OVERHAUL MANUAL

FOR

JABIRU 2200 & 3300 AIRCRAFT ENGINES

DOCUMENT No. JEM0001-15

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This Manual has been prepared as a guide to correctly overhaul Jabiru 2200 & 3300 aero engines.

It is the owner's responsibility to regularly check the Jabiru web site at www.jabiru.net.au for applicable Service Bulletins and have them implemented as soon as possible. Manuals are also updated periodically with the latest revisions available from the web site. Failure to maintain the engine or aircraft with current service information may render the aircraft un-airworthy and void Jabiru's Limited, Express Warranty.

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Should you have any questions or doubts about the contents of this manual, please contact Jabiru Aircraft Pty Ltd.

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2 General Information

WARNING:

Jabiru Aircraft Pty Ltd has devoted significant resources and testing to develop the Jabiru aircraft engines. These engines are intended to be installed in accordance with the details given in the appropriate Jabiru Engine Installation Manual. Any other uses or applications may be extremely hazardous, leading to property damage, or injury or death of persons on or in the vicinity of the vehicle. Jabiru Aircraft Pty Ltd does not support the use of this engine in any applications which do not meet the requirements of the appropriate Jabiru Engine Installation Manual. Any non-compliant installation may render the aircraft un-airworthy and will void any warranty issued by Jabiru.

The Jabiru Aircraft Engines are designed to be operated and maintained only in strict accordance with the appropriate Instruction and Maintenance Manual. Any variation of any kind, including alteration to any component at all, whether replacement, relocation, modification or otherwise which is not strictly in accordance with these manuals may lead to dramatic changes in the performance of the engine and may cause unexpected engine stoppage, engine damage or harm to other parts of the aircraft to which it may be fitted and may lead to injury or death. Jabiru Aircraft Pty Ltd does not support any modifications to an engine, its parts, or components. Any such actions may render the aircraft un-airworthy and will void any warranty issued by Jabiru.

Maintenance and modification cannot be supervised by the manufacturer. Maintenance requires extreme cleanliness, exact parts, precise workmanship and proper consumables. It is your responsibility to ensure absolute attention to detail no matter who may become involved in work on this engine. Your safety, your life and your passenger's lives rely on precise and accurate following of instructions in this manual.

In exchange for the engine manual provided by Jabiru Aircraft Pty. Ltd. ("Jabiru") I hereby agree to waive, release, and hold Jabiru harmless from any injury, loss, damage, or mishap that I, my spouse, heirs, or next of kin may suffer as a result of my use of any Jabiru product, except to the extent due to gross negligence or willful misconduct by Jabiru. I understand that proper skills and training are essential to minimize the unavoidable risks of property damage, serious bodily injury and death that arise from the use of Jabiru products.

2.1 List of Effective Pages / Issue Status

- This manual is revised as a whole. All pages retain the revision status of the overall document.
- Altered text is shown in red.
- In cases where the data contained in Appendix A is altered and the information in the main body of the manual is not an additional issue suffix will be applied: Issue 4-A1 indicates Issue 4 of the manual and Revision 1 of Appendix A. Whenever the main manual is updated this suffix is re-set

Table 1 – List of Approved Revisions

Issue	Reason for Issue
1	Initial Issue
2	Added notes re crankcase dowel fit, general update
3	2: Reading this manual section added. 3.6: Tool & gauge notes expanded. 4: Inspect before cleaning, 7/16" bolt details, oil return manifolds. 5.8: engine cooling notes added. 5.9: notes re flywheel screws. 5.10: oil return manifold notes. 5.11: barrel length notes, valve vacuum unit correction, pushrod length notes, hollow pushrod & rocker details. 5.15.2: new notes re fuel pump. 7.3: circlip notes, alternator installation notes.
4	Alter header. Add safety wire, hardware notes. Alter build book format. Create standard tables of torques, dimensions and clearances. Roller follower references added. Loctite 518 references added. Top valve spring washer inspection notes added. Rocker arm length note added. Flywheel dowel fit notes added. Reciprocating part weight limits added. 12-point 7/16" nuts added. Valve seat details altered.

Issue	Reason for Issue
5	Appendix A Tables Altered. Parts table updated. Table 13: spark plug gap removed. Pushrod cover circlip installation details added (Section 7.3.4 & Figure 192). Add certification basis notes (Section 2.4). Con rod installation altered (Section 7.1.3). Allowable compression side ring clearance altered (Table 12). Through bolt installation detail updated (Section 7.8, 7.3.3). Add details for series-wound alternator (Table 13). Update propeller flange installation details (Section 7.8.16 and 5.9.1.3). Add details for pistons with valve relief (Section 7.3.1, 7.8)
7	Ground run-in procedure checklist updated (Section 9.9.10) Corrections made to Mandatory check and Mandatory replacement items (Section 5.2) Corrections made to Mandatory Replacement Parts table (Appendix D) Firing order of distributor caps changed to be looking from flywheel end (Figure 199) Correction of upper limit main bearing clearance Table 12 Correction of build order for crankcase camshaft assembly 9.9.3 B Build Sheet Correction – Torque flywheel bolts in one step to value specified in Table 9
8	Corrections made to Mandatory replacement items Top End Overhaul (Section 5.3) Corrections made to Mandatory replacement items Full Overhaul (Section 5.2) Spark plug torque setting corrected (section 9.1) Corrections made to overhaul tools and equipment (Section 3.7) Change Oil pressure limits for Hydraulic Lifter engines (220-350 kPa) Add note to prime and install hydraulic lifters with side bleed hole facing up Correct Distributor firing order diagram (Figure 199) Change alternator stator screw thread locker to Loctite 263 (section 7.5.2) Change to Subassembly E Build Sheet – Flywheel, Ignition Coils, Starter Motor And Alternator Correct new build clearance tolerances (section 9.5) Add notes to Flywheel attachment procedure (section 7.8.7) Add note to Propeller Flange installation procedure (section 7.8.16) Reference to JEM0001 made in build sheets Update engine photographs (Figure 1 and Figure 2) Add alternator electrical load limit to section 9.6 Add note to check the valve rotates correctly on a set of collets (section 7.3.4) Correction to Update table, section 13.2
9	Oil specification changed (was MIL-L-22851 now obsolete) to SAE J-1899 Changes to Torque setting table made (Table 9) Additions to Top End Overhaul Mandatory replacement item table (section 5.3) Additions to Mandatory Replacement Parts Table (section 12.1) Add Crankshaft friction test procedure (section 4.4.2) Update to part history tables (section 13) Remove modified circlip pliars from Figure 21 Clarify distributor shaft procedure (section 7.8.6) Remove alternator dimension from Figure 147 Add laminated pole plates (Figure 149) 'Generic' Torque settings removed (Table 9) Note to install stud bolts with Loctite 263 added, no longer 620 (section 7.2.1) Fuel pump assembly revision (section 7.7.2) Add part in trouble shooting (section 8.5) regarding zero leak-downs when cold Revise rocker bush installation (section 5.11.8 and Figure 99)
10	Update instructions for flywheel attachment using Nordloc washers (section 7.8.7) Update to run-in sheet (section 9.9.10)
11	Add Double valve springs build tolerances (section 9.2) Correct carburettor setting table (section 5.15.1) Sealant only to be applied to O-ring and NOT on the cylinder face (section 7.8.1) Reference to circlip orientation (section 7.8.10)
12	Change alternator coil resistance range and include procedural specification report to refer to on measuring resistance (section 9.6) Update Build Tolerance and Maximum Allowable Clearances (section 9.2, 9.5) Add additional columns for engine run-in sheet Add clearances for Gen4 'Slotted Skirt' pistons Add Torque settings and means of identifying the difference between forged and billet machined conrods (section 7.1.4)
13	Edits to some mandatory replacement items (section 5.2 and 5.3) Add Broad lobe oil pump installation and clearance requirements Add requirement to apply bead of Loctite 518 around crankshaft before installing crank-gear
14	Added details about orientation of broad lobe oil pump. Remove oil pump clearances, qualification of overhauls oil pumps by oil pressure readings Warning regarding use of oil additives
15	Edit Table 10 Build Tolerances & Table 12 Wear Limits

2.2 Introduction

- This Engine Overhaul Manual has been written to cover the 4-cylinder 2200 and 6-cylinder 3300 Jabiru engines. Many engine components are common to both engines, for example the cylinders, pistons, connecting rods etc, as well as many accessories and consequentially the procedures in this Manual apply equally to both engines.
- Before attempting an overhaul the technician must be fully conversant with the appropriate Engine Instruction & Maintenance Manual and any relevant Service Bulletins, Service Letters or other manufacturer's data. Current information is available from the Jabiru Aircraft (Australia) web site – www.jabiru.net.au .
- Overhauls must only be carried out by an approved person. Depending on the country and the category of the aircraft this may be a Licensed Aircraft Maintenance Engineer, an RA-Aus Level 2 or equivalent. The responsibility for determining what qualifications are necessary to carry out an overhaul belongs to the person carrying out the work.

2.3 Applicability

- This manual is applicable to all 2200 and 3300 engine models and variants.

2.4 Certification Basis

- The 2200C engine is type Certified to the CS-22 Subpart H standard. Various 2200 and 3300 engine models also comply with the requirements of ASTM F2339.
- These standards are not equivalent to FAR 33 or CS-E: CS-22 Subpart H and ASTM F2339 are simplified engine design standards designed to be suitable for small aircraft with up to two seats certified using CS-22, CS-VLA or similar design standards.
- In all cases, participants in these categories accept that the aircraft, engines and propellers are not manufactured to the same standards as aircraft in normal categories and that different reliability expectations apply.

2.5 Reading This Manual

- If you are reading this manual on a computer and want to be able to quickly zoom in and out: Hold down the Ctrl key while rotating the wheel button on your mouse. In most programs this will instantly zoom in or out.
- To do the same thing on a modern laptop either plug in a wheel mouse as detailed above or use the built-in track-pad. Put two fingers on the pad close together then move then apart diagonally. To reverse, put two fingers on the pad at opposite diagonal points on the pad and bring them together diagonally. This works on most modern PC-laptops.
- This document has been created with hyperlinks between referenced items. So, when reading the manual on a computer you can click on the page number of an item on the table of contents and the computer will skip to that page. Also, if a paragraph says "refer to Section 5.9" – then you can click on the "5.9" and automatically skip to that page. Similarly, if Figures or Tables are referenced.
- To open a search window press "Ctrl-f". Depending on the program, this will normally open a small search window where you can enter keywords. For example, searching for the word "life" will allow you to quickly find all reference to lifed maintenance items.

2.6 Degree of Difficulty

- In this manual we have used a “spanner scale” to help overhaulers approach a job. Anyone considering undertaking a task in this manual must realistically assess themselves against this scale and not attempt any task for which they lack knowledge or the required tools.

Table 2 – The Spanner Scale

The Spanner Scale	Translation
	Simple, basic, straightforward. A careful layman, with guidance, can achieve this.
	Straightforward, but with some technical bits. Basic knowledge, care and guidance needed.
	Straightforward, but requires special tools, training and/or judgement. Sound basic knowledge guidance and a careful approach are required.
	A technical job. Take your time, double-check everything. Only for the experienced overhauler.
	A difficult job. Requires special tools, solid skills, good judgement. Only for experts.

2.7 Manual layout

- This Manual suggests that an engine overhaul will be conducted in three stages: *Disassembly*, *Inspection and assessment*, and *Assembly*. The intention is that an engine will initially be stripped and the mandatory replacement parts will be discarded. The remaining parts will be inspected and assessed for return to service and a single parts order will then be placed.
- Final assembly can take place once all the required parts are present.

2.8 Engine life

- Engine life is expressed here in cycles, with 1 cycle being nominally in the vicinity of 1,000 hours, the actual number of hours achieved being heavily dependent on the use of correct operating and maintenance procedures and, to a lesser degree, operating conditions.
- The expected life (expressed as time between complete overhauls) of a correctly operated and maintained Jabiru engine is 2 cycles, with a top end overhaul taking place at 1 cycle.
- Various components of the engine have a service life which is determined “on condition” – that is the overhauler must examine the part and make a judgement as to the part’s suitability for re-use. Other parts are evaluated both on condition and by a fixed maximum life – for example valves which are replaced around 1,000 hours (See Sections 5.1, 5.2 and 5.3).
- Engine life is measured via direct tachometer hour meters or “Hobbs” meters. Air switches or scaled hour readings based on cumulative power output are not to be used to determine when overhauls or services are due.

2.9 Complete overhaul, top end overhaul, wear tolerances

- While the overall thrust of this Manual is complete overhaul, distinction must be made between a complete overhaul and top end overhaul: the objective of a complete overhaul is to return the engine to a condition where it can be reasonably expected to achieve 2 cycles, while the objective of a top end overhaul is to return the top end of the engine (i.e. big ends, cylinders, pistons and cylinder heads) to a condition where it can be reasonably expected to achieve 1 cycle to take the engine to the next complete overhaul.
- Consequentially the allowable wear tolerances for a top end overhaul, which is intended to achieve 1 cycle, will be different to the allowable wear tolerances for a complete overhaul, which is intended to achieve 2 cycles.

2.10 Mandatory updates

- Jabiru has been producing engines for many years, and over that time we have made some improvements to our engine designs in light of operating experience. As a result we have compiled a list of mandatory updates that must be made to older engines during overhaul.
- During the Inspection and assessment stage these modifications will be addressed for each Subassembly.

- The requirements of these modifications must be taken into account when ordering parts.
- Section 10 refers.

2.11 Mandatory replacement of parts

- During overhaul (either complete or top end) some parts must be replaced regardless of condition: for example all bolts, all seals, O-rings, etc. Detailed listings will be found in the Inspection and assessment stage.

2.12 Recording

- Careful records of all overhauling work must be completed. It is strongly recommended that the overhauler print out the build sheets given as a part of this manual and use them to record all the details of the job.
- The overhaul booklets included in Section 9 are to be used for a top end overhaul – using only those pages relevant to the parts of the engine being renewed.

2.13 General Description

- The engines covered in this manual are all direct drive four and six cylinder, horizontally opposed, air-cooled models.

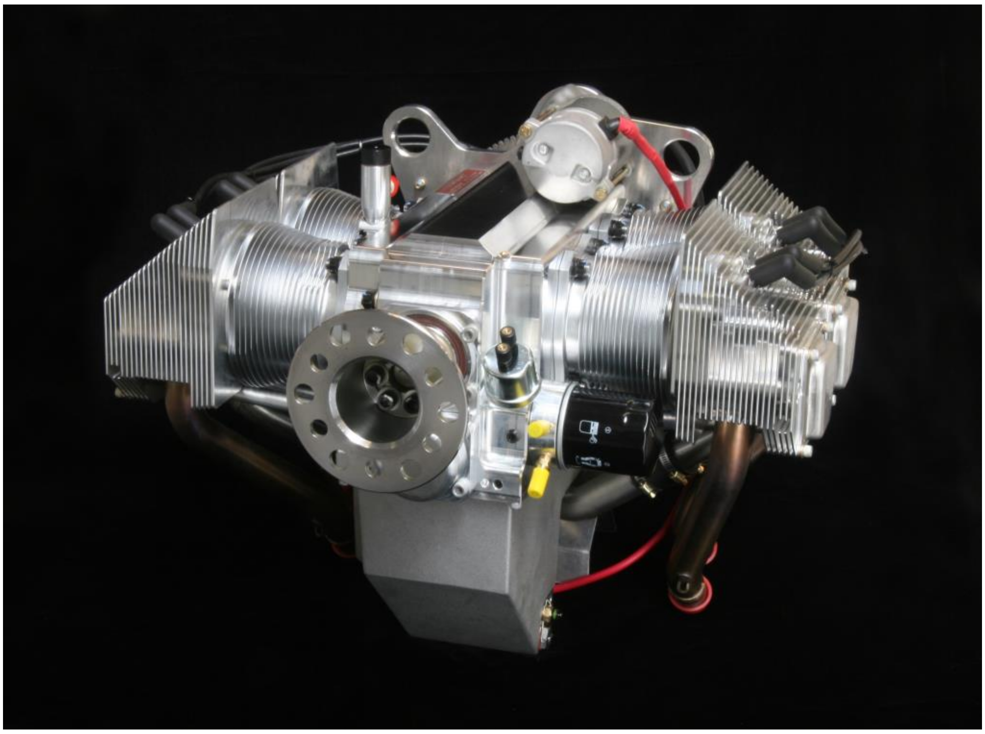


Figure 1 – 2200 Engine

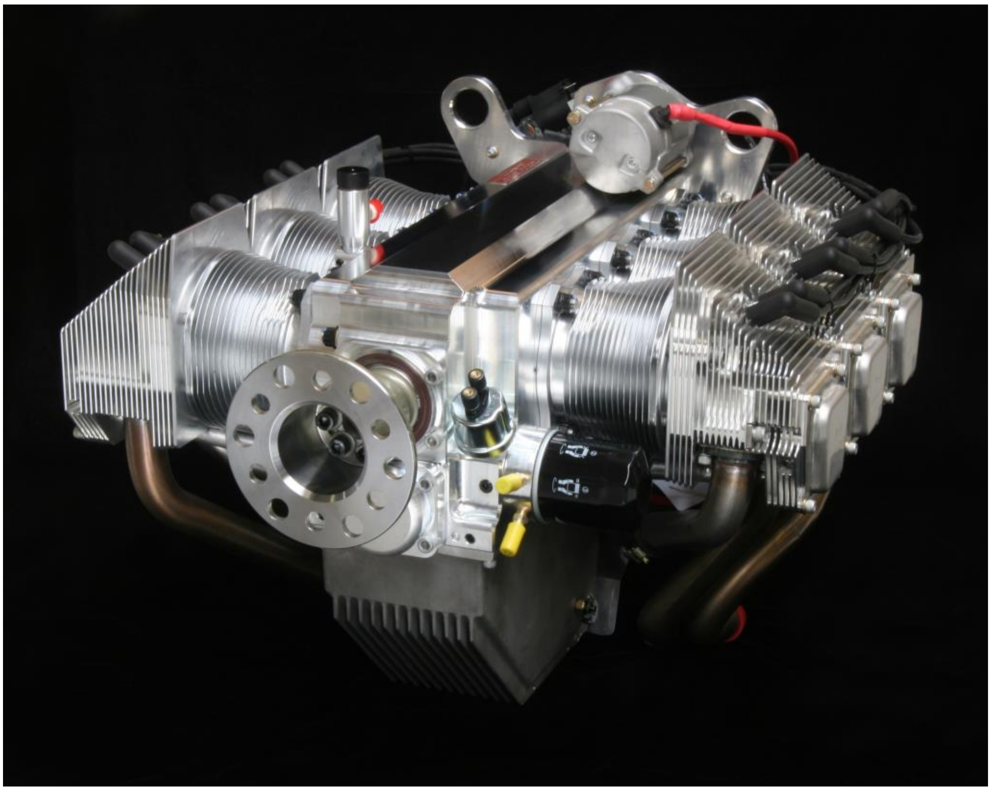


Figure 2 – 3300 Engine

2.13.1 Engine identification

- Engine serial numbers are located on the engine number plate that is affixed to the right rear top of the crankcase. An explanation of the cross-reference of engine numbers may be found in Section 13.1.

2.13.2 Build Configurations

- At many places in this manual a serial number range will be referenced with respect to an aspect of the engine build – i.e. S/No. 200 – 250 use a triple-flexed widget while engines outside that range have double-flexed widgets.
- In all cases this information refers to the configuration of the engine when it was originally built.
- In many cases this information will be changed – such as if the engine is upgraded to a newer configuration at overhaul. The overhauler must be aware of the potential for these changes and confirm the engine configuration before beginning re-assembly.

2.13.3 Part Identification

- Several components of the engines have been revised since the engines entered production. In some cases important differences between parts cannot be distinguished easily by inspection. In these cases identification markings have been applied to the parts. Where applicable, these markings will be shown and explained in the body of the manual below.

2.13.4 Cylinder Numbering Convention

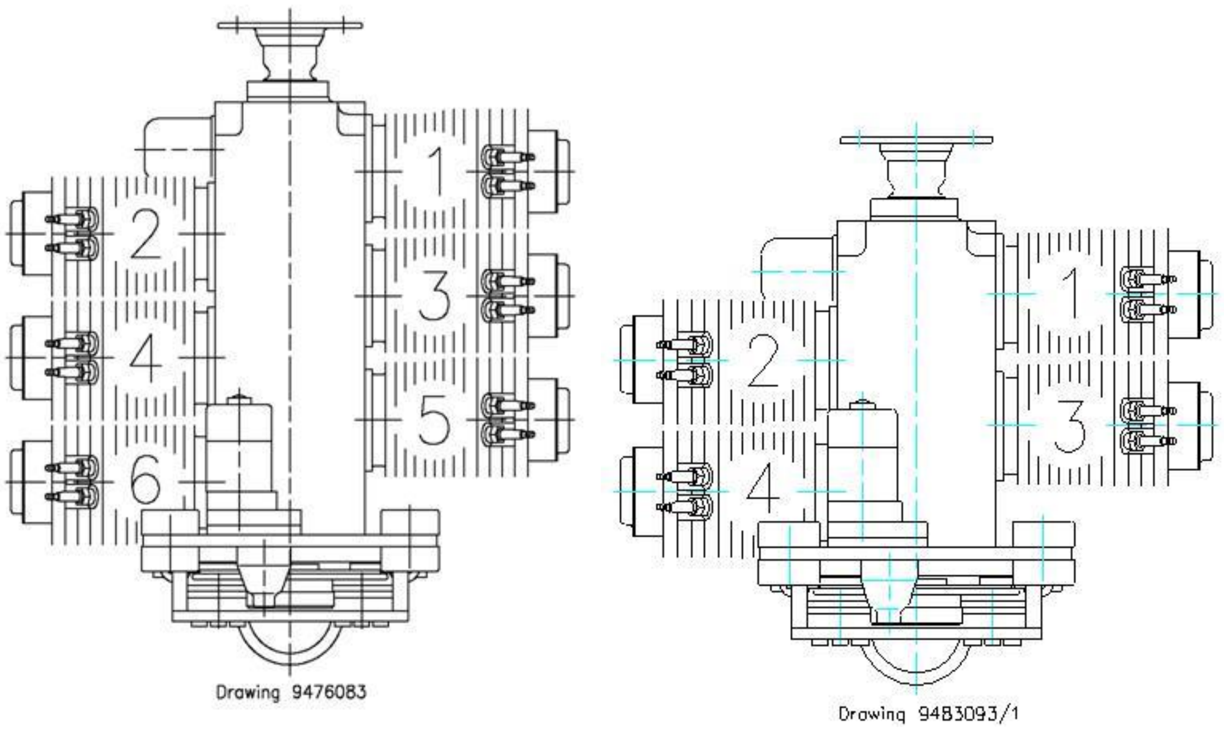


Figure 3 – Cylinder Numbering Convention

2.13.5 Cylinder heads

- The cylinder heads are machined from solid aluminium billet and are fitted to the cylinders by means of 6 retaining cap screws per head.

2.13.6 Valves, valve guides and seats

- Stainless steel valves run in press fitted aluminium/bronze valve guides and seat against nickel steel valve seats that have been shrunk fit into the cylinder heads.

2.13.7 Cylinders

- Cylinders are machined in one piece from solid bar 4140 chrome molybdenum alloy steel, with the pistons running directly in the steel bores.

2.13.8 Pistons

- The pistons are machined from aluminium castings and have 3 rings, the top 2 rings being cast iron to compliment the chrome molybdenum cylinder bores. The gudgeon pin (wrist pin) is of the full floating type and is retained by a circlip at each end.

2.13.9 Connecting rods

- The connecting rods are machined from solid bar 4140 chrome molybdenum alloy steel. They have replaceable bearing inserts in the crankshaft ends (big ends) and the piston ends (small ends) are machined to fit the gudgeon pin. The big end bearing end caps are fixed to the connecting rod by two Allen head cap screws through the rod into the end cap.

2.13.10 Crankshaft

- The crankshaft is machined from solid bar 4140 chrome molybdenum alloy steel and is stress relieved using a heat treatment process. The journals are precision ground prior to being inspected by the MPI (Magnetic Particle Inspection) method.

2.13.11 Crankcase

- The crankcase is machined from solid aluminium billet and consists of two halves divided along the vertical centreline and fastened together by the studs and nuts that retain the cylinders. The mating surfaces of the crankcase halves are joined without the use of a gasket, and the main bearing bores are machined for the use of automotive slipper type bearings. Thrust bearings are located fore and aft of the front double main bearing. The crankcase forms the bearings for the camshaft.

2.13.12 Camshaft

- The camshaft is machined from solid bar 4140 chrome molybdenum alloy steel and is hardened using a nitriding process.

2.13.13 Valve operating mechanism

- The camshaft is gear driven from the crankshaft. The camshaft operates cam followers that operate the valves though pushrods and valve rocker arms. The valve rocker arms are made from steel, induction hardened and mounted in the cylinder heads on steel shafts through low friction bronze/steel bushes.

2.13.14 Solid lifters

- 2200 and 3300 engines earlier than serial number [22A-2068] or [33A-961] utilise solid lifters driven by a 330° camshaft.

2.13.15 Hydraulic lifters

- 2200 and 3300 engines from serial number [22A-2068] or [33A-961] use hydraulic lifters.

2.13.16 Roller Followers

- 2200 and 3300 engines from serial number [22A-3596] or [33A-2539] use hydraulic lifters with roller bases.

2.13.17 Lubricating system

- All engines employ a full pressure wet sump lubrication system. A positive-displacement pump driven from the front of the camshaft provides oil pressure, and oil is circulated to the oil galleries through a spin-on automotive type oil filter. An adaptor fitted beneath the oil filter feeds oil to the oil cooler.
- The primary lubrication sections of the engine – crankshaft, big ends etc – use this full pressure lubrication system. Secondary lubrication sections of the engine such as the cylinder heads and gearbox use low pressure lubrication systems while tertiary lubrication sections such as piston/bore lubrication uses splash lubrication.

2.13.18 Cooling system

- Cooling is provided by air pressure that is built up above the cylinder heads in the ram air ducts and discharged, with an accompanying pressure drop, down through the cooling fins on the cylinder heads and cylinders and out of the lower rear of the engine cowling.

2.13.19 Induction system

- All engines are equipped with a BING brand pressure compensating float type carburettor. The inlet manifold is mounted in direct contact with the engine oil sump, thus providing a relatively constant temperature in the manifold for more uniform vaporisation of fuel. Fuel-air mix is distributed from the manifold to the cylinder heads by individual tubes.

2.13.20 Ignition system

- Dual transistorised ignition is provided by two flywheel mounted rare earth magnets that energise two fixed coils mounted adjacent to the flywheel. The resulting high-voltage current is distributed to the spark plugs by two gear driven distributors and associated high tension leads. The ignition system has fixed timing and is fully redundant, self-generating, and does not depend on battery power for operation. Spark is not generated below 275rpm crankshaft speed.

2.13.21 Electrical charging system

- An integral alternator, using rare earth magnets, provides alternating current for battery charging and powering electrical accessories. The alternator is attached to the flywheel and is driven directly by the crankshaft. The alternating current goes to a firewall-mounted regulator and thence to the aircraft electrical system.

2.13.22 Starter motor

- The 1.5kw starter motor is mounted to the engine mounting plate at the left rear of the engine with the drive gear positioned above and ahead of the flywheel when not engaged.

2.13.23 Sump

- The engines are equipped with a wet sump lubrication system. The sump is a cast aluminium item fitted to the underside of the engine and also provides the mounting points for the induction system and oil cooler.

2.14 Assessing An Engine

- While not intended as a complete guide, the overhauler must be aware that the following factors will affect the service life of an engine. With familiarity the overhauler will be able to look at an engine on receipt, assess it and have an excellent idea of what will need to be done and what has caused any issues. For example:
  1. Overheating causes higher than normal oil consumption.
  2. Hydraulic engines prior to oil fed rockers (hollow pushrods) have higher wear in rocker bushes.
  3. Non adherence to published bulletins will shorten engine life. It is essential that operators keep up-to-date with all updated Jabiru Service information.
  4. Operation with defective valves (partially sealing valves) will end with structural failures and expensive repairs.
  5. Operation with poor quality or incorrect fuel will cause problems.
  6. Oil/fuel additives are not to be used; some have proven to have highly detrimental effects on engines.
  7. Incorrect load (propellers) will shorten engine life.
  8. The installation and matching of the engine and propeller to the aircraft are absolutely essential for getting the best out of Jabiru Engines. Guidance material is available in the Jabiru Engine Installation Manuals and Instruction & Maintenance Manuals.

3 General overhaul procedures

3.1 Manual layout

- This manual is intended for use by experienced technicians and while all processes will be explained as clearly as possible, some knowledge is assumed. This manual is not intended to be sufficient reference for a person with no other training to safely complete an overhaul.
- The sections of the Manual are arranged in the stages in which work will be performed: the engine is stripped, all components are either discarded (mandatory replacement items) or cleaned then inspected and assessed for return to service and parts are ordered then the engine is assembled and finally tested and run-in.
- This Manual will describe the overhaul procedures by individual Subassembly of the engine, thus dividing the manual, for all practical purposes, into a series of individual handbooks dealing with each Subassembly in turn.
- The disassembly stage will be described in a slightly different sequence from the Subassemblies used in the Inspection and assessment and Assembly stages.
- Many of the photographs throughout this Manual are of a 2200 engine – the procedures used are common across Jabiru 4 and 6 cylinder engines, the only difference being the number of cylinders.
- Since there are various overhaul practices and instructions of a non-specific nature, such as cleaning and inspection, which apply equally to all basic engine components, these general instructions will be grouped together where possible, to avoid repetition.

3.2 Directional References

- In all references to orientation such as "the front of the engine" it will be assumed that the engine has been installed in a tractor configuration and "front" refers to the propeller end of the engine while "rear" refers to the flywheel end of the engine. "Left hand" and "right hand" refer to the same orientation when standing behind the engine facing towards the front of the engine.

3.3 Top End Overhaul vs Full Overhaul

- While the overall thrust of this Manual is complete overhaul some sections can also be applied to a top end overhaul.
- A top end overhaul means overhauling only the "top end" of the engine: big ends, cylinders, pistons and cylinder heads. If a top end overhaul is being conducted then only those items listed in Section 5.3 should be removed from the engine during the engine strip procedure.
- Note that greater wear tolerances may be used for a top end overhaul than would be used for a complete overhaul as a top end overhaul is only required to achieve a life of 1 cycle, taking the engine through to the next complete overhaul, whereas a complete overhaul is intended to return the engine to a state where it can be expected to achieve a life of 2 cycles.
- As for disassembly, on assembly only certain sections of this manual are relevant for a top end overhaul. These are detailed in Section 6.

3.4 Special Classes of Overhaul

- The following section discusses unusual cases, where an engine is presented to the overhauler where something other than normal operation has taken place.
- In general the procedures for dealing with these are the same as those for a normal overhaul, however the overhauler must be particularly alert and vigilant for unusual features within the engine. For example, during a severe prop strike the engine mount plate is often bent – sometimes only slightly – and this sort of damage may be missed if the inspection process is in any way lax.

3.4.1 Bulk Strip

- A Bulk Strip is a special class of procedure where an engine is pulled apart, inspected and then put back together again – generally using all the same components. It is generally called for when something has happened to put the internal condition of the engine into doubt – such as a propeller strike, in-flight failure or improper long term storage.
- In its purest form a bulk strip will not affect the life of the engine – so an engine which has a bulk strip at a time in service of 700 hours will still only have 300 hours left to run after the bulk strip has been completed and the engine re-assembled. However, often the customer will decide to incorporate a mini-overhaul or top-end into the bulk strip.

- The point of the bulk strip is to check several critical items inside the engine to ensure that it is suitable to be returned to service. Depending on what has happened to the engine some parts will mandatorily be replaced.
- In addition to the potential damage to the engine which required the bulk strip in the first place it is Jabiru policy that the engine must be made up-to-date and airworthy before being re-assembled. This means that items which are listed as a "Mandatory Update" within this manual must be carried out during a bulk strip as they would be during an overhaul. For example a crankshaft which has no flywheel dowels must be updated to accept them or replaced by a new assembly during a bulk strip.

3.4.1.1 Bulk Strip Checklist

- Personnel carrying out a bulk strip must be qualified to the same degree as those carrying out a full overhaul.
- The tools, equipment, sealants and compounds used in the bulk strip are the same as those used for a full overhaul – the person carrying out this work must have all available.
- Measure crankshaft and propeller flange run-out before disassembling the engine to help gauge the potential severity of the damage to the engine. Use the procedure detailed in Section 4.4.1.
- Engine strip and cleaning are the same as detailed in Section 4.
- Check for mandatory updates as detailed in Section 4 and replace / rework parts as necessary.
- Re-measure crankshaft and propeller flange run-out on the bench for best accuracy.
- MPI test the propeller flange, crankshaft and connecting rods.
- Replace all screws used in the propeller flange, flywheel and connecting rod attachments.
- Replace O rings and gaskets as required.
- Replace piston circlips with new parts
- Assembly of the engine is as detailed in Section 7.
- Fill out engine build sheets.
- Carry out engine test runs
- Carry out post-run inspections.
- Complete a report for the customer, detailing what was found in the engine and which parts were replaced.

3.4.2 Propeller strike procedures

- Propeller strike is categorized as being one of 2 types: low power strike and high power strike.
- A low power strike is defined as a propeller strike encountered while the engine is operating at a low power setting (eg. while taxiing) with a standard Jabiru softwood propeller. Damage to the propeller must extend no more than 100mm inwards from the blade tips. If any of these parameters are not met the event is considered to be a high power strike.
- High power strikes also include any other type of abrupt engine stoppage at any other engine operating condition.
- The flywheel retaining cap screws (6) and propeller flange retaining screws (6) need to be replaced after any prop strike.

3.4.2.1 Low Power Prop Strike Checklist

- The flywheel retaining cap screws (6) and propeller flange retaining screws (6) need to be replaced after any prop strike.
- If a low power strike has been encountered then crankshaft runout must be checked as detailed in Section 4.4.1 and if necessary the propeller flange and/or the crankshaft may need to be replaced.
- When replacing the flywheel and propeller flange cap screws remember that they are held in place with Loctite 620, which is very strong. They will be very difficult to undo and great care must be taken not to break any of them. Lock the crankshaft from turning and then apply heat to the area around the cap screws, and then try to crack each cap screw loose using an Allen key and a 3/8" breaker bar. This step may involve heating the end of the crankshaft several times until you can safely undo each cap screw. Details on removing these screws are included in Section 4.5.4. The procedure to be used for replacing the screws in the propeller flange is the same.
- Do NOT apply heat directly to the cap screws because this could weaken the screw material, but rather apply the heat to the area around the cap screws. This is particularly important because you will need to apply considerable turning force to undo each cap screw.

- Clean out all threads and then prime the threads and the new cap screws with Loctite 7471 cure accelerator and allow to dry. Apply a few drops of Loctite 620 Retainer to each thread and each cap screw and tighten in sequence to the recommended torque value from the table of limits. Section 7.8 details the assembly of the flywheel and propeller flange to the engine – these procedures are also to be used here.

3.4.2.2 High Power Strike Repair Checklist

- Jabiru policy for a high power strike is to Bulk Strip in accordance with Section 3.4.1.1: Disassemble, clean and inspect the engine updated. Re-assemble the engine, complete build sheets, test run, carry out a post-run inspection and complete a report for the customer.
- In particular, carefully check that the engine mount plate has not been bent, check the propeller flange for condition and straightness and inspect the flywheel connection for damage. Replace the crankshaft and MPI inspect the connecting rods. Check and carry out any mandatory updates.

3.4.3 Abrupt Engine Stoppage

- An abrupt engine stoppage may be caused by a number of different failures within the engine but essentially any hard, harsh stoppage of the engine is considered to fall into this category. A piston failure is a typical example.
- Abrupt engine stoppages are treated the same as high power propeller strike.

3.5 Sequence of Events

1. **Engine Build Sheet / Checklists** – fill out the necessary documents to record the details of the engine. Prepare the necessary sheets to record the configuration / condition of the engine as it is disassembled, cleaned and inspected.
2. **Disassemble** – disassemble the engine to the extent necessary for the proposed work – i.e. the top end only for a top end overhaul or completely for a full overhaul.
3. **Clean, Inspect, Measure And Assess** – clean the engine components, measure wear items and assess the engine's parts for re-use. Inspect parts as required (i.e. visual or Magnetic NDT processes). Refer to the mandatory replacement list given in Section 5 and if applicable, remove and quarantine any superseded components. Refer also to all the supplementary data applicable to the engine – such as Service Bulletins and Service Letters. This step is critical for the overhauler to assess the overall condition of the engine.
4. **Assemble** – Re-assemble the engine.
5. **Test Run** – A proof run and then running-in is necessary before the overhaul is considered complete. Running-in may be carried out in the air or, preferably, on a specialised ground-run stand using special oversized cooling ducts and oil cooler.
6. **Record** – The records of the overhaul must be completed, including lists of parts replaced and the records of the run-in (temperatures, pressures etc).

3.6 Maintainer Requirements

- The following are recommended as the minimum requirements for someone carrying out routine maintenance and inspection on Jabiru Engines.

3.6.1 Facilities

- An enclosed workspace with a sealed (i.e. not dirt) floor, adequate lighting, provision of compressed air and mains electricity. A clean, dust controlled area is required for heavy engine maintenance.

3.6.2 Training

- Completion of an approved instruction course specific to Jabiru Engines. Approved courses include those offered by Jabiru Aircraft Australia or by local Jabiru Aircraft representatives however completion of these courses does not guarantee competence. Jabiru training does not override requirements of the local Airworthiness Authority.

3.6.3 Rating

- Commercial maintainers must hold suitable ratings as required by their local Airworthiness Authority.

3.6.4 Experience

- A minimum of 1 years' experience working on Jabiru Engines under supervision is recommended for commercial maintainers before working un-supervised and before undertaking Top End Overhauls, Total Overhauls, Bulk Strips and other heavy maintenance.

3.7 Overhaul Tools & Equipment

3.7.1 Tool & Gauge Control

- Tool and gauge control is an important part of aviation maintenance systems. Tools and gauges must be accurate enough for the intended use (i.e. you would not use a 12" steel ruler to measure the cylinder bore diameter) and be accurately calibrated – for example by an approved laboratory.
- Calibrations must be kept up to date. This means a check calibration every year or more frequently for regularly used, critical tooling.
- Even quality equipment will wear over time so items like reams, go / no-go gauges and valve seat cutting tools must periodically be checked to ensure they remain within limits.

3.7.2 Tools:

Access to the following tools will be required:

- Allen keys: 1/4", 5/32" 3/16" and 3/16" ball end in regular 3/8" drive and "T" handle
- Circlip pliers (internal)
- Crowsfoot: 2" in regular 3/8" drive: 7/16", ½"
- Hydraulic lifter tool (hydraulic lifter engines only) refer to the drawing in the appendix
- Pliers: long nose, regular square jaw, side cutters
- Ring/open end spanners: 5/16", 3/8", 7/16", 1/2", 9/16", 10mm, 17mm
- Ratchet 3/8" drive, breaker bar, 2" extension bar, 3/8", 7/16", 1/2" sockets, 7/16" tube socket, 18mm spark plug socket
- Screwdrivers: flat blade and Phillips head in various sizes
- Feeler gauges: metric and imperial sizes
- Torque wrench: 3/8" drive, "name" brand (Snap-On, Warren & Brown etc), recently calibrated

3.7.3 Equipment:

Access to the following equipment will be required:

- Bench vice with padded jaws
- Calipers: must read up to 180mm
- Degreasing/cleaning system with solvent/solution containment/recycling
- Degree wheel
- Dial indicator and magnetic stand, vee blocks
- Hand press

- Heat gun or small butane/propane torch with a soft pencil flame
- Micrometer and internal measuring tools, must read up to 100mm
- Multimeter or an ohmmeter
- Spring scale: must read up to 2.5kg in 0.1kg increments
- Thread taps: 1/4", 5/16”, 3/8” UNF and UNC
- Valve seat cutters: 30°, 45° and 60°
- Valve spring compressor, motorcycle type or a ‘G’ clamp with a machined spring cup

3.7.4 General:

- Bearing blue, sometimes referred to as Prussian blue
- Brass drifts, punches, rags, soft mallet, hammers
- Greases: molybdenum disulphide, general purpose
- Loctite compounds: 242/243/262 ThreadLocker, 515 Sealant, 620 Retainer, 7471 Cure Accelerator
- Lubricants: engine oil, Nulon L90
- TorqueSeal brand security marking compound

3.7.5 Recommended Sealants Compounds & Lubricants

Figure 4 – Sealants, Compounds & Lubricants #1

- Loctite 7471 Cure Accelerator - Loctite 7471 is used where increased cure speed of Loctite anaerobic products is required. 7471 is particularly recommended when prevailing temperature is low (<15 °C). Used as a surface prep when very high quality fitting of screws is required.
- Nulon Extreme Pressure Anti-Seize Lubricant (L90) offers extremely high film strength and adhesion to protect moving parts against friction, wear and seizure in all types of extreme conditions. Used to lubricate parts during assembly, initial start and running.

Figure 5 – Sealants, Compounds & Lubricants #2

- Loctite Gasket Maker 515 Flange Sealant is a flexible, gasketing material for use on rigid machined flanges with less than 0.015"gap.
- Loctite Gasket Sealant #2 is a black, reliable, paste-like gasket sealant, dressing, and coating. Sets more slowly to a pliable film best suited for non-rigid, vibrating assemblies. Used on the induction manifold.
- Bearing Blue – a high colour marking aid which spreads very easily, does not clog or dry out.

Figure 6 – Sealants, Compounds & Lubricants #4

- Loctite C5-A Copper-Based Anti-Seize Lubricant. Prevents corrosion and seizure in high temperature environments; up to 1800ºF (980ºC), most commonly used on spark plugs, exhaust bolts, cylinder head bolts.
- Torque Seal F900 anti-tamper compound. Used to mark screw heads, nuts and washers. After setting becomes brittle so that any movement between these parts is clearly indicated by cracking in the Torque Seal. Used on many fasteners on the engine and aircraft, including engine through-bolt fasteners.

Figure 7 – Sealants, Compounds & Lubricants #4

- Loctite Gasket Maker 515 Flange Sealant is a flexible, gasketing material for use on rigid machined flanges with less than 0.015"gap.
- Loctite Gasket Eliminator 518 Flange Sealant forms a flexible, solvent-resistant seal that will not tear or decay. Seals to 300 °F and fills gaps to 0.50". It can be used on flexible metal assemblies, including aluminum surfaces.
- Rubber grease – used to initially fill seals and lubricate rubber parts on assembly – though Nulon L90 is preferred and generally more effective.
- High-temp grease – used to give initial start-up lubrication to many parts of the engine, including the oil seals.
- “Cam Honey” (Molybdenum Disulphide) for cam journals and lobes.

3.8 Loctite 620 & Other Retaining Compounds

Figure 8 – Sealants, Compounds & Lubricants #3

- Loctite 620 is designed for the bonding of cylindrical fitting parts. Typical applications include locating pins in radiator assemblies, sleeves into pump housings and bearings in auto transmissions. Particularly suitable for applications where temperature resistance up to 200°C is required. Used as an ultra-strong threadlock. Loctite 620 is specified in several places in Jabiru Engine assembly where a reliable bond is essential. When using it, follow the rules below:

WARNING

Failure to use Loctite 620 correctly can result in engine failure

- **Check use-by dates.** Loctite 620 (like most other compounds used on the engine for sealing etc) has a use-by date. Generally this is not printed on the bottle but can be found by contacting the distributor and telling them the batch number.
- **Work fast.** Loctite 620 can cure very quickly. All screws must be torqued to final settings as quickly as practical. Anything more than a minute is not recommended, particularly if cure accelerator spray (Loctite 7471) is used.
- **Only use as much as required/specified.** Excess compound can make it nearly impossible to disassemble the parts later.
- **Surface preparation is critical.** Threads must be cleaned and prepared properly.
- **To Remove.** Can normally be achieved by heating the screw to over 150°C using a pencil-point gas burner. Minimise direct heat applied to the head of the screw as this can weaken the drive socket – direct heat towards the thread as must as possible.

- Loctite 263 is designed for the permanent locking and sealing of threaded fasteners. Typical applications include the locking and sealing of large bolts and studs (up to M25). A high strength threadlock.
- Loctite 243 is designed for the locking and sealing of threaded fasteners which require normal disassembly with standard hand tools. Particularly suitable for applications on less active substrates such as stainless steel and plated surfaces, where disassembly with hand tools is required for servicing. A medium-strong threadlock. Typically used for cap screws into castings or Aluminium.

3.8.1 Special Tools

- Special tools can simplify the process and are shown in the photos below.

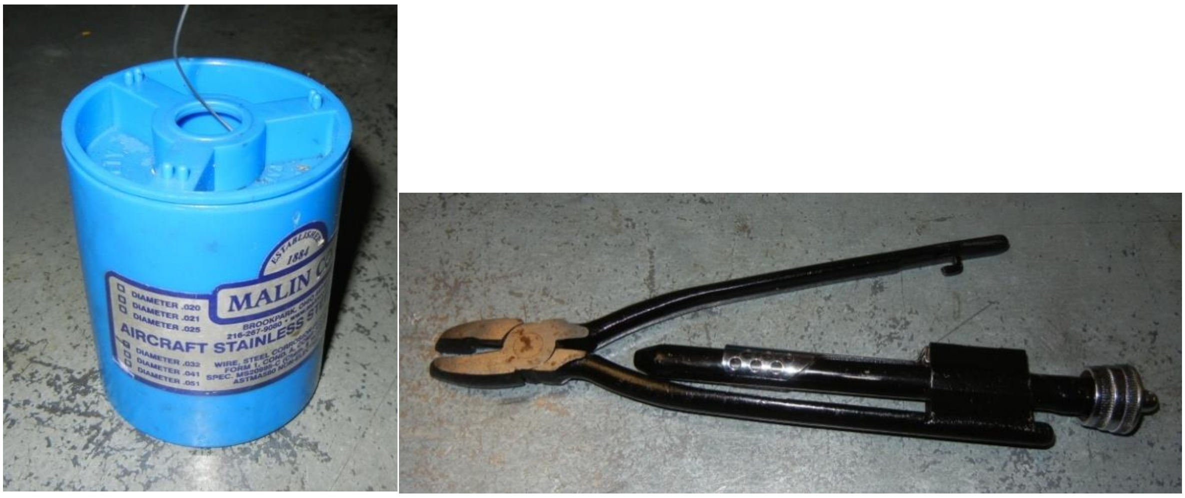


Figure 9 – Safety Wire / Wire Pliers

- Wire used to secure items (nuts, bolts etc) to prevent rotation in service.

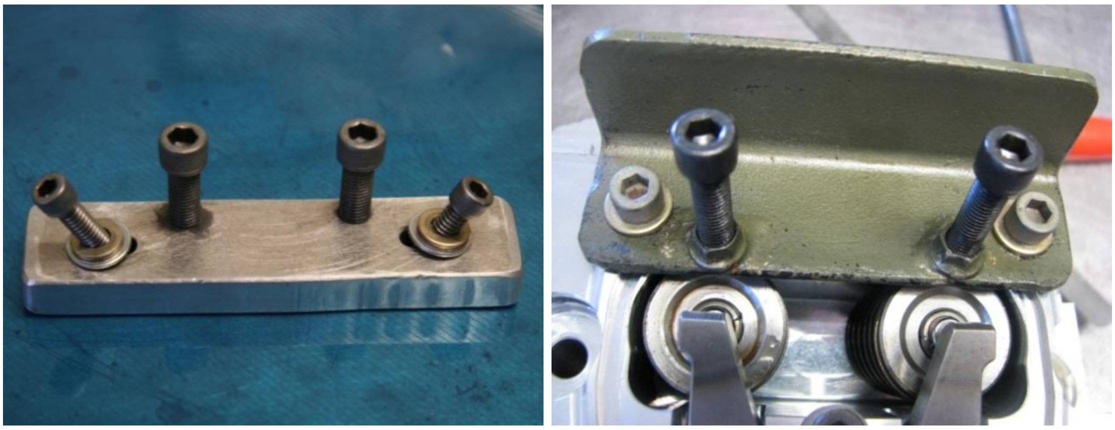


Figure 10 – Valve Compressor / Lifter Bleed Tools

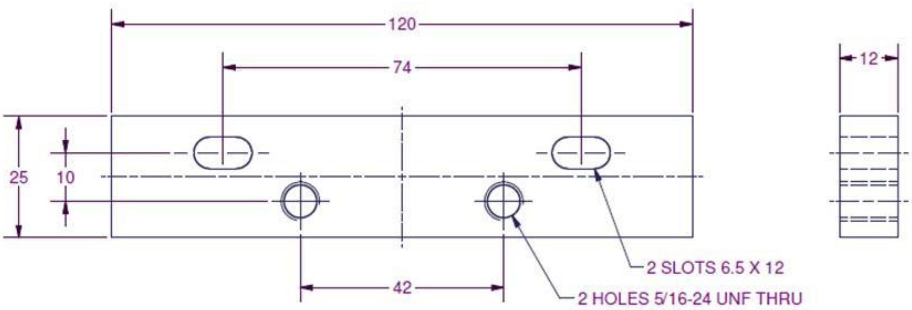


Figure 11 – Dimensional Details For Lifter Tool

- Used to compress the valve springs, allowing the rocker shaft to be removed and the hydraulic valve lifters to be bled.

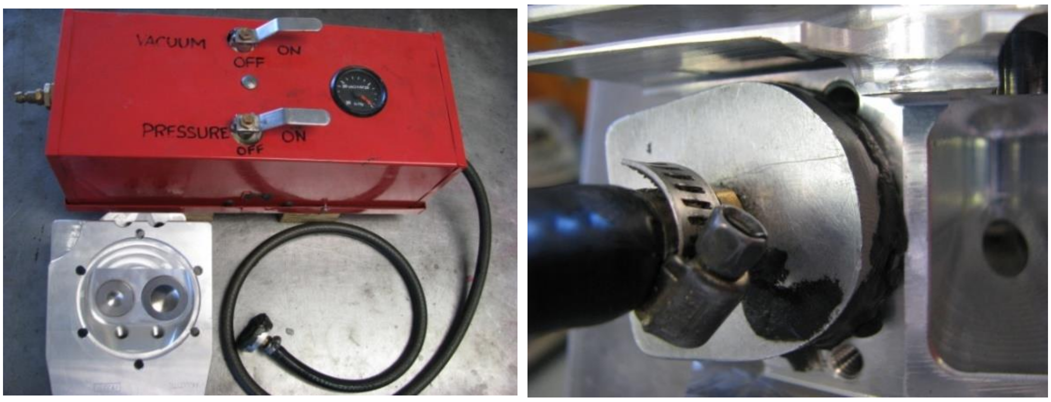


Figure 12 – Valve Leakage Vacuum Tester

- Connected to an air compressor generates a vacuum which is applied to the valve (while closed) to check for a poorly-sealing valve / seat. See Section 5.11.5 for details of use.

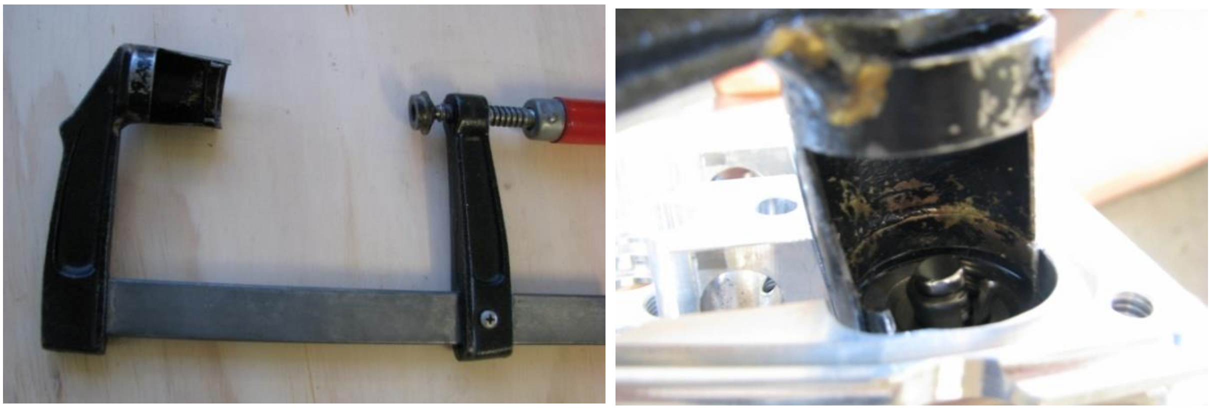


Figure 13 – Valve Spring Compressor / Collet Remover

- Modified sash clamp shown (commercial types are also available). Used to compress the valve spring to allow the collets to be removed from the valve and then the valve to be removed from the head. Also used for installation.

A screwdriver brazed to a modified spanner. Used to simplify adjusting the valve clearances in a solid-lifter engine. The spanner turns the rocker lock nut while the screwdriver turns the adjuster.

Figure 14 – Solid Valve Lifter – Rocker Adjustment Tool

Go-Nogo gauges are used to quickly and accurately check the inner size of a valve guide. Sizes 7.03 / 7.04 / 7.05 / 7.06 / 7.07 / 7.08. Gauges produced by 'Prittie' (www.prittie.com.au) are used in the factory.

Figure 15 – Valve Guide Size Gauges

An adaptor is made by welding a compressor air fitting to the base of an old spark plug. The adaptor is screwed into the spark plug hole of a head and connected to the leak-down tester to check the condition of the cylinder assembly.

Figure 16 – Leak Down Tester

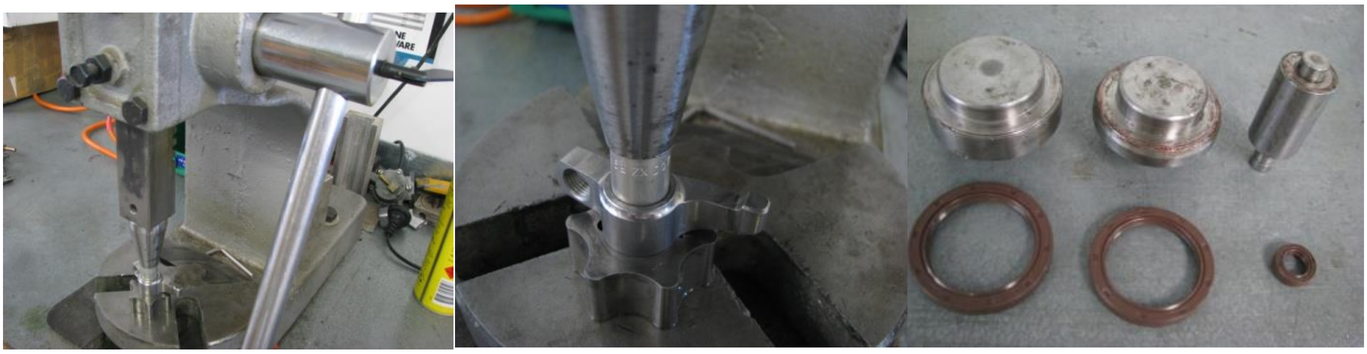


Figure 17 – Hand Press & Inserts

- A hand press is used to install rocker bushes, distributor shaft and crankshaft seals. Inserts are made for the press to suit the parts.

Figure 18 – Piston & Ring Installer

- Simplifies compressing the piston rings to allow installation of the piston / ring assembly to the cylinder.

Figure 19 – Cylinder Hone Helper

- Used during honing with a "Christmas tree" hone to make the base of the cylinder complete. Without the hone helper the hone would catch on the cylinder skirts. 4" "Christmas tree" hone shown at right.

Note – It is highly recommended that all honing processes required for cylinder barrels be outsourced to an experienced and reputable machine shop rather than making use of a Christmas tree hone.

Figure 20 – Piston Circlip Remover and Installer

- Modified screwdrivers shown on left which are used to remove the circlip from the piston.
- Tool shown on right which is used to install the circlips to the piston.

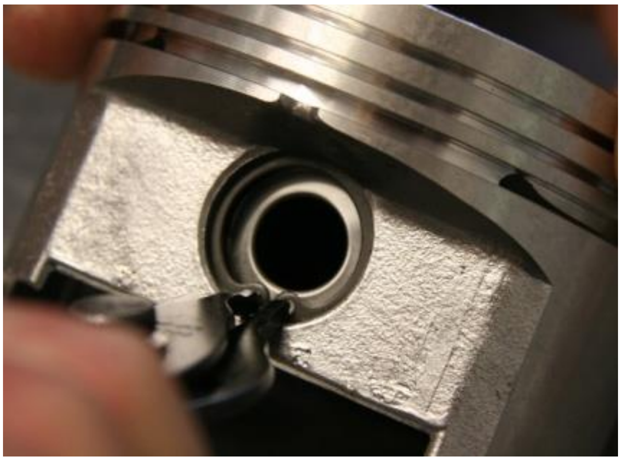


Figure 21 – Standard Circlip Pliers

- Standard (internal) circlip pliers are required.

An accurate optical tachometer. Reads directly from reflective strips fitted to the propeller and is used whenever an accurate check of RPM is required. Will usually read propeller RPM in sunlight without reflective strips.

Figure 22 – Optical Tachometer

A tool which is used to drill dowel holes in early model crankshafts and flywheels. Jabiru Service Bulletin JSB012 refers.

Figure 23 – Crankshaft / Flywheel Drilling Jig (for Dowels)

A degree wheel or degree disc – used during engine assembly to check engine timing.

Figure 24 – Degree Wheel

Used during initial engine proof runs and / or running-in. Used as a more accurate gauge to confirm the readings of the standard aircraft oil pressure gauge. Fitting uses 1/8 NPT thread.

Figure 25 – Supplementary Oil Pressure Gauge

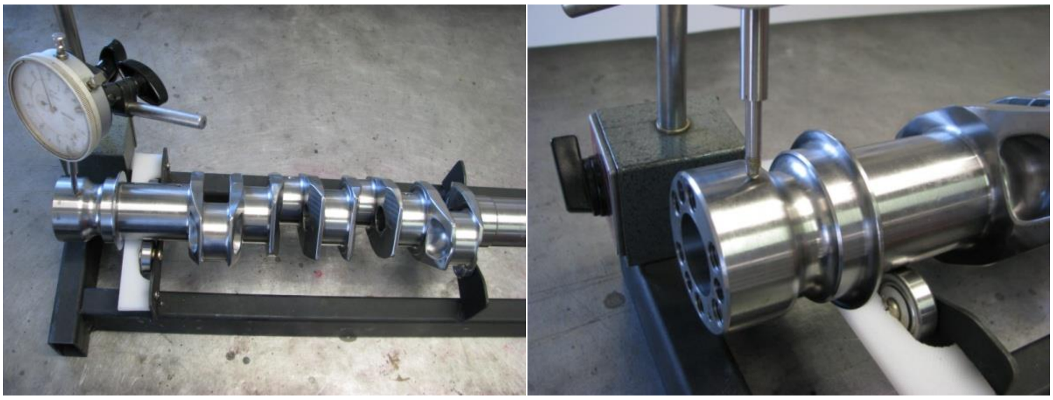


Figure 26 – Crankshaft Run-Out Test Bed

- A test bed to simplify measuring crankshaft and propeller flange run-out. This can also be done in a crankcase half.

Used to test ignition coil performance.

Figure 27 – Ignition Coil Tester

Figure 28 – "Finger Bar"

- A long lever arm fitted with pins that pit into the propeller flange holes. Allows the crank to be held easily while tightening or loosening propeller flange or flywheel screws.

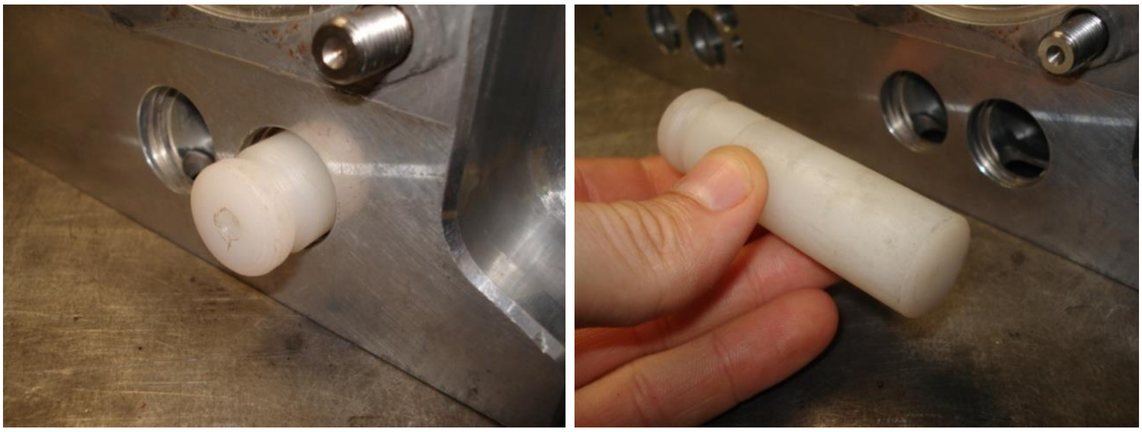
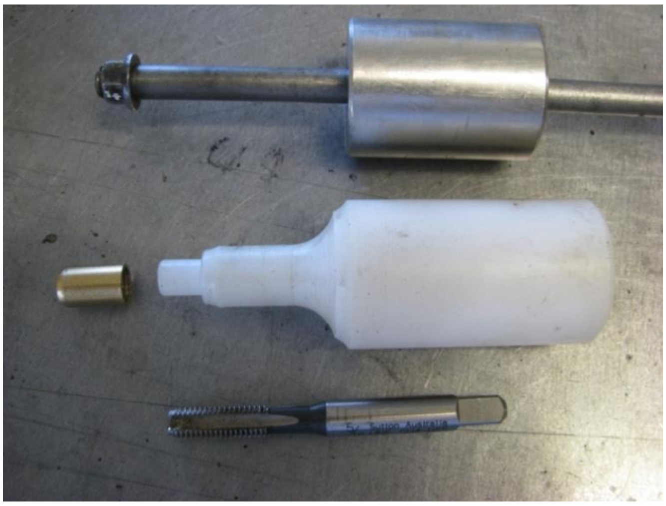


Figure 29 – Cam Timing Tool (Hydraulic Lifter)

- A piece of material (Nylon has been used here) machined to fit neatly into a hydraulic lifter socket with a socket in its tip to accept a dial gauge probe. As it sticks out the side of the case (unlike a normal hydraulic lifter) it is easier to use when checking cam timing.



The tap (at bottom) is used to cut a thread into the needle seat (small part, middle-left). The slide hammer (at top) screws into this thread and is used to draw the needle seat out of the carburettor. The nylon driver (in centre) is used to fit the new needle seat to the carburettor body.

Figure 30 – Carburettor Needle Seat Remover and Installer

Figure 31 – "Crowsfoot" Adaptors

- Commercially available tool designed for high-torque applications on small nuts.

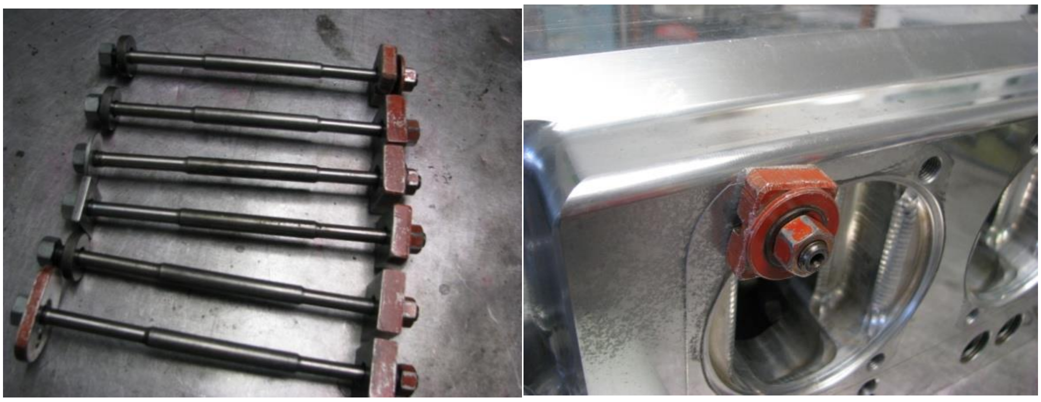
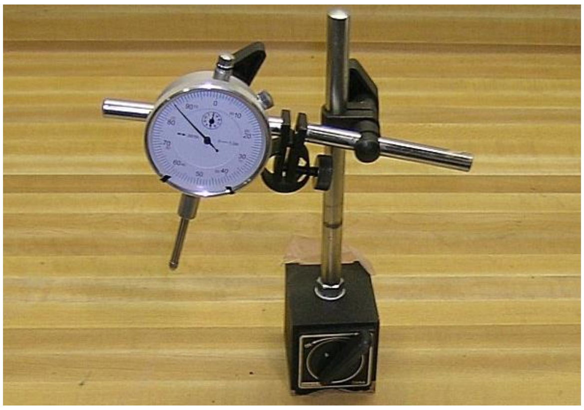


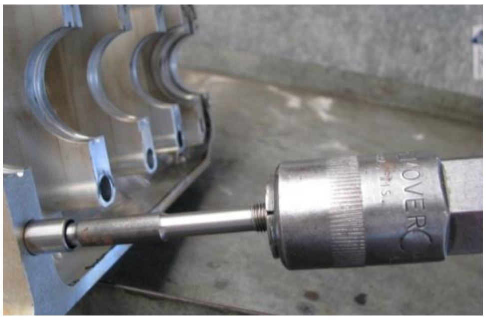
Figure 32 – Crankcase Dry Fit Through-Bolts and Nuts

- A set of engine through-bolts, spacers and non-locking nuts used to speed up test assembling of crankcases to measure bearing clearances etc.



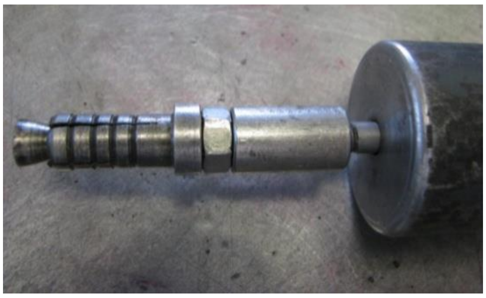
As well as Crankshaft run-in, a dial gauge is also used to locate top dead centre (TDC) in the cylinder.

Figure 33 – Dial gauge used to locate TDC



A tool which clamps onto the tip thread of the stud, holding it tightly and allowing the stud to be screwed out of the crankcase.

Figure 34 – Crankcase Stud Remover



An adapted puller used to remove the dowel pins from the crankcase halves.

Figure 35 – Crankcase Dowel Remover

Essentially a long, large punch used to both remove and install the welch plugs from the ends of the crankshaft.

Figure 36 – Crankshaft Welch Plug Installer / Remover

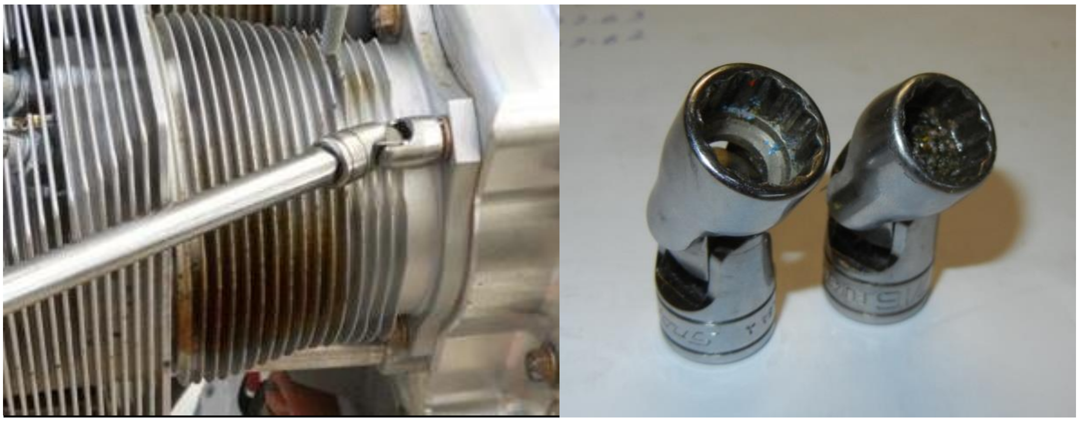


Figure 37 – Universal Joint tool FU14B

- Snap-On tool FU14B – a universal joint with inbuilt 7/16” nut drive. Used for changing through-bolt nuts without removing cylinder heads.
- FU16B is the equivalent part with ½” socket for use on 7/16” 12-point nuts.

3.8.2 Torque / Tension Wrench

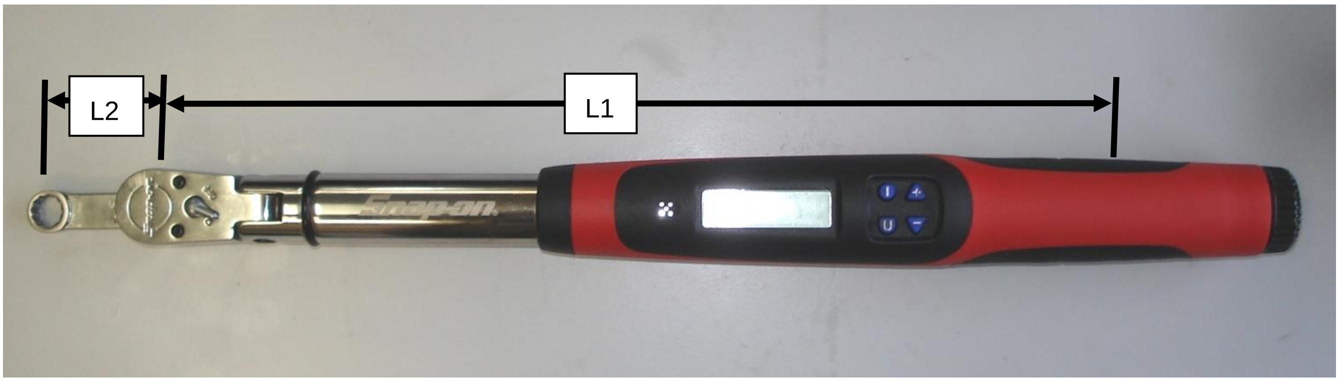


Figure 38 – Torque Wrench & Crowsfoot Adaptor Setting 1

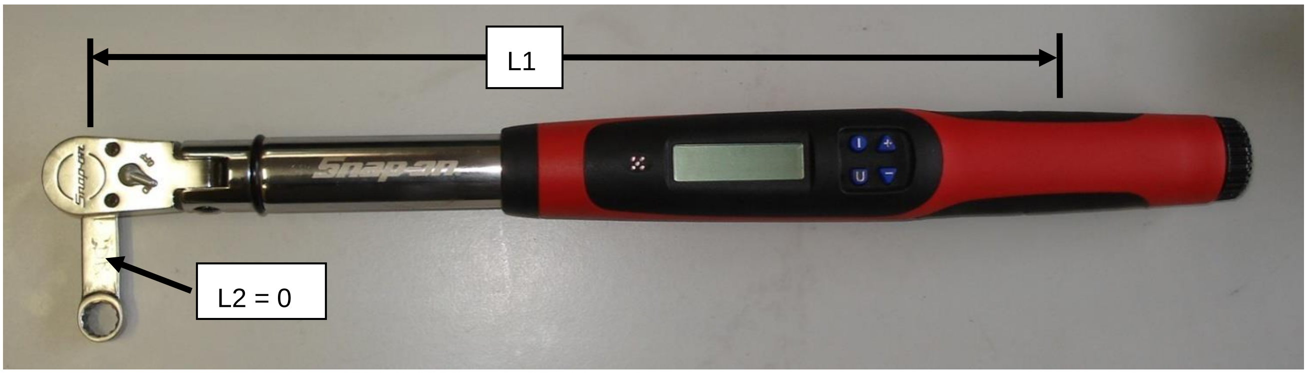


Figure 39 – Torque Wrench & Crowsfoot Adaptor Setting 2

- A good torque wrench is an essential tool for maintaining and overhauling Jabiru Engines. It's important to realise however that even the best wrench needs calibrating occasionally. This can be done using a dead weight on the end of a known arm or – preferably – sending the wrench away to be calibrated. Note that Civil Aviation Authorities generally require that the tool be calibrated in a way which is traceable to a NATA-standard laboratory.
- A "Crowsfoot" extension as shown in Figure 31 is also necessary – it allows high torque settings to be used on small nuts without damaging them. The crankcase through bolt nuts used on Jabiru engines are a good example of an application suitable for a crowsfoot extension. However, when using the extension as shown in Figure 38 the extra length will throw off the torque setting of the wrench. This must be corrected using the following formula:

$$Adjusted\ Torque\ Setting = Required\ Torque\ Setting \times \left(\frac{L1}{L1+L2}\right).$$

- L1 is the distance from the middle of the grip of the handle to the centre of the wrench drive lug
- L2 is the distance *in the direction of the handle* from the centre of the wrench drive lug to the centre of the nut socket of the adaptor.
- For example: a nut needs to be tensioned to 30lb.ft. The torque wrench is 12" long and the crowsfoot extension is 2" long. The extension is oriented as shown in Figure 38. This means that the torque wrench must be set to:

$$Adjusted\ Torque\ Setting = 30\ \times \left(\frac{12}{12+2}\right)$$

$$Adjusted\ Torque\ Setting = 30\ \times 0.857 = 25.7 lb.ft$$

- If the extension is oriented at 90° to the wrench as shown in Figure 39 then no correction is needed because L2 is zero.

