



INDUSTRIAL ENGINES

L, T, H and J Ranges

Operators Handbook

027-08152

INTRODUCTION

The purpose of this handbook is to lay down operating guidelines to the engine user who should consult his Lister 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 local Lister 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 Lister Parts

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

R. A. LISTER & CO. LTD. cannot therefore, be responsible for any damage arising from the use of such parts and the guarantee will be invalidated.

In your own interest, therefore, specify:

GENUINE LISTER PARTS

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1. INSTALLATION INFORMATION

This installation information is intended as a general guide only. Lister Diesels or 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. The maximum temperature is 52°C (125°F) and if it is desired to run at higher temperatures Lister Diesels or their Distributors must be consulted.

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

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.

ALL ENGINES

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 R. A. Lister comply with the requirements of the Health and Safety at Work Act 1974 (UK). Special accessories may require special guards which R. A. Lister do not supply and must be 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 supplied by R. A. Lister are designed to lift the engine plus R. A. Lister supplied accessories. They must not be used to lift complete assemblies such as a complete power plant.

Starting**All Engines:-**

Ensure engine is free to turn without obstruction. Check that the level of the fuel and lubrication oil is correct (also in gearboxes if fitted); check that the fuel and oil systems are correctly primed.

Hand Start Engines:-

Use the CORRECT Lister starting handle. Ensure there are no burrs on starting shaft, clean and lightly oil before fitting 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.

ALL ENGINES

On HR/W and HL engines, a clutch pin (pawl) on the starting handle engages with a keyway on the starting shaft. After fitting handle, before attempting to start engine, turn in opposite direction to that required to start the engine in order to check that the clutch pin will disengage from 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 correct procedures before attempting to start the engine. If these conditions cannot be met electric starting should be used.

Note: When 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 rectifier/regulator and tape 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 fuel 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. **CLEAN FUEL - FREE FROM WATER - IS OF UTMOST IMPORTANCE**

Note: *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.*

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 tank is refilled. See Priming-Fuel System in relevant engine section.

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 4..
- The oil should be suitable for oil changes every 250 hours or 125 hours in engines running at over 3000 rev/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 | | °C | °F | Monograde Oils | Multigrade Oils |
|-----------------------|----------|----|----------|----------------|------------------|
| | | | | | |
| Below | -15 | | 5 | SAE. 5W | 5W/20 |
| Between and | -15 4 | | 5 39 | SAE. 10W | 10W/30 |
| Between and | 4 30 | | 39 86 | SAE20/20W | 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 <i>blow-by past the piston, (do not disturb otherwise)</i> . |
| | 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 TORQUES (METRIC)

| Thread | Torque | | Engines | Location |
|------------|----------|----------|----------------|--|
| | Nm | lbf. ft. | | |
| M3 x 0.5 | 0.68 | 0.5 | LT LV | Fuel hose clips |
| M4 x 0.7 | 2.98 | 2.2 | LT LV TR TS TL | Governor link adjusting nuts |
| M4 x 0.7 | 2.98 | 2.2 | LT LV | Decompressor screw |
| M6 x 1.0 | 8.82 | 6.5 | TR TS TL | Decompressor screw nut Governor weight plate securing screw |
| M6 x 1.0 | 8.82 | 6.5 | LT LV | Valve rocker adjusting screw nuts |
| M6 x 1.0 | 8.82 | 6.5 | LT LV TR TS TL | Fuel filter to tank cap screw Manifold lower nuts Fuel pump holding down bolts |
| M6 x 1.0 | 4.07 | 3.0 | LT LV TR TS TL | Injector leak off banjo screw |
| M8 x 1.0 | 21.02 | 15.5 | LT LV | Connecting rod nuts |
| M8 x 1.0 | 21.02 | 15.5 | LT LV TR TS TL | Injector clamp screw |
| M8 x 1.25 | 21.05 | 15.5 | LV | Crankshaft balance plate nuts |
| M8 x 1.25 | 21.02 | 15.5 | LT LV TR TS TL | Manifold higher nuts |
| M8 x 1.25 | 21.02 | 15.5 | TR TS TL | Valve rocker adjusting screw nuts |
| M8 x 1.25 | 27.12 | 20.0 | LT LV TR TS TL | Main bearing housing screws Sump retaining screws |
| M8 x 1.25 | 7.9/14.4 | 5.8/10.6 | LT LV TS TL | Cold start cup taper thread |
| M10 x 1.25 | 57.0 | 42.0 | TR TS TL | Balance weights retaining screws |
| M10 x 1.25 | 40.69 | 30.0 | LT LV | Cylinder head nuts |
| M10 x 1.5 | 34.9134 | 25.0 | J range | Valve rocker screw nuts |
| M12 x 1.5 | 187.63 | 102.0 | LV | Gear end crankshaft drives |
| M12 x 1.5 | 28.48 | 21.0 | ALL | Fuel injection pipe nuts |
| M12 x 1.75 | 78.66 | 58.0 | J range | Shaft extension fan nuts |
| M12 x 1.75 | 78.66 | 58.0 | ALL | General |

ALL ENGINES

Spanner Torques (Metric) continued

| Thread | Torque | | Engines | Location |
|------------|---------|---------|-------------------|---------------------------------|
| | Nm | lbf.ft. | | |
| M12 x 1.75 | 54.25 | 40.0 | J range | Injector clamp nuts |
| M12 x 1.75 | 34.91 | 25.0 | J range | Fuel pump inlet union |
| M14 x 1.5 | 45.76 | 33.0 | HR HL J | Alternator pulley nut |
| M16 x 1.5 | 362.13 | 267.0 | TR TS TL | Gear end crankshaft drives |
| M16 x 2.0 | 196.66 | 145.0 | J range | Connecting rod nuts |
| M18 x 1.5 | 54.25 | 40.0 | ALL (less J) | Fuel pump delivery valve holder |
| M18 x 1.5 | 196.66 | 145.0 | LT LV | Flywheel retaining screw |
| M18 x 1.5 | 190/203 | 140/150 | JA | Cylinder head nuts |
| M18 x 1.5 | 244.13 | 180.0 | JW | Cylinder head nuts |
| M20 x 1.25 | 27.12 | 20.0 | LT LV TR TS TL HL | Injector top plug |
| M20 x 1.5 | 61.03 | 45.0 | J range | Fuel pump delivery valve holder |
| M20 x 2.5 | 393.33 | 290.0 | J range | Flywheel set screws |
| M21 x 1.5 | 88.16 | 65.0 | H & J ranges | Injector top cap and locknut |
| M24 x 2.0 | 474.71 | 350.0 | TR TS | Flywheel retaining screw |
| M24 x 3.0 | 434/461 | 320/340 | J range | Main bearing cap nuts |
| M39 x 3.0 | 610.33 | 450.0 | TL | Flywheel retaining nut |

8. SPANNER TORQUES (UNIFIED)

| Thread | Torque | | Engines | Location |
|-------------|--------|----------|--------------|---|
| | Nm | lbf. ft. | | |
| ½" - 24 UNS | 13.56 | 10.0 | J range | Fuel pump inlet union nut |
| ⅝" UNF | 20.34 | 15.0 | H range | Injector clamp nuts Valve rocker screws |
| ⅞" UNF | 43.4 | 32.0 | TR TS TL | Connecting rod nuts |
| 1" UNF | 65.1 | 48.0 | TR TS TL | Balance weight setscrew |
| 1 ⅛" UNF | 67.82 | 50.0 | TR TS TL | Cylinder head nuts |
| 1 ½" UNF | 92.3 | 68.0 | H ranges | Balance weight screws. Connecting rod nuts Cooling fan shaft nuts |
| 1 ⅞" UNF | 108.5 | 80.0 | HR/HL | Cylinder head nuts |
| | 135.63 | 100.0 | HRW | Cylinder head nuts |
| | 135.63 | 100.0 | HR/W4 & 6/HL | Flywheel setscrews. |
| 2" UNF | 271.26 | 200.0 | H range | Main bearing cap nuts |
| 1" UNF | 542.62 | 400.0 | HR/W2 & 3 | Flywheel crankshaft screw |
| ¾" UNF | 54.25 | 40.0 | HL J | AC5R Alternator |
| ¾" BSP | 20.34 | 15.0 | LV | Main bearing dowel locating plug |

9. 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.

