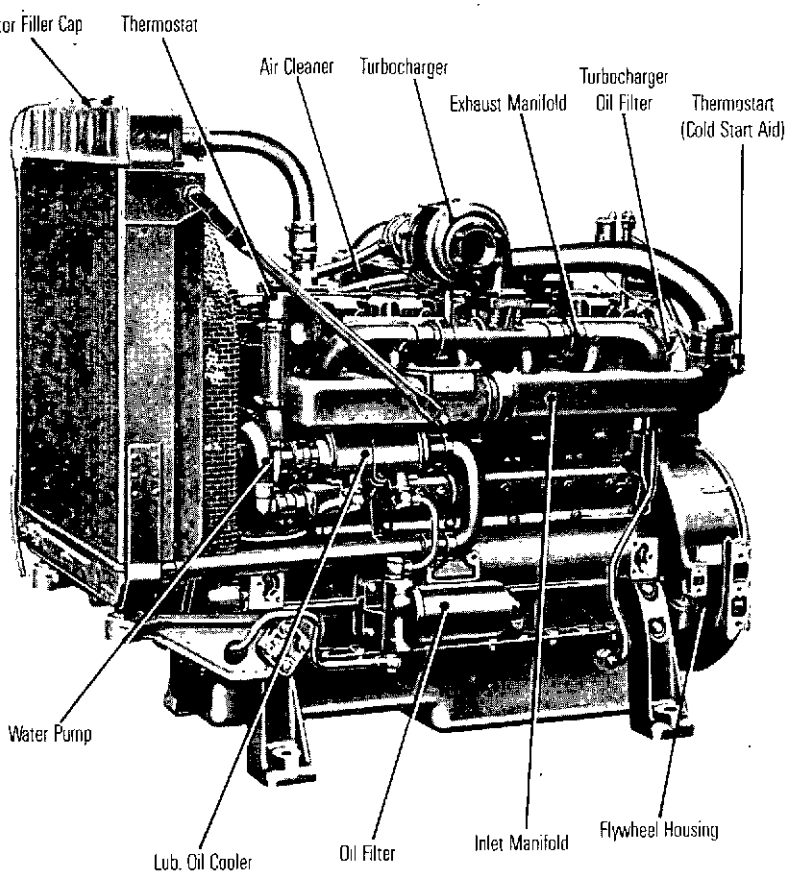


Figure 17. HRWS6 Water Cooled Engine

ENGINE NUMBER PLATE

The engine number plate is fitted to the air inlet manifold.

LUBRICATING OIL PRESSURE

2.1 - 3.1 bar (30 - 40 lbf/sq.in.)

OIL SUMP CAPACITIES

HRW4 Engines - 18.2 litres; Brit. 32 pints; U.S. 19.2 quarts.
HRW/S6 Engines - 23.9 litres; Brit. 42 pints; U.S. 25.2 quarts.

DECOMPRESSOR ADJUSTMENT

Decompressor levers are not fitted as standard on these engines, if they are fitted access is gained by removing the cylinder head cover.

1. Turn the engine until the piston is on T.D.C. firing stroke with both valves closed.
2. Set the adjustment screw so that when the cover is re-fitted the screw will just touch the exhaust valve rocker lever.
3. Turn the adjustment screw down a further three quarters of a turn and lock it in this position.

INJECTOR PRESSURE

The injectors are set on a rig to 180 atmospheres and will settle to 170 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust valves set with the engine cold is:-

0.38mm (0.015") GO
0.43mm (0.017") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke with both valves closed.
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that clearance is correct.
4. Repeat for remaining valves.

PRIMING THE FUEL SYSTEM

MINIMEC Fuel Pump

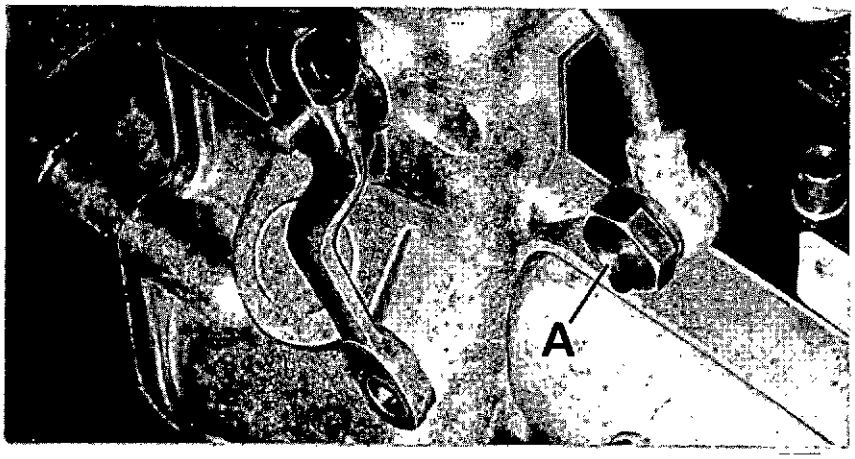


Figure 18. Priming the Minimec Fuel Pump

Connect the fuel supply and manually operate the fuel lift pump during the following operations:-