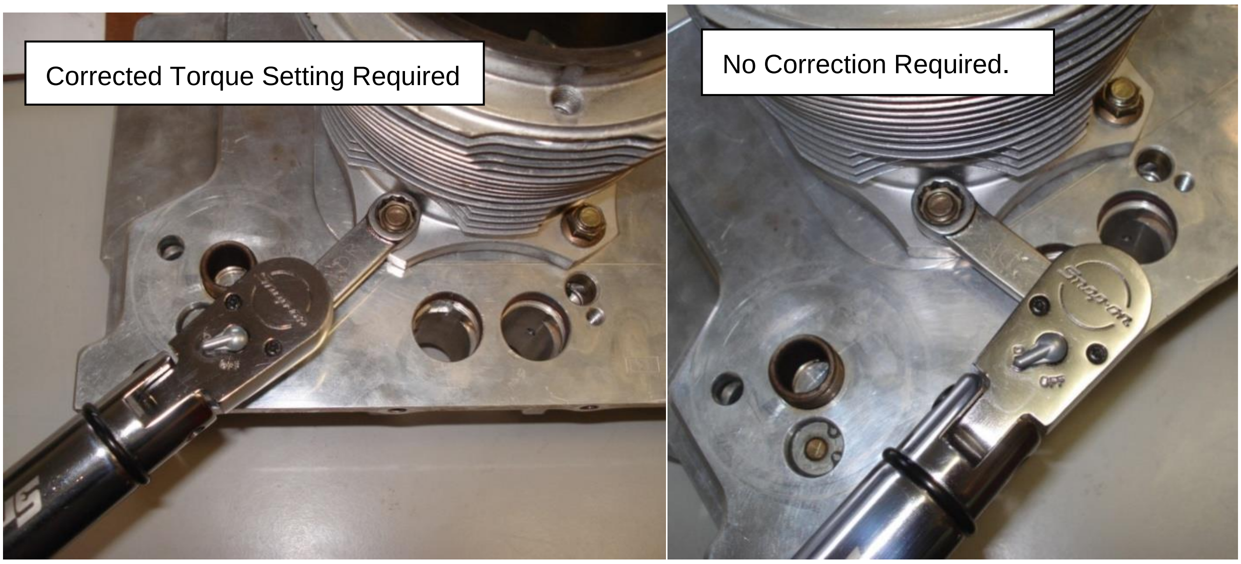


Figure 40 – Using A Crowsfoot Adaptor

3.8.3 Torque Application Procedure

- Good torque application technique is essential if an accurate bolt torque reading is going to be obtained.
- Firstly the nut must be tightened smoothly. Any jerks or bumps can cause the torque reading to be obtained prematurely.
- The torque must be obtained while the nut is turning. If you stop to reposition the torque wrench and then the required torque reading is obtained without the nut turning, the nut needs to be loosened a little and then tightened again so the torque reading is obtained while turning.
- Unless specified otherwise all torque settings given in this manual are "dry" – i.e. no special lubricant is applied to the threads or parts. Where directed otherwise it is vital that the directions are followed exactly.

3.9 Safety Wire

- Only stainless steel safety wire is used on the Jabiru Aircraft Engine.
- There are two methods of safety wiring; the double-twist method that is most commonly used, and the single-wire method used on screws, bolts, and/or nuts in a closely-spaced or closed-geometrical pattern such as a triangle, square, rectangle, or circle. The single-wire method may also be used on parts in electrical systems and in places that are difficult to reach.
- When using double-twist method of safety wiring, 0.032 inch minimum diameter wire should be used on parts that have a hole diameter larger than 0.045 inch (1.1mm). When using the single-wire method, the largest size wire that the hole will accommodate should be used.

WARNING

Care must be taken not to confuse steel with Aluminium wire.

- There are many combinations of safety wiring with certain basic rules common to all applications. These rules are as follows.
  a. When bolts, screws, or other parts are closely grouped, it is more convenient to safety wire them in series. The number of bolts, nuts, screws, etc., that may be wired together depends on the application.
  b. Drilled boltheads and screws need not be safety wired if installed with self-locking nuts.
  c. To prevent failure due to rubbing or vibration, safety wire must be tight after installation.
  d. Safety wire must be installed in a manner that will prevent the tendency of the part to loosen.
  e. Safety wire must never be over-stressed. Safety wire will break under vibrations if twisted too tightly. Safety wire must be pulled taut when being twisted, and maintain a light tension when secured (Figure 42).
  f. Safety-wire ends must be bent under and inward toward the part to avoid sharp or projecting ends, which might present a safety hazard.
  g. Safety wire inside a duct or tube must not cross over or obstruct a flow passage when an alternate routing can be used.
  h. Check the units to be safety wired to make sure that they have been correctly torqued, and that the wiring holes are properly aligned to each other. When there are two or more units, it is desirable that the holes in the units be aligned to each other. Never over-torque or loosen to obtain proper alignment of the holes. It should be possible to align the wiring holes when the bolts are torqued within the specified limits. However, if it is impossible to obtain a proper alignment of the holes without under-torquing or over-torquing, try another bolt which will permit proper alignment within the specified torque limits.
  i. To prevent mutilation of the twisted section of wire, when using pliers, grasp the wires at the ends. Safety wire must not be nicked, kinked, or mutilated. Never twist the wire ends off with pliers; and, when cutting off ends, leave at least four to six complete turns (1/2 to 5/8 inch long) after the loop. When removing safety wire, never twist the wire off with pliers. Cut the safety wire close to the hole, exercising caution.
  j. Install safety wire where practicable with the wire positioned around the head of the bolt, screw, or nut, and twisted in such a manner that the loop of the wire fits closely to the contour of the unit being safety wired.
- When using a wire twister (safety wire pliers), grip the wire in the jaws of the wire twister and slide the outer sleeve down with your thumb to lock the handles or lock the spring-loaded pin.
- Pull the knob, and the spiral rod spins and twists the wire.
- Squeeze handles together to release wire.

WARNING

When using wire twisters, and the wire extends 3 inches beyond the jaws of the twisters, loosely wrap the wire around the pliers to prevent whipping and possible personal injury. Excessive twisting of the wire will weaken the wire.

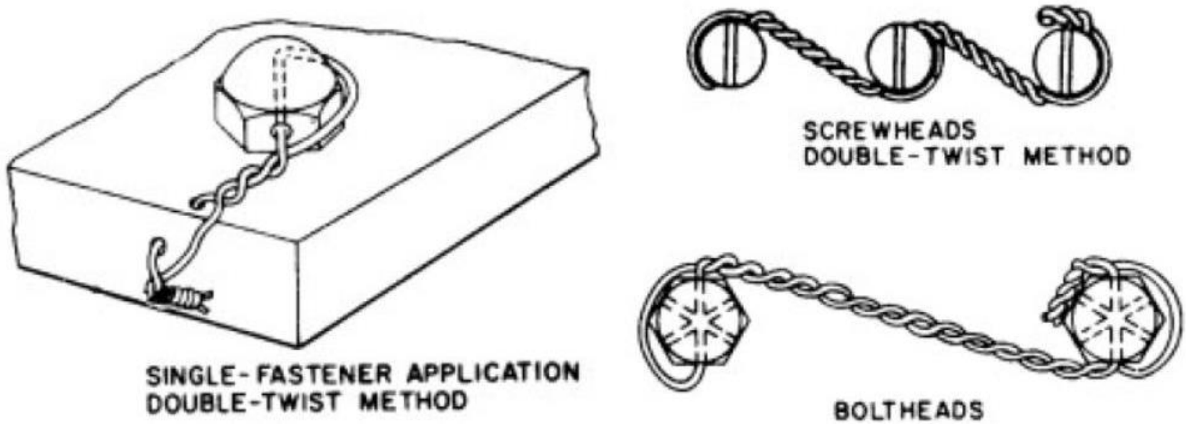


Figure 41 – Safety Wire Details

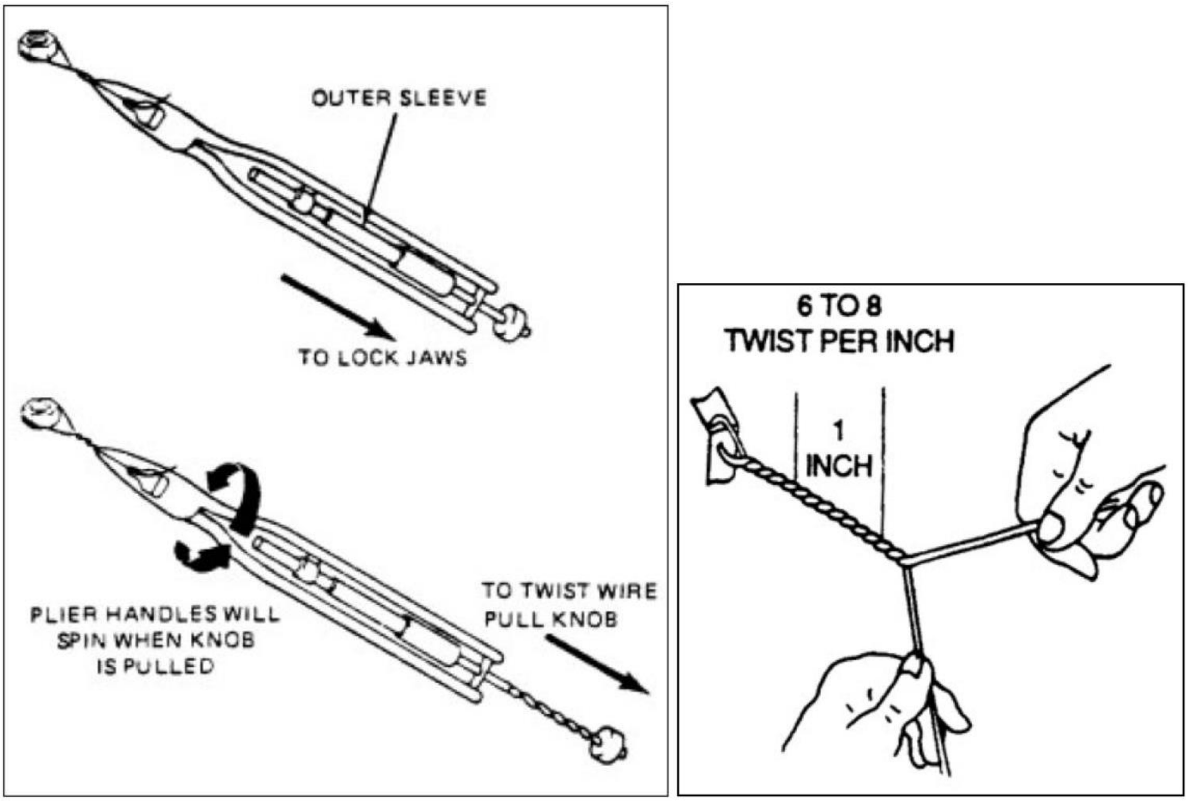


Figure 42 – Safety Wire Installation Using a Twister/Pliers & By Hand

3.10 Hardware

- Certain applications on the Jabiru Engine must use particular grades of hardware:
- Propeller flange attach screws, flywheel attach screws, connecting rod cap screws must be “Unbrako 1960” or “Brighton Best 1960 Grade” screws in black (not plated) finish.
- Where a specific type of hardware is described – i.e. AN4 bolts, ARP 12-point nuts – hardware must meet the specifications for that type of hardware.
- Custom hardware – such as through bolts – must be as described in this manual.

WARNING

Failure to use correct hardware may lead to an unsafe condition.

4 Disassembly Procedure

- As each part is removed from the engine it should be set aside for later evaluation – in our factory engine workshop we use disposable plastic containers to keep all of the smaller components (cap screws, bolts, nuts, washers, etc) separate during disassembly.

4.1 Preliminary Cleaning

- Inspect engines carefully before cleaning. The patterns of dirt, oil etc can indicate damage or wear and provide valuable information of which tasks should be added to the overhaul or inspection process.
- The engine must be cleaned externally before it is removed from the aircraft. A stiff-bristled brush, solvent (de-greaser), water and some compressed air will usually be adequate for this task.

4.2 Remove The Engine From The Aircraft

- Remove the cowlings and the spinner. Remove the propeller. Disconnect both cables from the battery and remove the battery from the aircraft. Disconnect the earth cable and free the starter motor power cable from the wiring loom.
- Remove the muffler and then remove the oil drain plug and drain the oil from the engine. Remove the ram air ducts. Disconnect all engine control cabling and disconnect the air intake duct from the carburettor. Remove the oil filter, the oil filter adapter and oil cooler.
- Disconnect and remove all engine wiring: the signal wiring from the oil pressure and temperature senders and fuel pressure sender (if fitted), the low-tension ignition wiring and the alternator wiring. Remove the oil pump from the front of the engine and undo the cap screws that hold the front oil seal around the crankshaft.
- Remove the engine from the airframe and place it onto the engine stand, holding it in place with 3 bolts through the propeller flange.

4.3 Engine Stand

- We recommend that an engine stand be used to hold the engine vertically during all workshop procedures.
- In our engine workshop we use a spare propeller flange bolted to the workbench. The propeller flange on the engine is then bolted to that flange so that the engine is held in an upright position as shown in Figure 43.
- You may find it convenient to simply bolt the propeller flange of the engine directly to the workbench using 3 suitable bolts.
- Note that for a top end overhaul the engine can remain in the aircraft, although the use of an engine stand may be more convenient and is usually faster.

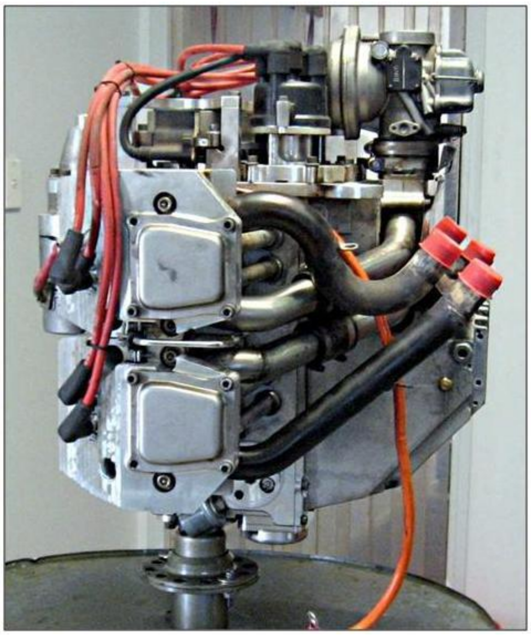


Figure 43 – Engine Stand

4.4 Special Checks Before Disassembly

4.4.1 In-Situ Propeller Flange & Crankshaft Run-Out Measurement

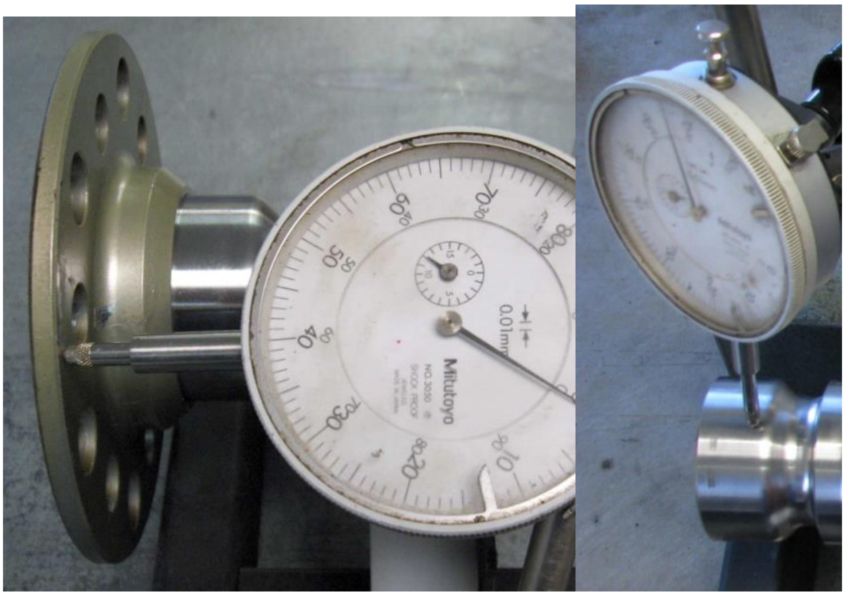


Figure 44 – Measuring Propeller Flange & Crank Run-Out

- This procedure is used to gauge the severity of any potential damage to the crankshaft or propeller flange before carrying out a bulk strip.
- Remove one spark plug from each head.
- Carefully sand off paint on crank diameter and prop flange where dial indicator will be located. Applying a little lubricant (such as greaseless lubricant spray) to the area being measured is also recommended.
- Position dial indicator onto crank as shown above and eliminate main bearing clearance by bearing down on crank when rotating. Rotate crankshaft to measure crankshaft run out. 0.01 - 0.03 mm is normal, but if run out exceeds of 0.08 mm the crankshaft must be replaced.
- Position dial indicator onto prop flange as shown above, eliminate end float by either pulling or pushing flange when rotating. Rotate prop flange to measure the face run out. 0.02 - 0.06 mm is normal, but if run out exceeds 0.08 mm then the prop flange must be replaced.

4.4.2 Engine Crankshaft friction test

- A crankshaft friction test is used to determine if an engine has a fretted crankcase. If the results of this test indicate fretting, the crankcase will need to be split and the crankcase halves reworked (which is beyond the scope of a standard top end overhaul).

NOTE

The engine crankshaft friction test must be conducted when the engine is cold
This procedure is not suitable for engines with the through bolt nuts installed with Loctite 620.

- Remove one spark plug from each cylinder. Turn the engine over several times. Position the crankshaft so that the magnets are almost lined up with the ignition coils, see Figure 45. Then using a spring balance at the tip of the propeller blade, (take care not to damage the propeller blade) pull the prop slowly in the direction of rotation. Take note of the reading on the scale as you do this. You will only get about 150mm of movement before the camshaft causes the prop to move more easily.

  Note: It may be difficult to attach a spring balance to the tip of a composite scimitar propeller, in this case choose and mark a location as close to the tip as possible. Mark the same location on all blades, for consistent measurements.

- Rotate the prop a ½ turn and measure the force to pull the propeller again. Repeat until you have at least three consistent readings.
- For each through bolt and stud bolt, undo the nuts about half a turn, then using a calibrated torque wrench, tighten each of the through bolts and stud bolt nuts the to the torque setting specified in Table 9
- Perform the propeller pull-tests again (again obtain at least three consistent readings). In doing the pull tests a second time ensure that you are turning the engine over in the same position as last time (i.e. the position of the coil magnets and cam lobe should be the same). If the force measurements obtained are more than 400 grams larger than measurements taken before the through bolts were re tightened, it shows that fretting of the crankcase has reduced main bearing clearances to an unacceptable level. The engine should be disassembled and the crankcase repaired by a Jabiru Authorised facility.

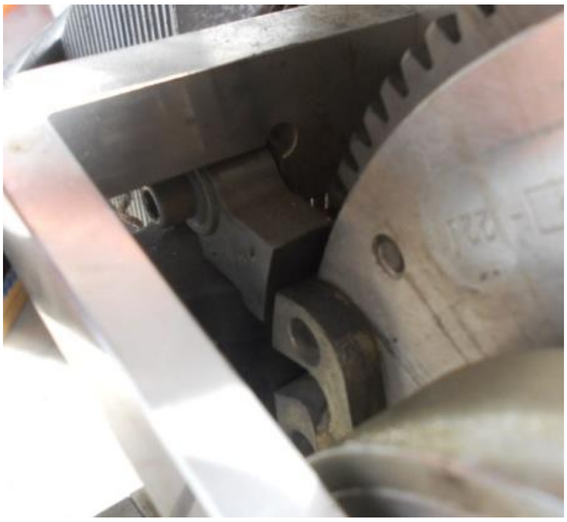


Figure 45 Coil position.

- Use a spring balance that can read at least 3 kg with a maximum of 50 gram increments.

Figure 46 Suitable spring balance.

WARNING

Through-bolts & studs are highly loaded. Never torque nuts above the torque setting given in Table 9 or damage to the bolts will result. Accurate wrench calibration & compensation for any adaptors used is vital when working on these parts.

The results of this test are an indicator only. False negatives and positives are possible. If in doubt, disassemble the engine and inspect to be sure.

4.5 Engine Strip: Complete Overhaul

4.5.1 Accessories

- Remove the spark plugs and exhaust system, followed by the carburettor, the machined inlet manifold and induction tubes. Remove the starter motor. Remove the distributor caps and high-tension leads, then the fuel pump, the ignition coils and finally the rear alternator bracing plate to expose the flywheel.

4.5.2 Cylinder Heads and Valve Gear

- Remove the rocker covers.
- Remove the NPT plug that covers the bottom cylinder head cap screw.

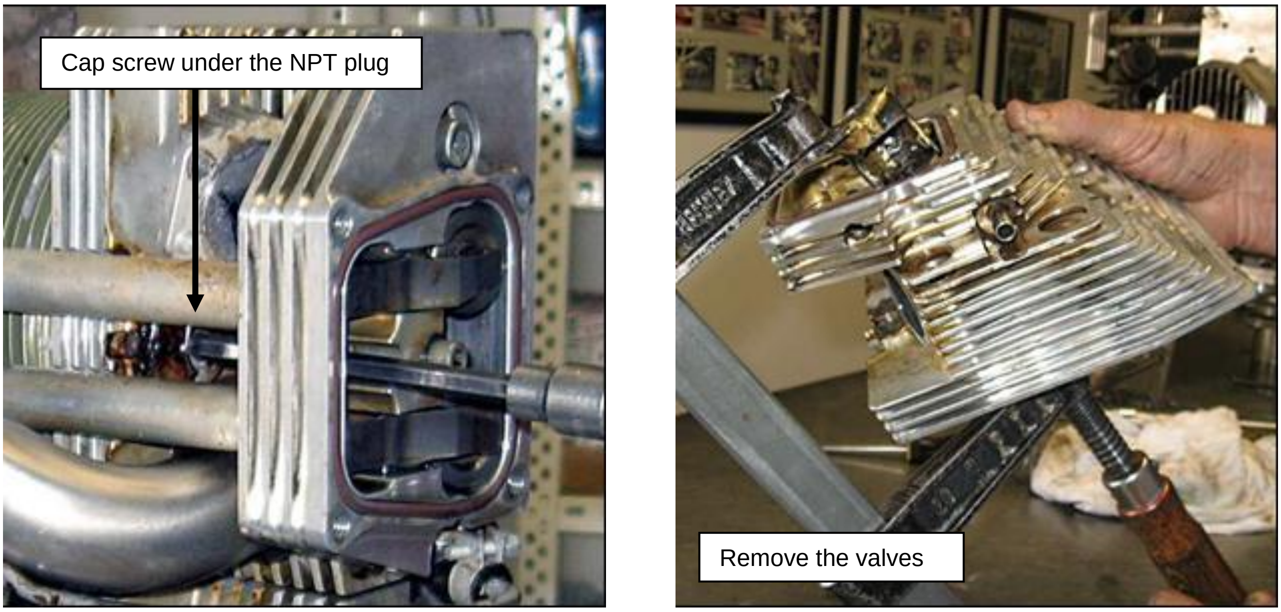


Figure 47 – Cylinder Head Disassembly

- Where equipped, loosen the hose clamps on the rubber oil line “T” connectors. Loosen and remove each of the 6 cylinder head cap screws from the cylinder head.
- The cylinder head should now be removed from the cylinder along with the pushrod tubes and pushrods and placed on the workbench. Remove the cap screw from between the rockers and carefully drive the rocker shaft out of the head, driving it from the non-slotted end.
- Remove the rockers.
- Using a valve spring tool, compress each valve spring and remove the collets and then remove the valve springs, spring guides and valves.
- Remove the O rings from the pushrod tube holes and the rocker shaft holes. Repeat for each cylinder head.

4.5.3 Cam Followers, Rocker Oil Lines

- Remove the pushrod adapters (hydraulic lifter models only) from the crankcase and use a small hooked tool (an old dentist’s probe is very useful) to extract each hydraulic lifter.
- Remove the cap screw that holds each rocker oil line to the side of the crankcase and remove each rocker oil line. Remove the O rings from the pushrod and oil line holes.
- Undo the retaining grub screw and extract the oil filler tube from between #1 and #3 cylinders.

4.5.4 Flywheel Cap Screws

- Now the cap screws that hold the flywheel to the crankshaft must be removed.
- These cap screws are held in place with Loctite 620, which is very strong, and they will be very difficult to undo. Great care must be taken not to break any of them or round the drive sockets of the cap screws. Due to the high stress on the screws and tools the Allen key must be in "as-new" condition with no wear to its drive faces.
- Apply heat to the area around the cap screws, shielding the magnets in the alternator from direct heat, and then try to crack each cap screw loose using an Allen key and a 3/8" breaker bar.
- As excess heat can de-magnetise the alternator magnets. Overhaulers may prefer to remove the magnet ring before attempting to remove the flywheel.
- This step can take an hour or more and it may involve heating the flywheel (thus the end of the crankshaft) several times until you can safely undo each cap screw.
- Do NOT apply heat directly to the cap screws as this can weaken the screw material. Instead, apply the heat to the area around the cap screws. This is particularly important because you will need to apply considerable turning force to undo each cap screw.
- It is good practise to wear leather gloves during this task to protect your hands from the heated items such as the heat shield and the flywheel.

WARNING

Used flywheel cap screws must be discarded and replaced with new items.

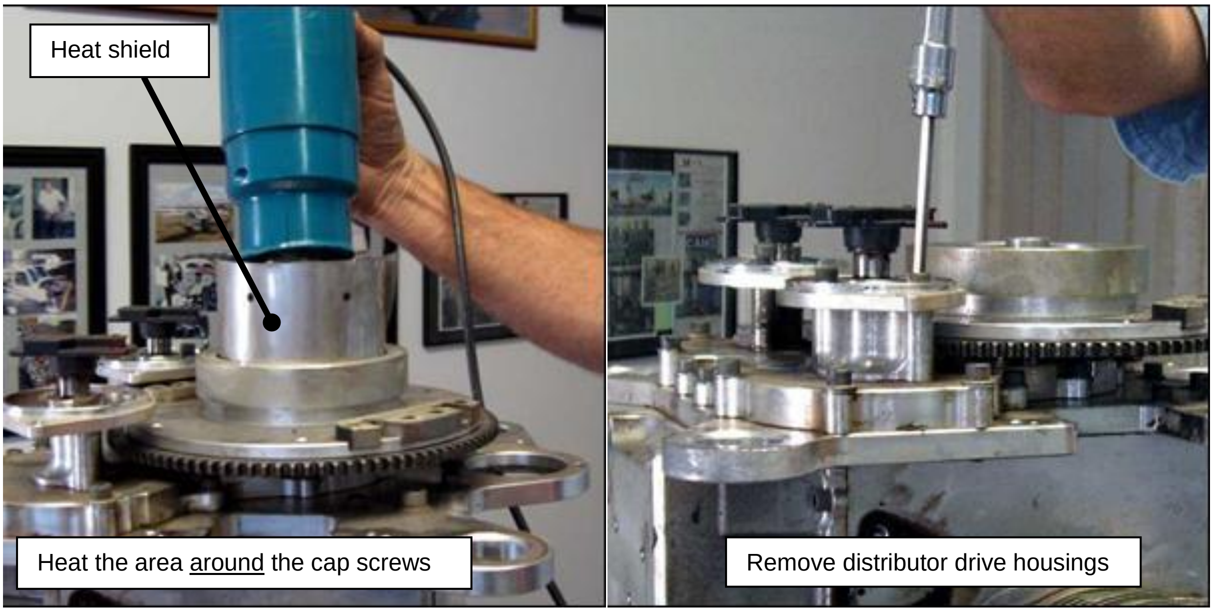


Figure 48 – Removing Flywheel Cap Screws & Distributor Drive Housings

4.5.5 Distributor Drive Housings

- Carefully lever each distributor rotor off of the distributor shaft – the rotors are held in place with 5-Minute Araldite and flock so you will need to work each one off gently.
- Undo the Allen head cap screws and remove the 2 machined distributor gear drive housings from the timing case as shown in Figure 48.
- Drive the oil seals out of the drive housings.

4.5.6 Flywheel

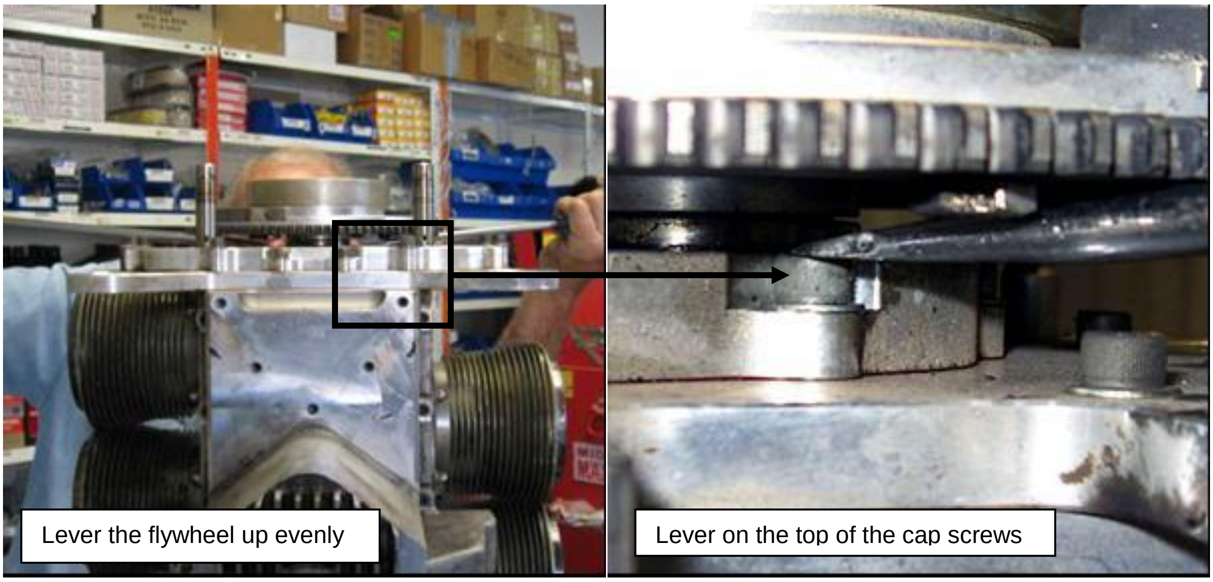


Figure 49 – Removing Flywheel

- Once all 6 cap screws have been removed the flywheel can be levered off of the crankshaft: note the leverage points in Figure 49, where 2 large screwdrivers are placed under the flywheel on the tops of opposing timing case cap screws and then moved evenly up to provide leverage to remove the flywheel from the crankshaft.

4.5.7 Timing Case

- Remove the cap screws from the timing case and remove the case from the engine mount plate – there are machined recesses in each side of the timing case, as shown circled in Figure 50, that are designed to allow a screwdriver tip to be inserted and twisted to break the gasket seal and free the timing case. A soft hammer may be used to help.
- Remove the distributor drive gears and shafts. Drive the oil seal out of the timing case.

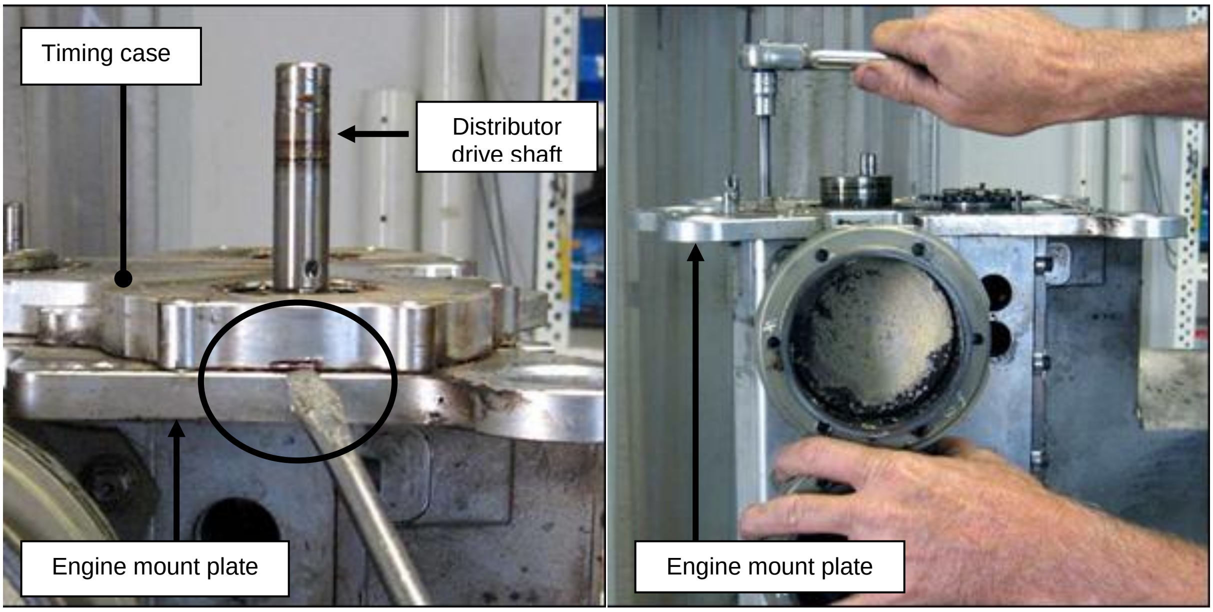


Figure 50 – Remove Timing Gearbox Case

4.5.8 Engine Mount Plate And Sump

- Remove the cap screws from around the engine mount plate and remove the plate from the crankcase. Remove the cap screws from around the sump flange and remove the sump.
- Figure 51 shows 2 hidden screws which hold the sump to the engine mount plate. These screws can only be accessed by removing the timing gearbox. Note that these screws have been omitted on later model engines to allow the sump to be removed without first removing the gearbox.

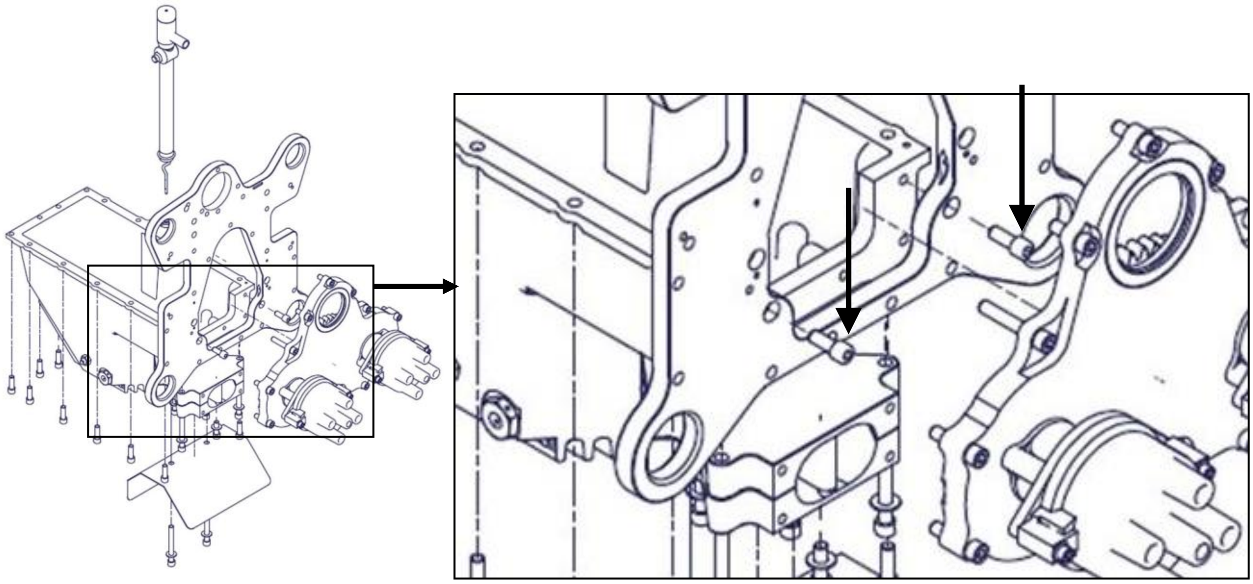


Figure 51 – Hidden Sump Screws

4.5.9 Starter Motor

- Remove clutch housing from starter housing
- Remove clutch and bendix gear assembly
- To disassemble the starter housing from the drive motor you need to remove the 2 long AN3 bolts. These bolts are Loctited on assembly and will require heating with a hot air gun onto the starter housing in the area where the bolts enter the housing. If the Loctite is not heated to soften it, there is a possibility that the bolts will shear off and a new starter housing will be required.
- Older motors used a different starter motor (on left, Figure 52). These motors are undone via Phillips-head screws through the cap of the motor.

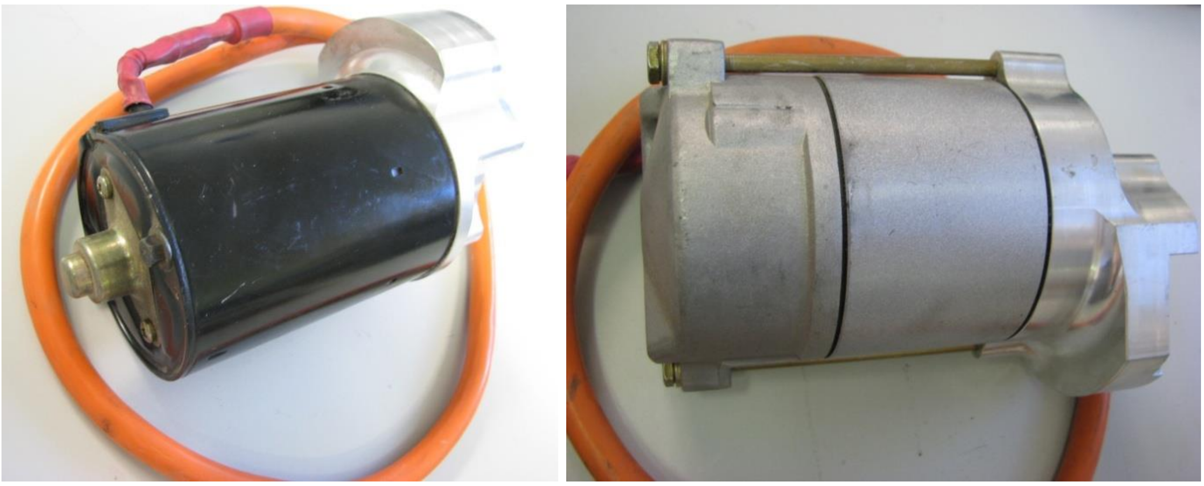


Figure 52 – Starter Motor Disassembly

4.5.10 Crankshaft Gear

- Once the engine mount plate has been removed the crankshaft gear can be removed from the end of the crankshaft. Using 2 large screwdrivers, lay one across the end of the crankcase to protect the surface and use the other to lever the gear off as shown below left, working from side to side.

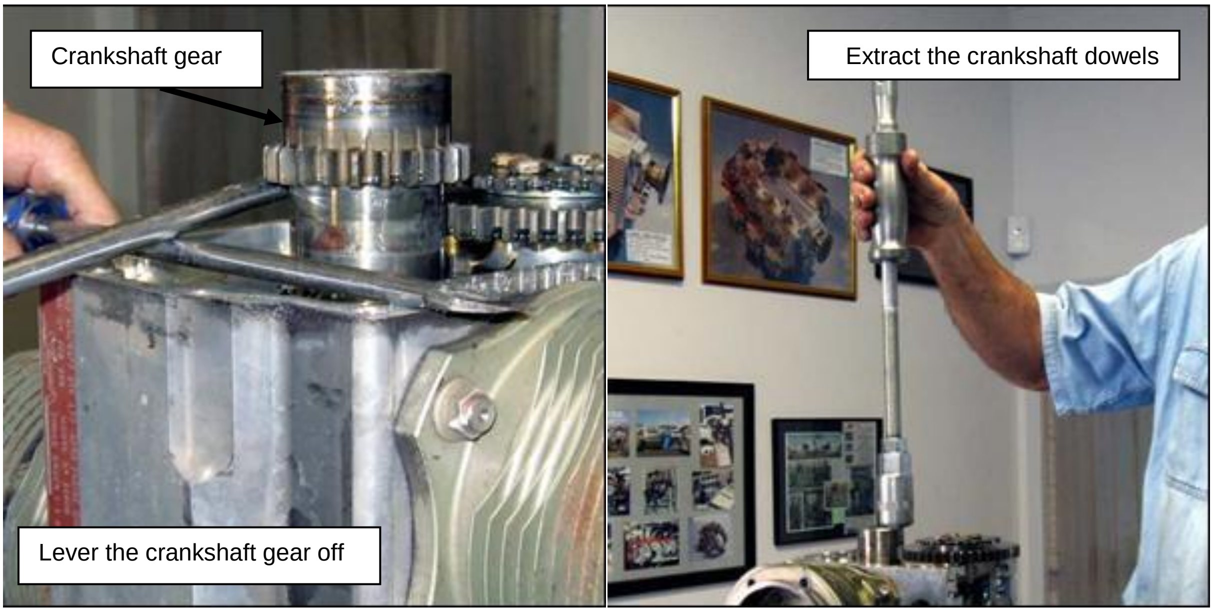


Figure 53 – Removing Crankshaft Timing Gear & Dowels

- Extract the 3 dowels from the end of the crankshaft – use a suitable collet type extractor (a commercially available tool) that has a straight pull as shown above right. It may be necessary to heat the end of the crankshaft slightly to extract the dowels.

4.5.11 Cylinders

Figure 54 – Remove Cylinders

- Undo the base nuts from each cylinder pair until one nut can be removed from the cylinder stud and then pull each cylinder off of the piston as shown in Figure 54. Note that these through bolts and studs are normally replaced at overhaul – see Section 5 for details.
- Some of the cylinder studs will come away with the cylinders: clamp these studs carefully in the padded jaws of a vice and remove the remaining base nuts from the studs.

4.5.12 Pistons

Figure 55 – Remove Pistons

- Use 2 small blade screwdrivers to lever out the top gudgeon circlip from each piston as shown in Figure 55. (round type clip shown – use std circlip pliers for circlips with eyes) Now, working on one piston at a time, support the top of the piston against the side load as shown above right and carefully extract the gudgeon pin out of the piston.
- Remove the piston from the connecting rod. Take care not to put any side load on the connecting rods while removing the gudgeon pins. A suitable soft drift may also be used to carefully drive the pins out.

4.5.13 Front Seal & Oil Pump Housings

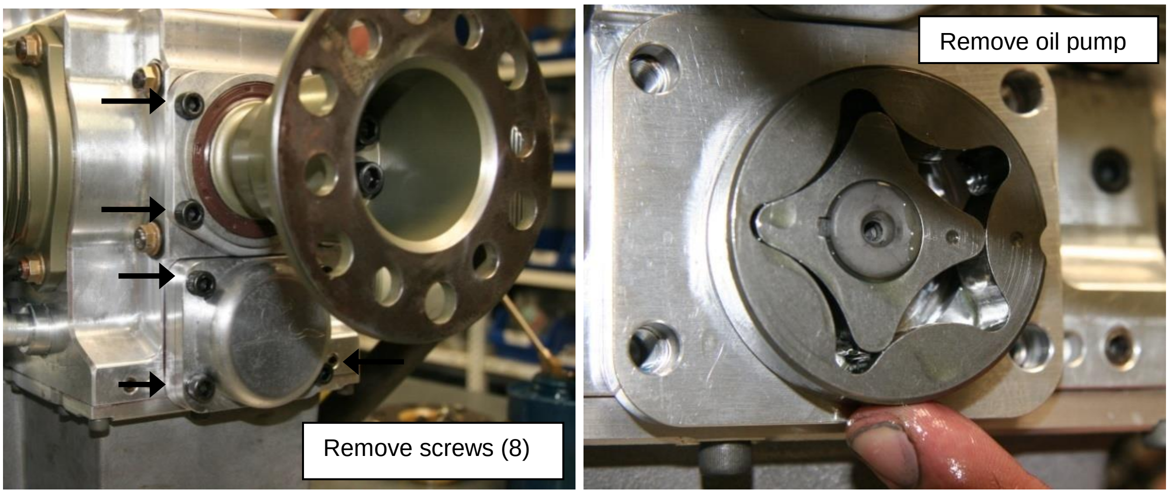


Figure 56 – Front Seal & Oil Pump Removal

- Before the crankcase can be split the screws holding the front crankshaft seal and the oil pump housing must be removed. The cap screws holding each must be removed. The oil pump and housing can be removed completely (a soft hammer may be necessary to break the seal of the housing from the crankcase). The seal housing cannot be removed completely at this stage but it should be freed from the crankcase (again, a soft hammer may be necessary).

4.5.14 Oil Return Manifolds

- Where equipped, oil return manifolds (Figure 57) are removed by removing the two retaining cap screws.
- Remove all O-rings from the manifolds.

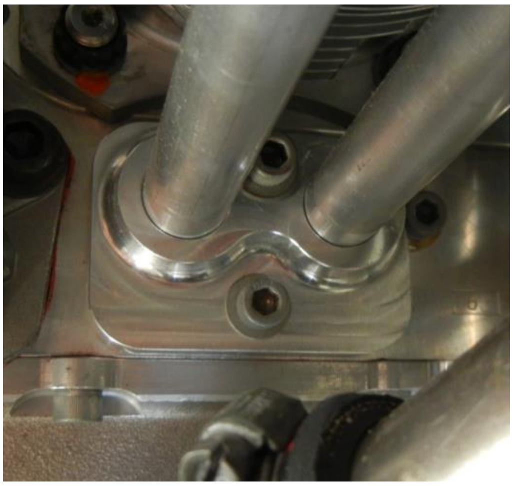


Figure 57 – Oil Return Manifolds

4.5.15 Roller Follower Locking Plate

- Where equipped, remove the roller follower locking plates from the crankcases.

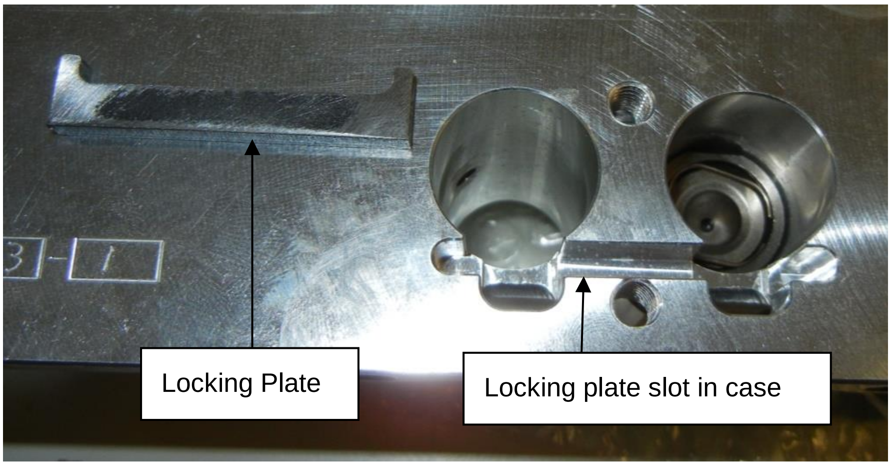


Figure 58 – Crankcase & Locking Plate

4.5.16 Crankcase

Figure 59 – Split Crankcase

- Now the crankcase halves can be split: remove the nuts from the retained studs and then set about carefully tapping each retained stud (located at the front and back of the case) with a suitable soft hammer until the case halves start to separate.
- Carefully pull each case half away from the crankshaft, taking care not to let the camshaft fall. Remove the camshaft from the case and set it aside.
- The oil filler support fitting, arrowed in Figure 59, can be removed now if necessary (i.e. if the case is to be line-bored). Otherwise it can be left in place.
- Remove the main bearing shells. Remove all 'O' rings. The front and rear retained studs should be left in the cases at this stage; if necessary they will be removed after the inspection stage.

4.5.17 Oil Pickup Tube and Strainer

- Heat and remove the oil strainer from the oil pickup tube – gently tapping with a soft hammer will help, as shown in Figure 60.
- Once the strainer has been removed the oil pickup tube can be carefully tapped back through the crankcase and removed.
- On most engines the oil pickup tube has a swelled end that seats in the crankcase, however some older engines may have the oil pickup tube pinned to the crankcase, so check before attempting to remove the tube.
- Remove the O ring from the pickup tube hole in the crankcase

Figure 60 – Remove Oil Strainer

4.5.18 Camshaft and Cam Followers

- Support the camshaft between the heavily padded jaws of a vice and remove the lockwire and the 4 bolts from the cam gears. Remove the gears and locating pin from the camshaft flange.
- Solid lifter engine only: remove the cam followers from each crankcase half.

4.5.19 Connecting Rods

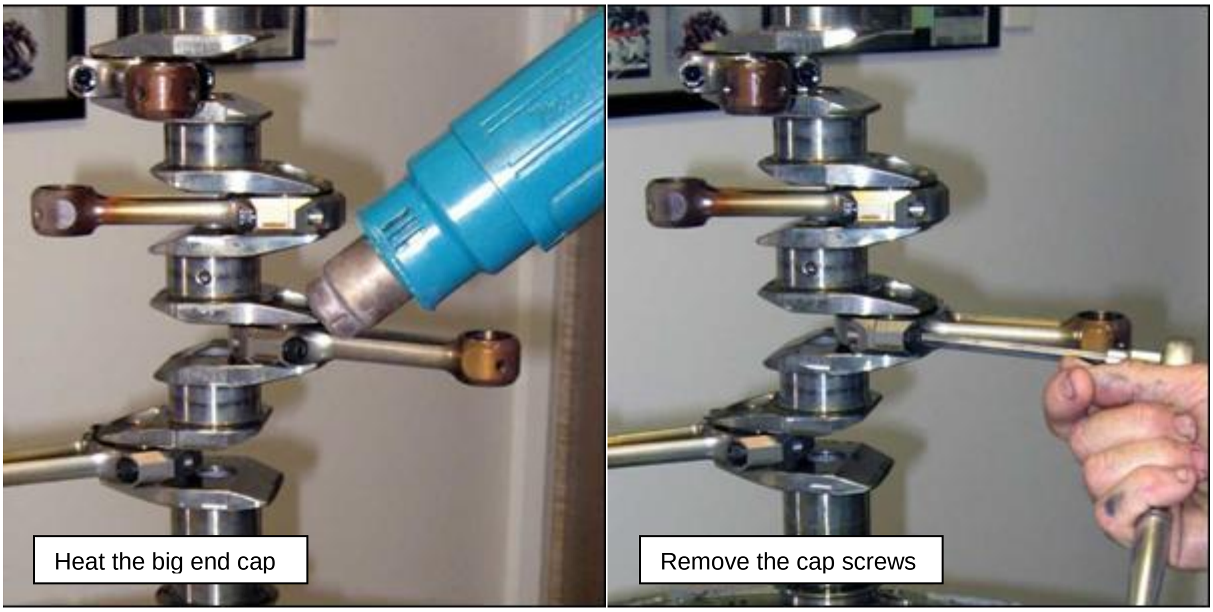


Figure 61 – Remove Con-Rods

- Remove each connecting rod from the crankshaft in the following matter: heat the big end cap and then remove each cap screw.
- Remove the rod and end cap and the rod and then remove the big end bearing shells.

- The caps are located to the rods using 2 off 3mm dowel pins. Care must be taken not to damage these pins on disassembly.
- The brown discolouration of the rods caused by hot oil – this must be removed if the rod is to be subject to a MPI.
- Note that each rod and cap are batch numbered and should be kept in pairs to maintain engine balance.

4.5.20 Crankshaft

- Using a long drift, punch the rear welch plug down until it can be removed from between the rear crank throws. Figure 62 shows the plug emerging, preceded by some sludge.

Figure 62 – Welch Plug & Propeller Flange Removal From Crankshaft

- Remove the crankshaft from the stand, clamp it between the heavily padded jaws of a vice and remove the propeller flange. Once again, heat the end of the crank (and NOT the cap screws) and then remove each cap screw taking care not to break them in the process.
- Lay the crankshaft on the bench and drive the 2 front welch plugs out from the rear – feed a long drift all the way through the crankshaft and drive both plugs out of the front of the shaft.
- Remove the front crankshaft seal housing from the crankshaft and drive the seal out of the housing.

4.5.21 Group the Parts

- This completes the complete overhaul disassembly stage. All parts can now be separated into 2 groups: the discard group, which will contain all of the parts that are subject to mandatory replacement; and the inspection group, which will be cleaned and inspected prior to being returned to service.

4.6 Engine Strip: Top End Overhaul

4.6.1 Accessories

- Remove the spark plugs and the exhaust system, followed by the carburettor, the machined inlet manifold and induction tubes. Remove the distributor caps and high-tension leads.

4.6.2 Cylinder Heads & Valve Gear

- As for complete overhaul disassembly.

4.6.3 Cylinders

- As for complete overhaul disassembly. Coat the bore of each cylinder with engine oil or a similar corrosion preventative. After measuring they may be honed lightly.

4.6.4 Pistons

- As for complete overhaul disassembly.

4.6.5 Connecting Rods

- As for complete overhaul disassembly. Remove the rod and end cap and remove the bearing shells, taking care not to drop any parts into the crankcase.

4.6.6 Flywheel & Gear Case

- As for complete overhaul disassembly: Remove the flywheel. Use pliers or similar to remove the rear seal and replace crank timing gear. Note that it may be necessary to withdraw the dowels from the crankshaft to allow the gear to be removed. On re-assembly check ignition and cam timing as detailed below.

4.6.7 Propeller Flange

- As for complete overhaul disassembly. Remove the propeller flange and replace the mounting screws.

4.6.8 Group the Parts

- This completes the top end overhaul disassembly stage. All parts can now be separated into 2 groups: the discard group, which will contain all of the parts that are subject to mandatory replacement; and the inspection group, which will be cleaned and inspected prior to being returned to service.

5 Inspection and assessment

5.1 Mandatory Replacement Items – Multi-Cycle Parts

- Certain components have a maximum life of more than 1 or 2 cycles. These parts have a maximum life as detailed in Table 11

5.2 Mandatory Replacement Items – Full Overhaul

Table 3 – Mandatory Replacement Items – Full Overhaul

Items To Be Checked & Re-Used If Good	Items To Be Replaced
Distributor posts	All necessary mods, plus:
Distributor drive gears	Crankshaft welch plugs
Camshaft Gears	Main bearings
Crankshaft	Thrust Bearings
Camshaft	Connecting rod bearings
Connecting rods	All O rings, gaskets & seals
Propeller flange	Pistons, piston gudgeon pins and circlips
Engine mount plate (engine back plate)	Piston rings
Starter motor and starter motor clutch	Intake and exhaust valves & collets
Carburettor	All nuts, bolts, screws, washers and studs
Ignition coils	Engine through-bolts
	Engine crankcase studs
Valve lifters (solid)	Distributor rotors & distributor caps
Alternator stator & rotor (magnet ring)	Spark plugs
Flywheel & ring gear	Fuel pump
Oil pump assembly	Rubber T – from rocker oil feed line
Exhaust pipes	Connecting rod bolts
Induction manifold & pipes	Oil pump woodruff key
Oil relief valve assembly	Fuel hoses
Sump	Flexible oil hoses
Carburettor rubber mount	All clamps
Crankcase halves	Oil filter
Oil temperature sender	Induction tube joiners
	Rocker bushes
Insulating plate on sump	Air filter
Pushrods	Valve lifters (hydraulic)
Pushrod tubes	Crankshaft timing gear
Valve rockers (and adjusters for solid lifter engines)	Valve springs
Oil cooler adaptor	Flywheel Bolts
Engine mount rubbers	Distributor shafts
Cylinder heads – upgrade earlier head types	Valve top spring washers
Cylinders	Rocker shafts
	Aluminium flywheel adapter / vacuum pump drive
	Steel flywheel starfish adapter
	Ignition leads
	Oil pressure sender

5.3 Mandatory Replacement Items – Top End Overhaul

Table 4 – Mandatory Replacement Items – Top End Overhaul

Items To Be Checked & Re-Used If Good	Items To Be Replaced
Crankshaft front seal	All necessary mods, plus:
Valve rockers (and adjusters for solid lifter engines)	Connecting rod bearings
Pushrods	Connecting rod bolts
Pushrod tubes	Intake and exhaust valves
Cylinders: measure & hone.	Pistons, piston gudgeon pins and circlips
Ignition coils	Piston rings
Ignition leads	Cylinder base O rings
Fuel pump	Spark plugs
Cylinder heads	Fuel pump gaskets
Valve guides	Cylinder head bolts
Carburettor – check jetting & float levels	Induction tube joiners
Flexible oil hoses	Oil filter
Alternator stator & rotor (magnet ring)	All cylinder head O rings
Starter motor & starter motor clutch	All intake & exhaust gaskets
Camshaft (visual check of lobes)	All intake & exhaust cap screws
	Valve lifters (hydraulic)
	Engine through bolts
	Crankshaft rear seal
	Flywheel cap screws
	Crankshaft timing gear
	Propeller flange cap screws
	Distributor seals
	Valve springs
	Rocker shafts
	Rocker bushes
	Distributor rotors
	Distributor caps
	Fuel hoses
	Air filter
	Aluminium flywheel adapter / vacuum pump drive
	Steel flywheel starfish adapter
	Top Spring Washers (must be 2mm thick hardened)
	Carburettor rubber mount
	Rubber T – from rocker oil feed line

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5.4 General

- From this stage on the engine will be divided into separate subassemblies and each subassembly will be subjected to 3 distinct stages of inspection and assessment:
  1. Check for mandatory update items
  2. Cleaning
  3. Inspection:
     a. Visual – scratches, burnt, bent, etc.
     b. Dimensional – precise measurements to spec
     c. Structural – MPI (Magnetic Particle Inspection) on steel parts
- At the end of this process a single parts order can be placed with your local Jabiru dealer.

5.5 Mandatory updates

- All engines must be checked for mandatory update items – these are intended to bring older engines up to the current specification and improve reliability and serviceability.
- Mandatory updates must be performed during overhaul.
- Refer to Section 12 for details.

5.6 Mandatory Discard

- For some parts there are certain incidents which can result in hidden, internal damage - for example the crankshaft of an engine which has had a severe prop strike. In these cases the part can be within tolerances for wear and straightness and even test well with a MPI – but experience has shown that the part may fail if returned to service.
- Any part for which this information is known will have a "Mandatory Discard" note in the inspection section below.

5.7 Cleaning

5.7.1 Materials and Processes

- Two processes are involved in cleaning engine parts; degreasing to remove dirt and sludge (soft carbon) which form the bulk of the cleaning required, and the removal of hard carbon by decarbonizing, brushing or scraping and grit-blasting.
- In many cases this manual recommends washing parts using Kerosene. In these cases any similar suitable solvent (such as diesel fuel) may be used at the discretion of the overhauler.

5.7.2 Degreasing

- Degreasing is best accomplished by immersing or flooding the part in kerosene or a suitable commercial solvent such as Varsol or Perm-A-Chlor and agitating with a brush.
- Overhaulers are warned against the use of any water-mixed degreasing solutions containing caustic compounds or soap. Such compounds, in addition to being potentially harmful to aluminium, may become impregnated in the pores of the metal and cause oil foaming when the engine is returned to service.

5.7.3 Removal of hard carbon

- While the degreasing solution will remove dirt, grease and soft carbon, deposits of hard carbon will almost invariably remain on some interior surfaces. To facilitate removal, these deposits must first be loosened by immersion in a decarbonising solution (usually heated). A variety of commercial decarbonising agents are available, including products such as Redik DKT, Gunk, Penetrol, etc. Only hydrocarbon based decarbonisers should be used: refer to the note above regarding water-mixed degreasing solutions.
- Decarbonizing will usually loosen most of the hard carbon deposits remaining after degreasing; the complete removal of all hard carbon, however, generally requires brushing or scraping. All of these operations demand care on the part of the mechanic to avoid damage to machined surfaces. In particular, wire brushes and metal scrapers must never be used on any bearing or contact surface.
- At the conclusion of cleaning operations, rinse the parts in petroleum solvent, water, dry and remove any loose particles by air blasting. Apply a liberal coating of engine oil or other anti-corrosion product to all steel surfaces.

5.8 Inspection

- The inspection of engine parts during overhaul is divided into three categories, visual, dimensional and structural. The first and last categories deal with the structural defects in parts while the second is concerned with the size, shape and fit.

Visual inspection should precede all other inspection procedures.

Dimensional inspections should be carried out in accordance with the measurements and tolerances detailed in the Table of Limits.

Structural integrity of steel components must be determined by MPI (Magnetic Particle Inspection).

5.8.1 Return to service repair work

- Some components will require repair work in order to be returned to service and this work will be performed as part of the Inspection and assessment stage.

5.8.2 High temperature operation

- The insides of pistons and the crankcase should be visually inspected during disassembly for burnt-on oil deposits that would indicate overheating and/or operation in extreme conditions.
- If such evidence of overheating is seen then the engine cooling arrangement must be inspected and possibly modified for greater cooling airflow before the overhauled engine is refitted. The Jabiru Engine Installation Manuals refer.

5.8.3 Bearing surfaces

- All bearing surfaces should be examined for scoring, galling and wear.
- Some scratching and light scoring of aluminium bearing surfaces in the engine will do no harm and should not be considered cause for rejection of the part, provided it falls within the tolerances set forth in the Table of Limits. Even though the part may come within specified limits it should not be reassembled into the engine unless inspection shows it to be free of other serious defects.
- All journal surfaces should be checked for galling, scores, misalignment and out-of-round condition. Shafts, pins etc, should be checked for straightness. This may be done in most cases by using vee blocks and a dial indicator.

5.8.4 Gears

- All gears should be examined for evidence of pitting and excessive wear. Bearing surfaces of all gears should be free from deep scratches. However, minor abrasions may be dressed out with a fine abrasive cloth. In particular the starter ring gear and the matching gear from the starter clutch are susceptible to damage and must be checked carefully.

5.8.5 Corrosion on stressed areas

- Pitted surfaces in highly stressed areas resulting from corrosion can lead to ultimate failure of the part. The following areas should be carefully examined for evidence of such corrosion: the fillets at the edges of crankshaft main and journal surfaces, connecting rods and the camshaft.
- If pitting exists on any of the surfaces mentioned to the extent that it cannot be removed by polishing with crocus cloth or other mild abrasive, the part must be rejected.

5.8.6 Magnetic particle inspection (MPI)

- All steel parts should be inspected by the magnetic particle inspection (MPI) method. The successful detection of structural failure by magnetic particle inspection demands skill and experience on the part of operating personnel.
- Too rigid an interpretation may result in the rejection of a sound part, while on the other hand, a part showing a dangerous indication may be returned to service as a result of a too casual diagnosis. In general, areas of stress concentration must be watched closely for fatigue cracks. These areas include such locations as keyways, radii in the corners of the crankshaft, gear teeth, small holes and fillets.

5.8.7 Damaged parts

- Abnormal damage such as burrs, nicks, scratches, scoring, or galling should be removed with a fine oil stone, crocus cloth, or any similar mildly abrasive substance.
- If scratches or galling are removed from a bearing surface of a journal it should be buffed to a high finish with a linishing wheel.
- Flanged surfaces that are bent, warped, or nicked may be repaired by lapping to a true surface on a surface plate. Again the part should be cleaned to be certain that all abrasive has been removed. Pipe tapped threads (NPT) must not be tapped deeper in order to clean them up, because this practice will invariably result in an oversized tapped hole.
- Following any repairs of this type, the part should be carefully cleaned in order to be certain that all abrasive has been removed and then checked with its mating part to assure that the clearances do not exceed those detailed in the Table of Limits.

5.8.8 Replacement of studs or broken cap screws

- The method of removing studs or broken cap screws depends on the type of stud or cap screw and if it is intact or broken.
- The procedure for removing studs or broken cap screws is as follows:
  1. If there is sufficient thread area available on the stud, use a collet grip tool consisting of a tapered collet that threads onto the stud and a housing that slips over the collet as shown at right. Tighten the bolt on top of the housing and draw the collet into the housing to load the puller onto the stud with a tight grip. Withdraw the stud by turning the housing. Heat may be required to loosen the Loctite.
  2. If a cap screw or stud is broken and there is not enough thread exposed to use the collet type tool, drill a small hole into the stud using a high-performance drill bit such as a cobalt high speed bit. Use a pilot bushing to guide the drill into the centre of the stud if it is broken close to or beneath the surface of the parent metal. Redrill and enlarge the hole to suit the proper size extractor, shown in Figure 63. Using the extractor, remove the stud. Again, heat may be required to loosen the Locktite. The RIDGID extractor is available from Ridge Tool Co. of Elyria, Ohio, USA or most tool suppliers. It is a very effective tool and the only screw extractor recommended by Jabiru Aircraft.

Figure 63 – Stud & Broken Cap Screw Removal

5.9 Subassembly A – Crankshaft, propeller flange and connecting rods

5.9.1 Crankshaft and propeller flange

5.9.1.1 Mandatory updates

- There are main 2 types of flywheels: alloy centred and the later model steel centred (commonly called the ‘starfish’ centre).
- If you have the alloy centred flywheel, check that the flywheel is dowelled to the crankshaft with 3 x 6mm dowels and retained with 6 x 5/16” x 1¼” UNF cap screws. Crankshafts using ¼” screws for flywheel retention must be replaced.
- Engines with the “starfish” flywheel are retained with 6 x 5/16” x 1” or 6 x 3/8” x 1” UNF cap screws. The flywheel end of the crankshaft should look like the “5/16”” or “3/8”” photos in Figure 64.
- If this is not the case and the flywheel end of your crankshaft looks like the “Old” photo then the crankshaft and flywheel must be modified before return to service and a new crankshaft timing gear must be purchased. Details of the process are given in Section 12.4.2.
- If the drilling and dowelling modification is required, complete the other cleaning and inspection steps below to determine if the crankshaft is fit for return to service in all other respects before sending it away for modification.
- Several different length dowels have been used: older flywheels without the “starfish” use 24mm long dowels. Engines using the “starfish” initially used 20mm long dowels while later versions reverted to 24mm. Refer to Section 13 for serial number ranges. In all cases the dowels are 6mm in diameter.

Figure 64 – Crankshaft End Detail (Dowel Holes)

5.9.1.2 Mandatory Discard

- Any crankshaft which has been subjected to a forced stoppage – for example from a severe prop strike or piston failure – must be discarded. Section 3.4 refers.

5.9.1.3 Optional Updates: Crank / Propeller Flange

- It is strongly recommended that during a full overhaul or bulk strip the engine configuration be updated to include 8mm dowels between the crankshaft and the propeller flange for those engines not built with this feature originally. This may require the replacement or modification of the propeller flange and crankshaft. Refer to Table 39 for S/No. at which this was introduced to production engines.

5.9.1.4 Optional Updates: Starfish Flywheel Adaptor

- Current engines use a steel adaptor between the crankshaft and the flywheel, called a "starfish" because of its shape (shown in Figure 65). While not mandatory it is strongly recommended that at overhaul engines are updated to this arrangement. The aluminium flywheel and alternator rotor are among the parts required for the update – contact Jabiru Aircraft for details.

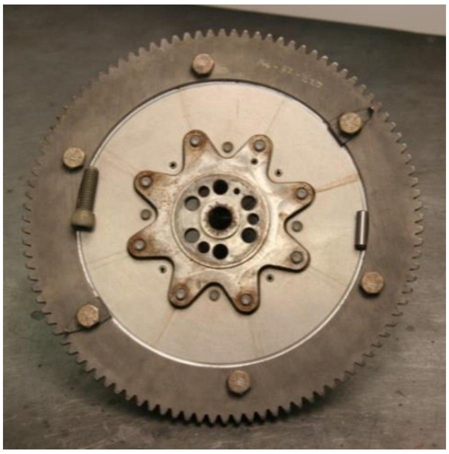


Figure 65 – Starfish Flywheel

5.9.1.5 Cleaning

- Clean away all paint from the front of the crankshaft and the propeller flange.
- Clean out all threaded holes in the ends of the crankshaft with a 5/16" or 3/8" UNF tap as appropriate then wash and blow out all debris from the holes.
- Wash the crankshaft thoroughly with kerosene, taking care to remove all of the sludge from the inside of the front main bearing: careful use of a small scraper will aid sludge removal. Individually clean each main to big end oil way drilling using a small brush or similar.
- Blow out all of the oil ways, dry the crankshaft and coat with engine oil or other corrosion preventative.

5.9.1.6 Inspection

- Inspect the internal face of the propeller flange where the screw heads & washers will seat when assembled. Ensure this surface is clean of all paint and retaining compound.
- The crankshaft and propeller flange must now be checked for straightness: lay the crankshaft between vee blocks and use a dial indicator on a magnetic base to check that the runout as measured at the very front of the crankshaft is within the range 0.01 to 0.05mm. Upper limits for crank run-out are given in Table 10.
- Now mount the propeller flange onto the crankshaft with 3 cap screws and position the crankshaft so that all end float is negated then check the propeller flange for straightness at the outer face of the flange with the dial gauge.
- Typical flange run-out should be in the range of 0.02 - 0.06mm. Upper limits are given in Table 10. Run-out exceeding these limits would indicate the requirement for a new propeller flange, assuming that the crankshaft is within tolerance.
- Note that this measurement can also be carried out with the crank fitted into a crankcase – provided that the case is fitted with the front, rear and thrust bearings.
- Measure the main and big end journals with a micrometer. The main bearing and big end journals must measure in the limits given in Table 10. Earlier cranks are 47.918 to 47.938 while later parts are 47.930 to 47.950. Ultimately the clearance between crank and bearings determines if a crank can be re-used. This must be checked before deciding if a replacement is necessary or not – acceptable clearances are given in Table 12.

Figure 66 – Crankshaft Measurement

- Measurements should be taken at several points around each journal and averaged. Note that it is unusual to find any significantly out-of-round journals.
- Check the oil holes in each journal (main and big end) for a radius. If a radius is not present then use a fine linishing or polishing wheel to create a radius – there must be no sharp edges that could form a stress point anywhere on the crankshaft.
- Check around the centre holes in the crank web for a radius: once again there must be no sharp edges that could form a stress point anywhere on the crankshaft. Older engines are more susceptible to this but new cranks should still be checked.
- A polishing wheel in a Dremel can be used to put a radius on the crank centre holes - see Figure 67.
- The overhauler must also check all oil galleries in the crankshaft are clear before installation. This can be done by feeding a piece of steel wire through the galleries. Note that this is also necessary with brand-new crankshafts to ensure that there is no swarf or other debris lodged in a gallery.

- The crankshaft and propeller flange must now be inspected for structural integrity with MPI (Magnetic Particle Inspection).

Figure 67 – Radius Crank Centre Holes

5.9.2 Connecting rods

5.9.2.1 Mandatory updates

- Connecting rods must be the current machined billet steel type as shown in the photo below.
- Older alloy or alloy-steel rods must be replaced with new steel rods.

Figure 68 – Steel Con-Rod

5.9.2.2 Mandatory Discard

- In any case where a rod has been subjected to severe loads – for example if the piston struck a valve – the rod must be discarded.

5.9.2.3 Cleaning

- Clean out the threads in the end cap with a 5/16" UNF tap.
- Extract the locating pins from the rods and wash out all debris from the holes.
- It may be necessary to lightly polish the inner bore of the little end of the rod. A build up of burnt oil or varnish here can make fitting the gudgeon pin difficult. This can be done by hand using fine emery paper or using a fine-grade flapper wheel on a die-grinder or Dremel. Only oil deposits must be removed – not metal.
- Wash the connecting rods thoroughly with kerosene and blow dry.
- Coat with engine oil or other corrosion preventative.

5.9.2.4 Inspection

- Inspect each rod visually for straightness and marking. Note that each rod/end cap pair is marked with a unique ID number and must only be refitted as a matched pair.
- The connecting rods must now be inspected for structural integrity with MPI (Magnetic Particle Inspection). Note that for MPI the rod must be as clean as possible – usually all burnt oil deposits must be removed.
- The rods must be subjected to a thorough visual inspection for straightness / trueness. As noted above, any rod which has been subjected to unusual loads must be discarded but otherwise a careful visual inspection of these parts is sufficient. Uneven bearing wear or abnormal little end wear are indicators of an untrue rod.

5.10 Subassembly B – Crankcase, camshaft and oil pump

5.10.1 Crankcase

5.10.1.1 Mandatory updates

- Check the rear camshaft bearing in either case half – there should be an oil channel 2mm wide and 2mm deep running from the rear main bearing oilway to the rear cam bearing as shown at right.
- If this channel is not present it must be cut into a case half at this time (only 1 case needs to be modified – not both).
- Clean the case thoroughly after any such work.

