



'A' Series Workshop Manual



Introduction

INTRODUCTION

The purpose of this manual is to give information, operating, maintenance and repair procedures for the AA1, AC1 (Series 2), AD1 and AD2 engines.

This manual deals with engines built after 1st January 1986. Comprehensive information for earlier AA1 engines can be found in Workshop Manual P027-08228

The manual is designed primarily for use by qualified technicians with electrical and mechanical experience.

This work can only be carried out if the necessary hand and service tools are available. When the user has insufficient tools, experience or ability to carry out adjustments, maintenance and repairs then this work should not be attempted.

Where accurate measurements, or torque values, are required they can only be made using calibrated instruments.

Under no circumstances should makeshift tools or equipment be used, as their use may adversely affect safe working procedures and engine operation.

The specification details given apply to a range of engines and not to any one particular engine. In cases of difficulty the user should consult the local Lister-Petter Distributor or Dealer for further advice and technical assistance.

The information, specifications, illustrations, instructions and statements contained within this publication are given with our best intentions and are believed to be correct at the time of going to press. Our policy is one of continued development and we reserve the right to amend any technical information with or without prior notice.

Whilst every effort is made to ensure the accuracy of the particulars contained within this publication, neither the Manufacturer, Distributor or Dealer shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

The information given is subject to the Company's current Conditions of Tender and Sale, is for the assistance of users and is based upon results obtained from tests carried out at the place of manufacture. This Company does not guarantee that the same results will be obtained elsewhere under different conditions.

Parts that have not been approved 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.

When purchasing parts or giving instructions for repairs users should, in their own interests, always specify Genuine Lister-Petter Parts and quote the Description of

Data on CD Rom

The Master Parts Manual, Technical Bulletins issued since June 1988 and parts information is available on CD Rom.
Please contact Lister-Petter for details.

Training

Comprehensive training in the correct operation, service and overhaul procedures of engines is available at the Lister-Petter International Product Training Centre. Please contact Lister-Petter for details.

If Problems Occur

If problems occur with your engine, or any of the Lister-Petter approved accessories fitted to it, your local Lister-Petter Distributor should be consulted.

There are Lister-Petter Distributors in most countries of the world and details for these can be obtained from any one of the companies listed on the back cover.

How to Use this Workshop Manual

Each section title is given at the top of the relevant pages and a full cross reference 'Index' appears at the back of the manual.

It is recommended the individual steps contained in the various maintenance or repair operations are followed in the sequence in which they appear.

At times it may be necessary to refer to other parts of the section, or to a different section, for more specific or detailed information.

Caution and Warning Symbols

When an engine is operating or being overhauled there are a number of associated practices which may lead to personal injury or product damage.

Your attention is drawn to the symbols shown and described below which are applied throughout this manual.

Caution

This caution symbol draws attention to special instructions or procedures which, if not correctly followed, may result in damage to, or destruction of, equipment.

Warning

This warning symbol draws attention to special instructions or procedures which, if not strictly observed, may result in personal injury.

Warning

Manual Contents

	page
Introduction	ii
Safety Precautions	iv
Section 1 - General Information	1
Section 2 - The Basic Engine	12
Section 3 - The Lubricating Oil System	41
Section 4 - The Fuel System and Governor	45
Section 5 - The Electrical System	63
Section 6 - Builds and Accessories	70
Section 7 - Conversion Factors	73
Index	78

Safety Precautions

SAFETY PRECAUTIONS

The following safety precautions are of a general nature; more specific precautions appear where they are relevant.

WARNING

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 any engine.

Before Starting Precautions

- Ensure the engine is free to turn without obstruction, is securely mounted, there is a generous supply of cooling and combustion air available and all guards are in position.
- Check that the lubricating oil level is correct. The oil sump must be filled to the 'full' or 'max' mark on the dipstick; do not overfill.
- Check that the fuel supply is adequate and the system is primed.
- Where possible, disengage the driven equipment while starting.
- Keep the body and loose clothing away from all moving parts, and hot surfaces, while the engine is being started or it is running.

Alternator Precautions

The following points must be strictly observed when charge windings are fitted otherwise serious damage can be done.

- Never remove any electrical cable while the battery is connected in the circuit.
- Only disconnect the battery with the engine stopped and all switches in the OFF position.
- Always ensure that cables are fitted to their correct terminals.
A short circuit or reversal of polarity will ruin diodes and transistors.
- Never connect a battery into the system without checking that the voltage and polarity are correct.
- Never flash any connection to check the current flow.
- Never experiment with any adjustments or repairs to the system.
- The battery and charge windings must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.

WARNING

Starting engines that are fitted with charge windings which have been disconnected from the battery will cause irreparable damage unless the starter leads from the

Precautions for Filters and Elements

- Particular attention is drawn to the instructions given later in this section for replacing filters.
- Used liquid filters and elements contain some of the filtered liquid and should be handled and disposed of with care.
- After handling new or used elements, the users hands should be thoroughly washed, particularly before eating.

WARNING

Fuel and new or used lubricating oil may cause skin irritation.

WARNING

The materials used in the manufacture and treatment of some filters and elements may cause irritation or discomfort if they come into contact with the eyes or mouth and they may give off toxic gases if they are burnt.

Fuel System Precautions

- When priming or checking the fuel injection pump timing, care must be taken to wipe spilled fuel from the outside of the engine.
- Always fit a new joint when a union has been disturbed.
- Special care must be taken to see that there is no leakage from the joints of the fuel pipe connection to the pump.
- When tightening or loosening the fuel injection pump delivery connections, use two spanners to prevent the pump from twisting on its seating and causing misalignment of the pump calibration marks.
- When refitting the fuel pipe from the pump to injector, the connection to the injector must be tightened before the connection to the fuel pump.
This procedure will ensure that there is no leakage from these joints.
- It is most important that all fuel joints are tight and leak proof.
- Always fill the fuel tank through a fine strainer, preferably at the end of the engine work period.
If any sediment is stirred up during the process this has time to settle before the engine is used again, this will minimise the risk of condensation contaminating the fuel. If cans are used, avoid tipping out the last few drops.
- Funnels are very difficult to keep clean in dusty conditions.

Wash them before and after use and wrap them up when not required, or fill the tank direct from a small mouthed screw capped fuel can.

WARNING

Care must be taken to ensure that no unprotected part of

Section 1 - General Information

Section 1 General Information

Section 1 - General Information

Technical Data

		AA1	AC1	AD1	AD2
Injection		Air cell	Direct		
Rotation - looking on flywheel		See Section 6			
Bore - nominal (not to be used for machining tolerances)	mm	69.85	76.20	80.00	
	in	2.75	3.00	3.15	
Stroke	mm	57.15	66.675	73.0	
	in	2.25	2.625	2.874	
Piston area	cm ²	38.32	45.60	50.265	100.53
	in ²	5.940	7.069	7.791	15.582
Cylinder capacity - total	l	0.219	0.304	0.367	0.734
	cm ³	219	304	367	734
	in ³	13.4	18.55	22.392	44.784
Compression ratio		17:1	18.5:1	18.8:1	
Mean piston speed at 3600r/min	m/sec	6.85	8.00	8.76	
	ft/min	1350	1575	1724	
Maximum permissible crankshaft end thrust	kg	54.0			
	lb	120.0			
Mechanical efficiency		59%	71%	72%	
Brake thermal efficiency		25%	33%	33.5%	
Oil sump capacity - with engine level See Note	l	1.9	2.7	2.7	3.7
	pt	3.33	4.75	4.75	6.5
	US qt	1.95	2.85	2.85	3.9
Capacity between dipstick marks See Note	l	0.65			1.2
	pt	1.2			2.1
	US qt	0.7			1.3
Lubricating oil pressure - mininum at idling with engine hot	bar	0.8			
	lbf/in ²	12.0			
Lubricating oil pressure - mean	bar	2.8 - 4.0			
	lbf/in ²	40 - 60			
Pressure relief valve setting	bar	3.0 - 3.3			
	lbf/in ²	43 - 48			
	l	3.8	5.0		

Section 1 - General Information

Basic Installation Details

These instructions are of a general nature and further information and installation drawings are available from Lister-Petter.

DISTORTION

The engine should be bolted down to a rigid bed to ensure there is no excessive vibration. Customers installing engines in their own equipment must ensure that no strain is imposed on the engine feet either by distortion during installation where the feet are not correctly shimmed or by deflection of the structure during operation.

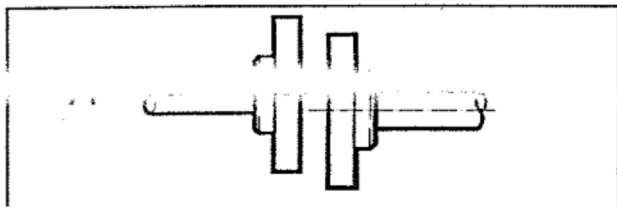
It is recommended that the units are bolted onto machined surfaces that are free from burrs, paints or other contaminants. Before tightening the holding down bolts a check for gaps between the unit mounting and the bed must be carried out. If any gap exceeds 0.125mm (0.005in) shims must be used to fill the gap.

ALIGNMENT

Accurate alignment is necessary between the engine drive shaft and the driven unit even with a flexible coupling fitted. Poor alignment shortens coupling life, causes bearing wear and produces excessive vibration.

Two principal types of misalignment can occur and they are shown in Figure 1, although there could be a combination of both.

- a. Parallel
- b. Angular



Parallel Misalignment

When the shaft of the driven unit is parallel to, but not in line with, the engine drive shaft.

Angular Misalignment

When the axis of the two shafts meet at the correct point but the shafts are at an angle to each other. To check the alignment the following procedure should be carried out:-

1. Fit the coupling halves to their respective engine drive shaft and the driven unit shaft.
2. Position and secure the engine and driven unit on the base frame so that the coupling halves are apart by the same amount as the thickness of the coupling middle section.
3. Check the parallel alignment by laying a straight edge across the coupling flanges at several positions around the circumference. An alternative method using a dial indicator can be used.
4. Using a suitable measuring tool check the angular alignment by measuring the gap between the coupling halves at several positions around the circumference of the couplings.
5. If the measurements made are more than 0.127mm (0.005in) adjust the parallel alignment by placing shims under the supports of the units as necessary and the conical alignment by adjusting position of the driven unit on its frame.
6. Fit and secure the middle flexible section of the coupling making sure that no strain is applied to it.
7. Tighten the grub screws or bolts securing the couplings to the shafts.

Section 1 - General Information

THE EXHAUST SYSTEM

Small, light, non-tubular exhaust silencers can be mounted direct onto the manifold or on very light and short extensions which must be no more than 152mm (6in) long. Heavy silencers must be remotely mounted and connected by flexible pipe or hose, with no solid extensions between the manifolds and the flexible element. The silencer outlet pipe must face away from the engine and care must be taken to ensure that all joints are gas tight.

In general the exhaust pipe run should be kept short and straight with a silencer or expansion chamber fitted as near as possible to the engine. The tail pipe beyond the silencer should be about 10 times the pipe diameter in length. When long tail pipes have to be fitted the bore of the pipe must be increased as shown in the accompanying table. When the larger diameter pipes are fitted they should be fitted from the manifold or cylinder head onward.

Pipe Length	Pipe Bore
0 - 4.5m (0 - 15ft)	44.5mm (1.75in)
4.5 - 7.5m (15 - 25ft)	50.8mm (2.0in)
7.5 - 18.8m (25 - 65ft)	63.5mm (2.5in)
18.8 - 39.1m (65 - 130ft)	76.2mm (3.0in)

A back pressure of 18.7mmHg (10.0in H₂O) must not be exceeded without de-rating.

Bends should have a radius of not less than 4 diameters at the centre line of the pipe. When reckoning the total effective length of the pipe an allowance of 0.3m(1ft) of the total centre line length must be made for each bend in the system. If the bends are sharper than 4 diameters the allowance must be increased to 0.6m (2ft) per bend. Where pipes must be led upwards from the engine a suitable drain cock, or drain tap with cock, should be fitted at the lowest point to prevent the condensate running into the engine.

It is important to ensure that exhaust gasses are not sucked by the air cleaner or flywheel cooling fan.

POWER RATING AND DERATING

Declarations of power given for Lister-Petter diesel engines are in accordance with ISO 3046/1:1986, which is exactly comparable with BS 5514 Part 1:1987 and DIN 6271.

Ambient Temperature

From the aspect of engine performance, the temperature at 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 flywheel fan inlet. The higher of these two temperatures is taken as being the Ambient Temperature as far as engine ratings are concerned.

The engines are able to run satisfactorily at ambient temperatures up to 25°C (77°F) without derating. Above this temperature the rated brake horsepower must be reduced in accordance with the relevant ISO, BS or DIN Standards.

The maximum ambient temperature at which an engine should be operated is 52°C (125°F); if an engine is required to run at a higher temperature Lister-Petter must be consulted.

Humidity

There are very few sites in the world that would require a de-rating in excess of 6% for humidity.

Altitude

The approximate relationship between barometric pressure and altitude above sea level up to 2440m (8000ft) is as follows:-

$$\begin{aligned}\text{Barometric pressure (mmHg)} \\ &= 760 - (0.08 \times \text{Altitude})\text{m}\end{aligned}$$

$$\begin{aligned}\text{Barometric pressure (inHg)} \\ &= 30 - (0.001 \times \text{Altitude})\text{ft}\end{aligned}$$

CARE OF YOUR NEW ENGINE

Before leaving the works each engine is carefully tested and inspected but after being put into service, further settling of some joints will occur and the valve gear will bed down.

It is important that a new or overhauled engine

Section 1 - General Information

- b. Change the lubricating oil for the first time after 25 hours and then every 250 hours.
- c. Adjust the tappet clearances.

Operating Instructions

Warning:

Starting any diesel engine can be dangerous in the hands of inexperienced people.

Before attempting to start any engine the operator should read the "Safety Precautions" inside the front cover and be instructed in the use of the engine control and the correct starting procedures.

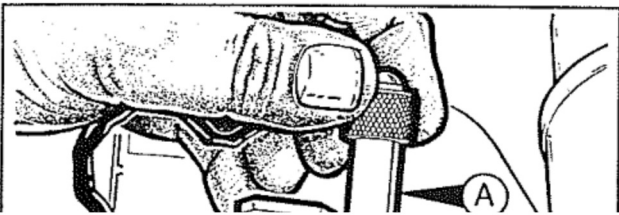
The following information is of a general nature and should be read in conjunction with, or substituted by, the equipment manufacturers instructions.

AA ENGINES

Cold Starting Below 15°C (59°F)

1. Withdraw the plunger (A) and fill the cup with the same type of lubricating oil as used in the engine.
2. Replace the plunger to inject the oil just before starting.

Repeat the above procedure if the temperature is below 0°C (32°F).



2. Move the decompressor lever towards its stop and hold it in this position.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted:-
 - a. Move the speed control lever towards the fast position.
 - b. Push down and release the overload stop lever which is located on the fuel pump side of the engine.
5. Move the decompressor lever downwards.
6. Turn the starting pulley against rotation until resistance is felt.
7. On a cold engine bounce the pulley vigorously against the resistance until the injector operates several times.
8. Wind the rope two turns around the pulley in the direction of rotation.
9. Pull the rope sharply until it unwinds from the pulley.
10. If a variable speed control is fitted reduce the speed as required.

Warning:

Do not wind the rope around the hand or wrist.