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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.

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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.*

10. ASSOCIATED PUBLICATIONS

Workshop Manuals

| Engine | Book No |
|-----------------|-----------|
| LT | 027-08202 |
| LV | 027-08226 |
| 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.*

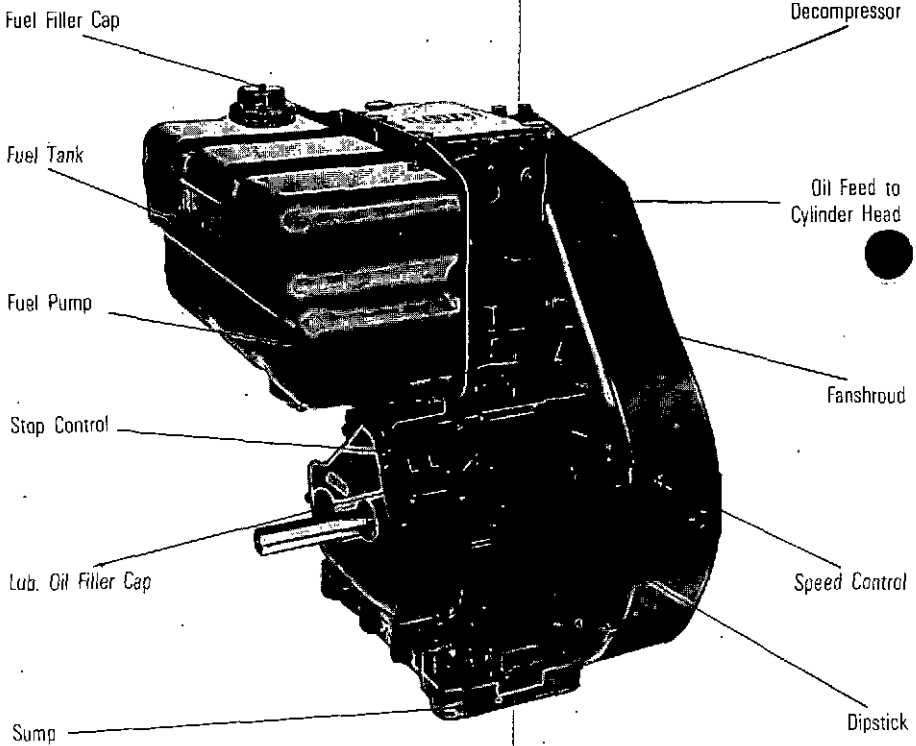
Parts List

| 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 No.**,
Part No. and **Description of part.**

LT

SECTION TWO - LT



The engine number plate is fitted to the air shield.

LT1 Air Cooled Engine

LUBRICATING OIL PRESSURE

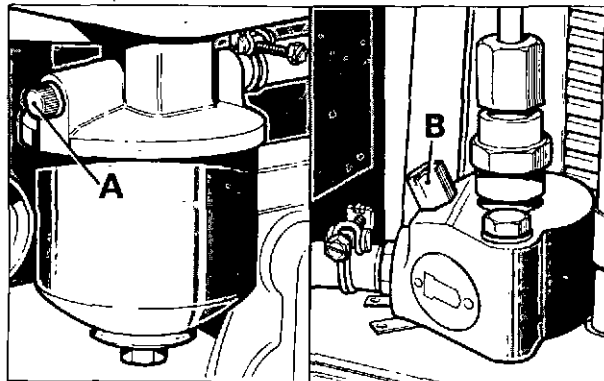
0.7 bar (10lbf/sq.in.) minimum at 1000 rev/min.

OIL SUMP CAPACITY

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

PRIMING THE FUEL SYSTEM

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



Priming 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).

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 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 (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 Starting

Note: *When running engines with alternator system disconnected from battery, disconnect leads from 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 fuel system is primed.
4. Ensure air cleaner is firmly attached and all air joints are properly sealed.
5. On electric start engines, ensure batteries are filled to correct level, charged and connected.

Cold Starting Below -10°C(14°F)

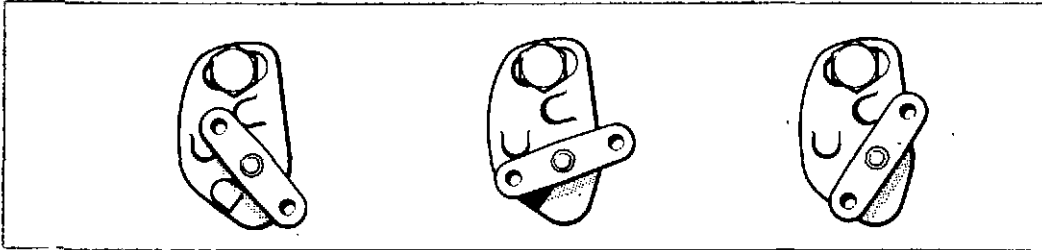
A cup and plunger may be fitted on the combustion air intake port. To operate, withdraw the plunger and fill one third of the cup with the same type of lubricating oil as used in the engine. Replace the plunger and inject the oil just before starting. The device must not be used more than three times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

LT

START

RUN

STOP



LT1 Engine Control

To Start Engine (Hand Starting)

1. Check the engine is free to turn without obstruction.
2. On LT1 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.
3. If a variable speed control lever is fitted, move towards FAST.
4. Move decompressor lever towards the flywheel, lightly oil end of starting shaft and fit correct and fully serviceable starting handle.
5. 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.
6. Crank the engine really fast and when sufficient speed is obtained, move decompressor lever towards fuel tank (or gear end) continue to crank until engine fires, retain grip on starting handle and remove from shaft.
7. On LT1 engines turn control lever to RUN position abutting against the middle catch.
8. When speed control is fitted, reduce speed as required

To Start Engine (Electric Starting with Starter Button)

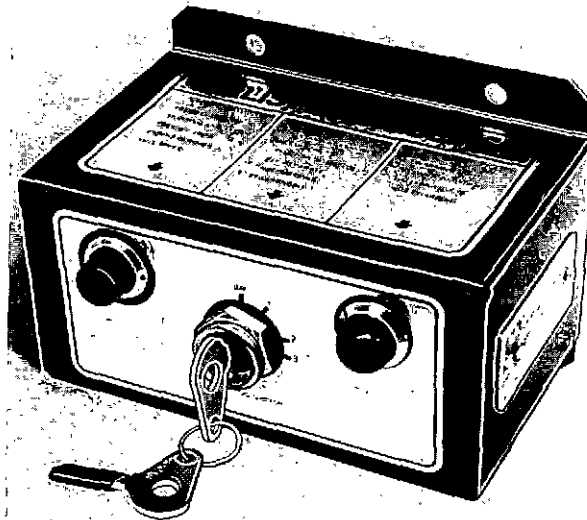
1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Press starter button and release immediately the engine fires.
3. Carry out items 7 and 8 as for Hand Starting.

To Start Engine (Electric Starting with Key Switch)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Turn switch in clockwise direction until engine fires.
3. Carry out items 7 and 8 as for Hand Starting.

Switch Positions

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



TL89

Key Switch.