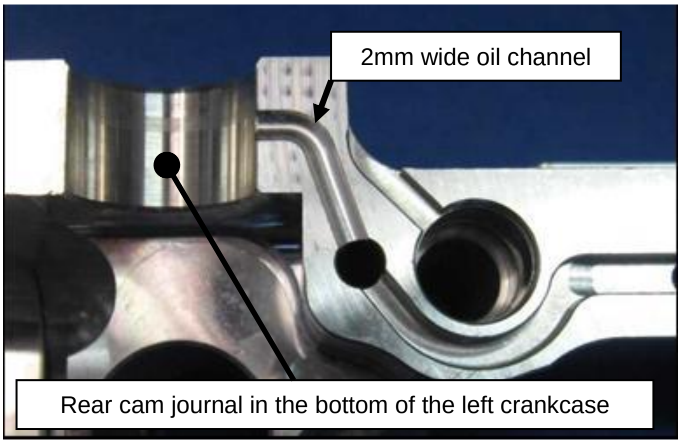


Figure 69 – Rear Cam Journal Oil Feed

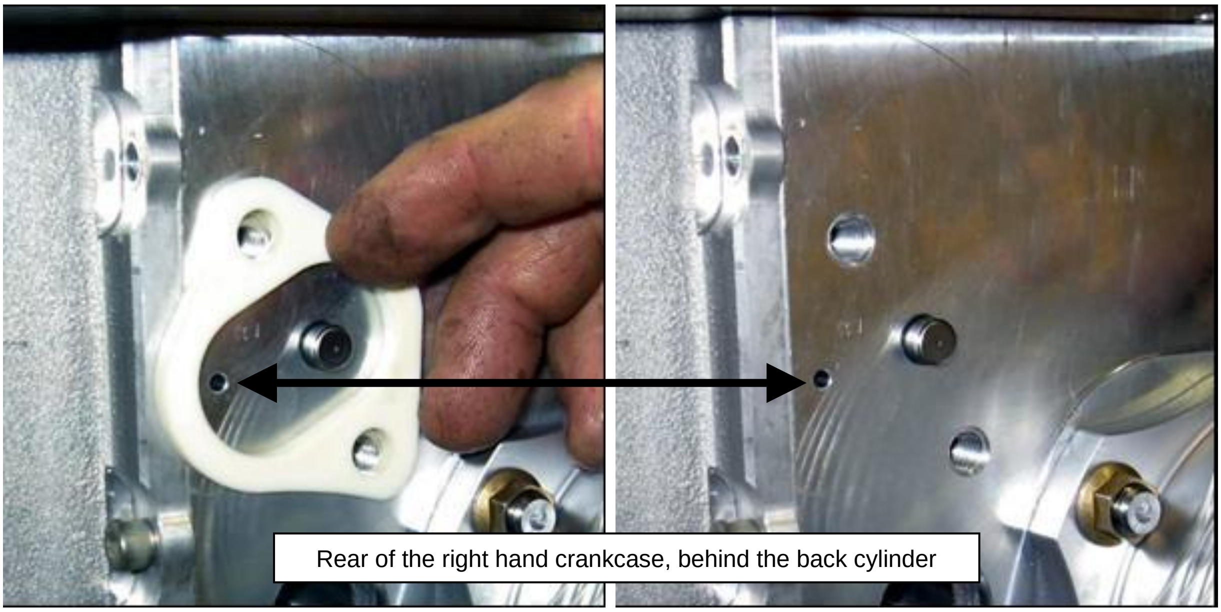


Figure 70 – Fuel Pump Oil Drain

- Check under the fuel pump drive rod for the presence of an oil return hole through the crankcase wall.
- If a hole is not present then position the fuel pump spacer over the stud holes, mark a position near the bottom of the cavity and drill a 1/8" hole through the crankcase wall as arrowed in the photos above. Radius each side of the hole and clean away any drilling debris.
- Very old 2200 engines did not have a "strainer" fitted to the oil pump pickup. For these engines a strainer must be fitted at overhaul – this may also require fitting a new oil pump pickup tube.

5.10.1.2 Optional Updates

- For hydraulic lifter engines the oil return manifolds shown in Figure 57 can be retrofitted. These parts improve the oil flow from the rocker chamber in the cylinder head back into the sump. Note that to use these parts shorter pushrod cover tubes are also required.
- Contact Jabiru Aircraft or our local representative for more information

5.10.1.3 Mandatory Discard

- In any case where fretting is found all engine through-bolts and studs must be replaced with new items. This is because fretting is a sign of stress within the crankshaft assembly components and means that the through-bolts and studs may have been subjected to excessively high loads and fatigue damage.

5.10.1.4 Cleaning

- Clean both crankcase halves thoroughly with kerosene. Remove the front and rear oil gallery NPT plugs from the left hand case and flush the galleries through. Clean out all threaded holes with the correct size UNC tap then wash and blow out all debris from the holes. Use a scraper made from Perspex or similar material to remove any sealing compound from the jointing surfaces.
- Blow through all oil galleries and take particular care that absolutely no dirt or debris remains in any part of the cases. Use a piece of steel wire to push through all oil galleries to check for debris – this is particularly important if the case has been line bored.

5.10.1.5 Crankcase Inspection and repair

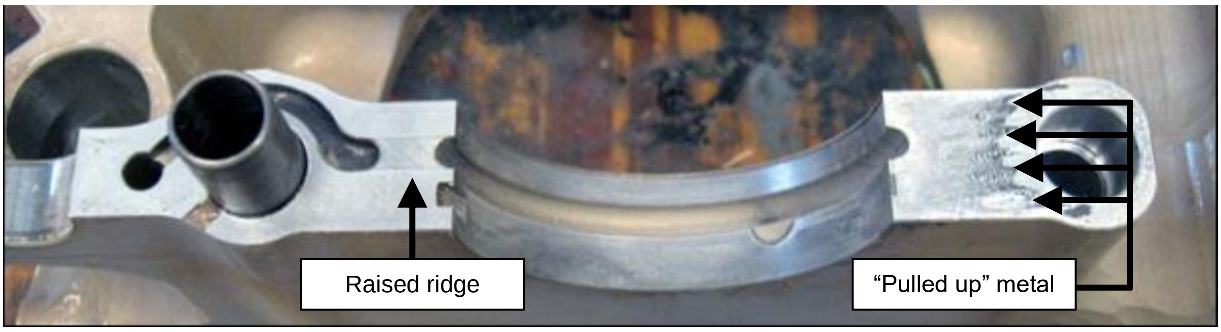


Figure 71 – Crankcase Fretting

- Inspect the cases for fretting around the main bearing posts. If fretting can be detected (either by observation and/or by feeling roughness against your fingernail across the affected area – see Figure 71) then it must be corrected by having both case halves surface skimmed and the bearing tunnels bored to the correct dimensions before return to service.
- If fretting has occurred then a complete set of new crankcase studs must be purchased and fitted during assembly, and the crankcase dowels must be shortened at one end by 0.5mm, then re-radiused / de-burred. A detailed explanation of crankcase fretting is included in this manual in Section 12.3.
- Clamp the case halves together using the old studs & nuts with 8mm packers under the nuts, torque to the value given in Table 9 for through bolts (use the value appropriate to the through bolt thread on the particular engine). Torque in 3 stages, working from the centre studs out to the front & rear studs. Measure the main bearing and camshaft bore sizes horizontally and vertically as shown in Figure 72.

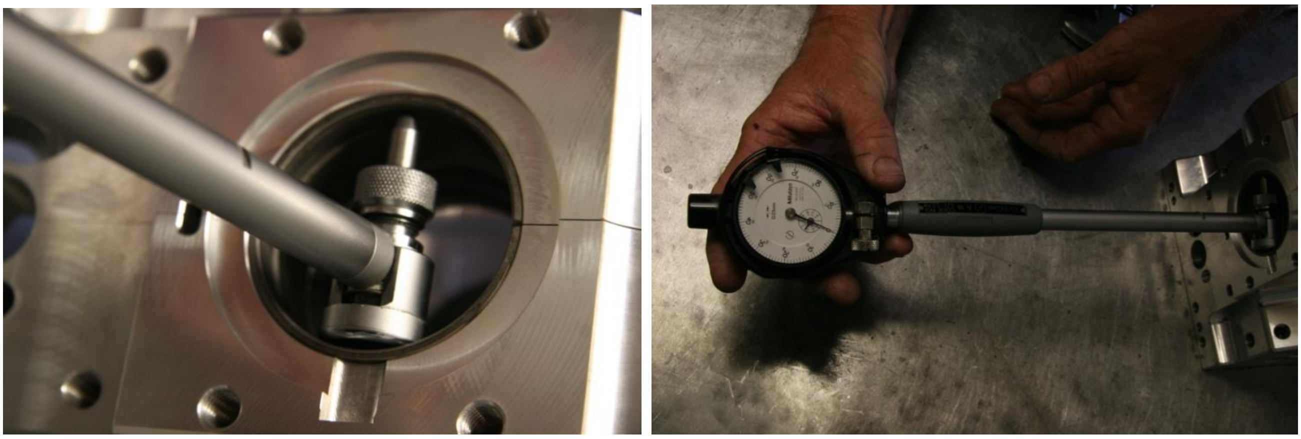


Figure 72 – Measuring Crankcase Bearing Tunnel

- The main bearing tunnel and the camshaft tunnel must both measure within the limits of Table 10. If the crankcase is not within these tolerances then both case halves must be surface skimmed and the bearing tunnels line bored to the correct dimensions before the crankcase can be returned to service. Again note that the target of these measurements is to get the crank – bearing clearance in the target range (Table 12). Depending on the measurements of the crank etc values outside those listed may still be acceptable provided that the clearances are within tolerance. Crank-main bearing clearances and cam-case clearances must be within the limits specified in Table 12.
- Where cases have been skimmed the main bearing and cam tunnels must be line bored per Table 10 for correct bearing fit up. This job can only be done by competent machine shop operators.

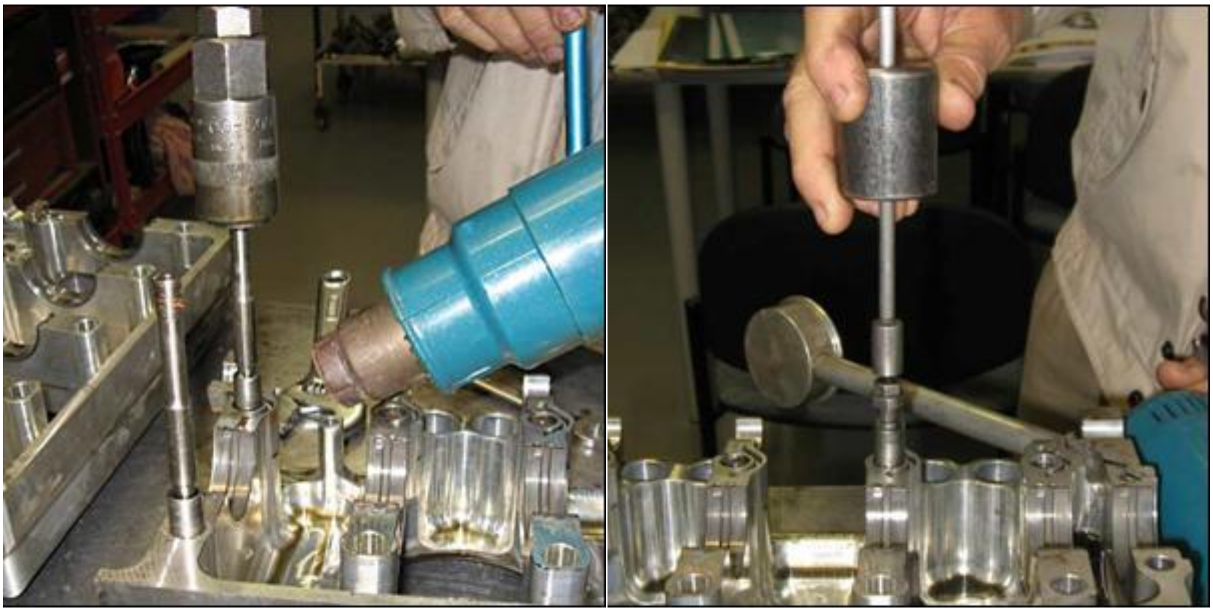


Figure 73 – Removing Studs and Dowels from Crankcase

- If the case is to be surfaced and line-bored then all dowels and studs must be removed from the crankcase. Use a collet type stud remover to unscrew the retained studs from the crankcase. Gentle application of heat will assist the removal as shown above. Extract the dowels from the lower stud holes – in Figure 73 an expanding puller is being used to pull the dowels out of the case. Clean the stud holes with an M10x1.5 tap (an old stud with grooves cut in the thread to act as a tap may also be used) and clean and dry the cases.

5.10.1.6 Main Bearings

- Examples of main bearing wear are shown below.
- Note that the use of automotive oils or oil additives has proven to cause very rapid wear in Jabiru engines. An air-cooled aero engine is operating at higher power settings and significantly higher temperatures than a car engine – and Jabiru engines hold less oil than a normal automotive engine. This puts a lot more pressure on the oil and unless the oil is specifically designed for the application it can break down, leading to rapid wear of the engine.

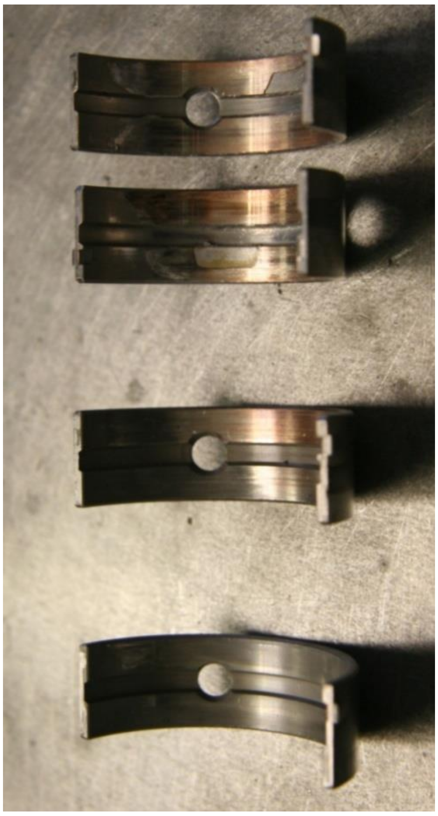


Figure 74 – Main Bearings

- The upper two bearing shells show severe wear. With wear this severe Babbit material would have been visible in the element during an oil filter inspection.
- Damage of this sort can be caused by dirty oil, the loss of oil pressure, use of automotive oil, oil additives or long-term operation with excessive oil temperatures.
- Uneven wear, with the Babbit material exposed.
- Normal wear – very little visible wear.

5.10.2 Hydraulic Valve Lifters

5.10.2.1 Mandatory Updates

- None for engines with solid valve lifters.

5.10.2.2 Mandatory Discard

- All Hydraulic valve lifters must be replaced at 1000 hours total time in service.

5.10.2.3 Cleaning – Hydraulic Lifters

- If required, the hydraulic lifters can be dismantled and cleaned quite simply using a solvent such as kerosene. However, extreme care is needed to make sure that each lifter is re-assembled correctly. The lifters contain many small parts which must be oriented correctly for the valving of the lifter to work. Note also that different lifters often have subtly different internal parts. Generally, as the lifters are relatively cheap, it is preferable for the overhauler to fit new parts instead of cleaning the old lifters.
- The base of the inside of the lifter tends to accumulate sludge and must be cleaned if it is to be re-used.
- Lifters must be cleaned and dried thoroughly before re-installation.

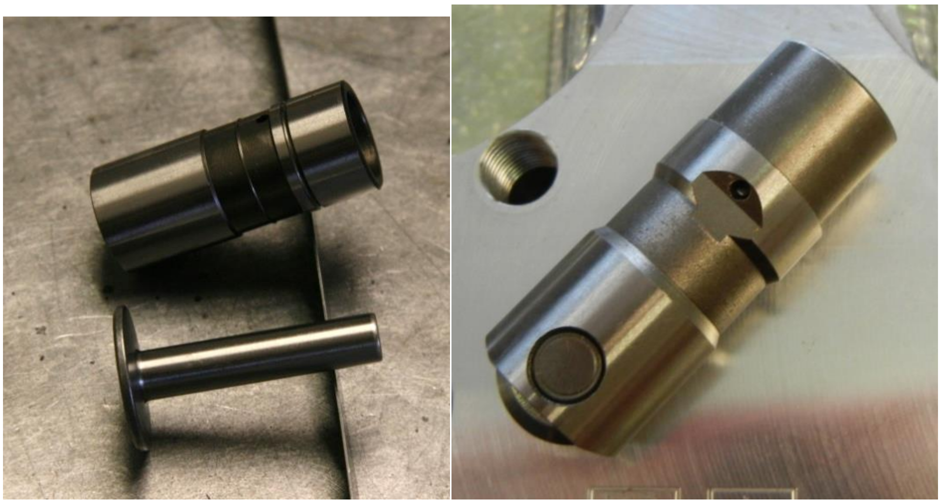


Figure 75 – Hydraulic Lifter (top left), Solid Lifter (lower left), Roller Follower (right)

5.10.2.4 Inspection

- If hydraulic lifters are removed for servicing they must be inspected for wear on the camshaft contact face. Note that the lifters have a slightly convex (dome-shaped) base. A straight edge placed over the base (Figure 76) should not quite sit flat on the base – a small gap must be visible at either side. A lifter which has worn flat must be discarded. The lifter must also be replaced is there is any other adverse wear of the lifter base – such as galling or pitting of the working surface.
- Before installation all hydraulic lifters must be polished around their base as shown below to remove any burrs and to polish off the sharp corner which can otherwise damage the cam. This is done using a “Scotch Brite” wheel on a bench grinder or similar – very little material is removed, just enough so that the corner feels smooth instead of sharp.
- Solid lifters require a careful inspection at full overhaul. The camshaft contact face of the solid lifter is flat and can be checked for wear using a straight edge.

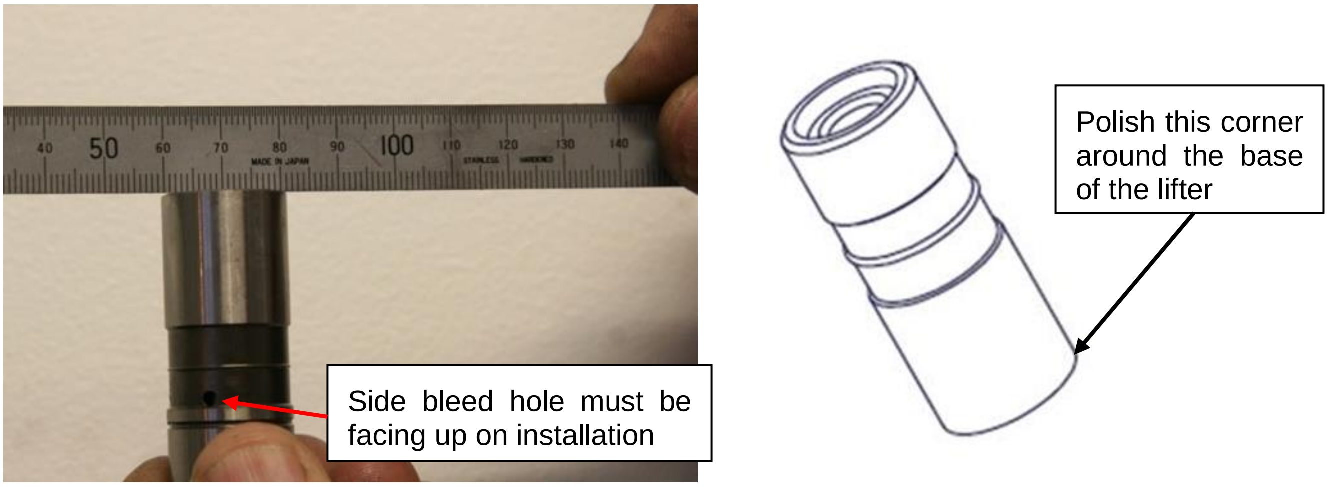


Figure 76 – Hydraulic Lifter Inspection

- Prior to installation hydraulic and roller follower lifters must be primed by injecting oil into the lifter. Non-roller hydraulic lifters must also be installed with the side bleed hole facing upwards. This allows the lifter to adequately bleed any remaining air during initial running.

5.10.3 Camshaft

5.10.3.1 Mandatory updates

- Check the camshaft material (all engines) – solid lifter cams made from a casting (indicated by the camshaft being hollow) must be replaced with a current billet steel solid lifter camshaft and new lifters.
- Check the camshaft identification:
  - solid lifter engine camshafts will have no markings around the front of the cam at all, indicating a solid lifter camshaft

- Hydraulic lifter engine camshafts have 2 dots on the flange and 2 rings around the front of the camshaft to indicate a hydraulic lifter camshaft. The photos above show a hydraulic lifter (260° duration, non-roller) camshaft.
- If the camshaft in your hydraulic engine has a single ring around the front (285° duration) it must be replaced with a current 2 ring camshaft and new lifters to suit at overhaul.
- Engines equipped with roller followers use a different cam which is not marked with ID rings. This part can be easily identified by the more rounded shape of the cam lobes (Figure 78)

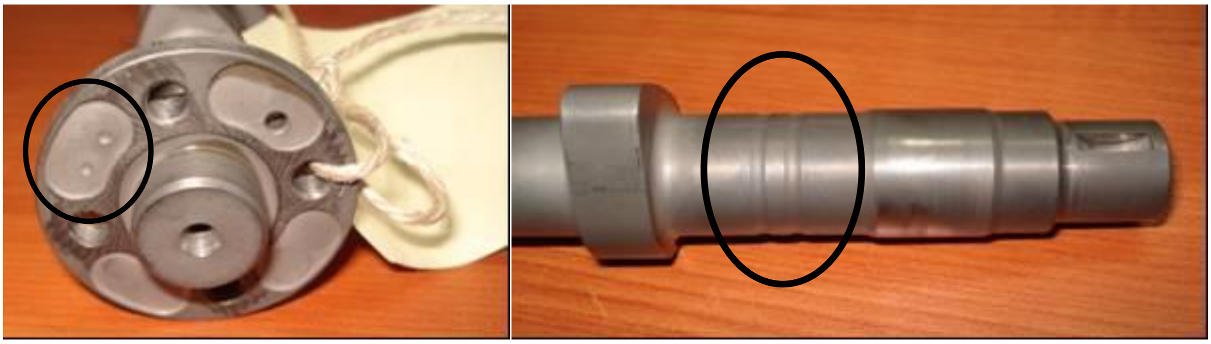


Figure 77 – 2-Ring Camshaft

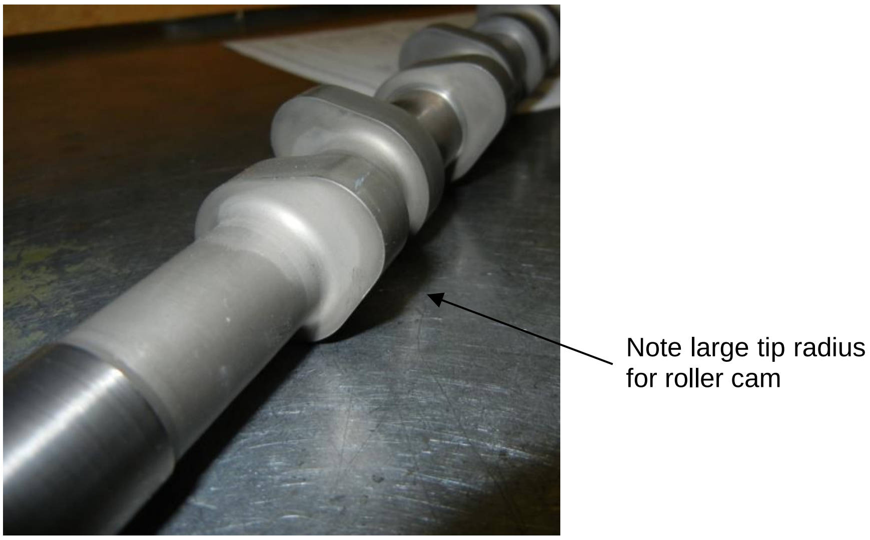


Figure 78 – Roller Cam Lobe

5.10.3.2 Cleaning

- Clean out the 4 threaded holes in the rear flange with a 1/4" UNF tap.
- Clean the camshaft with kerosene and dry.
- Coat with engine oil or other corrosion preventative.

5.10.3.3 Inspection

- Visually inspect the lobes for any abnormal wear patterns and any chipping around the sides of the lobes. Any chipping or signs of wear through the hardened surface will require a new camshaft. Inspect the lifters for signs of wear on the face. If replacing the camshaft the lifters must also be replaced.
- The camshaft and the camshaft drive gears must now be inspected for structural integrity with MPI (Magnetic Particle Inspection).
- The overhauler must be aware that of the different types and combinations of camshafts and lifters fitted to Jabiru engines over the years currently only three combinations are approved: a solid lifter (zero ring) cam with solid lifters, a hydraulic lifter (260° duration, 2-ring) cam for hydraulic lifters and a roller follower cam (rounded lobes) for roller follower engines. Engines with other configurations must be updated to an approved configuration at overhaul.

5.10.4 Oil pump

5.10.4.1 Mandatory updates

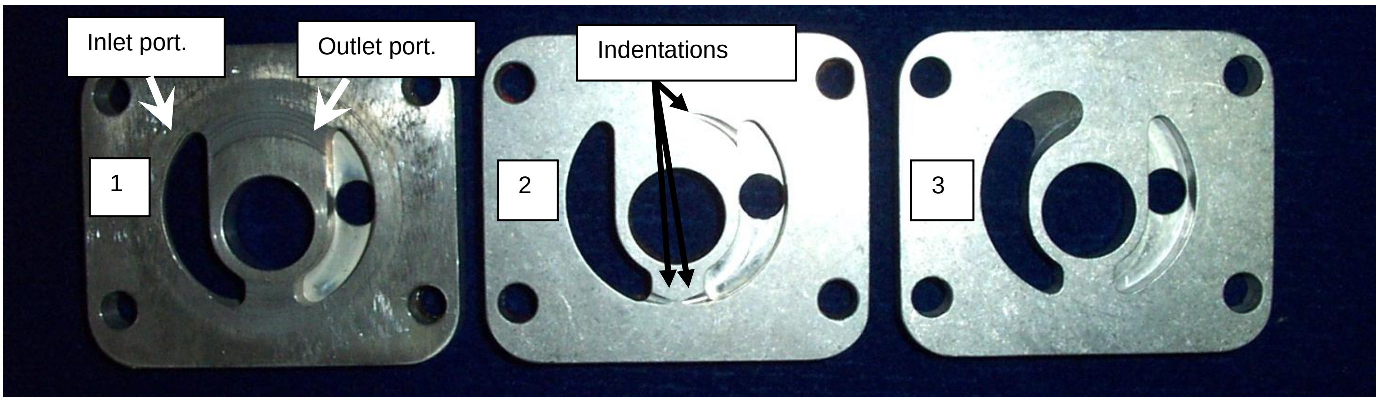


Figure 79 – Port Plate Evolution

- Jabiru Service Bulletin JSB004 also refers to this part. The original design for the oil pump port plate could suffer from cavitation which in turn caused pressure spikes and damage to the oil cooler. During overhaul old oil pumps must be modified as detailed below or have a new port plate fitted.
- Figure 79 above shows 3 different styles of oil pump port plate.
  - Plate #1: This is the original design, with the port plate outline unbroken by indentations.
  - Plate #2: This is an intermediate design. At the top of the outlet port and at the bottom of both ports there are small tapered indentations. Some versions of this plate will only have the larger indentation at the top of the outlet port, and not the pair at the bottom. Again, this design plate must be reworked to be equivalent to Plate #3.
  - Plate #3: This is the current plate design. The small indentations have been replaced by a large tapered cut at the top of the inlet port. Changes have also been made to the other side of the plate (which faces the crank cases) to remove sharp edges & reduce cavitation.
- Plates like Plate #1 & Plate #2 can be modified to be equivalent to Plate #3. Where the plate already has the indentation on the top of the outlet port, care must be taken to leave at least 2mm between it and the end of the new cut on the inlet side.

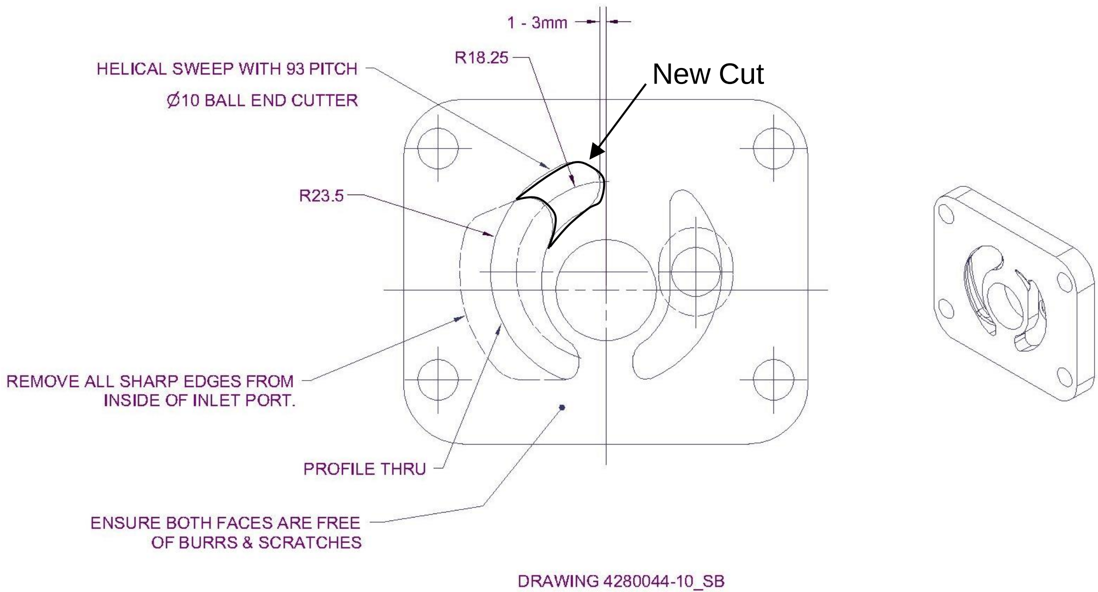


Figure 80 – Modified Port Details

- This work can be carried out by hand using a Die Grinder or similar tool. Jabiru Aircraft can provide a 1:1 template if required. This work requires the disassembly of the oil pump and should only be carried out by an approved person with appropriate skills.
- Alternatively a new port plate may be fitted.

5.10.4.2 Cleaning

- Wash the pump rotors and housing thoroughly and dry.
- Coat the pump rotors with engine oil or other corrosion preventative.

5.10.4.3 Inspection

- Basic measurement methods of the Oil pump gears and housing does not indicate if these components are serviceable. To qualify these parts for reuse and serviceability, check operational history of the oil pump and if oil pressure readings have been within accepted parameters, the pump will not require replacement. In lieu of this, a check of the oil pressure readings during the test run of the engine will indicate serviceability of the pump. Oil temperature must be at least 85°C for this test to be valid.
- Note that the inner and outer rotors each have a machined alignment markings used during installation.
  - For the **narrow lobe pump** These alignment markings must both face in the same direction.
  - For the **broad lobe pump** these markings must face in the opposite direction.
  - The difference between the narrow and broad lobe pumps is illustrated below in Figure 81.
- Note also that the alignment markings will move in relation to each other as the inner rotor rotates in relation to the outer rotor.

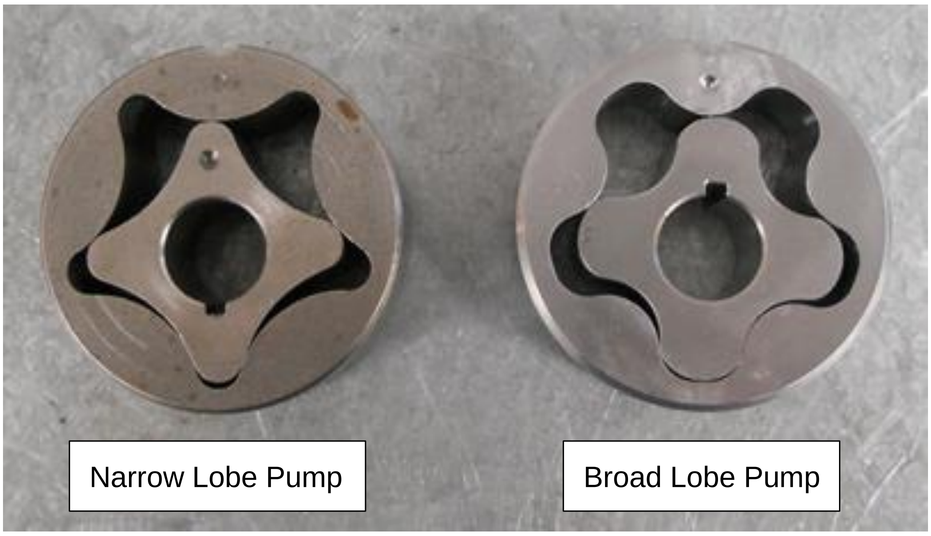


Figure 81 - Narrow and broad lobe pumps

It should be noted that some of the broad lobe inner gears have a line marking, as shown in the figure below, this should be installed face down. In other words the line on the inner gear should not be visible at the same time as the dot on the outer gear (like in Figure 81 above). Inner gears with no markings are non-directional.

Figure 82: Broad lobe inner gear with line marking.

5.10.5 Oil Pressure Relief Valve

5.10.5.1 Mandatory updates

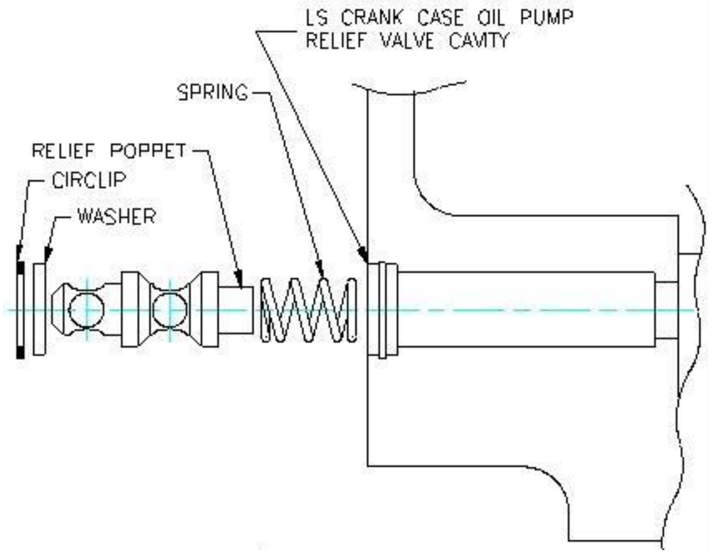


Figure 83 – Oil Pressure Relief Valve

- Relief poppets manufactured from brass must be replaced with steel items as they can wear at an accelerated rate.

5.10.5.2 Cleaning

- The oil pressure relief valve assembly is located underneath the oil filter / oil cooler adaptor on the side of the crankcase as shown in Figure 83.
- Wash the components of the valve thoroughly with kerosene and dry.

5.10.5.3 Inspection

- Visually inspect the poppet for wear. If it has a significant worn ring where it has been sitting against the washer then the marks must be polished out or the poppet replaced.
- Take note of the number of washers fitted under the relief valve spring – fitting more washers is a method of adjusting the average oil pressure of the engine – more washers = higher oil pressure. For a solid lifter engine high oil pressure is not a problem (within the set limits) however a hydraulic lifter engine needs mid-range oil pressure to operate properly. This will be adjusted during the engine test run. AN4 type washers are used with 1 being fitted as standard during factory assembly. Up to 3 can be used – more than 3 will result in coil-binding of the spring and relief valve malfunctions. Valve function can be checked by depressing the poppet and to ensure it can move off the seating washer.

5.11 Subassembly C – Pistons, cylinders and cylinder heads

5.11.1 Pistons and cylinders

- Complete overhaul: mandatory replacement of pistons, piston rings, gudgeon pins and piston circlips. Cylinders may require replacement as after honing if they do not have enough wear left to complete another cycle. Note that a light, quick hone is generally all that is required.
- Top end overhaul: mandatory replacement of pistons, piston rings and piston circlips.

5.11.1.1 Mandatory updates

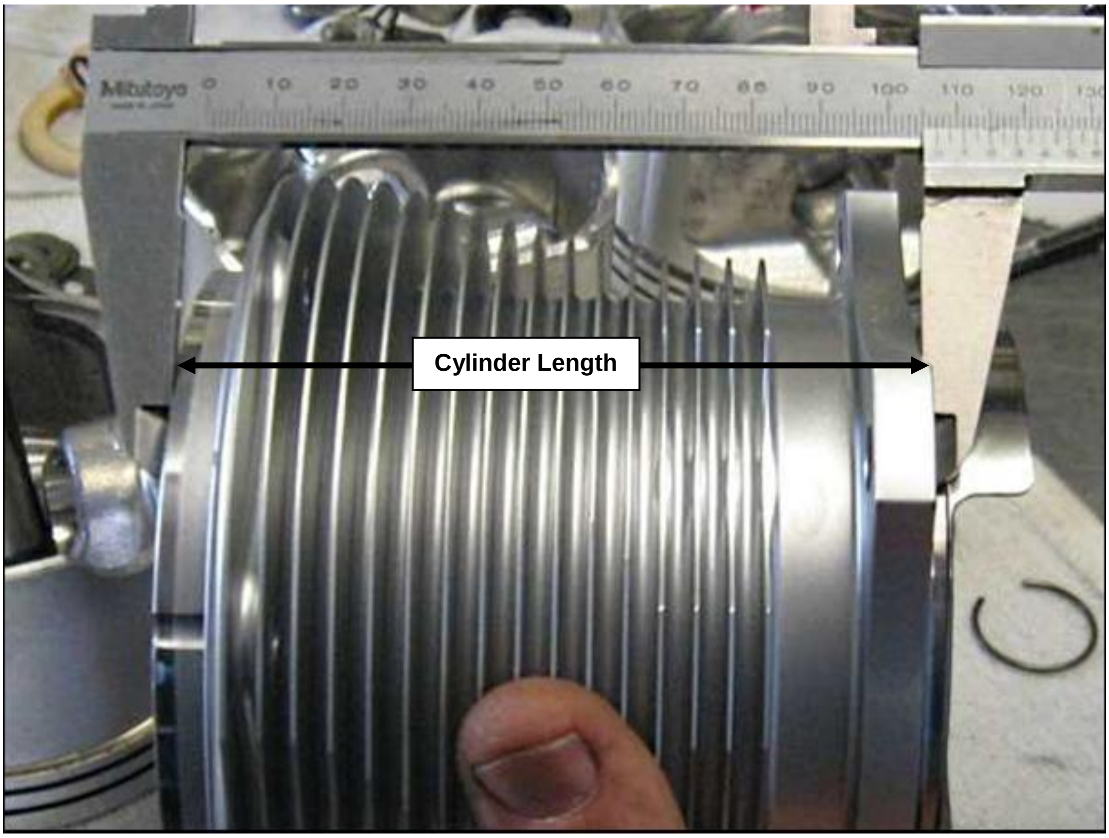


Figure 84 – Measuring Cylinder Length

- Top end overhaul: measure the length of the cylinders and any shims fitted – combined cylinder/shim length must be within the limits given in Table 10 when measured from the base flange to the top of the bore as shown above.
- Shorter cylinders must be replaced with longer cylinders. Alternatively 1.00mm or 0.50mm shims may be cut to suit the base of the cylinder and fitted between the cylinder and the crankcase. Note that only 1 shim can be fitted to any barrel – for example fitting 2 off 0.5mm shims to increase the barrel assembly length by 1mm is not acceptable. This distance is used to set the compression ratio of the engine and short cylinders give higher compression with reduced detonation tolerance.

WARNING

On no account may cylinders or cylinder / shim assemblies shorter than the minimum length given in Table 10 be used.

5.11.1.2 Cleaning

- **Top End Overhaul / Full Overhaul:** Pistons are to be replaced.
- If conducting maintenance: clean the pistons in a decarbonising solution. Clean the ring lands out carefully using a non-metallic scraper – a piece of Perspex is often useful for this task. A piece of broken piston ring can be used with extreme care but is not recommended because of the damage to the piston which may result – any other type of metal scraper is discouraged for the same reasons. Take care not to scratch the base or sides of the ring lands – this will inhibit ring sealing which may lead to blow by and other related problems. Wash the pistons with kerosene then soapy water, rinse and dry.

- Clean the cylinders thoroughly with kerosene, dry and apply engine oil or other corrosion protection to the bores immediately.
- After measuring, if a cylinder is deemed fit for re-use it should be lightly honed. Cylinders outside the limits given in Table 10 at the mid-bore are unfit for re-use.

5.11.1.3 Inspection and repair

- Note that whenever measuring cylinders or pistons measurements must be made both in the line of the gudgeon and at 90 degrees – as shown in Figure 85 (right). This is because wear of these parts is usually higher in one orientation than the other.

Figure 85 – Measuring Cylinders & Pistons

- **Top End Overhaul / Full Overhaul:** New pistons are to be fitted.
- Measure the cylinder diameters at approximately half stroke; for a top end overhaul they must not exceed the limits noted in Table 10 to be to be returned to service. A cylinder which measures smaller than this measurement will give 1 to 2 cycles further use if operated and maintained correctly. After measuring, check carefully for signs of ovality: measure at 3 equally spaced intervals around the bore.
- Measure the piston diameter and calculate the clearance between the cylinder wall and the piston: it must be within the limits given in Table 12 in order for the piston and cylinder combination to be returned to service.
- If the clearance is greater outside the limits given in Table 12, new cylinders must be fitted.
- **During Other Maintenance:** Check the side clearance of the top 2 rings (the gap between the side of the ring and the ring land on the piston). If the side clearance is outside the limits given in Table 12 new pistons must be ordered.
- Note that recent pistons incorporate an increased ring sliding clearance of 0.05mm to 0.10mm. Wire circlips on the gudgeon pin were also replaced with standard 25mm ID circlips at this time. 23mm internal circlips are also used on some engines.
- **Full Overhaul:**
- Measure the cylinder diameters at approximately half stroke; for a full overhaul they must not exceed the limits noted in Table 10 to be to be returned to service. A cylinder which measures smaller than this measurement will give 2 cycles further use if operated and maintained correctly. After measuring, check carefully for signs of ovality: measure at 3 equally spaced intervals around the bore.
- Measure the piston diameter and calculate the clearance between the cylinder wall and the piston: it must be within the limits given in Table 12 in order for the piston and cylinder combination to be returned to service.
- If the clearance is greater outside the limits given in Table 12, then parts must be changed – pistons or cylinders – to obtain correct clearance.
- If returning the cylinders to service, bead blast the outer cylinder area (fins and cylinder base) to remove all old paint and rust, then etch prime and paint with a high-temperature paint.

- The bores must then be lightly honed with a Sunnen brand MM33-J58 stone or equivalent so that a 30-40° crosshatch pattern is visible in the bore as shown in the drawing at right.
- This will allow the new rings to bed in quickly and minimise oil consumption for the rest of the cycle.
- Run a 5/16" UNF tap through the head bolt threads to clean any debris out that might cause incorrect torque readings.
- Wash the cylinder thoroughly with kerosene and then hot soapy water, rinse, dry and coat the bore with engine oil or other corrosion protection immediately.

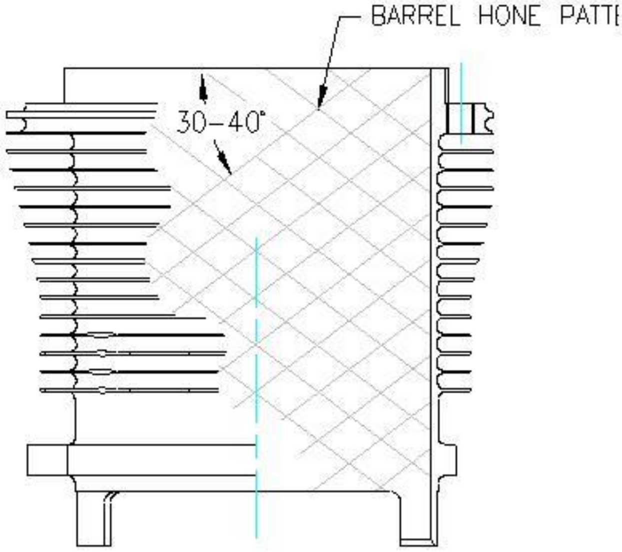


Figure 86 – Cylinder hone Pattern

5.11.1.4 Weighing

- Weigh piston / connecting rod / gudgeon pin / circlip / piston ring assemblies.
- Verify that each assembly falls within the limits given in Table 10.

5.11.2 Cylinder heads

- **Complete Overhaul:** mandatory replacement of cylinder head bolts, valves and collets.
- **Top End Overhaul:** mandatory replacement of cylinder head bolts and valve collets.

5.11.2.1 Mandatory updates

- **Top end Overhaul:** Older cylinder heads should be upgraded to the current "fine fin" model.

5.11.2.2 Cleaning

- **Top End Overhaul:** Run a 12mm tap through the spark plug threads.
- Clean the cylinder heads: bead blast the combustion chambers and valve seats.

5.11.2.3 Inspection and repair

- **Top End Overhaul:** Check for cracks between the valve seats and for movement of the valve seats in the cylinder head. Also check for cracking around the exhaust manifold stud threads. Dye penetrant testing may be required.
- Figure 87 (right) is a cylinder head in which the cylinder has crushed into the cylinder head. This can be caused by over-tensioning or operating the engine with too-high CHT's. This is not acceptable for re-use as it alters the engines compression ratio.

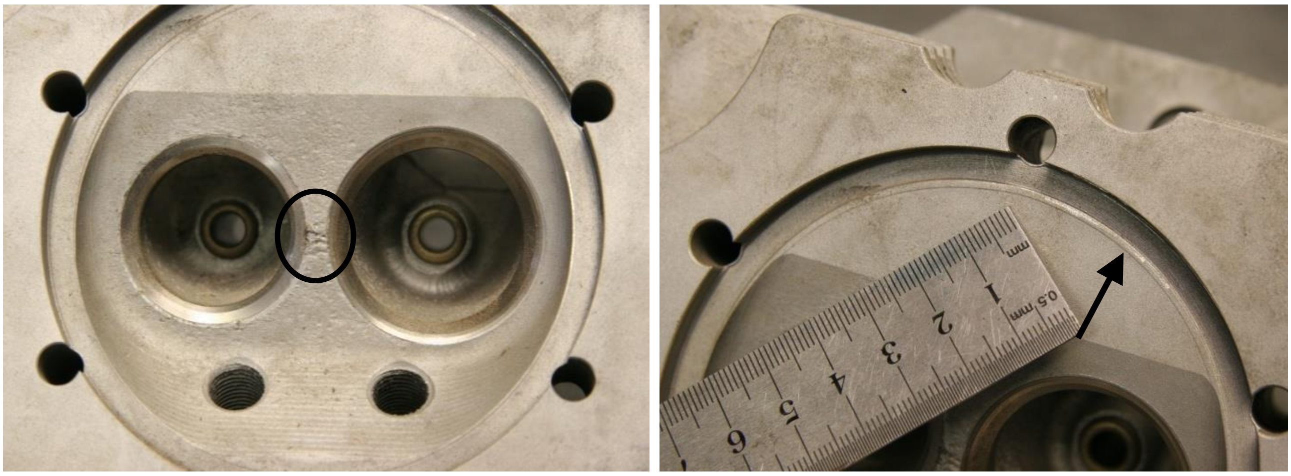


Figure 87 – Cracking Between Valves, Recessed Cylinder Spigot

5.11.3 Valves

- **Top End Overhaul:** Visually inspect each valve for any signs damage: this may include burnt seats, scoring of the stem or necking of the stem. This is a useful check as it will indicate very poor maintenance. Valves are replaced at both top end and full overhauls.
- Check that the heads of the valves protrude into the combustion chamber by the amount indicated in the drawing below – if the heads of the valves are recessed into the roof of the combustion chamber then new cylinder heads must be fitted. It is recommended that overhaulers do not attempt to replace the valve seats in the heads as this job requires special tools and extreme temperature differences.
- If refacing is required the inlet and exhaust faces should both be ground to 45°. Both valve and seat face have a parallel contact of 45° - there is no undercutting.

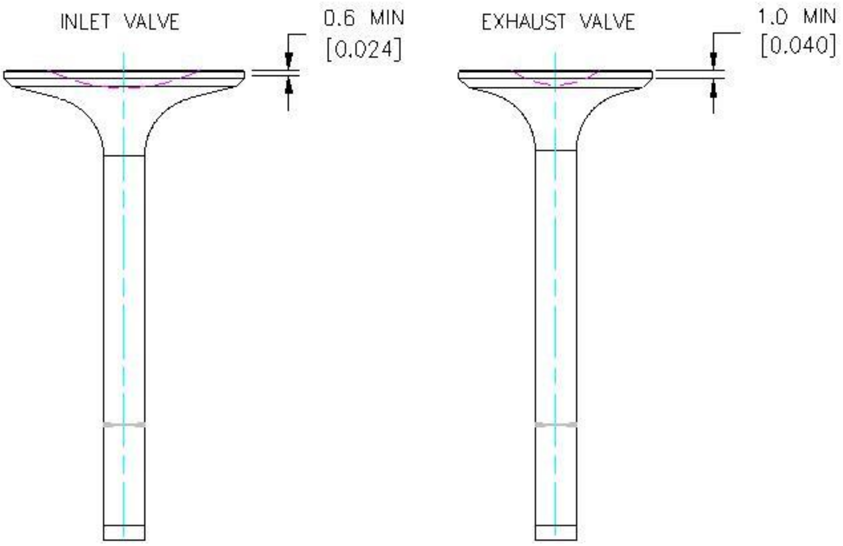


Figure 88 – Valve Measuring

5.11.3.1 Inspection and repair

Figure 89 – Valve Damage

- Figure 89 shows various types of valve damage. From left to right they are:
  1. Valve stem necking caused by the exhaust valve operating for some time with poor sealing. The exhaust gas leaking past the seat overheated the valve stem with the result as shown.
  2. A valve showing burnt residue on the valve seal face and rust on the valve stem from incorrect long term storage.
  3. A non-sealing valve.
  4. A badly burnt valve – this has run for many hours, allowing the exhaust gas to burn away the sealing face.

5. A failed valve. This can occur due to the valve sticking and being struck by the piston (intake valve) or by the valve being overheated and cracking (exhaust valve).

WARNING

Damage caused by valve sealing is a progressive process. If caught early the fix will be simple and cheap – if allowed to develop the repairs can be major and expensive.

- As a part of the daily inspection the engine must be turned over (or "pulled through") by hand while it is cold. This allows the operator to feel the compression of each cylinder in turn and assess if any cylinder is leaking. Tests like this will normally catch a poorly sealing valve before damage becomes critical.

5.11.4 Valve guides

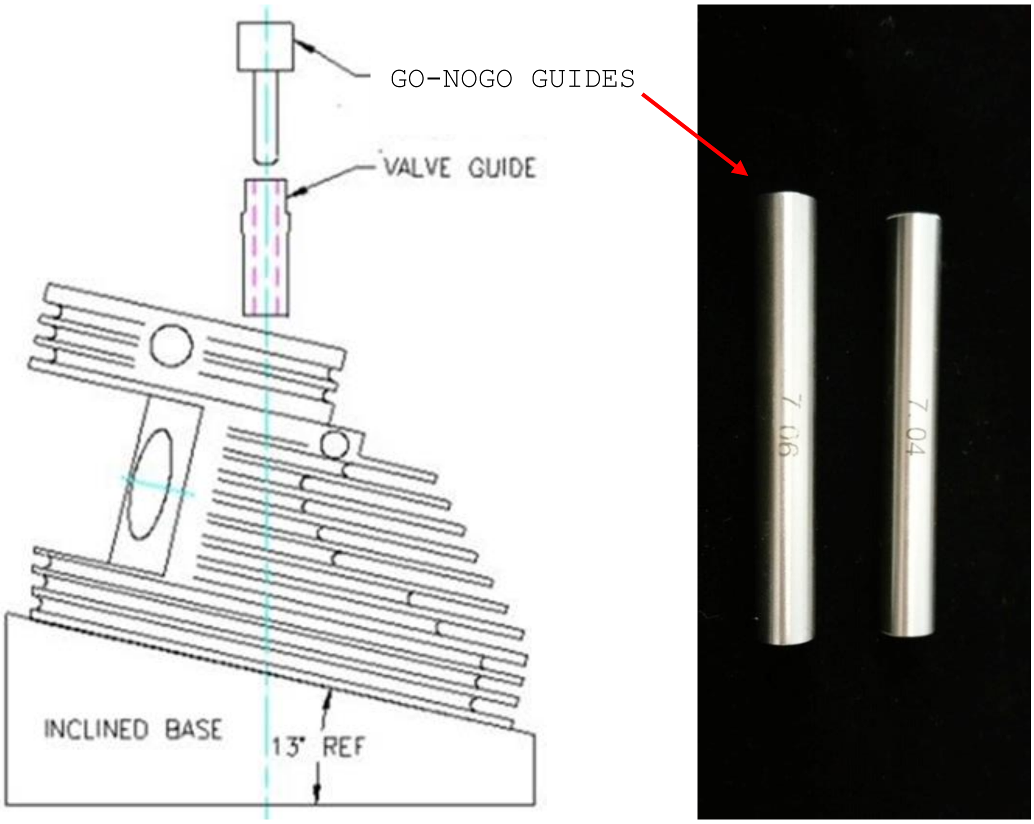


Figure 90 – Valve Guides

- **Top End Overhaul:**
- Use a micrometer to measure the valve stem diameter and a Go-No go gauge to measure valve guide bores and calculate the clearance: it must be within the limits set in Table 12. If the clearance is greater than this then new valve guides must be purchased and fitted.
- There is no point returning a cylinder head to service if it has valve guides already worn close to the maximum allowable – before the engine has completed its next cycle the guides will be unserviceable. Refer also to Section 12 for details.
- It is unusual for guides to need replacing after 1 cycle (1000 hours) however it can happen.

Figure 91 – Measure Guide Wear (Telescopic Gauge Left & Middle, Go-No-Go Gauge Right)

- An alternate method for measuring valve guides is to use a Go-No Go gauge as shown in Figure 91. The gauges must be machined very accurately to the required size. Gauges sizes of 7.04, 7.05, 7.06, 7.07mm etc are recommended. Figure 15 also shows these tools.
- We strongly recommend having a specialist fit the new valve guides.
- Heat the cylinder head evenly (using an oven or other uniform heat source) until the old guides can be driven out easily.
- If the head is not heated sufficiently it is possible that some metal may be picked up when the old guides are driven out, so aim to achieve a temperature of approximately 150°C for this operation.
- Once the old guides have been removed allow the head to cool naturally before sizing the holes to fit the new guides.
- Ream the valve guide holes out carefully if required until a 0.03 - 0.05mm interference fit is obtained and then heat the head again while cooling the guides in a plastic bag in the freezer for at least an hour. Then, working quickly, drive each guide home using a suitable tool with the head supported on an inclined base, all as shown in Figure 90.
- Make sure that the oil hole in each guide is facing up when fitted.
- Reaming the guide bore to the new build value set in Table 10.
- If new valve guides are fitted then the valve seats will need to be recut.

5.11.5 Valve seats

- **Top end overhaul:** apply bearing blue to the valve and rotate the valve against the valve seat using hand pressure only. Remove the valve and inspect for sealing between the valve and the seat – if there is not a uniform seal within the limits shown in Figure 92 then the seats will need to be cut and the valves may also need to be refaced.
- Valve seats are cut at 45 degrees for the actual seat and then under and over cut at 30 and 60 degrees as required to obtain a seat width as shown in Figure 92. In general, try to cut only the minimum amount from each seat in order to extend the life of cylinder heads.

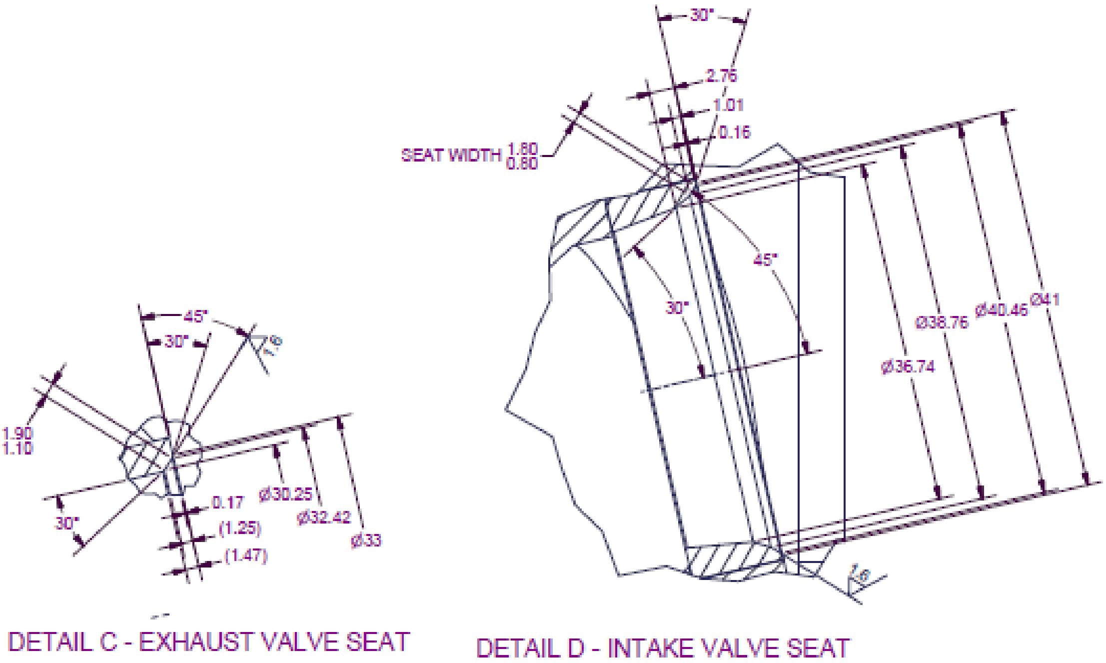


Figure 92 – Valve Seat Geometry

5.11.5.1 Inspection and repair

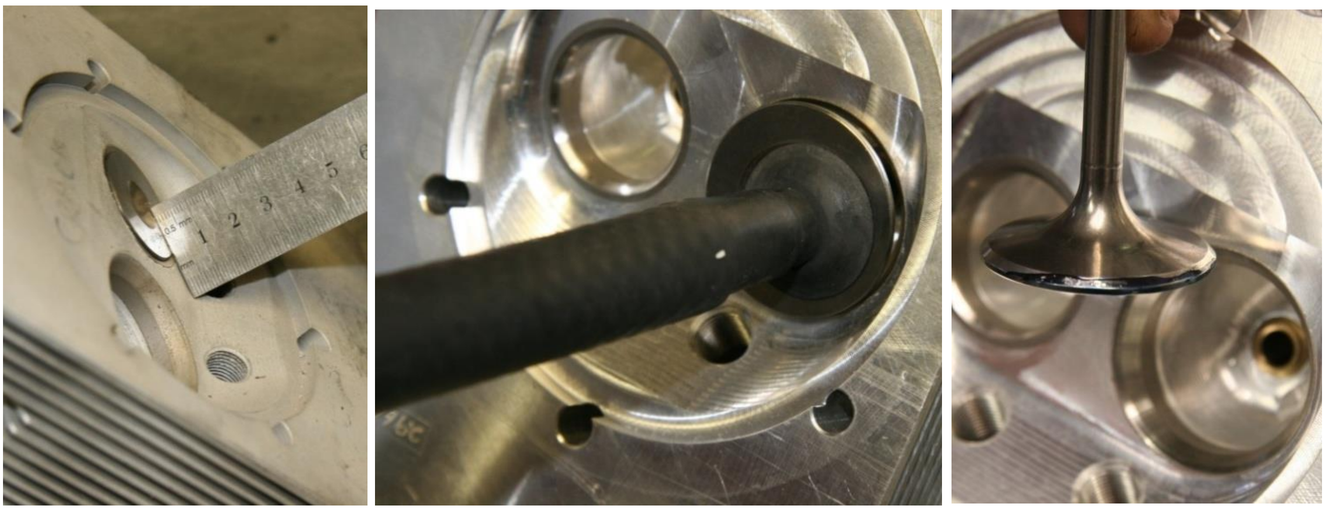


Figure 93 – Recessed Valve Seat, Valve Being Cut

- The valve face must protrude at least 0.6mm for both inlet and exhaust valves from the face of the combustion chamber.
- Figure 93 (left) shows a valve fitted to a recessed seat. This assembly is unserviceable. To avoid this, valve seats must be cut as lightly as possible.
- Figure 93 (2 right pictures, above) shows a valve / valve seat being cut using a hand grinder and valve lapping paste on the sealing face.

- After cutting the seal of the valves must be checked using a vacuum tester. This can be done without fitting the valve springs as the vacuum which is applied in this test holds the valve against the seat. Figure 94 shows a vacuum test rig. This system connects to the workshop's compressed air supply and uses a venturi effect within the silver box (right) to generate a partial vacuum. A fitting must be made to connect the vacuum tube to the cylinder head – we use a layer of insertion rubber to seal between the metal fitting and the cylinder head. Once operating the vacuum is assessed via a gauge. If the valve achieves 25inhg or less then the valve must be cut against the seat to improve the seal. Again, remember that the seats and valves must be cut as little as possible.
- Alternatively the seal can be checked using bearing blue, assessment of the lapping marks or by using liquids to look for leaks. Vacuum is the preferred method as it is fast, clean and accurate. The unit pictured below used compressed air to generate a vacuum and is manufactured by SMC, P/No. ZH13B.

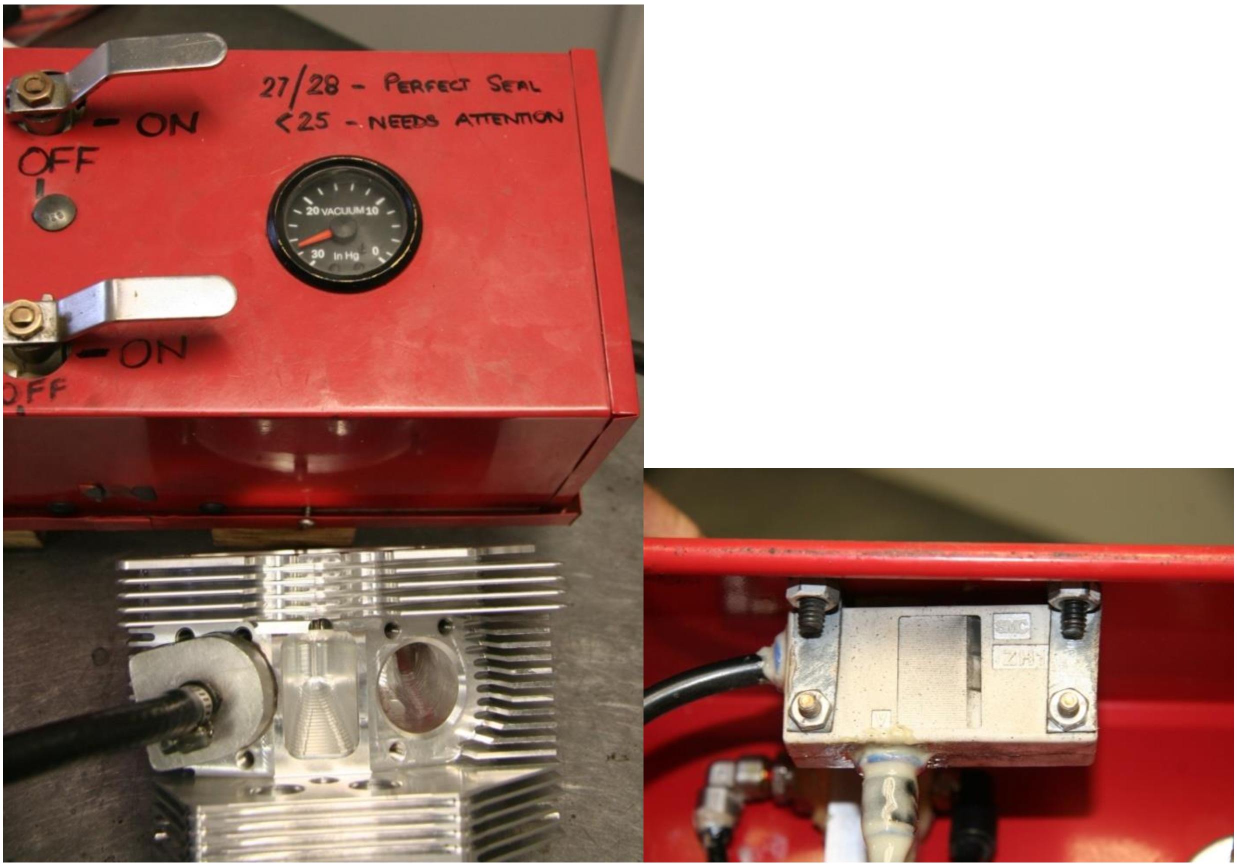


Figure 94 – Vacuum Test Rig

- If the valve seats are badly worn or recessed into the cylinder head then a new cylinder head must be fitted or new seats must be fitted to the old head. However, replacing the valve seats is a specialist task which we recommend that overhaulers do not attempt as it requires special tools and extreme temperature differences.
- Note that the hydraulic valve lifters have an internal piston with approximately 4.0mm of total travel - ±2.0mm from the original set position. This allows these engines to automatically adjust for up to this amount of variation in the valve train. Variations larger than this can lead to incorrect valve actuation and engine damage. Valve recession, cylinder head recession and similar factors all affect this measurement and must be monitored carefully during overhaul. Shorter length pushrods are available for hydraulic lifter engines to address this, however they are normally not required if the engine is overhauled using the guidelines given within this manual. Note that fitting shims to the engine will have the same effect on the lifter as using a shorter pushrod – i.e. the piston in the lifter will run higher in the bore. Accordingly the effect of using shorter pushrods can also be gained by fitting longer cylinders or cylinder shims. Normal valve tip to rocker clearance with lifter fully bled is around 1.8 / 1.9mm. With later shortened pushrods of 215mm, add 1.0mm to above dimensions.

5.11.6 Cylinder Head – Cylinder Seal


Figure 95 – Valves Assembly, Cylinder Head / Cylinder Lapping

5.11.6.1 Inspection and repair

- If second-hand cylinder heads are being used they must be lapped to seal onto the cylinder spigot. The process is similar to grinding a valve – valve grinding paste is applied to the cylinder spigot and the head rotated against it. An old, unservicable cylinder, held in a vice, should be used for this task. This step is not necessary with new heads. Figure 95 refers.
- A visual check will show when the surfaces are mated / lapped properly. As per the valves, care should be taken to remove the minimum amount of material.
- After lapping the valves or head must be cleaned thoroughly to make sure all the grinding paste has been removed.

5.11.7 Valve Springs, Spring Washers & Pushrods

- **Complete Overhaul:** Mandatory replacement of valve springs.
- Upgrade to Double Valve springs is highly recommended

5.11.7.1 Mandatory updates

- The valve springs used for hydraulic lifter engines are different to those used in solid lifter engines. Note that the spring designed for the hydraulic lifter engine can also be used on solid lifter engines.
- Pushrods are different lengths for hydraulic and solid lifter engines.
- Acceptable pushrod lengths are given in Table 10.

5.11.7.2 Inspection and repair

- **Top End Overhaul:** mandatory replacement of valve springs
- Upgrade to Double Valve Spring is highly recommended
- Check both ends of the springs for sharp edges or burrs which could damage the valve spring washers. Sharp edges and burrs should be polished off.
- Mandatory replacement of top spring washers (note that top spring washers are only supplied as a kit with a pre-fitted valve (either inlet or exhaust) and a pair of collets. These parts are pre-fitted in the factory to ensure the valve rotates correctly in the given pair of collets and top spring washer. New top spring washers MUST be installed with the supplied exhaust valve and collets (not with old items).
- Double Valve springs must be installed with the appropriate double stepped top and bottom spring washers.
- Engines CANNOT have a mixture of Single and Double valve springs, all cylinder heads must be upgraded to double valves springs at the same time.

Figure 96 – Valve Springs, Pushrods

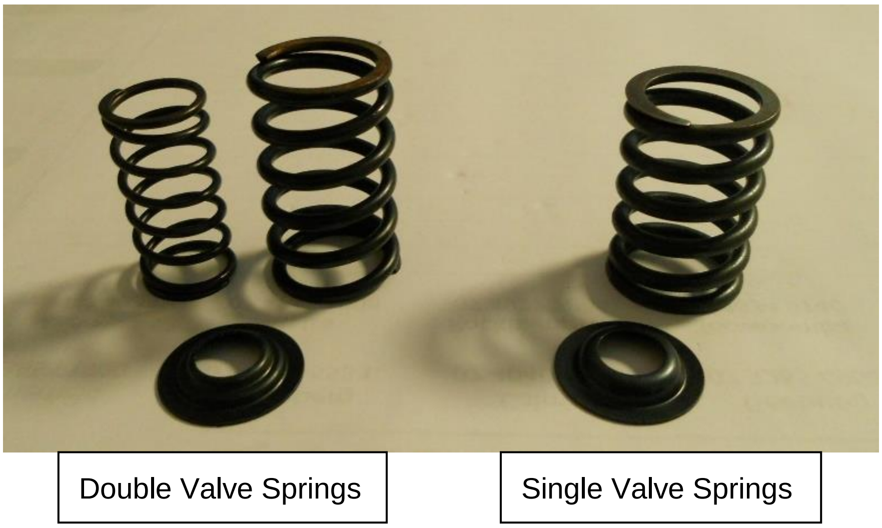


Figure 97 – Double Valve springs vs original single spring

- Check the pushrods for straightness: use vee blocks & dial gauge or check by rolling the rods along a piece of thick flat glass. Check the pushrod ends for signs of wear or damage. The photo above-middle shows a badly worn pushrod end on the left compared to a good pushrod end on the right. Replace any bent or damaged pushrods. Pushrod length limits are given in Table 10.
- Later engines use hollow pushrods to lubricate the rocker gear (Figure 96, right). Again, the 215mm long part is recommended.
- Engines equipped with roller followers use a different length hollow pushrod – as detailed in Table 10.
- Check the pushrod cover tubes for straightness and smoothness: during final assembly these slide through the O rings in the cylinder heads and any roughness may rip the O rings, so this would be a very good time to polish the outside of each pushrod tube and replace any bent or damaged tubes.
- Pushrod tubes must be checked for wear at the O ring seal (Figure 98). Wear or damage here will cause oil leaks and must be polished out or the tube replaced.

Figure 98 – Pushrod Tube End

5.11.8 Rockers

5.11.8.1 Mandatory updates

- Engines being converted to pushrod oil feed must use new lifters, pushrods, rockers and rocker bushes as detailed below.