Section 1 - General Information

Hand Starting

1. Before attempting to start the engine read the "Safety Precautions" inside the front cover.
2. Move the decompressor lever towards its stop and hold in this position.
3. Move the engine control to the RUN position.
4. If a variable speed control is fitted:-
 - a. Move the speed control lever towards the fast position.
 - b. Push down and release the overload stop lever which is located on the fuel pump side of the engine.
5. Crank the engine really fast and when sufficient speed is obtained, move the decompressor lever down and continue to crank until the engine fires, retain a firm grip on the starting handle and remove it from the engine.
6. When a speed control is fitted, reduce the speed as required.

Stopping the Engine

Move the engine control to STOP and wait until the engine comes to rest.

Warning:

Never stop the engine by using the decompressor lever or valve damage may occur.

AC and AD ENGINES

Hand Starting

1. Before attempting to start the engine read the "Safety Precautions" inside the front cover.
2. Move the decompressor lever towards its stop and hold it in this position.
3. If a variable speed control is fitted move the lever towards the fast position.
4. Move the engine control anti-clockwise to the RUN position.
5. Crank the engine really fast and when sufficient speed is obtained, release the decompressor lever and continue to crank until the engine fires, retain a firm grip on the starting handle and remove it from the engine.
6. When a speed control is fitted, reduce the speed as required.

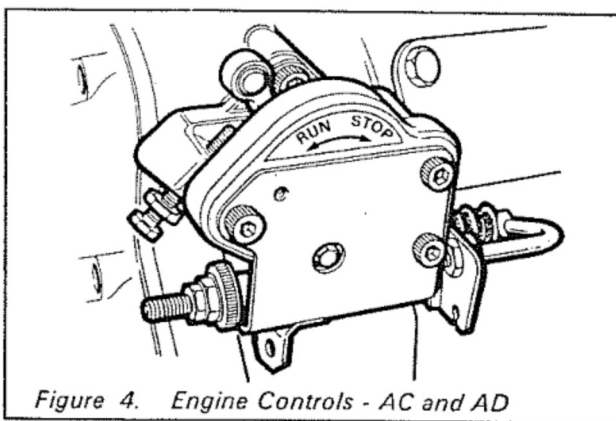


Figure 4. Engine Controls - AC and AD

Rope Start

Rope starting is not recommended at temperatures below -10°C (14°F).

1. Before attempting to start the engine read

Section 1 - General Information

7. On a cold engine bounce the pulley vigorously against the resistance until the injector operates several times.
8. Wind the rope two turns around the pulley in the direction of rotation.
9. Pull the rope sharply until it unwinds from the pulley.
10. If a variable speed control is fitted reduce the speed as required.

Warning:

Do not wind the rope around the hand or wrist.

Electric Starting with Key Start

1. Before attempting to start the engine read the "Safety Precautions" inside the front cover.
2. If a variable speed control is fitted move the lever towards the fast position.
3. Move the engine control anti-clockwise to the RUN position.
4. Turn the starter key clockwise and release immediately the engine fires.
Do not operate the start key for more than 20 seconds at a time.
5. If a variable speed control is fitted reduce the speed as required.

Electric Starting with Heater Plug

1. Before attempting to start the engine read the "Safety Precautions" inside the front cover.
2. If a variable speed control is fitted move the lever towards the fast position.
3. Move the engine control anti-clockwise to the RUN position.
4. Turn the starter key in a clockwise direction and hold it there for 20 seconds.
5. Turn the key clockwise and hold it in the next clockwise position until the engine fires.
Do not operate the start key for more than 20 seconds at a time.
6. If a variable speed control is fitted reduce the

Stopping the Engine

Move the engine control to STOP and wait until the engine comes to rest.

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

Warning:

Never stop the engine by using the decompressor lever or valve damage may occur.

Section 1 - General Information

Routine Maintenance

Following the initial attention the normal Routine Maintenance, as specified on the following page, must be carried out.

The routine servicing and maintenance periods given are based on average operating conditions. Under very dusty conditions air cleaners, lubricating oil and fuel filters will require more frequent attention. Decarbonising may be required more frequently when engines are running on light loads for long periods.

General Instructions

It is sound engineering practice to tighten bolts or nuts holding cylinder heads, sumps, covers, and doors diagonally. This will ensure the component is pulled down square, resulting in less chance of oil seepage from the joint.

When re-assembling an engine it is always advisable to renew nuts and bolts that have been taken from high stress locations, in particular nuts and/or bolts from connecting rods and cylinder heads should be renewed.

Decarbonising the engine is usually carried out at 2000 hours unless the engine shows signs of loss of compression or blow-by past the pistons.

When re-assembling an engine it is always advisable to apply a small quantity of new lubricating oil to all moving parts. After any maintenance work on the engine has been completed the lubricating oil and fuel levels must be checked and all safety guards replaced before starting.

Wear protective overalls, and keep items of loose clothing clear of all hot and moving parts. Use protective barrier cream when necessary.

Wherever possible clean components and the surrounding area before they are removed or dismantled. Take particular care to exclude all dirt and debris from the fuel injection equipment while it is being serviced.

Take extreme care to exclude dirt from all jointing surfaces and jointing compound from all tapped holes unless otherwise specified.

It is recommended that all oil seals are replaced once they have been removed from their original position. Seals must be fitted square in the housing and all lip seals must be fitted with the lip facing the correct direction.

Do not allow grease or oil to enter a blind threaded hole as the hydraulic action present when the bolt or stud is screwed in could split or stress the housing.

To check or re-torque a bolt or nut it is slackened a quarter of a turn and then re-tightened to the specified value.

On nuts with identification marks on one face the frictional area of that surface will be reduced therefore the nut should be fitted with the unmarked face towards the component.

Service Tools are designed to aid the dismantling and assembly procedures and their use will prevent possible unnecessary damage to components. It is recommended that Service Tools are always used, some operations cannot be safely carried out without the aid of the relevant tool.

Warnings:

Before carrying out any maintenance work on an engine it is advisable to remove the battery and, to avoid possible damage, the battery and charging system must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.

Damage will be caused to the flywheel fan if it is used to turn the crankshaft.

CRANKCASE VACUUM

The value depends to some extent on the type and size of air cleaner fitted to the engine.

Regardless of the type of air cleaner used, the vacuum with a clean air cleaner must not be less than the minimum figures given in the table below. The vacuum is measured with a manometer at the lubricating oil filler/dipstick hole with the engine running at any speed. To use a manometer it will be necessary to modify a filler cap by removing the dipstick section and replacing it with a suitable union to accommodate the manometer pipe.

Section 1 - General Information

In engines in good condition the vacuum increases slightly with engine speed but not proportionally, a fluctuating vacuum may indicate faulty oil seals, valves, or piston blow-by troubles.

Crankcase pressure can cause serious oil leaks, and often occurs in engines which need overhauling.

All Engines	mm WG	50.8 - 203.2
	in WG	2.0 - 8.0

Maintenance Schedule

Daily
Check the supply and level of the fuel.
Check the level and condition of the lubricating oil.
Clean the air cleaner under very dusty conditions.

Every 125 Hours

The previous and the following items.
Clean the air cleaner under moderately dusty conditions.
Check for fuel and lubricating oil leaks.
Check the serviceability of the battery.

Every 250 Hours

The previous and the following items.
Check all external nuts, bolts and unions for tightness.
Check and adjust the valve clearances with the engine cold.
Check and adjust the decompressor setting.
Renew the oil filter element.
On all engines except AC1 Build 05, drain the sump and refill with new oil of the correct type

Every 500 Hours
The previous and the following items.
On all AC1 Build 05 engines drain the sump and refill with new oil of the correct type and specification.
Renew the air cleaner element.

Every 1000 Hours

The previous and the following items.
Drain and flush the fuel tank.
Change the fuel filter element.
Clean the cylinder and cylinder head fins under dusty conditions.
Ensure that all guards are firmly attached and not damaged.
Decarbonise if the engine power has deteriorated.

Every 5000 Hours

The previous items and give the engine a major overhaul, if necessary.
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Section 1 - General Information

Starting, Running and Injector Faults

This section can only be included as a guide and any rectification to the engine should be carried out in accordance with the local Lister-Petter Distributor's instructions.

Difficult Starting
Incorrect grade of fuel or oil.
No fuel in tank.
Choked fuel filter.
Air lock in the fuel system.
Faulty injector or fuel pump.
Stop/start lever in the wrong position.
Retarded injection.
Injector loose in the cylinder head.
Leaking or sticking valves.
Sticking piston rings.
Worn cylinder.
Incorrect decompressor clearance.
Load not disconnected.
Battery not serviceable.
Faulty, dirty or loose electrical connections.
Turning the crankshaft the wrong way.
Faulty starter motor or solenoid.
Engine seized.
Faulty heater plug.
Knocking
Valve, probably exhaust, sticking in the guide and touching the piston.
Worn connecting rod bush or bearing.
Worn gudgeon pin or small end bearing.
Insufficient clearance between the piston and cylinder head.
Injection too early.
Flywheel coupling or pulley loose.
Excessive camshaft or crankshaft end float.
Excessive carbon deposits on the pistons.
Excessive clearance between the piston and

Late injection of fuel.
Too much side play on valve rockers.
Low load running.
Low temperature running.
Dark Blue Smoke
Piston rings worn.
Cylinder bore worn.
Faint Blue Smoke
Light load.
White Smoke
Water in the fuel supply.
Black Smoke
Overload.
Choked air filter.
Inlet air temperature too high.
Defective injector spraying.
Unsuitable fuel oil or water in fuel.
Engine Stops
Lack of fuel.
Air or water in fuel system.
Choked fuel filter.
Blocked injector nozzle.
Excessive overload.
Overheating.
Loss of compression.
Loss of oil.
Loss of electrical supply to the fuel control solenoid, if fitted.
Automatic shutdown, if protective devices are fitted.
Loss of Power
Loss of compression.
Incorrect tappet clearance.

Section 1 - General Information

Loss of Oil Pressure

Low oil level in the sump.

Choked oil pump.

Badly worn crankshaft or big end bearings.

Oil pump failed.

Oil diluted with fuel.

Unsuitable lubricating oil (too thin).

Overheating

Cooling air being recirculated.

Cooling air inlet obstructed.

Cooling air outlet obstructed.

Driven unit cooling air also used to cool engine.

Fins of the cylinder head or cylinder barrel blocked with dirt.

Running on excessive overload.

Lubricating oil level too low or too high.

Injection timing faulty.

Low Compression

Injector loose on its seat.

Injector washer scored.

Piston ring gaps in line.

Inlet or exhaust valve not seating.

Cylinder head gasket leaking.

Hunting

Tight spots on governor linkage.

Injector pump rack not free.

Air in the fuel system.

Faulty injector.

High Oil Consumption

Valve guides worn.

Piston rings worn.

Cylinder bore worn.

Loss of Crankcase Vacuum

Worn piston rings.

Worn cylinder barrel bore.

Worn oil seals.

Too much oil in the sump.

Oil filler cap not seating.

Leaking Oil Seals

Too much oil in the sump.

Loss of crankcase vacuum.

INJECTOR FAULTS

This section can only be included as a guide and any rectification to the injector should be carried out in accordance with the local Lister-Petter Distributor's instructions.

Excessive Leak-off (back leakage)

Needle slack or worn.

Cap nut not tight.

Dust or dirt between the nozzle and holder faces.

Incorrect Opening Pressure

The adjuster may have worked loose and moved.

The needle may be dirty or seized.

Blocked nozzle hole.

The adjuster spring has broken.

Nozzle Wet.

The needle is sticking or tight.

Carbon deposits on the nozzle or needle seats.

The seats are distorted, hammered, scratched or eroded.

The Injector Does Not 'Chatter' When Injecting

The needle is tight or sticking.

Leaking seats.

The cap nut is distorted.

The injector may be set at a very low breaking pressure.

Dirt on the nozzle or holder faces.

Distorted Spray

Carbon on the needle.

The nozzle hole is blocked.

The needle is sticking or damaged.

The seats are distorted, hammered, scratched or eroded.

Section 2 - The Basic Engine

This section deals with all 'A' range engines built after 1st January 1986 and is therefore not specific to any one type or build of engine.

Every effort must be made to maintain the engine in a clean condition and all fuel and oil leaks must be dealt with when they occur. With a new or overhauled engine the joints settle during the first few hours running and their tightness must be subsequently checked.

Tables showing the recommended Jointing Compounds, Spanner Torques and Service Tools can be found at the end of this section.

Warning:

Damage will be caused to the flywheel fan if it is used to turn the crankshaft.

ASSEMBLY LUBRICATION

When assembling the engine, use new engine lubricating oil to lubricate the following items prior to fitting.

- All main bearings.
- The connecting rod bearings.
- Cam followers, camshaft bearings, valve rocker bores and the valve push rod cups.
- The gear train.
- Pour a small quantity of oil through the oil pump plate.
- Lightly oil all other moving parts and fastener threads.

THE ROPE START ASSEMBLY - GEAR END

The rope start facility is not fitted to AD2 engines.

Dismantling the Rope Start

1. Open the guard (A).
2. Pull the pulley (B) off of the shaft (C).
3. Remove the four setcrews and the guard (A).
4. Remove the four setscrews securing the adaptor plate (D) and remove it.

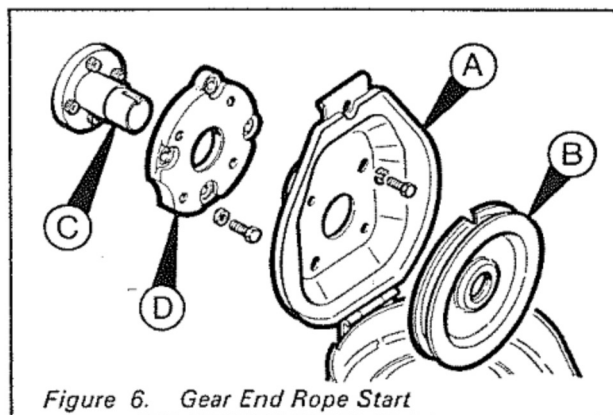


Figure 6. Gear End Rope Start

Assembling the Rope Start

1. Replace the adaptor plate and the four setscrews.
2. Replace the guard and pulley.

THE ROPE START ASSEMBLY - FLYWHEEL END

Section 2 - The Basic Engine

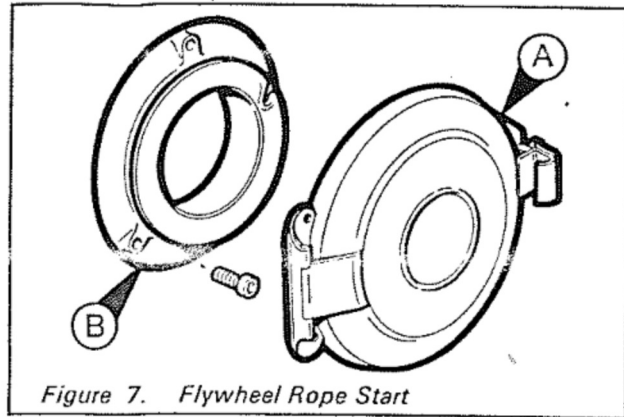


Figure 7. Flywheel Rope Start

Assembling the Rope Start

1. Replace the flywheel pulley.
2. Replace the guard.

THE GEAR END HAND START

This start facility is not fitted to AD2 engines.