LT

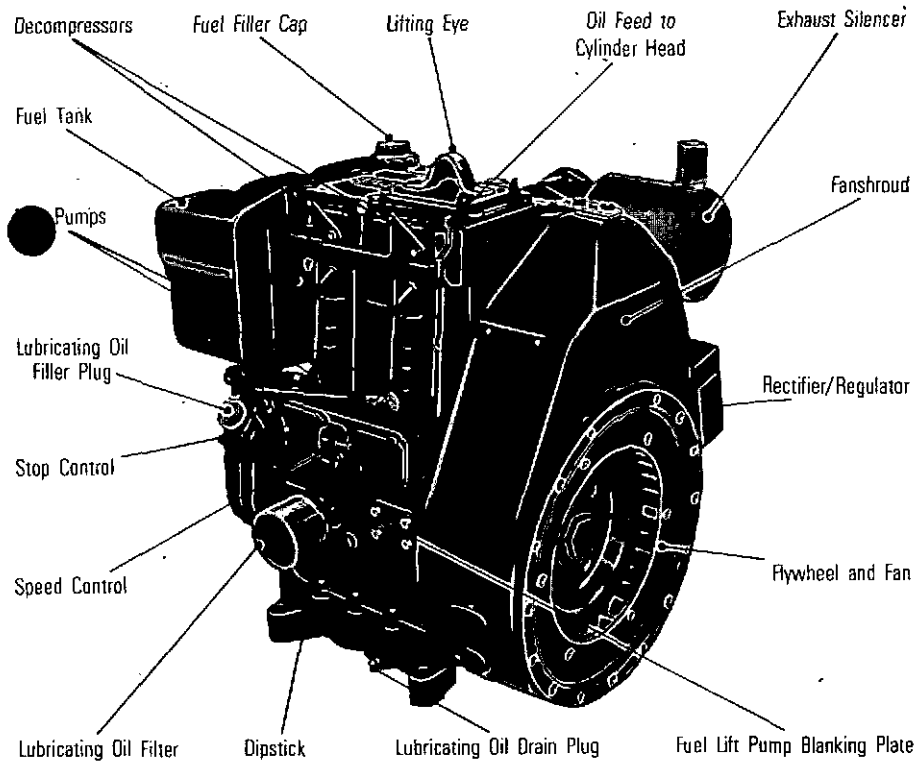
To Stop Engine

Move control lever to stop position (anti-clockwise).

Note: *After engine has stopped ensure electric start switch (if fitted) -is switched off.*

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

SECTION THREE - LV



The engine number plate is fitted to the air shield.

LV2 Air Cooled Engine

LUBRICATING OIL PRESSURE

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

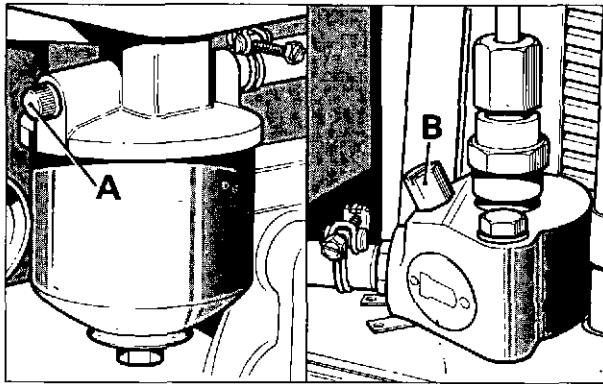
OIL SUMP CAPACITY

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.



Priming Fuel System

1. Fill fuel tank.
2. Vent fuel filter through bleed screw 'A' until a full air free flow of fuel is obtained.
3. Vent fuel at pump through bleed screw 'B', starting with the pump nearest the filter until all air is expelled.

When a remote mounted fuel supply is used the bleed screw is located on the top of the fuel filter nearest the fuel inlet.

DECOMPRESSOR ADJUSTMENT

1. Remove 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 on 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

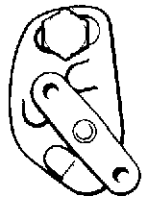
0.18mm (0.007") NOT GO

To Adjust

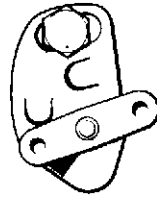
1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke with both valves closed.
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting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

STARTING AND STOPPING

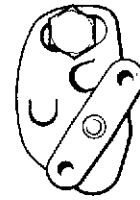
START



RUN



STOP



LV1 Engine Control

STOP

START



LV2 Engine Control

Before Starting

1. Read 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 fuel system is primed.
4. On electric start engines, ensure batteries are filled to correct level, charged and connected. If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming lever on the lift pump.

Note: LV2 cylinder engines are fitted with automatic excess fuel selection and 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 running engines with the alternator system disconnected from battery disconnect stator leads from rectifier/regulator unit and tape up separately.

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.

TO START ENGINE (HAND STARTING)

1. Check the engine is free to turn without obstruction.
2. Check the control lever is in the start position.
3. If a variable speed control is fitted move towards FAST.
4. Move decompressor levers towards the flywheel and fit correct and fully serviceable starting handle.
5. Turn the engine slowly from 3 - 20 turns according to the temperature and period of standing to prime combustion chamber and lubricating oil system.
6. Crank the engine really fast and when sufficient speed has been obtained, move decompressors towards gear end; continue to crank until engine fires. Retain grip on starting handle and remove from engine.
7. On LV1 engines turn control lever to RUN position abutting against the middle catch.
8. When a speed control is fitted reduce speed as required.

Start Engine (Electric Starting with Starter Button)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Press starter button and release immediately the engine fires.
3. Carry out items 7 and 8 as for Hand Starting.

To Start Engine (Electric Starting with Key Switch)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Turn switch in clockwise direction until engine fires.
3. Carry out items 7 and 8 as for Hand Starting.

Switch Positions

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

To Stop Engine

Move control lever to stop position (anti-clockwise).

Note: *After engine has stopped ensure electric start switch (if fitted) is switched off.*

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

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

**STOP****START**

Engine Control

Before Starting

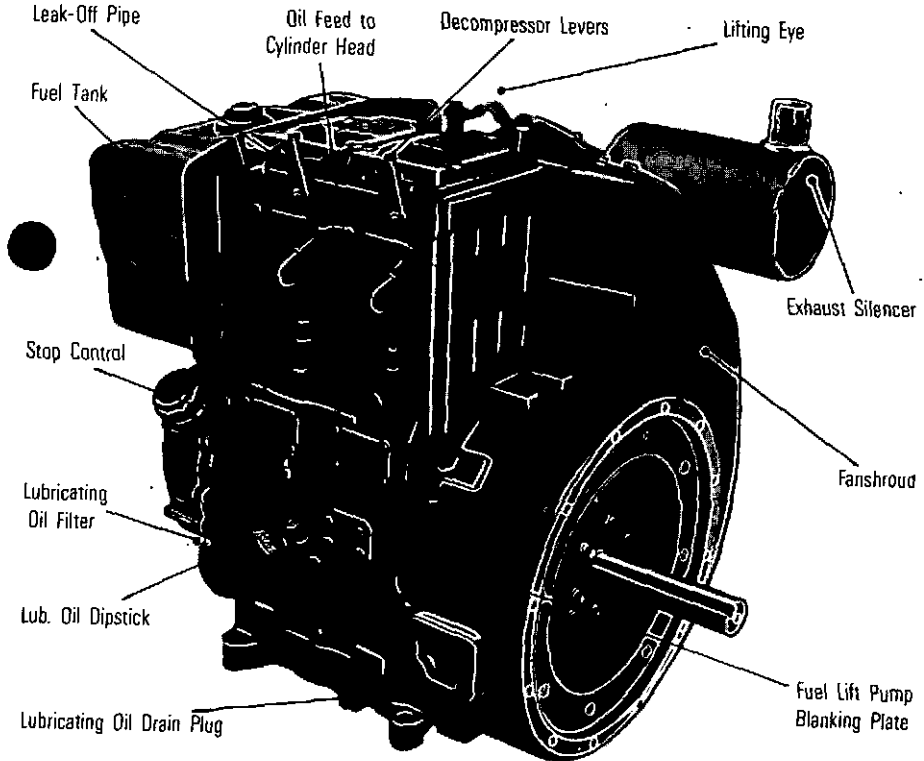
1. Read the Safety Precautions in Section One.
2. Fill the engine - and gearboxes etc. if fitted - with the right grade of lubricating oil to the correct level.
3. Ensure there is an adequate supply of fuel and the fuel system is primed. If the engine is fitted with a fuel lift pump, prime the fuel filter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

Note: Before running engines with alternator disconnected from the battery disconnect leads from rectifier/regulator unit and tape up separately.

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.