1. Slacken the bleed screw on top of the fuel filter body and re-tighten when a full air free flow of fuel is obtained.
2. Release the vent screw 'A' on the side of the pump and re-tighten when a full air free flow of fuel is obtained.

PRIMING THE FUEL SYSTEM

DPA Fuel Pump

Connect the fuel supply and manually operate the fuel lift pump during the following operations:-

1. Slacken the bleed screw on top of the fuel filter body and tighten when a full air free flow of fuel is obtained.
2. Slacken the bleed screws 'A','B' and 'C' in that order and tighten each one when an air free flow of fuel is obtained.
3. Slacken any two fuel injector pipe unions at the pump end.
4. Set the engine control (1) to RUN; on variable speed engines set the speed control to the FAST position.
5. Turn the engine until an air free flow of fuel is obtained.
6. Tighten the injector pipe unions.

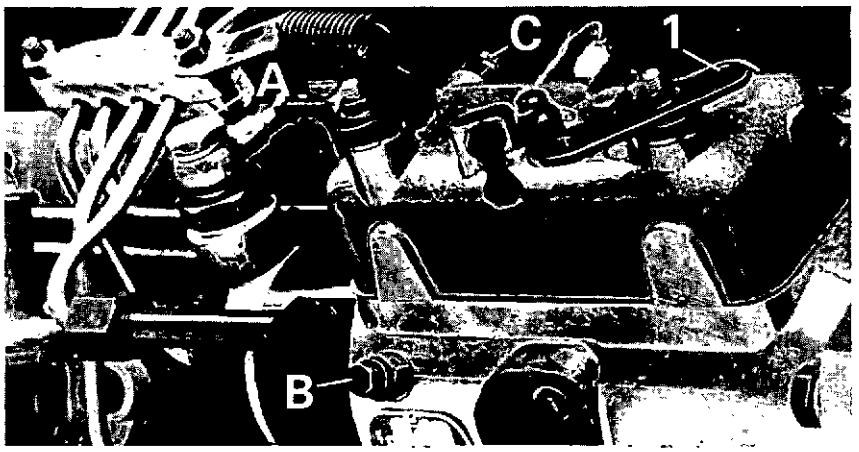


Figure 19. Priming the DPA Fuel Pump

STARTING AND STOPPING

Turbocharged Engines

If possible, turbocharged engines should be run for about one minute on no load after starting and before stopping to ensure satisfactory turbocharger lubrication at the start and for general heat dissipation before stopping.

Before Starting

1. Read The Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc., if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed.
4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. Fill the radiator, heat exchanger or cooling tanks to the correct level. Cooling tanks must have the top pipe covered at all times, radiators and heat exchangers should be filled to within 25mm (1") of the bottom of the filler opening.
6. Move the Control Lever (1) anti-clockwise to the RUN position
7. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.

Electric Start with Push Button

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. On engines fitted with a MINIMEC fuel pump, press the excess fuel button (2) in the centre of the stopping lever to obtain maximum fuel for starting.
6. Press the starter button and release immediately the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

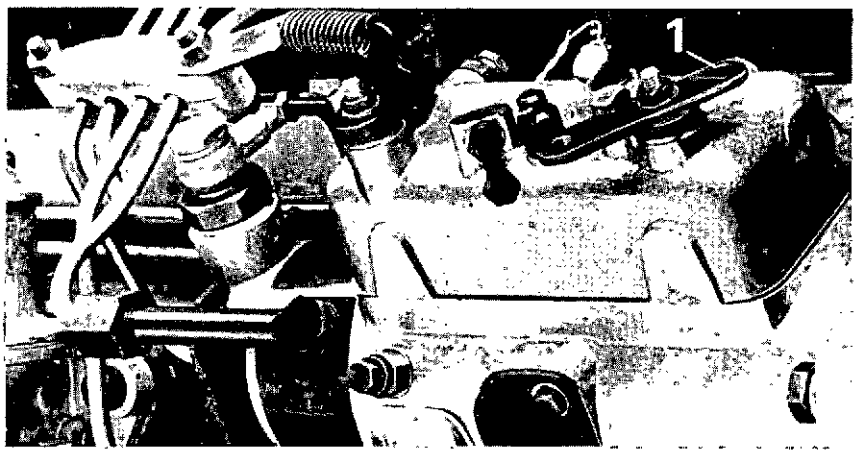


Figure 20. Engine Controls - DPA Pump

Figure 21. Engine Controls - Minimec Pump

Electric Start with Thermostart Cold Starting Aid

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Press the starting aid push button and hold for 15 to 20 seconds then press the electric start button.
6. Release both push buttons immediately the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