Dismantling the Gear End Start

1. Remove the three retaining screws and washers from the gearwheel guard (A) and remove it.
2. Remove the retaining circlip (B) and the gearwheel (C).
3. Remove the three setscrews and washers securing the backplate (D) and mounting bracket (E) to the adaptor (F).
4. Remove the pinion assembly (G) from the extension shaft (H).
5. Drain the lubricating oil from the shaft.
6. Remove the extension shaft.
7. Clean and examine all parts for wear and damage.

Assembling the Gear End Start

1. Fit the extension shaft and torque load the four retaining screws to 19.0Nm (14.0lbf ft).
2. Fit the backplate (E) and mounting plate (D).
3. Slide the clutch and pinion assembly (G) onto the extension shaft (H). Ensure that the clutch grips when it is rotated anti-clockwise viewed from the shaft end.
4. Remove the setscrew from the end of the shaft and using a syringe fill the small oil reservoir in the shaft with 7cc of SAE 20W/20 lubricating oil.
5. Replace the setscrew and torque load it to 8.0Nm (6.0lbf ft). Lock the setscrew using Loctite 87AV.
6. Lightly lubricate the gearwheel bush, fit the gearwheel and circlip.
7. Replace the guard.

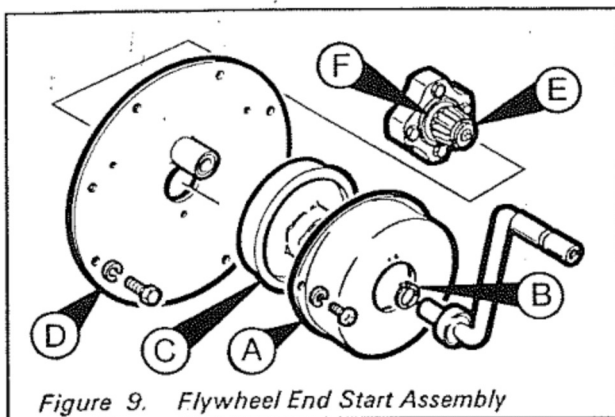
THE FLYWHEEL END HAND START

This start facility is not fitted to AD2 engines.

Dismantling the Flywheel End Start

1. Remove the four screws securing the starting gear guard (A) and remove it.
2. Remove the retaining circlip (B) and the gearwheel (C).
3. Remove the four set screws and washers retaining the mounting plate assembly (D) to the engine bell housing and Withdraw the assembly.
4. Lock the flywheel to prevent it turning.

Section 2 - The Basic Engine



Assembling the Flywheel End Start

1. Fit the extension shaft (F) and torque load the four retaining screws to 34.0Nm (25.0lbf ft).
2. Slide the clutch and pinion assembly (E) onto the extension shaft (F). Ensure that the clutch grips when it is rotated clockwise viewed from the shaft end.
3. Fit the mounting plate (D).
4. Remove the setscrew from the end of the shaft and using a syringe fill the small oil reservoir in the shaft with 7cc of SAE 20W/20 lubricating oil.
5. Replace the setscrew and torque load it to 8.0Nm (6.0lbf ft). Lock the setscrew using Loctite 87AV.
6. Lightly lubricate the gearwheel bush, fit the gearwheel and circlip.
7. Replace the guard.

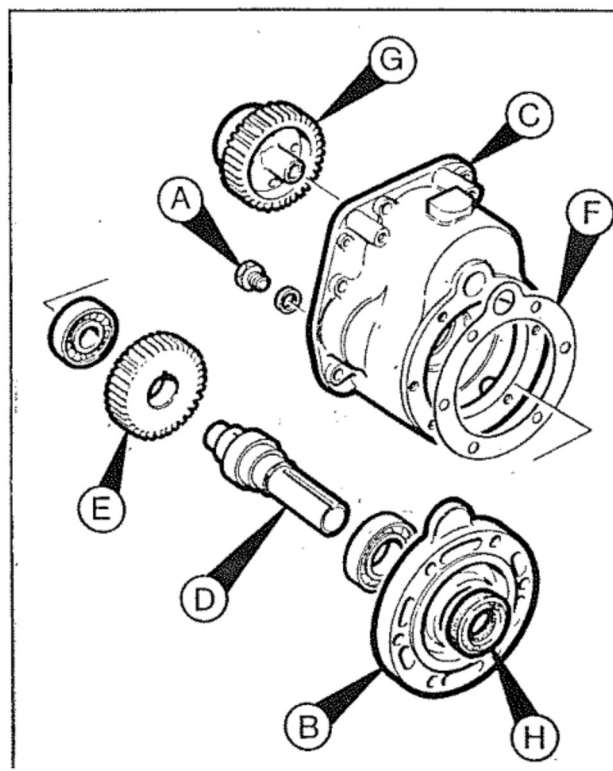
THE REDUCTION GEARBOX

Three reduction gearboxes (6:1, 4:1 and 2:1) are available for each type of engine.

3. Remove the gear case complete with the power take-off shaft (D) and the driven gearwheel (E). Take care to retain the end float shims (F).
4. Remove the eight capscrews and remove the gearcase from the crankcase.
5. Remove the four nuts and washers (capscrews on 2:1 ratio) securing the driving gearwheel (G).
6. Clean and examine all parts for wear and damage.

Warning:

If the taper roller bearing is being removed the housing should be placed in boiling water before attempting to remove or fit the bearing tracks. After a few minutes sufficient expansion will have taken place, to ease removal or replacement.



Section 2 - The Basic Engine

4. Assemble the bearing housing (B) over the power take-off shaft assembly (D); protect the oil seal by using a sleeve.
5. Replace the endfloat shims (F). Initially it is advisable to fit sufficient shims to give excessive endfloat and then correct back; see the 'Warning'.
6. Fit the bearing housing and shaft assembly to the gearcase (C).
7. Using a dial test indicator check the endfloat of the power take-off shaft.
The 0.05-0.127mm (0.002-0.005in) endfloat is adjustable by adding or removing 0.05, 0.127, 0.178 or 0.508mm (0.002, 0.005, 0.007 or 0.020in) shims.
8. Tighten the bearing housing bolts.

Warning:

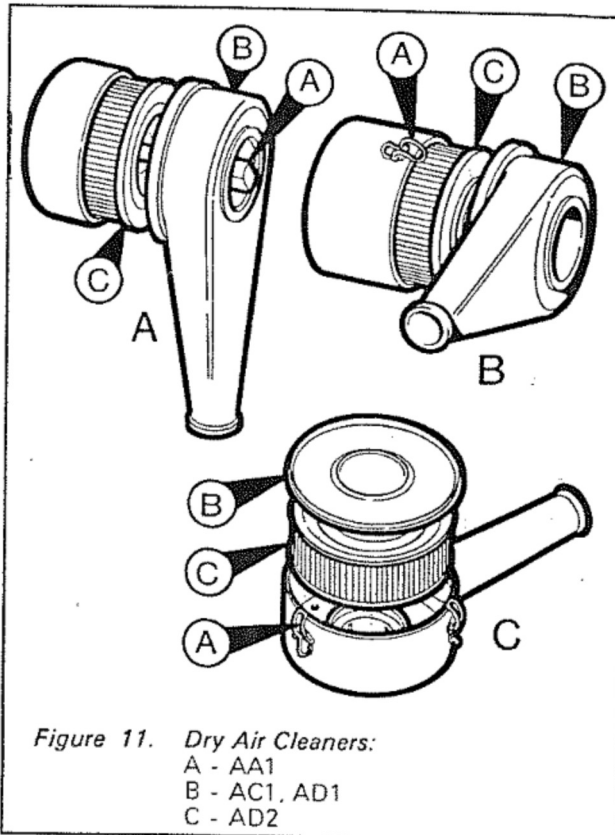
If the bearing housing (B) is tightened down with insufficient shims (no endfloat) it could result in a cracked housing or gearcase.

THE AIR CLEANER

A dry or oil bath air cleaner is fitted to the air inlet manifold adaptor by two studs and nuts and the crankcase breather pipe is attached to the manifold adaptor by a spring clip.

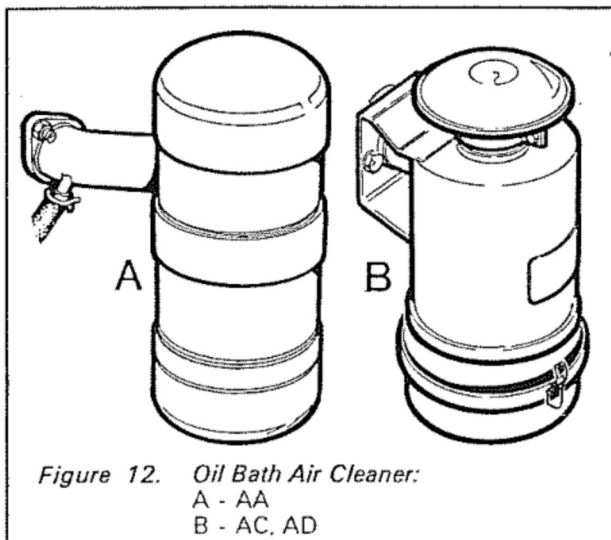
Dry Air Cleaner

1. Unscrew the nut (A), or release the clips, (A) and lift off the snout or cover (B).
2. Remove the element (C) from the cleaner body.



3. Clean the cleaner body and snout of all dust.
4. Fit a new element and joint if necessary.
5. Replace the cover...

Section 2 - The Basic Engine



4. Fill the lower section with new engine lubricating oil to the mark.
5. Replace the lower section.

THE LIFTING EYE

To remove the lifting eye remove the cylinder head nut securing it.

THE MANIFOLDS

The inlet and exhaust manifolds are secured to the cylinder head by studs and nuts. Before the inlet manifold can be removed the crankcase breather pipe must be disconnected from it by squeezing the spring clip tails together and pulling the pipe off.

REMOVING THE FUEL TANK

THE AIR COWLING

Three sides of the engine are encased in a one-piece air cowl to direct cooling air from the flywheel fan around the cylinder.

Removing the Air Cowling

1. Drain the fuel tank.
2. Remove the fuel pipes.
3. Remove the fuel tank.
4. Remove the two securing nuts and the lifting eye.
5. Remove the screw/s from behind the fuel tank on AC and AD engines.
6. Lift off the cowling.

Refitting the Air Cowling

1. Replace the cowling over the cylinder head studs.
2. Replace the screw/s behind the fuel tank.
3. Replace the fuel tank.
4. Tighten the two retaining nuts.
5. Replace the fuel pipes.

THE CRANKCASE BREATHER

The breather assembly is fitted to the top of the crankcase and is connected to the inlet manifold by a rubber pipe secured at both ends by spring wire clips.



Section 2 - The Basic Engine

THE FUEL INJECTOR

AA engines are air cell injection therefore the AA injector and injector sealing washer are not interchangeable with those fitted to AC and AD engines which have direct injection.

The following paragraphs are included only to describe the dismantling and assembly procedures, comprehensive instructions can be found in Section 4.

Removing the Injector - AA

1. Remove the air cleaner and fuel tank.
2. Remove the air cowling; not fitted to AA1 Build 05.
3. Slacken and remove the pump to injector fuel pipe (A); hold the fuel pump delivery valve holder with a spanner to prevent it turning.
4. Disconnect the leak-off pipe (B) from the injector.
5. Remove the two injector holding down nuts (C).
6. Remove the injector (D) and the sealing washer (E).

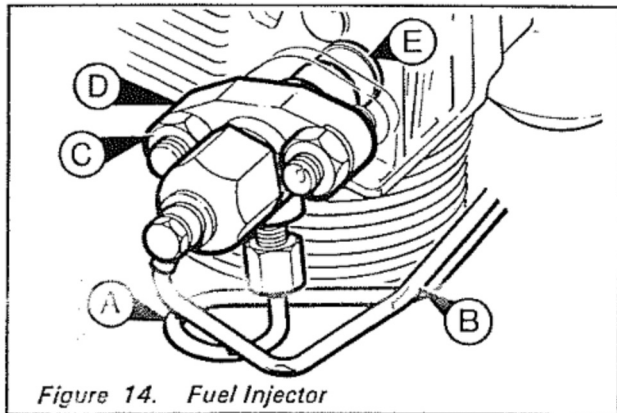


Figure 14. Fuel Injector

7. If the injector cannot easily be removed use the Service Tool 317-50027 and Adaptor 317-50095.

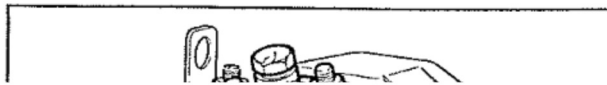
5. Replace the fuel pump to injector pipe and tighten the unions finger tight.
6. Tighten the unions a **further half turn with a spanner.**
7. Torque load the injector nuts to 18.0Nm (13.0lbf ft).
8. Replace the leak-off pipe.
9. Replace the cowling, lifting eye, air cleaner and the fuel tank.
10. After the initial run following an injector replacement re-torque the two retaining nuts.

Note:

If the injector sealing washer has been used more than once it will become compressed and may adversely affect combustion. Care should be taken to ensure two washers are not fitted.

Removing the Injector - AC, AD

1. Slacken and remove the pump to injector fuel pipe (A); hold the fuel pump delivery valve holder with a spanner to prevent it turning.
2. Disconnect the leak-off pipe (B) from the injector.
3. Remove the two injector holding down nuts (C).
4. Lift off the injector clamp (D).
5. Lift out the injector (E) and the sealing washer (F).



Section 2 - The Basic Engine

Replacing the Injector - AC, AD

1. Ensure the seatings in the cylinder head are clean and smooth.
2. Fit the sealing washer onto the injector with the dimple facing towards the injector.
3. Replace the injector into the cylinder head.
4. Place the injector clamp over the injector with the cut out section facing outwards.
5. Replace the two clamp nuts leaving them finger tight.
6. Replace the fuel pump to injector pipe and tighten the unions finger tight.
7. Tighten the unions a **further half turn with a spanner.**
8. Torque load the injector nuts to 3.0Nm (6.0lbf ft).
9. Replace the leak-off pipe.
10. After the initial run following an injector replacement re-torque the two clamp nuts.

Note:

If the injector sealing washer has been used more than once it will become compressed and may adversely affect combustion. Care should be taken to ensure two washers are not fitted.

Injector Removal Tool

1. Remove the fuel pipes from the injector.
2. Screw the adaptor (A) into the leak-off hole of the injector.



Warning:

Care must be taken to ensure that any part of the hand is not likely to become trapped between the two parts of the tool while it is being used. Excessive force must not be used.

THE FUEL INJECTION PUMP

The pump is fitted onto the crankcase at the gear end and is operated directly from the camshaft.

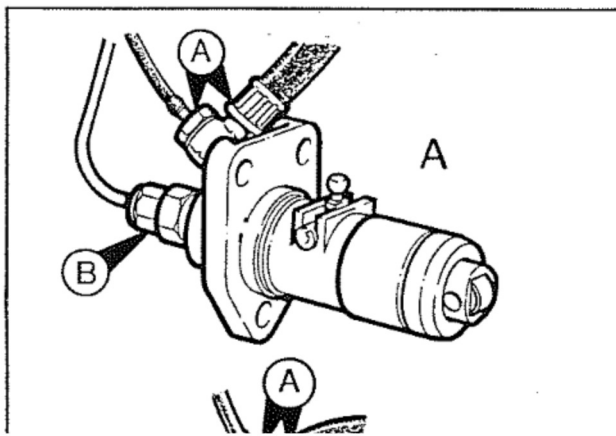
AA, AC and AD1 have similar physical characteristics but only AC and AD1 fuel pumps are interchangeable.