SECTION FOUR - TR/TS



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

TS2 Air Cooled 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

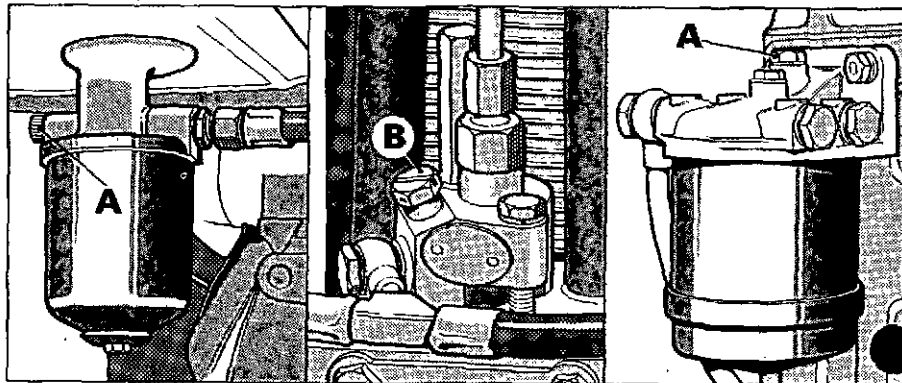
TR/TS3 - 6.5 litres; Brit. 11.4 pints; U.S. 6.8 quarts

These figures include the filter.

PRIMING THE FUEL SYSTEM

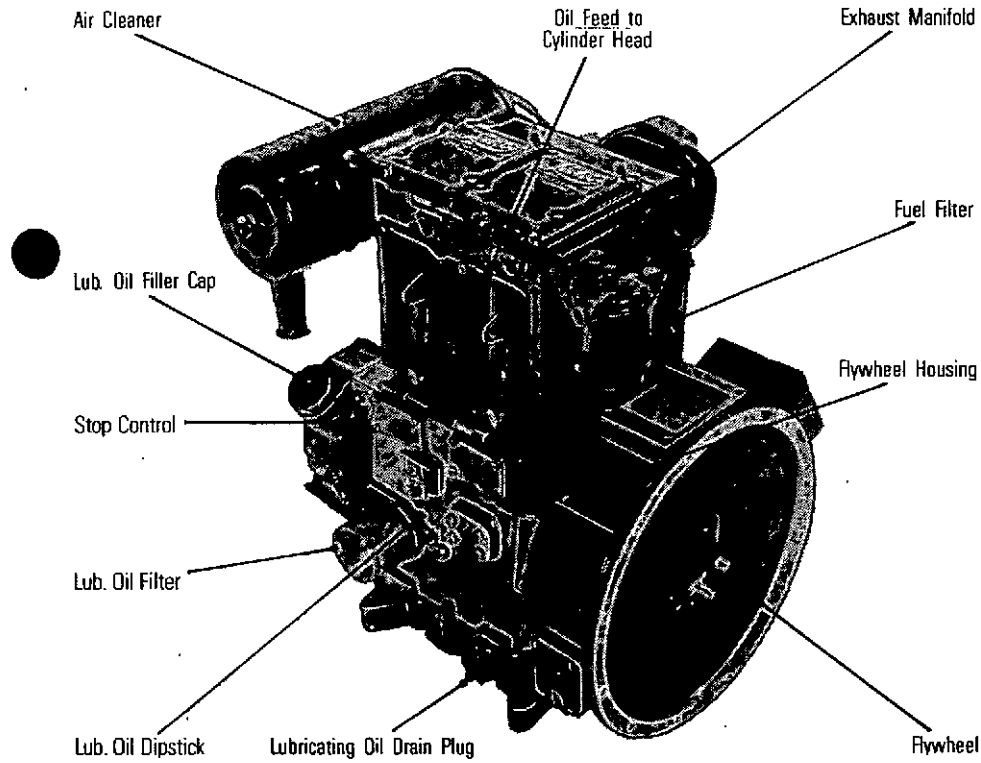
Note: *If engines are fitted with self priming fuel systems it should never be necessary to prime the system.*

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



Priming Fuel System

SECTION FIVE - TL



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

TL2 Air Cooled 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

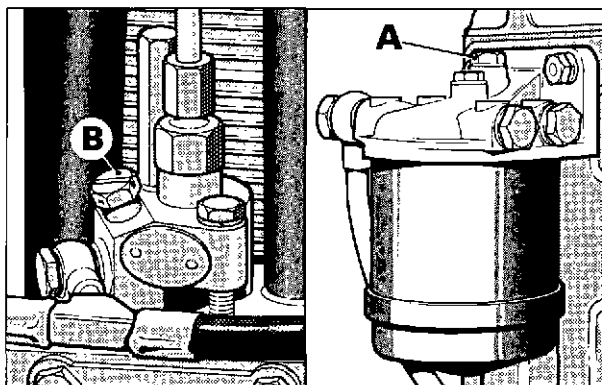
TL2 - 4.3 litres; 7.6 Brit pints; 4.6 U.S. quarts.

TL3 - 6.5 litres; 11.4 Brit.pints; 6.8 U.S.quarts.

Note: *These figures include the filter.*

PRIMING THE FUEL SYSTEM

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



Priming 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: *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.*

To Start Engine (Hand Starting)

1. Check the engine is free to turn without obstruction.
2. Check the control lever is in the start position.
3. If a variable speed control is fitted move towards FAST.
Move decompressor levers towards the flywheel and fit correct and fully serviceable starting handle.
5. Turn the engine slowly from 3 - 20 turns according to the temperature and period of standing to prime combustion chamber and lubricating oil system.
6. Crank the engine really fast and when sufficient speed has been obtained, move decompressor lever(s) towards gear end; continue to crank until engine fires. Retain grip on starting handle and remove from engine.
7. When speed control is fitted reduce speed as required.

To Start Engine (Electric Starting with Starter Button)

1. Carry out items 1, 2 and 3 as for Hand Starting
2. Press starter button and release immediately the engine fires.
3. Carry out item 7 as for Hand Starting.

To Start Engine (Electric Starting with Key Switch)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Turn switch in clockwise direction until engine fires.
3. Carry out item 7 as for Hand Starting.

Switch Positions

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

To Stop Engine

Move control lever to stop position (anti-clockwise) and hold in this position until the engine stops.

Note: *After engine has stopped ensure electric start switch (if fitted) switched off.*

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

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.
- 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

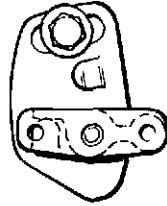
0.20mm (0.008") NOT GO

To Adjust

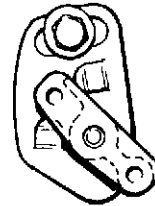
1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting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

STARTING AND STOPPING

STOP



START



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 air cleaner is firmly attached and all joints are properly sealed.
5. Ensure batteries are filled to correct level, charged and connected.

Note: *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 alternator system disconnected from the battery disconnect leads from the rectifier/regulator unit and tape up separately.

To Start Engine (Electric Starting with Starter Button)

1. Check the engine is free to turn without obstruction.
2. Check the control lever is in the start position.
3. If a variable speed control is fitted move to the FAST position.
4. Press starter button and release immediately the engine fires.
5. If a speed control is fitted reduce speed as required.

To Start Engine (Electric Starting with Key Switch)

1. Carry out items 1, 2 and 3 as above
2. Turn switch in clockwise direction until engine fires and release.
3. Carry out item 5. as above.