Key Start with Thermostart

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Turn the key in a clockwise direction and hold it at position 2 for 15 to 20 seconds before turning to position 3 to energise the starter.
6. Release key when the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

Switch Positions

1. Warning light on - No charge.
2. Cold start.
3. Energise starter.

Emergency Hand Starting

This facility is not fitted as standard.

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Move the Stopping Lever to the RUN position.
6. If a variable speed control is fitted move it to the FAST position.
7. On engines fitted with a MINIMEC fuel pump, press the excess fuel button (2)in the centre of the stopping lever to obtain maximum fuel for starting.
8. Move the decompressor levers towards the flywheel, lightly oil the end of starting shaft and fit a correct and fully serviceable handle.
9. Crank the engine and when sufficient speed is obtained, move the decompressor levers towards the gear end, continue to crank until the engine fires. Retain a firm grip on the starting handle and remove it from the shaft.
10. When a speed control is fitted reduce the speed as necessary.

To Stop Engine

Turn the control lever (1) clockwise and hold it in this position until the engine stops.
After prolonged running the stop control may become hot, therefore it is advisable to use hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is turned off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVERS (IF FITTED) OR VALVE DAMAGE MAY OCCUR

SECTION EIGHT - HL4 & 6

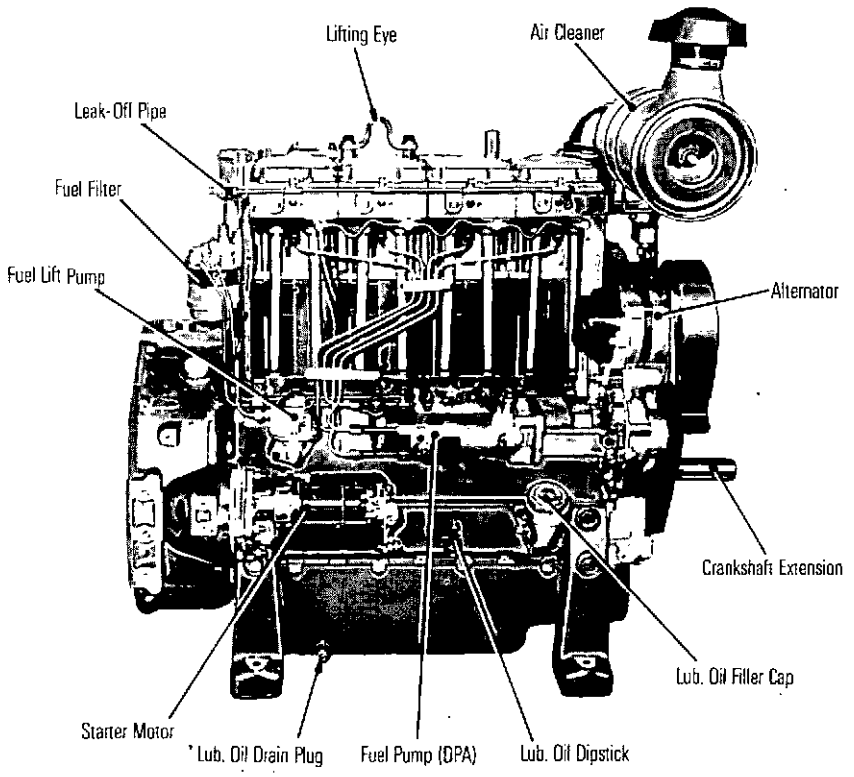


Figure 22. HL4 Air Cooled Engine

ENGINE NUMBER PLATE

The engine serial number plate is fitted to the axial fan cowling.

LUBRICATING OIL PRESSURE

2.1 - 3.1 bar (30 - 40 lbf/sq.in.)

OIL SUMP CAPACITIES

Four Cylinder Engines 18.2 litres; Brit. 32 pints; U.S. 19.2 quarts.
Six Cylinder Engines 23.9 litres; Brit. 42 pints; U.S. 25.2 quarts.

DECOMPRESSOR ADJUSTMENT

Decompressor levers are not fitted as standard on these engines, if they are fitted access is gained by removing the cylinder head cover.