AA, AC and AD1 timing shims are interchangeable.

The following paragraphs are included only to describe the dismantling and assembly procedures, comprehensive instructions can be found in Section 4.

Removing the Pump

1. Remove the tank.
2. Remove the air cowling if necessary.
3. Slacken and remove the pump inlet (A) and delivery (B) pipes; hold the fuel pump delivery valve holder with a spanner to prevent it turning.



Section 2 - The Basic Engine

5. Remove the pump retaining nuts.
6. Refer to Figure 18 and align the fuel pump rack ball (C) with the cut-out (D) in the crankcase by positioning, and holding, the engine control lever approximately 10° before the vertical position.

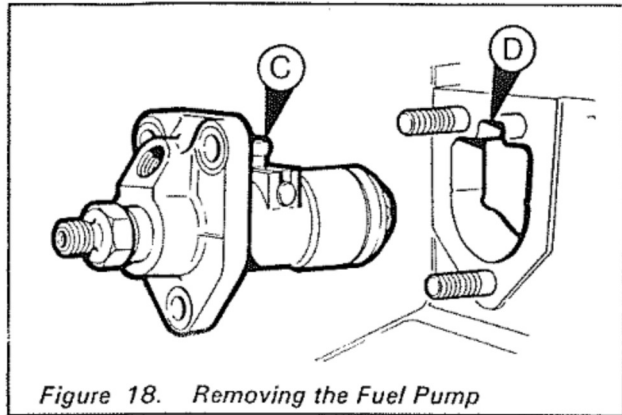


Figure 18. Removing the Fuel Pump

7. Remove the fuel pump and retain the timing shims.

Warning:

Do not use force or a screwdriver to remove the pump.

If difficulty is experienced, remove the gear end cover and position the fuel pump rack ball to clear the cut-out.

Replacing the Fuel Pump

1. Turn the engine to TDC on the exhaust stroke.
2. Place the pump timing shims over the pump mounting studs.
3. Position the governor lever fork in line with the cut-out in the crankcase by moving, and holding, the engine control lever approximately 10° before the vertical position.

Note:

It is recommended that all fuel equipment washers are renewed on assembly and therefore a suitable supply should be stocked.

THE OIL SUMP

The sump is secured to the crankcase by eight, ten on AD2 engines, capscrews and the integral engine mounting bolt drillings are located on each corner of it. Two drain plugs are fitted.

Removing and Refitting the Sump

1. Lift out the dipstick.
2. Drain the oil.
3. Stand the engine on its flywheel.
4. Remove the capscrews diagonally.
5. Lift off the sump and joint.
6. Clean and dry the crankcase and sump mating surfaces.
7. Fit the joint and sump onto the crankcase.
8. Replace the capscrews finger tight.
9. Torque load the capscrews, diagonally, to 12.0Nm (9.0lbf ft).
10. Stand the engine the correct way up and refill the sump with new oil.

THE CYLINDER HEAD COVER

The light alloy cylinder head cover, which is bolted to the top of the cylinder head, gives access to the decompressor and valve gear.

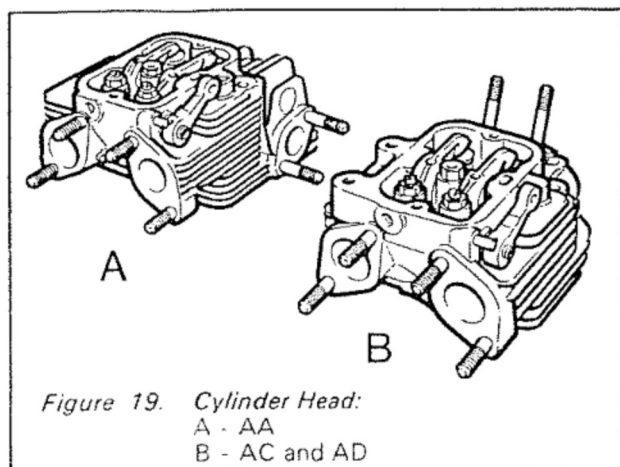
Removing the Cylinder Head Cover

Section 2 - The Basic Engine

THE CYLINDER HEAD

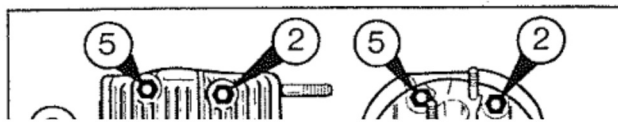
The finned cylinder head is a one-piece alloy casting and carries the valves, valve guides, decompressor and the injector.

The AA cylinder head is fitted with an air cell and oil priming device and is therefore not interchangeable with AC or AD heads.



Removing the Cylinder Head

1. Remove the exhaust and inlet manifolds.
2. Remove the air cowling
3. Remove the fuel pipes.
4. Remove the crankcase to cylinder head oil pipe.
5. Remove the cylinder head cover.
6. Remove the injector.
7. Gradually slacken the cylinder head retaining nuts in the sequence shown in Figure 20.



10. Mark the position of the push rods to identify their location on re-assembly and lift them out.
11. Lift off the cylinder head.
12. Remove the push rod tubes.
13. Place a suitable length of tube, over one cylinder head holding down stud and secure by fitting a cylinder head nut finger tight. This will prevent movement of the barrel if the crankshaft is turned.

Fitting the Cylinder Head

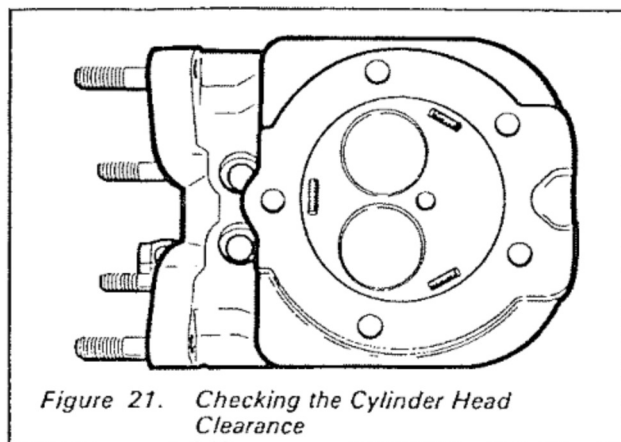
When the cylinder head is being replaced it is recommended that a new cylinder head gasket, rocker support 'O' ring seal and push rod seals are fitted.

1. Fit a new cylinder head gasket onto the top of the barrel.
2. Replace the push rod tubes using new seals.
3. Carefully fit the cylinder head over the studs.
4. Lightly lubricate the push rods with new engine oil and place them in their original positions.
5. Fit a new valve rocker support 'O' ring seal, the rocker support and the valve rockers.
6. Replace and gradually tighten the cylinder head retaining nuts, in the sequence shown in Figure 20, until they are finger tight. While tightening the nut holding the rocker support ensure that the support is correctly located over the locating pin in the cylinder head.
 - a. Before tightening AD2 cylinder head nuts the manifold flanges of both cylinder heads must be lined up, either with a straight edge or by fitting a manifold. If the straight edge method is used any

CHECKING CYLINDER HEAD CLEARANCE

1. Remove the cylinder head and push rods.
2. Turn the crankshaft until the piston is 6.35mm (0.25in) before TDC.
3. Using a very small amount of high melting point grease place three pieces of lead wire 1.2mm (0.048in) thick equidistant on the cylinder head as shown in Figure 21.

Extra care should be taken to ensure they are not placed over the valve heads or combustion chamber.

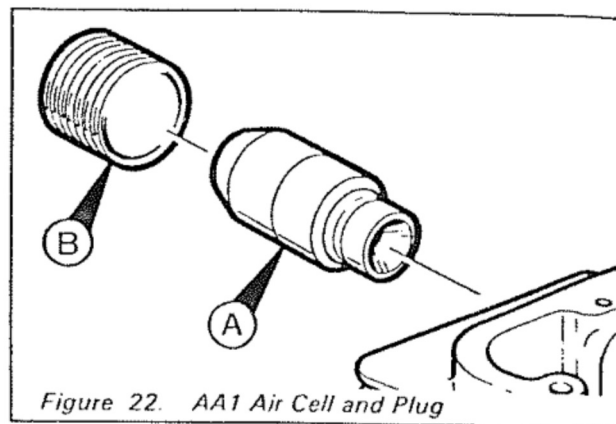


4. Replace the cylinder head gasket. On AA engines the raised sections of the gasket must be fitted facing the cylinder barrel.
5. Replace the cylinder head and torque the bolts to 27.0Nm (20.0lbf ft) following the sequence given in Figure 20 on page 20..
6. Turn the piston past TDC.
7. Remove the cylinder head and measure the thickness of the lead; this should be as specified below.

	Bolt	mm	in
AA	05	0.46-0.56	0.018-0.022
	All others	0.56-0.66	0.022-0.026

THE AIR CELL - AA

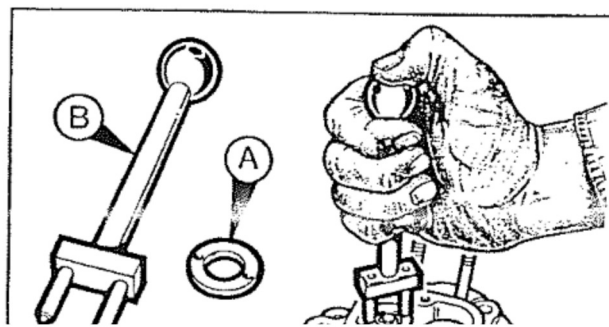
The air cell (A) is only fitted to AA1 engines and can be removed after removing the plug (B). On refitting the plug Achesons anti-scuffing graphited grease is used.



THE VALVES

Removing the Valves

1. Remove the cylinder head
2. Remove the valve rocker assembly.
3. Lay the cylinder head upright on a bench and place a circular block of hardwood under the head of the valve to be removed.
4. Place the adaptor (A) onto the valve spring carrier with the two indentations facing outwards.



Section 2 - The Basic Engine

Refitting the Valves

AA1 Build 05 engines are fitted with an inlet valve stem oil seal and an exhaust valve stem 'O' ring.

1. Assemble the valves in the reverse order ensuring the collets are securely in position with their tops sunk in the valve spring carrier.
2. Replace the valve rocker assembly.
3. Replace the cylinder head and check the valve clearance.
4. Replace the valve rocker cover.

VALVE GUIDES

The valve guides are a press fit into the cylinder head and an oil seal is fitted onto the top of the inlet valve guide.

Removing Valve Guides

1. Remove the cylinder head.
2. Remove the valves.
3. Remove the inlet guide oil seal.
4. Place the head in hot water for a few minutes.
5. Place the head on its side in a soft jawed vice leaving access to the guide from the underside.
6. Fit the narrow end of the Service Tool 390263 into the guide from the valve seat side and use a hammer to remove the guide.
It is recommended that suitable precautions are taken to prevent the guide causing personal injury when it comes away from the head.

Refitting Valve Guides

1. Place the head in hot water for a few minutes.
2. Stand the cylinder head the correct way up, preferably on a bench.
3. Place the new guide squarely into the guide hole.

VALVE SEAT INSERTS

The valve seats are cast iron inserts which are pressed into position in the cylinder head. Oversize inserts, 360049, are available.

The valve depth from the cylinder head face must be as specified below.

If the seats are badly pitted and require cutting back to such an extent that the depth exceeds the maximum tolerance oversize inserts must be fitted.

Valve Depth from Cylinder Head Face

		New	Not to Exceed
AA	mm	0.63 - 1.06	1.27
	in	0.025 - 0.042	0.050
AC, AD	mm	0.25 - 0.65	0.84
	in	0.010 - 0.025	0.033

Fitting New Valve Inserts

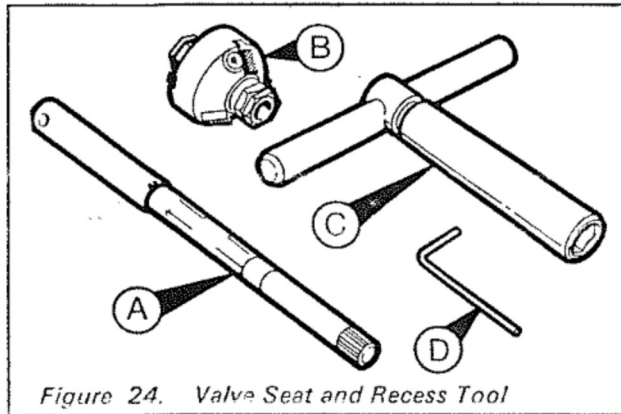
1. Remove the cylinder head.
2. Remove the old inserts.
3. Machine the inlet and exhaust valve insert bores to 32.004-32.029mm (1.260-1.261ins) to a cylinder head depth of 4.750-4.801mm (0.187-0.189in).
The insert bores should be radiused to suit the chamfered lead on the insert.
4. Heat the cylinder head to 150°C (302°F) and with the insert at ambient temperature press it into position with the chamfered end first.
5. Machine the valve seats to $\frac{3}{4}$, before grinding in the valves, and they must be concentric with the guide bores to within 0.005mm (0.002in) TIR.
6. Grind in the valves as described in "Valve Grinding".

Section 2 - The Basic Engine

Valve Seat and Recess Cutting

The correct valve seat angle will be maintained if the procedure below, using Service Tool 317-50042, is followed.

1. Fit the correct adjustable mandrel (A) into the valve guide and turn the adjuster until the flutes just bind onto the guide.
2. Select the necessary cutting tool (B) and assemble it to the handle (C).
3. Place the cutter over the mandrel and adjust the three individual blades by using the Allen Key (D).



4. Rotate the tool in a clockwise direction until the valve seat or recess finish is satisfactory.

Warning:

The valve guide will be damaged if the mandrel is adjusted too much when it is located in the guide.

Care must be taken to ensure an even, gentle downward pressure is applied when using the cutter to prevent the removal of too much metal.

Valve Grinding

1. Lightly lubricate the valve stem with new engine oil.
2. Place a very small quantity of grinding paste

6. Replace the valves and rotate them backwards and forwards a few times and remove them.
If the valves have been correctly ground a thin polished line will appear all round the mating surfaces.
7. Check the dimensions as given in "Valve Depth from Cylinder Head Face" on page 22 and if they are outside the tolerance new inserts must be fitted.

VALVE CLEARANCE

The valve clearance, 0.1mm (0.004in), must be measured and adjusted when the engine is cold.

It is important that the clearance is maintained correct to prevent serious damage to the valve gear.

With new engines, or engines which have just been overhauled, the valve gear beds down rapidly during the first 500 hours running and it is essential that the clearance is checked every 25 hours until it is found that the clearances remain constant. The periods between checks may then be increased to 250 hours.

Adjusting the Valve Clearance

Due to the close confines of the rocker box and difficulty in obtaining an accurate adjustment with a standard feeler gauge it is recommended that the Service Tool 317-50094 is used.

1. With the cylinder head cover removed, turn the engine until the piston is at TDC on the firing stroke.
2. Ensure the decompressor is clear of the exhaust valve rocker.
3. Hold the adjusting screw (A) with a screwdriver and slacken the locknut (B).



Section 2 - The Basic Engine

6. Re-check to ensure the clearance is correct.
7. Repeat the procedure for the second valve.
8. On AD2 engines turn the engine until the piston is at TDC on the firing stroke for the second cylinder and repeat the above procedure.