5.11.8.2 Inspection and repair

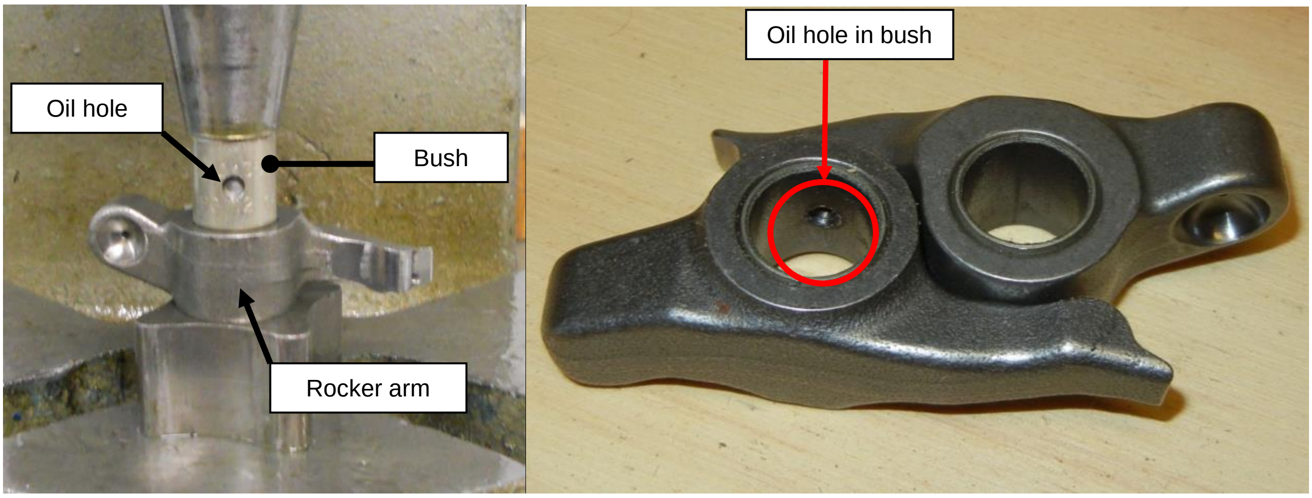


Figure 99 – Fitting Rocker Bush

- Measure the rocker shafts and the rocker bushes and calculate the clearance – ensure it is within the limits given in Table 10. Bushes are replaced during a full overhaul. If the clearance is greater that this limit then new rocker bushes must be ordered.
- Use a hand press to push the old bushes out with the new bushes, making sure that the oil hole in each bush is oriented towards the bottom of the rocker as shown in Figure 99. Typically the inner size of fresh bushes is around 12.06mm.
- If this hole is not present rapid wear of the bush will occur.
- Push the new bushes completely into each rocker – the width of the bush determines the amount of end float for the rocker.
- Rocker shafts must be inspected for serviceability. Check for scoring etc – slight imperfections can be polished out – larger damage requires the replacement of the shaft. Shafts measure 11.98mm when new. If using a shaft with slight wear it can be inserted into the head from the other direction which places the worn section on top of the shaft where it will not wear anymore or affect rocker operation.
- In all engines the rocker end which presses against the valve stem must be checked for wear. In some cases this face may require polishing to remove defects.
- For engines using the hollow pushrod lubrication system the valve rockers are equipped with an oilway running from the pushrod socket to the tip of the rocker (see Figure 100). This oilway also feeds into a groove in the bush installation bore. At overhaul or when new parts are fitted these oilways must be inspected visually and using a fine probe (such as a 1.0mm drill bit) to ensure they are open and free of obstructions. After probing blow the oilways out with compressed air to shift any debris.
- In solid valve lifter engines the rocker adjusters & lock nuts must also be examined & assessed for wear

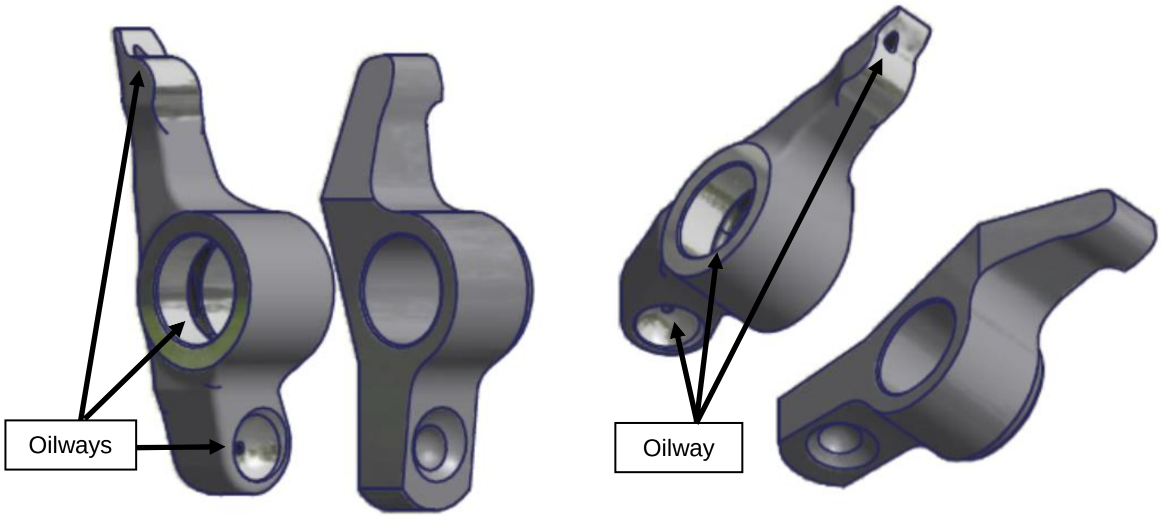


Figure 100 – Solid VS Hollow Valve Rockers

5.12 Subassembly D – Sump & Induction Manifold

5.12.1 Sump

5.12.1.1 Mandatory Updates

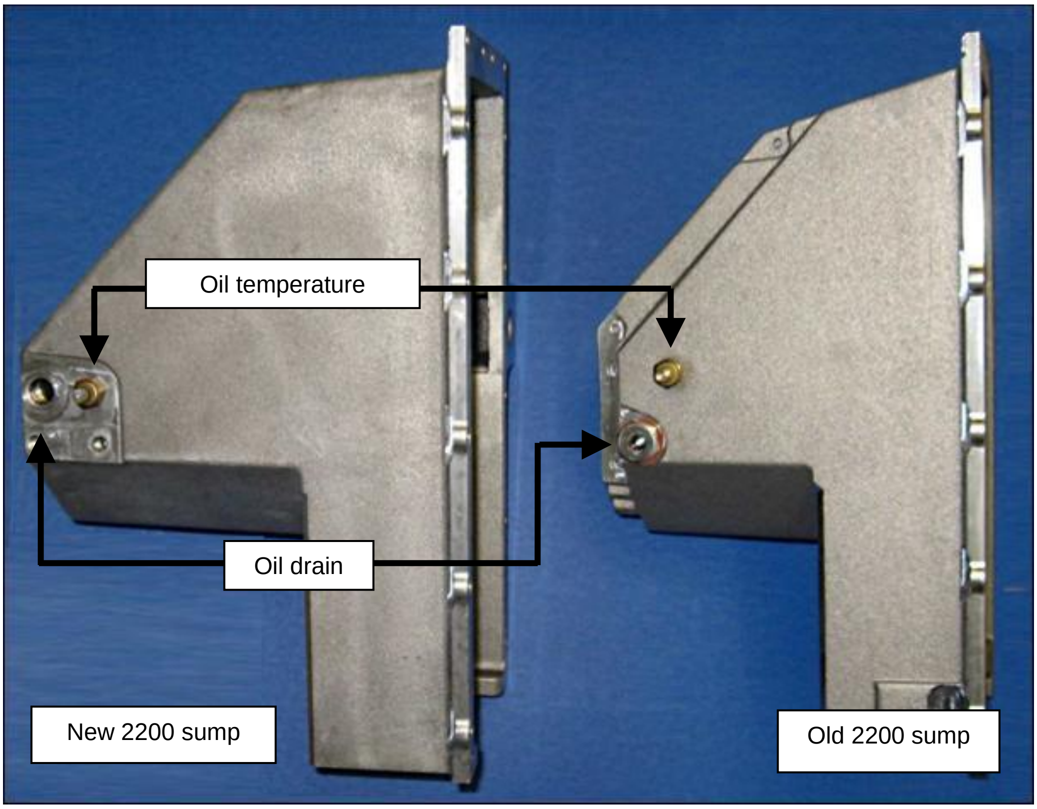


Figure 101 – 2200 Engine Sumps

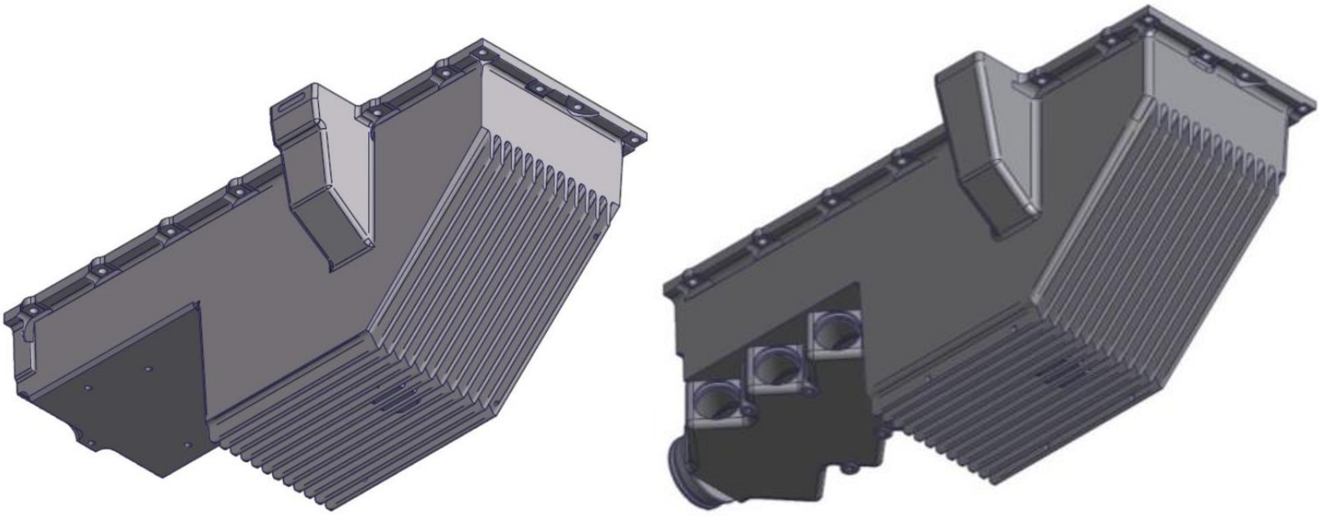


Figure 102 – 3300 Engine Sumps

- Very old type 2200 & 3300 engines used sumps where the induction manifold was cast as a part of the sump, with the intake tubes exiting the manifold at 90°. These sumps must be replaced with a newer type at overhaul.
- 2200 engines: check the sump type – the older, finned sump is smaller, while the new, larger sump has no fins. Finned sumps on 2200 hydraulic lifter engines must be replaced with the current model, larger sump. This will reduce crankcase pressure and excessive blow-by of engine oil into the overflow bottle. Either sump may be used on a solid lifter engine. Note that although the sump volume was increased the oil capacity stayed the same. Different oil cooler mounting brackets are required for each sump.
- 3300 engines: two types of sumps, shown in Figure 102, are acceptable for use. Note the intake tubes leaving the manifold at an angle.

5.12.1.2 Cleaning

- Remove drain plug and temperature sensor and clean threads. Use a scraper made from Perspex or similar material to remove any sealing compound from the jointing surfaces. Clean the sump with kerosene and dry. Blow out all holes.

5.12.1.3 Inspection And Repair

- Inspect the sump for any signs of cracking around the bolt holes on the flange, and check the threads in the drain and temperature sensor mounting holes.
- Check your dipstick length against the limits given in Table 10: Measure from the top of the dipstick handle to the Full and Low marks.

5.12.2 Induction Manifold

5.12.2.1 Mandatory Updates

- There are no mandatory updates to the induction manifold assembly.

5.12.2.2 Optional Updates

- 2200 engines: Early 2200 engines had the induction manifold cast as part of the sump & were equipped with a 32mm carburettor. It is recommended to fit a new sump & 40mm carburettor at overhaul.
- 3300 engines:
  - Most 3300 engines are equipped with a bolt-on induction manifold assembly similar in appearance to the 2200 engine part shown in Figure 195 (note the shape of the diffuser used in this part – circled in the figure).
  - Later engines use a "Series III" bolt-on induction manifold assembly. This system incorporates two round diffusers into the manifold body in place of the "airfoil" shaped part shown in Figure 195. It also uses different angles and shapes for the induction pipes themselves.
  - Current engines use an induction cast into the sump as shown in Figure 102 (right).
- All of these configurations are acceptable for the 3300 engine: upgrades in this area at overhaul are optional.

5.12.2.3 Cleaning

- Disassemble and wash. Note that to remove the Loctite sealing compound it may be necessary to use a plastic scraper and / or scouring pad.

5.12.2.4 Inspection And Repair

- Visually inspect.

5.13 Subassembly E – Flywheel, Ignition Coils, Starter Motor and Alternator

5.13.1 Ignition Coils & Alternator

5.13.1.1 Mandatory Updates

- Flywheel – must be dowelled to the crankshaft with 6mm dowels and 5/16” or 3/8” (not ¼”) cap screws – refer to Subassembly A (Section 5.9) for details of this modification. Note that early “Starfish” type flywheel used 20mm long dowels while the previous assembly and the current version “Starfish” use 24mm.
- Ignition coils: Shiny black coils marked “LEADING X” must be replaced.
- Alternator: 3-phase alternators must be replaced.
- Tachometer: sensors must be “hall effect” type or read from two dedicated tags fitted to the flywheel. Senders which read directly from the starter ring gear teeth must be replaced.

5.13.1.2 Cleaning

- Clean the flywheel with kerosene and dry.
- Wipe all electrical components with a soft cloth; use a brush if necessary to dislodge dust from each unit. Do not use chemical cleaners on any electrical components.

5.13.1.3 Inspection And Repair

- Inspect the starter drive gear and the flywheel ring gear for chipped teeth: if any teeth are chipped or missing then a new gear must be ordered. The ring gear may have either 99 or 101 teeth – you must specify the exact tooth count when reordering either gear. Note also that the engine backing plate is specific for each ring gear – i.e. a 99-tooth-compatible backing plate must be used with a 99 tooth ring gear and vice versa for a 101 tooth part.
- Magneto and alternator magnets must be tested using a prop bolt attached to a spring balance. Details of the testing method and the required limits are given in Section 9.6.
- Magnets that are weaker than this must be replaced. When replacing magnets the North (N) pole must be oriented outwards on the flywheel. It is very rare for magnets to lose their strength but it can happen if the magnets are overheated or subject to an impact.
- Test the ignition coils as detailed in Section 9.6.
- Test the resistance between the alternator poles and the resistance to ground as detailed in Section 9.6.
- Replace any units that fail to meet these values.
- Visually inspect the alternator for signs of burning, rubbing, chafing or other damage. Replace if damage is found. Disassembly is only required if damage is found.
- In particular inspect the connectors on the output wires from the alternator. If there are indications of excess heat these connectors must be removed and new, high-quality insulated female connectors fitted. Ensure the new connectors are a tight fit when test-assembled with a male connector.

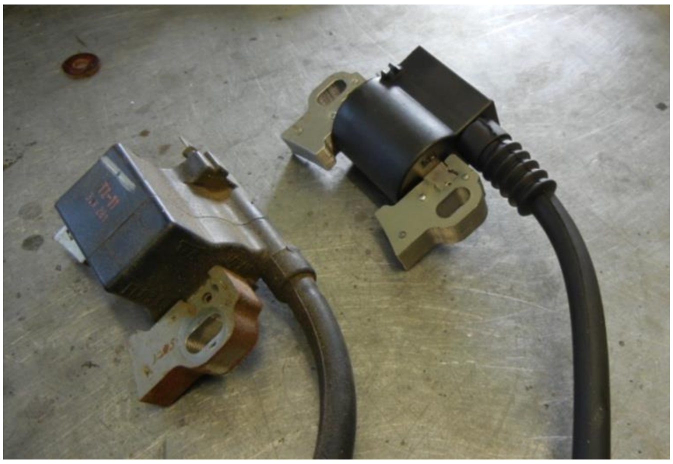


Figure 103 – Different Ignition Coil Models (Honda on Left, Jabiru on Right).

5.13.2 Flywheel/Starfish Attachment

- Inspect the fit of the dowels between the crankshaft and flywheel:
  - Normally the dowels will remain in the crankshaft when the flywheel and gear are removed. If any dowels come out of the crank assess the fit by inserting a new dowel: the correct fit of dowel into crank is an interference fit: the parts require a firm tap from a copper hammer to assemble.
  - Assess the fit of the dowels into the crank timing gear: a mild interference fit where the parts can be assembled by light hammer taps is the minimum acceptable fit.
  - Where equipped, assess the fit of the dowels into the flywheel spacer / vacuum pump drive: a slip fit where the parts can be assembled by hand but no movement can be felt between the parts is the minimum acceptable fit.
  - Assess the fit of the dowels into the flywheel (or starfish, where equipped). An interference fit where the parts must be assembled by firm hammer taps is the minimum acceptable fit.
- Unacceptably loose fits require the replacement of parts.

- Inspect the condition of the flywheel attachment holes. Figure 104 shows a "Starfish" which was damaged by a prop strike: it can be seen that the screw and dowel holes are elongated. This part must be replaced. Elongation can be checked by placing a tapered round item in each hole – such as a suitably sized punch or pen – to identify any damage.

Figure 104 – Damaged Flywheel "Starfish"

5.13.3 Starter Motor

5.13.3.1 Mandatory Updates

- Older (Black) starter motors were less powerful. It is recommended that these be replaced at overhaul.

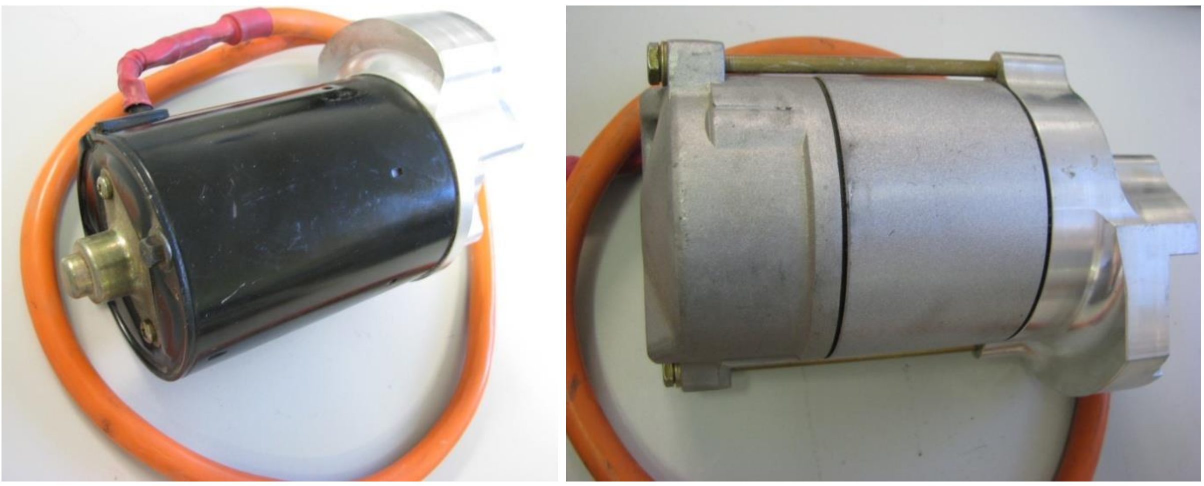


Figure 105 – Starter Motor Old & New

5.13.3.2 Cleaning

- Clean and wash all parts in solvent except the motor. Clean the motor by wiping with a clean rag to remove dust and metal particles. Clean the commutator with a soft brush and a fast drying solvent (Figure 107, left).

5.13.3.3 Inspection And Repair

- Check commutator for wear, if you are not experienced in this field then seek a suitable qualified person to check the commutator for serviceability.
- Check brushes for wear, if you are not experienced in this field then seek a suitable qualified person to check the brushes for serviceability, replace if they are less than 10 mm long.
- Check bendix gear for chipped or missing teeth, and that the clutch slides freely on the shaft, replace if necessary.
- Check the ball bearings on the motor rotor for serviceability, replace if necessary (Figure 107, right), using a suitable puller to remove the old part.
- Check the bushes at each end of the clutch and bendix gear for wear and replace as required, lubricate the bushes with grease.

Figure 106 – Typical Disassembled Starter Motor

Figure 107 – Starter Motor Overhauling

5.13.4 Engine Mount Plate

5.13.4.1 Mandatory Updates

- As noted above, engine mount plates are specific to the flywheel ring gear used – there are 99 and 101 tooth versions of the plate to suit the different gears. Parts must be matched on assembly.
- Note that the 2200 mount plate is shorter (vertically) than the 3300 plate.

5.13.4.2 Inspection And Repair

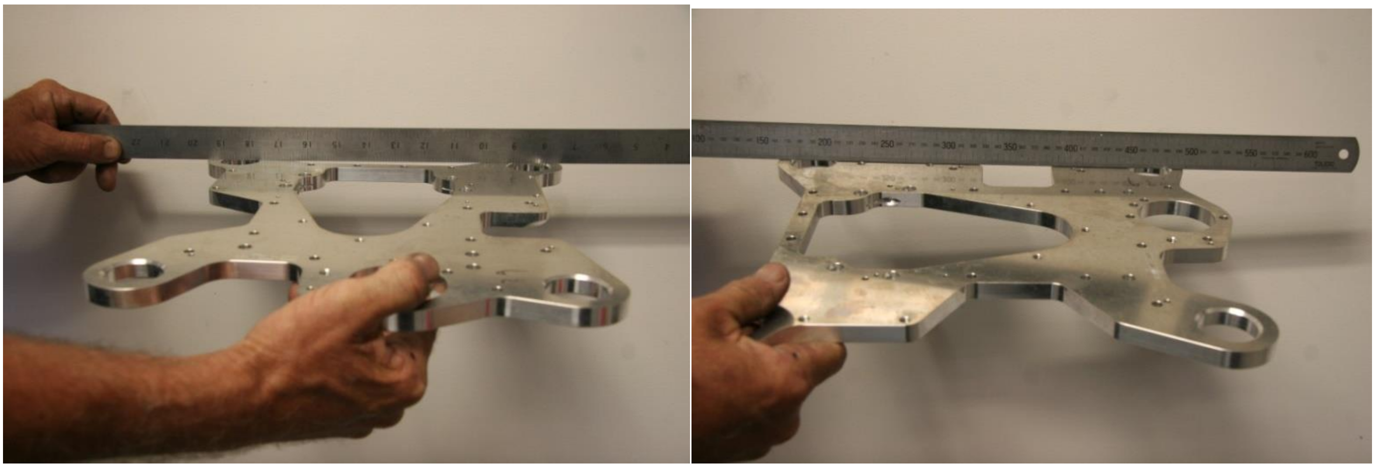


Figure 108 – Checking Engine Mount Plate Trueness

- Check to ensure the plate being inspected is suitable for use on the engine – matching the ring gear and the engine model.
- Using a straight edge, carefully check the plate in both directions for trueness. Often an engine which has been in an accident or had a severe propeller strike will be bent. Figure 108 refers

5.14 Subassembly F – Gear case and distributors

5.14.1 Gear Case & Distributors

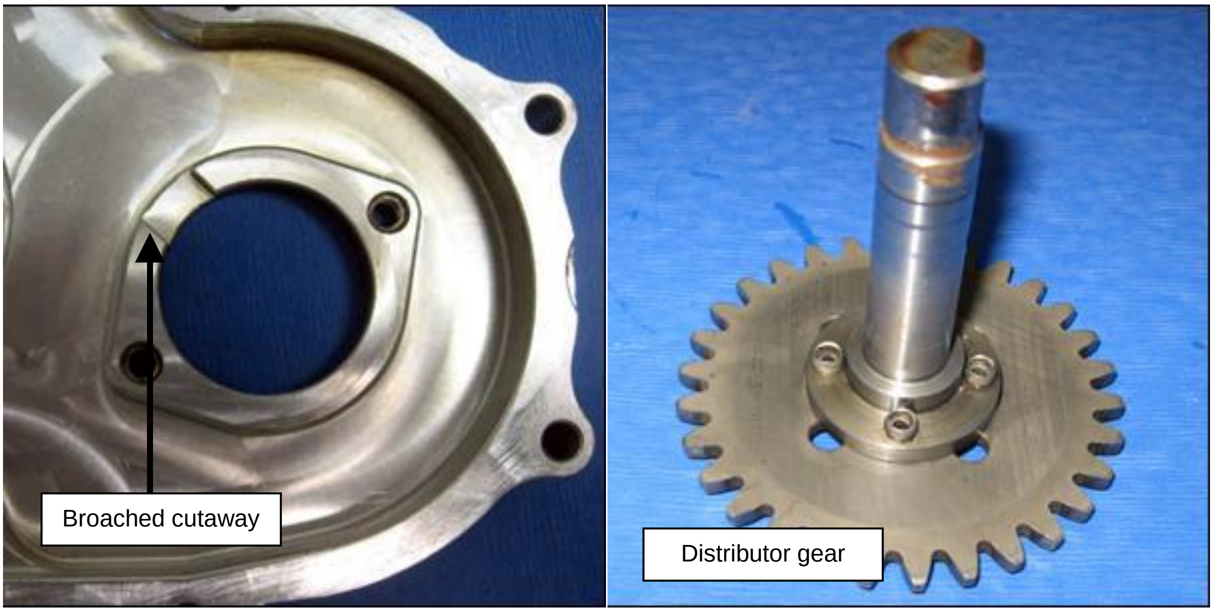


Figure 109 – Distributor Gears & Case

5.14.1.1 Mandatory Updates

- Check the inner boss of the main timing gear case around the distributor drives for a broached cutaway as shown arrowed in yellow above left. If this cutaway is not present it must be ground into the case before it can be returned to service. Use a Dremel tool with a cutting burr or a hand file to make the cutaway as shown above left: it should measure 12mm wide and 3mm deep when complete. This must be done for both distributors.

5.14.1.2 Cleaning

- Scrape all gasket material from the timing case flange with a Perspex scraper.
- Check that all threads are clean – use a tap if necessary.
- Clean all components thoroughly with kerosene and dry.

5.14.1.3 Inspection and Repair

- Check the rivets that hold the distributor gears to the shafts as shown above right and replace any that are loose with new 3/16" x 5/16" Monel rivets, taking care to drive the pin out of the centre of the rivet on completion of fitting.
- Check gears and gear teeth for any marks or scoring.
- Check the shafts for corrosion and seal marking and polish as required. Measure the distributor shaft to bearing clearance: it must be within the limits of Table 12 to be returned to service.
- If deep score marks (from the seal) are present (as shown in Figure 109 – right) the shaft must be replaced.
- Check the interior of the distributor cap, looking for cracks, corrosion and making sure that the carbon brush in the centre of the cap is fitted and in good condition.
- Check the high-tension leads and replace any which have chafing or other damage. Damage needing replacement is rare, however chafing must be guarded against carefully.
- Check the fit of the high-tension lead caps onto the distributor and spark plugs. Visually check the metal contacts inside the caps. If the fit is loose or if the contact is visibly damaged as shown in Figure 110 then a screwdriver or similar must be used to re-shape the contact (it should be round) and to re-size it for a better fit – for a spark plug the diameter of the contact needs to be reduced to tighten while for a distributor cap it needs to be expanded. Each cap should fit with a clear "click" as it connects to the distributor cap or spark plug.

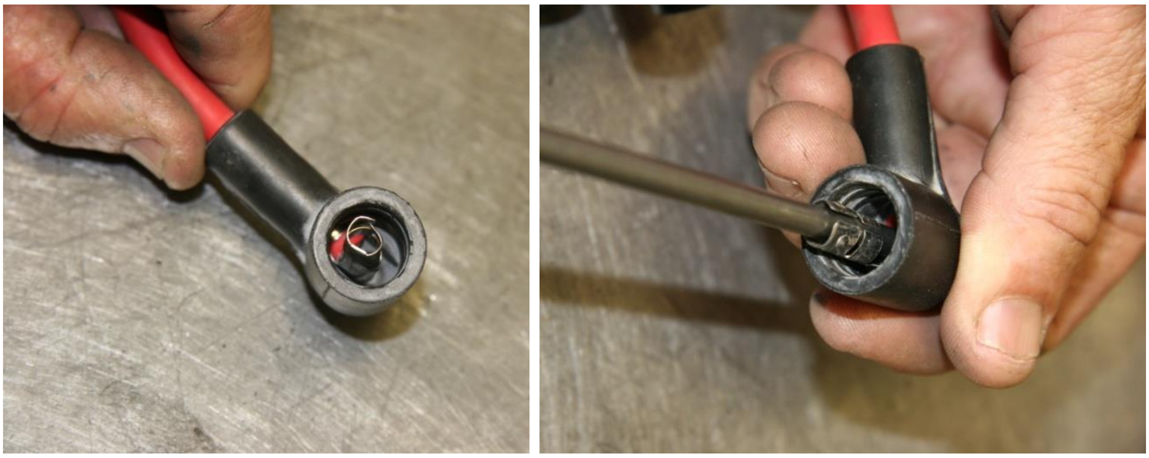


Figure 110 – Adjusting High Tension Lead Caps

5.15 Subassembly G – Fuel Pump And Carburettor

5.15.1 Carburettor

5.15.1.1 Mandatory Updates

- Check the carburettor for current tuning and jetting using the table below:

Table 5 – Carburettor Tuning

			NEEDLE JET	MAIN JET	IDLE JET	NEEDLE
2200	SOLID LIFTER	32mm Bing	2.68 2.70 2.72	2.35	0.45	Std circlip 2nd from bottom
		40mm Bing	2.76 2.78 2.80	2.50 2.55	0.35 / 0.45	Std circlip 2nd from bottom
		40mm Economy	2.80	2.25 2.35	0.45	Economy needle
	HYDRAULIC	40mm Economy	2.90	2.45	0.45	Swelled type
3300	SOLID LIFTER	40mm Bing	2.80	2.80	0.35 / 0.45	Std circlip 2nd from bottom
		40mm Economy	2.85	2.55	0.35 / 0.45	Economy needle
	HYDRAULIC	40mm Economy	2.85 2.90	2.55 2.60	0.35 / 0.45	Non-swelled type

- Order any replacement parts required to achieve current carburettor tuning standards.
- Refer also to Jabiru Service Bulletin JSB018. In some applications non-standard jets will be required and are acceptable if their use is based on proper testing.
- To improve cold starting the choke jet may be enlarged. Drilling to 1.2mm is recommended for Australian applications. The choke jet is located in the bowl as shown in Figure 111 (left).
- To improve the engine's idle the idle jet port must be drilled out to 1.6mm. This is done at the factory during assembly but is worth checking at overhaul. Figure 111 (right) shows the drilling being done by hand. Note the air nozzle blowing into the idle jet to force the aluminium shavings from the drill out of the carburettor.
- New fuel hose must be fitted.
- The float bowl needle seat must be checked. 3300 engines use a 2.4mm diameter, specially shaped orifice in this part while the 2200 engine uses 2.0mm – though the 2.4mm seat is also acceptable for 2200 applications. Figure 30 shows the tools needed to change the seat which is located in the carburettor body above the float needle. As noted at Figure 30, if the seat is to be changed a tap is used to remove the old part and a special nylon drift used to install the new. More details of this process are included in Section Figure 115.

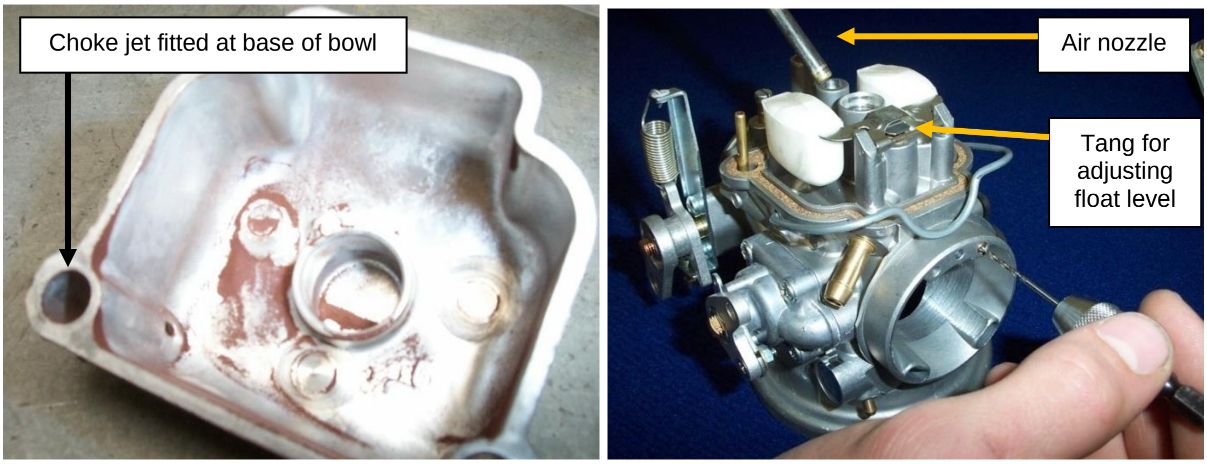


Figure 111 – Carburettor Updates

5.15.1.2 Cleaning

- On initial disassembly, check for contamination like that shown in Figure 111 (left). Contamination like this will be an early indicator for increased wear in the engine and will warn the overhauler to check thoroughly for wear on parts like cylinders.
- The carburettor exterior can be cleaned using kerosene, then washed with water and air dried.
- The carburettor interior can be cleaned using a carburettor cleaner aerosol – with the exception of the diaphragm. The diaphragm can be carefully washed using warm soapy water.
- Blow out all passageways using compressed air.

5.15.1.3 Inspection and repair

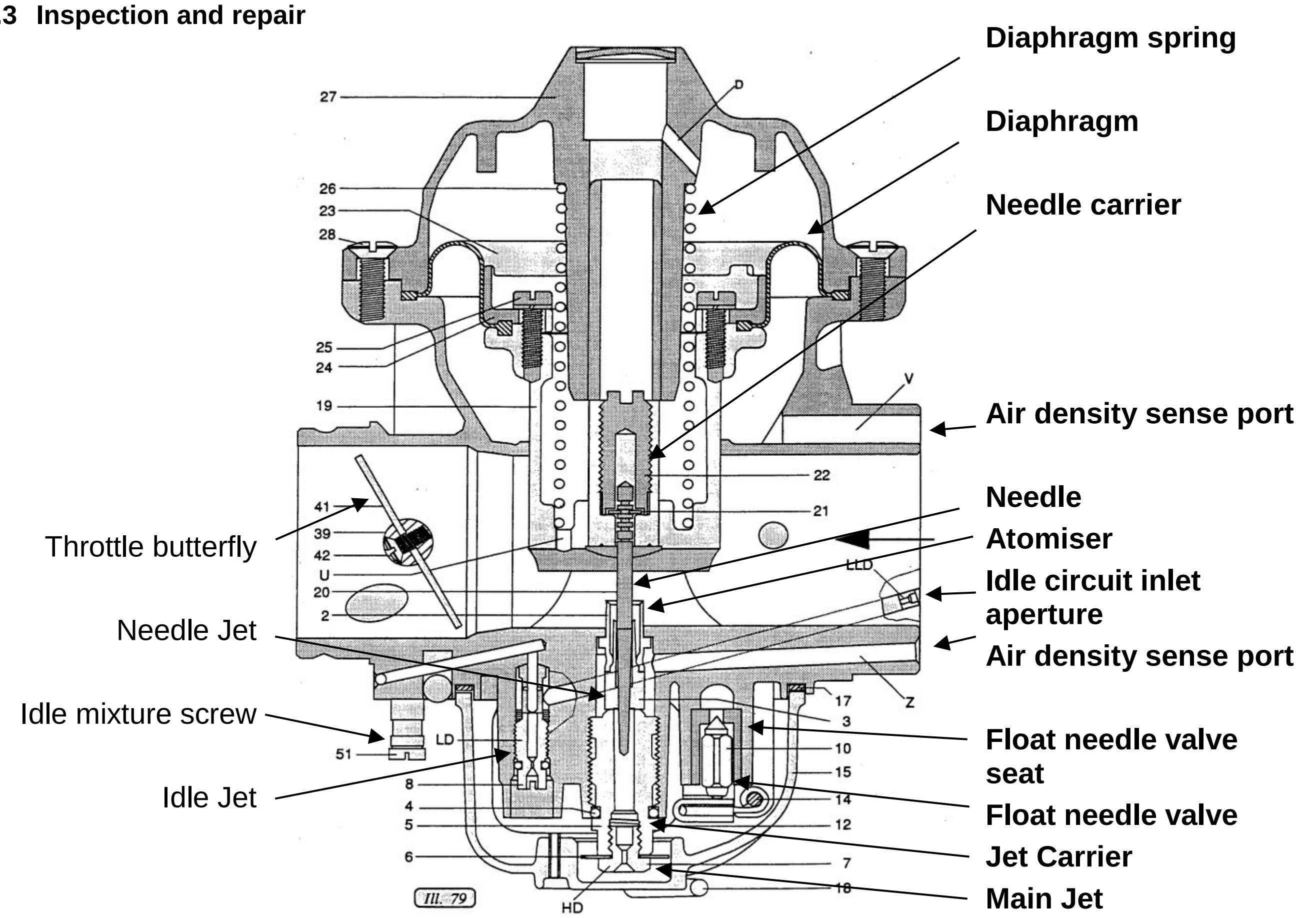


Figure 112 – Carburettor Schematic

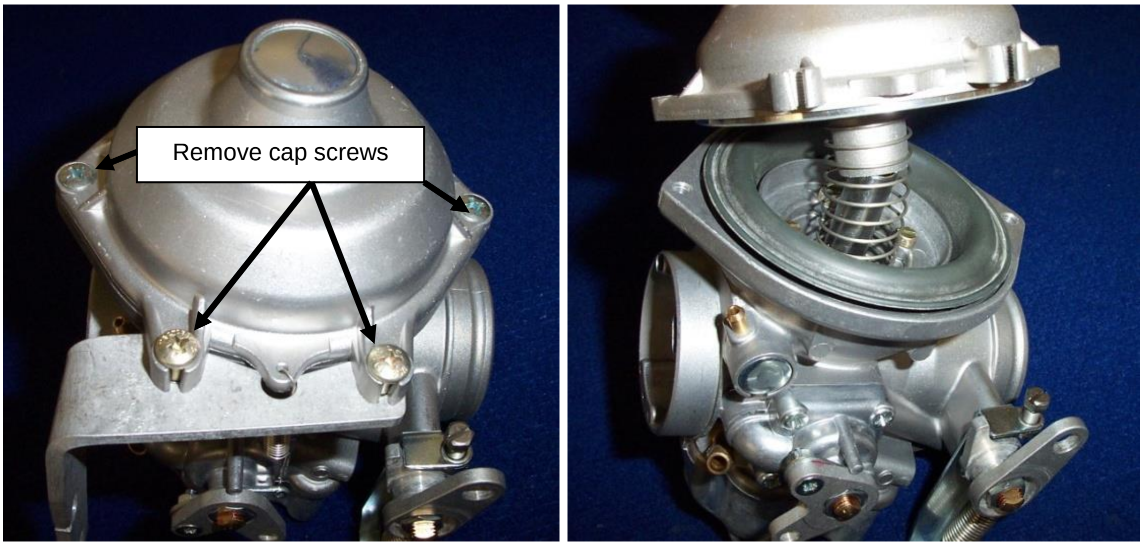


Figure 113 – Disassembling Carburettor #1

Figure 114 – Disassembling Carburettor #2

- Remove the upper cap of the carburettor and inspect the rubber diaphragm for any cracking, perishing or other damage. Hold the diaphragm up to a strong light and carefully stretching each section in turn. If any leaks are found then a new diaphragm must be ordered. Lift the slide and diaphragm assembly out of the carburettor body, remove the needle (using a flat-bladed screwdriver, Figure 114 left) and inspect the condition of the parts, checking the needle for wear and to determine if it is the current design.
- Remove the float bowl, floats, needle valve and jets. Hold each jet up to the light to check that it is clean. Particularly check for varnish which can form inside the jet, reducing its internal size. This varnish can normally be removed easily using an aerosol carburettor cleaner. Do not use drills or wire to clean jets as this can alter their internal size and affect the engine tuning.

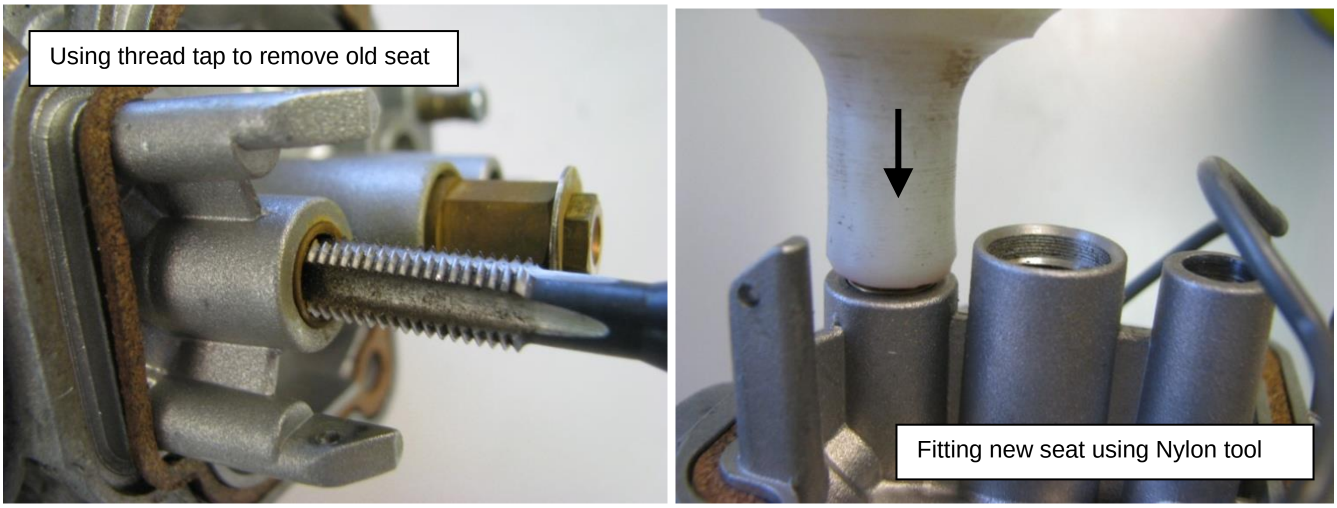


Figure 115 – Fitting New Float Needle Seat

- The float bowl needle seat must be checked. 3300 engines use a 2.4mm diameter, specially shaped orifice in this part while the 2200 engine uses 2.0mm (though the 2200 can also use a 2.4mm seat if required). Figure 30 shows the tools needed to change the seat which is located in the carburettor body above the float needle. As noted at Figure 30, if the seat is to be changed a tap is used to remove the old part and a special nylon drift used to install the new.

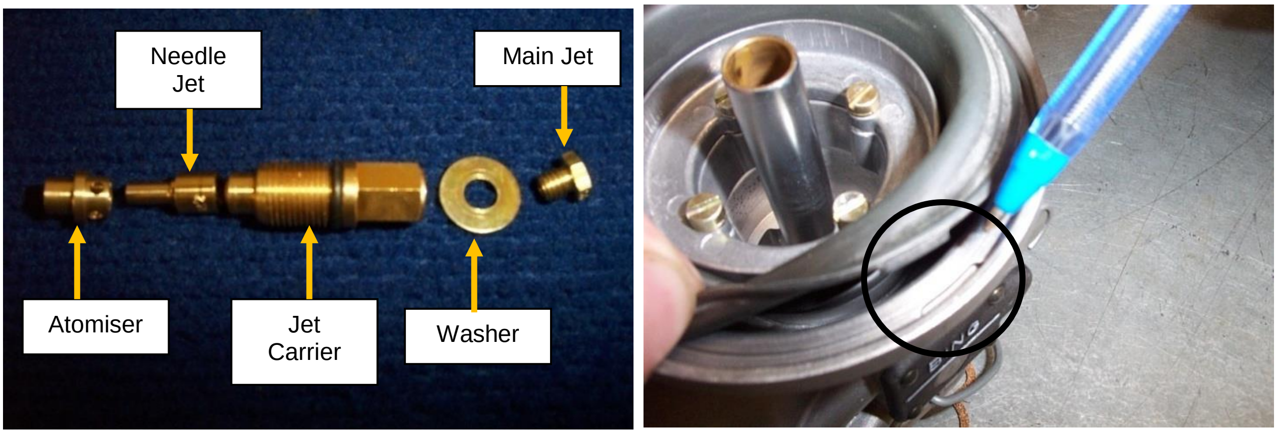


Figure 116 – Carburettor Jets & Diaphragm

- During re-assembly ensure that the atomiser, needle jet, jet carrier, washer and main jet are installed in the correct orientation and correct order as shown in Figure 116 (left). Also ensure that the tag on the diaphragm is aligned and fitted correctly to the socket in the carburettor body as shown in Figure 116 (right)
- Check the idle mixture screw. Screw fully in then screw it out 1 turn for 2200 and 3300 engines. The idle screw is shown in Figure 114.
- The float level must be set at 11-13mm down from the lip of the bowl. Adjust the brass tang of the float as required. An alternate setting method is to turn the electric fuel pump on and lift the floats, noting at what float height the flow cuts off.
- Carefully check the condition of the rubber coupling between the carburettor and the engine. Particularly on installations where a “pod” filter is used this coupling can crack – and the cracks can be hard to spot.
- Set the throttle butterfly idle stop so that the butterfly is just cracked. This setting will then need to be confirmed during the engine test run.

5.15.2 Fuel Pump

5.15.2.1 Inspection & Repair

- **Top End Overhaul:** check fuel pump diaphragms and gaskets, replace as required.
- **Complete Overhaul:** replace fuel pump and gaskets complete.

- Two different fuel pumps have been used on Jabiru Engines – as shown in Figure 117. Note the cast emblems on the top of the pump on the left – this is a Type 1 pump while the other is a Type 2. Both pumps are driven by pushrods acting from a special lobe of the camshaft, however the Type 2 pump requires a different length pushrod to the Type 1: refer to Table 10 for lengths.
- Wherever a Type 1 pump is replaced with a Type 2 the pump pushrod must also be replaced.

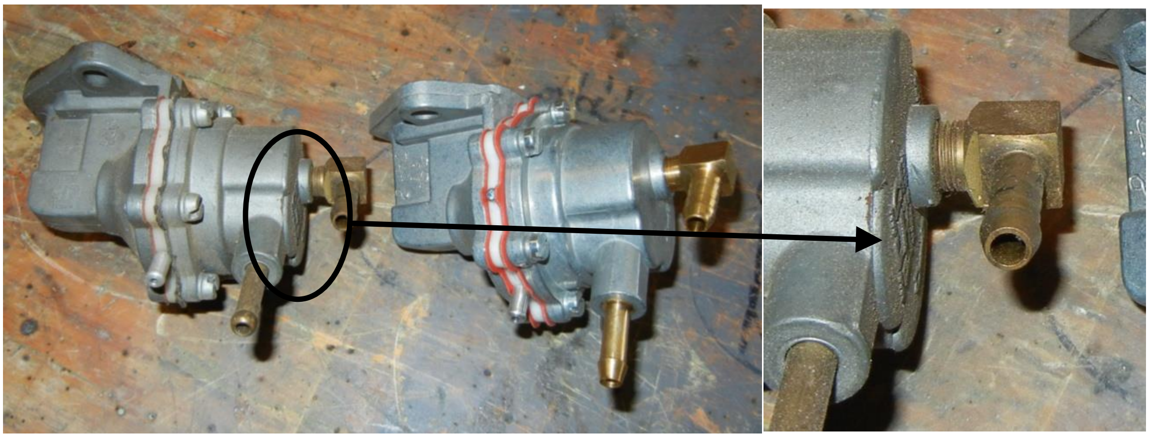


Figure 117 – Fuel Pumps (Type 1 on Left, Type 2 on Right)

5.16 Subassembly H – Final Assembly

5.16.1 Exhaust System

5.16.1.1 Mandatory Updates

- Engines equipped with exhausts which require gaskets between the manifold and the cylinder head are recommended to be replaced with non-gasket exhaust systems at overhaul.

5.16.1.2 Inspection & Repair

- Visually inspect the entire system for cracks, dents and wear.
- Inspect sealing faces for damage such as gas erosion.
- Spring tags that are excessively worn must be replaced.
- Systems that show signs of excess leakage must be adjusted or replaced.

6 Assembly – Top-End Overhaul

6.1 General

- Those parts which must be replaced during a top end overhaul are detailed in Section 5.3
- Those parts of an engine which have been disassembled for a Top-End overhaul are to be assembled in accordance with the details given in the full overhaul assembly part of this manual.
- Special top end overhaul build sheets are given in Section 9.

6.2 Engine Through-Bolts

- As a pre-emptive test the engine through-bolts may be checked as detailed in Section 4.4.2. If fretting is suspected it may be necessary to fully strip the engine to have the cases "decked" and line-bored. Note that fretting can lead to failures of the engine through bolts and engine stoppage – so suspected case fretting must be taken seriously.

6.3 Fuel Pump

- For a top end overhaul the fuel pump must be inspected.
- Measure the push rod which drives the pump from the camshaft. Its length must be within the limits set in Table 10 and the ends must be in good condition – no excess wear, scoring etc.
- Remove the cap of the pump and visually check that the internal parts are in good condition – no tears or cracking in the diaphragms or rust on the spring. Re-assemble.
- Pre-lube the pushrod using a small amount of grease.
- New gaskets must be used when re-fitting the pump. All joints must have 1 face coated with Loctite 515 sealant.
- Apply Loctite 243 to the 5/16 x 1 1/4" cap screws and tighten to the value given in Table 9.
- Assemble the connecting rods, cylinders, piston and cylinder head assemblies in accordance with the full overhaul procedures detailed in Section 7 below.

7 Assembly – Full Overhaul

- Once all parts have been inspected and all required new parts have been obtained then the assembly process can begin.
- The process described here will be to complete each subassembly stage first and then the final stage will be described in Subassembly H – Final assembly (Section 7.8), where each of the subassemblies will be combined to form the complete overhauled engine.
- Remember that for a Jabiru Engine it is required that at certain stages of the assembly a second person check the work and sign the build sheet to verify that it has been done correctly.
- Prior to starting the assembly process, take the time to thoroughly clean your work area – wash the workbench and engine stand down, clean all of your tools and make sure that you have everything that will be required before starting work.
- Check the engine configuration against Section 12 for mandatory updates.
- Keep your work area sealed against dust and dirt ingress and cover all work in progress with a clean cloth or seal in a plastic bag between operations.
- For critical fasteners torque specifications are given in Table 9. Table 9 also gives generic torque values for other applications.

7.1 Subassembly A – Crankshaft, propeller flange and connecting rods

7.1.1 Crankshaft, propeller flange

- Before beginning assembly ensure that the crank and propeller flange have been checked for run-out (see Section 4.4.1).
- Fit the 3 welch plugs to the crankshaft. All of the welch plugs should be expanded slightly before fitting. The plugs and the areas in the crankshaft where they will be fitted must be cleaned with Loctite 7471 cure accelerator and then have a few drops of Loctite 620 Retainer applied around the inside of the crankshaft and the outside of the plug before fitting.
- Cleanliness is essential when using Loctite!

Figure 118 – Crankshaft Painting, Degree Wheel

- Start with the front 7/8" plug, located at the back of the front double main bearing, driving the plug in from the rear, then the rear 7/8" plug at the back of the crankshaft and finally the 28mm front plug located at the very front of the crankshaft – tap each plug squarely into place using a suitable sized drift or punch: a very long 3/8" drive extension can be used for the front 7/8" plug. The front and rear welch plugs should be tapped ¼" in from the face of the crankshaft, so that their outside lip sits about 1mm in from the face of the crank.
- Mask the oil seal bearing surface on the front of the crankshaft and paint the front end of the crankshaft with a suitable paint (Figure 118 Left – note masking tape visible on seal face). Paint the propeller flange at the same time. When painting these parts always take care not to paint any mating faces or faces where screw heads will bear.
- Fit the propeller flange temporarily and mount the crankshaft vertically to the workbench/engine stand on top of a degree wheel, with the #1 big end journal pointing at the 90 degree before top dead centre (BTDC) mark on the degree wheel as shown at Figure 118, (right). i.e. set up so that TDC faces the assembler's chest and #1 big end points to the left.
- Note that the propeller flange will be finally fitted after the front crankshaft seal housing has been fitted when the engine is removed from the workbench/engine stand.

7.1.2 Connecting rods

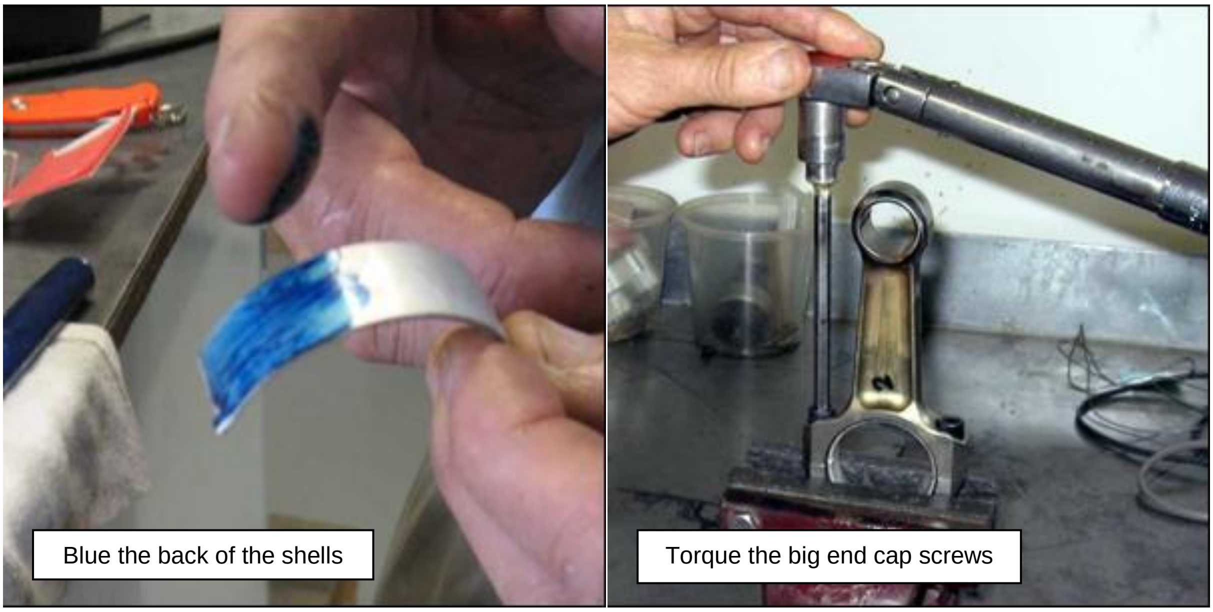


Figure 119 – Blueing Bearings, Assembling Rods

- Apply bearing blue to the back of the big end shells and fit them to the rods, hold the connecting rod in the padded jaws of a vice and tighten the cap screws to 18 ft lb in 2 stages.
- Loosen one big end cap screw then measure the bearing crush as the gap between the other side of the rod and the bearing cap with a feeler gauge. Bearing crush should be in the range given in Table 12. If the bearing crush exceeds these limits it can be corrected by carefully sanding the ends of the bearing shells on a sheet of 600 grit sandpaper laid on a flat surface and then rechecking. Remember that altering bearing crush will also alter the big end size slightly, so it must be re-measured after adjusting the crush. Also note that the critical parameter to be considered is the bearing-crank clearance. In most cases it is best to check the clearances first and then confirm acceptable crush.

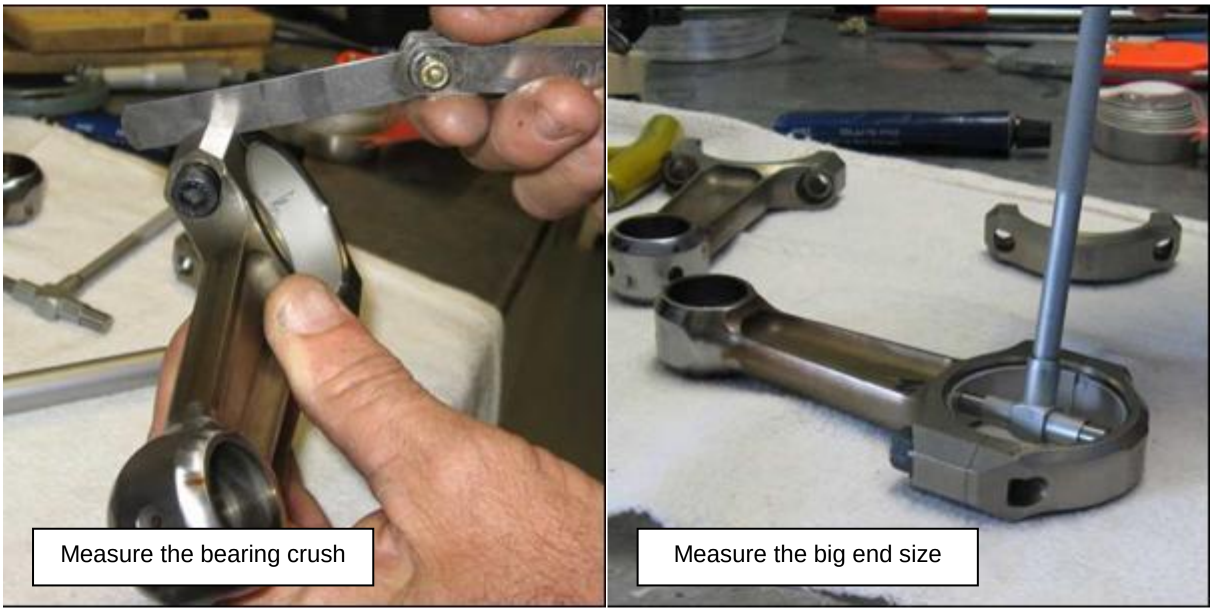


Figure 120 – Measuring Connecting Rods

- Retighten the cap screws to 18 ft lb then measure and record the big end size of each connecting rod and each big end journal. Calculate the big end bearing clearance. If necessary, move the connecting rods from one journal to another until you get a uniform clearance in the range given in Table 12. Record the clearances on the build sheet. A typical crankshaft journal will measure around 45.00mm, requiring a typical big end bearing inner diameter of 45.04 – 45.06mm (see Table 10 for details). Again the clearance between bearing and journal is the critical thing and must be in the range given in Table 12. If the clearance is too large then in some cases the bearing can be carefully sanded by rubbing the ends of the bearing shells on a sheet of 600 grit sandpaper laid on a flat surface – though bearing crush must be maintained. If the clearance is too small a different shell or rod may be tried which gives a better fit.

WARNING

It is imperative that these tolerances are achieved.

- Mark each connecting rod with the journal/cylinder number for later refitting. Remember that oil pressure is directly controlled by the sum of the bearing clearances, so take the extra time to obtain uniform clearances across all connecting rod/big end journal combinations.
- Remove the bearing shells and check the blue on the back for contact – there must be at least 90% surface contact between the back of the bearing shell and the connecting rod.
- Check the clearance of the gudgeon pins in the small end of each connecting rod. It may be nessesary to hone the bore of this hole to achieve correct fit. This requires skill and special tools. It is highly recommended that this task be outsourced to a reputable machine shop. Inexperience or use of incorrect tool will likely create a fit which is too loose, making the connecting rod unservicable.
- Clean the bearing shells and connecting rods carefully before final fitting. Clean the cap screws and the threads in the bearing caps using a 5/16" tap, then Loctite 7471 cure accelerator and allow to dry.
- Weight of reciprocating parts must be as detailed in Section 5.11.1.4. Extra care must be taken if a partial set of pistons are to be fitted – i.e. 1 new piston to an engine. In this case the weight of the new piston must be compared to to the weight of the existing pistons.

7.1.3 Assemble

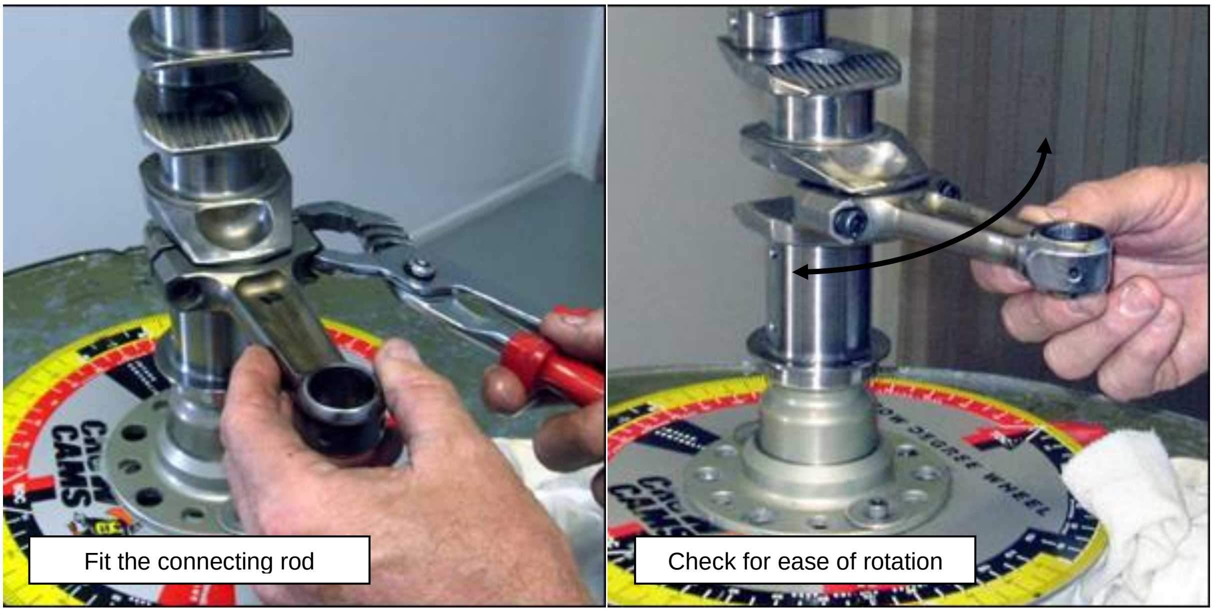


Figure 121 – Fit Connecting Rods

- Fit the bearing shells to each connecting rod and it's respective bearing cap: apply a smear of Nulon L90 to the bearing surface and the journal and fit the rod and bearing cap to the crankshaft with the dowel side of the connecting rod facing towards the rear of the engine (towards the flywheel). Engine oil should also be applied to the connection.
- Press the rod and the bearing cap together by hand or gently with a pair of multigrips. This must be done to seal the connection between cap and rod – if the cap is not fitted against the rod when Loctite is applied to the threads then a small amount of the retaining compound can find its way between the mating surfaces, holding them slightly apart and altering the fit of the rod to the crank. This can lead to excess clearance between the rod and crank – which is not acceptable.
- Apply a smear of Loctite 620 Retainer to the first 3 threads of each cap screw and the first 3 threads in the bearing cap then fit each pair of cap screws and tighten initially to 10 ft lbs then to the final value given in Table 9. Perform a final check for ease of rotation: the connecting rod should move smoothly around the big end journal.
- If it does not rotate freely then the rod should be removed and inspected. Scuffing of the bearing surfaces near the join between cap and rod will require that the connecting rod can be fully disassembled and the

big end polished in the areas adjacent to the join between rod and cap. If there is no particular scuffing pattern then the crankshaft journal should be polished before refitting the rod with new cap screws and retesting. In cases like this also check that the crank journal remains round.

- Wipe away any excess Loctite from the end of the cap screws when fitting is complete. Note that any excess Loctite left on these parts can harden, then break free and be carried to the oil pressure relief valve, causing oil pressure problems later.

WARNING

Loctite and other compounds can cure quickly at times. Overhaulers must work steadily to ensure all treated connections are tightened fully before the compound cures.

- Recheck the torque for each cap screw before fitting the next connecting rod.
- If the crankshaft and connecting rods assembly will be left exposed for more than an hour or so the entire assembly should be oiled lightly and covered with a plastic bag or wrapped with a clean cloth to prevent corrosion or dirt from taking hold.

7.1.4 'Billet machined' and 'Forged' conrod

The Torque table in section 9.1 specifies different torque settings for 'billet machined' and 'forged' conrods. It is very important that the correct torque setting is used for the specified conrod type.

Figure 122 shows the difference between the two components.

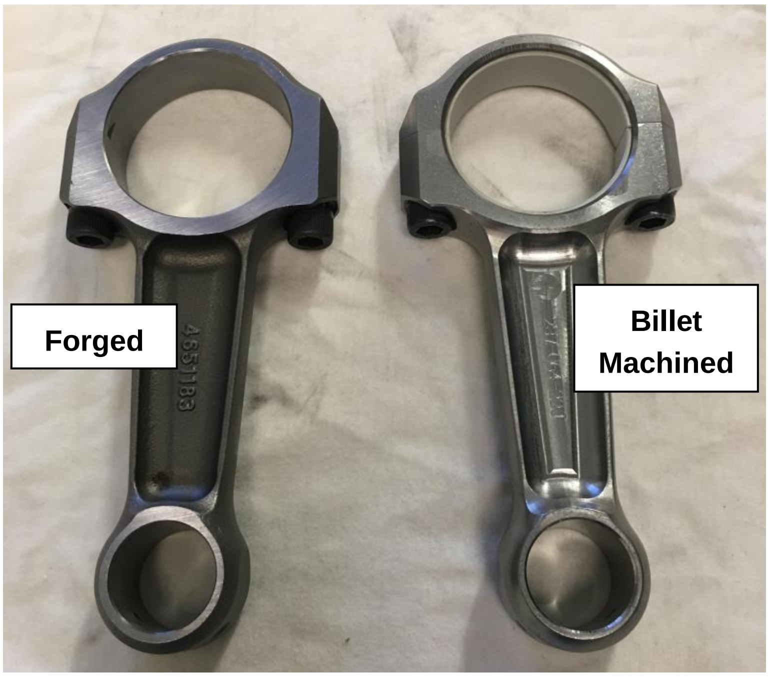


Figure 122 - Forged conrods vs Billet machined conrods

7.2 Subassembly B – Crankcase and camshaft

7.2.1 Crankcase

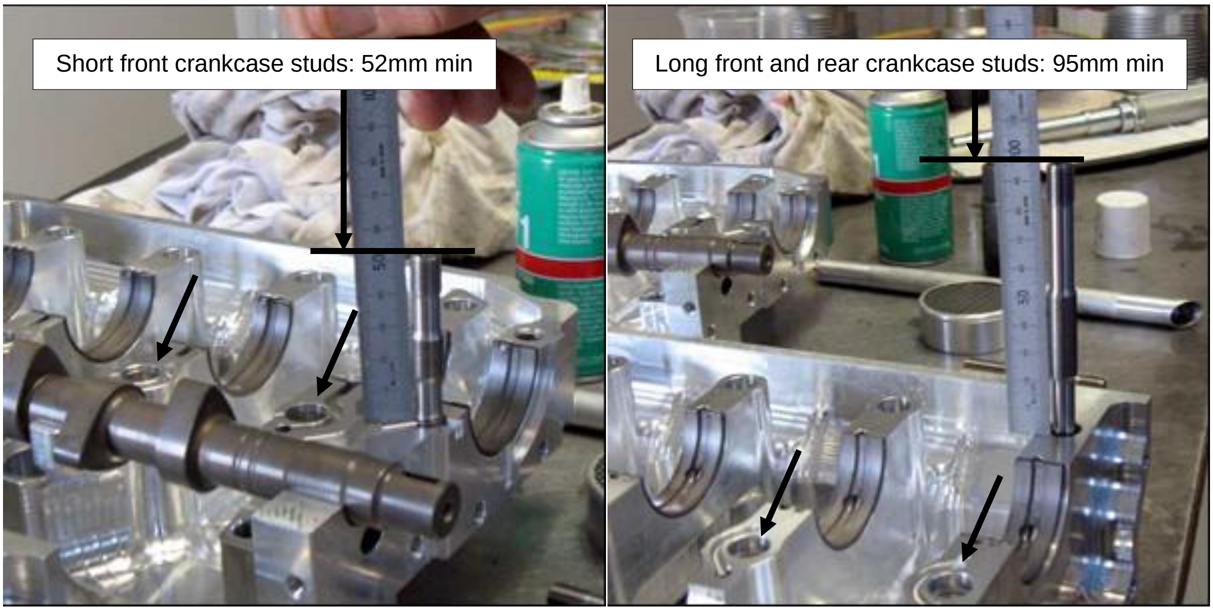


Figure 123 – Crankcase Assembly Preparation

- Lubricate and fit the O rings to the bottom main bearing stud holes (arrowed in Figure 123 - left) and then fit the front and rear crankcase studs using Loctite 263 Thread locker: clean and prime the threads first using Loctite 7471 cure accelerator. Use a collet type stud tool to screw the 2 short front crankcase studs to a free length of 52mm and the 2 long front and the 2 rear crankcase studs to a free length of 95mm as shown in Figure 123. Note: Later longer studs are positioned 54mm and 97mm free length above the crankcase join.
- Fit the hollow dowels to one crankcase half in the positions arrowed above. It is vital that poorly fitted dowels are not used at the crankcase join – if the dowels can be pushed in by hand then they are too loose. The correct fit it a light “tap” fit using a soft hammer. Oversize dowels are available to ensure a snug fit. These are identified by “dots” machined into them as shown in Figure 124 – the standard size has no dots then the size increases progressively up to the 3-dot dowel which is the largest size available. Experience in Australia has shown that 1-dot dowels are suitable for most overhauled engines with 2-dot and 3-dot parts being used very occasionally.
- The overhauler may opt to fit somewhat loose-fitting dowels for temporary assembly of the engine to measure bearing sizes. This simplifies subsequent disassembly. Where such parts are used they must be clearly marked so that they are not fitted to an engine during final assembly by mistake.

WARNING

Ensure correct size dowels are used for final assembly.

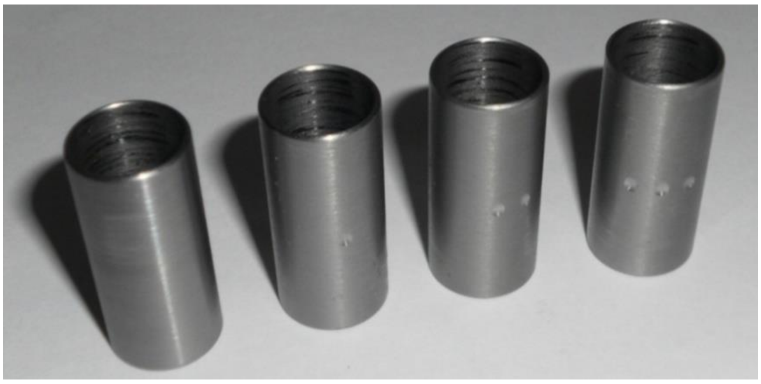


Figure 124 – Crankcase Dowels

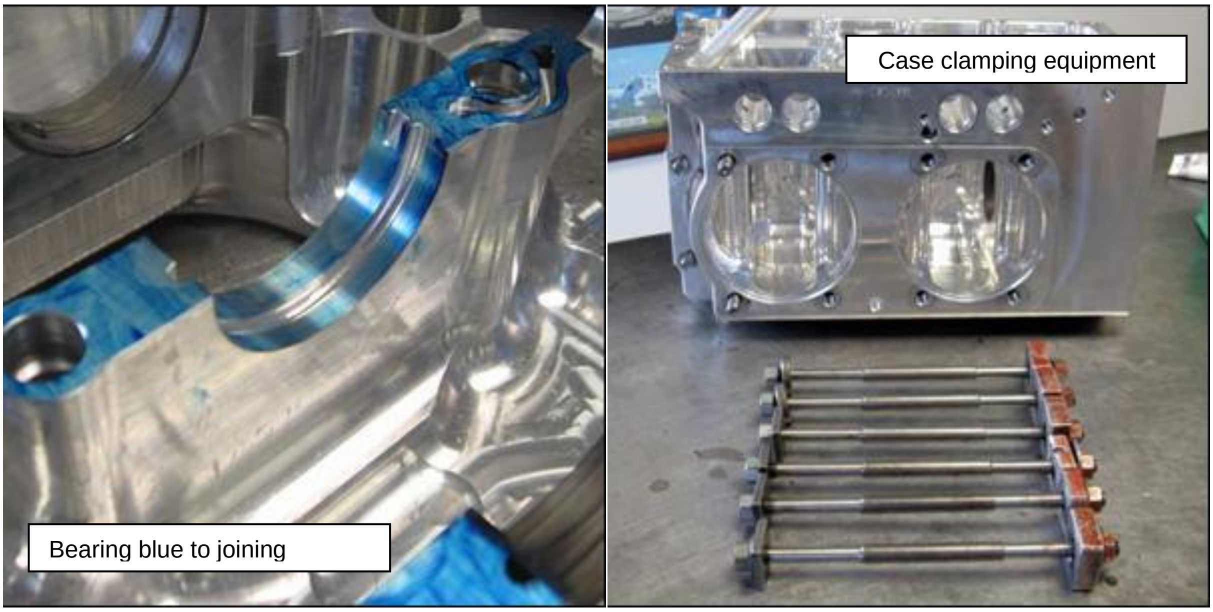


Figure 125 – Crankcase Clamping Preparation

- Apply bearing blue to one joining surface of a crankcase half and under the main bearing shells, fit the dowels and main bearing shells and fit the crankcase halves together.
- The oil filler tube is fitted to the right crankcase now or later during final assembly.
- Clamp the case halves using the old studs and nuts with 8mm packers under the nuts. Torque to the value given in Table 9 (as appropriate to the bolt size) in 3 stages, working from the centre studs out to the front and rear studs. Measure the main bearing bore size with the new main bearing shells in place.
- The bore size with the new main bearing shells in place must be within the limits given in Table 10 when measured directly across between the case halves.
- The diameter of the main crankshaft journals subtracted from this bearing inner diameter gives the bearing clearance. Clearances must be within the limits given in Table 12.
- Disassemble the case halves & check for 90% surface contact on the back of the bearing shells & across all jointing surfaces. Clean off the bearing blue with some kerosene or suitable solvent on a clean cloth & refit the bearing shells to the main bearing bores. Apply a light coating of oil to the shells.

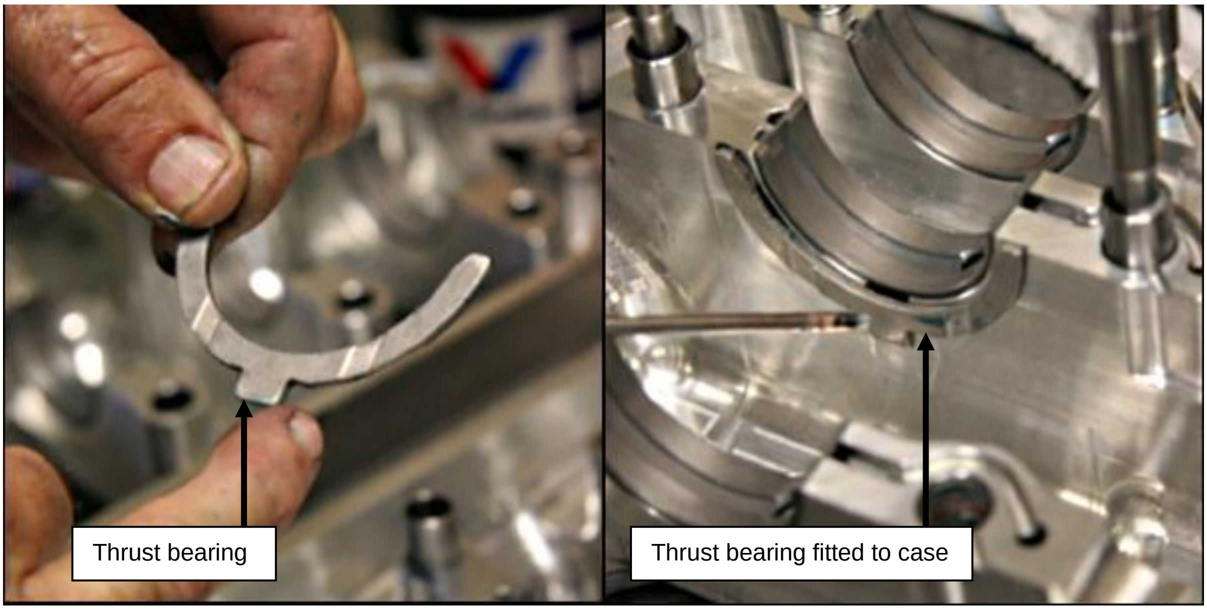


Figure 126 – Fitting Thrust Bearings

- Fit the thrust washers to the machined positions either side of the second front main bearing: use some general purpose grease to hold them in place.

- Offer one half of the crankcase up to the crankshaft. Fit a dial gauge on a magnetic base to the top of the crankshaft and measure the end float of the crankcase half on the crankshaft by moving the crankcase half up and down by hand. End float must be within the limits of Table 12 – 0.25mm is typical. Record the value (alternatively feeler gauges may be used). Remove the case from the crankshaft and set aside until final assembly. Fit the oil pickup tube O ring to the crankcase, then fit the oil pickup tube from the front of the case. The oil strainer housing is then Loctited to the pickup tube using Loctite 620. Note that the strainer must face forwards / down as shown.

Figure 127 – Fitting Oil Pickup Tube

- Fit solid lifters to the lifter bores in the case, lubricating each lifter stem and holding each lifter in place with a small amount of grease under the head. The camshaft will hold the solid lifters in one half of the case in place during fitting. Once the case is joined it is impossible to fit or remove solid lifters. Lubricate the base of the lifters and the cam lobes using moly grease or cam honey. This prevents damage during initial starting of the engine.
- Hydraulic lifters will be fitted later in the final assembly process as they can be fitted from outside the case.