1. Turn the engine until the piston is on T.D.C. firing stroke with both valves closed.
2. Set the adjustment screw so that when the cover is re-fitted the screw will just touch the exhaust valve rocker lever.
3. Turn the adjustment screw down a further three quarters of a turn and lock it in this position.

INJECTOR PRESSURE

The injectors are set on a rig to 180 atmospheres and will settle to 170 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust valves set with the engine cold is:-

0.05mm (0.002") GO
0.10mm (0.004") NOT GO

For hand start engines fitted with alloy push rods:-

0.38mm (0.015") GO
0.43mm (0.017") NOT GO

To Adjust

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke with both valves closed.
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that clearance is correct.
4. Repeat for the remaining valves.

PRIMING THE FUEL SYSTEM

MINIMEC Fuel Pump

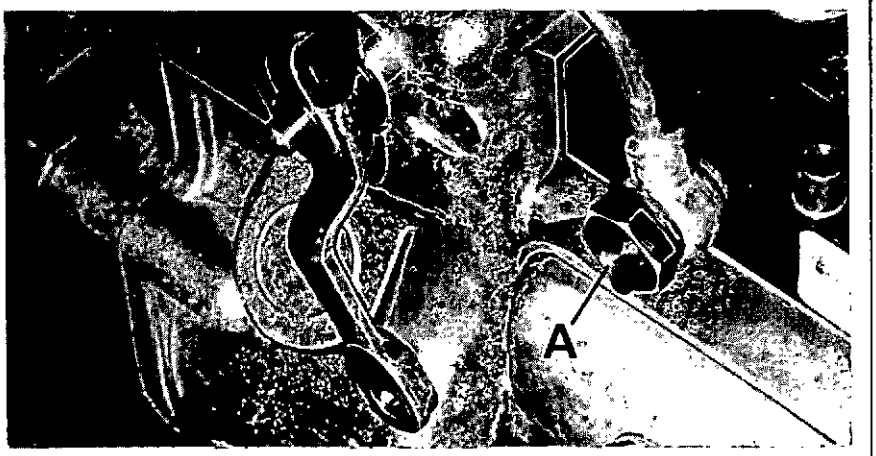


Figure 23. Priming the Minimec Fuel Pump

Connect the fuel supply and manually operate the fuel lift pump during the following operations:-

1. Slacken the bleed screw on top of the fuel filter body and re-tighten when a full air free flow of fuel is obtained.
2. Release the vent screw 'A' on the side of the pump and re-tighten when a full air free flow of fuel is obtained.

PRIMING THE FUEL SYSTEM

DPA Fuel Pump

If a fuel pump solenoid valve is fitted it must be energised during priming.
Connect the fuel supply and manually operate the fuel lift pump during the following operations:-

1. Slacken the bleed screw on top of the fuel filter body and tighten when a full air free flow of fuel is obtained.
2. Slacken the bleed screws 'A','B' and 'C' in that order and tighten each one when an air free flow of fuel is obtained.
3. Slacken any two fuel injector pipe unions at the pump end.
4. Set the engine control (1) to RUN; on variable speed engines set the speed control to the FAST position.

5. Turn the engine until an air free flow of fuel is obtained.
6. Tighten the injector pipe unions.

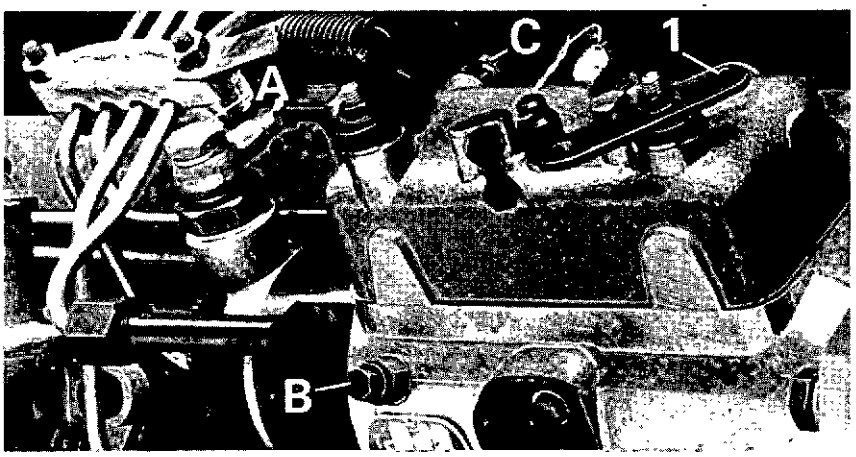


Figure 24. Priming the DPA Fuel Pump

STARTING AND STOPPING

Turbocharged Engines

If possible, turbocharged engines should be run for about one minute on no load after starting and before stopping to ensure satisfactory turbocharger lubrication at the start and for general heat dissipation before stopping.