THE DECOMPRESSOR

The decompressor operates on the exhaust valve and an 'O' ring seal fitted to the spindle inside the cylinder head, prevents oil seepage.

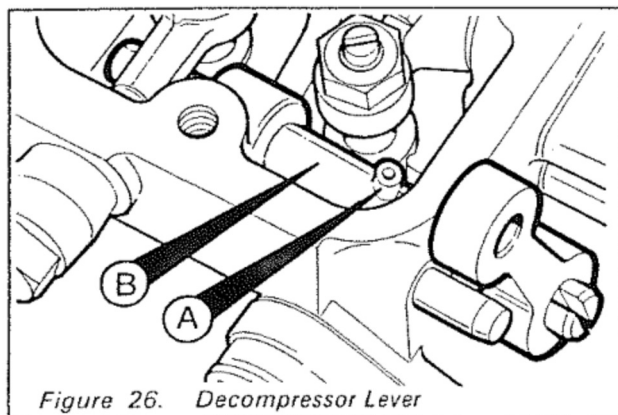


Figure 26. Decompressor Lever

Removing the Decompressor

1. Remove the cylinder head cover.
2. Use a suitable punch and hammer to push the roll pin (A) through the spindle (B); care must be taken to ensure the pin does not foul on the cylinder head casting.
3. Withdraw the decompressor lever from the cylinder head.

Decompressor Adjustment

The decompressor lever must only be adjusted after the valve clearance has been correctly set.

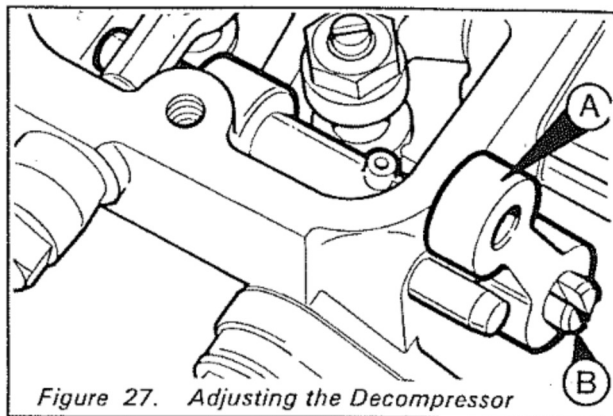


Figure 27. Adjusting the Decompressor

4. Replace the cylinder head cover.
5. On AD2 engines turn the engine until the piston is at TDC on the firing stroke for the second cylinder and repeat the above procedure.

THE CYLINDER BARREL

The cylinder barrel can be removed without the need to remove the piston and connecting rod assembly.

Removing the Barrel Only

1. Remove the cylinder head.
2. Turn the piston to TDC.
3. Lift off the cylinder barrel.
4. Check the cylinder bore wear, if this has reached the maximum of 0.15mm (0.010 in), refer to "Dimensions of Wearing Parts and Clearances" on page 37, the cylinder must be rebored and an oversize piston and rings fitted.

The cylinder should be bored and honed to the size listed in the relevant table.

Refitting the Cylinder Barrel Only

Section 2 - The Basic Engine

Removing the Barrel and Piston Assembly

1. Remove the cylinder head.
2. Lift out the sump dipstick.
3. Drain the oil from the sump.
4. Turn the engine onto its flywheel.
5. Remove the sump retaining capscrews and remove the sump and gasket.
6. Turn the piston to a suitable position to give access to the connecting rod big end bearing cap bolt.
7. Remove the big end bolt and the bearing cap.
8. Turn the piston to TDC.
9. Lift off the cylinder barrel complete with the piston and connecting rod.
10. Retain the cylinder head clearance shims which are fitted between the cylinder barrel and crankcase.
11. Replace the bearing cap onto the connecting rod.
12. Withdraw the piston and connecting rod assembly from the cylinder barrel.
13. Check the cylinder bore wear, if this has reached the maximum of 0.15mm (0.010 in), refer to "Dimensions of Wearing Parts and Clearances" on page 37, the cylinder must be rebored and an oversize piston and rings fitted.
The cylinder should be bored and honed to the size listed in the relevant table.

CYLINDER REBORE DIMENSIONS

AA

		Bore Size
Standard	mm	69.850-69.875
	in	2.750-2.751
Oversize 0.508mm (0.020in)	mm	70.358-70.383
Oversize 1.016mm (0.040in)	mm	71.374-71.399

AD

		Bore Size
Standard	mm	80.00
	in	3.1496
Oversize 0.508mm (0.020in)	mm	80.51
	in	3.1696
Oversize 1.016mm (0.040in)	mm	81.02
	in	3.1896

Cylinder Bore Glazing

When the engine has been fully run in, the bore will have a highly polished and very hard surface, if new piston rings are fitted without the cylinder being rebored, the new rings will not bed satisfactorily. Under these conditions the hard polished bore must be lightly roughened using a medium grade carborundum cloth radially by hand sufficient only to produce a matt surface on the bore. Alternatively, a suitable sized de-glazing tool or the rotary bush type with silicone-carbide tips may be used.

After this treatment extreme care must be taken to ensure the cylinder is thoroughly washed in kerosene to remove all traces of carborundum.

Refitting the Cylinder Barrel

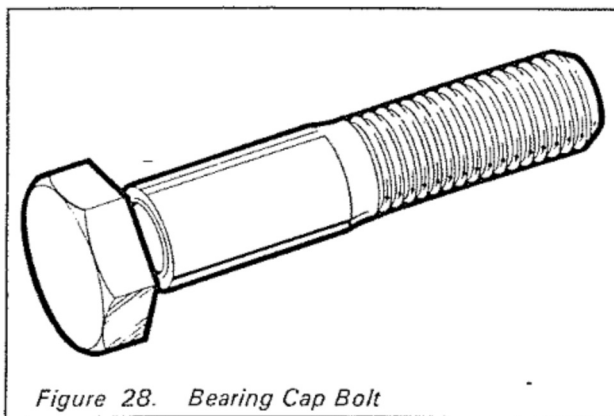
1. With the engine on its flywheel turn the crankshaft crankpin to TDC.
2. Fit the piston to the connecting rod after immersing the piston in hot water to allow the gudgeon pin to slide freely.
3. Secure the gudgeon pin by replacing the circlips; ensure the circlips are correctly fitted in their grooves.
4. Distribute the piston ring gaps around the piston circumference so that the gaps are not in line.
5. Lightly lubricate the crankshaft crankpin, cylinder bore, piston and piston rings with new engine oil.

Section 2 - The Basic Engine

- b. The connecting rod is assembled to the crankshaft journal the bearing cap faces away from the camshaft.
10. Turn the crankshaft and at the same time push down on the top of the piston until it is in a suitable position to give access to the connecting rod big end bearing.
11. Fit the connecting rod cap ensuring that the numbers on the cap and rod assembly are correctly matched and are on the same side.
12. Tighten the big end bolt to a torque of 34Nm (25 lbf ft).

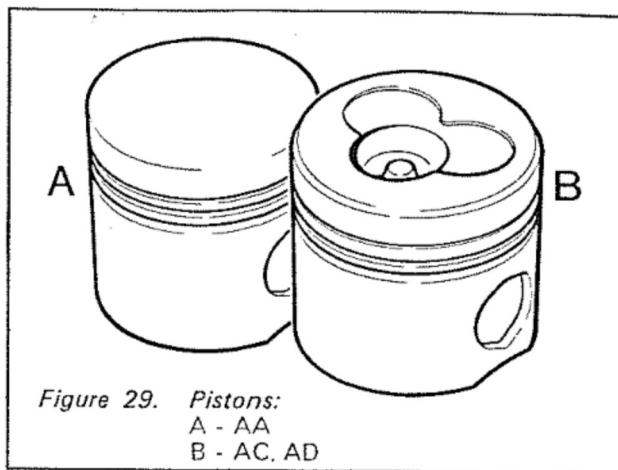
Note:

Care must be taken to ensure the correct type of connecting rod cap bolts, as shown in Figure 28, are fitted and it is recommended that they are replaced on every occasion they are removed, if not, **they must be replaced every fourth time.**



THE PISTON

The piston is manufactured from low expansion alloy and is fitted with a firing ring, compression ring and one oil ring. The gudgeon pin is retained by two circlips and runs in a bush in the small end



Removing the Piston

1. Remove the cylinder barrel.
2. Withdraw the piston from the barrel.
3. Release the circlip from one end of the gudgeon pin.
4. Push out the gudgeon pin.
If the pin is tight, place the piston in hot water until it can be removed; it may be necessary to protect the hands.
5. Using a suitable piston ring expander remove the piston rings.

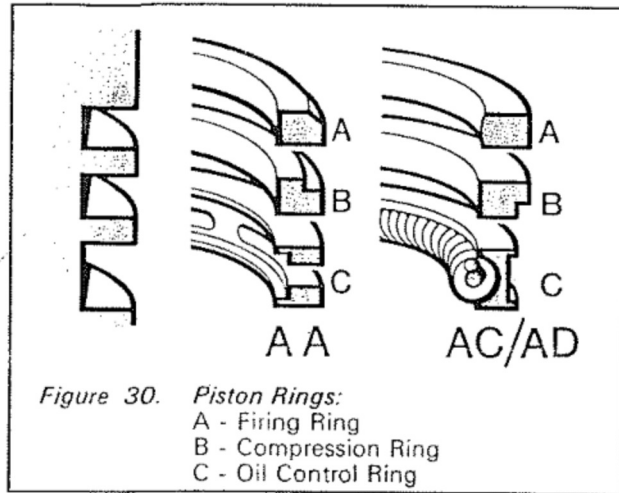
Inspection and Servicing

The dimensions to be expected can be found in "Dimensions of Wearing Parts and Clearances" on page 37.

1. Clean the piston and remove all traces of carbon from both the upper and underside of the head, ring grooves and the oil holes. Insert the piston into the cylinder barrel with the crown towards the bottom end of the bore and about 13mm (0.05in) from the bottom edge.
2. Insert the rings one at a time, pushing each

Section 2 - The Basic Engine

2. Insert the gudgeon pin and circlips.
3. Using a standard piston ring expander replace the piston rings in the order shown in Figure 30.



4. Distribute the piston ring gaps around the piston circumference so that the gaps are not in line.
5. Lightly lubricate the piston and piston rings with new engine oil.
6. Using a suitable piston ring clamp compress the rings and fit the piston and connecting rod assembly into the cylinder.

THE CONNECTING ROD

The connecting rod is connected to the crankpin by a conventional big end bearing, the cap being held in position by two bolts. Care must be taken to ensure the correct type of connecting rod cap bolts, as shown in Figure 28 on page 26, are fitted and it is recommended that they are replaced on every occasion they are removed, if not, **they must be replaced every fourth time**.

Small End Bush

When fitting a small end bush extreme care must be taken to ensure that the oil feed hole coincides with the hole in the connecting rod and the bush enters squarely.

Large End Bearings

New bearings are machined to give the required fit when in position and should not be scraped or bedded in, neither should shims of any description be fitted. When fitting bearing shells ensure that the connecting rod bore and the outside of the shells and their split face are clean.

Connecting rods and caps are stamped with an assembly serial number and care must be taken to ensure that these numbers match and on assembly are on the same side.

Inspection and Servicing

- a. Clean the connecting rod and examine for bending and twisting.
- b. Examine the small end bush for wear.
- c. If the big end has been dismantled because of metal failure all of the oil passages must be examined for obstruction and fragments of metal.
- d. Check the bearing shell clearance as described in "Checking Bearing Clearance" on page 31.

THE FLYWHEEL

The flywheel rotates within the fanshroud aperture and is fitted with the engine cooling air fan on the crankcase side. All flywheels have tapped holes for attaching couplings, shaft extensions, pulleys etc.

AC and AD engines may be fitted with a flywheel mounted battery charging system and a starter motor ring gear; refer to Section 6.

The flywheel is keyed on to the crankshaft and held in position with a tab washer and nut and the tolerance for bore and face run-out must be within 0.13mm (0.005in) TIR.

Section 2 - The Basic Engine

4. Use a 1 1/8 AF socket and slacken the flywheel nut several turns.
5. Remove the flywheel locking device.
6. Fit the Service Tool 393175, with suitable setscrews through the 'C' holes, onto the flywheel.

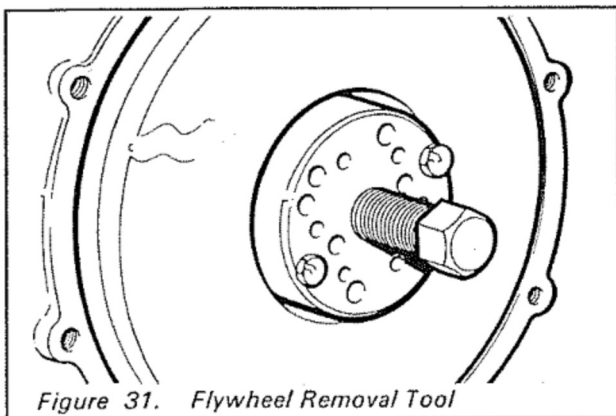


Figure 31. Flywheel Removal Tool

7. Lightly oil the tool centre bolt and tighten it until the flywheel is loosened from the crankshaft.
8. Remove the tool.
9. Remove the retaining nut and tabwasher.
10. Screw two suitable bolts into the flywheel and use these to carefully slide the flywheel off the crankshaft and out of the housing taking care not to damage the cooling fan or the charging equipment if it is fitted.

Fitting the Flywheel

1. Fit the flywheel key into the crankshaft.
2. Lightly oil the crankshaft and flywheel bore.
3. Align the flywheel keyway with the key on the shaft and push the flywheel on the shaft as far as possible.

THE GEAR END COVER

The end cover is secured to the crankcase by eight socket head capscrews and two dowels. The end cover joint must be fitted dry and it is recommended that a new joint is fitted when the end cover is replaced.

Warning:

Do not use a screwdriver, or similar tool, between the cover and crankcase to lever the cover off.

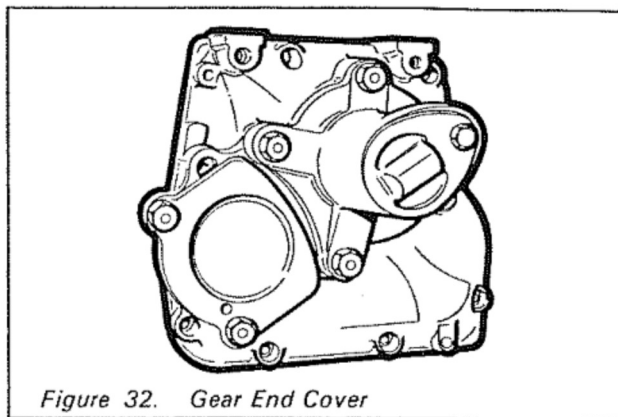


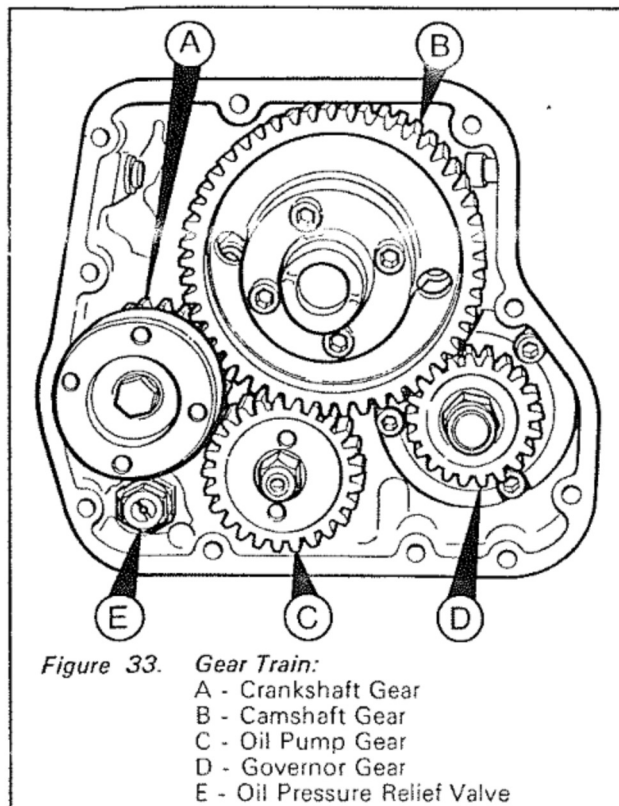
Figure 32. Gear End Cover

End Cover Oil Seal

Before fitting a new oil seal it is important that the recess in the seal is filled with Shell Alvania R2 Grease. This is a Lithium Grease to NLG1 No 2 consistency. In the event of non-availability of the grease soak the seal in engine lubricating oil at ambient temperature for 24 hours.