Switch Positions

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

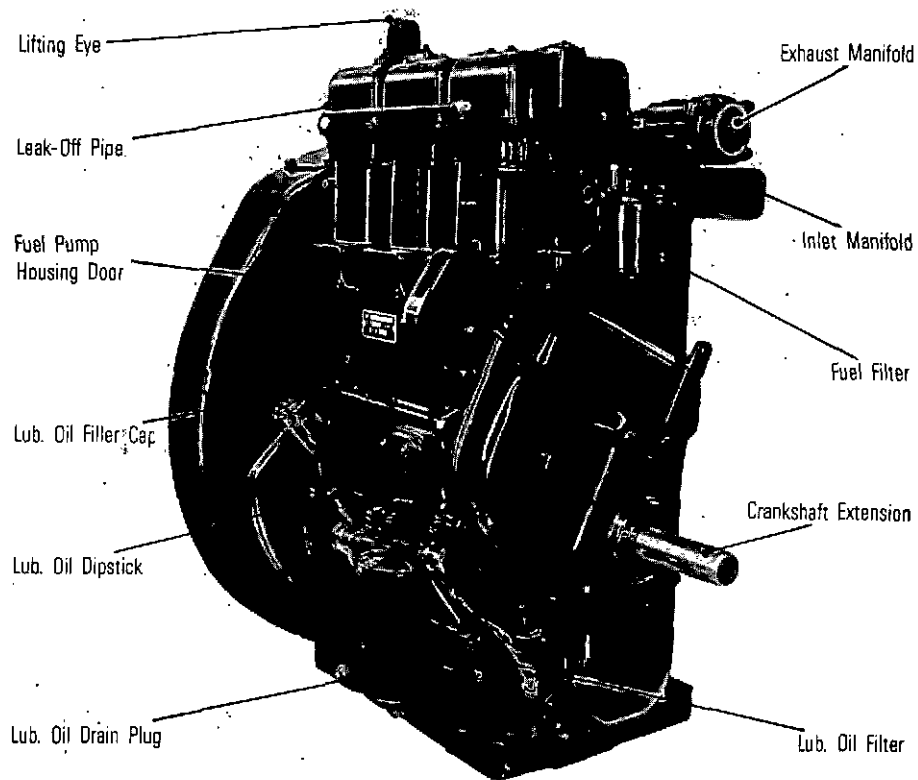
To Stop Engine

Move the control lever to the stop position and hold until the engine stops.

Note: *After the engine has stopped ensure the electric start key switch (if fitted) is switched off.*

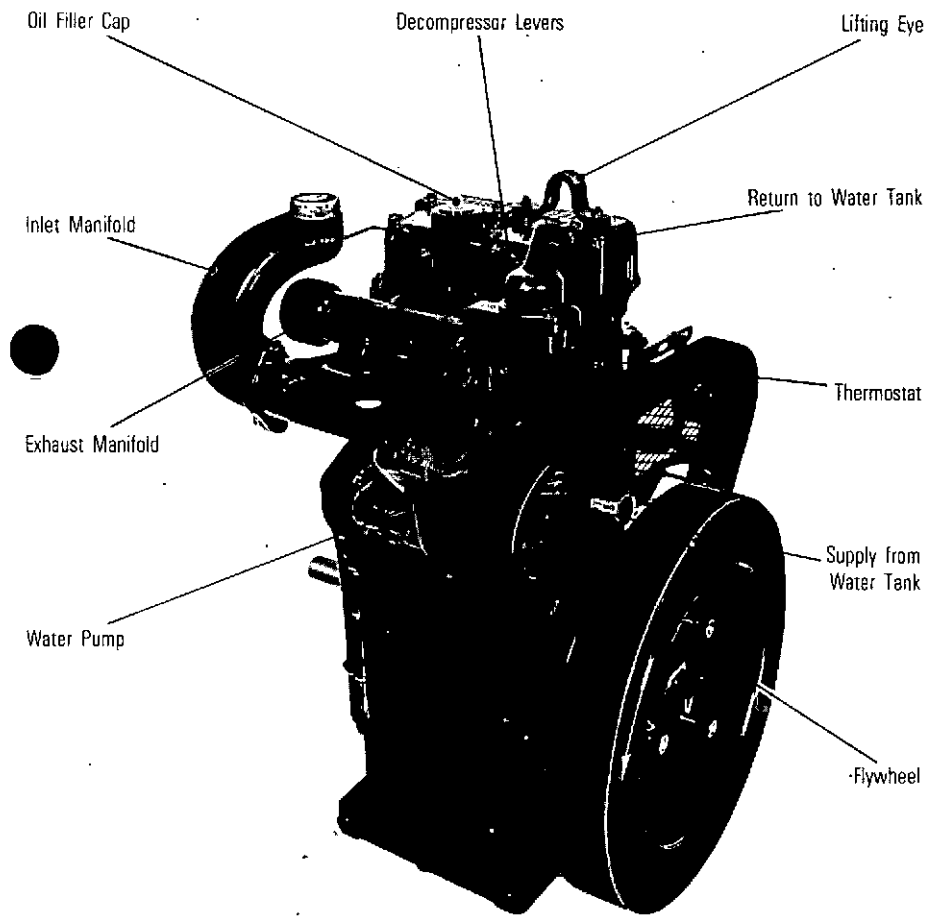
**NEVER STOP THE ENGINE BY OPERATING THE
DECOMRESSOR LEVERS (IF FITTED) OR
VALVE DAMAGE MAY OCCUR**

SECTION SIX - HR/W2 & 3



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

HR3 Air Cooled Engine



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

HRW2 Water Cooled Engine

HR/W 2 & 3

LUBRICATING OIL PRESSURE:

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

OIL SUMP CAPACITIES

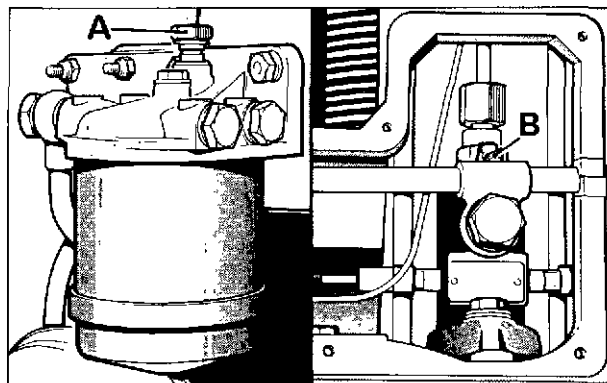
HR/W2 - 10.8 litres; Brit.19 pints; U.S.11.4 quarts.

HR/W3 - 14.8 litres; Brit.26 pints; U.S.15.6 quarts.

PRIMING THE FUEL SYSTEM

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

1. Fill fuel tank or connect 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.



Priming Fuel System

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.
● 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 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)

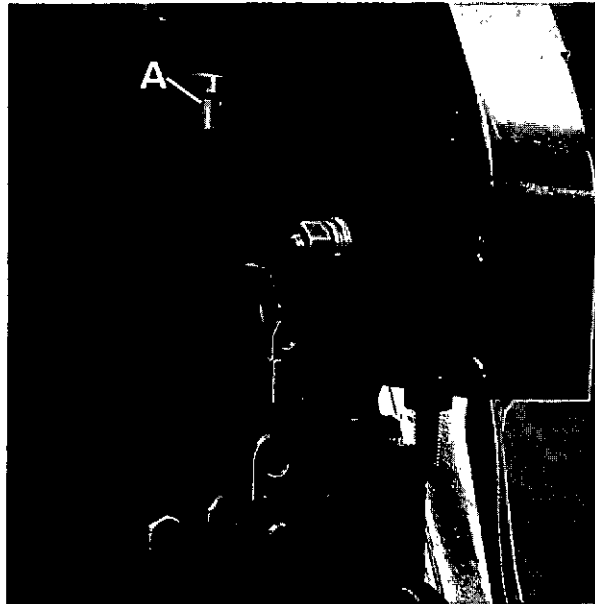
0.38mm (0.015") GO
0.43mm (0.017") NOT GO

To Adjust

- 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 clearance is correct.
4. Repeat for remaining valves.

STARTING AND STOPPING



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 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 batteries are filled to 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.

Start Engine (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 towards FAST.
4. Move decompressor levers towards the gear end, lightly oil end of starting shaft and fit 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 engine fires. Retain grip on starting handle and remove from shaft.
7. When speed control is fitted, reduce speed as required.

To Start Engine (Electric Starting)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Press starter button and release immediately the engine fires.
3. Carry out item 7 as for Hand Starting.