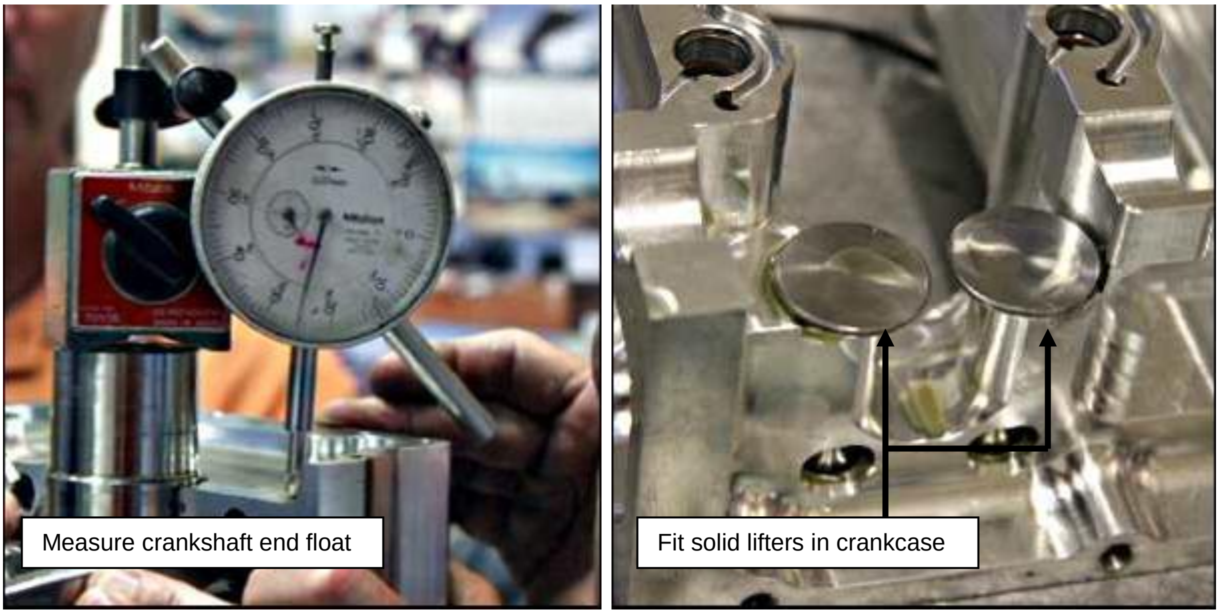


Figure 128 – Checking Crankshaft End Float, Installing Solid Lifters

7.2.2 Camshaft

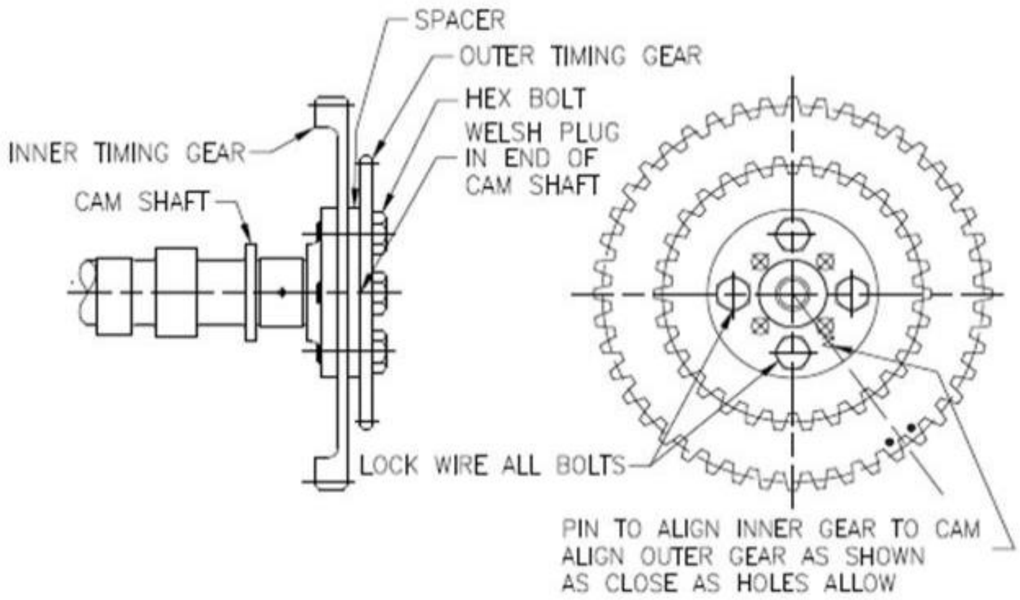


Figure 129 – Cam Timing Gear Assembly

- Clamp the camshaft between the heavily padded jaws of a vice and fit the large inner gear, the alloy spacer and the small outer gear to the flange at the rear of the camshaft: clean and prime 4 new AN4-H5A bolts and the cam flange threads with Loctite 7471 cure accelerator, align the inner gear so that the alignment hole on the camshaft flange aligns with the hole in the inner gear.
- Hold that position and fit the spacer and the outer gear as shown in the drawing above and secure in place with the AN4 bolts with Loctite 620 Retainer applied to the threads. Torque the value given in Table 9 and lockwire the bolts in place in pairs as shown above left (also refer to Section 3.9).
- Oil the cam bearing surfaces and then place the camshaft into one half of the crankcase and check for end float between the rear flange and the rear housing with feeler gauges as shown below (right). Value measured must be within the limits given in Table 12 (around 0.10mm is typical). Record the value.

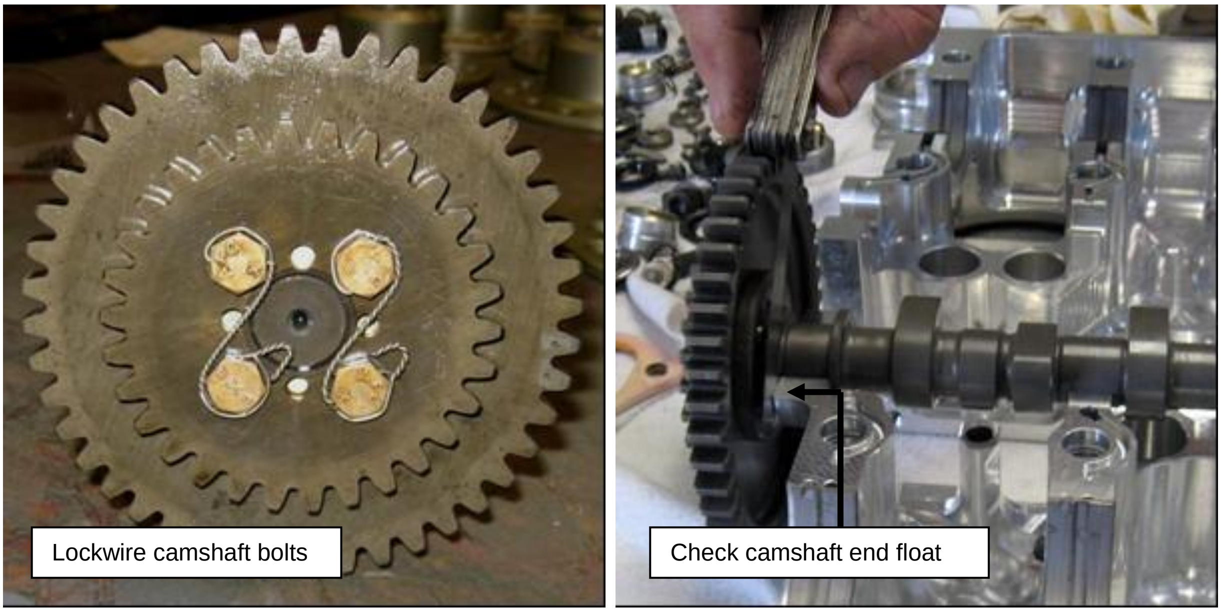


Figure 130 – Assembling Cam & Fitting to Crankcase

7.3 Subassembly C – Pistons, cylinders and cylinder heads

- In this subassembly task the piston rings will be gapped and fitted to the piston, the front gudgeon pin circlip will be fitted to the piston and finally the piston will be inserted into the cylinder ready for later final fitting to the connecting rod.

7.3.1 Pistons

- Several different variations of piston have been used in Jabiru engines. In some instances it may be required to partially replace an engine's pistons (i.e. replacing 2 pistons in a 4-cylinder engine) during maintenance. In this case the overhauler must accurately weigh reciprocating part assemblies per Section 5.11.1.4.
- For in-service maintenance purposes it is acceptable practice to fit piston assemblies in pairs – i.e. pistons #1 and #2 may weigh 529g and 530g respectively while pistons #3 and #4 weigh 533g and 532g. However where possible it is recommended that all reciprocating assemblies be weight matched. Where all pistons in an engine are replaced the limits detailed in Section 5.11.1.4 apply.

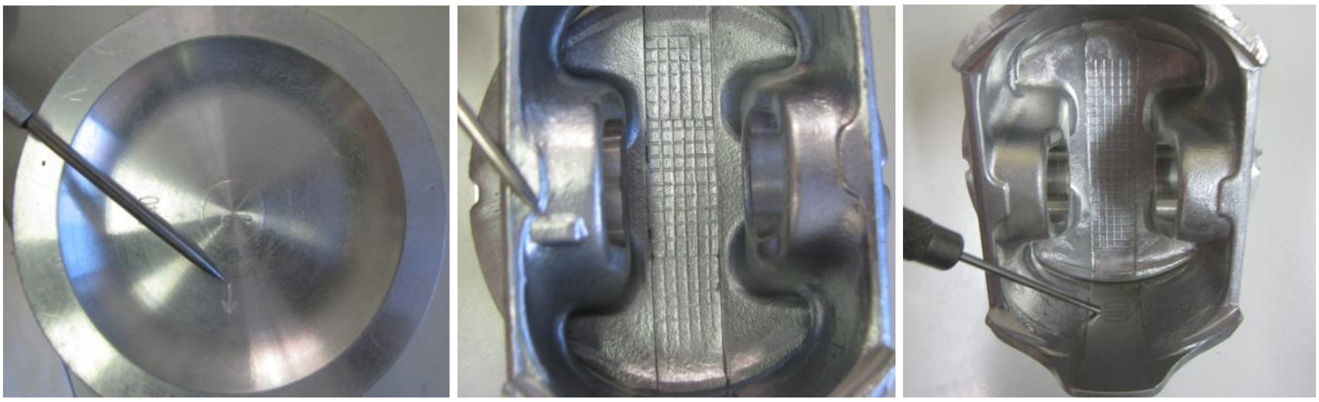


Figure 131 – Thrust Direction Markings For Pistons

- Current pistons feature modifications to the piston crown to allow the piston to prevent a stuck valve impacting the piston. Assembly for these parts is the same as for older piston types and is as detailed herein. However, note that these parts are handed – with a different part number being used on the left side of the engine compared to the right. When confirming piston orientation note that the valve relief is always on the sump side of the engine as shown in Figure 132.

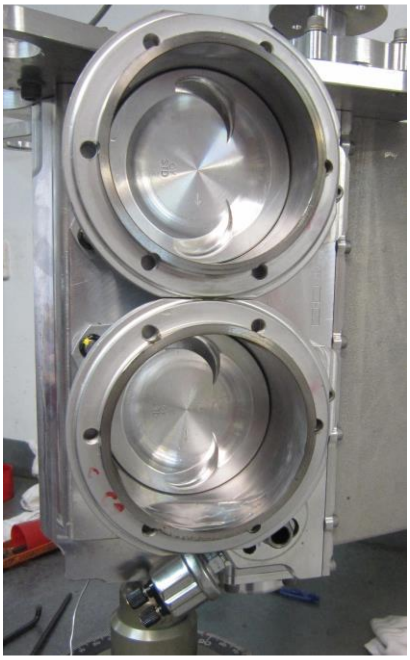


Figure 132 – Installation of Pistons With Valve Relief

- Looking at the underside of the piston there is a cast-in lump on one gudgeon pin housing (see Figure 131). This lump must be fitted to the engine on the side of the connecting rod closest to the propeller flange. Another marking used for the same job is a small arrow or indent cast into the crown. The arrow must point towards the propeller flange and/or the indent must be on the propeller flange side of the connecting rod. These markings show the correct orientation of the piston to the thrust loads from combustion relative to the propeller. In addition, or when the thrust mark is absent for some pistons, the manufacturer’s mark is orientated towards the bottom (sump side) of the engine for the RHS of the engine and towards the top of the engine for the LHS of the engine (from the pilot’s perspective), see Figure 131 right image.

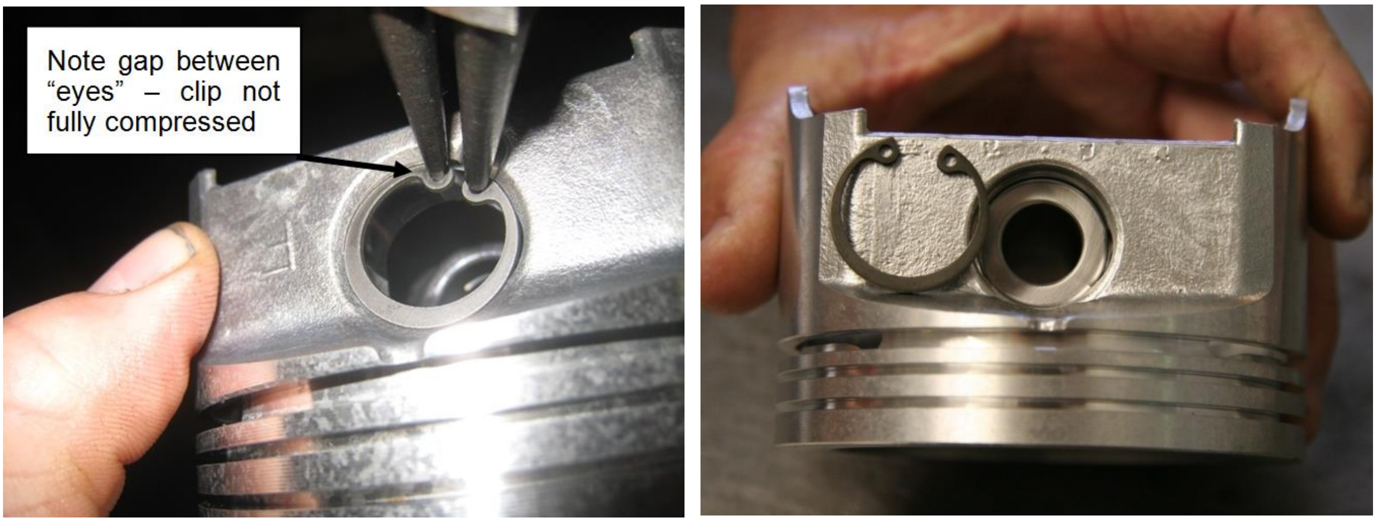


Figure 133 – Fitting Circlip to Piston

Figure 134 – Fitting Wire-Type Piston Circlips

- Fit wire-type circlip:
  - Many engines use a wire circlip in place of the part shown in Figure 133. Installation of that type of clip is shown in Figure 134.
  - The circlip has a lot of tension and as a result installation can be tricky.
  - Overhaulers must **roll** the clip into the groove – they must never be levered in as this can damage the piston or the clip.
  - Take care not to scratch or burr the piston or to bend the clip itself.
  - As the clip slips into the groove, listen for a crisp “snap” sound, indicating that it has dropped fully into place. Always give the installed clip a close inspection after installation. Use a small screwdriver or pick to check that it is tightly in place – in the case of the piston, apply an “opening” load to the ends of the clip, expanding it into the groove. The clip should not move and should not spin in the piston. If in doubt, fit a replacement.
- Fit conventional circlip:
  - Both 25mm and 23mm internal circlips have been used in Jabiru engines, as shown in Figure 133.
  - Visually inspect the clips supplied and identify the “flat” and “round” sides. Figure 135 shows the two different sides of a typical clip – note the sharp corners on the top of the left clip while the clip on the right has a rounded top face and rounded corners. This comes from the clip manufacturing process and will be apparent in all clips of this type – one side will be “sharp” and the other “round”.

- The clips must be installed so that the "rounded" side faces the item being retained (the gudgeon pin in this case). See Figure 136 for an illustration of the correct and incorrect orientation. A clip that is installed the wrong way won't be able to carry as much load and will fail more easily.
- When fitting the clip, take care to compress it by the bare minimum amount required. DO NOT compress the clip until the eyes touch. Over-compressing will permanently damage the clip: Figure 137 shows a clip which was over-compressed lying on top of a brand new clip. Note how the clip on top has been bent to a smaller size compared to the one underneath. This damage to the clip reduces the force it can apply to its housing and makes it easier to dislodge. Specially modified circlip pliers such as those shown in Figure 21 may be used to prevent damaging clips.
- As the clip is fitted, listen for the crisp "snapping" sound that indicates it has dropped fully into place.
- Orient the clip as shown in Figure 136: the opening in the clip faces along the axis of the barrel.
- Ensure that both ends of the clip are positioned in full-depth sections of the groove
- Always give the installed clip a close inspection after installation. Use the circlip pliers or a small screwdriver or pick to check that it is tightly in place – as shown in Figure 136, apply an "opening" load to the eyes to expand the clip. The clip should not move and should not spin in the piston. **If the clip moves, discard it and fit a replacement.**

Figure 135 – The Two Sides of Circlips

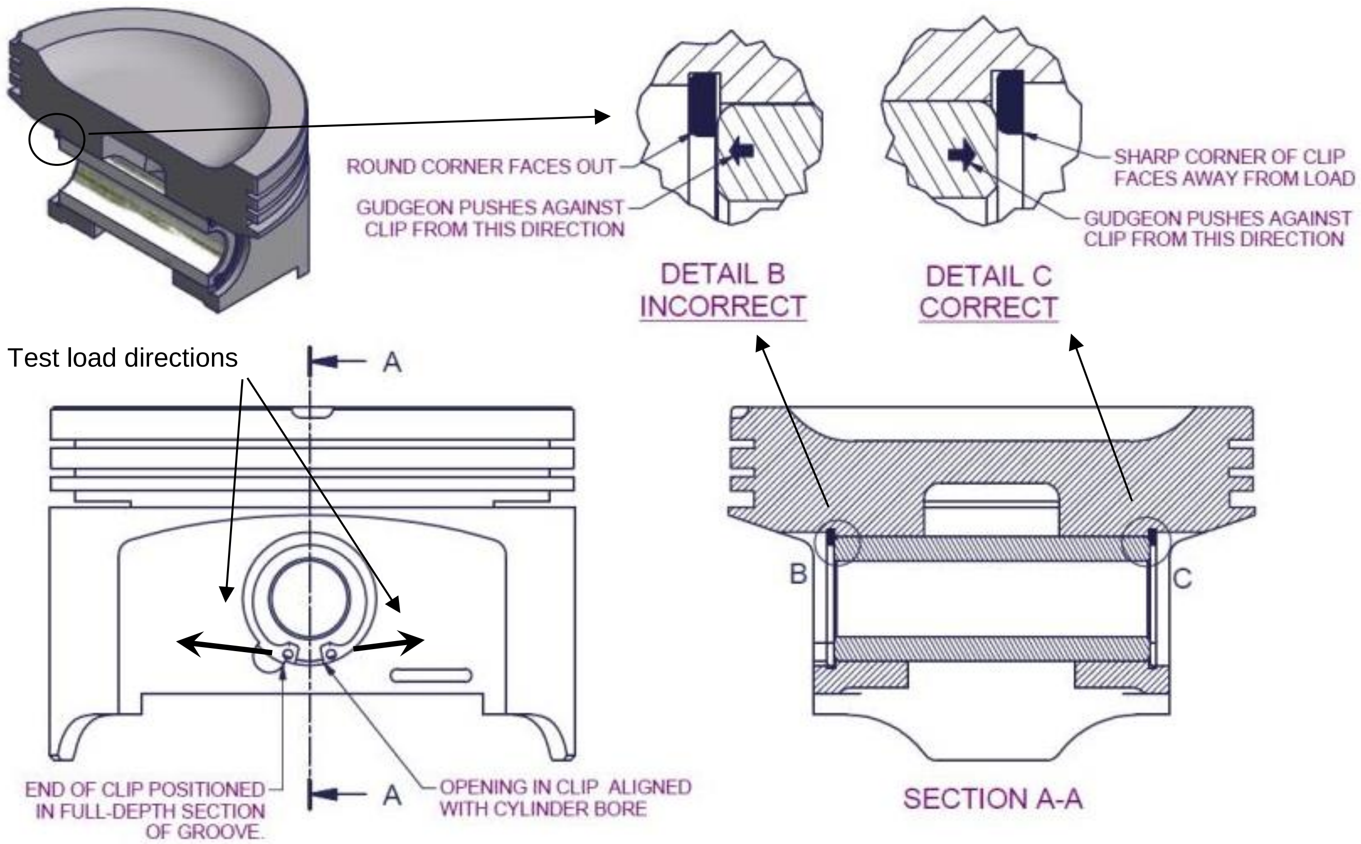


Figure 136 – Clip Installation Detail

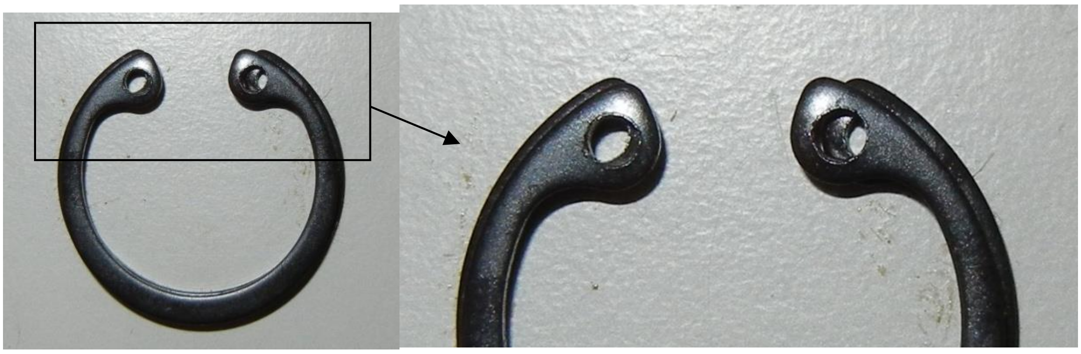


Figure 137 – Over-Compressed and New Clips

WARNING

Clips that are loose will rotate in service and wear the piston circlip groove away resulting in a loose fit and, eventually, the gudgeon pin being liberated & engine failure.

Circlips must be fitted and inspected correctly or engine failure will result.

- Fit the circlip on the propeller flange side of the pistons now – the second circlip will be fitted on assembly to the connecting rod.
- Oil the pistons and cylinders using engine oil.
- One at a time, fit the compression rings (the first and second ring of each piston) into their cylinder. Use a piston to press the rings down into the bore – this will position the rings properly perpendicular to the bore, making sure they are not at an angle. Using a feeler gauge, measure the ring gap of each ring and record the value in the build sheet. Ensure the gaps are within the limits given in Table 12. 0.50 – 0.60mm is typical in a 97.60mm bore though the gap will vary depending on the exact size of the barrel. Figure 138 shows this process. The end gap can be adjusted if required, however this is a standard engine-building process and will not be described here. Care must be taken to ensure that pistons, rings and cylinders are maintained in sets so that the engine is eventually assembled using parts which have been measured together – not with the rings which were checked in cylinder #2 being fitted to cylinder #4.

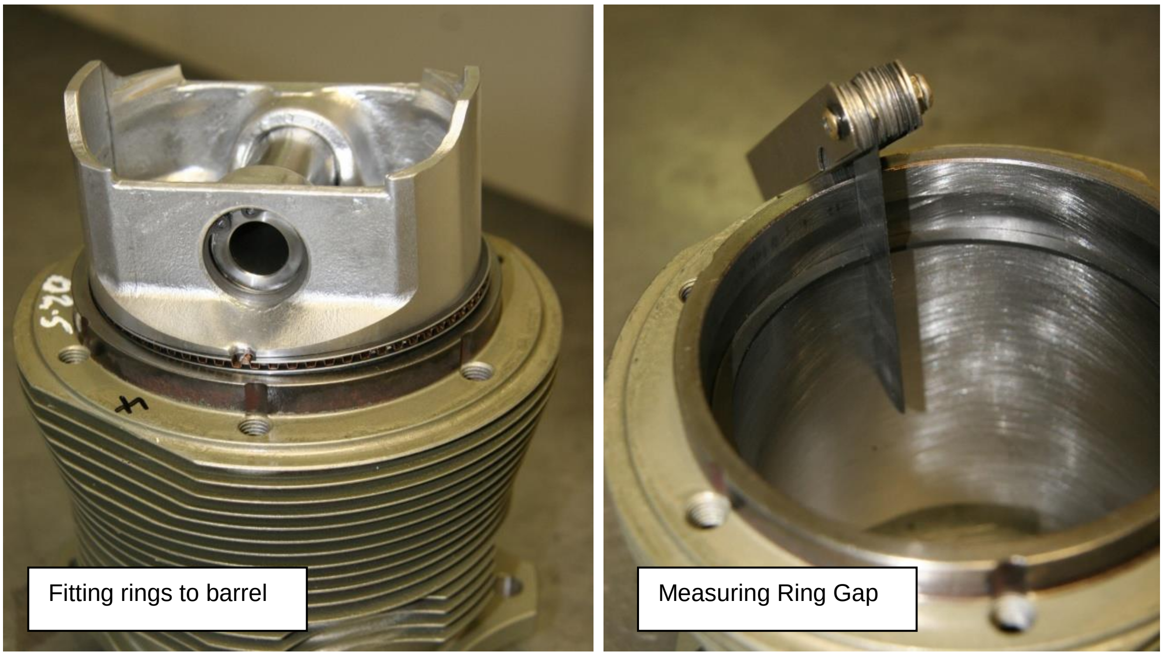


Figure 138 – Checking Piston Ring Gap

Figure 139 – Compression Ring Cross Section

- Fit the rings to the piston.
- The "square" compression ring goes into the groove closest to the piston crown. The compression ring with the cut-out section fits in the next groove down (see Figure 139).
- Some compression rings are marked with an "R". Compression rings with either of these markings must be fitted with the marking pointing towards the piston crown.
- Check the fit of the compression rings to the piston. Ensure ring sliding clearance is within the limits given in Table 12.
- Note that the oil rings must be fitted so that the scraper ring ends (i.e. the join in the upper scraper ring is not in line with the join in the lower scraper ring) are separated and the expander has not overlapped itself.
- Fit the gudgeon pin to the piston on the side where the circlip has not been fitted.

7.3.1.1 Piston skirt types

- There are two valve relief pocketed piston used in Jabiru engines.
- Split skirt pistons – feature a visually distinctive split between the crown and skirt and were designed for use in all Jabiru engines using steel barrels (generation 1, 2 and 3)
- Slotted skirt pistons – Feature a bridge between the crown and skirt with 4 oil slots machined through on each side. These were designed for use in in the aluminium barrels of generation 4 engines however they can be used in Gen 1,2,3 engines where availability dictates the need, so long as the correct clearances are maintained.

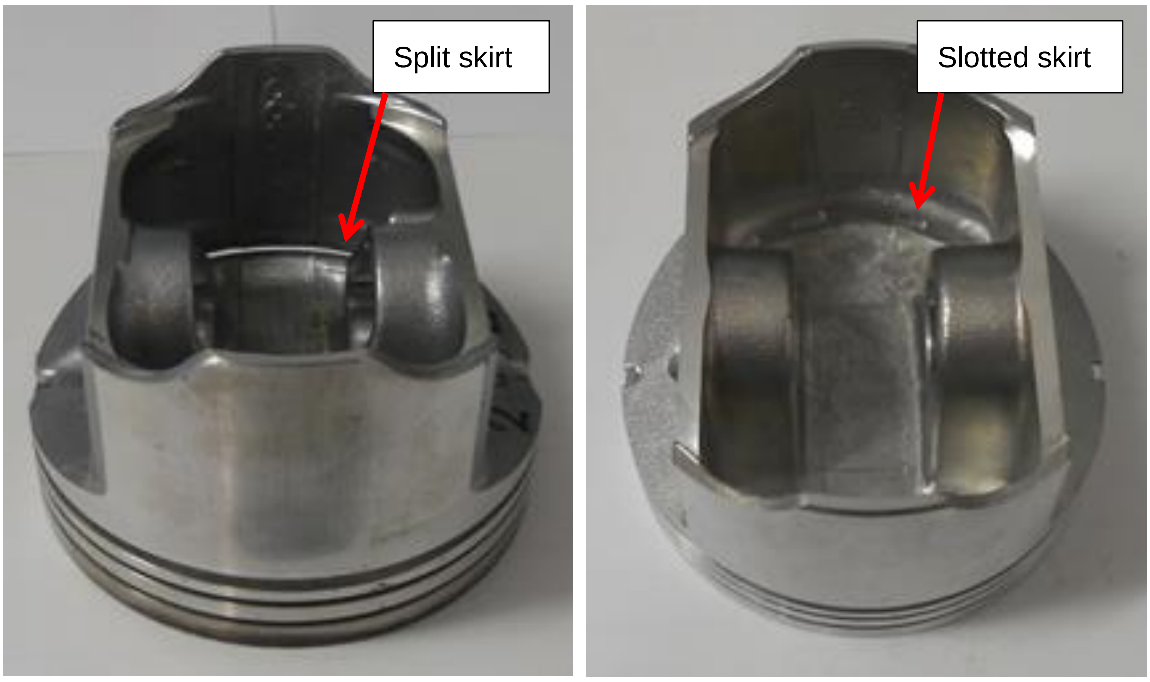


Figure 140 - Split and Slotted skirt pistons

WARNING

The required piston skirt-to-barrel clearances are DIFFERENT for split skirt and slotted skirt pistons running in steel barrels. Ensure the correct clearances are used (see section 9.5)

7.3.2 Cylinders

- Each cylinder should be clearly marked with a number using permanent marker or similar – these numbers can be cleaned off at the end of the build using tool cleaner or similar. In the meantime the numbers will allow the overhauler to easily identify cylinder head / piston / rod / cylinder sets. The numbering system of the cylinders for the engines is given in Figure 3.

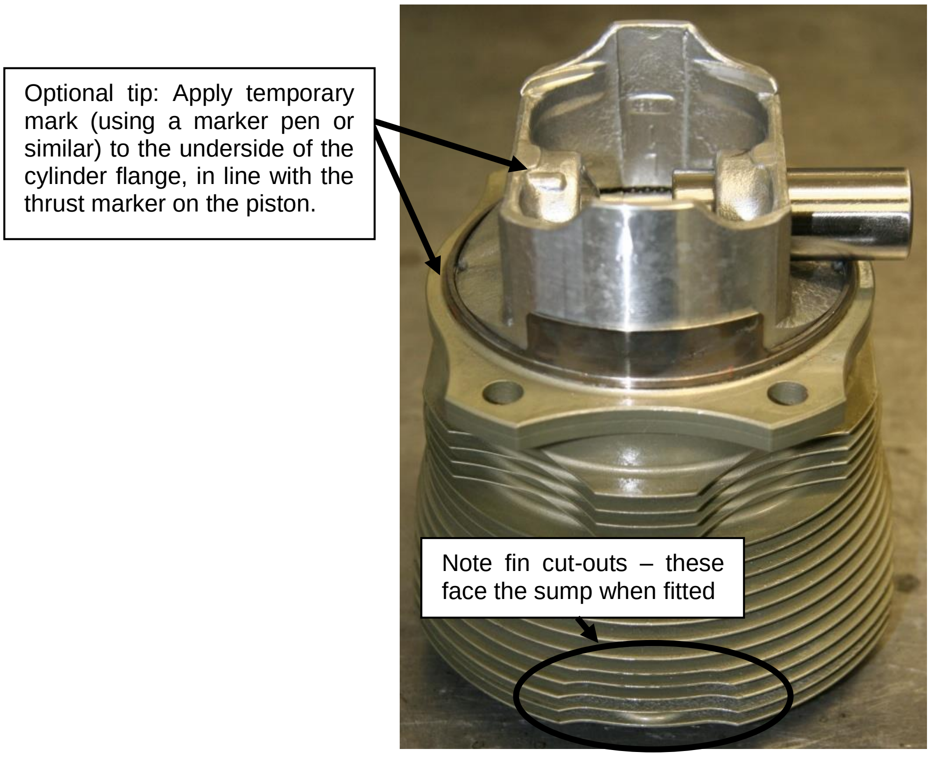


Figure 141 – Piston / Ring / Cylinder Assembly

- If new cylinder heads are being used in the build then lapping the cylinder to the head is not required. Otherwise the procedure noted in Section 7.3.4 must be followed.
- Fit the rings to the piston. Orient the ring gaps at 120° intervals around the piston so that it is unlikely that the gaps will ever line up. The rings must also be oiled for assembly.
- Fit the piston to the cylinder (using a commercial ring compressor or a special tool per Figure 18) from the underside (skirt side) of the cylinder. Do not push the piston far up into the cylinder as this makes assembly difficult – it should be left as shown, down near the cylinder skirt.
- Ensure the piston is oriented correctly into the cylinder – the side of the cylinder with the cut-out areas in the fins faces the engine sump. Piston orientation is noted in Section 7.3.1. A good tip here is to apply a temporary mark to the underside of the cylinder showing the front side, making later assembly easier.
- Start the gudgeon pin into the piston as shown in Figure 141 (left).
- Fit the cylinder base O rings to the cylinder.

WARNING

Ensure that the thrust direction markings of the pistons are oriented correctly

Ensure that the cylinders are oriented correctly (top/bottom).

7.3.3 Through-Bolt Nuts

- Count out a set of engine through-bolt nuts.
- 12-point nuts with washers must be used on all cylinder base applications.
- Check that all nuts and washers are clear of the radius on the base of the cylinder barrel. Figure 142 (right) shows how using certain (large-flange) nuts can result in the nut hitting on the radius at the cylinder base. To avoid this it is necessary to use a “Small-flange” nut per Figure 142 left, or a nut which has been modified – the diameter of the nut base can be reduced in a lathe. This requirement also applies to the washers used: these parts are custom made for Jabiru from hardened steel – substitutes must not be used.
- Later engines (See Section 13 for serial number ranges) use 7/16” hardware on the engine through bolts and studs. On these parts a custom-made nut (shown in Figure 143) is used. At overhaul these are to be removed and 7/16” 12-point nuts & washers fitted (Figure 143 right).

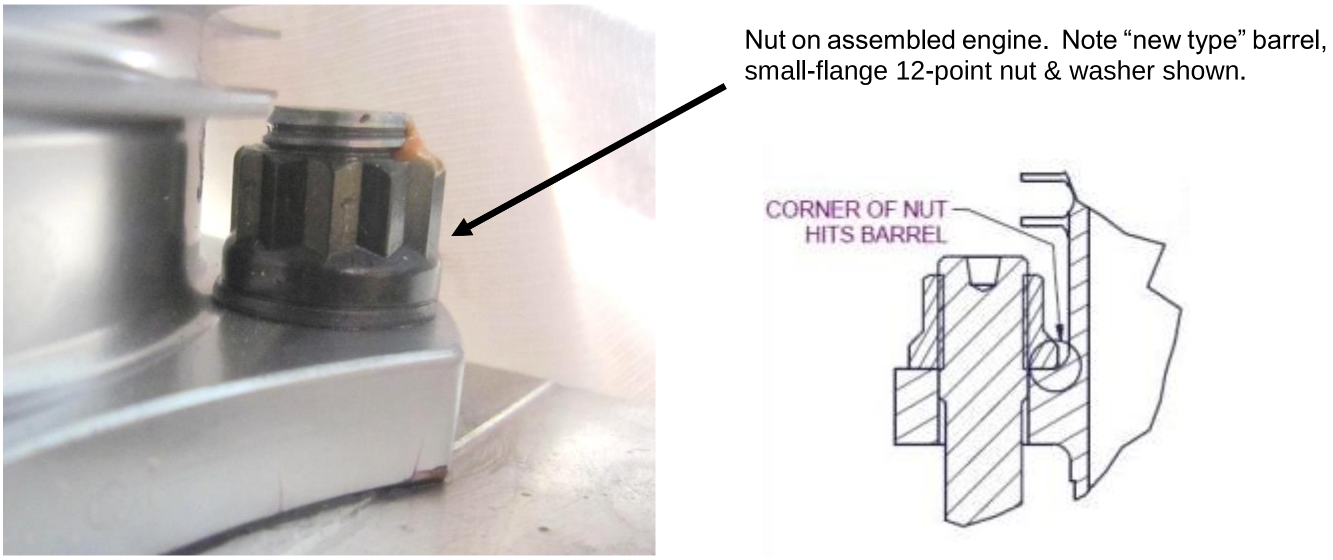


Figure 142 – Through Bolt Nut Installation Detail

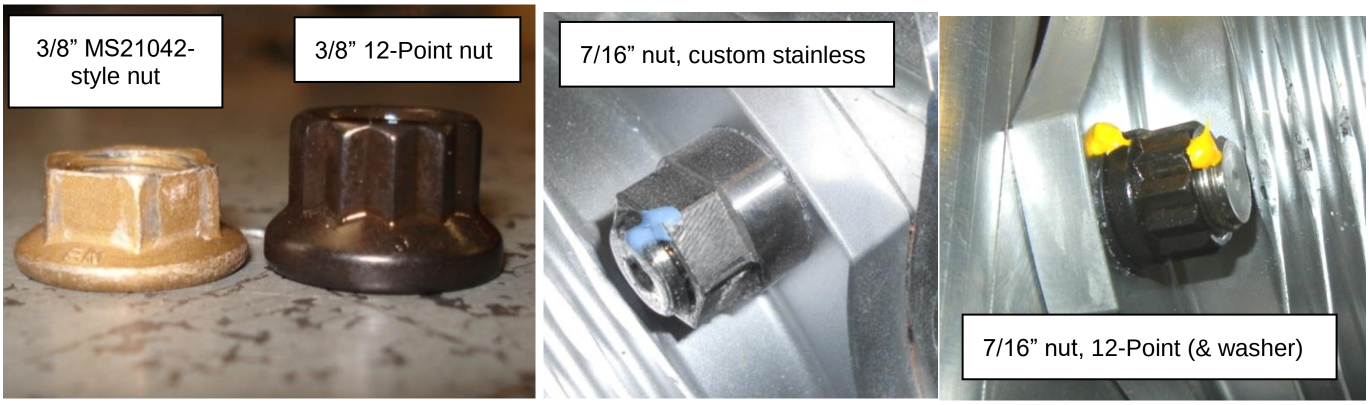


Figure 143 – 12-Point Nuts, 7/16” Hardware (on right)

WARNING

MS21042-type nuts must be replaced with 12-point nuts at overhaul or whenever the barrel is removed for maintenance.

Assembly with nut hitting barrel radius can lead to engine failure

7.3.4 Cylinder heads

- Each cylinder head should be clearly marked with a number using permanent marker or similar – these numbers can be cleaned off at the end of the build using tool cleaner spray. In the meantime the numbers will allow the overhauler to easily identify cylinder head / piston / rod / cylinder sets. The numbering system of the cylinders for the engines is given in Figure 3.
- Note that the 2200 engine uses two different cylinder heads – one for cylinders 1 & 4 and another for 2 and 3 - Figure 144 refers. The Jabiru 3300 engine uses the same cylinder head for all cylinders – though they are fitted with different induction or exhaust pipes depending on where they are fitted to the engine.

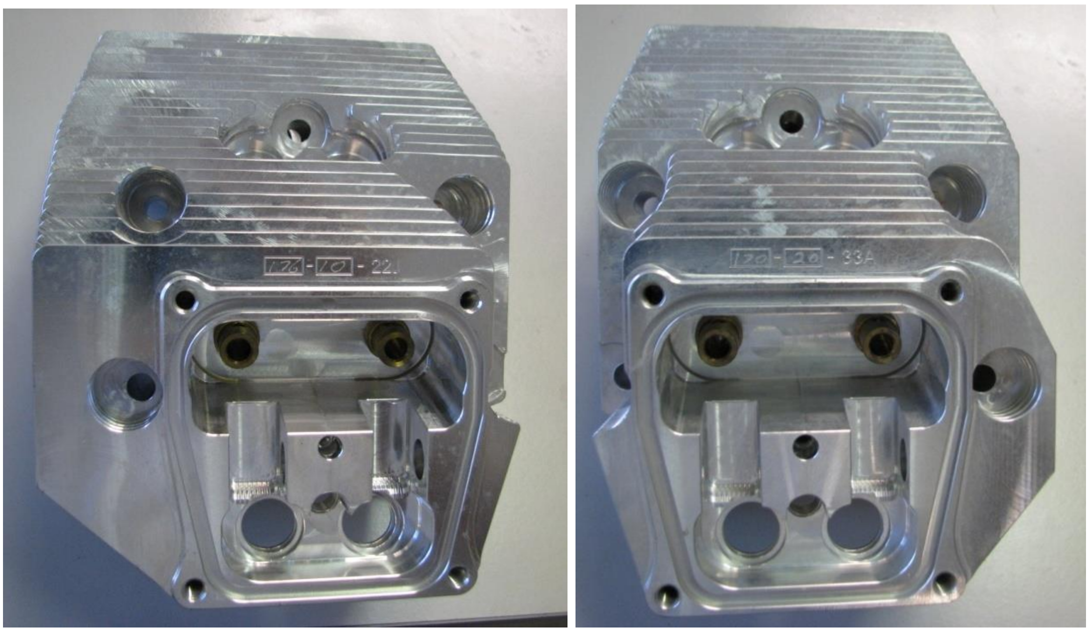


Figure 144 – Cylinder Head Comparison (2200 head on left, 3300 on right).

- Where second-hand heads are used they will have had their valve seals tested as detailed in Section 5.11.5. This process also applies when fitting new cylinder heads: the seal of each valve must be tested as detailed in Section 5.11.5. If the seal is not good enough then the valve and seat will need to be lightly cut. After cutting ensure that the cylinder head and valves are thoroughly washed to remove all residue of the valve cutting paste.
- Where new valve springs are used, inspect both ends for sharp edges and burrs which may damage the valve spring washers. Polish off any edges or burrs found.
- Prior to installing valves into the head, check the collet grooves are clean and free of metal burrs. Also check the grooves in the collets themselves. Test fit each pair of collets onto the valve stem retaining them in place with a Top valve spring retaining washer, check the valve rotates smoothly between the collets. DO NOT install if there is excessive friction (this can can failure of the Top spring retaining washer) another set of collets should be used.

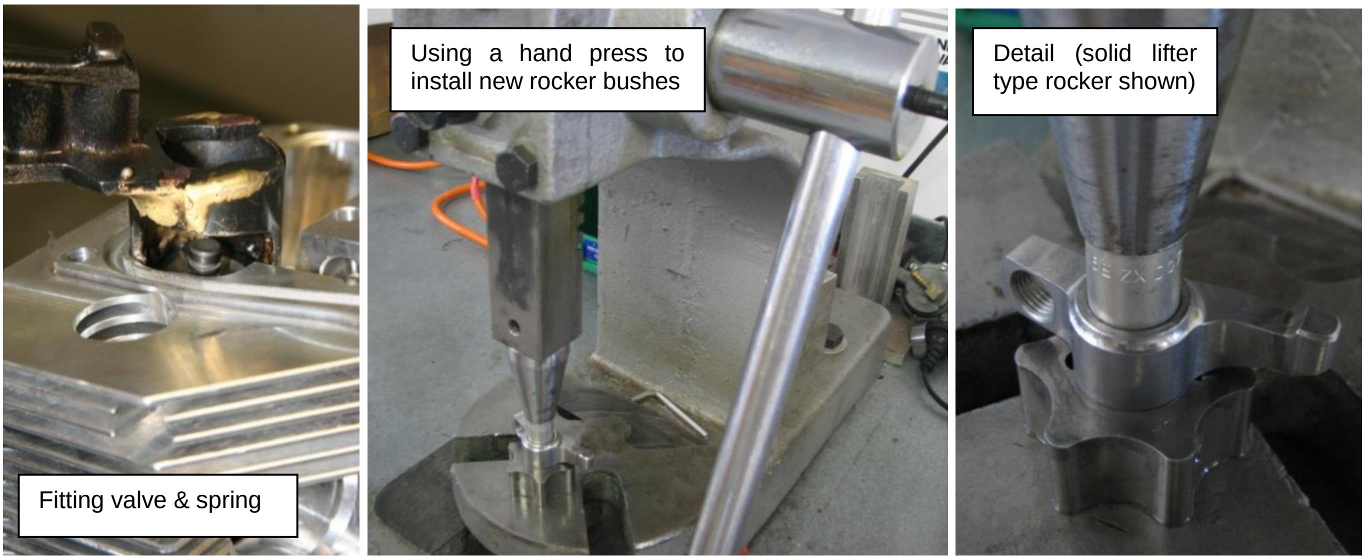


Figure 145 – Fitting Valves to Head, Fitting Bushes to Rockers

- Fit new O rings (2) to the rocker shaft bore of the cylinder head and 2 new O rings to the pushrod tube bores. Use Nulon L90 to lubricate the O rings for assembly and to prevent damaging them while fitting the rocker shaft and pushrod tubes. Do not use rubber grease as it will attack these O rings and metal parts. Note that the large rocker cover O ring is fitted later in the assembly process.
- Lubricate the valves and valve guides using oil, then fit the valve springs and collets to the cylinder head using a spring compressor as shown in Figure 145. Ensure that the lower steel washer (shown at the lower left of Figure 95 – left) is fitted to the base of each spring.
- Note that the rocker shaft and valve rockers are fitted later in the assembly process. However now is the time to fit new bushes to the rocker arms (if needed). A special tool and a hand press (as shown in Figure 145) simplifies this job. Orient the new bushes so that the joint in the bush is pointing away from the crankshaft. Additional details are shown in section 5.11.8.
- Fit the induction pipe to the head, again taking care that the correct pipe is fitted to the correct head (the pipes are stamped with their cylinder number). New gaskets must be used.
- If new heads are being fitted to an engine then in most cases some small Welch plugs must be fitted to the head. For engines using the external oil feed tube for the rocker gear small tubes must also be fitted to the head. Both of these parts are pressed into the cylinder head (Figure 146).
- For engines using the hollow pushrod oil feed the oil ports in the side of the heads are not used. In that case 2 Welch plugs (Figure 146, right) are fitted to the head – one on each side – to blank them off.
- Fit the outer pushrod cover retaining circlips to the heads as shown in Figure 190. Note the orientation of these clips: the opening of the clips must point towards the access hole (and 1/8” NPT plug) for the lower head bolt. In other orientations the clips may interfere with the fit and function of the pushrods.

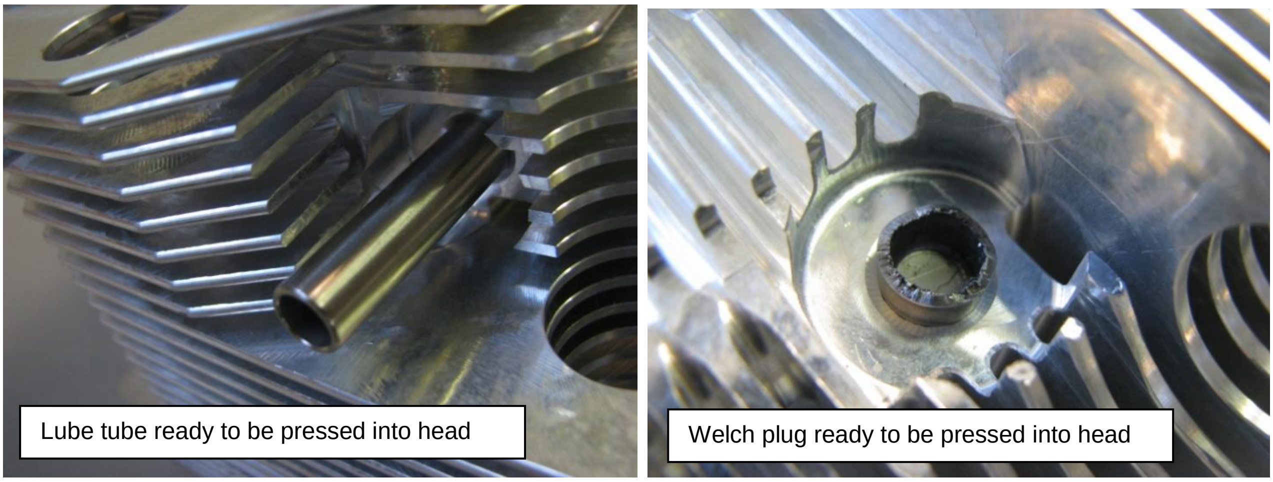


Figure 146 – Cylinder Head Welch Plug & Lube Tube Installation.

7.4 Subassembly D – Sump

- It is acceptable to fit the induction plenum chamber to the sump before fitting the sump to the engine. However for this manual the sump will be fitted first and the plenum later.
- If the crankcases have been surfaced and line-bored it is possible that the sump dowel pins may not align correctly. After the crankcases have been joined the sump must be dry-fitted to confirm that everything lines up as it should. In some cases some of the mounting holes through the sump may have to be enlarged slightly using a small round file and the locating pins may not fit. This is unusual and generally should not occur, provided that the cases have not been surfaced by more than the maximum allowable amount. Check for alignment of all mounting screws and for the fit of the sump against the gear case at the rear of the engine.
- After dry fitting, ensure that all dowels are in place (if applicable – early engines had none).
- Fit a new O ring to the oil filler housing and to the dipstick.

7.5 Subassembly E – Flywheel, Ignition Coils, Starter Motor And Alternator

7.5.1 Ignition Coils

- Ignition coils are fitted with insulating washers between the coil and the mounting post. These are essential as they greatly reduce the operating temperature of the coil, improving its longevity.
- Ignition coils must be fitted with the output lead pointing in the direction of propeller rotation. Coils installed backwards may fire with the wrong timing or not work at all.

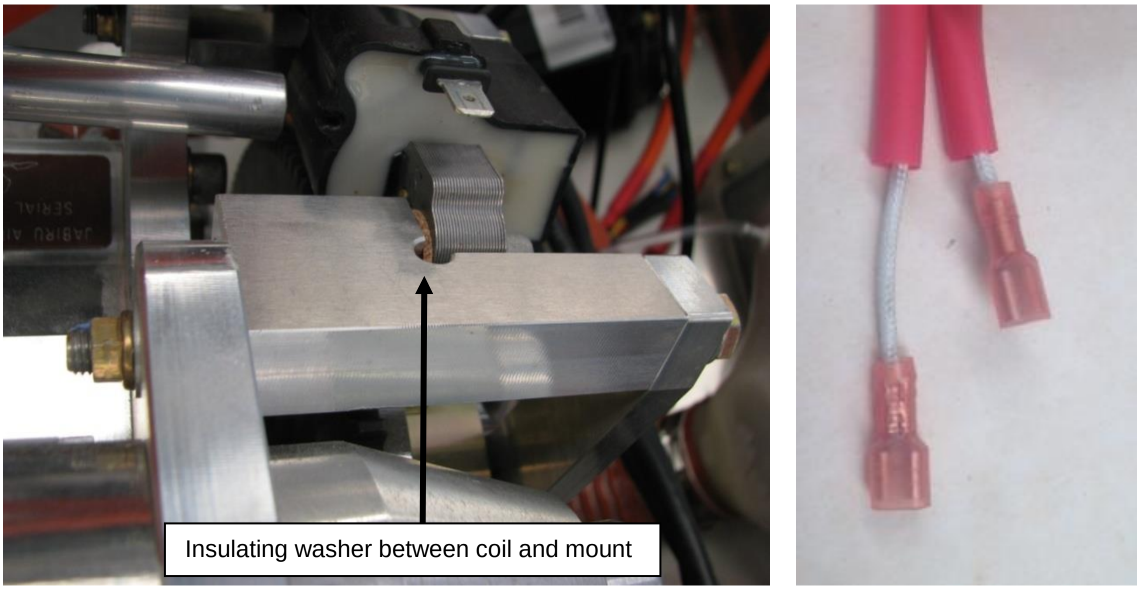


Figure 147 – Ignition Coil Insulating Washer and Stator electrical leads

7.5.2 Alternator

- Dome-head screws are used in the alternator magnet housing (Figure 148, right). This provides clearance from the stator – if normal socket head screws are used here alternator damage will result.
- Screw the alternator stator to the mount plate using machine screws. A small amount of Loctite 263 is used on these screws.
- The two alternator leads must be of different lengths (at least 25mm difference) to ensure an electrical short cannot occur between the two connectors (see Figure 147 right)

7.5.3 Flywheel

- If the engine is being updated to a "Starfish" style flywheel then the alternator rotor and the ignition magnets must be fitted – otherwise these parts are left undisturbed on the flywheel during overhaul.
- Fit the ring gear to the flywheel using 6 off 1/4 x 1/2 Grade 8 bolts to the torque value given in Table 9. Note the two tags fitted to the ring gear which are used by the tacho to measure RPM.
- Whenever working with the rare-earth magnets used in Jabiru Engines, remember that shocks (like a sharp tap with a hammer) and heat (such as from a heat gun when removing the flywheel screws) can de-magnetise the magnets.
- There are two types of magnet retaining pole plates:
  - Solid Pole Plates (shown Figure 148) are fitted with 1/2" 10-32 countersunk screws.
  - Laminated Pole Plates (shown Figure 149) are fitted with 5/8" 10-32 dome head screws
  - Both types can be used on all flywheels, however all sets must be consistent on the flywheel to ensure the flywheel balances correctly.
- The magnets themselves are potted in Silastic 1080 to prevent them vibrating. Note that the magnets must be set with their north poles facing outwards. After assembly the magnet assemblies must be tested as detailed in Section Table 13. If necessary new magnets may need to be fitted.
- The alternator rotor assembly is located on the flywheel using 4 roll pins. These are fitted to the flywheel, then the rotor tapped into place using a soft hammer. The rotor is then screwed to the flywheel using 4 off 5/8" x 10-24 button head cap screws. A small amount of Loctite 620 is applied to these screws.

- Finally the “starfish” adaptor itself is screwed to the flywheel using 8 off 1/4" x 5/8" UNF cap screws & Belleville washers (torque per Table 9). Loctite 620 is applied to these screws. Note that the “starfish” has a front and a back – care must be taken to orient it correctly to the flywheel body, aligning the datum holes in the starfish and flywheel body.

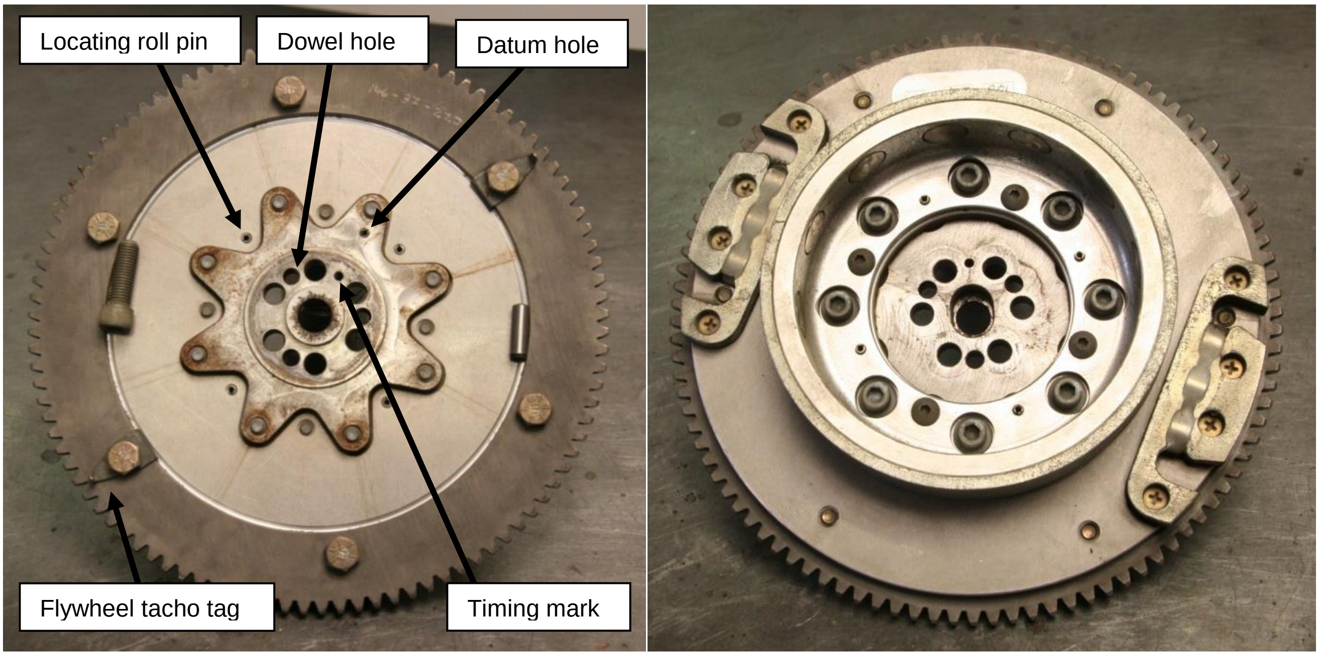


Figure 148 – Flywheel Assembly

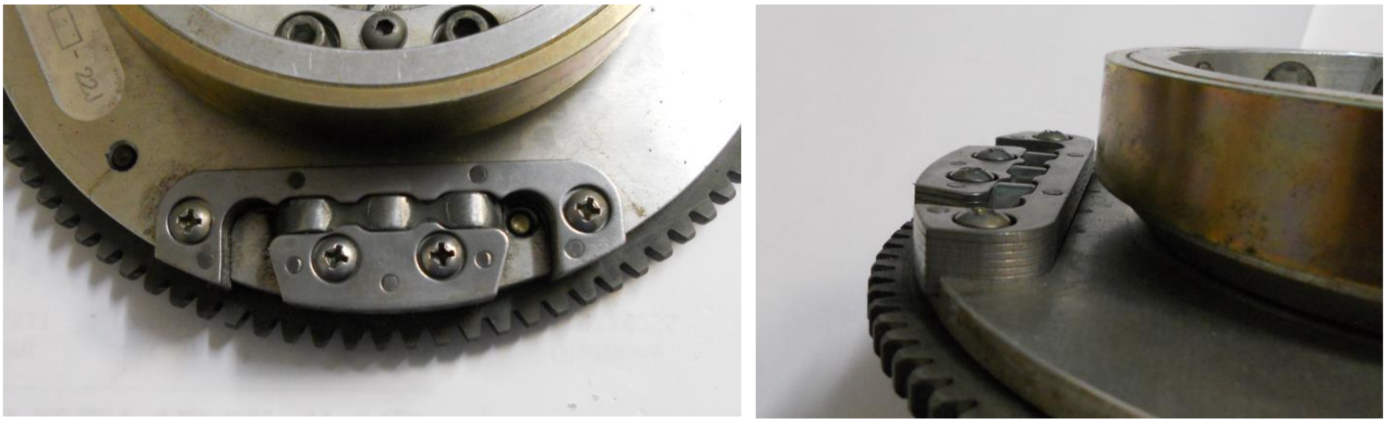


Figure 149 - Laminated Magnet retaining pole plates

7.5.4 Starter Motor

- Assemble motor and starter housing, and include the earth wire, (refer to JSL 005-1 service bulletin for details if the earth wire connection was not connected to the long through bolt on the starter motor). Assemble bolts with a small amount of Loctite 243 on the threads of the long AN3 bolts and tighten, check that the armature is able to rotate freely after tightening bolts.
- Apply grease to the clutch gear and assemble into the starter housing, then fit the clutch housing.
- The assembly is now ready to be fitted to the engine rear plate with the 3 socket head screws and Belleville washers, torque per Table 9.

7.6 Subassembly F – Gear case and distributors

7.6.1 Engine Mount Plate & Tacho Pickup

- Note that the 2200 mount plate is different from the 3300 version – these parts cannot be interchanged. As discussed in Section 5.13.4, for each engine there are 2 different engine mount plates available – one to suit the 99 tooth ring gear and another to suit the 101 tooth ring gear. It is not mandatory for these parts to be updated on overhaul, however the parts must be matched (ring gear to engine mount plate) for proper operation.
- Fit the oil feed tubes (2 – 1 one for each distributor shaft) as shown.
- The tacho pickup post (where equipped) and the gearbox locating pins can also be fitted now.
- Where the hall-effect type tacho sender is used (Figure 151) it must be installed during final assembly

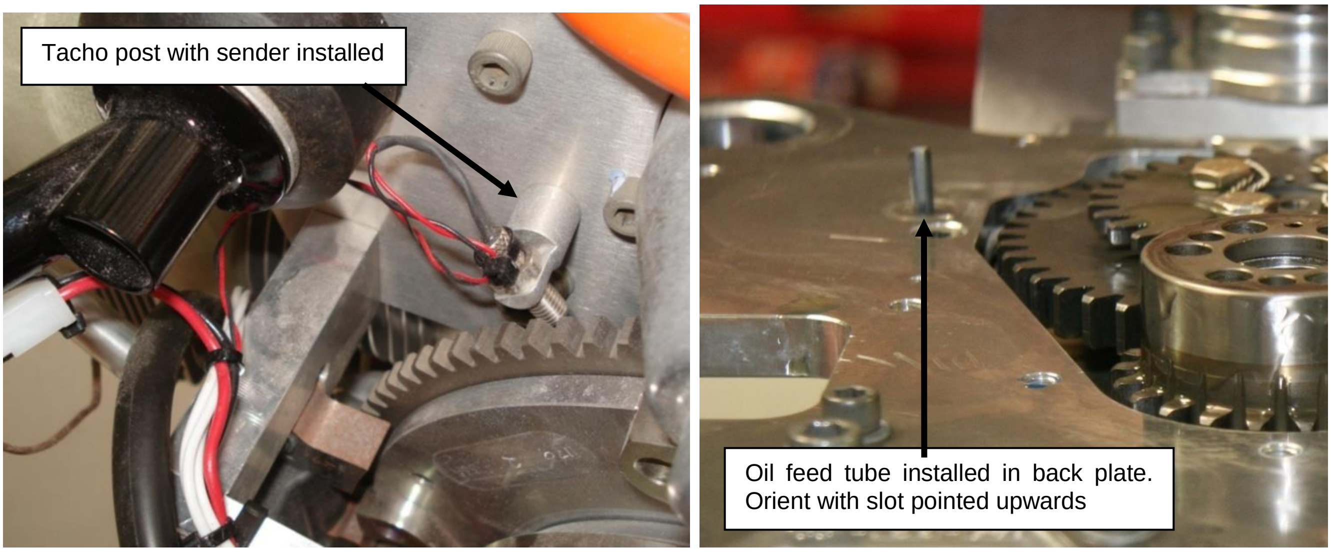


Figure 150 – Installation of Oil Feed Tubes & Tacho Pickup Post

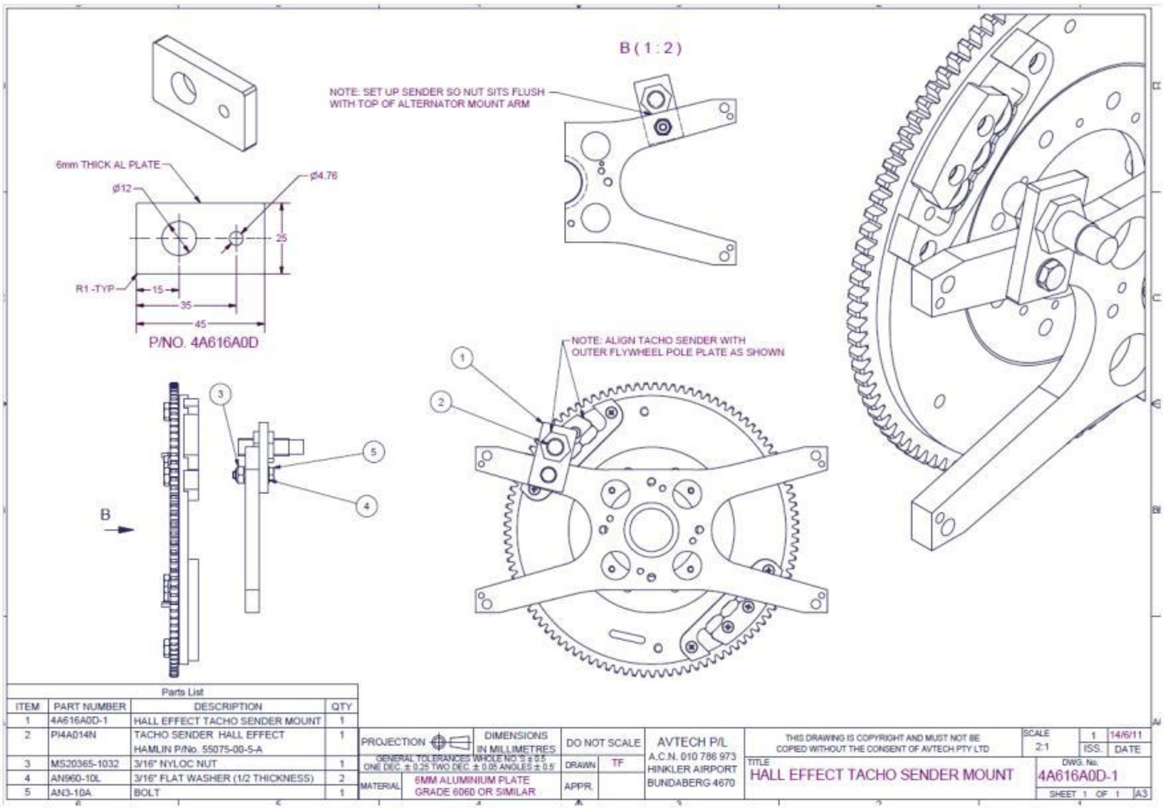


Figure 151 – Hall affect Tacho Sender

7.6.2 Distributor Case & Distributor Mounts

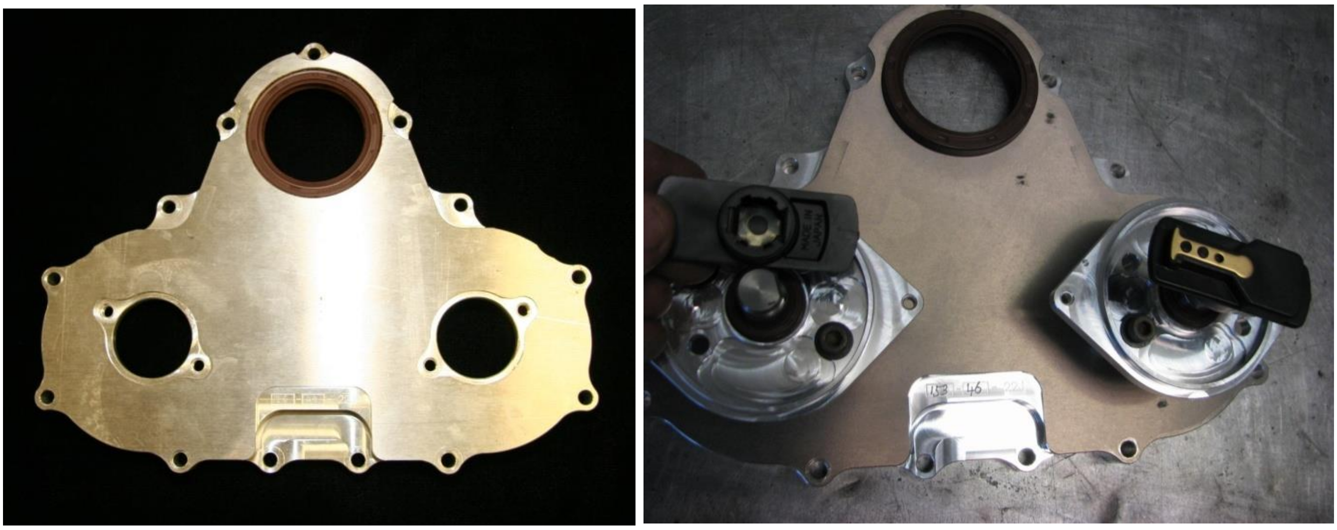


Figure 152 – Installation of Seals & Assembly

- Fresh seals must be fitted to the case and to the distributor mounts as shown in Figure 152. Note that later engines use a larger crankshaft timing gear and a thinner oil seal to suit. Oil seal size must be matched to fit the gear used.
- These seals must be well lubricated using grease for assembly – this part of the engine tends to run slightly dry and generous lubrication now will greatly reduce wear of these parts.
- The distributor posts, shafts and mount plates can be fitted to the distributor case now. Loctite 515 sealant is used on all mating surfaces.
- Glue the distributor rotors to the shafts using 5-minute Araldite mixed with a suitable filler (such as cotton flock) as shown in Figure 153.
- New bushes must be fitted to the distributor housings as shown in Figure 153. Distributor posts must be generously lubricated with Nulon L90 or grease.
- If the distributor shaft has been replaced it will be necessary to rivet the drive gear to the new shaft as shown in Figure 154. 3/16" stainless steel (Monel) blind rivets must be used. Ensure that the heads of the rivet do not get caught on the edge of the shaft and that the tails are not so long that they project past the shoulder of the shaft. Also ensure that the remainder of the rivet tails are driven out of the rivet – otherwise they can work loose in service and damage the engine.

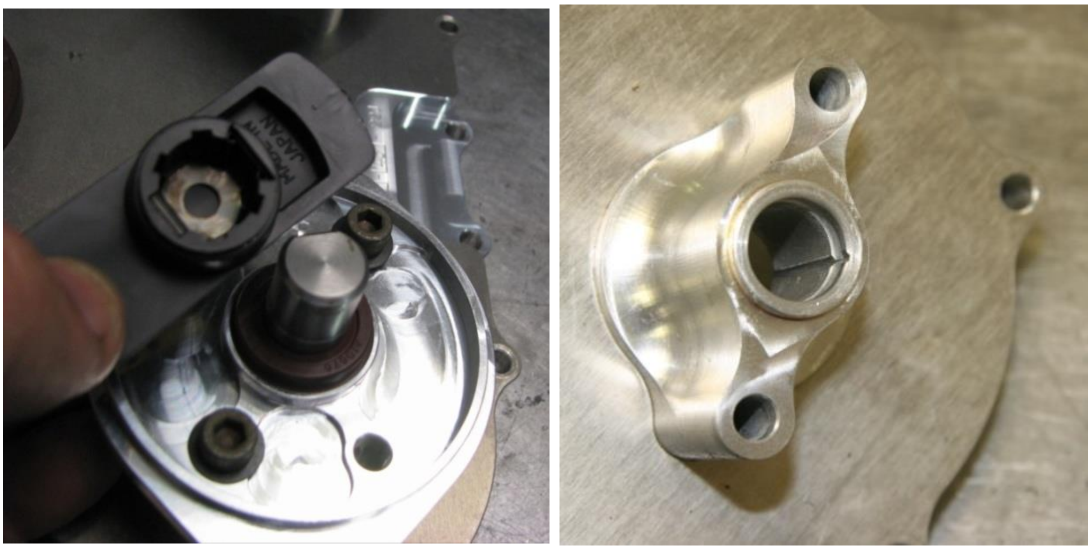


Figure 153 – New Distributor Shaft Bush Fitted – nopic x 1

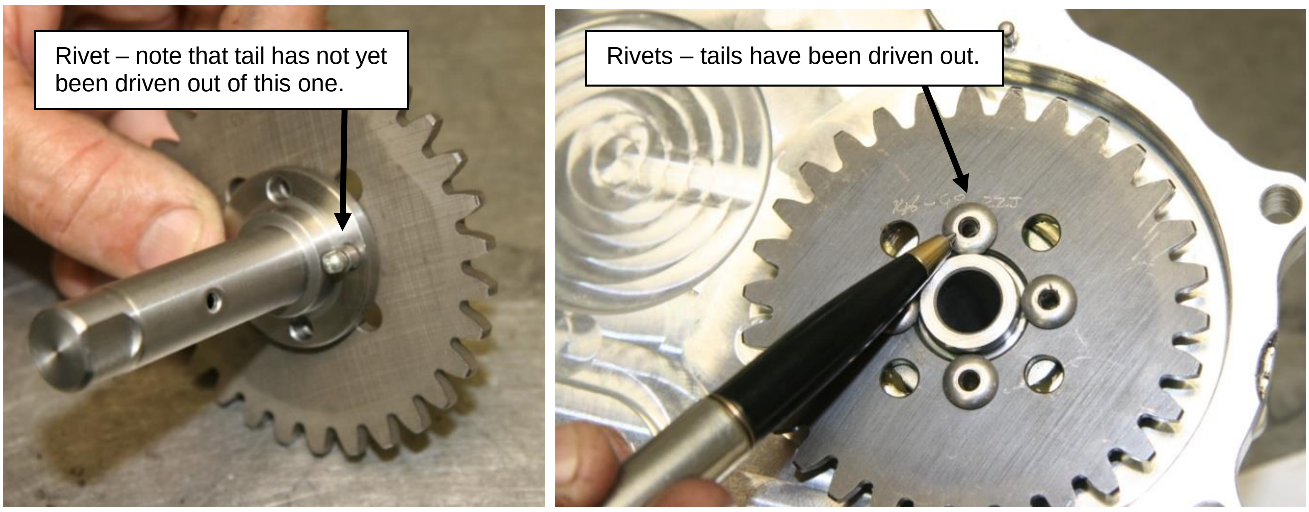


Figure 154 – Assembling Distributor Gear to shaft

7.7 Subassembly G – Fuel Pump And Carburettor

7.7.1 Carburettor

- Pre-fit the carburettor to the rubber mount, ready to be fitted to the engine.

7.7.2 Fuel Pump

- At a full overhaul a new fuel pump and new fuel lines are fitted.
- Pre-lube the pushrod using a small amount of grease.
- New gaskets must be used when re-fitting the pump. All joints must have 1 face coated with Loctite 515 sealant.
- Apply Loctite 263 to the 5/16 x 1 1/2" cap screws and tighten as detailed in Table 9. These screws are fitted with both Belleville and plain washers as show below in Figure 155.