1. Place a new seal into the outside neck of the end cover, lip side first, and position it squarely on the shoulder of the seal boss.
2. Using the oil seal Service Tool 393211 press the seal into position within the oil seal housing boss until it is flush with the outside face of the cover.
In an emergency, if the tool is not available a suitable plug, preferably hard wood, can be used.

Section 2 - The Basic Engine



THE CRANKSHAFT

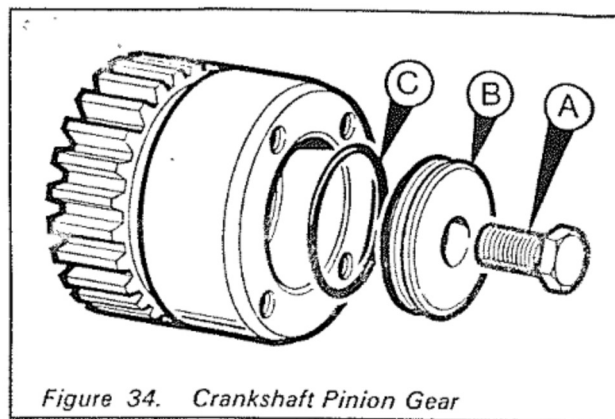
The crankshaft is a steel forging and is carried in steel backed copper faced main bearings which are located in the crankcase at the gear end and flywheel ends.

End thrust is taken on steel backed copper faced thrust washers fitted at the gear end of the crankcase and in the flywheel end main bearing housing.

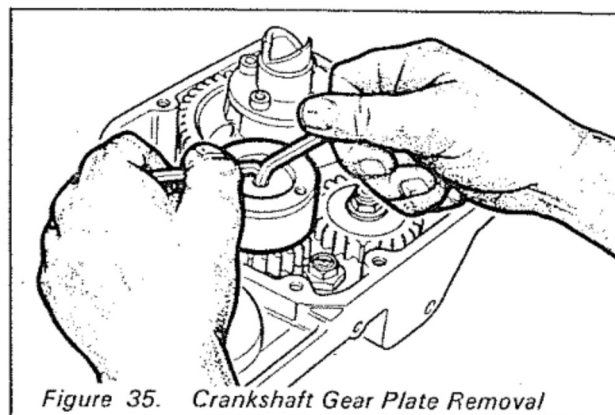
Extreme care must be taken to ensure that the crankshaft float is correctly maintained when driven units are connected.

The main bearings are the floating type and have an oil feed hole which must be correctly located.

An interference fit pinion is keyed onto the end



The plate (B) can be lifted out by using two suitable Allen keys placed into the bolt hole as shown in Figure 35.



5. Fit the Service Tool 393175 onto the pinion gear using two suitable setscrews through the 'B' marked holes.
6. Lightly oil and tighten the centre bolt of the tool until the pinion is drawn off the crankshaft.



Section 2 - The Basic Engine

On AD2 engines remove the oil suction pipe and strainer; see "The Oil Pump Strainer" on page 42.

9. Remove the cylinder barrel(s), piston(s) and connecting rod(s).
10. If flywheel charge windings are fitted remove the screws securing the stator, adaptor and the cable clamp. Feed the cable through the flywheel housing before removing the stator and adaptor.
11. On AD2 engines remove the two bolts that hold the intermediate main bearing housing in position, note the position of the two bearing halves and remove them.
12. Remove the six nuts and washers retaining the flywheel end main bearing housing and guard.
13. Remove the flywheel guard and housing assembly.
14. Carefully remove the crankshaft through the flywheel end of the crankcase.
15. If necessary remove the crankshaft thrust washer from inside the gear end of the crankcase.

Inspection and Servicing

- a. Inspect the main bearings for scoring or wear. If necessary the bearings can be removed and replaced as described in "Crankshaft Main Bearings" on page 32. If the connecting rod big end has been dismantled because of failure of the bearing, all of the oil passages must also be examined for obstruction and fragments of metal.
- b. Check the crankshaft to bearing clearances.
- c. Examine all bearing surfaces for scoring and

CRANKSHAFT REGRIND DIMENSIONS

AA and AC

		Journal and Crankpin
Standard	mm	41.275-41.262
	in	1.6250-1.6245
Undersize 0.254mm (0.010in)	mm	41.021-41.008
	in	1.6150-1.6145
Undersize 1.508mm (0.020in)	mm	40.767-40.754
	in	1.6050-1.6045

AD

		Crankpin Journal
Standard	mm	44.450-44.425
	in	1.750-1.749
Undersize 0.254mm (0.010in)	mm	44.20
	in	1.740
Undersize 1.508mm (0.020in)	mm	43.94
	in	1.730

		Main Journal
Standard	mm	41.262-41.275
	in	1.6245-1.6250
Undersize 0.254mm (0.010in)	mm	41.008-41.021
	in	1.6145-1.6150
Undersize 1.508mm (0.020in)	mm	40.754-40.767
	in	1.6045-1.6050

Refitting the Crankshaft

1. If necessary fit new main bearings.
2. If new bearings are not being fitted ensure that the journal bearing surfaces and oil holes are clear.
3. Place a small quantity of new engine oil in the gear end bearing and on the crankshaft journals.
4. Fit the gear end thrust washer in the crankcase, making sure that the grooved side is facing away from the crankshaft.

Section 2 - The Basic Engine

7. Fit the flywheel end thrust washer into the flywheel end main bearing housing, making sure that the grooved side is facing away from the housing.
8. Coat the flywheel end main bearing housing studs with Loctite Drilloc 711.
9. Fit a new joint to the main bearing housing and using Service Tool 317-50101 to prevent damaging the oil seal on the keyway edges replace the housing.
10. Torque load the six nuts diagonally to 23.0Nm (17.0lbf ft).
11. Check that the crankshaft is free to rotate.
12. Check the crankshaft endfloat by using a feeler gauge inserted between the thrust washer face and the crankshaft or by using a dial gauge.
The endfloat should be 0.102-0.635mm (0.004-0.025in).

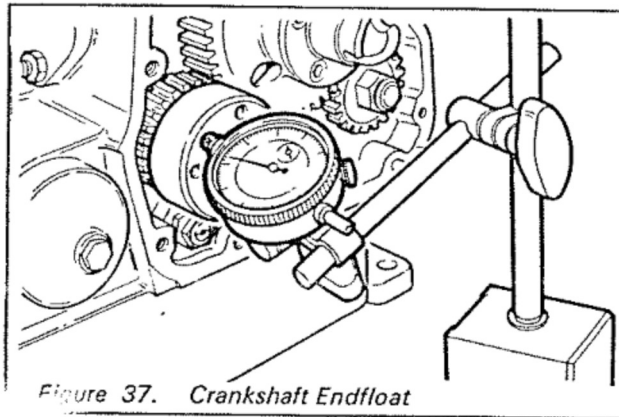


Figure 37. Crankshaft Endfloat

13. Fit the Woodruff key at the gear end.
14. Heat the crankshaft pinion gear to straw yellow and fit it to the crankshaft without delay.
Insufficient heat or delay in fitting could well

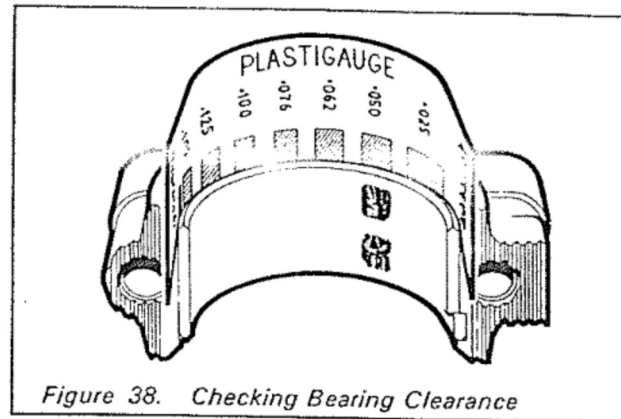
18. Replace the plate by pushing it into position; resistance will be felt due to the new 'O' ring.
19. Replace the bolt and torque load it to 37.5Nm (27.5lbf ft).

Note:

Items (A), (B) and (C) in 15. above are illustrated in Figure 34 on page 29.

CHECKING BEARING CLEARANCE

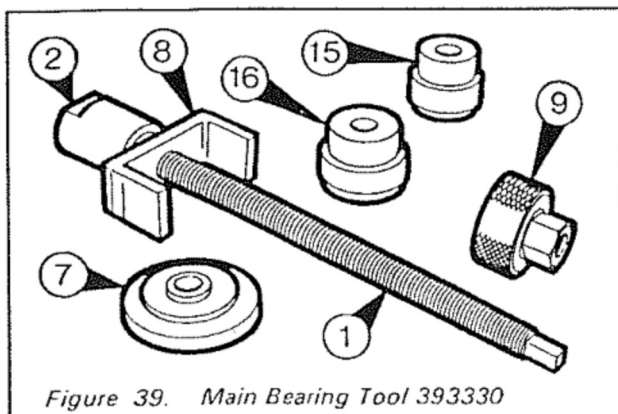
1. Place a piece of the correct size Plastigauge approximately 6.35mm (0.25in) off-centre across the full width of one bearing shell.



Section 2 - The Basic Engine

CRANKSHAFT MAIN BEARINGS

The legend numbers referred to in the illustration and text are also marked on the individual tool items.



Gear End Main Bearing Removal

1. Fit the nut (2) onto the screw (1).
2. Place the small dolly (15) onto the screw with the flanged end next to the nut (2).
3. Loosely fit the flywheel end bearing housing.
4. Insert the assembly through the bearing from the gear end.
5. Fit the depth plate (7) and the thrust nut (9) to the screw.
6. Using the correct size of spanner, and pulling against the flywheel bearing housing, tighten the thrust nut (9) until the bearing is removed from the crankcase.

Gear End Main Bearing Replacement

1. Fit the nut (2) onto the screw (1).
2. Place the small dolly (15) onto the screw with the flanged end next to the nut (2).
3. Place the new bearing onto the dolly (15) and fit the large dolly (16) into the bearing.
4. Loosely fit the flywheel end bearing housing.
5. Fit the screw assembly from the gear end

Flywheel End Main Bearing Removal

1. Fit the nut (2) onto the screw (1).
2. Hold the nut firmly across its flats in a vice.
3. Place the small dolly (15) onto the screw (1) with the flanged end next to the nut (2).
4. Remove the oil seal.
5. Fit the bearing housing, thrust face uppermost, onto the screw.
6. Fit the bridge (8) followed by the thrust nut (9) onto the screw (1).
7. Using the correct size of spanner, tighten the thrust nut (9) until the bearing is removed.

Flywheel End Main Bearing Replacement

1. Fit the nut (2) onto the screw (1).
2. Hold the nut firmly across its flats in a vice.
3. Place the small dolly (15) onto the screw (1) with the flanged end next to the nut (2).
4. Place the new bearing onto the dolly (15) and fit the large dolly (16) into the bearing.
5. Using the bridge (8), thrust nut (9) and the correct size of spanner tighten the thrust nut (9) until the bearing inner edge is almost flush with the housing thrust face.
6. Remove the tool taking care to prevent it dropping onto the new bearing.
7. Check the oil holes in the crankcase and bearing align.

FLYWHEEL END OIL SEAL

When fitting the flywheel end oil seal, ensure that it is fitted squarely in the housing before pressing, or driving, in the seal. The seal face must be flush with the outer face of the bearing housing.

Before fitting anew oil seal it is important that the recess in the seal is filled with Shell Alvania R2 Grease; this is a Lithium Grease to NLG1 No.2

Section 2 - The Basic Engine

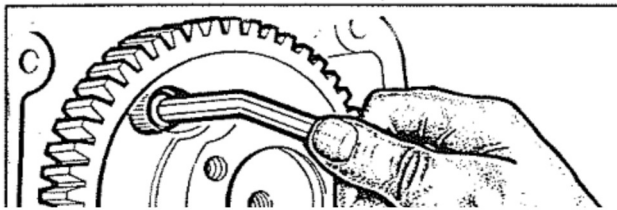
THE CAMSHAFT

The steel camshaft is carried in bearings in the crankcase at the flywheel and gear ends end and in the centre web. A thrust plate is fitted behind the camshaft gear and the gearwheel is keyed and an interference fit.

The rotary oil pump is driven by the camshaft gearwheel and cams on the camshaft operate the valve tappets and fuel pump.

Removing the Camshaft

1. Lift out the dipstick.
2. Drain the oil from the sump
3. Drain and remove the fuel tank.
4. On AC and AD engines remove the fuel lift pump and plunger if a pump is fitted.
5. Remove the fuel pump.
6. Remove the fuel injector.
7. Remove any accessories fitted to the gear end cover.
8. Remove the gear end cover.
9. Remove the cylinder head cover, the valve rockers and push rods; note the position of the pushrods.
10. Stand the engine on its flywheel end.
11. Remove the oil sump.
12. Remove the two camshaft thrust plate retaining screws; these are accessible through holes in the gearwheel as shown in Figure 40.



16. Remove the cam followers noting their positions.

Inspection and Maintenance

- a. Check the cam lobes and cam followers for wear or damage.
- b. Check the camshaft core plug for leaks.
- c. Before fitting the camshaft check the camshaft bearings and thrust plate for damage or wear.
- d. Check the camshaft and crankshaft pinions teeth for wear.
- e. Examine the oil seal in the end cover for damage or wear.

Camshaft Bushes

New bushes should be immersed in clean engine oil before fitting and it is recommended that they are replaced as a set.

1. Remove the camshaft.
2. Use a suitable brass drift to remove the bushes.
3. Ensure the crankcase bush bore is clean and not damaged.
4. Using a suitable dolly or hardwood block drive in the new bushes.

Camshaft Core Plug

1. Drive out the old plug.
2. Coat the periphery of the new plug with Hylomar PL14.
3. Fit the plug from the inside of the crankcase with the cup bottom entering first.