Start Engine (Electric Starting with Key Switch)

1. Carry out items 1, 2 and 3 as for Hand Starting.
2. Turn switch in clockwise direction until engine fires and release.
3. Carry out item 7 as Hand Starting.

HR/W 2 & 3

Switch Positions

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

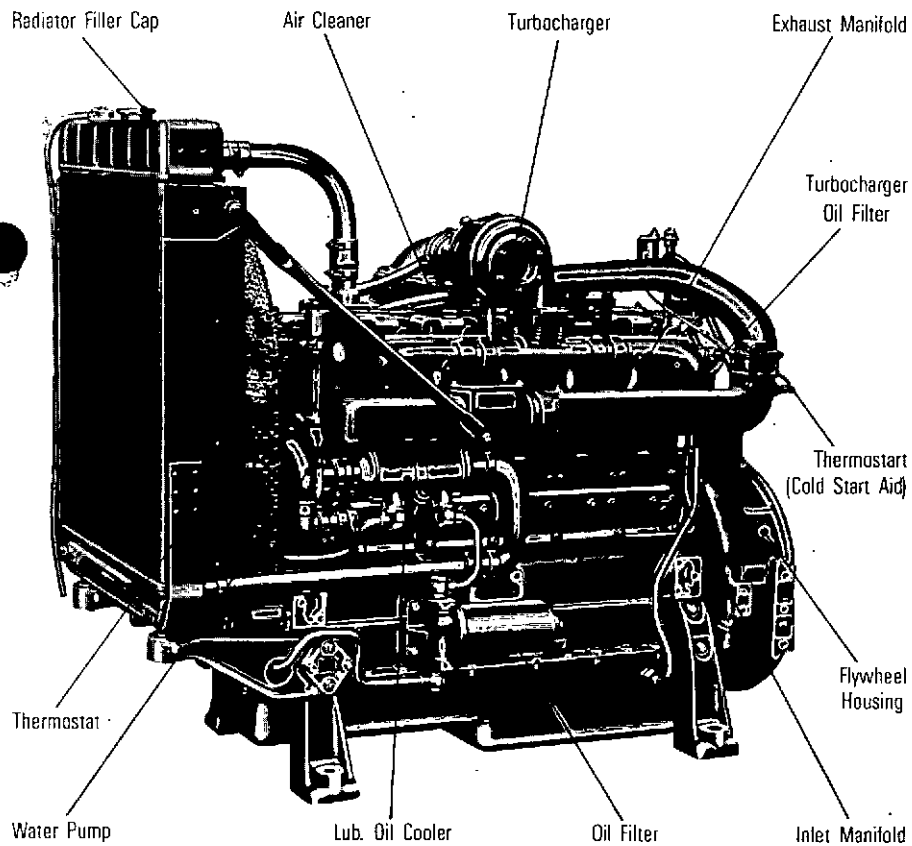
To Stop Engine

Move the control lever anti-clockwise towards the flywheel and hold in this position until the engine stops.

Note: After engine has stopped ensure 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



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

HRWS6 Water Cooled Engine

HRW4-6 & S6

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

Note: *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

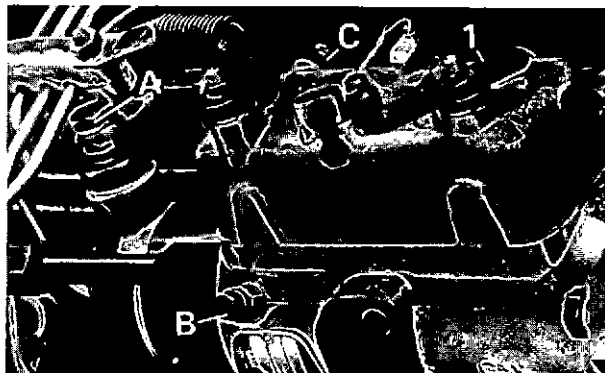
The valve clearance for both inlet and exhaust valves set with the engine cold is:-

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**DPA Fuel Pump**

DPA Fuel Pump

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

1. Slacken bleed screw on top of the fuel filter body and tighten when a full air free flow of fuel is obtained.
2. Slacken bleed screws 'A','B' and 'C' in that order and tighten 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.

MINIMEC Fuel Pump

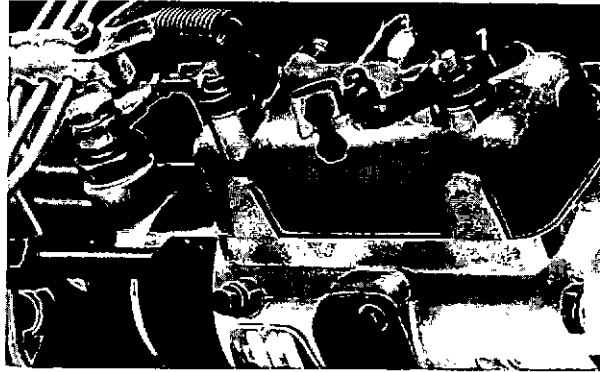


Minimec Fuel Pump

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

1. Slacken 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.

STARTING AND STOPPING



Engine Controls - DPA Pump



Engine Controls - Minimec Fuel Pump

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 fuel system is primed.

HRW4-6 & S6

4. Ensure 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 batteries are filled to correct level, charged and connected.

To Start Engine (Electric Start with Push Button)

1. Check the engine is free to turn without obstruction.
2. Move the Stopping Lever to the RUN position.
3. If a variable speed control is fitted move it to the FAST position.
4. 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.
5. Press the starter button and release immediately the engine fires.
6. When a speed control is fitted reduce speed as necessary.

To Start Engine (Electric Start with Thermostart Cold Starting Aid)

1. Carry out items 1, 2, 3 and 4 as To Start Engine (Electric Start with push button)
2. Press the starting aid push button and hold for 15 to 20 seconds then press the electric start button.
3. Release both push buttons immediately the engine starts.
4. When a speed control is fitted reduce speed as necessary.

To Start Engine (Key Start with Thermostart)

1. Carry out items 1, 2, 3 and 4 as To Start Engine (Electric Start with push button)
2. Turn key in a clockwise direction and hold at position 2 for 15 to 20 seconds before turning to position 3 to energise the starter.

3. Release key when the engine starts.
4. When a speed control is fitted reduce speed as necessary.

Switch Positions

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

Emergency Hand Starting

Note: *This facility is not fitted as standard.*

1. Check the engine is free to turn without obstruction.
2. Move the Stopping Lever to the RUN position.
3. If a variable speed control is fitted move it to the FAST position.
4. 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.
5. Move decompressor levers towards the flywheel, lightly oil end of starting shaft and fit correct and fully serviceable handle.
6. Crank the engine and when sufficient speed is obtained, move decompressor levers towards the gear end, continue to crank until engine fires. Retain grip on starting handle and remove from shaft.
7. When a speed control is fitted reduce speed as necessary.

To Stop Engine

Turn the control lever (1) clockwise and hold in this position until the engine stops.

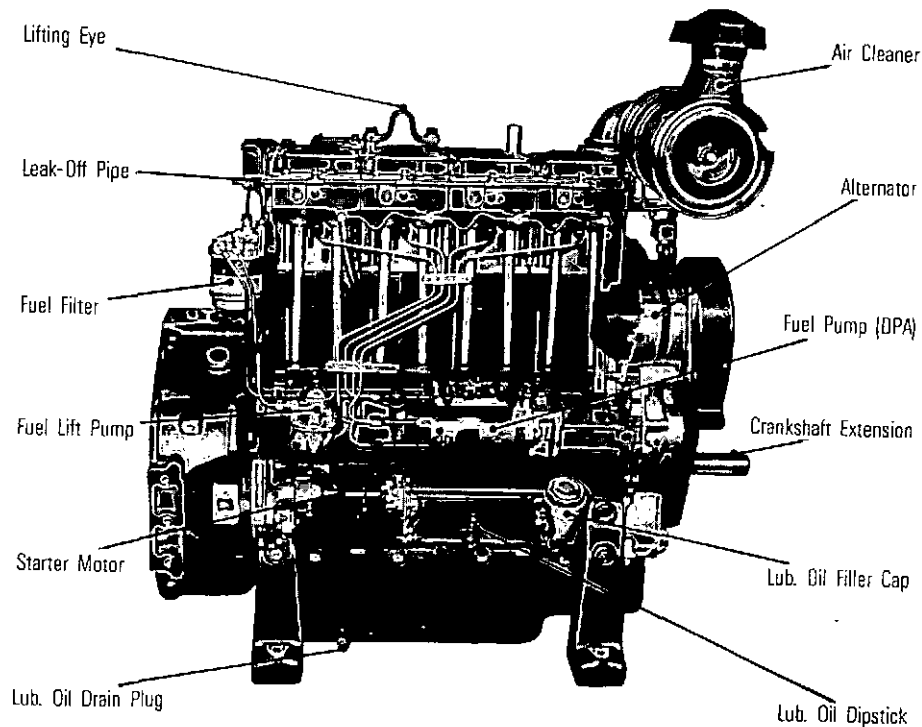
Note: *After engine has stopped ensure electric start switch (if fitted) is turned off.*

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

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.