ITEM	PART No.	DESCRIPTION	QTY
1		CRANKCASE REFERENCE ONLY	1
2	PG10342N	GASKET FUEL PUMP	2
3	PG118634	FUEL PUMP INSULATOR	1
4	PG10332N	FUEL PUMP G875	1
5	4566064-3	FITTING FUEL PUMP BREATHER	1
6	PZ0092N	HOSETAIL ELBOW 1/8"BSP-1/4	1
7	4510054-8	FUEL PUMP PUSHROD (2.2L)	1
8	PH10624-2	5/16" BELLEVILLE WASHER	2
9	4984124-4	FUEL DRIP TRAY FOLDED	1
10	PH4A001	5/16" UNC x 1 1/2" CAP SCREW	2
11	AN960-516	5/16" WASHER	2
12	PZ0069N	HOSETAIL STRAIGHT 1/8" BSP-1/4	1

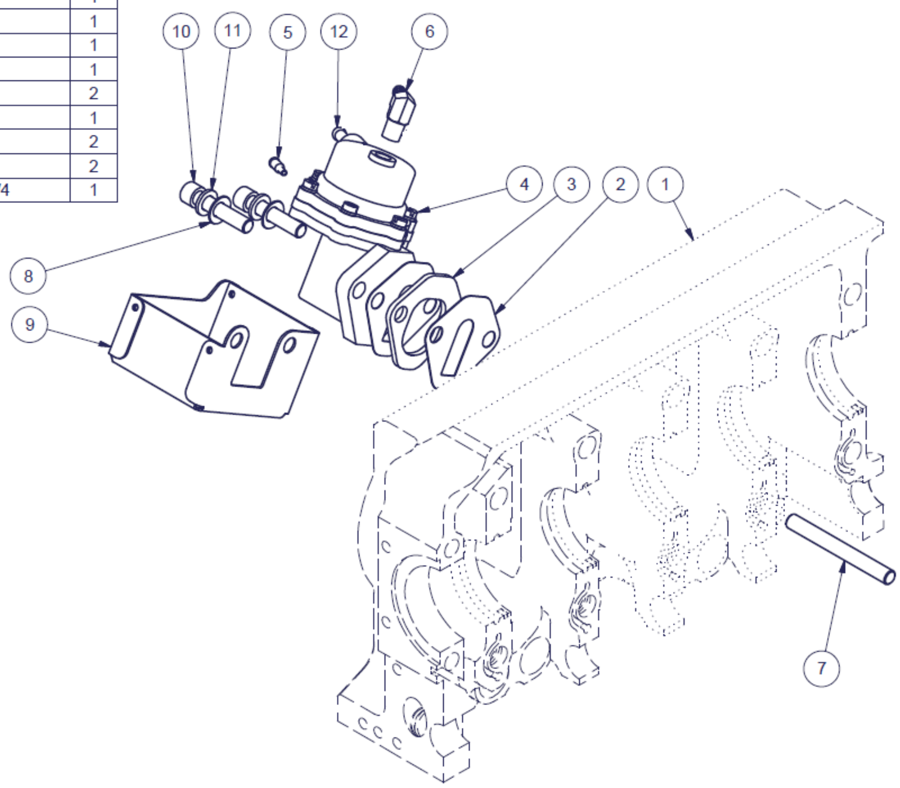


Figure 155 - Mechanical fuel pump installation

7.8 Subassembly H – Final assembly

- Now that each Subassembly is ready the overhauled engine can be final assembled.
- Note that the entire crankcase assembly process including the fitting of pistons and cylinders MUST be completed in one continuous operation otherwise the Loctite 515 Sealant around the crankcase join can dry before uniform pressure is applied to the crankcase join by the cylinder nuts, so make sure that you have all parts ready for completion up to this stage (i.e. pistons and cylinders) before starting to fit the crankcase halves to the crankshaft.

7.8.1 Crankcase Joining

- During the joining process various sealants will be used which will cure quickly – therefore it is essential that the overhauler be thoroughly organised before starting this task and that they work efficiently and quickly once they have begun. If too much time is taken the engine must be disassembled and re-cleaned, ready for another attempt at joining.
- Pre-Joining Checklist:
  1. Ensure all tools, parts, sealants and compounds are available for the build and ready to be fitted. Parts in particular must have been cleaned, inspected and had any necessary remedial work carried out before beginning the final assembly.
  2. Oil all bearings lightly.
  3. Oil or grease (lightly) camshaft tunnel
  4. Thrust bearings are installed correctly and oiled.
  5. All required measurements have been taken – cam end float, crank end float etc.
  6. For solid lifter engines, ensure the valve lifters are fitted and lubricated.
  7. Count all engine through bolts and place them close to hand.
  8. Count all engine through bolt nuts and place close to hand.
  9. Confirm that all gudgeon pins are started into their pistons & are ready to go.
  10. Count all piston circlips and place close to hand.
  11. Check that suitable spanners are available – torque wrench, special spanners for tightening the lock nuts on the through-bolts, "crowsfoot" adaptors etc.
  12. Confirm the orientation of the cylinders and the pistons within the cylinders.
  13. Confirm that the sump oil pickup and strainer, through bolt dowels and studs have been fitted to the crankcase.
  14. Confirm that the cam is assembled to its gears, ready to fit.
  15. Apply a little grease to the cam and to the lifters.

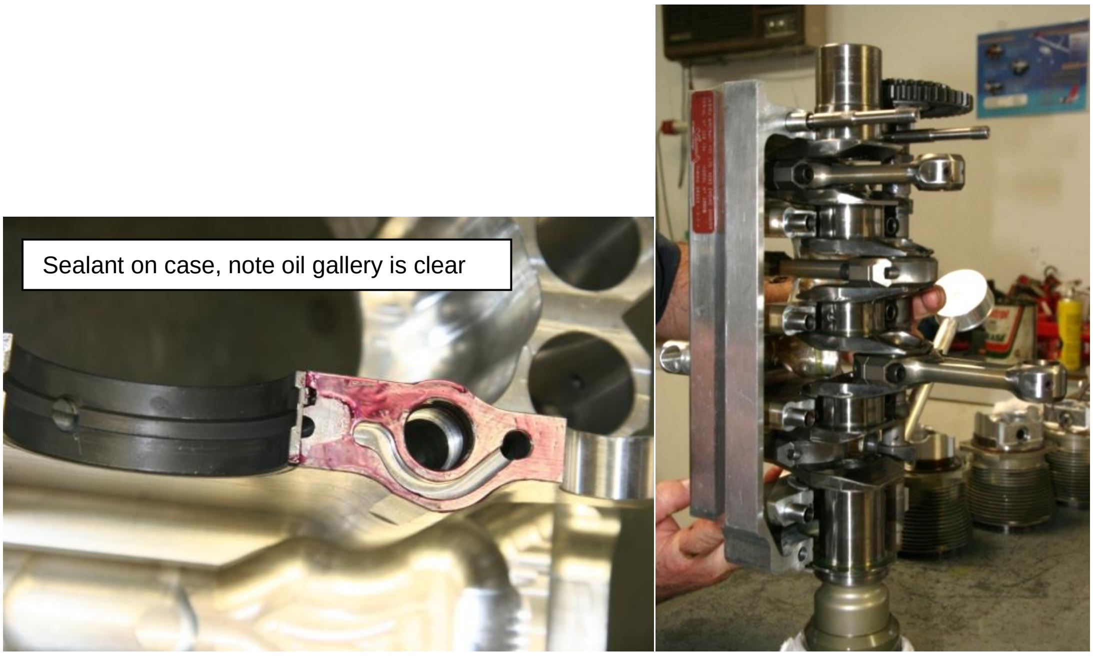


Figure 156 – Applying Sealant to Case, Fitting to Crank

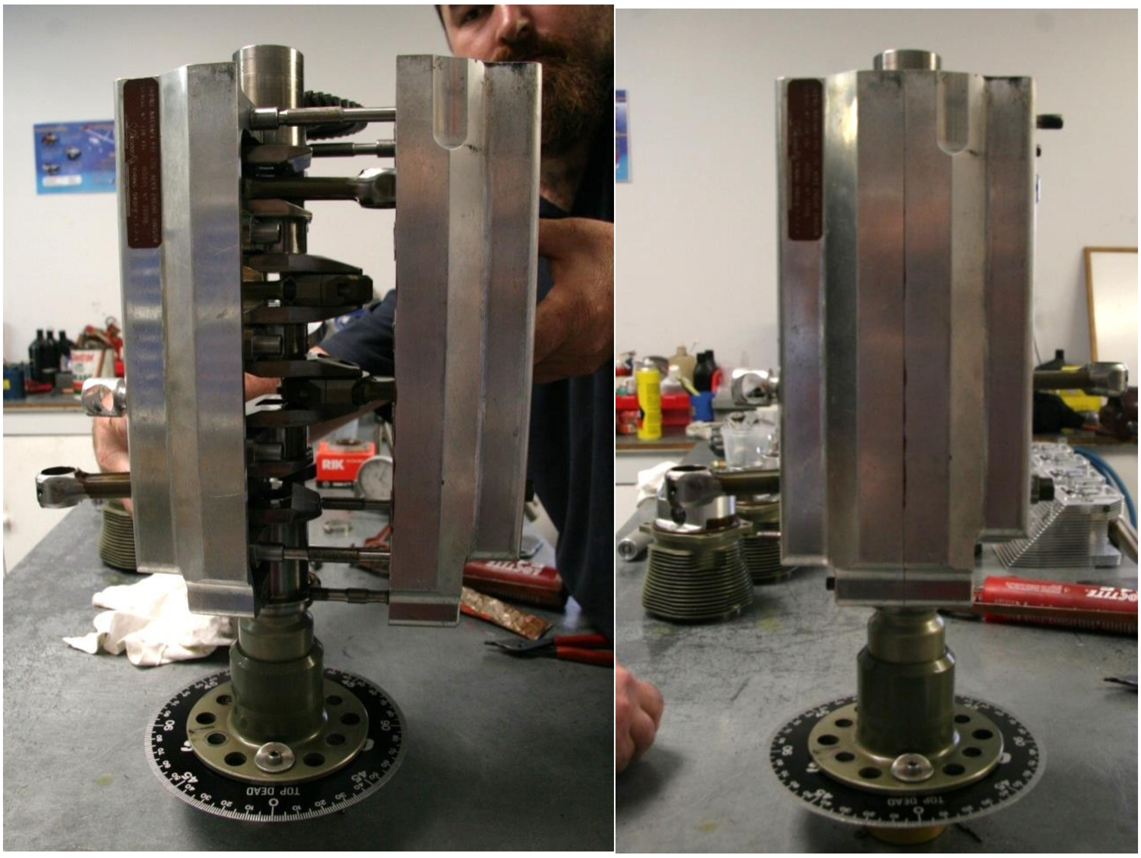


Figure 157 – Fitting The Second Case Half

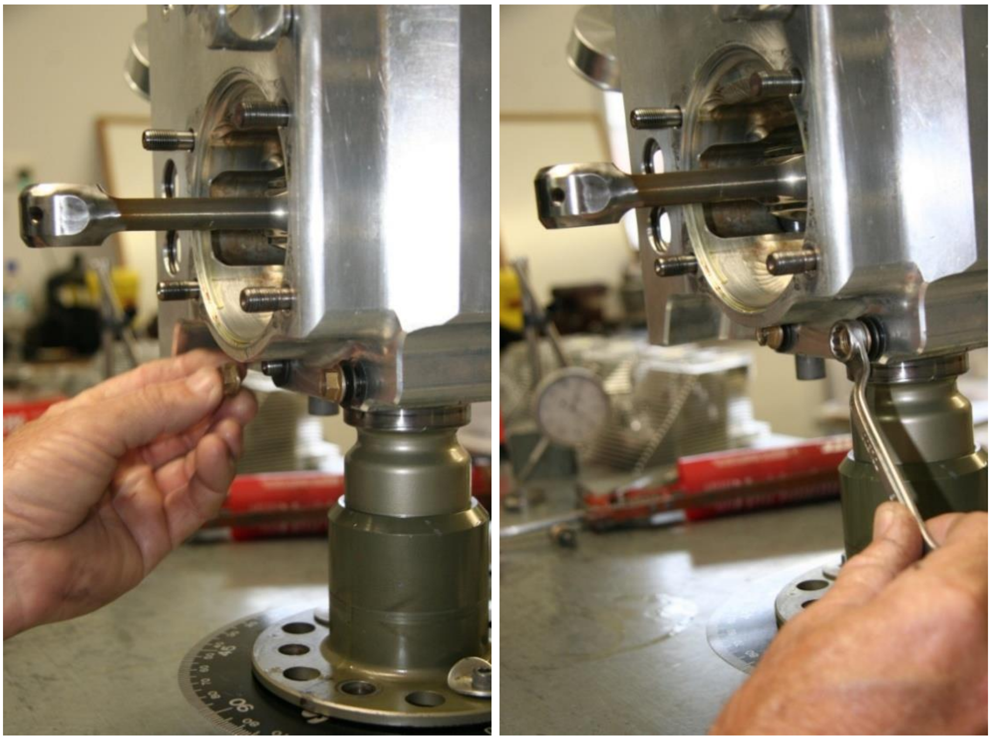


Figure 158 – Tightening The Front Crankcase Studs

- Apply a light coating of Loctite 515 sealant to one crankcase joining face. Ensure that all oil galleries and feeds are free – an excess of sealant can block these, leading to engine damage.
- Fit one side of the crankcase to the crankshaft, taking care not to dislodge any of the bearing shells or mark them with a sharp corner.
- Place the camshaft in the journals of the fitted case half.
- Fit the second side of the crankcase. The front and rear studs must now have nuts fitted and tightened lightly.

Figure 159 – Applying Sealant and O-Ring to Cylinder Base

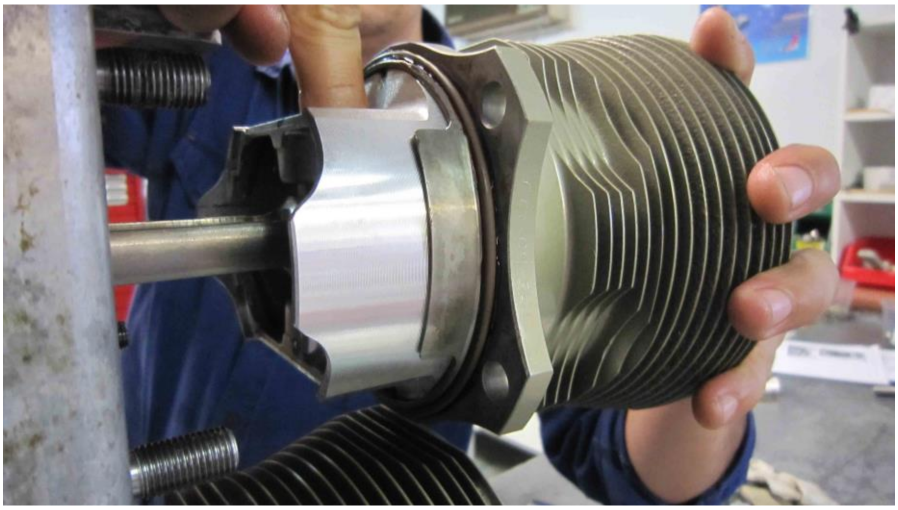


Figure 160 – Fitting Gudgeon Pin

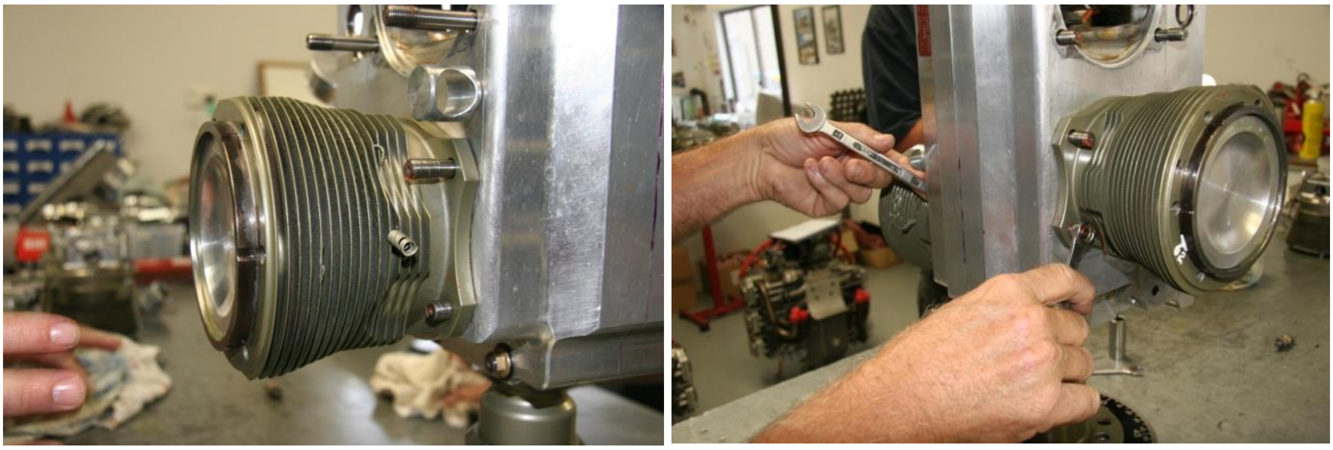


Figure 161 – Fitting Cylinder, Inserting & Tightening Through-Bolts

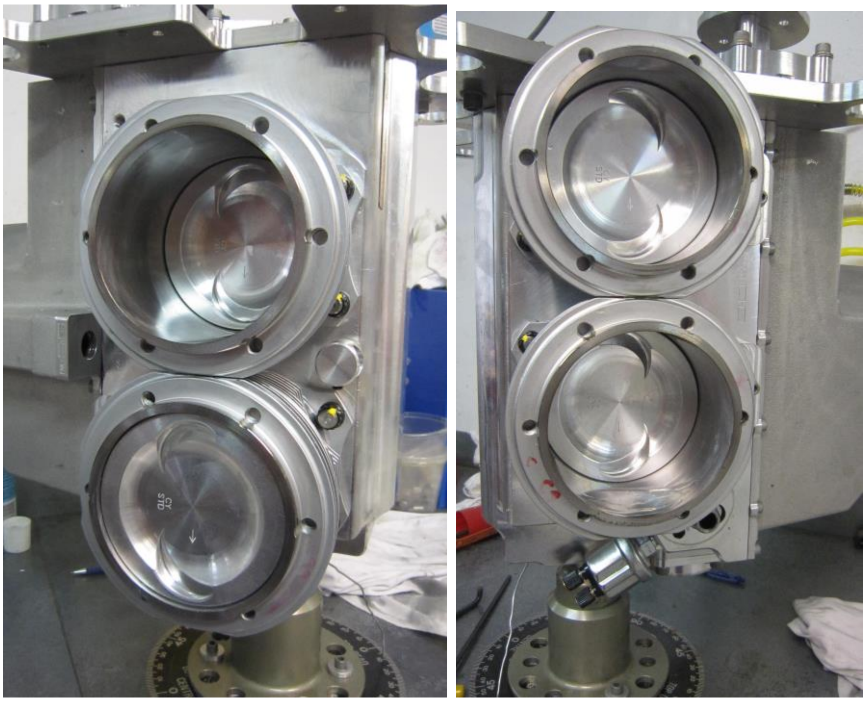


Figure 162 – Piston Orientation

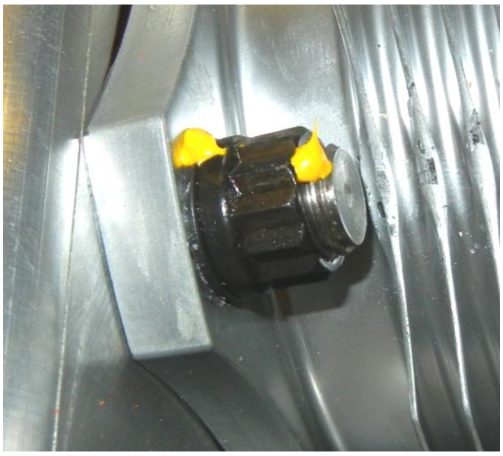


Figure 163 – Torque Seal Applied

- Apply a small amount of Loctite 518 sealant to the cylinder base O ring (Figure 159). Then offer the cylinder / piston assembly up to the engine. Double-check the thrust direction of the piston now – if necessary rotate the piston in the bore to correct the orientation (Arrows / moulded lugs on propeller flange side of the connecting rod). Insert the gudgeon pin and circlip, then fit the cylinder up against the crankcase. Verify that the piston orientation is as shown in Figure 162: valve relief on the lower (sump side) of the piston.
- The orientation of the cylinder must also be double-checked – make sure the cut-outs in the fins are facing the sump – these are to give clearance to the pushrod tubes. Figure 141 shows the cut-outs.
- Fit the through-bolts to the engine. **Care must be taken to centre the through-bolts so that the same amount of thread shows on both sides of the engine**. Refer to Table 6 for approved configurations to be used at overhaul or maintenance. Note that the front studs of the engine use a nut / washer combination different to the other studs.
- Tighten all through-bolts and studs to 20lb.ft without locking compound.

Table 6 – Hardware Configuration Summary

Size	Hardware Type	Washers Used	Loctite
3/8”	- 3/8” 12-point nut: reduced flange on cylinder bases. - 3/8” 12-point nut: full flange on front studs.	- AN960-6 on front crankcase studs. - 5/8” OD Hardened on cylinder bases.	None.
7/16”	- 7/16” 12-point nut: reduced flange on cylinder bases - 7/16” 12-point nut: full flange on front studs	- AN960-7 on front crankcase studs. - 5/8” OD Hardened on cylinder bases.	None.

- Starting from the middle cylinders:
  - Remove both nuts from one through-bolt
  - Visually inspect the cylinder base for marks where the base of the nut has pressed against the lower radius of the barrel.
  - Tighten all through bolts and studs to the value given in Table 9. Ensure even amounts of thread are visible on both sides of the engine for through bolts. Apply torque wrench to nuts on both ends of through-bolts.
  - Repeat for all through bolts and studs on the engine.
- Mark the completed nuts with anti-tamper paint as shown in Figure 163. Note the torque seal applied to the nut base / washer / cylinder flange to show if there is any movement in this location.
- A special tool is available from Snap-On which speeds up the installation of the cylinder barrels – P/No. FU14B is a small universal joint with a built-in 7/16” nut socket. This allows tensioning of the through-bolts without a crowsfoot – eliminating the need to make an allowance for the crowsfoot arm on the torque setting. FU16B is the equivalent tool with a ½” socket for use on 7/16” 12-point nuts.

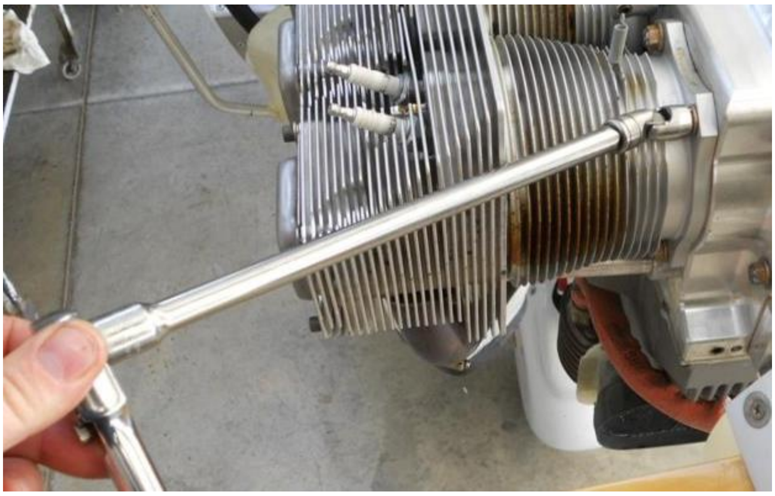


Figure 164 – Universal Joint tool FU14B (FU16B for ½” Socket)

- Repeat this process on all the remaining through-bolts and studs.
- Rotate the crank inside the crankcase. Assess the force required to turn crank: excess friction indicates that bearings have tightened up and minimum clearances have not been maintained. This may indicate an error in measurements or – in the case of a top-end overhaul – fretting damage to the cases. Contact Jabiru Aircraft or our local representative for guidance. Assessing friction is an exercise in judgement and overhaulers must develop a feel for this aspect. The engine being worked on may be compared with another engine where practical.
- Issue 1 of Service Bulletin JSB 031 noted that in some special cases where 12-point nuts are fitted to older through-bolts the nut may overhang the thread of the bolts. This was due to the extra length the 12-point nuts. While this was acceptable in some cases for engines subject to the Service Bulletin Issue 1 re-work it is **NOT ACCEPTABLE** during a normal engine overhaul. New design through-bolts must be used which are long enough to accommodate the 12-point nuts.

WARNING

DO NOT EXCEED SPECIFIED TORQUE – through-bolt damage will result.

ALL BOLT TORQUE SETTINGS IN THIS MANUAL ARE “DRY” UNLESS STATED OTHERWISE

Correct tightening procedures must be used. See Section 3.8.3.

Fitting cylinders & through-bolts is a critical operation & must only be attempted by trained technicians.

- Excess sealant can now be wiped off the cylinder bases and the crankcase join – this is most easily done once the sealants have dried.

7.8.1.1 Additional Information – Through-Bolt Tension

- Technicians reading this must understand the difference between "bolt tension" and "nut torque".
- Torque is the setting on the torque wrench & defines how much rotational force it takes to turn the nut.
- Bolt tension is the actual tensile load in the bolt – the force holding the parts together.
- Tuning a guitar is a good illustration of the difference between bolt tension and nut torque – for a given torque on the guitar string adjustor the tone of the string might be too high or too low – in that case the musician can set the string tension directly by turning the adjuster until the string tone is right. For a through-bolt we cannot measure the tension directly and we are forced to make assumptions of the relationship between nut torque and bolt tension – in effect we are trying to set the guitar string tone indirectly by assuming that a given torque on the string adjuster will give a certain string tone.
- Testing has shown that assembling these parts dry gives good, repeatable results for bolt tension. Altering these parameters has unpredictable effects and is not recommended.

7.8.2 Option – Fitting Oil Pump

- It is possible to fit the oil pump now rather than later. This allows the overhauler to turn the cam by hand as the oil pump housing is being tightened to check for binding between the oil pump gears.
- Full fitting details are given in Section 7.8.17.

7.8.3 Setting Cam Timing

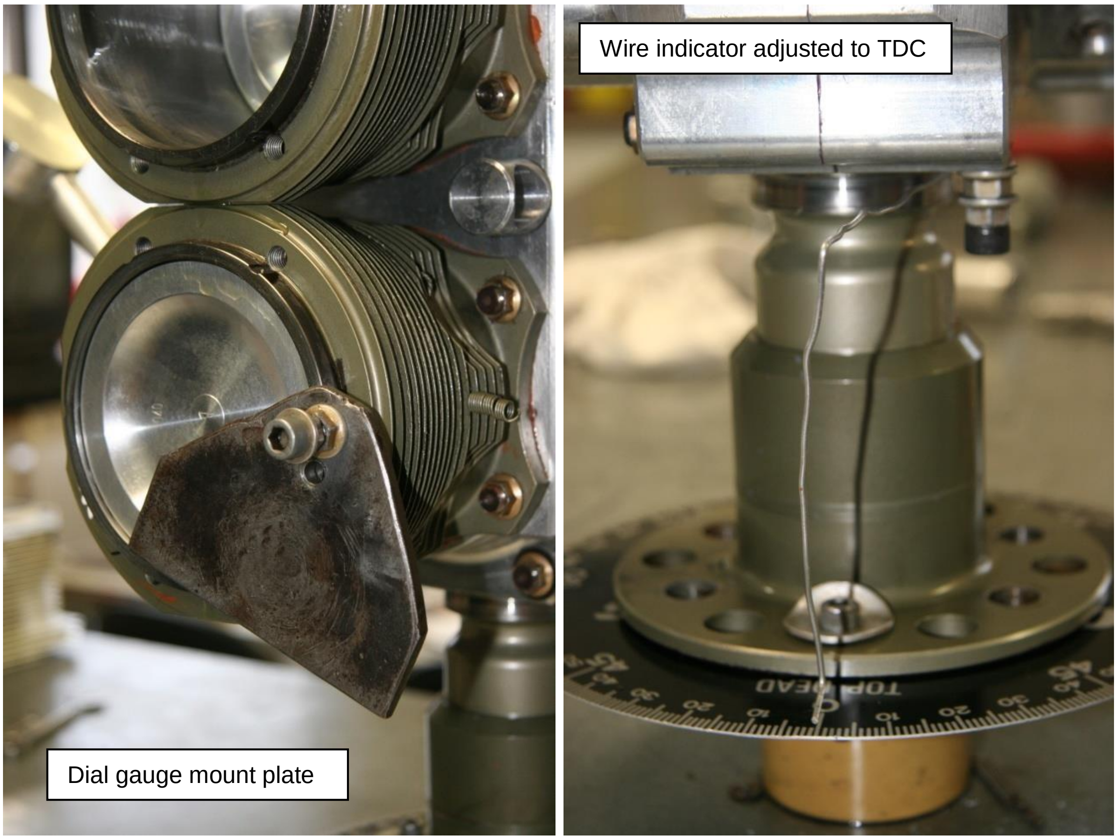


Figure 165 – Measuring Top Dead Centre

- In newer engines the datum marks on the gears are invariably accurate, however timing must still be checked in case older parts are being used.
- Fit a mount plate and dial gauge to cylinder #1 of the engine and use the dial gauge to accurately locate top dead centre for that cylinder. This is done by using the dial gauge to estimate TDC then bending the wire to point at 0° on the degree wheel. Then rotate the engine to the right (against rotation) until the dial gauge records movement of 0.5mm from TDC and record the degree wheel reading. Move the engine back to 0° then turn it to the left until the gauge reads 0.5mm – record the degree wheel reading. Calculate the centre point between these two readings – this is the true TDC for this cylinder. The engine can then be rotated until the wire points at this reading and the wire re-bent to point at 0°. Care must be taken from now on not to bend the wire! Double-check this position by repeating the above procedure – twisting to the left, then to the right.
- Rotate the cam until the two timing marks on the large cam gear are pointing towards the crankshaft.
- Before fitting the Crank-gear, apply a bead of Loctite 518 around the entire perimeter of the crankshaft
    - Ensure the bead is continuous and un-broken
      The bead should be applied **22mm** down from the flywheel attachment face (see Figure 167).

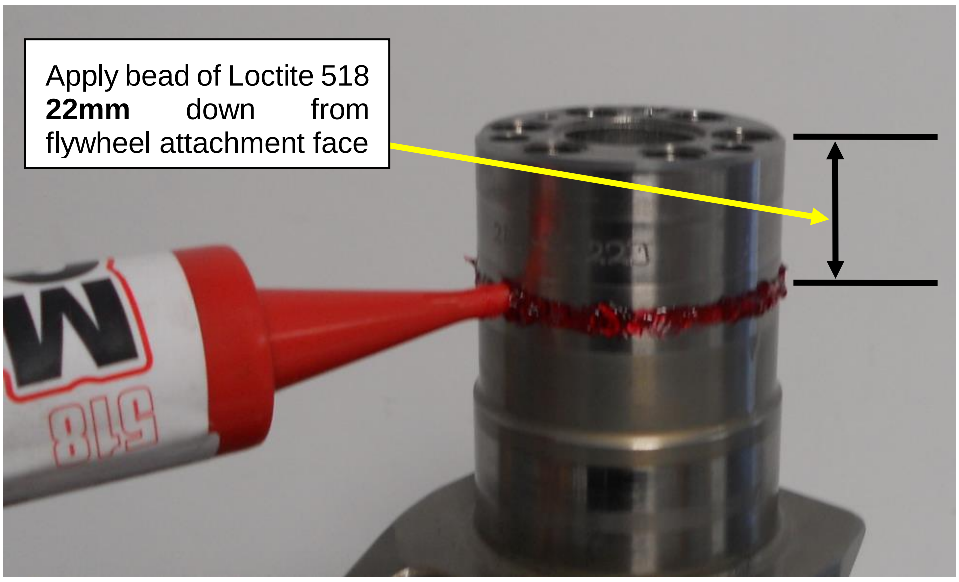


Figure 166 - Apply bead of Loctite 518 around perimeter of crank-gear

NOTE

The inclusion of a bead of Loctite 518 between the crankshaft and the crank-gear is important, as a means of excluding oil from between the crank-gear and crankshaft during service of the engine.

- The camshaft drive gear can now be fitted to the end of the crank as shown in Figure 167 – so that the tooth on the crankshaft gear with the timing mark is between the two teeth of the cam gear with timing marks.
- A single cap screw can now be added to the crankshaft gear to lock it in place relative to the crankshaft. Once this is done the timing must be checked by reading directly from the camshaft.
- For a hydraulic lifter engine – for measurement purposes – fit a hydraulic lifter to the lowermost port of the engine (as shown in Figure 168 – alternatively a special tool such as that shown in Figure 29 can be used).
- Now rotate the engine to find the point of maximum lift of the cam lobe being checked. The procedure here is the same as for finding TDC for the cylinder – with the exception that the timing pointer wire must not be bent! Estimate the point of max lift for the cam, then turn the engine either way until the dial gauge records 0.5mm movement. Record the timing readings and calculate the centre point.
- Peak lift occurs about 70 – 72° after Bottom Dead Centre (71° typical) for the exhaust lobe and 68 – 72° (71° typical) before Bottom Dead Centre for the intake lobe.

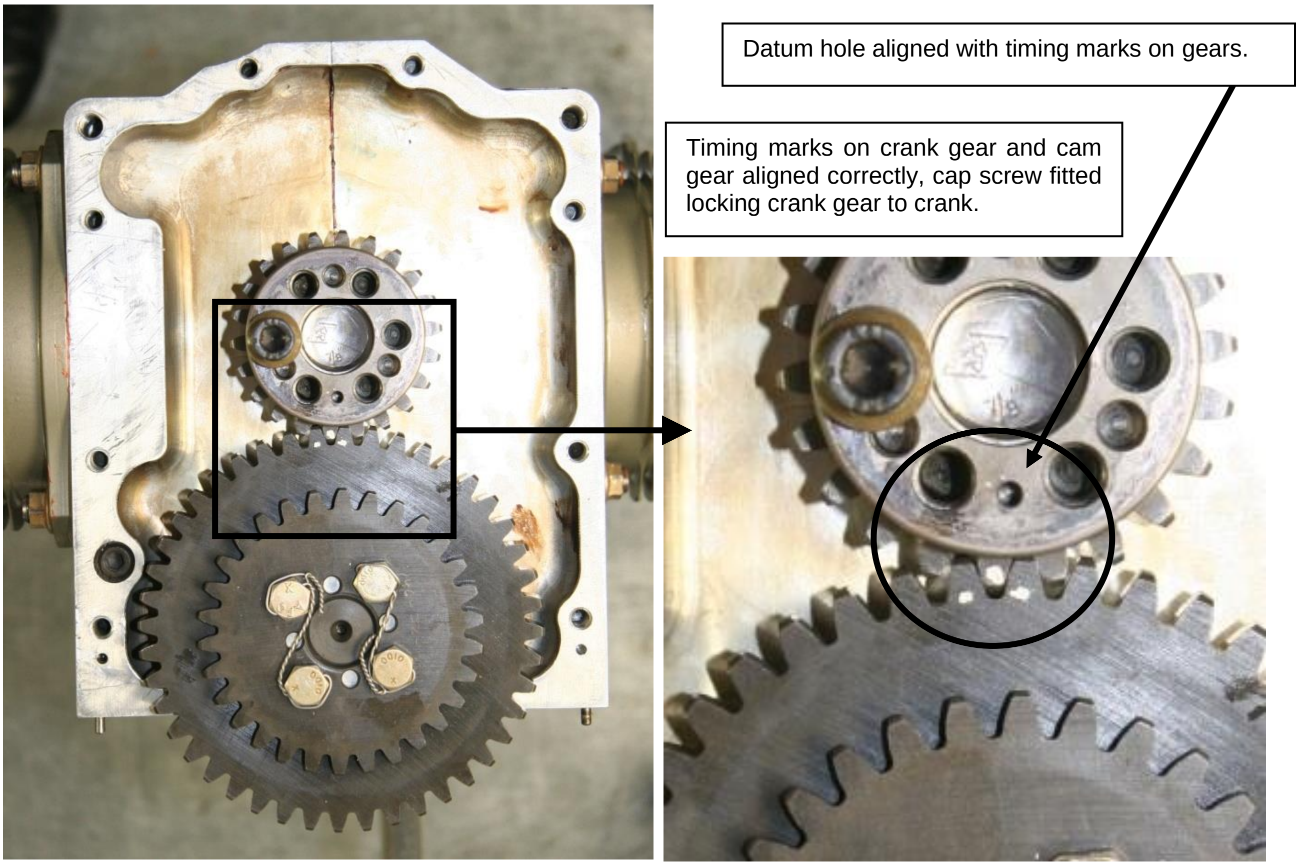


Figure 167 – Setting Cam Timing

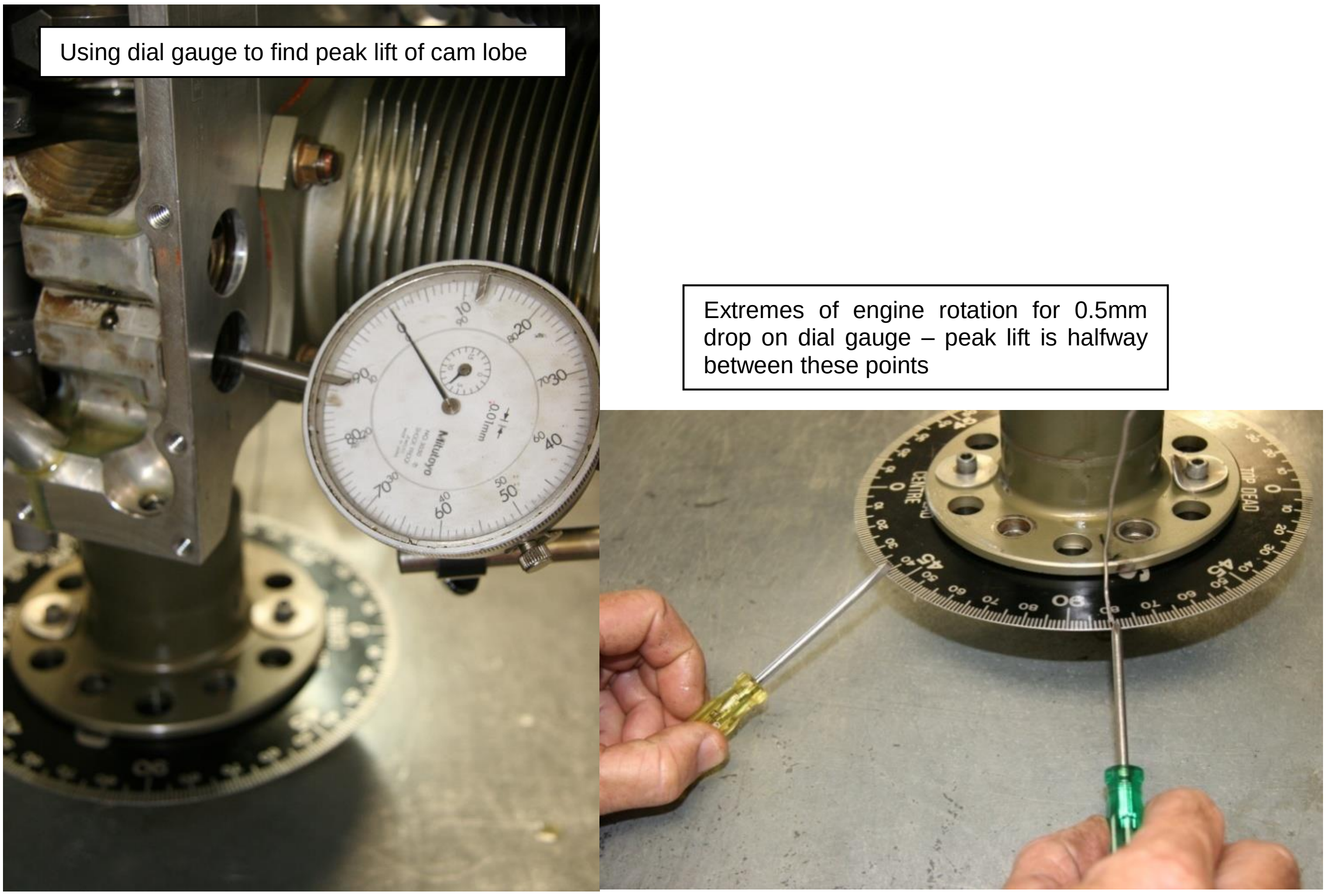


Figure 168 – Checking Cam Timing #1

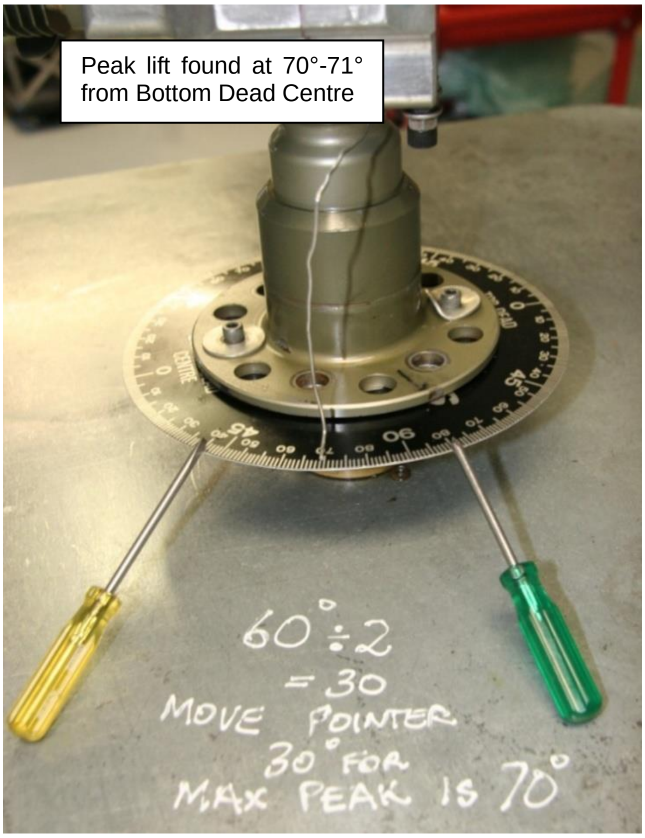


Figure 169 – Checking Cam Timing #2

7.8.4 Sump

- As an alternative to the order given below the sump may be fitted after the engine backing plate.
- Lightly apply Loctite 515 to the horizontal mating face of the sump. Note that our experience is that it is easier to apply the sealant to the sump than to the crankcase.
- Fit the sump using cap screws and locating pins as shown in Figure 170. Note that on early engines the length of the screw which is in line with the internal oil pickup is 5/8" long compared to ¾" for all other locations. Later sumps have a raised boss for this position allowing the longer screw to be used.
- Some engines have provision for a pair of cap screws to secure the rear of the sump to the engine mount plate (see Figure 51). These screws have proven unnecessary and should be omitted during overhaul.
- Attach the oil filler mount fitting to the right crankcase using Loctite 243.
- Fit the oil filler tube to the engine, lubricating the tip with Nulon L90 for assembly. Tighten the grub screw which holds the tube in place.
- The dipstick can now be fitted.

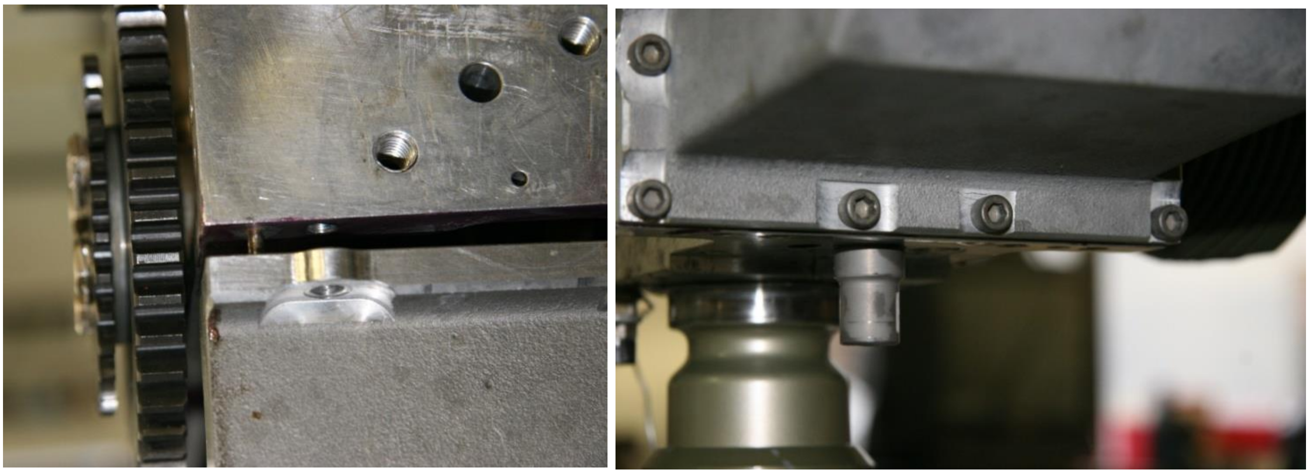


Figure 170 – Fitting Sump

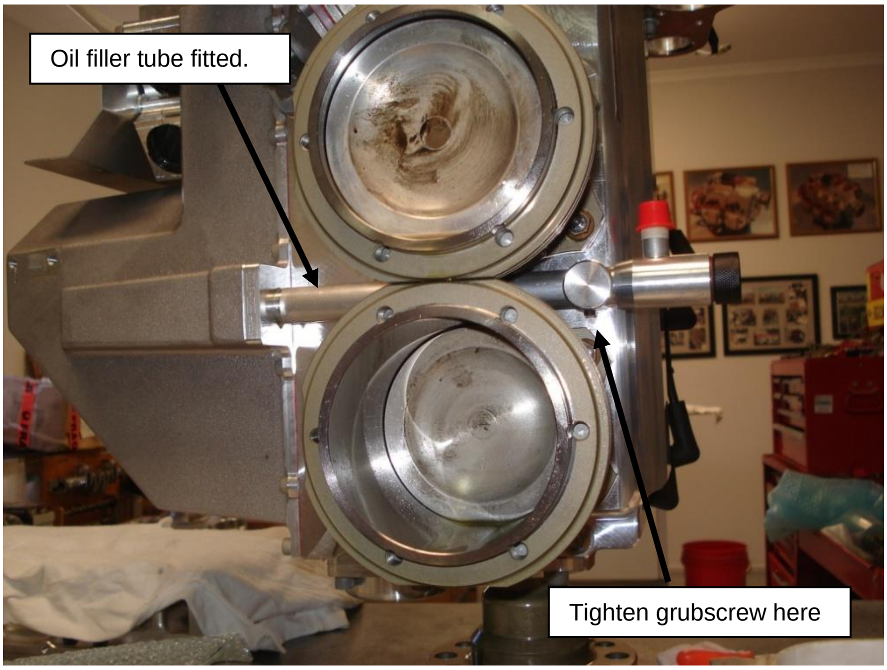


Figure 171 – Oil Filler Tube Installation

7.8.5 Engine Mount Plate

- Before installing the engine rear back-plate. First install the 1/8-NPT oil galley plug with Loctite 243 to seal the oil galley.
-

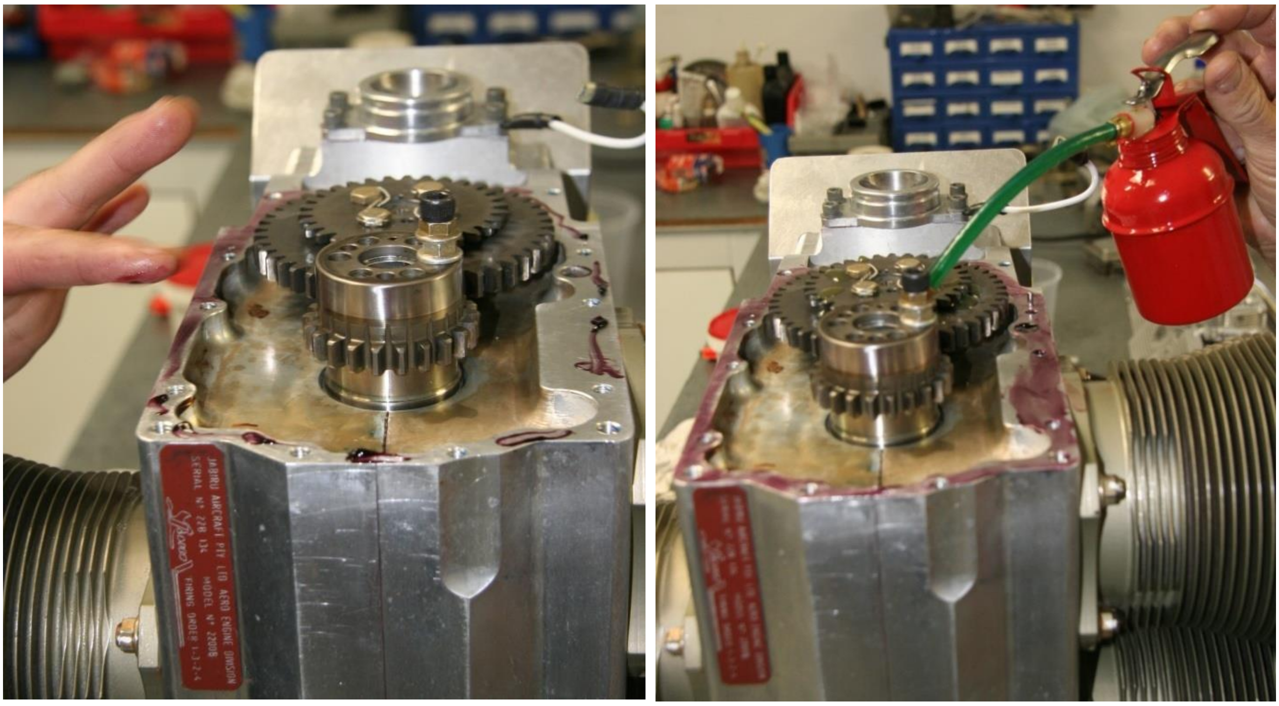


Figure 172 – Sealing Engine Mount Plate

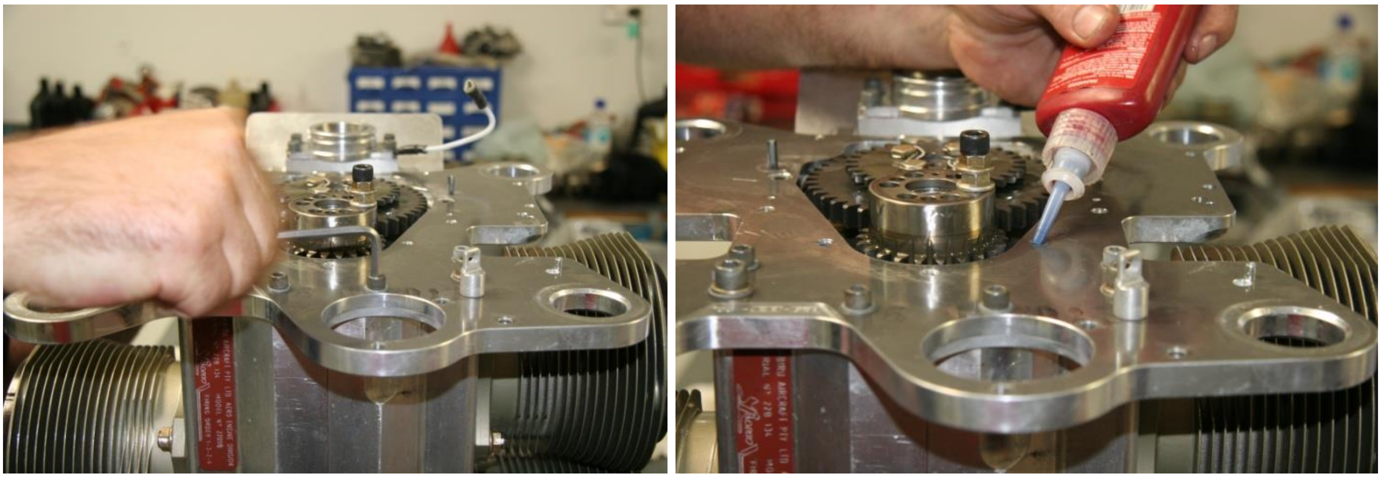


Figure 173 – Fitting Engine Mount Plate

- Apply Loctite 515 sealant to the rear of the crankcase and sump as shown in Figure 172. The cam drive gears should also be lubricated with oil now, before the gear cover is fitted.
- Tighten the screws holding the plate to the crankcases. Note that different sized screws are used on the plate - Figure 174 refers.

□ = 5/16 x 1 1/4" UNC

1 x Belleville + 1 flat washer (2)

△ = 1/4 x 5/8" UNC (2)

○ = 1/4 x 1" UNC (4)

→ = Not Used

- Note that some engines were equipped with 2 extra screws into the sump. These are unnecessary and should be omitted at overhaul.
- Loctite 243 is applied to the holes for the gearbox mounting screws.

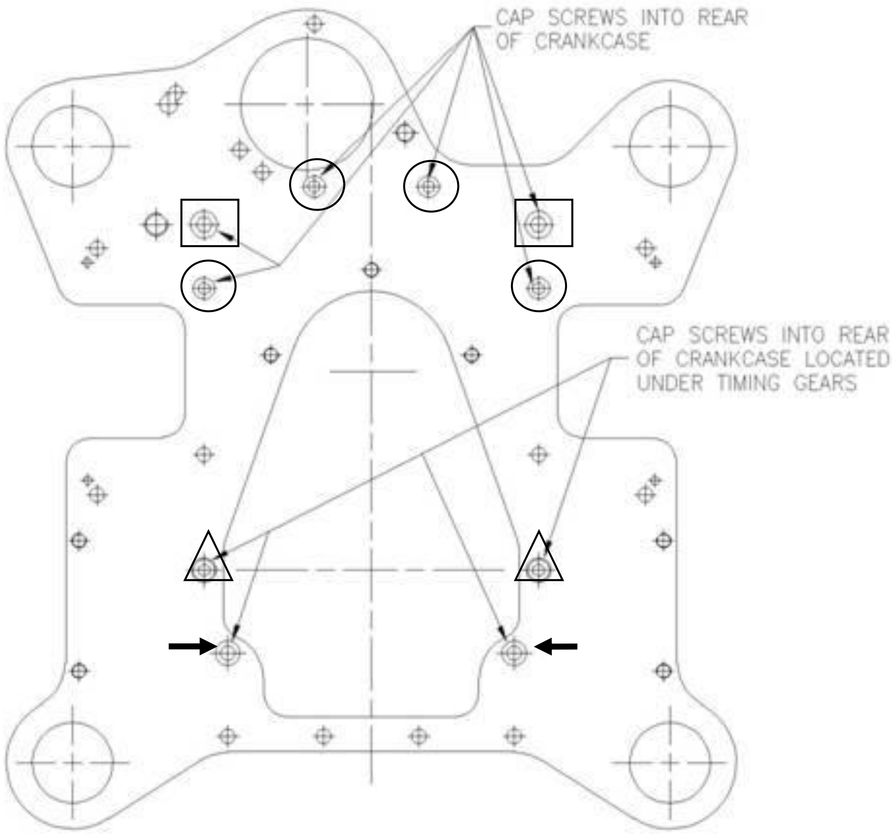


Figure 174 – Engine Mount Plate Screw Locations

7.8.6 Distributor drives

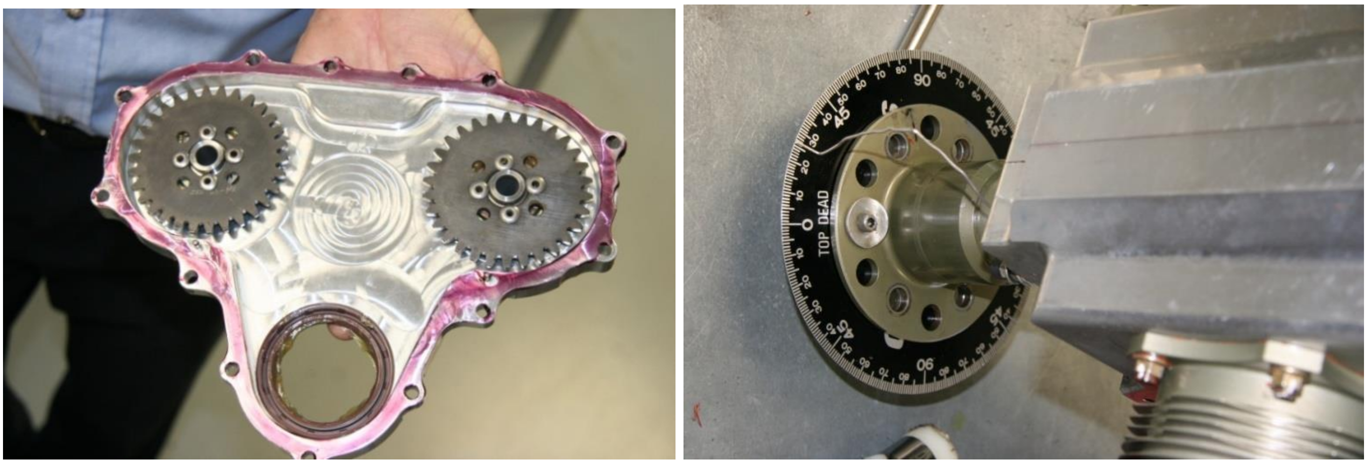


Figure 175 – Fitting Distributor Case & Setting Timing

- Ensure distributor shafts are generously lubricated before assembly.
- Apply Loctite 515 sealant to the gear case as shown in Figure 175.
- Start with the engine positioned at TDC (i.e. piston #1 is fully extended out and the timing marks on the crank gear and camshaft timing gear are meshed as shown in Figure 167)
- Rotate the engine back to 25° before TDC.
- In this engine position manually align both distributor rotors to point to the timing mark engraved on the distributor mount plate – use a ruler to check that they are nearly parallel as shown in Figure 176. They will not be exactly parallel but they should be close – and provided the timing mark lines up with the tip of the cap it will work properly. Carefully lower and mesh the distributor gears with the outer camshaft gear.
- The gear case can now be tightened onto the engine mount plate to the torque specified in Table 9.
- Note that certain 3300 engines (See Section 13 for serial number information) have different flywheel starfish. These parts have been indexed to give 20° or 23° BTDC for spark timing instead of the original 25°. These are engraved with “20° BTDC” or “23° BTDC” as appropriate. When using this part the timing procedure given herein must be adjusted to suit.

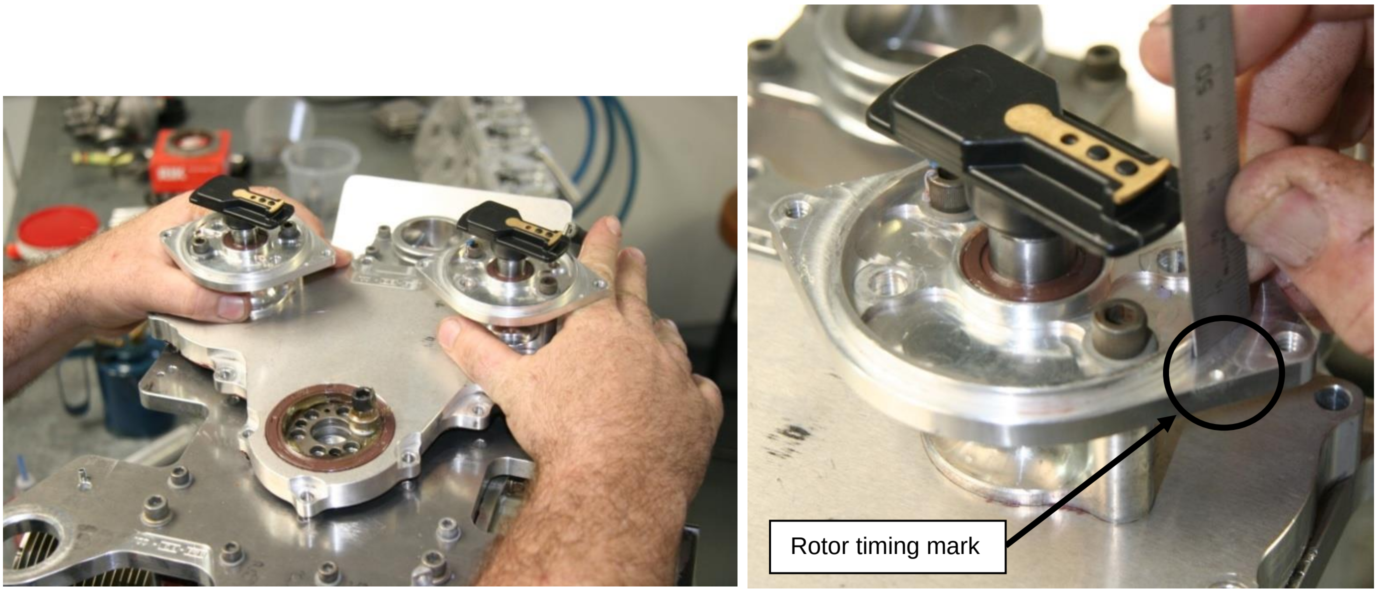


Figure 176 – Setting Distributors, Checking Rotor Position

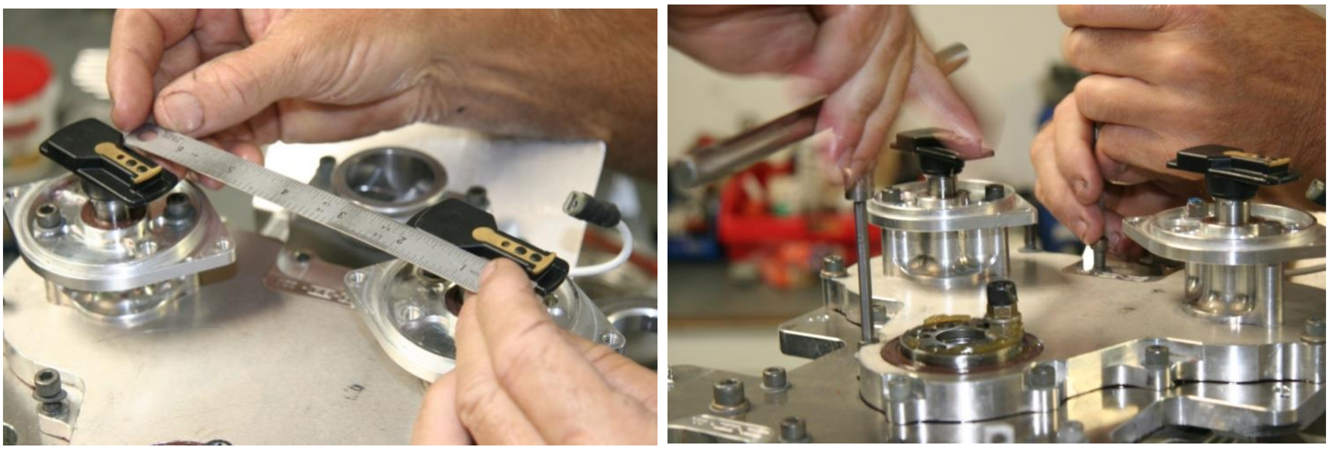


Figure 177 – Checking Rotors, Tightening Distributor Case

- Tighten the screws holding the gearbox to the engine. Note that different sized screws are used on the plate - Figure 178 refers.

□ = 1/4 x 3/4" UNC
+ 1 x Belleville washer (3)

△ = 1/4 x 1 1/4" UNC (6)

○ = 1/4 x 1 3/4" UNC (4)
+ Belleville washer

- Note that early engines used 1/4 x 1 1/2" screws in place of 1/4 x 1 3/4". Overhaulers must check the thread depth before final fitment of these screws.

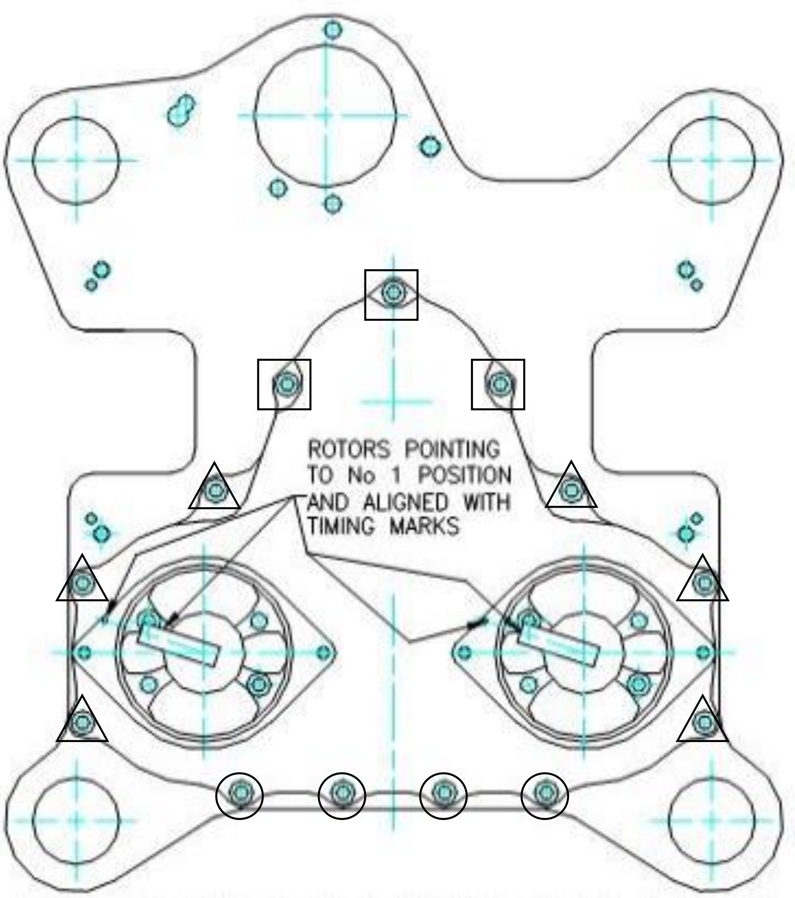


Figure 178 – Gearbox Installation

7.8.7 Flywheel and Alternator Rotor

- While the engine is still set at 25° before TDC (or as required to set the distributor timing) the flywheel will fit onto the engine with its magnets aligned at the ignition pole positions. For the 2200 engine this means the magnets are pointing to the left and right of the engine. For the 3300 the magnets are at the 1 o'clock, 5 o'clock and 9 o'clock positions. There is also a timing mark (a hole) on the flywheel which aligns to a corresponding hole in the crankshaft gear. Figure 180 refers.
- Note that fitting three 6mm dowel pins is a mandatory update – older engines which were not originally equipped with dowels must be upgraded at overhaul.
- Remove the temporary cap screw which was used to lock the gear to the crankshaft & preserve the cam timing.
- Ensure that the crankshaft screw threads are clean of locking compound by running a bottoming tap through each of them. The tap should be run carefully by hand to ensure the threads are not damaged. The tap used is either a 3/8-UNF, 5/16-UNF or 1/4-UNF depending on the configuration.
- Once the timing marks are aligned and the temporary locking screw is removed, the flywheel can be fitted to the engine.
- Align the timing marks and then tap the dowels through the flywheel into the crank using a soft hammer. The 6mm dowel pins (3 off) are fitted dry (without Loctite). Note that 20mm or 25mm long dowels are required, depending on the configuration of the engine. The dowel holes in the crankshaft are drilled and reamed to depth so the dowels should be tapped in until they stop. After installation measure the length the dowel protrudes from the crank: approximately 18mm is required for non-starfish engines and 12mm for starfish types. Excess length must be corrected as it will cause assembly problems. The dowels must not protrude above the surface of the flywheel once fitted. Protruding dowels can cause failure of the flywheel attachment screws.
- Steel centre flywheels use 5/16 x 1" or 3/8" x 1" screws, Aluminium centre flywheels use 5/16 x 1 1/4". All types are fitted dry and **without Loctite** using a single Nordloc washer pair as the locking device. The following method should be used to ensure the flywheel is retained securely and correctly.

NOTE:

The crankshaft and flywheel mating faces must be kept dry and clean during installation

NEVER INSTALL A FLYWHEEL WITH OIL CONTAMINATION!

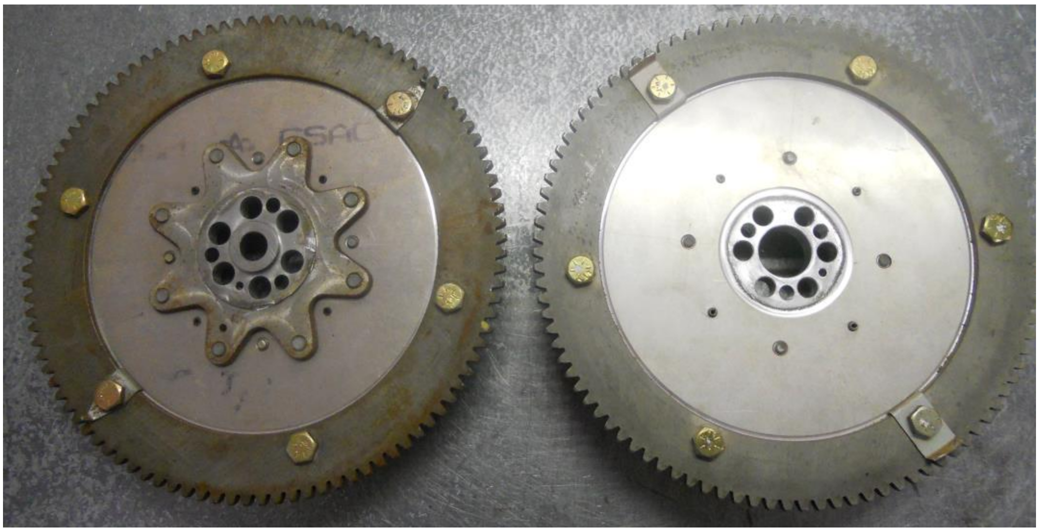


Figure 179 – Steel centred flywheel (left) aluminium flywheel (right).

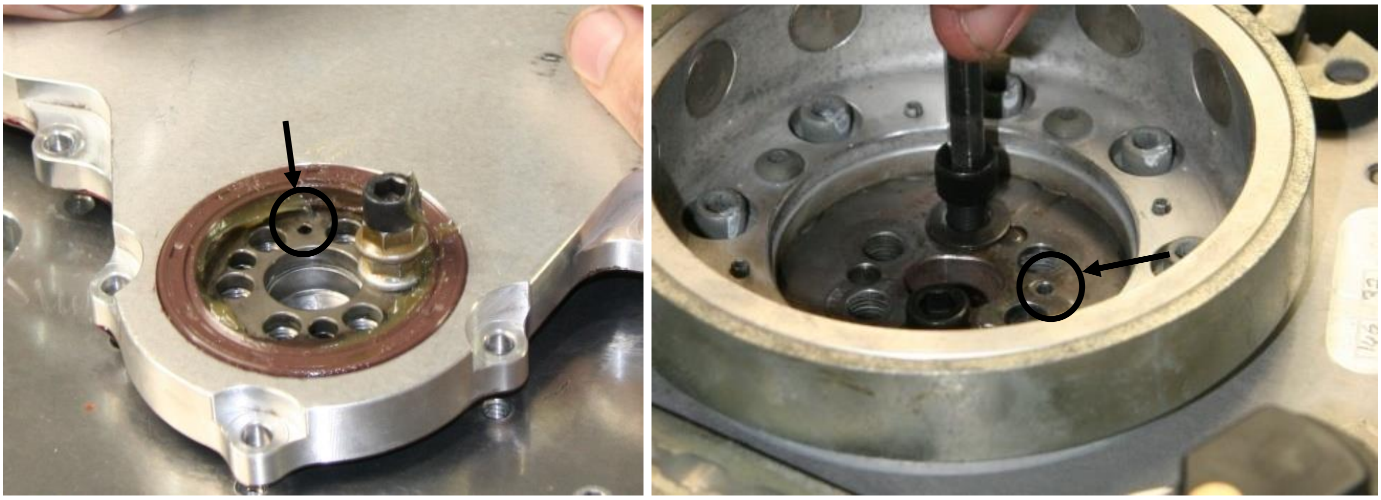
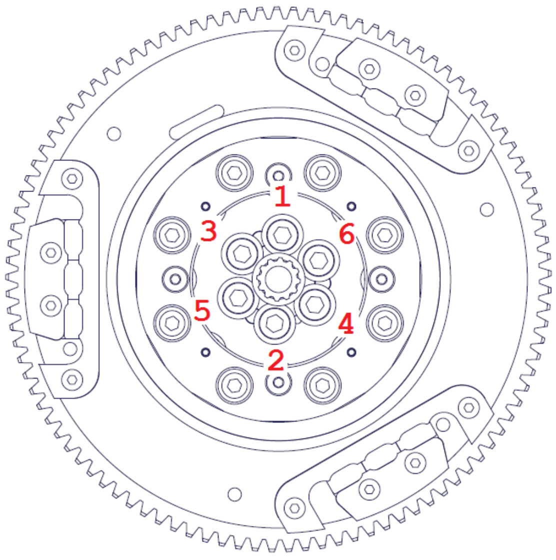


Figure 180 – Flywheel & Crank Timing Marks

1) Install the six capscrews with one plain washer up to **15 ft.lb** torque setting using the diagonal tightening pattern shown in Figure 181.
2) Tighten all six screws up to **Prescribed Torque setting** (Table 9) again using the diagonal tightening pattern in Figure 181.
    a. The plain washers used may be old hardware and may be reused each time a flywheel is installed (i.e. new plain washers not required).
3) Remove ONE capscrew and plain washer (discard plain washer).
4) Reinstall the previously removed capscrew this time with ONE Nordloc Washer pair. Install directly to **Prescribed Torque setting** (Table 9) torque setting. Tighten in one smooth motion without pause.
5) Apply torque seal, paint pen or liquid marker pen from capscrew across washers and onto the flywheel.
6) Repeat previous three steps installing the other five screws ONE AT A TIME using the diagonal pattern order shown in Figure 181.
    a. A Nordloc washer pair features two separate halves. Ensure the two halves are installed with the broad wedges of each half contacting each other (not the thin wedges) see Figure 182.
    b. Generally Nordloc washers are supplied preassembled with a small amount of temporary adhesive holding the two halves together.

If for whatever reason you must disassemble the screws again. You MUST NOT reuse the Nordloc washers or bolts. **Always use new Nordloc washers and bolts for flywheel installations.**



Flywheel capscrews tightened using the diagonal pattern shown (from 1 to 6). Any screw can be designated as number 1.