Camshaft Pinion Gear

It is recommended that the gear is heated, preferably using an oil bath, before attempting to fit it to the camshaft. If an alternative source of

Section 2 - The Basic Engine

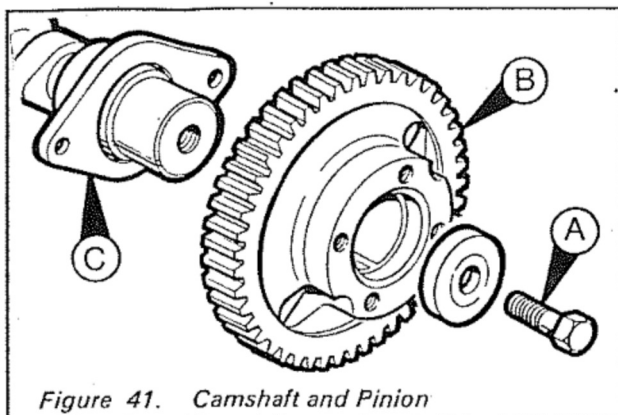


Figure 41. Camshaft and Pinion

Refitting the Camshaft Pinion

1. Place the thrust plate onto the camshaft.
2. Fit the Woodruff key at the gear end.
3. Heat the camshaft pinion gear to straw yellow and fit it to the camshaft without delay.
Insufficient heat or delay in fitting could well cause the pinion to become jammed on the camshaft, whereas overheating may cause softening of the pinion.
4. When the pinion gear has cooled sufficiently fit the plate and the retaining setscrew which should be torque loaded to 37.5Nm (27.5lbf ft).

Refitting the Camshaft

1. With the engine standing on its flywheel place the camshaft followers in their original positions and push them as far as they will go into the crankcase.
2. Lightly oil the camshaft and bearings with new engine oil.
3. Carefully replace the camshaft through the

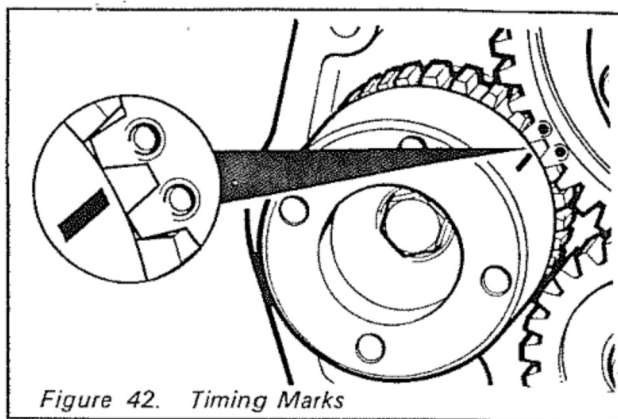


Figure 42. Timing Marks

4. Turn the camshaft as necessary to align the thrust plate mounting holes with the holes in the pinion gear.
5. Replace and tighten the two thrust plate retaining capscrews.
6. Check the camshaft end float using a dial indicator as shown in Figure 43; this should be 0.127-0.305mm (0.005-0.012in) and is not adjustable.

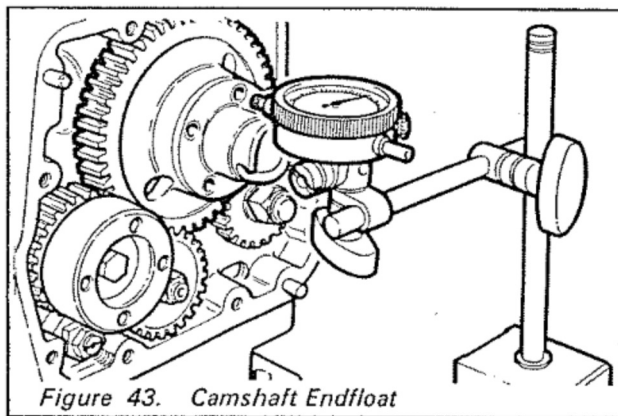


Figure 43. Camshaft Endfloat

7. Replace the crankshaft pinion gear.
8. Replace the gear end cover.
9. Refit the sump using a new gasket and stand

Section 2 - The Basic Engine

THE GOVERNOR

The governor is fully covered in Section 4. The following paragraphs are included only to describe the dismantling and assembly procedures.

Removing the Governor

1. Lift out the dipstick.
2. Drain the oil from the sump.
3. Drain and remove the fuel tank, if fitted.
4. Remove the gear end cover.
5. If necessary remove the governor pinion gear retaining nut and pull off the pinion.
6. Remove the three capscrews retaining the governor.
7. Turn the crankshaft sufficiently to ensure one of the 'flats' on the assembly will clear the camshaft pinion gear teeth.
8. Lift out the governor assembly.

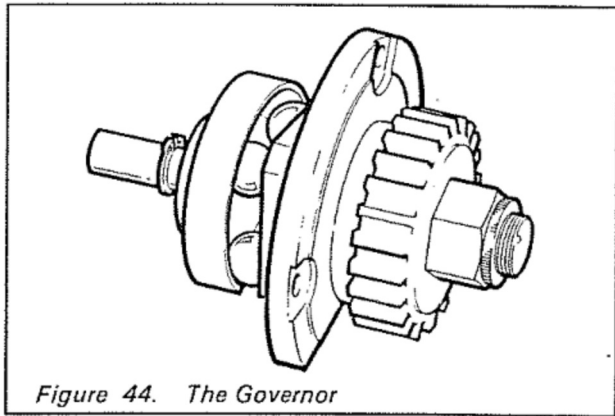


Figure 44. The Governor

Servicing the Governor Assembly

1. Clean the assembly in kerosene.
2. Check the governor balls and sliding cone for wear or damage.

3. Align the key and keyway and fit the gearwheel and nut.

THE GOVERNOR LINKAGE

The governor linkage is covered in Section 4.

DECARBONISING

Decarbonising should be carried out after 2000 hours running or if the engine shows loss of compression or blow-by past the piston.

Thoroughly clean and examine the following items for damage or wear and renew any defective parts as necessary.

1. Piston.
2. Piston rings, grooves and oil holes.
3. Valve ports, valves and valve seats.
4. Exhaust manifold, piping and silencer.
5. Fins on the cylinder, cylinder head and injector.
6. Regrind the valves and seats.

CLEANING THE COOLING FINS

The cylinder barrel and head fins must be kept reasonably clean otherwise seizure of various components can occur because of overheating. Cleaning frequency depends on the nature and concentration of the substances contained in the cooling air; fluff, hair, vegetable fibre, and other such items have a greater clogging effect than dry dust. The fins should always be cleaned when the engine is decarbonised but can also be cleaned, when necessary, by removing the air cowl and raking the dust off the fins with a hooked piece of wire.

Section 2 - The Basic Engine

calibration fluid is passed through the fuel pumps and injectors.

- d. Stop the engine and drain the lubricating oil from the sump, after which the crankshaft should NOT be turned until the engine is again required for service.
The calibration fluid should be left in the fuel system.
- e. Seal all openings on the engine with tape.
- f. Remove the batteries, when applicable, and store fully charged with the terminals coated with petroleum jelly.
- g. Grease all external bright metal parts and the speed control linkage.
- h. Tie labels on the engine clearly stating what steps have been taken to inhibit the engine during storage.

Warning:

As a direct result of combustion the lubricating oil will contain harmful acids and therefore it should not be left in the sump if it is known that the engine will not be used for extended periods.

JOINTING COMPOUNDS

Some engines may have been assembled with jointing compounds that have been superseded. Providing all traces of the old compound and joint are removed the later specified compounds can be used.

Flywheel End Bearing Housing Studs Coat the studs with Loctite Drilloc 711.
Fuel Injection Pump Studs Coat the studs with Loctite Drilloc 711.
Oilway Plugs - except crankcase plugs Fit the plug with Stag 'A' type jointing compound.
Oil Filler Collar Coat with Loctite 87AV Red Compound.
Valve Rocker Box Oilway Plug Coat with Hylomar PL32.
All Compressed Asbestos Fibre Gaskets Assemble clean and dry.
Air Cell Retaining Plug Assemble using Achesons anti-scuffing graphited grease.
Oil Seals Fill the seal recess and smear the crankshaft sealing area with Shell Alvania 2 grease.
Camshaft Core Plug Coat the periphery of the plug with Hylomar PL14.
Cylinder Head Gaskets Assemble dry.
Cylinder Head Clearance Shims Assemble dry.

SERVICE TOOLS

This table gives the service tools that are available for particular servicing operations..

Due to continued development and improvement it is quite possible that any tool purchased may not completely resemble that described or illustrated, however the principle for using it will remain the same.

All the tools listed can be ordered by quoting the part number and description following the same procedure as for ordering other Lister-Petter spares.

Part Number	Description of Tool
390263	Valve guide remover
393155	Valve spring compressor
393171	Jacking screw; included with 393175
393175	Gear and flywheel puller kit
393211	Oil seal sleeve
393212	Speed adjusting tool
392333	Main bearing adaptor
303330	Main bearing removal and replacement tool
317-50027	Slide hammer
317-50042	Valve seat and recess cutting tool
	with 317-50030
317-50094	Valve clearance gauge
317-50095	Injector removal adaptor; use with 317-50027
317-50101	Flywheel end crankshaft oil seal

Section 2 - The Basic Engine

DIMENSIONS OF WEARING PARTS AND CLEARANCES

Component	Initial Dimension		Initial Clearance		Maximum Clearance	
	mm	in	mm	in	mm	in
AA - All Builds Cylinder Bore	69.850 69.875	2.7500 2.7510	0.150	0.0059		
Piston Diameter - bottom of skirt across thrust face	69.751 69.726	2.7461 2.7451	0.099	0.0039	0.403	0.0159
Piston Ring Gap	0.279 0.406	0.0110 0.0160	0.279 0.483	0.0110 0.0190	1.19	0.047
Firing and Compression Ring Width	1.984 1.958	0.0781 0.0771	0.038	0.0015		
Firing and Compression Ring Groove Width	2.022 2.047	0.0796 0.0806	0.089	0.0035	0.114	0.0045
Oil Ring Width	3.967 3.942	0.1562 0.1552	0.041	0.0016		
Oil Ring Groove Width	4.008 4.034	0.1578 0.1588	0.091	0.0036	0.119	0.0047
AC - All Builds Cylinder Bore	76.200 76.225	3.0000 3.0010	0.142	0.0056		
Piston Diameter - bottom of skirt across thrust face	76.103 76.083	2.9962 2.9954	0.097	0.0038	0.395	0.0156
Firing and Compression Ring Gap	0.305 0.432	0.012 0.017	0.305 0.508	0.012 0.020	1.321	0.052
Oil Ring Gap	0.229 0.356	0.009 0.014	0.305 0.432	0.012 0.017	1.245	0.049
Firing Ring Width	1.750 1.737	0.0689 0.0684	0.064	0.0025		
Firing Ring Groove Width	1.814 1.991	0.0714 0.0784	0.245	0.0100	0.330	0.0130
Compression Ring Width	1.984 1.958	0.0781 0.0771	0.038	0.0015		
Compression Ring Groove Width	2.022 2.047	0.0796 0.0806	0.089	0.0035	0.117	0.0046
Oil Ring Width	3.970 3.945	0.1563 0.1553	0.038	0.0015		
Oil Ring Groove Width	4.008 4.034	0.1578 0.1588	0.089	0.0035	0.097	0.0038
AD - All Builds Cylinder Bore	80.000 80.025	3.1496 3.1506	0.145	0.0057		
Piston Diameter - bottom of skirt across thrust face	79.905 79.880	3.1459 3.1449	0.095	0.0037	0.395	0.0156
Firing Ring Gap	0.305 0.432	0.012 0.017	0.305 0.511	0.012 0.020	1.300	0.051
Compression Ring Gap	0.304 0.432	0.012 0.017	0.304 0.511	0.012 0.020	1.300	0.051
Oil Ring Gap	0.240 0.490	0.009 0.019	0.240 0.569	0.012 0.022	1.354	0.053
Firing Ring Width	1.753 1.740	0.0690 0.0685	0.114	0.0045		

Section 2 - The Basic Engine

Component	Initial Dimension		Initial Clearance		Maximum Clearance	
	mm	in	mm	in	mm	in
Small End Bearing Diameter - AA, AC	22.231 22.244	0.87525 0.87575	0.025	0.0010		
Gudgeon Pin Diameter - AA, AC	22.225 22.220	0.87575 0.8748	0.005	0.0003	0.035	0.0014
Small End Bearing Diameter - AD	22.244 22.257	0.8750 0.87626	0.034	0.0013		
Gudgeon Pin Diameter - AD	22.228 22.223	0.8751 0.8749	0.016	0.0006	0.050	0.0020
Big End Bore (in rod) - AA, AC	44.983 44.971	1.7710 1.7705				
Bearing Shell Thickness - AA, AC	1.8313 1.8225	0.07210 0.07175	0.076 0.033	0.0030 0.0013	0.112	0.0044
Crankpin Diameter - AA, AC	41.275 41.262	1.6250 1.6245				
Big End Bore (in rod) - AD	47.142 47.130	1.8560 1.8555				
Bearing Shell Thickness - AD	1.327 1.321	0.0522 0.0520	0.076 0.028	0.0030 0.0011	0.112	0.0044
Crankpin Diameter - AD	44.450 44.425	1.7500 1.7490				
Main Bearings - Bore Diameter (when pressed in housing)	41.338 41.308	1.6275 1.6263	0.076	0.0030		
Crankshaft Journals - Diameter	41.275 41.262	1.6250 1.6245	0.033	0.0013	0.112	0.0044
Thrust Bearing/Crankshaft Endfloat	2.362 2.311	0.0930 0.0910	0.102 Endfloat	0.004 Endfloat	0.635 Endfloat	0.025 Endfloat
Camshaft Bush Bore Diameter - Flywheel End (when pressed in housing)	25.464 25.390	1.0025 0.9996	0.102	0.0040		
Camshaft Journal - Flywheel End	25.375 25.362	0.9990 0.9985	0.015	0.0006	0.150	0.0059
Camshaft Bush Bore Diameter - Intermediate and Gear End (when pressed in housing)	34.996 34.910	1.3778 1.3744	0.112	0.0044		
Camshaft Journal - Intermediate and Gear End	34.900 34.884	1.3740 1.3734	0.010	0.0004	0.165	0.0065
Camshaft Assembly - Endfloat	0.127 0.305	0.0050 0.0120			0.335	0.013
Oil Pump - Rotor End Clearance			0.025 0.064	0.0010 0.0025	0.127	0.005
Oil Pump - Rotor Form Clearance			0.051 0.127	0.0020 0.0050	0.203	0.008
Oil Pump - Shaft/Bore Clearance			0.038 0.076	0.0015 0.0030	0.127	0.005
Valve Spring - approximate free length	38.00	1.5				
Valve Guide Bore	7.201 7.226	0.2835 0.2845	0.081	0.0032		
Valve Stem Diameter	7.160 7.145	0.2819 0.2813	0.041	0.0016	0.103	0.0041
Valve Rocker Arm Bore	15.870 15.900	0.6248 0.6260	0.071	0.0028		

Section 2 - The Basic Engine

SPANNER TORQUE SETTINGS

Location	Nm	lbf ft
Breather Base to Crankcase	5.0	4.0
Leak-off Banjo Bolt	7.0-8.0	5.0-6.0
Fuel Injector Stud Nut - AC, AD	8.0	6.0
Lubricating Oil Pump Screw	10.0-12.0	7.0-9.0
Solenoid Bracket Button Head Screw - AA	11.0	8.0
Gear Cover Cap Screw Sump Cap Screw	12.0	9.0
Oil Gallery Plug Lubricating Oil Filter Centre Bolt	14.0	10.0
Gear End Adaptor Housing Retaining Bolts	17.0/23.0	13.0/17.0
Fuel Injector Stud Nut - AA Fuel Injection Pump Nuts	18.0	13.0
Crankshaft Extension Shaft Screw Camshaft Extension Shaft Screw Starting Handle Shaft Retaining Screw - AC, AD	19.0	14.0
Crankshaft Cheek Weight Screw - AD	22.0	16.0
Rear Main Bearing Housing Nuts	23.0	17.0
Cylinder Head Nut - AA, AC	27.0	20.0
Cylinder Head Nut - AD	30.0	22.0
Connecting Rod Large End Bolt Starting Pinion Cap Screws - AD2	34.0	25.0
Camshaft Gearwheel Retaining Screw Crankshaft Gearwheel Retaining Screw Flywheel End Extension Shaft Bolt Starting Handle Shaft Retaining Screw - AD2	36.0	27.0
Fuel Pump Delivery Union Intermediate Bearing Housing Bolt - AD2	41.0	30.0
Air Cell Plug - AA	95.0	70.0
Flywheel Nut	210.0	155.0

Section 3 - The Lubrication System

OIL SPECIFICATION

The Oil Specification is given in the Operators Handbook - 027-08183.