Before Starting

1. Read The Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc., if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed.
4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. Move the Control Lever (1) anti-clockwise to the RUN position
6. On electric start engines, ensure the batteries are filled to the correct level, charged and connected.

Electric Start with Push Button

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. On engines fitted with a MINIMEC fuel pump, press the excess fuel button (2)in the centre of the stopping lever to obtain maximum fuel for starting.
6. Press the starter button and release immediately the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

Figure 25. Engine Controls - Minimec Pump

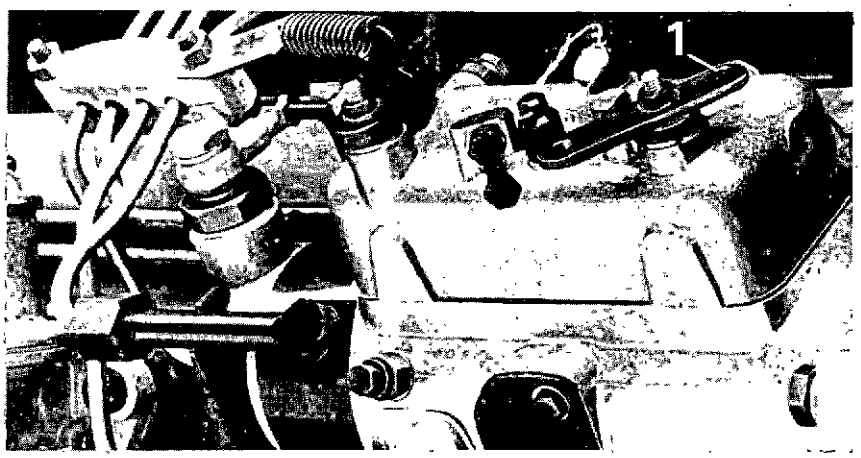


Figure 26. Engine Controls - DPA Pump

Electric Start with Thermostart Cold Starting Aid

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Press the starting aid push button and hold for 15 to 20 seconds then press the electric start button.
6. Release both push buttons immediately the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

Key Start with Thermostart

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Turn the key in a clockwise direction and hold it at position 2 for 15 to 20 seconds before turning to position 3 to energise the starter.
6. Release key when the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

Switch Positions

1. Warning light on - No charge.
2. Cold start.
3. Energise starter.

Emergency Hand Starting

This facility is not fitted as standard.

1. Read The Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted move it to the FAST position.
5. Move the Stopping Lever to the RUN position.
6. If a variable speed control is fitted move it to the FAST position.
7. On engines fitted with a MINIMEC fuel pump, press the excess fuel button (2)in the centre of the stopping lever to obtain maximum fuel for starting.
8. Move the decompressor levers towards the flywheel, lightly oil the end of starting shaft and fit a correct and fully serviceable handle.
9. Crank the engine and when sufficient speed is obtained, move the decompressor levers towards the gear end, continue to crank until the engine fires. Retain a firm grip on the starting handle and remove it from the shaft.
10. When a speed control is fitted reduce the speed as necessary.

To Stop Engine

Turn the control lever (1) clockwise and hold it in this position until the engine stops.
After prolonged running the stop control may become hot, therefore it is advisable to use hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is turned off.