Figure 181 - Flywheel diagonal tightening pattern

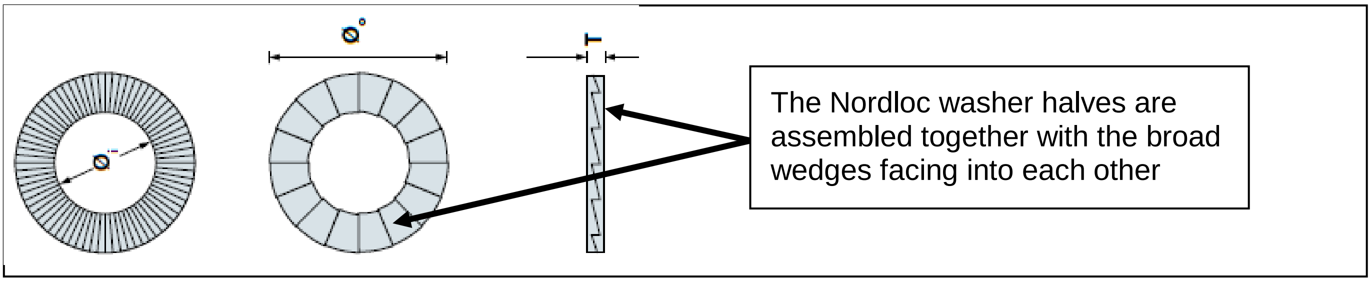
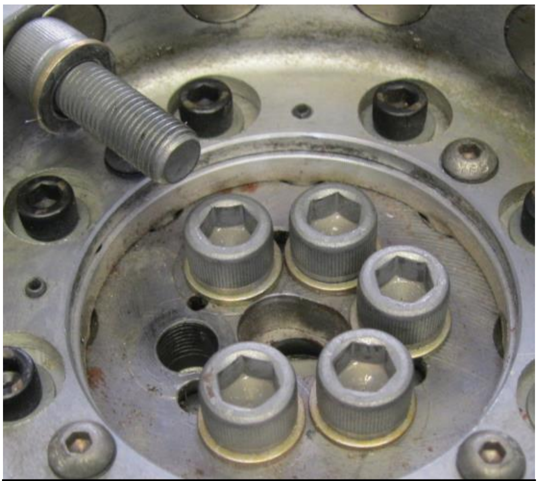


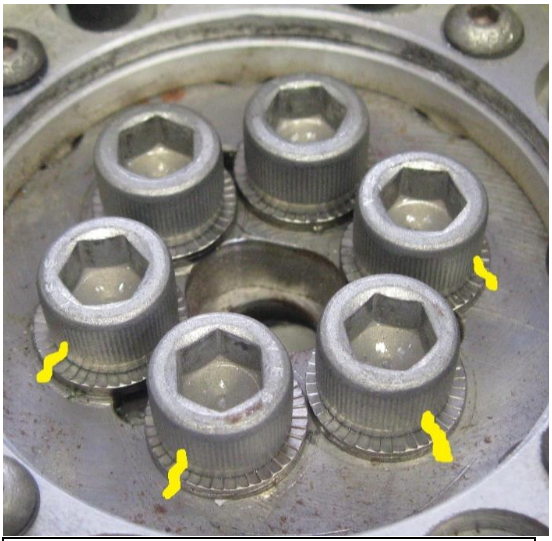
Figure 182 - Nordloc washer halves assembled together

Install capscrews with 6 old plain washers to **15ft.lb** and then the **Prescribed Torque** (Table 9) progressively using diagonal pattern shown in Figure 181



Remove ONE capscrew.

Reinstall capscrew with ONE Nordloc washer pair to **Prescribed Torque** (Table 9) directly. Apply Torque seal, paint pen mark or liquid paper



Repeat for the other five screws ONE AT A TIME using the diagonal pattern shown in Figure 181

Figure 183 - Flywheel Capscrew installation procedure with Nordloc washers

7.8.8 Ignition Posts & Alternator Stator

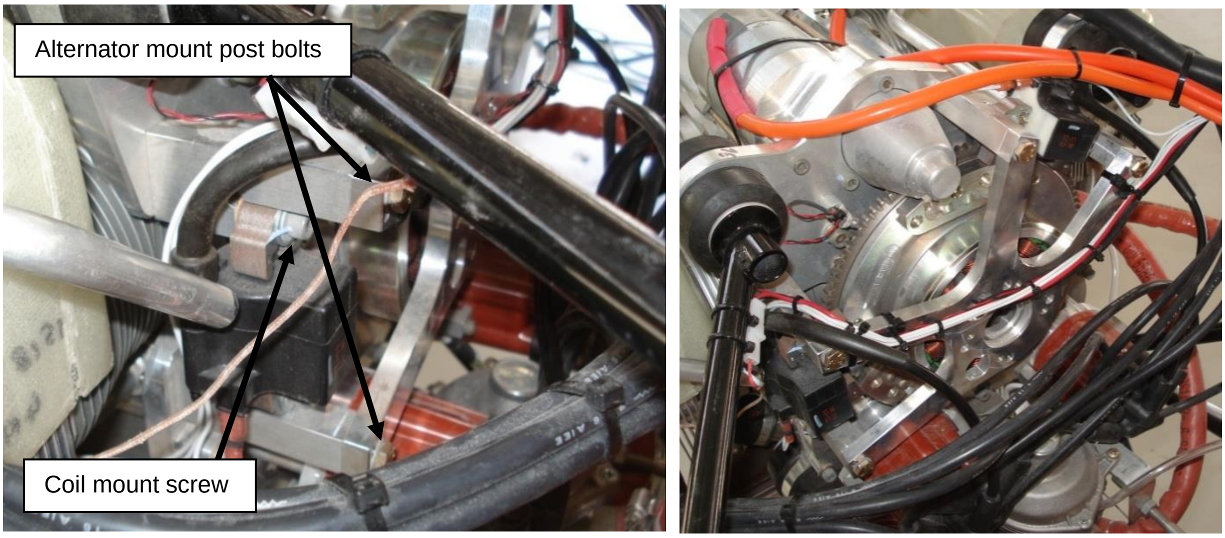


Figure 184 – Ignition Post & Alternator Stator Installation

- The alternator and ignition coil posts are held to the engine using 4 off AN4-37A bolts. Ensure that metal-lock nuts are used as shown in Figure 184. Roll pins are also used to hold these parts in position – tap them together on assembly using a soft hammer.
- Once the posts are in place the ignition coils can be fitted. The simplest method is to use a large 0.010" feeler gauge – lie this gauge against one of the magnet poles of the flywheel – the magnetism will keep it in place. Then rotate the engine until this pole lies beside the coil whose gap you wish to set. Again, the magnetism will hold the coil against the feeler gauge and the coil mounting screws can now be tightened. Once both coils have been positioned this way check the gap between each magnet pole and each ignition coil – on older engines the magnet poles may not be in exactly the same position on the flywheel which may vary the gap. In this case a compromise adjustment must be found to get all coil gaps within the limits set in Table 12.
- Note that insulating washers are fitted between the ignition coils and the mounting post – this is to minimise heat transfer into the coil.
- When installing the coils note the orientation – in all cases the output lead from the coil must point in the direction of propeller rotation.

7.8.9 Distributor Caps

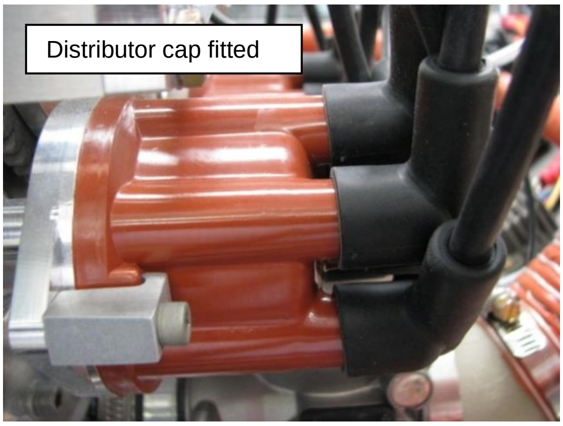


Figure 185 – Distributor Cap Installation

- Fit the distributor cap to the mount plate using the clamps & cap screws. Note that the cap must fit tightly – if there is any movement in the cap once the clamps have been tightened then a new cap may be required. In early engines these clamps tended to be slightly too long so clamps may be modified – inspection of the cap will show if it has worn or if the clamps are the wrong length.

7.8.10 Cylinder Heads

- The cylinder heads must be fitted to the engine in a sequence as the rocker shafts are installed in-situ. The recommended sequence is: fit an upper head – say 5 or 6 for a 3300 engine – first, then work downwards, completing each head assembly in turn.
- For each head the following sequence must be followed:
  1. The outer bottom circumference edge of the hydraulic lifter should be lightly polished to remove any burrs or sharp edges.
  2. For hydraulic lifter engines, fill the lifters with oil (using an oil can - Figure 186) and fit the lifters to the crankcase. The outside of the lifter must also be well lubricated with oil before fitting and note also the light covering of grease which has been applied to the camshaft lobes – this is to minimise wear during initial start-up. Note that solid lifter engines have their lifters fitted before crankcase assembly – there is no way to do it once the case halves are assembled.
  3. For engines equipped with roller cam followers the follower locking plates must be installed now – see Figure 187. This plate should be a neat fit with a small amount of clearance from the lifter. It may be necessary to lightly linish the plates before installing to remove sharp edges etc. Note the orientation of the plate when installed: the two “legs” on the plate must point out of the case.
  4. Fit new O rings to the crankcase to seal the pushrod tubes (solid lifter models) – see Figure 186.
  5. For hydraulic lifter engines, fit new O rings to the pushrod tube adaptors. Again these must be well lubricated with oil or Nulon L90. Fit the adaptors to the crankcase. See Figure 190 for circlip orientation.
  6. For roller follower models, the oil return manifolds can be fitted now. Fit new O rings and use a small amount of Loctite 515 to seal the manifold to the engine. Figure 188 shows the manifolds installed.
  7. Fit the pushrod tubes (2) to the crankcase.
  8. If the engine uses an external oil feed pipe this must be fitted between the cylinders. It should be fitted but the clamps not tightened until all the heads are fitted. For later specification engines which use the pushrod tubes to feed oil to the rocker gear this step is omitted. Note that if an engine has been converted from the external oil feed to the new hollow pushrod oil feed it will be necessary to fit blanking plugs to the old oil feed holes in the sides of the crankcase as shown in Figure 193. Solid lifter engines must use the external oil feed tube system.
  9. Fit the cylinder head to the cylinder, feeding the pushrod tubes into the head – see Figure 190.
  10. Apply high-temperature lubricant to the threads of the cylinder and the cylinder head screws – these are susceptible to rust which can lead to inaccurate bolt tension readings later in service. The lubricant is designed to prevent rust on the threads and to ensure a consistent torque setting during the engine’s service life. Figure 189 refers.
  11. Install the cylinder head bolts and washers with a light tension setting. In particular the lower head screw (which is accessed via the hole inside the rocker cavity) must be left loose – the special washer under this screw can rub against the rocker tubes and so must be carefully positioned to avoid this. Figure 189 (right) shows this screw being tightened.
  12. Using the spring compressor tool shown in Figure 10 and Figure 192, open both valves to allow the installation of the valve rockers. This step may be bypassed for a solid lifter engine if the overhauler prefers, but even for those engines this tool makes the assembly simpler by allowing the heads to be fitted as complete assemblies.
  13. Fit the valve rockers, taking care that the pushrod is correctly seated into the sockets in the lifter and in the rocker. The rockers and the rocker shaft must be lubricated well with Nulon L90 or oil as shown in Figure 191 and then driven in using a suitable punch and a soft hammer. The shaft is punched in with the rounded end leading.
  14. Fit the rocker shaft locking screw and remove the valve compressor tool.
  15. Tighten the cylinder head screws (6) to 15 lb.ft and then to the value specified in Table 9 using a standard diagonal tensioning pattern.
  16. Fit the tapered blanking plug to the access hole for the lower cylinder head screw (shown in Figure 190 – left). Note that this plug must not be over-tightened. If the plug is done up too tightly then over time its tapered thread will wear the thread in the cylinder head, requiring it to be screwed in further and further to be tight. Eventually the thread can be worn so much that the tapered plug will not lock in. A tension of about 6lb.ft is sufficient for this plug.

17. For engines using an external oil feed tube for the rocker gear the rubber "T" pipes can be centred between each head and the clamps tightened now.
18. For a solid lifter engine, once all the heads are fitted the valve clearance can be adjusted.

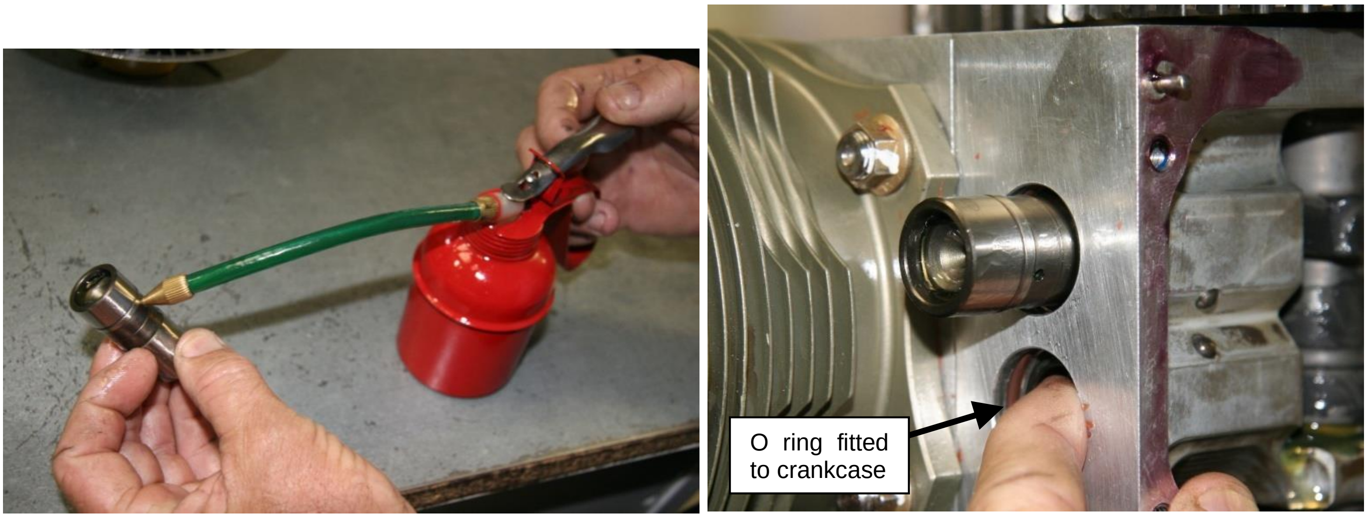


Figure 186 – Fitting Hydraulic Lifter To Crankcase

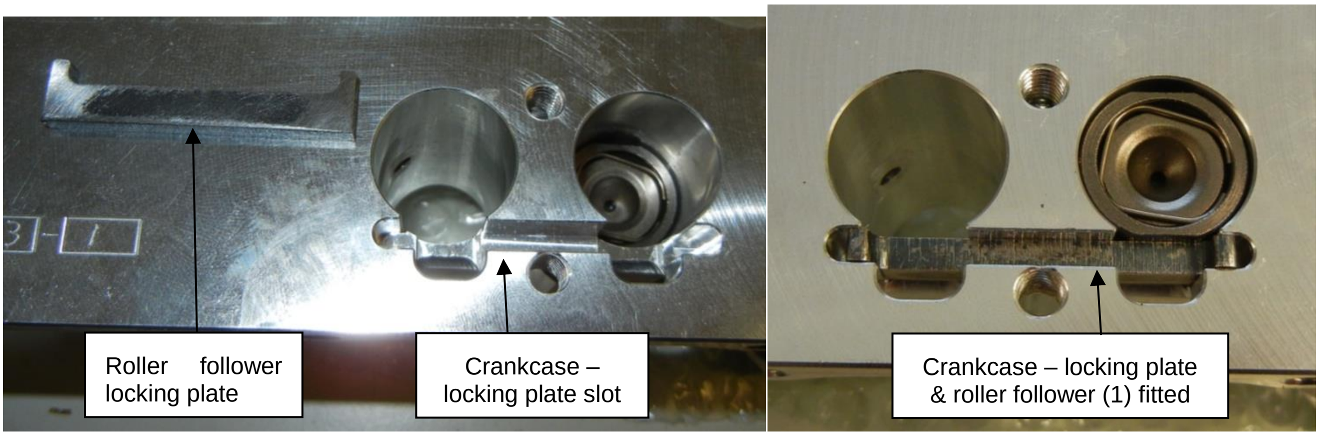


Figure 187 – Crankcase & Locking Plate

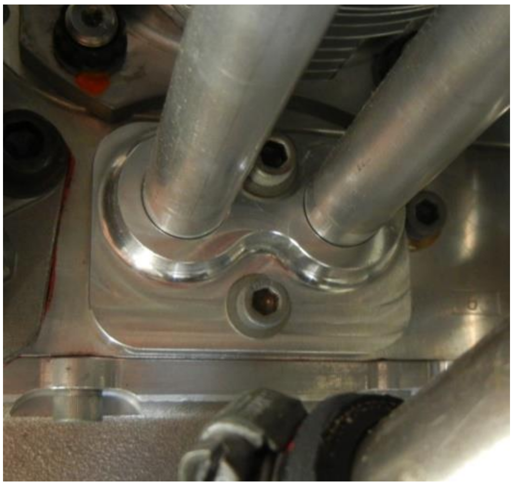


Figure 188 – Oil Return Manifold Fitted

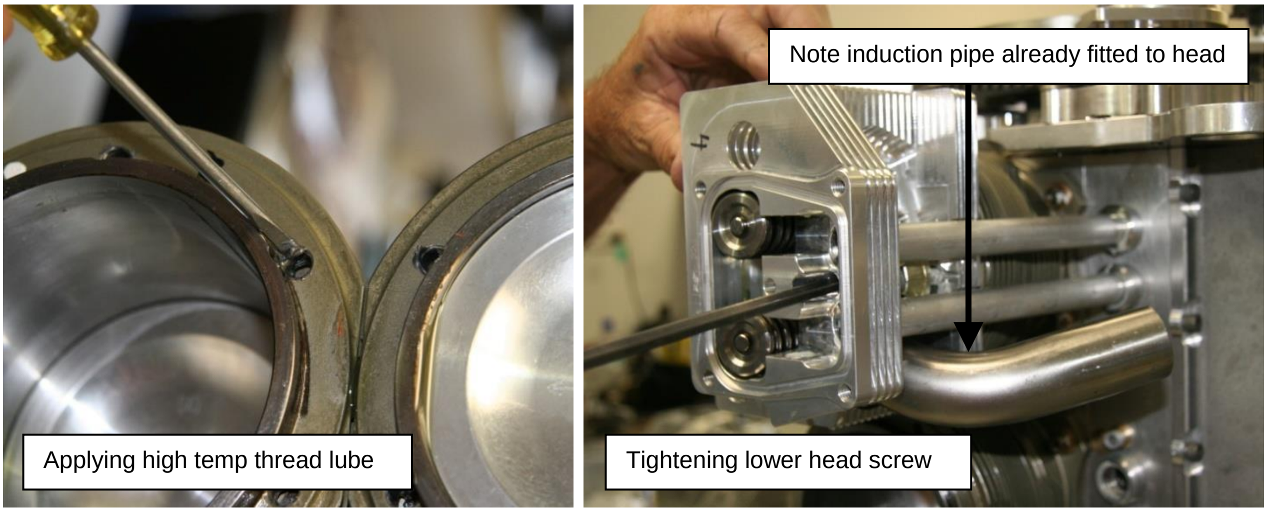


Figure 189 – Applying Thread Lubricant & Tightening Lower Head Screw

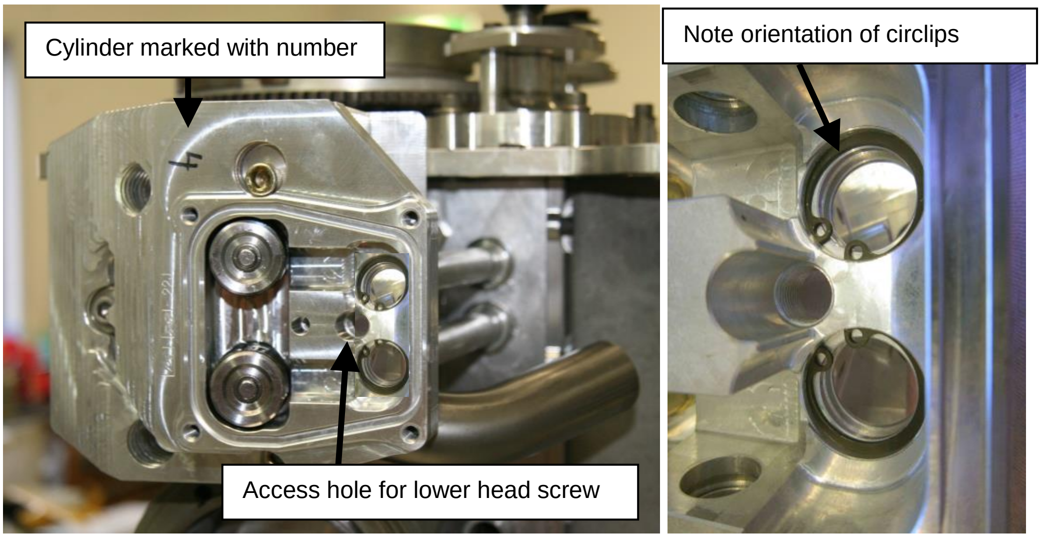


Figure 190 – Fitting Rockers #1

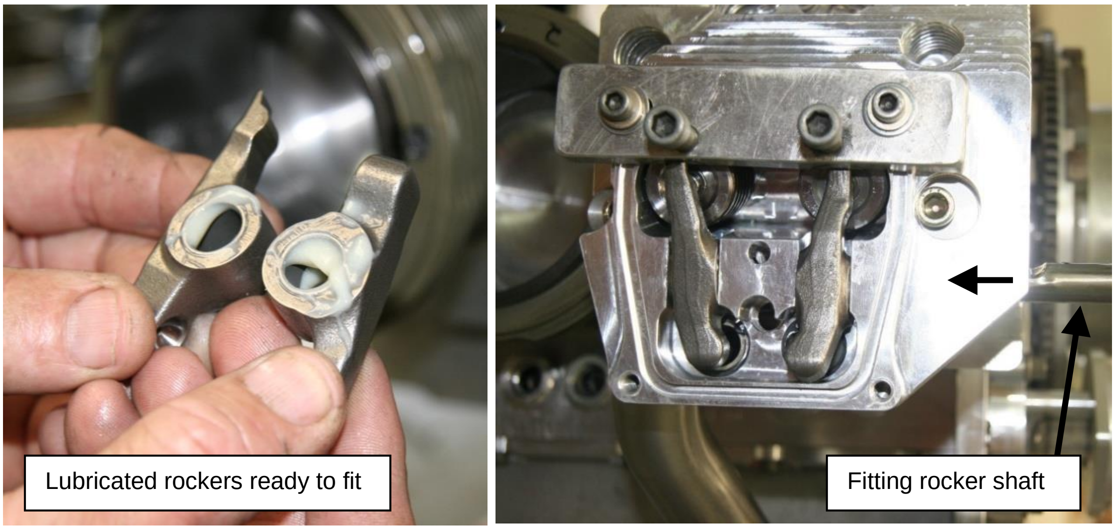


Figure 191 – Fitting Rockers #2

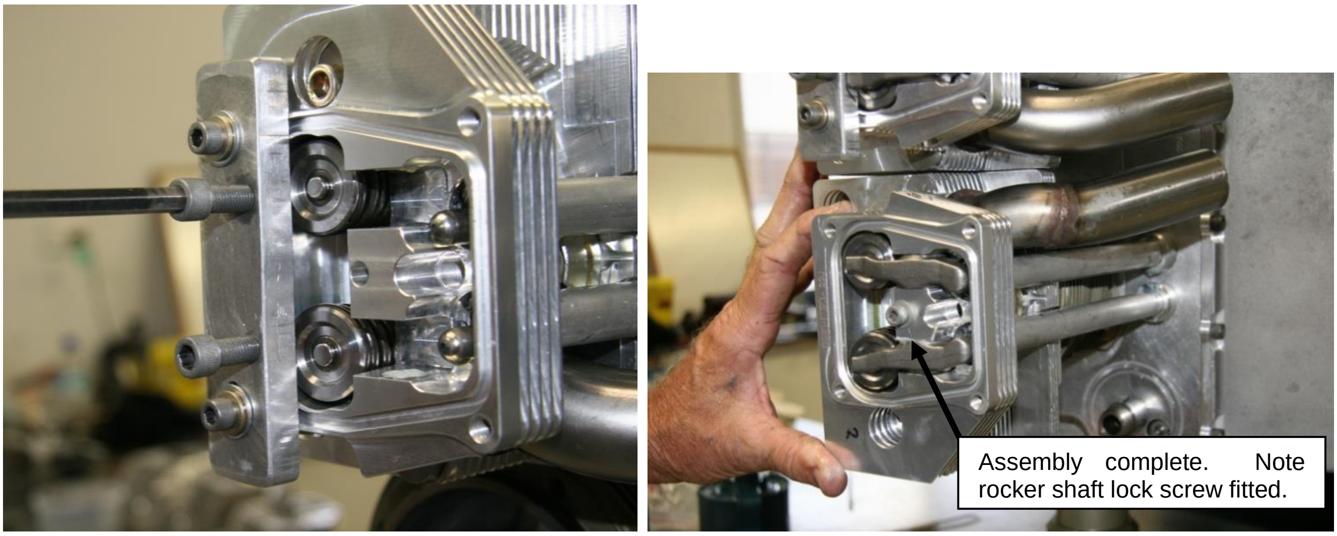


Figure 192 – Fitting Rockers #3

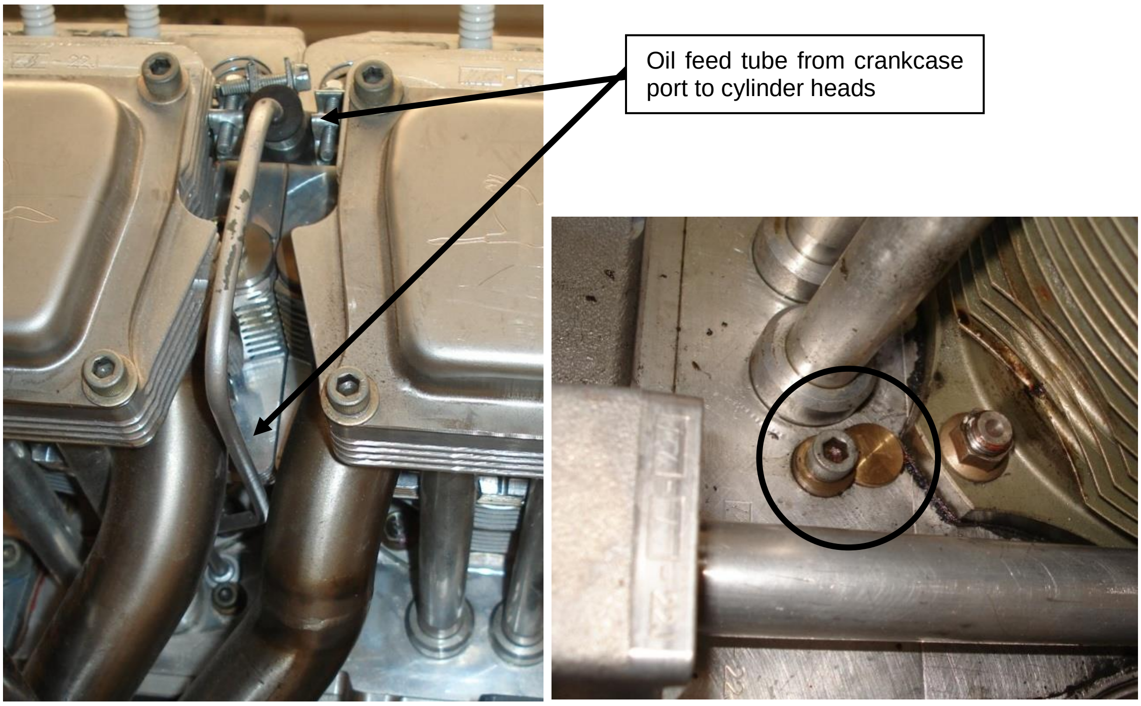


Figure 193 – Rocker Lube (Left) & Crankcase Oil Port Blanking Plug

- For a solid lifter engine, to adjust the valve clearances use the following procedure:
    1. Start with the top valve in the top head. Rotate the engine on the work stand to the point where the valve is fully depressed then rotate it through another whole revolution. This will place the follower exactly on the "back" of the cam where there is no lift. Note that the engine should always be turned in the direction of its normal rotation.
    2. Using a spanner and screwdriver (or special tool as shown below) adjust the clearance to 0.010".
    3. Repeat this process for each valve in the engine.

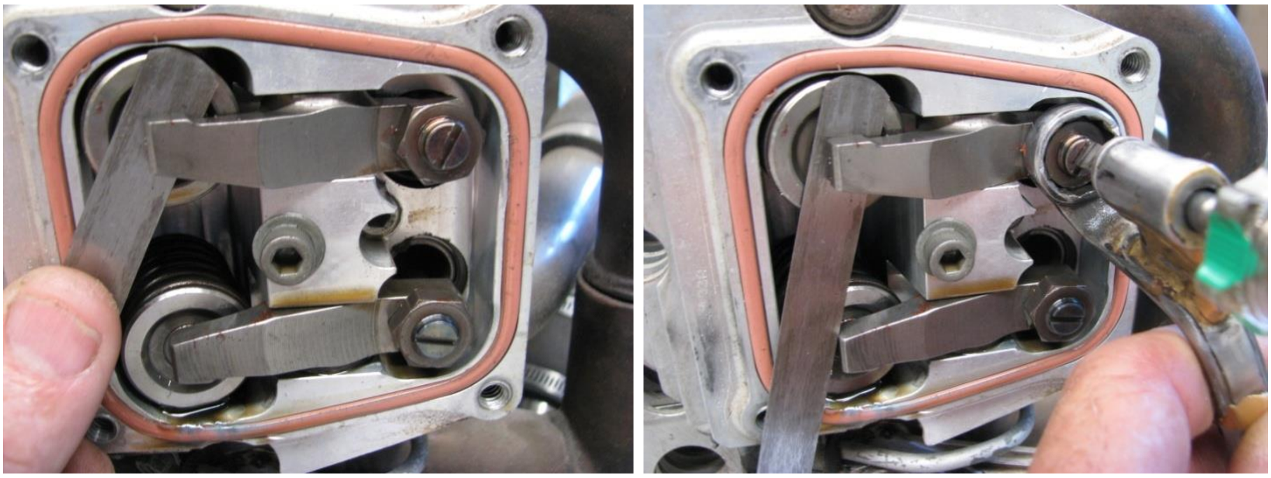


Figure 194 – Valve Clearance Adjustment (Solid Lifter)

7.8.11 Induction Plenum & Tubes

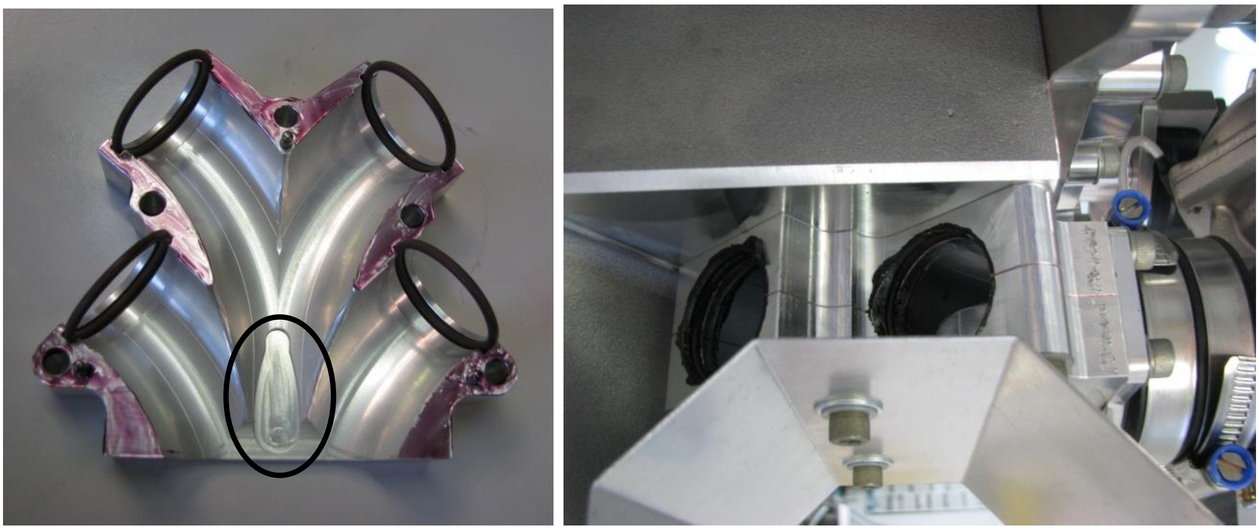


Figure 195 – Induction Manifold Installation

- The upper induction pipes have all been fitted to the cylinder head during sub-assembly and by now it will be obvious if any have been fitted to the wrong head.
- Fit the diffuser(s) inside the plenum chamber halves. 2200 and most 3300 engines both use an “airfoil” diffuser shaped as circled in Figure 195 (Left). Later 3300 engines use two round diffusers.
- The two halves of the plenum chamber are fitted together as shown, using Loctite 515 sealant between the halves.
- Once assembled by hand the plenum chamber can be fitted to the engine.
- Insert new O rings into the plenum chamber as shown. In this application the O rings must be installed with a light coating of L90.
- Fit the rubber joining hoses onto each induction pipe and push them up towards the head. The hose clamps should also be fitted now, but not tightened.
- One by one, fit the lower induction pipes into the plenum chamber. Before fitting, apply Loctite #2 gasket seal (as shown in Figure 196) around the outside end of the induction pipe. Care must be taken to get the amount of sealant right – too little will result in leaks which can dangerously affect the fuel/air mixture while too much will form blobs inside the induction manifold and will need to be cleaned out.
- While the sealant is still wet push the rubber joining hoses over the joints in the pipes. Mark or measure the pipes so that the hose is centred over the join. Then tighten the hose clamps – orient the clamps for easy access when installed on the aircraft.
- The carburettor mount is sealed to the rear face of the plenum chamber using Loctite 515 and attached using cap screws as shown in Figure 197. Apply Loctite 243 to these screws.

- The carburettor coupling and carburettor can now be fitted as shown, making sure that the earth strap is fitted between carburettor and plenum as shown. Do not use any lubricant on this connection as it can result in the carburettor slipping out of the coupling and engine stoppage.

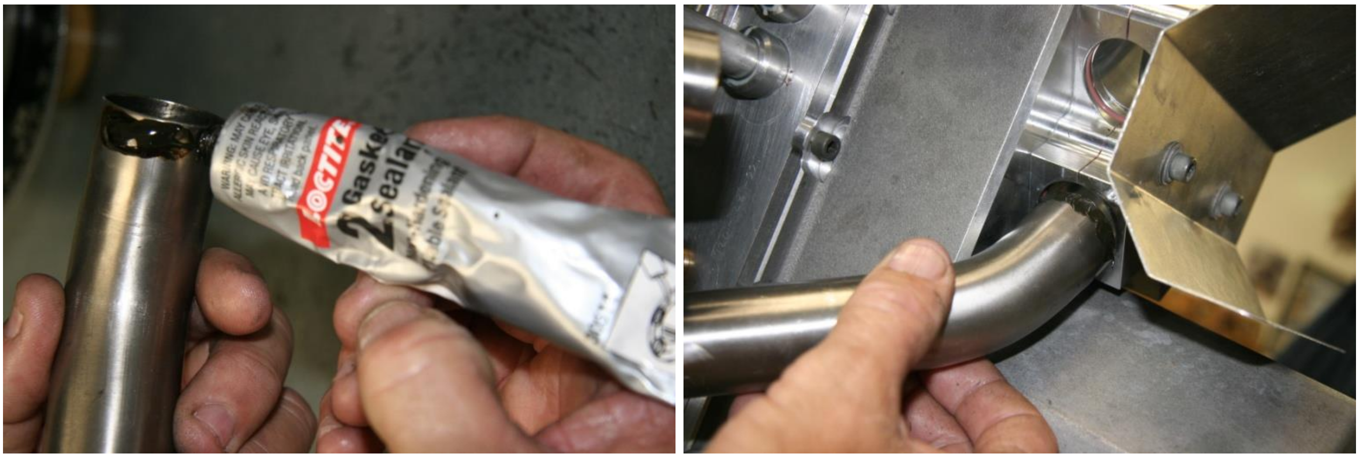


Figure 196 – Fitting Induction Pipes to Plenum Chamber

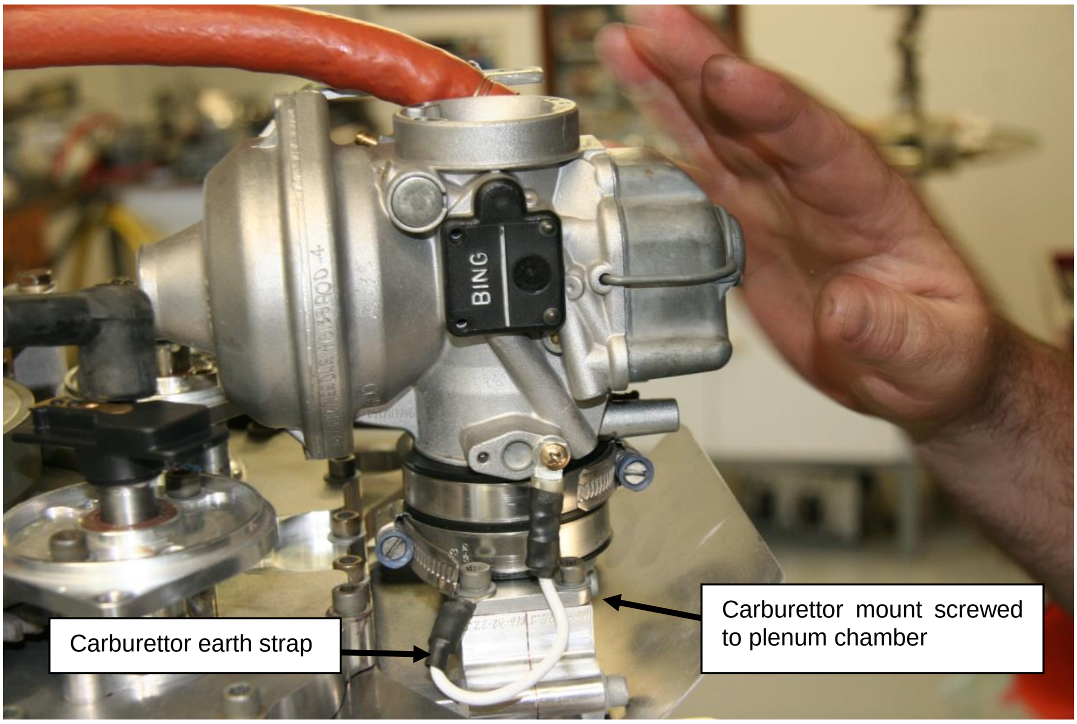
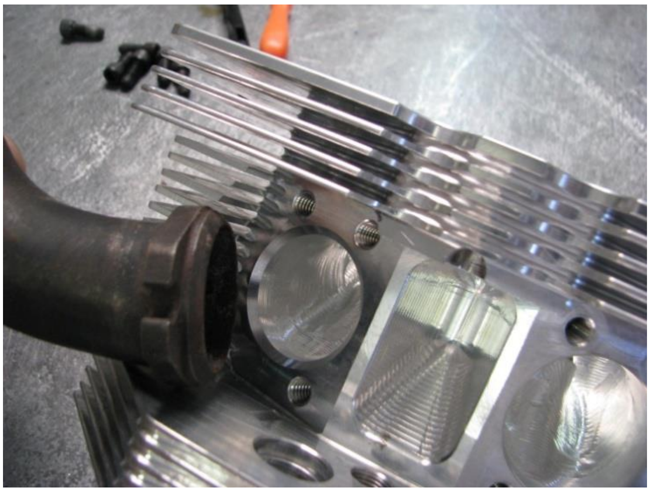


Figure 197 – Fitting Carburettor

7.8.12 Exhaust Pipes



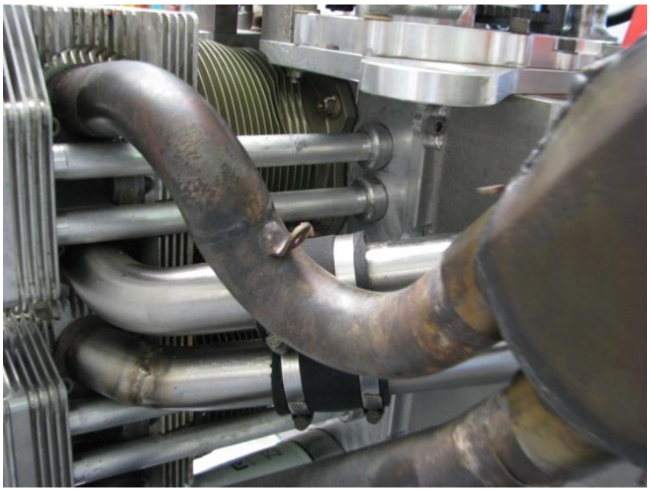


Figure 198 – Exhaust Installation

- Early engines used gaskets between the cylinder head and the exhaust manifold which must be renewed at overhaul or top end inspection. For engines in this configuration a shake-proof washer must be fitted to the flange screws.
- Newer engines use a metal-on-metal seal with a 45° seat at the exhaust port of the head – for these engines there is no seal and no shake-proof washers needed.
- Loosely fit the exhaust pipes to the engine. Each pipe will have 3 (for gasket type) or 2 (metal seat type) cap screws holding the pipe to the head.
- On the final assembly into the aircraft the muffler will be fitted and positioned, then the screws tightened.

7.8.13 Carburettor

- Cap the air and fuel inlets before taking the engine out of the overhaul room.

7.8.14 High-Tension Leads & Spark Plugs

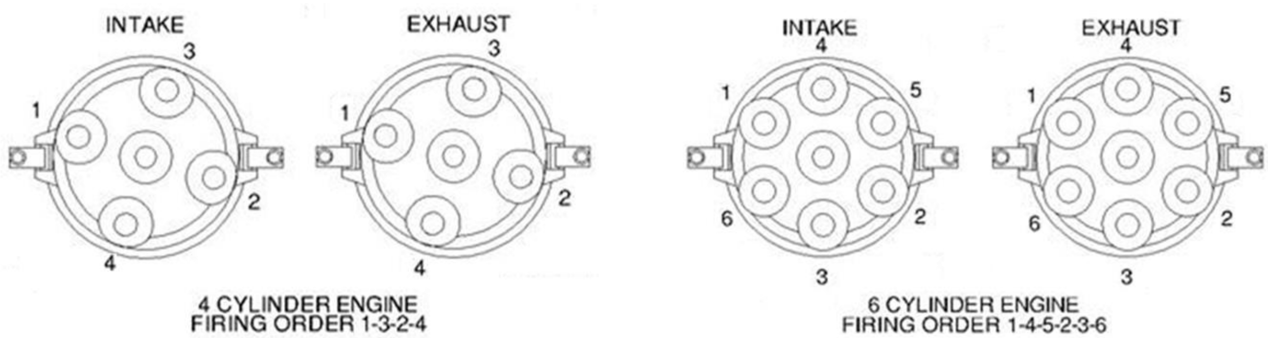


Figure 199 – Firing Order of Distributor Caps

- Note that in Figure 199 all distributors are shown looking from the flywheel end of the engine. “Exhaust” and “Intake” refer to the position of the spark plugs in the cylinder – on the exhaust or intake side of the head.
- Assemble the high-tension leads onto the engine, cable-tying them as shown in Figure 200.

WARNING

Do not use lubricant to fit the HT lead boots as this can result in the lead slipping out of the socket in service.

- During assembly, check each HT lead fitting for tightness in the distributor cap; expand each metal fitting until it snaps neatly into place in the cap.

- NGK D9EA spark plugs are used in Jabiru Engines. If other brands are used care must be taken to ensure they are equivalent to the D9EA in all respects. Note that Resistor type plugs are not recommended as they reduce the spark strength and can contribute to difficult starting – and that Iridium plugs are generally resistor types.
- The spark plug gap is set to the value given in Table 12. Generally around 0.23" works well though the gap can be reduced to the minimum (0.018"–0.020") during winter to give easier starting
- Always use a high-temperature graphite lubricant such as anti-seize when fitting the plugs. Tighten the plugs to the setting given in Table 9. Note that excess lubricant on the plug thread can cause plug misfiring when heated.

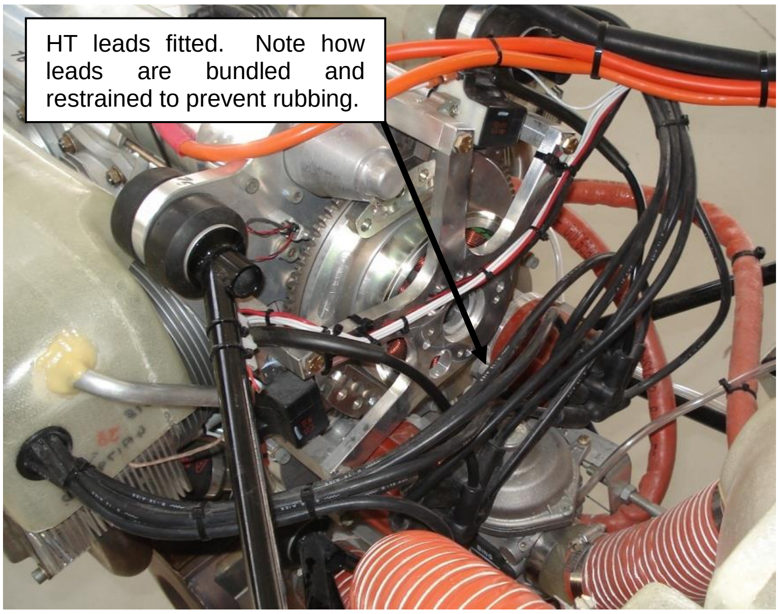


Figure 200 – HT Leads Fitted To Engine

REMOVE ENGINE FROM STAND.

7.8.15 Front Crankshaft Seal Housing

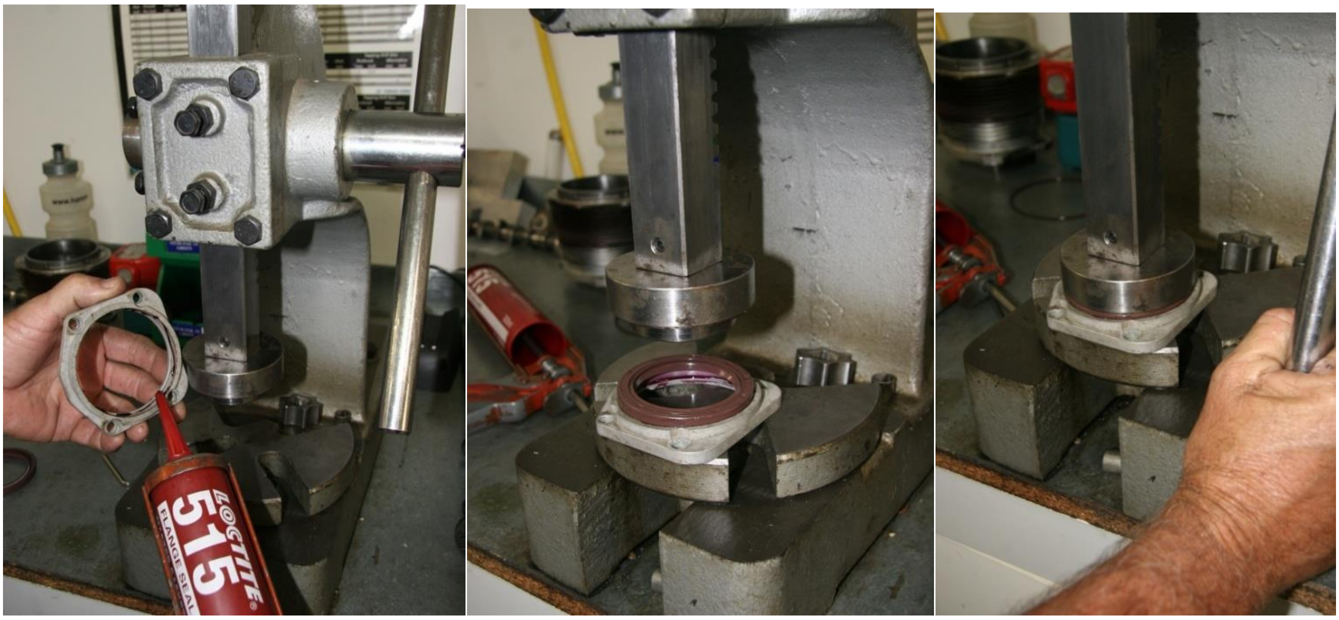


Figure 201 – Fitting Seal To Housing

Figure 202 – Front Seal Housing Ready To Fit

- Note that this task must be performed before fitting the propeller drive flange or the oil pump housing.
- Apply Loctite 515 to the inner face of the seal housing and fit the new seal as shown in Figure 201. Using a hand press with dies made to suit makes this job much easier and is strongly recommended.
- Fill the seal with high temperature grease or commercial seal lube and fit the housing to the engine as shown in Figure 203 (right). Note the orientation of the housing. Use 4 off 5/16" cap screws with Loctite 243 on the threads. Note that earlier engines used 1/4" screws. Either type assembly is acceptable.

7.8.16 Propeller Flange

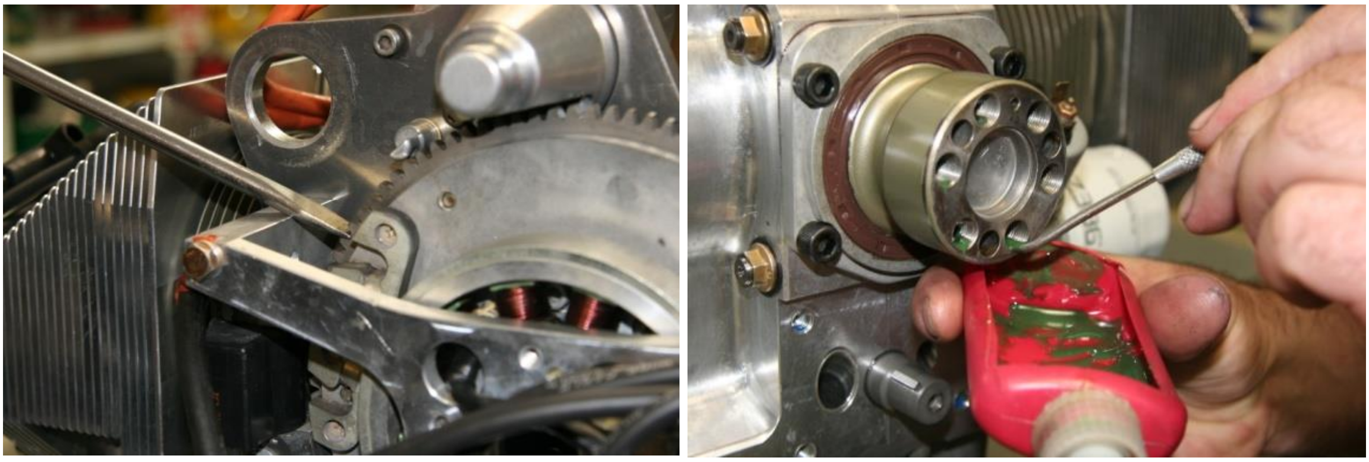


Figure 203 – Preparing To Fit Propeller Flange

WARNING

This task requires a second person. It is safety critical and should only be attempted by experienced, competent overhaulers.

- Before beginning this task ensure that all parts, hardware and compounds are close to hand and ready to be fitted. Dry-fitting the flange before final fit-up is strongly recommended. In some cases some paint may need to be removed from the front of the crankshaft or from the flange to allow the flange to fit easily.
- The cure time for the retaining compounds used in this task can be short and so this task must be completed quickly and efficiently.
- Before beginning the fit up, use taps to ensure that all threaded holes in the crankshaft have been cleaned and the old retaining compound removed. This must be done carefully and by hand to make sure the tap engages properly with the thread and does not damage it. Prop flange retaining screw holes are 3/8" UNF while the rear flywheel retaining screw holes are 5/16" UNF or 3/8" UNF. After removing the tap use compressed air to blow out any debris from inside the holes.

- Dry fit the cap screws to the propeller flange and verify that there is sufficient thread engagement into the crankshaft – a minimum 9mm (0.0.354”) of full thread engagement is required – which generally equates to a total of around 11-12mm (0.433-0.472”) measured from the tip of the screw to the flange mating face. If a Belleville (cone or spring washer) is used, the compressed thickness of the washer must be accounted for – the numbers given here assume a std Jabiru Belleville washer is fitted (and compressed) while measuring. While this is not normally an issue when using a Jabiru propeller flange, manufacturing tolerances mean that this must still be checked. If using a non-Jabiru flange then this dry fit stage is of critical importance to ensure that the flange is fitting properly (not binding on the crank, is sitting co-axial with the crank etc). If replacement hardware is used ensure that it is “Unbrako 1960” grade or equivalent.
- Clean the threads of the screws using Loctite 7471 cure accelerator & allow to air dry. After priming, ensure the threads stay clean – contamination with oil (even skin oils from fingers) can reduce the strength of the bond of the retaining compound.
- Clean the threads in the crankshaft using Loctite 7471 cure accelerator & air dry.
- Ensure that there is no paint, Loctite or other contaminants on the internal face of the propeller flange where the mounting screws and washers seat.
- Because the retaining compound sets quickly it is recommended to pre-heat the propeller flange to around 60 – 80°C using a heat gun or similar. At this temperature the flange expands and will fit over the dowel pins more easily.
- Fit the flange to the crankshaft; this can be done most quickly by carefully positioning the pre-heated flange in place with the dowels lined up with the holes in the flange. Then, using a piece of timber as a “soft” driver fitting inside the flange, drive the flange into position with a hammer.
- Alternative method for flange installation:
  - After initial cleaning of the threads of the crankshaft and of the cap screws fit the flange to the crankshaft using 3 of the screws, tightening evenly to ensure flange is pulled correctly into position.
  - Do Not Apply Loctite! Tighten to the torque specified in Table 9.
  - Visually inspect the flange and ensure it is correctly fitted: ensure there is no gap between the flange and the crank and that the flange is sitting straight.
  - Remove screws; the flange will remain in place on the dowel pins.
  - Repeat the steps given above for final cleaning and application of Loctite.

WARNING

It is vitally important that the screws are removed, male and female threads are cleaned and the screws re-installed with Loctite: failure to apply retaining compound can result in engine failure.

- Once the flange is in place and both male and female threads are clean apply a small amount – approximately the size of a large match head – of Loctite 620 retaining compound to the flange screws. Roll the threads of two screws together to spread the compound evenly over the threads of both, ensuring that the same amount adheres to both and is evenly spread.

Apply the same amount (approximately the size of a large match head) of Loctite 620 to the threads in the crankshaft. Apply the compound as shown in Figure 203: Use a scribe or small probe to apply the Loctite to the threads inside the crankshaft. Apply in the range 1 – 6mm from the front face of the crank.

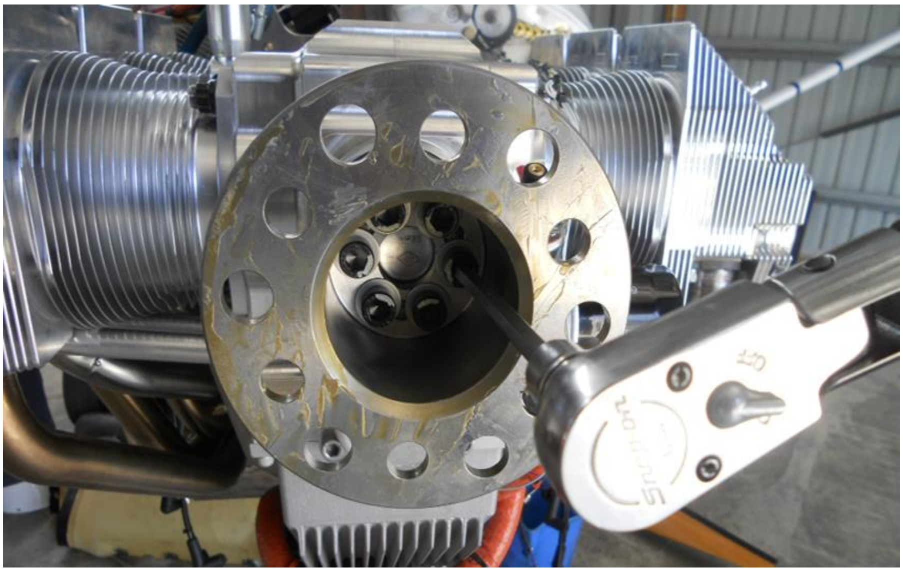


Figure 204 - Installing the Propeller flange

- Allow the retaining compound time to cure (refer to manufacturer specifications) before starting the engine.

NOTE:

Ensure the propeller flange and crankshaft mating faces are clean and dry before installation

7.8.17 Oil pump

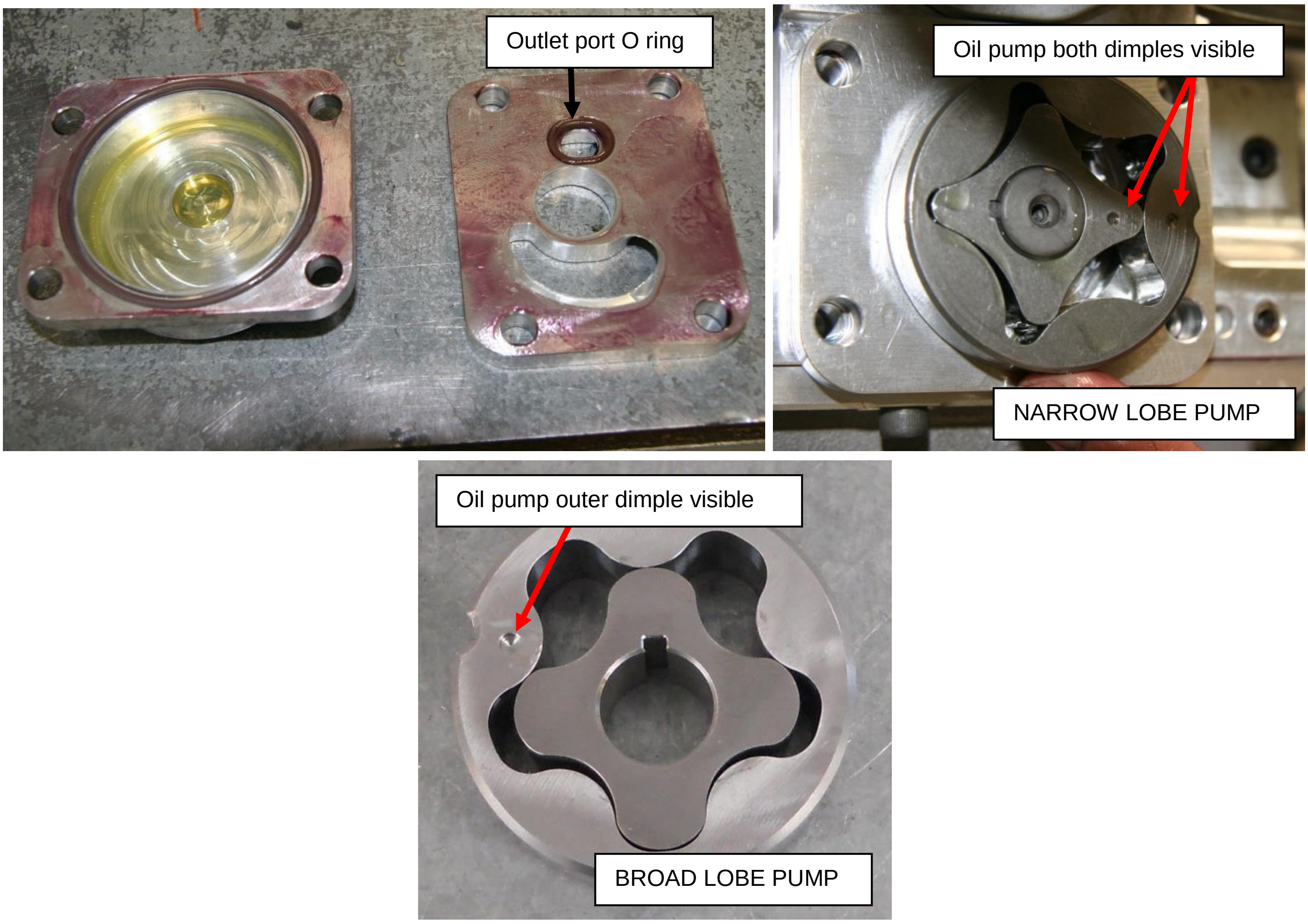


Figure 205 – Fitting Oil Pump & Port Plate

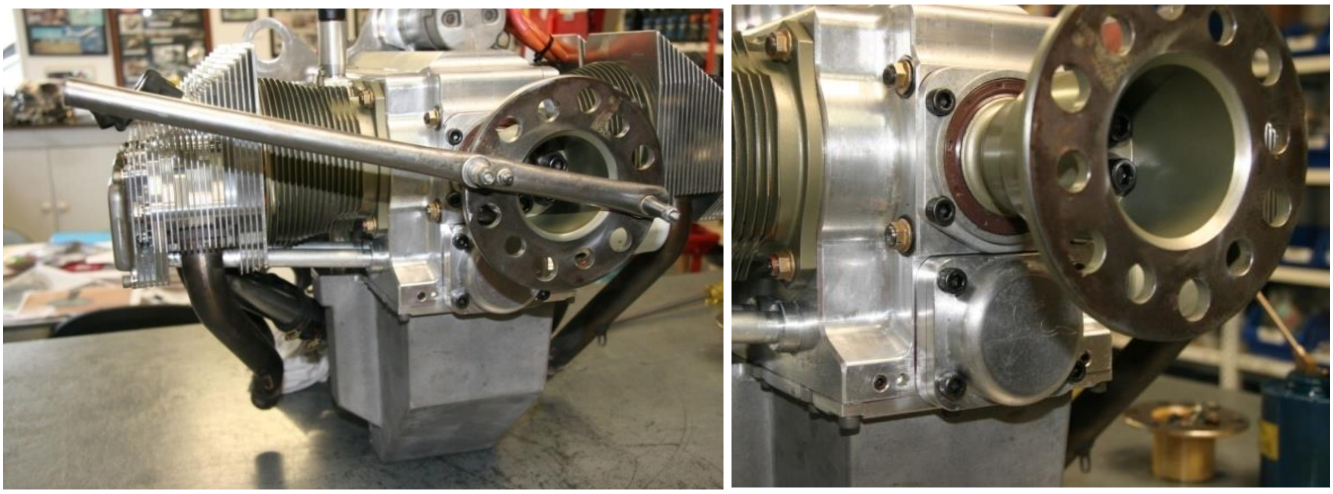


Figure 206 – Engine Turning Tool, Installed Oil Pump

- Fit a new BS112V O ring to the port plate to seal the pressure delivery port (Figure 205).
- Apply Loctite 515 sealant to 1 face of each joint – as shown with the rear side of the pump housing and the rear side of the port plate is recommended. Ensure the O rings are coated with sealant.
- Fit the port plate to the engine, then fit the new woodruff key and the oil pump gears to the camshaft. Ensure that the key is sitting correctly and that the dimples on the oil pump are oriented correctly
  - For the **Narrow Lobe Pump**, Both dimples must be visible (i.e. facing outwards) Figure 205.
  - For the **Broad Lobe Pump**, The dot on the outer pump is visible; the dash on the inner oil pump is NOT visible.
  - Occasionally the key may need to be lightly sanded to fit the cam or pump gears. This can be done by placing a piece of 600 grit wet and dry emery paper on a flat surface and rubbing the key against it. The fit needs to be snug however – do not remove too much material.
- Fit the outer pump housing over the gears and insert & hand tighten the retaining cap screws. Use Loctite 243 on the threads and ensure the Jabiru bird is oriented correctly.
- While the housing is still loosely held to the engine, rotate the crankshaft through at least 2 full revolutions. This turns the cam and allows the oil pump to find its preferred position. The housing can now be tightened to the value given in Table 9. Failure to turn the engine can result in the oil pump being offset from the cam axis – this applies side loads to the cam and can eventually crack it or break the tip off altogether.

7.8.18 Oil Pressure Relief Valve

Figure 207 – Lapping Oil Pressure Relief Valve

- If new parts are being fitted to the oil pressure relief valve it will be necessary to lap the valve poppet against the washer to ensure a good fit and seal. This is done by hand, using valve grinding paste to bed the parts together.
- After lapping ensure that all parts are thoroughly cleaned to remove all valve grinding paste.
- Fit the components of the valve as shown in Figure 208. Ensure the circlip is fitted with the flat face outwards and the curved face inwards – and that it “snaps” into position clearly when fitting.
- Press and release the poppet a few times to make sure everything is working as it should.
- At least one washer must be fitted under the spring otherwise the spring can cause the crankcase material to wear with direct contact. Test running will reveal if more washers or a thinner single washer is needed to adjust the running oil pressure.

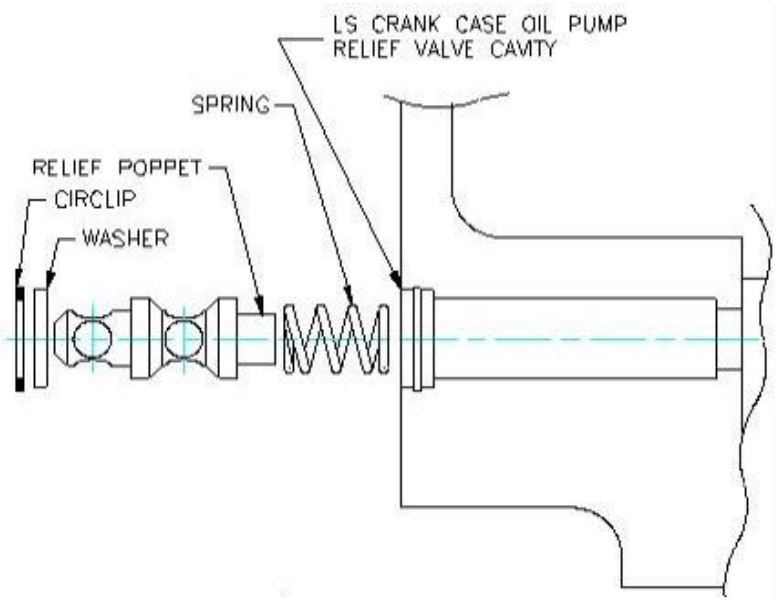


Figure 208 – Oil Pressure Relief Valve Assembly

8 Post-Assembly

8.1 Oils

- During initial running a non-detergent oil must be used to encourage proper bedding-in of components. Oils must meet the following standards:
  - Aero Oil W Multigrade 15W-50, or equivalent Lubricant complying with SAE J-1899, or
  - Lycoming Spec. 301F, or
  - Teledyne–Continental Spec MHF-24B
- Table 7 shows oil recommendations for initial running. We recommend Aero Shell 100, Exxon Aviation Oil 100 or BP Aviation Oil 100.
- This oil must be used for the first 25 hours of operation after a top end inspection or overhaul or whenever new or honed cylinders are fitted.
- For further information on oils to use refer to the Jabiru Instruction & Maintenance Manual appropriate to the engine.

Table 7 – Oil Recommendations for Run-In.

Oil Weight:	80	100	120
Outside Air Temperature	-17°C to 25°C (1° to 77°F)	15°C to 35°C (59° to 95°F)	Above 35°C (95°F)

WARNING

Automotive oils MUST NOT be used. Automotive oils are not designed for the unique environment of an air-cooled aero engine and have proven to give disastrous wear rates.

WARNING

Jabiru has not verified the attributes claimed by oil additive manufacturers and warn against using them as they may have detrimental effects.

8.2 Before First Start

- **Check oil pressure.** The simplest way to do this test is to remove a spark plug from each cylinder, then use the starter motor to spin the engine until the oil pressure reading comes up. Alternatively an external oil pressure source can be plumbed into the engine. This test ensures that the oil circuit of the engine is working properly before starting – if a fault in the oil circuit was found with the engine running damage to the main bearings etc is very likely.
- **Install to a suitable running rig.** Engines can be run-in on the ground on a test rig – however it is essential that this rig have oversize cooling ducts for the cylinder heads and for the oil cooler. Normal aircraft ducts are not enough – running an engine on the ground using aircraft cooling ducts can quickly overheat and ruin an engine.

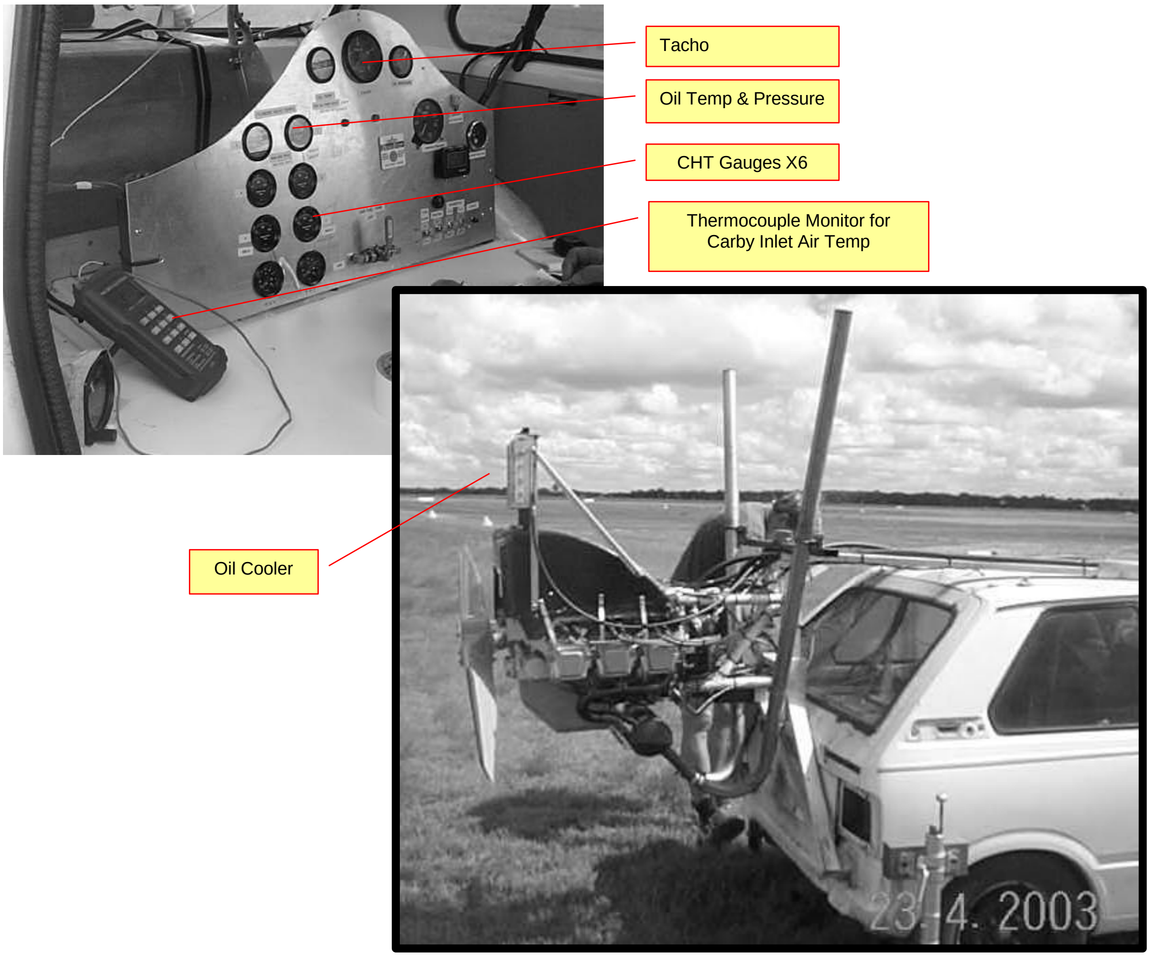


Figure 209 – Engine Ground Running Rig

- **Fit a suitable propeller.** Carrying on from the last point, if the engine is being run on the ground then a suitable "club" prop must be fitted. A club prop must allow the engine to reach a minimum of 3250 RPM and a maximum of 3400 RPM. A prop which does not meet either of these limits will not load the engine correctly and can initiate long-term operating issues.

8.3 Ground Run-In & Test Procedures

- Test running is an essential part of the full overhaul or top end overhaul process. It is worth spending extra effort during this testing to catch any small issues which may grow more serious in operation.
- At the completion of assembly of the engine after overhaul, it is recommended that the engine be mounted upon a suitable test stand for its initial or run-in operation.
- Alternately the engine may be re-fitted to the aircraft and run. While the very first runs may take place on the ground in an airframe, any further testing must be carried out in the air to ensure sufficient airflow for engine cooling.
- The run-in serves a two-fold purpose; first, to seat piston rings and burnish any new parts that have been installed and second, to give the operator control over the first critical hours of operation, during which time he can observe the functioning of the engine by means of the test cell instruments or, if the engine is re-fitted to the aircraft, the aircraft instrumentation.
- Also at this time any malfunctions can be corrected and oil leaks repaired.
- The first few hours after an overhaul are critical for the rest of the life of the engine and no effort should be spared to conduct engine running according to the following criteria. What follows is a very specific set of power settings, typically periods of full power operation followed by reduced power periods to ensure correct cooling. If these instructions are followed to the letter the rings will bed into the cylinders correctly and this will result in a much more pleasant engine with a decent life expectancy provided that our daily inspection and maintenance procedures are followed. A sample ground run-in procedure is included in the engine overhaul booklets in Section 9 below.
- On completion of the run post-run-checks must be carried out – refer to Sections 9.9.10 and 0 for details.