DESCRIPTION AND OPERATION

A rotary type lubricating oil pump is mounted inside the gear end cover and is driven by a gear from the camshaft pinion.

The lubricating oil can be drained by removing one of two drain plugs located at the bottom of the sump.

The oil is drawn through a strainer in the sump to the rotary pump, through a pressure relief valve to the filter. From the filter it is distributed by oilways to the crankshaft main bearings and an external pipe feeds oil through a restrictor to the valve rockers. The connecting rod small end bearings and the camshaft are splash lubricated.

A combined oil filler and dipstick is located in the crankcase on the manifold side of the engine.

LUBRICATING OIL PRESSURE

The oil pressure must be checked after an engine overhaul or if the oil system has been disturbed.

1. Remove the blanking plug from below the valve rocker oil supply pipe union; this is located on the opposite side of the crankcase to the manifolds.
2. Fit a 1/8 inch BSP union, capillary pipe and pressure gauge.
3. Start the engine and check that the pressure builds up.

OIL SUMP CAPACITY

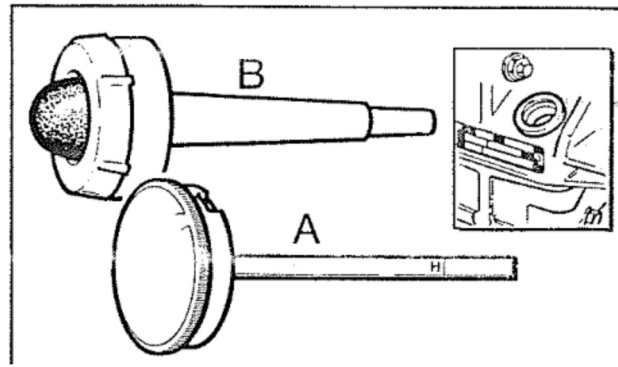
	litres	pints	US quarts
AA1	1.9	3.25	2.0
AC1	2.7	4.8	2.9
AD1	2.7	4.8	2.9
AD2	3.7	6.5	3.9

THE OIL SUMP

The sump is secured to the crankcase by capscrews and the integral engine mounting bolt drillings are located on each corner of it and two drain plugs are fitted.

Draining the Sump

1. If possible run the engine immediately before draining the oil.
2. Place a suitable container under the drain plug.
3. Lift out the dipstick.
4. Remove the plug.



Section 3 - The Lubrication System

3. Start the engine and run it for a few minutes to circulate the oil and check the drain plug does not leak.
4. Stop the engine and allow time for the oil to settle and re-check the level on the dipstick.
5. Add more oil if necessary.

Removing and Refitting the Sump

1. Drain the oil.
2. Stand the engine on its flywheel.
3. Remove the capscrews diagonally.
4. Lift off the sump and joint.
5. Clean and dry the crankcase and sump mating surfaces.
6. Fit the joint and sump onto the crankcase.
7. Replace the capscrews finger tight.
8. Torque load the capscrews, diagonally, to 12.0Nm (9.0lbf ft).
9. Stand the engine on the sump and refill with new oil to the specification given above.

THE OIL PUMP

The rotary oil pump is mounted on the crankcase inside the gear end cover and is driven from the camshaft pinion gear.

The oil pressure relief valve is set at 3.0-3.3bar (43-48lbf ft²).

Removing the Oil Pump

1. Lift out the dipstick.
2. Drain the oil sump.
3. Remove the fuel tank.

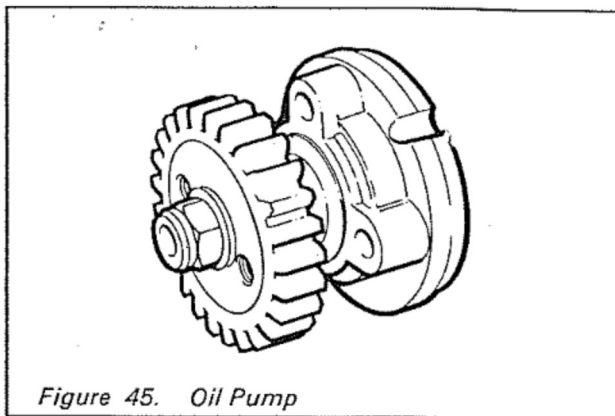


Figure 45. Oil Pump

9. Clean the crankcase pump orifices.
10. Clean the pump in kerosene and allow it to drain.
11. Check the rotors for wear; if they are worn the complete pump assembly must be replaced.
The clearances can be found in "Dimensions of Wearing Parts" in Section 2.

Refitting the Pump

1. Before fitting the pump to the engine pour a small quantity of new engine oil into the pump through the inlet and delivery ports.
2. Align the pump assembly with the offset capscrew thread holes.
3. Fit the three capscrews and washers and torque load them to 13.6Nm (10.0lbf ft.).
4. Align the shaft key and the pump gearwheel and fit the pump gearwheel.
5. Replace the nut and washer retaining the gearwheel.
6. Tighten the pump gear retaining nut.
7. Replace the camshaft.
8. Fit a new joint and replace the gear end

Section 3 - The Lubrication System

Cleaning the Strainer - AA, AC, AD1

1. Lift out the dipstick.
2. Drain and remove the sump.
3. Remove the centre bolt (A), strainer clip (B) and lift out the strainer (C).

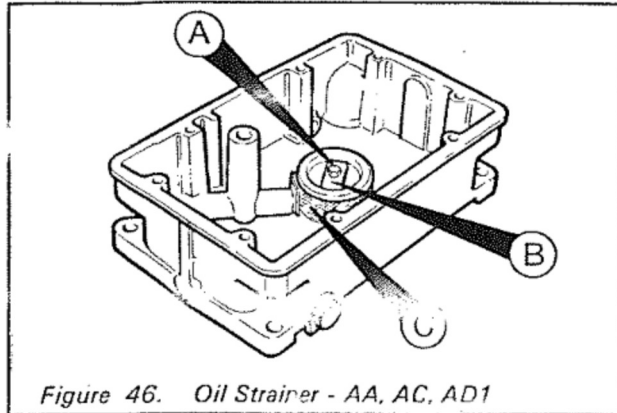
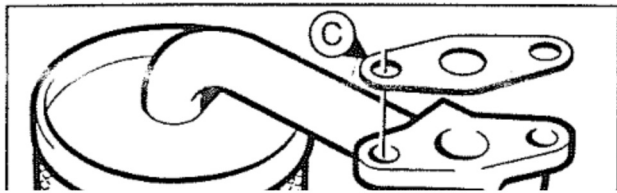


Figure 46. Oil Strainer - AA, AC, AD1

4. Clean the strainer using clean kerosene and allow it to drain.
5. Locate the strainer in the sump making sure it is correctly seated.
6. Fit the strainer clip and centre bolt, making sure that the concave side of the clip holds the strainer.
7. Renew the sump gasket and fit the sump.

Cleaning the Strainer - AD2

1. Drain and remove the sump.
2. Remove the two bolts (A) from the crankcase.
3. Remove the strainer assembly (B) and the flange gasket (C).



5. Fit a new flange gasket.
6. Locate the strainer flange and replace the two retaining bolts taking care to tighten them evenly.
7. Renew the sump gasket and fit the sump.

THE OIL PRESSURE RELIEF VALVE

A pre-set ball type oil pressure relief valve is fitted at the side of the pump and should not require adjustment. If it is dismantled extreme care must be taken to check the number of turns necessary to remove the adjusting screw, so that it can be returned to its original position on assembly.

The position of the relief valve is shown in Figure 33 on page 29.

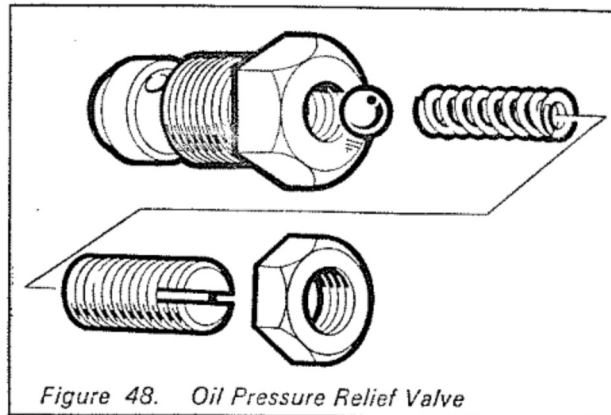


Figure 48. Oil Pressure Relief Valve

Section 3 - The Lubrication System

THE OIL FILTER

The oil filter is mounted inside the crankcase at the gear end and consists of a detachable cover containing the element which is secured by a centre bolt into the crankcase.

Removing the Filter

1. Unscrew the centre bolt (A) and withdraw the filter cover (B) and the element (C).
2. Clean the cover and chamber.

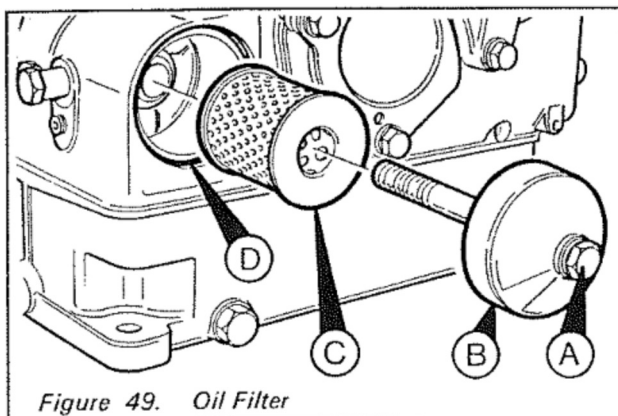


Figure 49. Oil Filter

Refitting the Filter

No attempt must be made to clean the filter element.

1. If necessary fit a new seal (D).
2. Fit a new element into the crankcase and replace the cover.
3. Tighten the centre bolt to a maximum torque loading of 13.6Nm (10.0lbf ft.).

THE CYLINDER HEAD OIL FEED

An external pipe, secured by $\frac{1}{2}$ inch swivel union plugs torque loaded to 14.0Nm (10.0lbf ft), carries lubricating oil from the internal oil gallery to the cylinder head valve rockers.

A lip type oil seal is fitted to the gear end cover and the main bearing housing. The fitting of lip type oil seals is described in "End Cover Oil Seal" on page 28.

The lip seals used must be the approved type as supplied by Lister-Petter and are fitted without any jointing compound being applied. Ordinary rubber seals may quickly harden in use, rapidly wear the shaft, or not even seal on fitting.

A lip type seal will not seal if the shaft is scratched or bruised within 5mm (0.20in) either side of the path of the lip of the seal. A finely and accurately ground shaft without chatter marks and with a surface finish of 0.4 microns Ra (16 micro inches CLA) maximum is advisable and it is essential to check that no damage has taken place during transit or servicing. Emery cloth of any grade must not be used in the area of the lip. Very fine scratches should be corrected by polishing the working surface with a wet mixture of metal polish and optical aluminium oxide powder, failing this domestic scouring powder may be used. To rub the shaft, a strip of rag some 400mm long by 50mm wide should be folded lengthwise and made into a 10mm belt. Wet the belt with the abrasive mixture, wrap once right around the shaft and use it with a reciprocating motion.

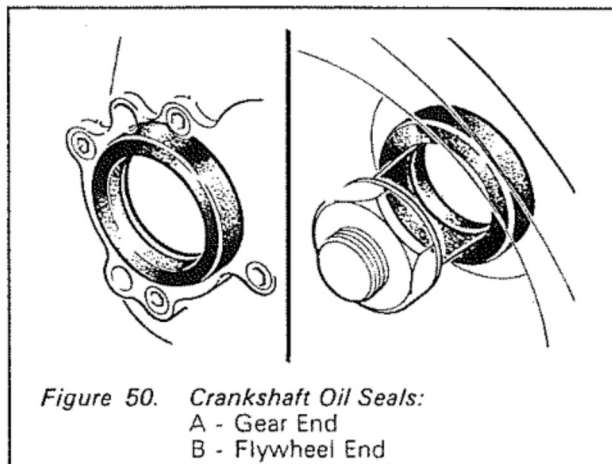


Figure 50. Crankshaft Oil Seals:
A - Gear End
B - Flywheel End

Flywheel End Oil Seal

When fitting the flywheel end oil seal ensure

Section 4 - The Fuel System and Governor

The Fuel System

FUEL SPECIFICATION

The Fuel Specification is given in the Operators Handbook - 027-08183.

PRECAUTIONS

- When priming or checking the fuel pump timing, care must be taken to wipe spilled fuel from the outside of the engine.
- Always fit a new joint when a union has been disturbed.
- Special care must be taken to see that there is no leakage from the joints of the fuel pipe connection to the pump.
- When tightening or loosening the fuel pump delivery pipe connections use two spanners to prevent slackening the pump delivery valve union.
- When refitting the fuel pipe from the pump to injector the connection to the injector must be tightened before the connection to the fuel pump. This procedure will ensure that there is no leakage from these joints.
- It is most important that all fuel joints are tight and leakproof.
- Always fill the fuel tank through a fine strainer, preferably at the end of the engine work period. If any sediment is stirred up during the process this has time to settle before the engine is used again. If cans are used, avoid tipping out the last few drops.

DESCRIPTION AND OPERATION

The fuel injection equipment is manufactured to very fine limits and requires extreme care and absolute cleanliness in handling. All orifices on any part of the fuel system that is removed from an engine must be sealed, failing this the item should be placed in a clean container containing clean fuel.

The fuel system comprises a fuel tank, fuel filter and a fuel injection pump and injector. Fuel is supplied from the tank via a filter to the pump through a flexible pipe and by a rigid pipe from the pump to the injector. The leak-off from the injector is fed through an external pipe back to the tank or to the inlet side of the filter when the system is fitted with a remote tank.

FUEL INJECTION EQUIPMENT

The fuel injection equipment fitted to the engines is identified in the relevant Parts List

AA1 - 027-08097.
AC1 - 027-08096
AD1 - 027-08099
AD2 - 027-08100

THE FUEL TANK

Engine mounted tanks are fitted at the gear end of the engine and will be supported on studs and nuts or bolts and spacers.

Three fuel tanks are available:-

3.8 and 5.1 litres with an internal filter.
9.0 litres with a gauze strainer in the filler and remote mounted filter.

Removing the Fuel Tank

1. Drain the tank.