NEVER STOP THE ENGINE BY OPERATING THE DECOMPRESSOR LEVERS (IF FITTED) OR VALVE DAMAGE MAY OCCUR

SECTION NINE - JA/JW

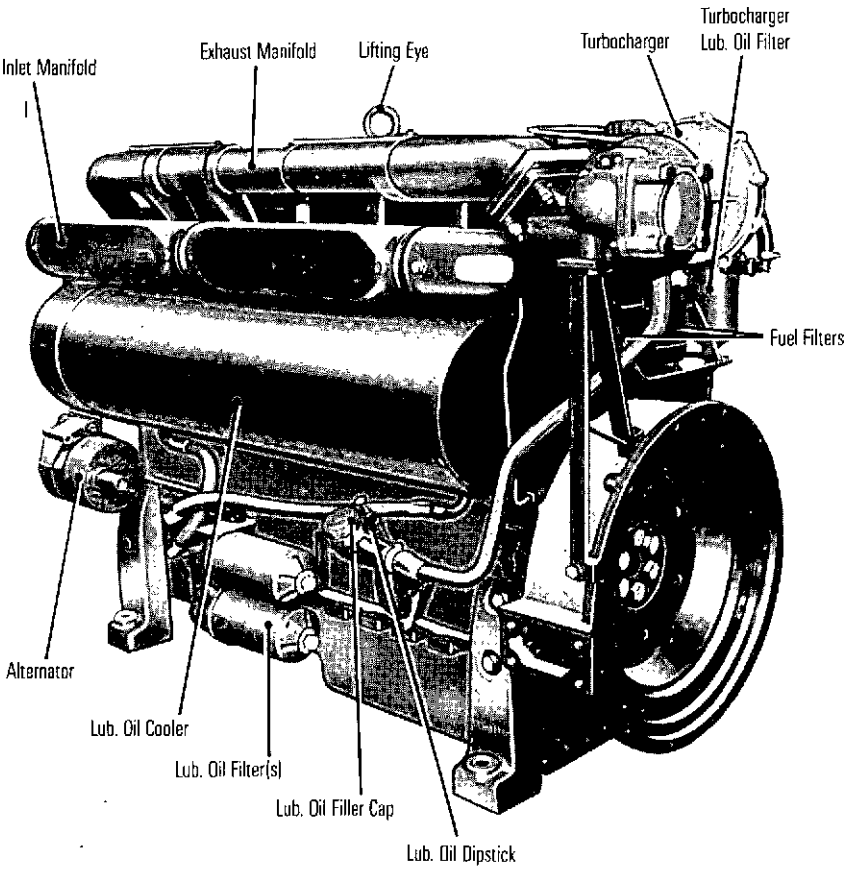


Figure 27. JAS6 Air Cooled Engine

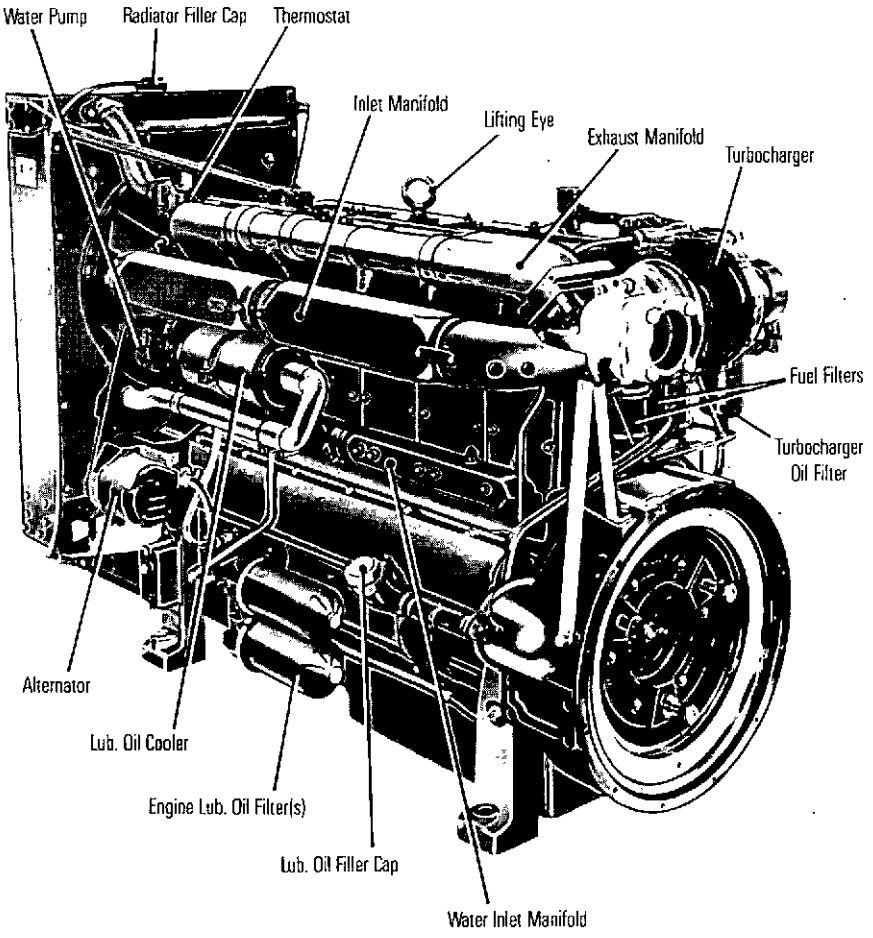


Figure 28. JWS6 Air Cooled Engine

ENGINE NUMBER PLATE

The engine serial number plate is fitted to the air inlet manifold.