SECTION EIGHT - HL4 & 6



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

HL4 Air Cooled Engine

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

Note: *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 engines fitted with alloy push rods for hand starting:-

0.38mm (0.015") GO

0.43mm (0.017") NOT GO

To Adjust

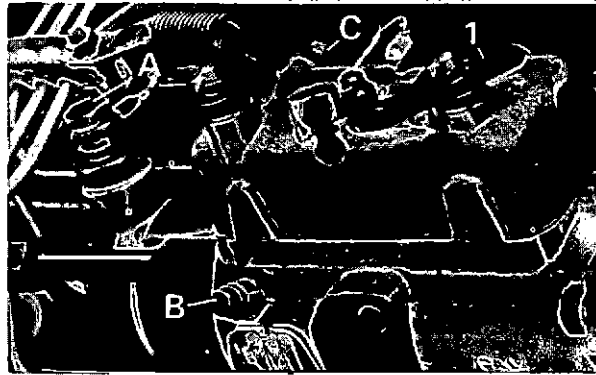
1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke with both valves closed.

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

DPA Fuel Pump

Note: If a fuel pump solenoid valve is fitted it must be energised during priming.



DPA Fuel Pump

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

1. Slacken bleed screw on top of the fuel filter body and tighten when a full air free flow of fuel is obtained.
2. Slacken bleed screws 'A', 'B' and 'C' in that order and tighten when an air free flow of fuel is obtained.
3. Slacken any two fuel injector pipe unions at the pump end.
4. Set the speed 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.

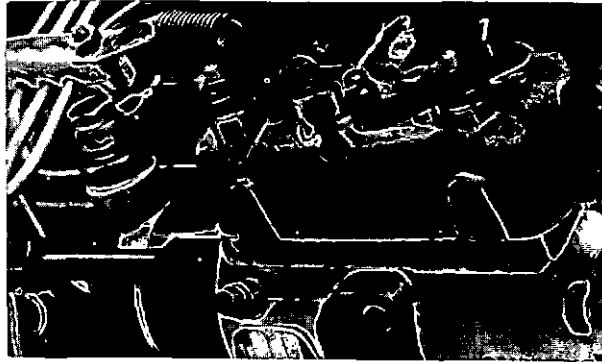
MINIMEC Fuel Pump

Minimec Fuel Pump

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

1. Slacken 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.

STARTING AND STOPPING



Engine Controls - DPA Pump



Engine Controls - Minimec Fuel Pump

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 fuel system is primed.

4. Ensure 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 batteries are filled to correct level, charged and connected.

To Start Engine (Electric Start with Push Button)

1. Move the Control Lever to the RUN position.
2. If a variable speed control is fitted move it to the FAST position.
3. On engines fitted with a MINIMEC fuel pump press the excess button (2) in the centre of the control lever to obtain maximum fuel for starting.
4. Press the starter button and release immediately the engine fires.
5. When a speed control is fitted reduce speed as necessary.

To Start Engine (Electric Start with Thermostart)

1. Carry out items 1, 2 and 3 as above.
2. Press the starting aid push button and hold for 15 to 20 seconds then press the electric start button.
3. Release both push buttons immediately the engine starts.
4. When a speed control is fitted reduce speed as necessary.

To Start Engine (Key Start with Thermostart)

1. Turn key in a clockwise direction and hold at position 2 for 15 to 20 seconds before turning to position 3 to energise the starter.
2. Release key when the engine starts.
3. When a speed control is fitted reduce speed as necessary.

Switch Positions

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

Emergency Hand Starting

Note: *This facility is not fitted as standard.*

1. Check the engine is free to turn without obstruction.
2. If a variable speed control is fitted move towards FAST.
3. Move decompressor levers towards the gear end, lightly oil end of starting shaft and fit correct and fully serviceable handle.
4. Crank the engine and when sufficient speed is obtained move decompressor levers towards the flywheel and continue to crank until engine fires. Retain grip on starting handle and remove from shaft.
5. When speed control is fitted, reduce speed as required.

To Stop Engine

Turn the control lever (1) clockwise and hold in this position until the engine stops.

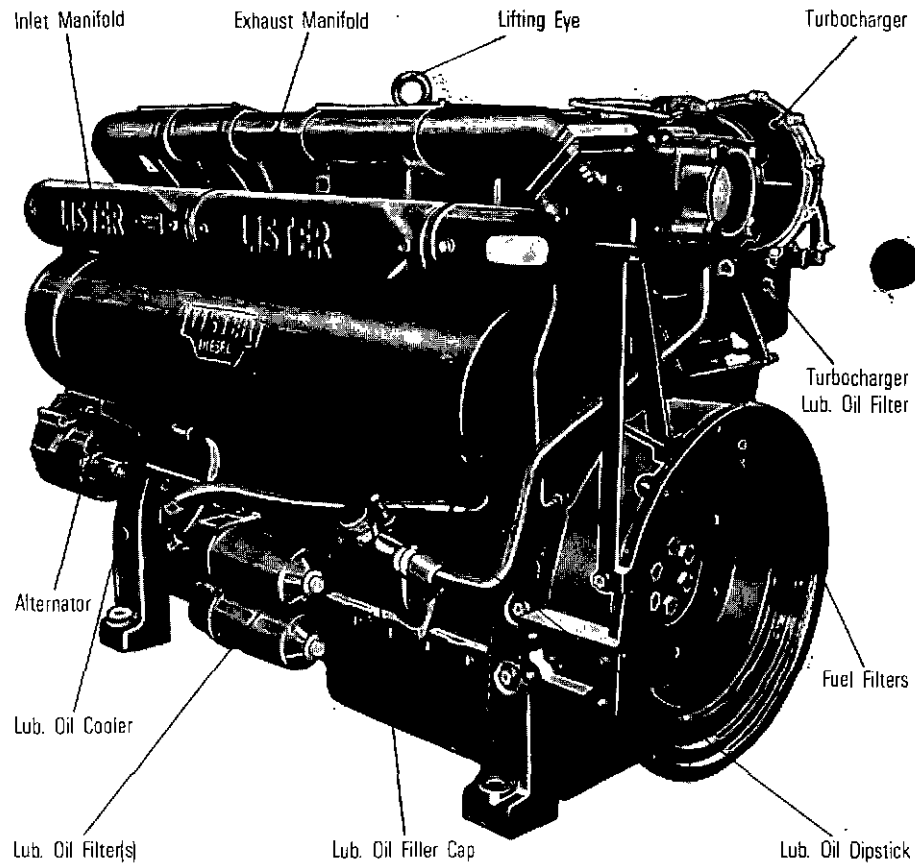
Note: *After engine has stopped ensure electric start switch (if fitted) is turned off.*