LUBRICATING OIL PRESSURE

2.8 - 3.8 bar (40 - 50 lbf./sq.in.)

OIL SUMP CAPACITY

44.4 litres; Brit. 78 pints; U.S. 46.8 quarts.

PRIMING THE FUEL SYSTEM

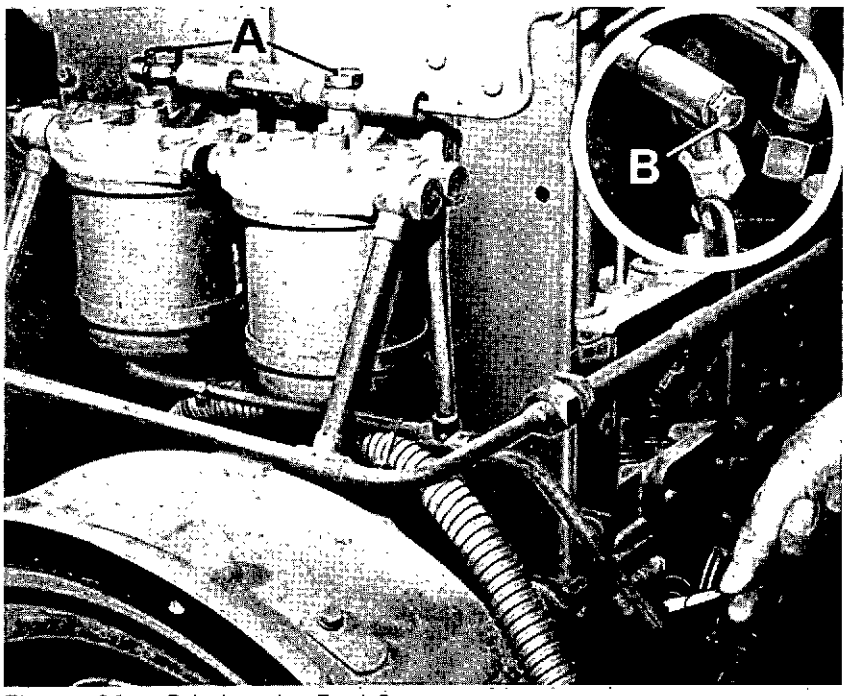


Figure 29. Priming the Fuel System

1. Connect the fuel supply.
2. Operate the fuel lift pump operating lever and slacken the bleed screws 'A' on top of both fuel filters, re-tighten each bleed screw when a full air free flow of fuel is obtained.
3. Slacken the bleed screw 'B' at the gearcase end of the fuel pump delivery pipe and re-tighten when an air free flow of fuel is observed.

INJECTOR PRESSURE

The injectors are set on a rig to 180 atmospheres and will settle to 170 atmospheres when working in the engine.

VALVE CLEARANCE

The valve clearance for both inlet and exhaust, set with the engine cold is:-

Air Cooled Engines

0.05mm (0.002") GO
0.10mm (0.004") NOT GO

Water Cooled Engines

0.10mm (0.004") GO
0.15mm (0.006") NOT GO

To Adjust

A barring hub can be fitted to the crankshaft extension to enable the engine to be turned by hand and it is recommended that the injectors are removed to decompress the engine.
The firing order is 1-5-3-6-2-4.

1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting screw, and re-check to ensure that the clearance is correct.
4. Repeat for all remaining valves.

STARTING AND STOPPING

Turbocharged Engines

If possible, turbocharged engines should be run for about one minute on no load after starting and before stopping to ensure satisfactory turbocharger lubrication at the start and for general heat dissipation before stopping.

Before Starting

1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc., if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed by using the priming lever on the lift pump.

4. Ensure the air cleaner is firmly attached and all air joints are properly sealed.
5. Ensure the batteries are filled to the correct level, charged and connected.
6. Fill the radiator, heat exchanger or cooling tanks to the correct level. Cooling tanks must have the top pipe covered at all times, radiators and heat exchangers should be filled to within 25mm (1") of the bottom of the filler opening.

TO START ENGINE

Hand start facilities are not available for this range of engines.