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

TURBOCHARGED ENGINES

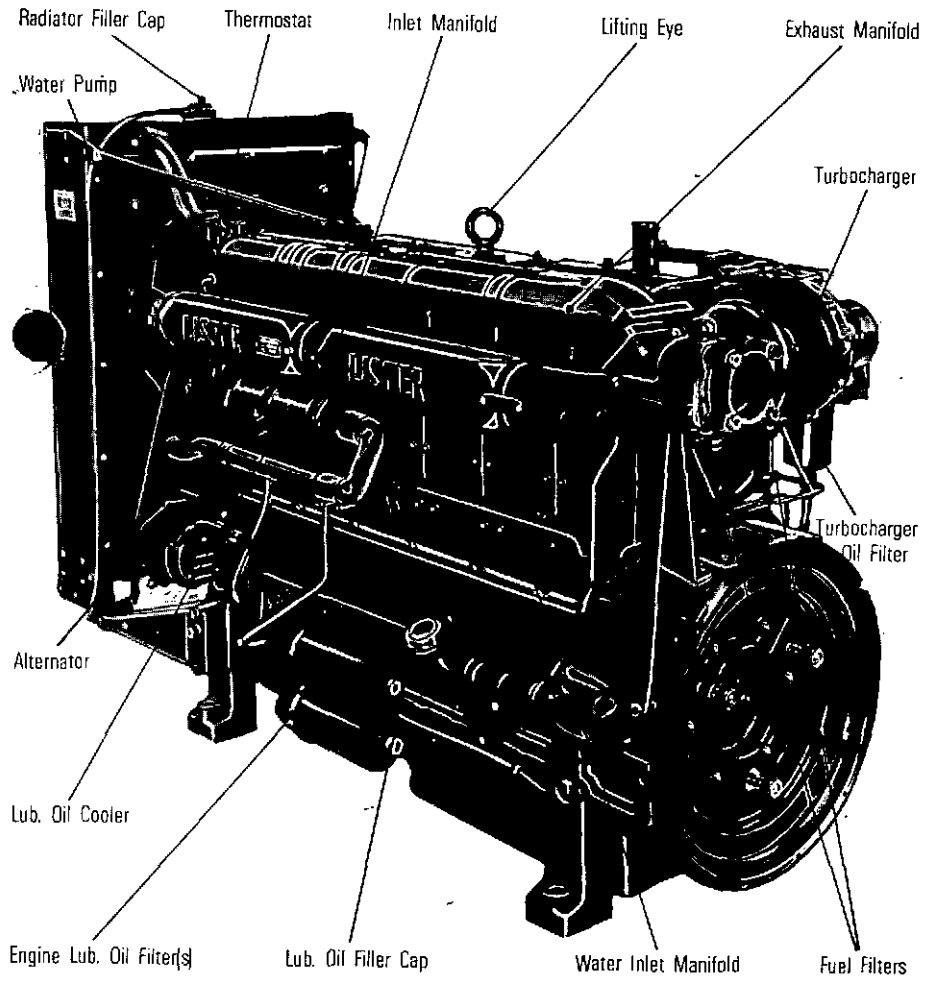
If possible, turbocharged engines should be run for about one minute on no load after starting and before stopping to ensure satisfactory turbocharger lubrication at the start and for general heat dissipation before stopping.

SECTION NINE - JA/JW



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

JAS6 Air Cooled Engine



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

JWS6 Water Cooled Engine

LUBRICATING OIL PRESSURE

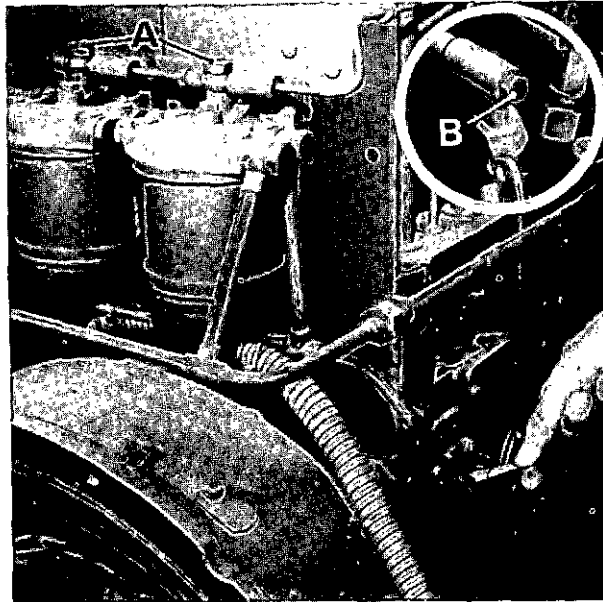
2.8 - 3.8 bar (40 - 50 lbf./sq.in.)

OIL SUMP CAPACITY

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

PRIMING THE FUEL SYSTEM

1. Connect fuel supply.
2. Operate the fuel lift pump operating lever and slacken both 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 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.



Priming Fuel System

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

Note: *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.

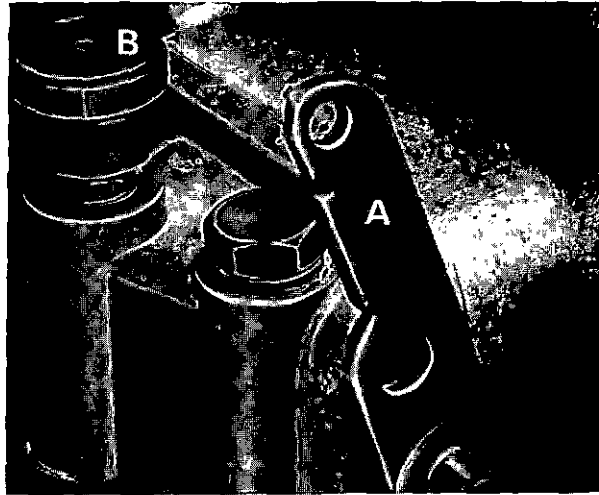
1. Remove the cylinder head cover and turn the engine until the piston is on T.D.C. position on the firing stroke (both valves closed).
2. Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.
3. Tighten the locknut whilst restraining the adjusting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

STARTING AND 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 fuel system is primed by using the priming lever on the lift pump.
4. Ensure air cleaner is firmly attached and air joints are properly sealed.
5. Ensure 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.



Engine Control

TO START ENGINE

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

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

To Start Engine (with Key Switch)

1. Check the engine is free to turn without obstruction
2. Move the control lever 'A' to the RUN position.
3. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
4. If a variable speed control is fitted move towards FAST.
5. Turn switch in clockwise direction until engine fires and release.
6. When speed control is fitted reduce speed as necessary.

To Start Engine (with Thermostart Cold Starting Aid)

1. Check the engine is free to turn without obstruction
2. Move the control lever 'A' to the RUN position.
3. Lift the excess fuel button 'B' if necessary, to allow extra fuel for starting.
4. If a variable speed control is fitted move towards FAST.
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 starts.
7. When speed control is fitted reduce speed as necessary.

To Start Engine (with Key Start and Thermostart)

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

TO STOP ENGINE

Turn the control lever (A) clockwise and hold in this position until the engine stops.

Note: *After engine has stopped ensure electric start switch (if fitted) is switched off.*

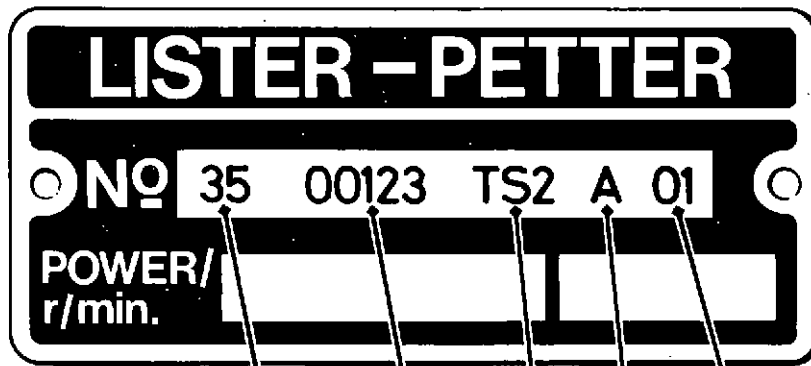
Switch Positions

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

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.

SPECIMEN ENGINE NUMBER PLATE



Year Engine No. Type Rotn. Build No.

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



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