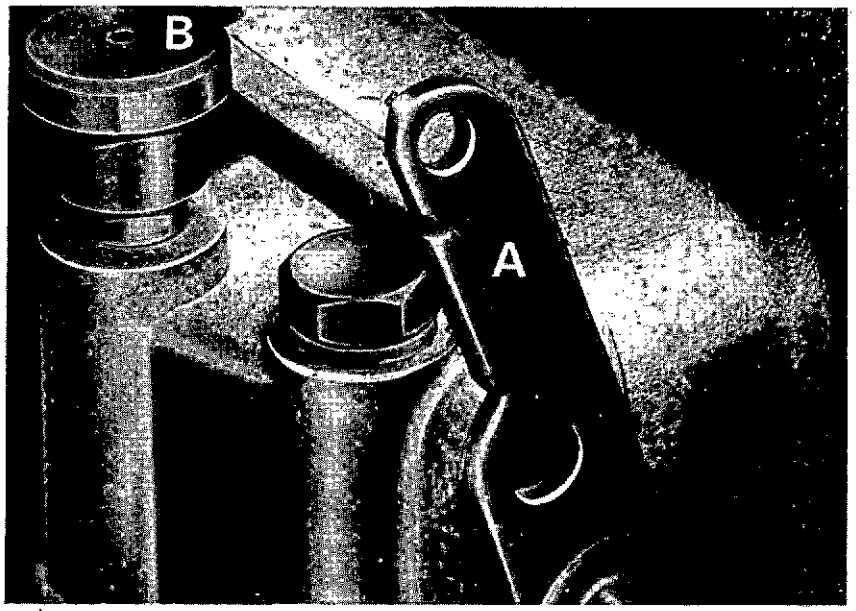


Figure 30. Engine Control

1. Read the Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction.
3. Move the control lever 'A' to the RUN position.
4. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
5. If a variable speed control is fitted move it to the FAST position.
6. Press the starter button and release it immediately the engine fires.
7. When a speed control is fitted reduce the speed as necessary.

To Start Engine with Key Switch

1. Read the Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction
3. Move the control lever 'A' to the RUN position.
4. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
5. If a variable speed control is fitted move it to the FAST position.
6. Turn the key in a clockwise direction and hold it at position 3 to energise the starter.
7. *Release the key when the engine fires.*
8. When a speed control is fitted reduce the speed as necessary.

Switch Positions

1. Warning light on - No charge.
2. Cold start (if fitted)
3. Energise starter

To Start Engine with Thermostart Cold Starting Aid

1. Read the Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction
3. Move the control lever 'A' to the RUN position.
4. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
5. If a variable speed control is fitted move it to the FAST position.
6. Press the starting aid push button and hold for 15 to 20 seconds then press the electric start button. Release both push buttons immediately the engine starts.
7. When a speed control is fitted reduce the speed as necessary.

To Start Engine with Key Start and Thermostart

1. Read the Safety Precautions in Section One.
2. Check the engine is free to turn without obstruction
3. Move the control lever 'A' to the RUN position.
4. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
5. If a variable speed control is fitted move it to the FAST position.
6. Turn the key in a clockwise direction and hold it at position 2 for 15 to 20 seconds turn the key clockwise to position 3 to energise the starter.
7. Release the key when the engine fires.
8. When a speed control is fitted reduce the speed as necessary.

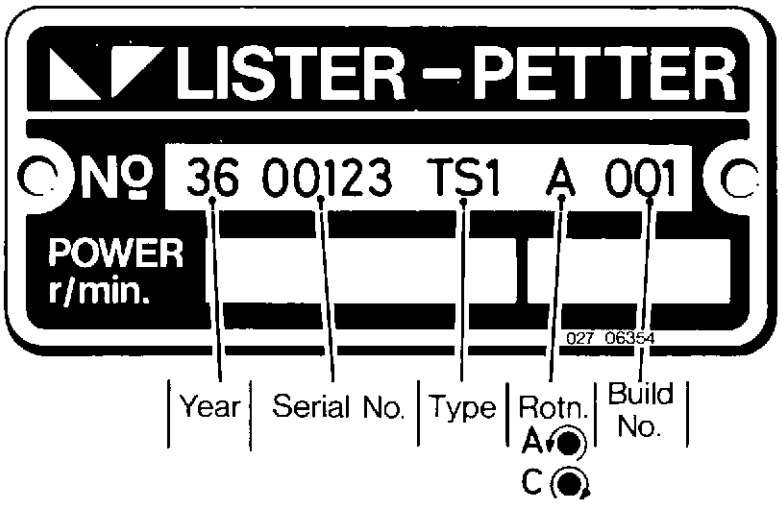
J

TO STOP ENGINE

Turn the control lever (A) clockwise and hold in this position until the engine stops.
After prolonged running the engine control may become hot, it is advisable to use hand protection.
After the engine has stopped ensure the electric start switch, if fitted, is switched off.

SPECIMEN ENGINE NUMBER PLATE

The position of the engine number plate is given at the beginning of each Engine Section.



When ordering replacement parts always quote the:-

- **Engine Number**
- **Part Number**
- **Description of Part.**

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