8.4 Final Tasks

- Unless the engine is to be fitted to an aircraft and used immediately it must be inhibited to prevent corrosion. Engines which have just been run-in are very susceptible to corrosion and so must be inhibited immediately that post-run checks have been completed. Details are included in Section 0.
- Thoroughly clean engine
- Apply caps to all engine openings: carburettor air intake, fuel pump and carburettor fuel fittings, engine crankcase breather, exhaust tubes, oil cooler adaptor fittings.
- Apply a warning tag to the engine. The tag should state, at a minimum:
  - ENGINE RUN-IN COMPLETED.
  - ENGINE OIL DRAINED
  - CORROSION INHIBITOR APPLIED
  - DO NOT RUN ENGINE UNTIL ALL CAPS HAVE BEEN REMOVED AND OIL HAS BEEN ADDED TO THE SUMP.

- Finally, the documentation must be completed. Build sheets and test cards must be filled out. Normally the statement or report given to the customer will include lists of the new parts fitted. The build sheets used by Jabiru Aircraft are all included in Section 9 and it is strongly recommended that these are used.

8.5 Troubleshooting

Table 8 - Troubleshooting

Symptom	Suggestion
Poor cold starting	1. Check starter motor and overhaul if required 2. Check battery health 3. Old spark plugs or plug gap too large 4. Battery too far from starter motor, loss of power due to cable resistance. 5. Incorrect oil grade for the temperature. Multigrade preferred. 6. Confirm tuning correct 7. Do not use choke & throttle together during start attempts. 8. Check choke jet is drilled to approx 1.2mm
Low oil pressure	1. Oil pressure relief valve needs cleaning or re-seating 2. Gauge error 3. Cavitation on oil pump feed – oil pickup needs re-sealing 4. Excess internal clearances
High CHT	1. CHT sender not perfectly centred over spark plug. 2. Poor installation of engine to aircraft. See Jabiru Engine Installation Manual 3. Valves not seating – adjust 4. Tuning incorrect 5. Propeller sizing wrong – engine overloaded
High oil usage	1. Worn valve guides 2. Worn or stuck piston rings 3. Worn, glazed or out-of-round cylinder barrels 4. Poor engine installation – incorrect oil vent location 5. Use of oil additives
High oil temperature	1. See rocker chamber vent Service Bulletin (for certain 2200 engines) 2. Poor engine installation - See Jabiru Engine Installation Manual 3. Oil level too high
"Missing" in flight	1. Carby ice 2. Ignition coil gap needs adjusting, defective coil 3. Replace spark plugs 4. Check ignition leads for fretting or shorts 5. Carburettor float level too low or too high. 6. Tuning incorrect
Carburettor flooding	1. Electric fuel pump giving too much pressure (must be less than 4psi) 2. Carby float needle seat scratched or incorrect size
Broken through-bolts	1. Detonation, most likely due to incorrect tuning 2. Over-tensioning 3. Re-use of bolts / studs at overhaul.
Flywheel Attachment Damage	1. Incorrect propeller choice 2. Prop strike or other engine damage 3. Detonation 4. Loose or poorly maintained propeller 5. Incorrect Loctite / installation
Valve Failure	1. Carburettor tuning – running too lean 2. Poor valve adjustment 3. Excess valve guide wear
Excess Metal in Oil Filter	1. Corrosion in cylinder barrels 2. Dirty oil

Symptom	Suggestion
	3. Cam / lifter face wear. Pushrod wear 4. Note that a certain amount of metal in the filter is normal for a Jabiru engine due to the piston ring / cylinder materials used.
Piston Pick Up	1. Incorrect piston / cylinder sizing 2. Lack of oil 3. Overheating, especially during ground running
Leak down test indicates low or zero.	1. Leaking valves due to carbon build-up in valve guides, valve sealing face or valve seat 2. Cylinder head recession, allowing pushrod to hold valve open when cold, can be caused by: a. Re torqueing cylinder head bolts whist engine is hot b. Over torqueing cylinder head bolts (purposefully or as the result of incorrect torque wrench calibration) c. Prolonged Excessive Cylinder head temperatures 3. Valve seat recession, again allowing the pushrod to hold the valve off the seat when cold a. Primarily caused by prolonged excessive cylinder head temperatures 4. Incorrect valve clearance (solid lifter engines only) 5. Leaking piston ring a. due to wear, carbon build-up, worn cylinder 6. Leaking between cylinder head and barrel a. Incorrect cylinder head bolt torque b. Overheating cylinder head

* (Hydraulic lifter engines only) – A lifter bleed down check can be used to determine if the lifter is sitting within the hydraulic adjustment limits (typically 4mm of travel) using an appropriate bleed down tool (see Figure 10). If there is no bleed down at all detected, then the lifter has bottomed out and the pushrod could be holding the valve open slightly.

WARNING

Incorrect use or lack of experience using a lifter bleed down tool can cause the pushrods to become permanently bent.

9 Appendix A - Build Sheets & Test Cards – APPROVED SECTION

9.1 Torque Settings

9.1.1 Table of Torque Specifications

Table 9 – Torque Specifications

Part	Nom. Dia	Torque: nm	Torque ft.lbs
Alternator & coil mount bolts	1/4"	11	(8)
Camshaft gear bolts (lock wired)	1/4"	11	(8)
Carburettor flange cap screws	1/4"	11	(8)
Connecting rod cap screws (billet conrod)**	5/16”	24	(18)
Connecting rod cap screws (forged conrod)**	5/16”	38	(28)
Crankcase main studs / through bolts	3/8" 7/16”	47 58	(35) (43)
Crankcase front studs	3/8" 7/16”	40 47	(30) (35)
Propeller flange cap screws	3/8"	40	(30)
Cylinder head cap screws	5/16"	34	(24)
Engine mount plate bolts	1/4"	14	(10)
Engine mount plate bolts	5/16"	16	(12)
Flywheel-crank cap screws (installed with Nordloc washers)	5/16” 3/8”	39 48	(29) (35)
Starfish – alloy flywheel cap screws	1/4”	11	(8)
Gearbox cover cap screws	1/4"	14	(10)
Oil Pump cap screws	5/16"	20	(15)
Jabiru Wooden Propeller bolts	1/4"	8	(6)
Starter motor cap screws	1/4"	14	(10)
Spark plugs	18mm	16-19	(12-14)
Sump cap screws	1/4"	11	(8)
Sump plug	1/2"	19	(14)
Tappet cover cap screws	1/4"	8	(6)
Mechanical fuel pump cap screws	5/16”	24	(18)
Cylinder Head Cap Screws	5/16”	34	(24)
Jabiru Propeller Bolts (using multiple Belleville washers)	1/4"	8	(6)

** It is crucial that the correct torque setting is used for the specified type of conrod. The difference between a ‘billet machined’ and ‘forged’ conrod is shown in section 7.1.4.

9.2 Build Tolerances

- All dimensions are given in millimetres

Table 10 – Build Tolerances

Part	New Build	Top End Overhaul	Full Overhaul
Prop flange run-out (Measured at outer diameter)	0.060 Max	Per New Build	Per New Build
Crankshaft run-out	0.050 Max	Per New Build	Per New Build
Crankshaft Main journals	47.930 – 47.950	N/A	Per New Build *See Note 1
Crankshaft Big end journals	44.998 – 45.010	Per New Build	Per New Build
Crankshaft Thrust face	56.950 - 57.050	N/A	Per New Build
Crankcase Main bearing bores (no bearing)	51.980 – 52.040	N/A	Per New Build *See Note 1
Crankcase Main bearings (bearings fitted)	47.985 - 48.030	N/A	Per New Build *See Note 1
Crankcase Crank thrust (bearings fitted)	56.650 - 56.850	N/A	Per New Build
Crankcase Cam bearing bores	19.99 – 20.040	N/A	Per New Build
Crankcase Cam thrust face	14.95 – 15.10	N/A	Per New Build
Crankcase Lifter stems: solid lifter	8.965 - 8.990	N/A	Per New Build
Crankcase Lifter bores: solid lifter	9.000 - 9.050	N/A	Per New Build
Crankcase Lifter bores: hydraulic lifter	21.420 – 21.440	N/A	Per New Build
Connecting Rods Big Ends (no bearings)	48.015 – 48.030	Per New Build	Per New Build
Connecting Rods Big ends (bearings fitted)	45.040 - 45.070	Per New Build *See Note 1	Per New Build *See Note 1
Connecting Rods Small ends	23.02 – 23.03	Per New Build	Per New Build
Connecting Rods Length between bore centres	109.95 – 110.05	Per New Build	Per New Build
Camshaft Journals	19.94 – 19.95	N/A	Per New Build *See Note 1
Camshaft Valve lift	6.900 - 7.100	N/A	Per New Build
Camshaft Fuel pump lift	2.450 - 2.550 at pump 2.9 – 3.1 at cam	N/A	Per New Build
Camshaft Thrust faces	15.18 – 15.25	N/A	Per New Build
Pistons Diameter (across the skirt)**	97.480 - 97.530	Per New Build	Per New Build
Pistons Height	65.500	Per New Build	Per New Build
Pistons Pin diameter	22.990 - 23.000	Per New Build	Per New Build
Cylinder Bore diameter**	97.61 – 97.63	Per New Build	Per New Build
Cylinder Bore out of roundness**	0.00 - 0.02	Per New Build	Per New Build
Cylinder Length over flanges	106.95 – 107.00	N/A	Per New Build
Valves Stem diameter Inlet and Exhaust	6.970 - 6.990	Per New Build	Per New Build
Valves Guide ID Inlet and Exhaust	7.040 - 7.050	Per New Build	Per New Build
Valve Spring free length (single spring)	38.000 - 40.000	Per New Build	Per New Build

Double Valve Spring free length (outer spring) (inner spring)	45.50 – 46.50 40.50 - 41.50	Per New Build Per New Build	Per New Build Per New Build
Distributor Shaft diameter	14.94 – 14.97	N/A	Per New Build
Distributor Shaft post ID	15.000 - 15.030	N/A	Per New Build
Distributor Shaft end float	1.000 - 1.200	N/A	Per New Build
Fuel Pump Pushrod Type 1	72.75 – 72.85	N/A	Per New Build
Fuel Pump Pushrod Type 2	74.75 – 74.85	N/A	Per New Build
Pushrod length: solid valve lifters.	211.5 – 212.5	Per New Build	Per New Build
Pushrod length: hydraulic valve lifters, solid pushrod.	215.2 – 215.3	Per New Build	Per New Build
Pushrod length: hydraulic valve lifters, hollow pushrod.	214.7 – 215.3	Per New Build	Per New Build
Pushrod length: roller followers, hollow pushrod.	205.35 – 205.85	Per New Build	Per New Build
2200 Old Sump: Dipstick length from top of cap to markings.	Full Mark: 279 – 281 Low Mark: 294 – 296	Per New Build	Per New Build
2200 New Sump: Dipstick length from top of cap to markings.	Full Mark: 314 – 316 Low Mark: 329 – 331	Per New Build	Per New Build
3300 Sump: Dipstick length from top of cap to markings.	Full Mark: 279 – 281 Low Mark: 294 – 296	Per New Build	Per New Build
Piston, gudgeon, circlip, connecting rod, big-end bearing assembly weights – maximum difference between lightest and heaviest assembly used in engine	Up to 3g	Per New Build	Per New Build

*Note 1: Bearing journal sizes of early model engines differ slightly from those of later model engines. In some cases journals outside the limits given may still provide bearing clearance within acceptable limits when assembled with matching parts; i.e. an older crankshaft may measure slightly under the current lower limit but provide acceptable clearance when used in a matching older crankcase. This is acceptable practice and parts less than 0.05mm outside the size limits specified may be used, provided that the requirements for bearing crush, bearing fit and bearing clearance are all met.

WARNING

This leeway applies only to those items specified in Table 10.

** Cylinder bore and piston measurements are only a typical range the more important factors to determine are the maximum out of roundness of the barrel and the piston skirt clearance.

9.3 Multi-Cycle Items

Table 11 – Mandatory Replacement Items – Multi-Cycle Parts

Item	Maximum Life
Reserved	-

9.4 Compounds & Sealants

- Specific compounds and sealants are specified in the assembly checklists given below.
- Generic fastener retaining compound: Use Loctite 243 unless specified otherwise.
- Retaining compound need not be used on fasteners with inbuilt locking (such as MS21042 type lock nuts) unless specified otherwise.

9.5 Maximum Allowable Clearances (Wear Limits)

- All dimensions are given in millimetres
- "New Build Clearances" assume use of all current-spec parts.

Table 12 – Clearance and Wear Limits

Part	New Build Clearances	Top End Inspection	Full Overhaul
Crankshaft end float	0.20 - 0.80	N/A	Per New Build
Main bearing Clearance	0.04 – 0.10	N/A	Per New Build
Big end bearing clearance	0.04 – 0.08	Per New Build	Per New Build
Big end bearing crush	0.05 – 0.20	Per New Build	Per New Build
Camshaft bearing clearance	0.05 – 0.08	N/A	Per New Build
Camshaft end float	0.05 - 0.50	N/A	Per New Build
Solid Lifter to crankcase	0.15	N/A	Per New Build
Hydraulic Lifter to Case	0.19	N/A	Per New Build
Piston to cylinder (split skirt pistons)**	0.08 – 0.13	Per New Build	Per New Build
Piston to cylinder (slotted skirt piston)**	0.13 – 0.17	Per New Build	Per New Build
Piston compression ring end gap	0.40 - 1.20	N/A	Per New Build
Piston compression ring side clearance	0.08 - 0.12	N/A	0.05 – Early model 0.08 - 0.12 – Late model
Gudgeon pin to piston	0.04	Per New Build	Per New Build
Inlet and Exhaust valve stem to valve guide	0.05 – 0.08	Per New Build	Per New Build
Distributor shaft/post	0.03 – 0.09	N/A	0.03 – 0.15
Distributor shaft end float	0.5 – 1.20	N/A	Per New Build
Rocker shaft to rocker arm	0.12 – 0.18	Per New Build	Per New Build
Ignition coil gap	0.25 – 0.30 (0.010" – 0.012")	Per New Build	Per New Build
Spark Plug Gap	0.56 - 0.61 (0.022" - 0.024")	Per New Build	Per New Build
Valve clearance (solid lifter engines)	0.254 – 0.305 (0.010" - 0.012")	Per New Build	Per New Build

** The difference between 'split skirt' and 'slotted skirt' pistons is identified in section 7.3.1.1

** Cylinder bore and piston measurements are only a typical range the more important factors to determine are the maximum out of roundness of the barrel and the piston skirt clearance.

9.6 Electrical System Specifications

Table 13 – Electrical System Specifications

Ignition	
All Coils	Strong & continuous spark required with 8mm gap when tested using coil tester (Figure 27)
Coil to flywheel gap	0.27mm to 0.30mm
Ignition harness resistance	6.7 KΩ per 300mm length
Ignition magnet Strength (see Figure 210)	1.5 – 2.5kg.
Alternator	
Coil resistance: early 2200 10 Pole. (Per Document AR01-1)	0.01 Ω to 0.4 Ω
Coil resistance: Parallel Wound 12-Pole. (Per Document AR01-1)	0.01 Ω to 0.4 Ω
Coil resistance – Series Wound 12-Pole. (Per Document AR01-1)	0.01 Ω to 0.4 Ω
Coil earth resistance	Infinite
A.C. output: early 2200 (10 Pole)	30.0 VAC at 3000 RPM,
A.C. output: (2x6 parallel wound 12 pole)	30.0 VAC at 3000 RPM
A.C. output: (series wound 12 pole)	Up to 40.0 VAC at 3000 RPM
D.C. output	Up To 14.3 VDC at 3000 RPM
Maximum load: (10 pole)	10Amps continuous
Maximum load: (12 pole parallel and series)	17Amps continuous
Tachometer	
Coil resistance	160 Ω to 170 Ω
Gap, flywheel tags to sender	0.40mm – 0.50mm

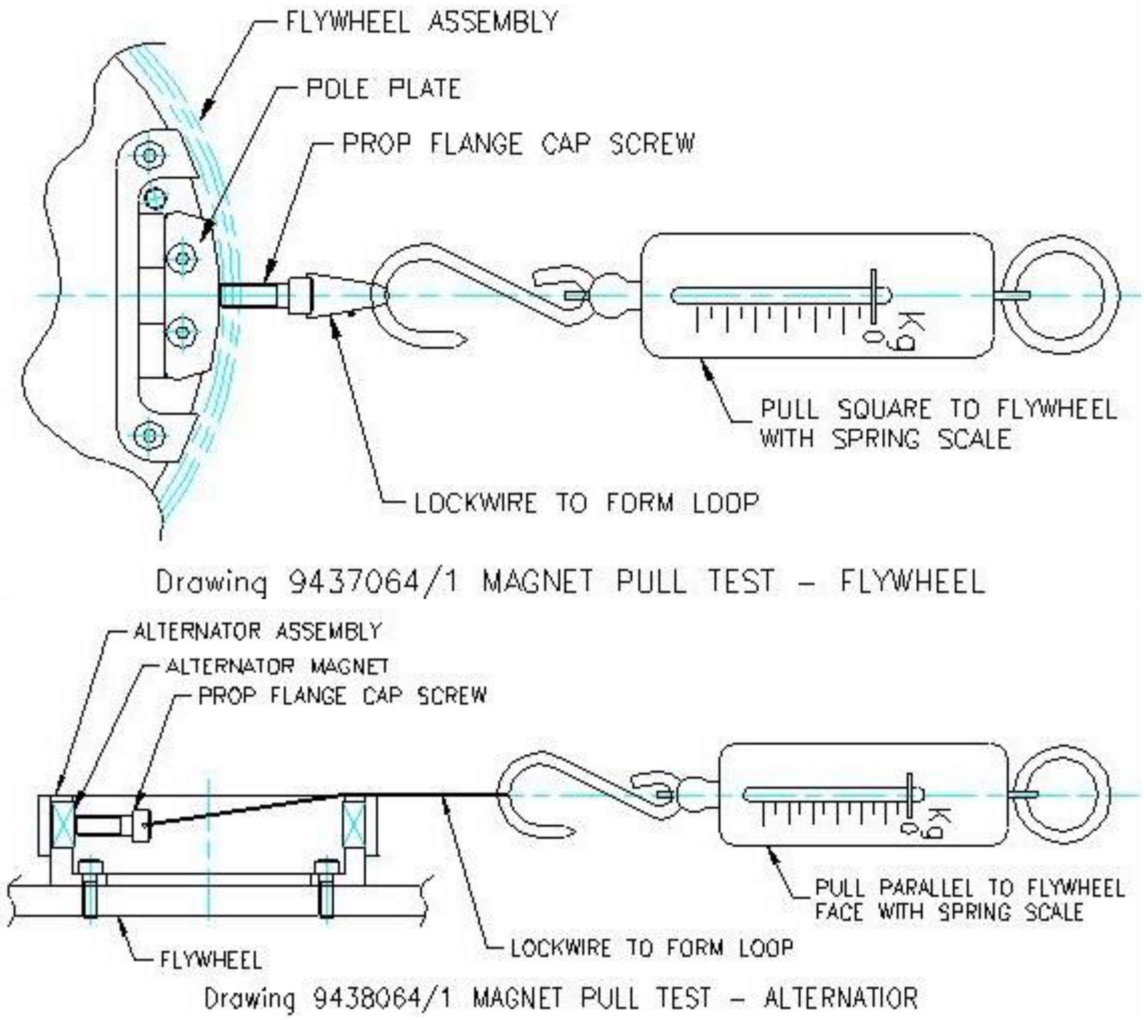


Figure 210 – Magnet Tests

- Magneto and alternator magnets are tested using a prop bolt attached to a spring balance as shown above: place the bolt on each magnet in turn and record the tension required to pull the bolt free from the magnet. Tension requirement is detailed in Table 13.

9.7 Disassembly Record Sheet

9.7.1 Engine Details

Engine Serial #:________________ Date:____________

9.7.2 Engine Disassembly Record Sheet

- A disassembly control / record checklist is given below. This checklist describes disassembly as the reverse of the assembly processes detailed in Sections 9.9.9 to 9.10.10. The assembly checklists referenced need not be completed: completion of Table 14 is sufficient record of the disassembly.
- Where assembly checklists require measurements these steps may be skipped during disassembly.
- Where assembly checklists include the application of compounds these may be skipped during disassembly.
- Where assembly checklists require stage inspections these may be skipped during disassembly.
- Disassembly for full overhaul as detailed. Disassembly for top-end overhaul may substitute Sections 9.10.2 to 9.10.7 in Table 14.

Table 14 – Engine Disassembly

No.	Details	Initials	Checked By	Date
Z1	Disassembly: Reverse process detailed in Build Sheet H (Section 9.9.9, “Final Assembly”)			
Z2	Disassembly: Reverse process detailed in Build Sheet G (Section 9.9.8, “Fuel Pump & Carburettor”)			
Z3	Disassembly: Reverse process detailed in Build Sheet F (Section 9.9.7, “Gear Case”)			
Z4	Disassembly: Reverse process detailed in Build Sheet E (Section 9.9.6, “Flywheel, Ignition Coils, Starter Motor & Alternator”)			
Z5	Disassembly: Reverse process detailed in Build Sheet D (Section 9.9.5, “Sump”)			
Z6	Disassembly: Reverse process detailed in Build Sheet C (Section 9.9.4, “Pistons, Cylinder & Cylinder Heads”)			
Z7	Crankshaft Disassembly: Reverse process detailed in Build Sheet B (Section 9.9.3, “Crankcase & Camshaft Assembly”)			
Z8	Crankshaft Disassembly: Reverse process detailed in Build Sheet A (Section 9.9.2, “Crankshaft, Propeller Mount Flange & Conrods”)			
Z9	Clean parts to be re-used.			
Z10	Corrosion protect & store components as required.			
Z11	**Stage Inspection of Engine**			

I hereby certify that the engine has been disassembled, cleaned, corrosion protected and stored in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:______________________Date:____________for Jabiru Aircraft Pty Ltd

9.8 Sample Completed Build Sheet

Filled out by overhauler

Filled out by supervisor

Table 15 – Build Sheet A (EXAMPLE)

No.	Details	Para	Initials	Checked By	Date
A1	*Inspect for Burrs, Oil Holes, Chamfers; Clean Crankshaft, Conrods and Propeller Mount Plate*	0.0	XYZ		1-1-13
A2	*Inspect Oil Holes and insert Welch Plugs*	0.0	XYZ		1-1-13
A3	*Measure Crankshaft dimensions. (Includes crank run-out)*	0.0	XYZ		1-1-13
A4	*Inspect and measure Propeller Mount Flange (includes flange run-out)*	0.0	XYZ		1-1-13
A5	*Inspect and measure Conrods (includes bearing crush, bearing clearance)*	0.0	XYZ		1-1-13
A6	*Temporarily Mount Propeller Mount Flange to Crankshaft and bolt to stand*	0.0	XYZ		1-1-13
A7	*Fit the Conrods to the Crankshaft; Use Loctite 620 on the bolts and torque per Table 9*	0.0	XYZ		1-1-13
A8	*Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12*	-	XYZ		1-1-13
A9	***Stage A - Stage Inspection of Assembly***		XYZ	DPS	1-1-13

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed: XYZ____________________ Date: 1-1-13______ for Jabiru Aircraft Pty Ltd

Filled out by overhauler

MPI Release Note No. 1234578910

9.9 Jabiru Engine Build Booklet

9.9.1 Engine Details

Engine Serial #:__________________ Date:______________

9.9.2 Subassembly A Build Sheet – Crankshaft, Propeller Mount Flange and Conrods

Table 16 – Build Sheet A

No.	Details	Para	Initials	Checked By	Date
A1	Inspect for Burrs, Oil Holes, Chamfers; Clean Crankshaft, Conrods and Propeller Mount Plate	5.9			
A2	Inspect Oil Holes and insert Welch Plugs	5.9, 7.1			
A3	Measure Crankshaft dimensions. (Includes crank run-out)	5.9			
A4	Inspect and measure Propeller Mount Flange (includes flange run-out)	5.9			
A5	Inspect and measure Conrods (includes bearing crush, bearing clearance)	5.9, 7.1			
A6	Temporarily Mount Propeller Mount Flange to Crankshaft and bolt to stand	7.1			
A7	Fit the Conrods to the Crankshaft; Use Loctite 620 on the bolts and torque per Table 9	7.1			
A8	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
A9	**Stage A - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

MPI Release Note No.
(N/A for new engine builds)

9.9.3 Subassembly B Build Sheet – Crankcase and Camshaft Assembly

Table 17 – Build Sheet B

No.	Details	Para	Initials	Checked By	Date
B1	Inspect case, deburr, clean, check oil holes	5.10			
B2	Fit inner crankcase "O" rings	7.2			
B3	Fit all studs. Use Loctite 620 on threads.	7.2			
B4	Fit crankcase dowls	7.2			
B5	Blue and fit bearing shells	7.2			
B6	Assemble and torque	7.2			
B7	Measure main bearings	7.2			
B8	Measure Cam Follower Bores	7.2			
B9	Disassemble	7.2			
B10	Fit oil relief valve, oil pressure sender and pressure switch. Use Loctite 262 to seal pressure sender & switch.	7.2			
B11	Fit Solid Lifters	7.2			
B12	Check Camshaft End Float	7.2			
B13	Check Crankshaft End Float	7.2			
B14	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
B15	**Stage B - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:______________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.4 Subassembly C Build Sheet – Pistons, Cylinders and Cylinder Heads

Table 18 – Build Sheet C

No.	Details	Para	Initials	Checked By	Date
C1	Clean and deburr all parts	5.11			
C2	Install pushrod tube 'O' Rings, springs, washers and circlips	7.3			
C3	Check valve seats, fit spring retainers, install valves	7.3			
C4	Complete rocker shaft and rocker assemblies	7.3			
C5	Fit cylinder base 'O' rings	7.3			
C6	Measure and fit front piston circlip	7.3			
C7	Check ring end gaps, fit rings to pistons	7.3			
C8	Fit cylinders to heads. Torque per Table 9	7.3			
C9	Install piston assembly to cylinder just clear of the oil ring	7.3			
C10	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
C11	**Stage C - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.5 Subassembly D Build Sheet – Sump

Table 19 – Build Sheet D

No.	Details	Para	Initials	Checked By	Date
D1	Clean and inspect the sump.	5.12			
D2	Clean out blind threads using a suitable sized tap	5.12			
D3	Ensure all seals and gaskets on plugs and terminals are serviceable.	5.12, 7.4			
D4	**Stage D - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.6 Subassembly E Build Sheet – Flywheel, Ignition Coils, Starter Motor And Alternator

Table 20 – Build Sheet E

No.	Details	Para	Initials	Checked By	Date
E1	Clean and de-burr starter ring gear & bendix gears.	5.13			
E2	Assemble magnets, pole plates, tacho tags and alternator rotor to flywheel	5.13			
E3	Verify magnet strength and polarity correct	5.13			
E4	Check condition of starter motor and bendix clutch, fit new bushes if required or replace	5.13			
E5	Assess fit of flywheel dowels	5.13, 7.5			
E6	**Stage E - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.7 Subassembly F Build Sheet – Gear Case

Table 21 – Build Sheet F

No.	Details	Para	Initials	Checked By	Date
F1	Deburr, clean and inspect all of the gears	5.14			
F2	Measure the shaft post internal diameters and the distributor shaft diameters	5.14			
F3	Using loctite 515 fit the shaft posts to the gear housing	5.14			
F4	Fit the distributor shaft seals and rear crankshaft seal	7.6			
F5	Fit shafts to gears	5.14			
F6	Fit the distributor shafts and gears to the gear housing	5.14			
F7	Check End Clearance of Distributor Shaft to Case Flange	5.14			
F8	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
F9	**Stage F - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.8 Subassembly G – Fuel Pump and Carburettor

Table 22 – Build Sheet G

No.	Check	Size	Para	Initials	Checked By	Date
G1	Main Jet		5.15			
G2	Needle Jet		5.15			
G3	Idle Jet		5.15			
G4	Needle		5.15			
G5	Float seat ___ mm dia		5.15			
G6	Gravity Feed Valve 47-969		5.15			
G7	Air Bleed ∅1.6mm		5.15			
G8	Idle Mixture Screw Out 1 Turn		5.15			
G9	Choke Jet ∅1.2mm		5.15			
G10	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12		-			
G11	**Stage G - Stage Inspection of Assembly**					

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.9 Subassembly H – Final Assembly

Table 23 – Build Sheet H

No.	Details	Para	Initials	Checked By	Date
H1	Apply Loctite 515 to crankcase halves; lubricate where necessary	7.8			
H2	Locate camshaft in crankcase half	7.8			
H3	Locate 2 crankcase halves over crankshaft	7.8			
H4	**Stage H1 - Stage Inspection of Assembly**	-			
H5	Apply Loctite 518 to cylinder base flanges	7.8			
H6	Tension front (2) and rear (2) crankcase studs	7.8			
H7	Place all through bolts in crankcase for cylinder bases	7.8			
H8	Fit piston and cylinder Assemblies. Check circlips	7.8			
H9	**Stage H2 - Stage Inspection of Assembly**	-			
H10	Tension the cylinder base studs/bolts	7.8			
H11	Fit pushrods and valve gear. Set gap per Table 12 (solid lifter engines)	7.8			
H12	Apply Loctite 515 to sump sealing faces & fit to cases.	7.8			
H13	Apply Loctite 515 to induction manifold sealing faces. Assemble and fit to sump.	7.8			
H14	Apply Loctite No. 2 to induction tubes & fit to induction manifold.	7.8			
H15	Check camshaft timing	7.8			
H16	Apply Loctite 515 to sealing faces and fit engine mount plate and gearbox housing	7.8			
H17	Fit flywheel, alternator mount plate and ignition coils	7.8			
H18	Fit Carburettor assembly	7.8			
H19	Fit fuel pump. Apply Loctite 515 to sealing faces. Apply Loctite 243 on fuel pump screws.	7.8			
H20	Fit oil pump assembly. Apply Loctite 515 to sealing faces.	7.8			
	Fit front seal and propeller flange. Torque per Table 9 Apply Loctite 515 to sealing faces.	7.8			
	Fit exhaust system	7.8			
	Stage H3 - Stage Inspection of Assembly				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.10 Ground Run-In Procedure

Pre Run-In Checks:
- ☐ Correct Oil Type & Quantity
- ☐ All connections secure
- ☐ Idle Set
- ☐ Propeller Secure

Time	Dur (mins)	Condition	RPM	CHT 4/6 (100 – 180°C)	Oil Temp (50–118°C)	Oil Pressure, Idle Min 80 kPa (220 – 525 kPa, solid lifter) (350kPa optimal, hydraulic lifter)		Volts AC	Fuel pres	EGT
						Mech gauge	Sender			
	2	Start and Idle	1000 - 1200							
	4	Hot Idle Check 1	1400							
	2	Very High Idle	1800							
	2	High Idle	1400							
	3	Mid Power	2000							
	2	High Idle	1600							
	2	60% Power	2400							
	2	High Idle	1800							
	2	70% Power	2600							
	2	Mid Power	2000							
	2	75% Power	2800							
	2	Mid Power	2200							
	2	85% Power	3000							
	2	Cooling Run	2000							
	4	75% Power	2800							
	2	Mid Power	2000							
	2	85% Power	3000							
	3	60% Power	2400							
	4	85% Power	3000							
	3	50% Power	2400							
	3	Takeoff Power	Full:							
	2	60% Power	2600							
	2	Mid Power	2000							
	2	Cooling Run	1600							
	2	Hot Idle Check 2	Idle (800-1100):							

O.A.T.____________________ °C		Alternator:________V (AC), _________V (DC) at 2800 RPM
Magneto RPM Drop Left: ________ Magneto RPM Drop Right: ________	Limits: 0 – 100 RPM Test at 2000 RPM	Use: Aero Shell 100/Exxon 100/BP Aviation Oil 100 2200 2.2 Litres or 2 Litres + Fill Oil Filter 3300 3.4 Litres or 3.2 Litres + Fill Oil Filter
Idle Comments:		Top End (RPM) Comments:
Overall Comments:		Any Changes / Adjustments Made During Run:

Post Run-In Checks:
- ☐ Check for Oil Leaks
- ☐ Check Induction / Exhaust

Leak-down test results	#1	#2	#3	#4	#5	#6
	/80	/80	/80	/80	/80	/80

I hereby certify that the above engine has been run-in in accordance with the current revision of the 2200 / 3300 assembly instructions provided in JEM0001

Signed:_______________________Date:_____________for Jabiru Aircraft Pty Ltd

Engine Post Run Procedure – Stage J

Table 24 – Sheet J – Post Run Inspection

No.	Details	Para	Initials	Checked By	Date
J1	Heads re-torqued per Table 9. Valves adjusted (solid lifter engines)	7.8			
J2	Check induction/exhaust bolts	-			
J3	Any changes to be made	-			
J4	Rerun, check for oil leaks and/or any modifications made (oil pressure/leaks etc)	-			
J5	Check voltage output of alternator Volts:_________	-			
J6	Leak Down Test Results:	-			
	1 [-] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ]				
	[-] [80] [80] [80] [80] [80]				
J7	Check all paper work	-			
J8	Drain fuel/oil. Prepare for shipment, inhibited and sealed	-			
J9	Clean engine thoroughly.	-			
J10	Remove spark plugs. Inhibit using a spray atomiser with each piston in the down position. Rotate the crankshaft 10 – 12 times. Use SHELL Aero fluid 2UN (MIL-C-6529C Type 1) or similar engine corrosion inhibitor. Install spark plugs and connect leads.	-			
J11	Seal or cover all openings	-			
J12	Attach a warning tag to the engine (oil drained warning).	-			
J13	**Stage J - Post Engine Run Procedure Completed**				

I hereby certify that the above Post Run Procedure has been carried out in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.9.11 Jabiru Engine Build: Parts Measure and Clearance Record Sheet

Table 25 – Measure & Clearance Record Sheet

Engine No. (Include model)				**Date:**				
Crankshaft	P/No.		Batch:	Item:	Comments			
Crank Mains:	1	2	3	4	5	6	7	8
Crank Run-Out:								
Prop Flange Run Out								
Crankcase Left	P/No.		Batch:		Item:	Comments		
Crankcase Right	P/No.		Batch:		Item:	Comments		
Crankcase Assy Main Tunnels	1	2	3	4	5	6	7	8
Clearances	1	2	3	4	5	6	7	8

Crankshaft	P/No.	Batch:	Item:	Comments		
Crank Big Ends	1	2	3	4	5	6
Conrod Big Ends	1	2	3	4	5	6
Clearances	1	2	3	4	5	6

Camshaft	P/No.	Batch:		Item:	Comments			
Camshaft Journals	1	2	3	4	5	6	7	8
Camshaft Tunnel	1	2	3	4	5	6	7	8
Clearances	1	2	3	4	5	6	7	8

Head 1	P/No.	Batch:	Item:	Comments		
Head 2	P/No.	Batch:	Item:	Comments		
Head 3	P/No.	Batch:	Item:	Comments		
Head 4	P/No.	Batch:	Item:	Comments		
Head 5	P/No.	Batch:	Item:	Comments		
Head 6	P/No.	Batch:	Item:	Comments		
In. Valve Guides	1	2	3	4	5	6
Ex. Valve Guides	1	2	3	4	5	6
In. Valves	1	2	3	4	5	6
Ex. Valves	1	2	3	4	5	6
In. Clearances	1	2	3	4	5	6
Ex. Clearances	1	2	3	4	5	6

Cylinder Barrel 1	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 2	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 3	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 4	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 5	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 6	P/No.	Batch:	Item:	Comments		
Barrel 1	Bore:	Length:		Barrel 4	Bore:	Length:
Barrel 2	Bore:	Length:		Barrel 5	Bore:	Length:
Barrel 3	Bore:	Length:		Barrel 6	Bore:	Length:
Piston Diameters:	1	2	3	4	5	6
Clearance	1	2	3	4	5	6

Ring Gap Top	1	2	3	4	5	6
Ring Gap Bottom	1	2	3	4		

Comments:____

I hereby certify that the above parts have been measured, engraved & installed as recorded.

Signed:________________________Date:______________for Jabiru Aircraft Pty Ltd

9.10 Top End Overhaul Booklet

9.10.1 Engine Details

Engine Serial #:________________ Date:____________

9.10.2 Top End Subassembly A Build Sheet – Conrods

Table 26 – Top End Build Sheet A

No.	Details	Para	Initials	Checked By	Date
A1	Clean Conrods	5.9			
A2	Inspect and measure Conrods (includes bearing crush, bearing clearance)	5.9, 7.1			
A3	Fit the Conrods to the Crankshaft; Use Loctite 620 on the bolts and torque per Table 9	7.1			
A4	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
A5	**Stage A - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:______________________Date:____________for Jabiru Aircraft Pty Ltd

MPI Release Note No. [ ]

9.10.3 Top End Subassembly C Build Sheet – Pistons, Cylinders and Cylinder Heads

Table 27 – Top End Build Sheet C

No.	Details	Para	Initials	Checked By	Date
C1	Clean and deburr all parts	5.11			
C2	Install pushrod tube 'O' Rings, springs, washers and circlips	7.3			
C3	Check valve seats, fit spring retainers, install valves	7.3			
C4	Complete rocker shaft and rocker assemblies	7.3			
C5	Fit cylinder base 'O' rings	7.3			
C6	Measure and fit front piston circlip	7.3			
C7	Check ring end gaps, fit rings to pistons	7.3			
C8	Fit cylinders to heads. Torque per Table 9	7.3			
C9	Install piston assembly to cylinder just clear of the oil ring	7.3			
C10	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
C11	**Stage C - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.10.4 Top End Subassembly E Build Sheet – Starter Motor

Table 28 - Top End Build Sheet E

No.	Details	Para	Initials	Checked By	Date
E1	Fit new bushes and bearings to starter motor & bendix gear assembly. Fit new brushes to motor & re-assemble with Loctite 243	5.13			
E6	**Stage E - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.10.5 Top End Subassembly F Build Sheet – Gear Case

Table 29 – Top End Build Sheet F

No.	Details	Para	Initials	Checked By	Date
F1	Deburr, clean and inspect all of the gears	5.14			
F2	Measure the shaft post internal diameters and the distributor shaft diameters	5.14			
F3	Fit new crankshaft timing gear	7.6			
F4	Using loctite 515 fit the shaft posts to the gear housing	5.14			
F5	Fit the distributor shaft seals and rear crankshaft seal	7.6			
F6	Fit shafts to gears	5.14			
F7	Fit the distributor shafts and gears to the gear housing	5.14			
F8	Check End Clearance of Distributor Shaft to Case Flange	5.14			
F9	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12	-			
F10	**Stage F - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.10.6 Top End Subassembly G – Fuel Pump and Carburettor

Table 30 – Top End Build Sheet G

No.	Check	Size	Para	Initials	Checked By	Date
G1	Main Jet		5.15			
G2	Needle Jet		5.15			
G3	Idle Jet		5.15			
G4	Needle		5.15			
G5	Float seat ___ mm dia		5.15			
G6	Gravity Feed Valve 47-969		5.15			
G7	Air Bleed ∅1.6mm		5.15			
G8	Idle Mixture Screw Out 1 Turn		5.15			
G9	Choke Jet ∅1.2mm		5.15			
G10	Record measurements & clearances in build record sheet - Table 25. Ensure all measurements and clearances are within the appropriate limits given in Table 10 and Table 12		-			
G11	**Stage G - Stage Inspection of Assembly**					

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

9.10.7 Top End Subassembly H – Final Assembly

Table 31 – Top End Build Sheet H

No.	Details	Para	Initials	Checked By	Date
H1	Place all through bolts in crankcase for cylinder bases	7.8			
H2	Apply Loctite 518 to cylinder base flanges.	7.8			
H3	Fit piston and cylinder Assemblies. Check circlips	7.8			
H4	**Stage H1 - Stage Inspection of Assembly**	-			
H5	Tension the cylinder base studs/bolts	7.8			
H6	Fit pushrods and valve gear. Set gap per Table 12 (solid lifter engines)	7.8			
H7	Apply Loctite 515 to sump sealing faces & fit to cases.	7.8			
H8	Apply Loctite 515 to induction manifold sealing faces. Assemble and fit to sump.	7.8			
H9	Apply Loctite No. 2 to induction tubes & fit to induction manifold.	7.8			
H10	Apply Loctite 515 to sealing faces and fit engine mount plate and gearbox housing	7.8			
H11	Fit flywheel, alternator mount plate and ignition coils	7.8			
H12	Fit Carburettor assembly	7.8			
H13	Fit fuel pump. Apply Loctite 515 to sealing faces. Apply Loctite 243 on fuel pump screws.	7.8			
H14	Fit exhaust system	7.8			
H15	**Stage H3 - Stage Inspection of Assembly**				

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:______________for Jabiru Aircraft Pty Ltd

9.10.8 Top End – Engine Ground Run-In Procedure

Use the procedure given in 9.9.10

9.10.9 Top End – Engine Post Run Procedure – Stage J

Use the procedure given in Table 24

9.10.10 Parts Measure and Clearance Record Sheet

Table 32 – Top End Measure & Clearance Record Sheet

Engine No.			**Date:**			
Crankshaft	P/No.	Batch:	Item:	Comments		
Crank Big Ends	1	2	3	4	5	6
Conrod Big Ends	1	2	3	4	5	6
Clearances	1	2	3	4	5	6
Head 1	P/No.	Batch:	Item:	Comments		
Head 2	P/No.	Batch:	Item:	Comments		
Head 3	P/No.	Batch:	Item:	Comments		
Head 4	P/No.	Batch:	Item:	Comments		
Head 5	P/No.	Batch:	Item:	Comments		
Head 6	P/No.	Batch:	Item:	Comments		
In. Valve Guides	1	2	3	4	5	6
Ex. Valve Guides	1	2	3	4	5	6
In. Valves	1	2	3	4	5	6
Ex. Valves	1	2	3	4	5	6
In. Clearances	1	2	3	4	5	6
Ex. Clearances	1	2	3	4	5	6
Cylinder Barrel 1	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 2	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 3	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 4	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 5	P/No.	Batch:	Item:	Comments		
Cylinder Barrel 6	P/No.	Batch:	Item:	Comments		
Barrel 1	Bore:	Length:		Barrel 4	Bore:	Length:
Barrel 2	Bore:	Length:		Barrel 5	Bore:	Length:
Barrel 3	Bore:	Length:		Barrel 6	Bore:	Length:
Piston Diameters:	1	2	3	4	5	6
Clearance	1	2	3	4	5	6
Ring Gap Top	1	2	3	4	5	6
Ring Gap Bottom	1	2	3	4		

Comments:____

I hereby certify that the above parts have been measured, engraved & installed as recorded.

Signed:______________________Date:_____________for Jabiru Aircraft Pty Ltd

10 Appendix B – Other Documentation

10.1 Job Traveller

Table 33 – Job Traveller

Jabiru Engine – Job Traveller	Form: JABENGJT-1
☐ CASA VH Registration No. ……………………	☐ RA-Aus or Other Registration No. ……………….....
Job Number:	Order / Invoice No:
Engine Model: ☐-2200 ☐-3300 ☐-5100	Engine Serial Number:
Date Received:	Owner:
TSO:	

Work to be done (*iaw Jabiru Approved Data & certified for in the applicable section of the engine overhaul booklet*):

☐ - Trade-In (Full Overhaul)	☐ - Full overhaul & return to owner
☐ - Top End Inspection	☐ - Bulk Strip
☐ - Maintenance (RA-Aus only)	☐ - Other:

Records to be filed:

☐ - Copy of ARC	☐ - Jabiru Engine Job Traveller
☐ - Copy of all job sheets	☐ - Copy of specialist inspection reports - MPI etc.
☐ - Report to owner	☐ - Copy of log book entry
☐ - Job book, completed.	

Parts Shipped To Jabiru With Engine:

☐ - Exhaust extractors	☐ - Muffler
☐ - Starter Motor	☐ - Oil Cooler

Use:

☐ - School – mainly circuits	☐ - School – mainly cross-country
☐ - School – even mix of circuits and cross-country	☐ - Private
☐ - Unknown	

Reason for Overhaul:

☐-Time Expired	☐-Update Spec
☐-Other:____	

Since manufacture or its last overhaul has the engine had any of the following::

A prop strike or other accident?	☐-Yes ☐-No	Poor cylinder leak-downs?	☐-Yes ☐-No
High, low or fluctuating oil pressure?	☐-Yes ☐-No	Major work (i.e. top end overhaul)	☐-Yes ☐-No
High oil temperature?	☐-Yes ☐-No	Been hard to start when hot?	☐-Yes ☐-No
High cylinder head temperatures?	☐-Yes ☐-No	Been hard to start when cold?	☐-Yes ☐-No
Been using a Jabiru Prop?	☐-Yes ☐-No		
If the engine has had major work, please give a quick description of what was done and who carried it out:			

Shipping Details:		
Parts to be shipped to customer with engine:	☐-Exhaust extractors ☐-Starter Motor	☐-Muffler ☐-Oil Cooler
Overhauled by:	☐-________________________	☐-Jabiru;____________________________
☐ - INHIBITED	Date:	Signed by:

10.2 Summary of Parts Used

- Note: Refer to lists in Sections 5.2 and 5.3 for parts which MUST be replaced at overhaul.

Table 34 – Summary of Parts Used

ENGINE NO:		**DATE:**	
☐ Bulk Strip	☐ Overhaul	☐ Hydraulic	
☐ Maintenance	☐ Top End Overhaul	☐ Solid Lifter	

	NEW	**ORIGINAL**		**NEW**	**ORIGINAL**
CRANKCASE	☐	☐	**HEADS**	☐	☐
Main Bearings	☐	☐	Rockers	☐	☐
Through Bolts	☐	☐	Shafts	☐	☐
Engine Mount Plate	☐	☐	O Rings	☐	☐
Pick Up Stainer	☐	☐	Collets	☐	☐
Oil Pressure Switch	☐	☐	Valve	☐	☐
Oil Pressure Sender	☐	☐	Springs	☐	☐
Oil Cooler Fitting	☐	☐	Adjustors	☐	☐
Valve Lifters	☐	☐	Solid Pushrods	☐	☐
Tacho Pick-up	☐	☐	Pushrod Tubes	☐	☐
Oil Feed To Heads	☐	☐	Rocker Covers	☐	☐
Oil Pick-up	☐	☐	Valve Guides	☐	☐
O Rings	☐	☐	Rubber T's	☐	☐
CRANKSHAFT	☐	☐	Lifter	☐	☐
Conrods	☐	☐	**CYLINDERS**	☐	☐
Conrod Bearings	☐	☐	O Rings	☐	☐
Prop Drive	☐	☐	SUMP	☐	☐
Front Seal	☐	☐	Long Temp Sender	☐	☐
Crank Gear	☐	☐	Swept Plenum Chamber	☐	☐
CAM	☐	☐	Induction Pipes	☐	☐
CAM Gear Outer	☐	☐	O Rings	☐	☐
CAM Gear Inner	☐	☐	Induction Gaskets	☐	☐
FLYWHEEL	☐	☐	Heat Shield	☐	☐
Magnets (ignition)	☐	☐	Induction Hose Joiners	☐	☐
Vac Drive Plate	☐	☐	**EXHAUST PIPES**	☐	☐
Ring Gear	☐	☐	Ex-Gaskets Type	☐	☐
ALTERNATOR	☐	☐	Bevel Type	☐	☐
Magnet Ring	☐	☐	**OIL COOLER**	☐	☐
Stator	☐	☐	Oil Cooler Adaptor	☐	☐
PISTONS	☐	☐	Oil Hoses	☐	☐
Rings	☐	☐	**FUEL PUMP**	☐	☐
Gudgeons / Circlips	☐	☐	Push Rod	☐	☐
IGNITION HARNESS	☐	☐	Gaskets / Spacer	☐	☐
Plugs	☐	☐	**STARTER MOTOR**	☐	☐
Rotors	☐	☐	Clutch Assy	☐	☐
Dizzy Caps	☐	☐	**OIL PUMP**	☐	☐
Dizzy Shafts	☐	☐	Housing	☐	☐
Dizzy Gears	☐	☐	Spacer Plate	☐	☐
Seals Dizzy	☐	☐	Gears	☐	☐
Rear Seals	☐	☐	**CARBY**	☐	☐
Dizzy Case	☐	☐	Fuel Line	☐	☐
Dizzy Posts	☐	☐	Mount	☐	☐
Coils	☐	☐		☐	☐

10.2.1 Bulk Strip Checklist

Table 35 – Bulk Strip Checklist

Customer:	
Engine Model:	☐ 2200A ☐ 2200J ☐ 2200C ☐ 3300A ☐ 3300L
Engine S/No.	
Brief description of prop strike:	

No.	Details	Initials	Checked By	Date
1	Disassemble engine per Section 4			
2	Original Prop Flange Engraving: Measure Original Prop Flange Run Out:__________mm (Limits per Table 10) ☐ Serviceable ☐ Unserviceable			
3	Where Used: New Prop Flange P/No:___________ New Prop Flange Engraving:_______ New Prop Flange Run Out:________mm			
4	Original Crankshaft Engraving: Measure Original Crankshaft Run Out:___________mm (Limits per Table 10) ☐ Serviceable ☐ Unserviceable			
5	Where Used: New Crankshaft P/No:____________ New Crankshaft Engraving:________ New Crankshaft Run Out:_________mm			
6	Assemble engine per Section 7.			
7	**Stage Inspection of Assembly**			

I hereby certify that the above subassembly has been assembled in accordance with the current revision of the engine overhaul manual (JEM0001).

Signed:________________________Date:_____________for Jabiru Aircraft Pty Ltd

10.3 Job Summary Sheet

Table 36 – Job Summary Sheet

Customer:	
Engine Model:	☐ 2200A ☐ 2200J ☐ 2200C ☐ 3300A ☐ 3300L
Engine S/No.	
Work Performed:	☐ Bulk Strip ☐ Top End Overhaul ☐ Full Overhaul
Engine Run-In:	☐ 9.9.10 (Ground Run Record) attached ☐ Table 24 (Post ground run check sheet) attached.
Parts Used:	☐ Table 34 (Summary of parts used) attached.
Bulk Strip Checklist:	☐ Table 35 attached (where appropriate)

i. Refer to engine maintenance manual (normally JEM0002) for initial running requirements for overhauled engines.
ii. Engine shipped with NO OIL. Oil must be added to sump (2.2 L for 2200 engines, 3.3L for 3300) before starting.
iii. Oil grade must comply with requirements of the engine maintenance manual (normally JEM0002).
iv. All caps and covers must be removed from the engine before starting.
v. During shipping inhibitor may have collected in the carburettor. Inspect & clean carby if necessary before starting.

11 Appendix C - Wear Factors

11.1 Wear Factors

- The following table shows typical wear amounts per 1,000 hours of operation, and is intended to all the reader to assess the possibility of components achieving 1 or more cycles.
- Note that these values are given as a guide only. Operation of engines with poor quality "dirty" oil/and or corrosion mixed in with oil has elevated wear on contact surfaces. Many other environment-specific factors will also vary the engine wear rates.
- When carrying out a top end inspection, the overhauler must keep these factors in mind – for example a cylinder measuring 97.65mm may be within the wear limits for the part but it will not survive another full cycle. Parts which are unlikely to survive in service for another full cycle must be replaced.

Table 37 – Wear Factors

Part	Typical Wear for 1 Cycle (1000 hours)
Crankshaft end thrust	0.02
Crankshaft Main Bearings	0.005 - 0.010
Crankshaft Mains	0 - 0.005
Crankshaft Big Ends	0.005 - 0.01
Camshaft End Thrust	0.06
Camshaft Bearing Areas (5)	0.01
Camshaft Followers on Stem (Solid)	0.0 - 0.005
Camshaft Fuel Lobe	0.01
Connecting Rod Bearing	0.025 - 0.06
Crankcase Cam Tunnel	0.015
Crankcase Cam Follower Bores	0.02 - 0.03 (Solid Lifter)
Gudgeon Pin Diameter	0.000 - 0.005
Pump Push Rod Length	0.01 - 0.03
Distributor Posts	0.01 Typical
Distributor Shafts	0.00 - 0.01
Valve Rocker Shafts	0.015
Rocker Bushes (Hydraulic)	0.012 - 0.020
Rocker Bushes (Hydraulic – Pushrod Oil Feed)	Approx ½ of above Hydraulic
Rocker Bushes (Solid)	0.06 - 0.10
Valve Stems Inlet	0.00
Valve Stems Exhaust	0.00 - 0.01
Valve Spring Length	Shortened by 1.60 - 1.80
Cylinder Head Inlet Valve Seat	Visual
Cylinder Head Exhaust Valve Seats	Visual
Cylinder Head Inlet Valve Guides	0.01 - 0.02
Cylinder Head Exhaust Valve Guides	0.01 - 0.02
Cylinder Bore Wear	0.01 - 0.03 (width and taper)
Piston Diameter	0.0 - 0.01
Piston Ring Sliding Clearances	<0.01
Ring Gaps	1.50 Typical
Ring Gaps - On Oil Additive Engines	3.00 - 4.50

12 Appendix D - Mandatory Replacement Parts

12.1 General

- Note that while a reasonable stock of spare parts is kept, some older parts may no longer be produced.

Table 38 – Mandatory Updates

Item	Notes
Cylinders	- Overall length of barrel and any shim used must be 107.0mm. - Spigot type must be used (no head gaskets)
Camshafts	- Only steel "solid" cams must be used. Hollow cast items must be replaced. - 2200 Solid lifter engines must use cam P/No. 4738092 - 2200 Hydraulic lifter engines must use cam P/No. 4A432A0D - 3300 Solid lifter engines must use cam P/No. 4625072 - 3300 Solid lifter engines must use cam P/No. 4A433A0D
Cylinder Heads	- 2200 – P/No. 4A225A0D / 4A226A0N OR - 2200 – P/No. 4A499A0D / 4A500A0N - 3300 – P/No. 4A255A0D OR - 3300 – P/No. 4A506A0D - Heads with "WELLTITE" valve seats only may be used.
Crankshafts	- 2200: Cranks to be upgraded or replaced to use 5/16" (or 3/8") flywheel screws & 6mm dowels.
Oil Pumps	- New port plate must be fitted or existing part modified to match current porting specs. Details in body of this manual.
Oil Pressure Relief Valve	- Brass poppets must be replaced with steel parts.
Flywheel	- Mandatory upgrade to use 5/16" screws and 6mm dowels. - Recommended update to use "Starfish" steel attach adaptor system.
Pushrods	- Solid lifter engines – P/No. 4642084 - Hydraulic lifter engines, external oil pipe feed – P/No. 4A089B0D - Hydraulic lifter engines, hollow pushrod oil feed – P/No. 4A421D0D - Roller lifter engines – P/No. 4A536A0D
Rear Engine Mount Plate	- Either type may be used (99 tooth or 101 tooth). - MUST match flywheel ring gear fitted to engine.
Rear Gear Box	- Must have oil drain grooves in distributor bosses.
Valve Lifters	- Solid lifter P/No. PG92324 - Hydraulic P/No. PG4A019 - Roller Follower: P/No. PE4A022A0D
Sump	- 2200 solid lifter may use 4A298A0D or 4823002 - 2200 Hydraulic lifter must use 4A298A0D. - 3300 engine uses P/No. 960409X or 4A540A0D - All hydraulic lifters to be replaced at 1000 hours TIS.
Induction System	- 2200: Bolt-on induction to be used (sumps with manifold cast in to be replaced)
Carburettor	- 40mm type to be used, settings as detailed above.
Exhaust System	- Recommended upgrade to systems without gasket between head and exhaust – both engines.
Propeller Drive Flange	- "Standard", "2-inch" or "3-inch" extensions may be used.
Solid Lifter Valve Rockers	- Solid lifter, coarse fin head – 4769094 / 477009N

	- Solid lifter, fine fin head – 4A268A0D / 4A268B0N
Valve Rockers	- Hydraulic lifter, coarse fin head – 4A087A0D / 4A088A0N - Hydraulic lifter, fine fin head - 4A268A0D / 4A268B0N - Hydraulic lifter, fine fin head, pushrod oil feed - 4A520A0D / 4A520C0N OR 4A422A0D / 4A423A0N
Valve Rocker Bushes	- Hollow pushrod rocker bushes P/No. SAPG121415F - All other rockers – P/No. PG121414F
Valve Springs	- "Hydraulic" type to be used for all engines.
Alternators	- 10 or 12 pole single phase – 3-phase alternators must be replaced.
Dipsticks	- 2200 engine, sump P/No. 4823002 requires P/No. 4533064 - 2200 engine, sump P/No. 4A298A0D requires P/No. 4A400A0D - 3300 engine uses P/No. 4533064
Conrods	- Alloy rods must be replaced with steel items.
Oil Feed To Rockers	- Solid lifter engine must use external oil feed pipe. - Hydraulic lifter engines - external oil feed pipe may be retained. Upgrading to hollow pushrod oil feed system is recommended.
Crankcases	- Very early 2200 cases must be replaced. - All 3300 cases may be used if serviceable. - All cases must have oil drain holes under the mechanical fuel pump - All cases must have oil channels for the cam journals - Solid lifter parts are available.
Oil Pick Up	- Very early 2200 engines did not have a "Strainer" on the pickup pipe intake. Upgrading to fitting a strainer is mandatory.
Pistons	- Confirm piston part number on order to ensure a proper match to the rod/barrel/head combination used.
Ignition Coils	- Shiny black coils marked "LEADING X" must be replaced.
Starter Motor	- Bosch or Denso types may be used if serviceable. - Denso types have more power and give better starting.
Top Spring Washers	- Replace with 2mm thick, hardened washers - New Valves and Collets must also be used

12.2 Camshaft

- Solid lifter engines do not require camshaft mandatory updates beyond those listed in Table 38 below.
- Hydraulic lifter engines require updating as detailed below and in Section 5.10.3

12.3 Crankcase

12.3.1 Maximum Surfacing / Decking Limit

- A maximum of 0.15mm may be taken from each case half over its life.

12.3.2 Fretting General Information

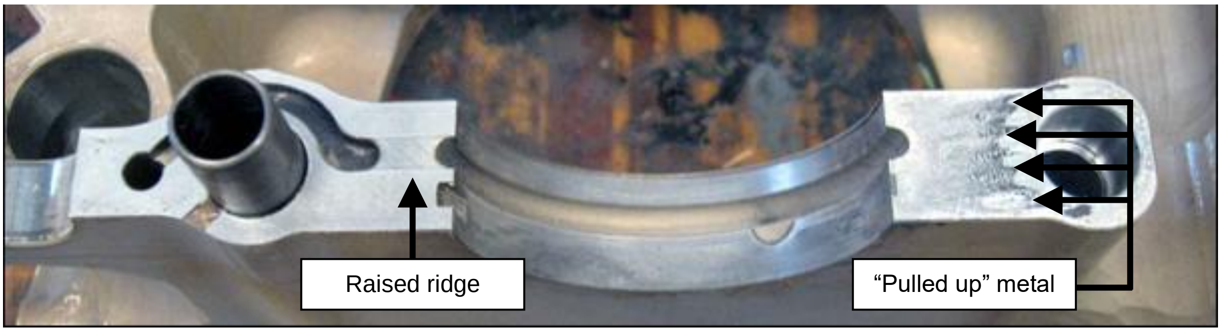


Figure 211 – Crankcase Fretting

- Cases which have suffered fretting can be identified as shown in Figure 211. There will be characteristic markings on the crankcase joining face near the main bearing journals which can be felt by scratching with a fingernail – the raised portions will be clearly evident.
- Suspect cases can also be checked in the field by performing a crankshaft friction test (see section 4.4.2).
- An engine which operates for an extended period with fretting can lead to unrepairable crankcase damage, through bolt failure and engine stoppage.
- The main causes of crankcase fretting in the Jabiru Engines are:
  a. Pre-ignition or detonation due to lean running, incorrect fuel, low octane fuel, contaminated fuels or combinations.
  b. Incorrect through-bolt torque or uneven bolt tensioning.
  c. Reduced through-bolt tension due to cylinder base cracking
  d. Cracked or broken through-bolts
  e. Poorly matched case halves
  f. An inadvertent lean run – for example due to a incorrectly set float level or partially blocked fuel filter.
  g. Running engines with high valve stem-to-guide clearances, promoting oil residue in the intake system. This has the effect of reducing the octane number (or AKI) of the fuel and can lead to detonation or pre-ignition.

12.3.3 Fretted Crankcase Repair

- Fretting can be repaired by surfacing (or "decking") the crankcase, then line-boring the crankshaft and camshaft tunnels. Surfacing should always take the bare minimum material to remain within the limits set. Excess surfacing will lead to the sump and backing plate not fitting the cases, rendering them unserviceable.

WARNING

This process requires specialist equipment, tools and training to be successful. Overhaulers must not attempt this job without access to these items.

- First the crankcases need to be completely stripped. All bolts, studs, dowels, fittings and plugs must be removed. Heat may be required to extract some items.

Figure 212 – Stripping Crankcases

- Cases must be surfaced using a special machine. Care must be taken to not exceed the maximum allowable amount. Operators must take the minimum material required to remove the fretting damage – usually removing less than 0.1mm of material is sufficient.

- New crankcase through-bolts and studs must be fitted. The original parts must be discarded.
- The original crankcase dowels can be re-used, however after the case has been surfaced they need to be shortened slightly – 0.5mm – and radiused / de-burred on the modified end.
- After surfacing the cases must be bolted together and line bored along the crankshaft and camshaft tunnels.
- After line boring the tunnels must be within the newly manufactured tolerance range – main bearing tunnel is 51.976 to 52.000mm and 20.00 to 20.01mm for the cam tunnel.
- During line boring all crankcase dowels, studs and through-bolts must be fitted and correctly tensioned.

WARNING

ALL through bolts and crankcase studs must be replaced in a fretted case.

The same process which damages the cases also damages the bolts and studs and bolt failures are likely if they are re-used.

- After surfacing and line boring the case need to be thoroughly de-burred and cleaned. Remember to fit the O-rings to the studs as required on permanent assembly. Refer to the main body of the manual above for detailed instructions on how to carry out this work.

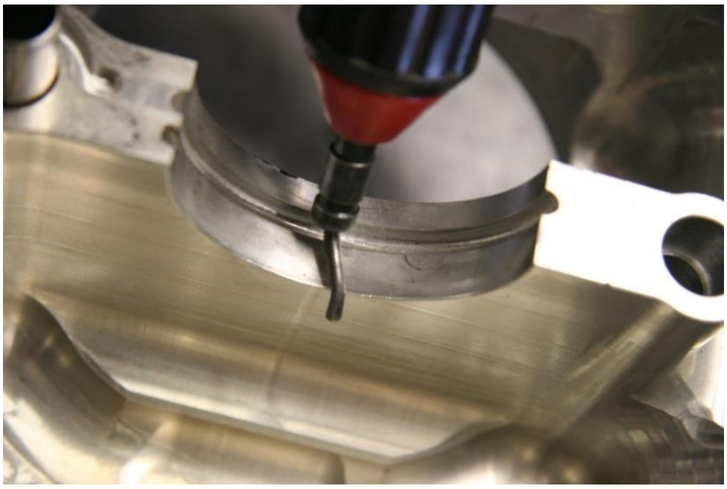


Figure 213 – De-Burring Crankcase After Surfacing & Line Boring

12.4 Crankshaft

12.4.1 Maximum Time In Service

- Jabiru Aircraft apply a maximum Time In Service of to a crankshaft as detailed in Section 9.3.
- Once a crankshaft reaches this Time In Service it must be discarded and replaced with a new item.

12.4.2 Dowel Pins

- Section 5.9.1.1 describes the difference between "old" and "new" crankshafts. "Old" type crankshafts must be replaced with "new" type or re-worked to the "new" configuration.
- Most old crankshafts can be re-worked to new specifications. Any crank which has not exceeded its maximum Time In Service and which uses 5/16" flywheel mounting cap screws may be re-worked as detailed in Jabiru Procedure AVDALSR038.
- Details of this procedure are reproduced below for ease of reference.

12.4.2.1 General

- This procedure is for the installation of crankshaft to flywheel dowels on the 2200 and 3300 Jabiru engines.

12.4.2.2 Applicability

- To be carried out at major overhaul (2000hs TSO) of Jabiru 2200 & 3300 engines.

  2200A Engines - up to S/No. 2057[1]

  3300A Engines - up to S/No. 836.

- See service bulletin JSB 012 for details.

12.4.2.3 Special Tools

- The following special tools are required for this procedure.
  a. Dowel Hole Drilling Fixture (P/No. 8A021B0D) - Figure 214.
  b. 15/64" drill bit - Figure 215.
  c. Spiral ream Diameter 6 Tolerance H7 - Figure 215
  d. 4 x 1 1/2" x 5/16"UNF cap screws - Figure 215
  e. 4 x 5/16" UNF nuts.

Figure 214 – Drilling Fixture – Crankshaft Side on Left, Flywheel Side On Right

[1] Note that some early engines use ¼" bolts to attach the flywheel. These crankshafts cannot be drilled to accept dowels. The crank must be replaced with a new part.

Figure 215 – 15/64" Drill (Left), 6mm Ream (Centre), UNF Cap Screws (Right)

12.4.2.4 Procedure

12.4.2.4.1 Preparation

- This procedure is normally scheduled to happen during the engine's major overhaul – that is, when the engine cases have been split and the crank removed.
- If required, it is possible to drill the crank while it is still in the cases. To do this the timing gearbox must be removed to allow removal of the cam gear and to expose the crank. Care must be taken to ensure no swarf is allowed to enter the engine, and the engine must be restrained & supported as noted below.
- The photographs used in this procedure were taken on a bench to give an idea of the procedure involved. In practice, a good quality drill-press must be used. The engine/crankshaft or flywheel must be carefully aligned with the drill axis and restrained to ensure it does not move.

12.4.2.5 Crankshaft.

- The crankshaft should be drilled first. The drilling guide is a close fit on the end of the crankshaft and should be placed gently by hand or pulled in squarely using the cap screws. Care must be taken, as attempting to force the fixture onto the shaft may damage the crank. Line up the small hole in the fixture with the corresponding hole on the crankshaft.

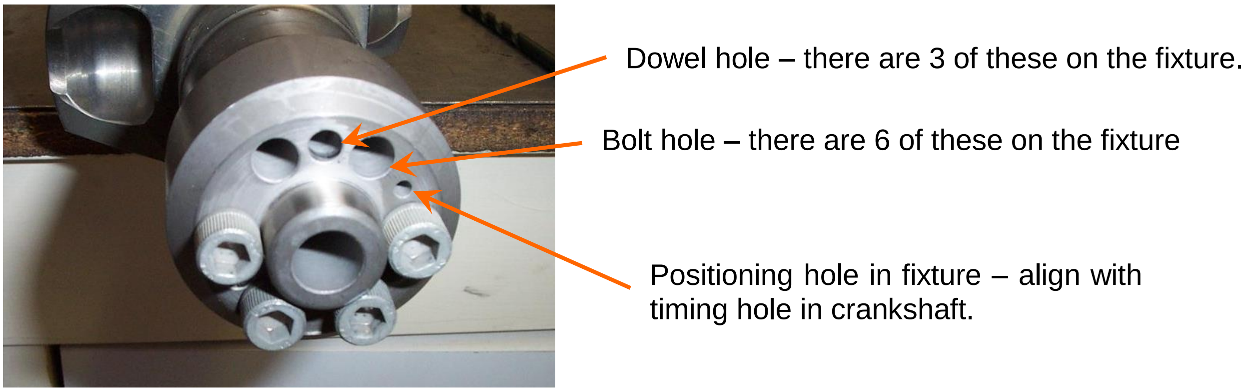


Figure 216 – Guide positioned on crankshaft.

- The 4 cap screws will need to be arranged as shown above so that they don't foul the drill. As each hole is drilled move two of the screws around so the next dowel hole can be accessed. Always keep two of the bolts tight so the guide can't move.

Figure 217 – Drilling & Reaming Crankshaft – ILLUSTRATION ONLY.

- Use of a suitable lubricant when drilling the crankshaft is recommended as it is a high grade steel. It will also prolong the life of the drilling jig. Drill the crankshaft dowel holes 10 deep (i.e. 10mm of full-diameter hole – the tip length of the drill is not counted in this length). When reaming, the guide is used to ensure a straight entry for the ream. The first time the jig is used the ream will be quite tight in the holes. Minimum ream depth into the crankshaft is 6.5mm – but due to the use of hand tools reaming to 7-8mm depth is recommended.

12.4.2.5.1 Flywheel.

- Like the crankshaft, the flywheel needs matching dowel holes. When fitting the drilling guide to the flywheel use the positioning hole to align it correctly. Use the 4 x 5/16" UNF screws used in the crankshaft section above to hold the fixture to the flywheel – use nuts and washers on the rear side (alternator side) of the flywheel. Move the bolts around so that there is a clear space around the hole being drilled. Make sure two bolts always stay tight so that the guide can't move.
- Once the guide is in place, drill all the way through the flywheel for each of the dowel holes. Then ream the holes using the guide to align the ream. Being aluminium it is very easy to ruin the fit of the hole if the guide is not used.

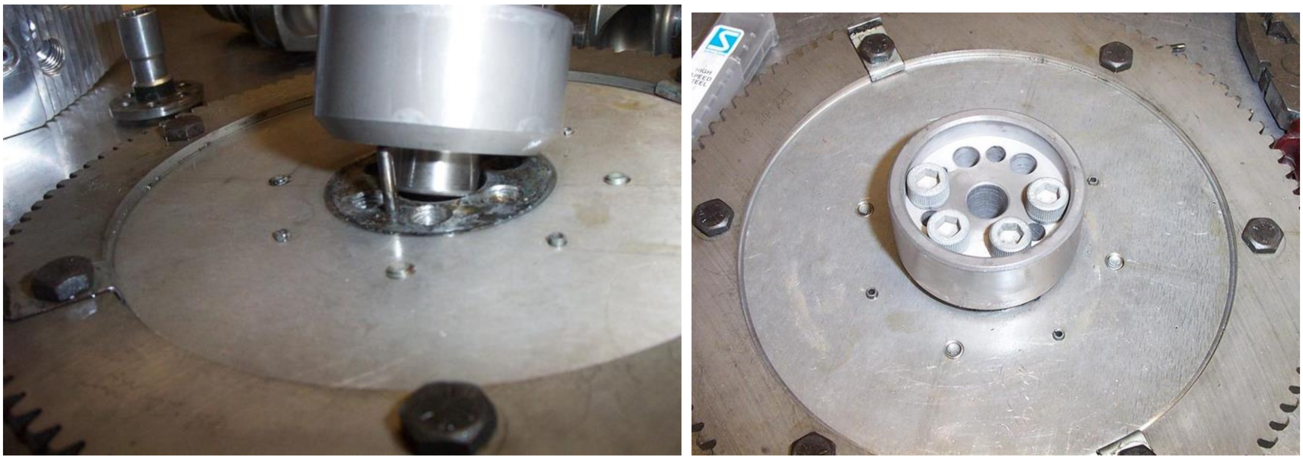


Figure 218 – Aligning Guide & Fitting To Flywheel.

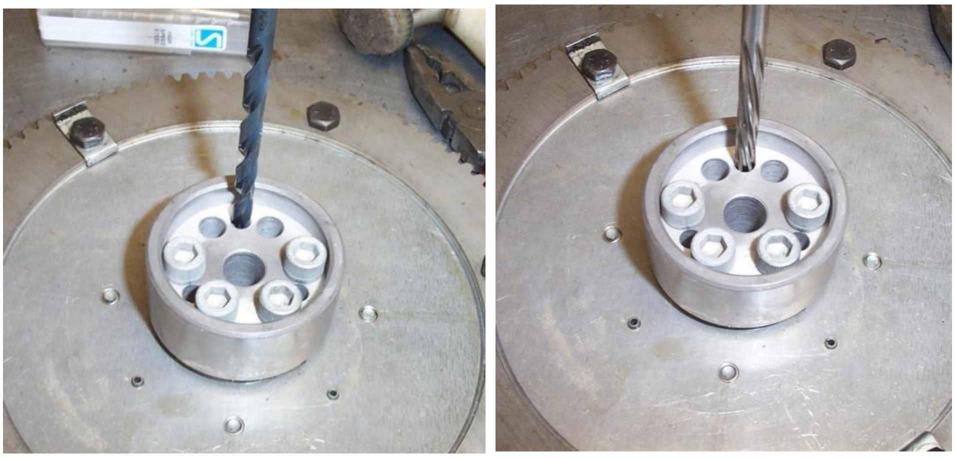


Figure 219 – Drilling & Reaming Flywheel – ILLUSTRATION ONLY.

12.4.2.6 Assembly.

- Once the dowel holes have been drilled and before the engine is assembled, dowels and a new vacuum pump drive (P/No. 4646084) and timing gear (P/No. 4643084) are required. The timing gear cannot be drilled as it is hardened and Nitrided. Insert dowels once flywheel, vacuum pump drive and timing gear are installed on crankshaft and loosely bolted up. Knock dowels through flywheel until their tips are approximately 2mm recessed into the flywheel. Tighten flywheel bolts to specifications.

Parts List

ITEM	PART NUMBER	DESCRIPTION	QTY
1	4644082	CRANKSHAFT LONG 2.2L	1
2	4643084	GEAR CRANKSHAFT 22T 10DP 5/16 BOLTS	1
3	4645083	FLYWHEEL ASSY	1
4	4646084	FLYWHEEL SPACER & VAC PUMP DRIVE COUPLING (2.2L) 5/16 BOLTS	1
5	PE4A007N	DOWEL PIN. 6mm OD x 24mm LONG	3
6	PH9912N	WELSH PLUG 28 DIA	1
7	PH0646N	WELSH PLUG 7/8" DIA	2
8	PH0656N	SOCKET HD SCREW 5/16 UNF X 1 1/4	6
9	PH10624	5/16" BELLEVILLE WASHER	6

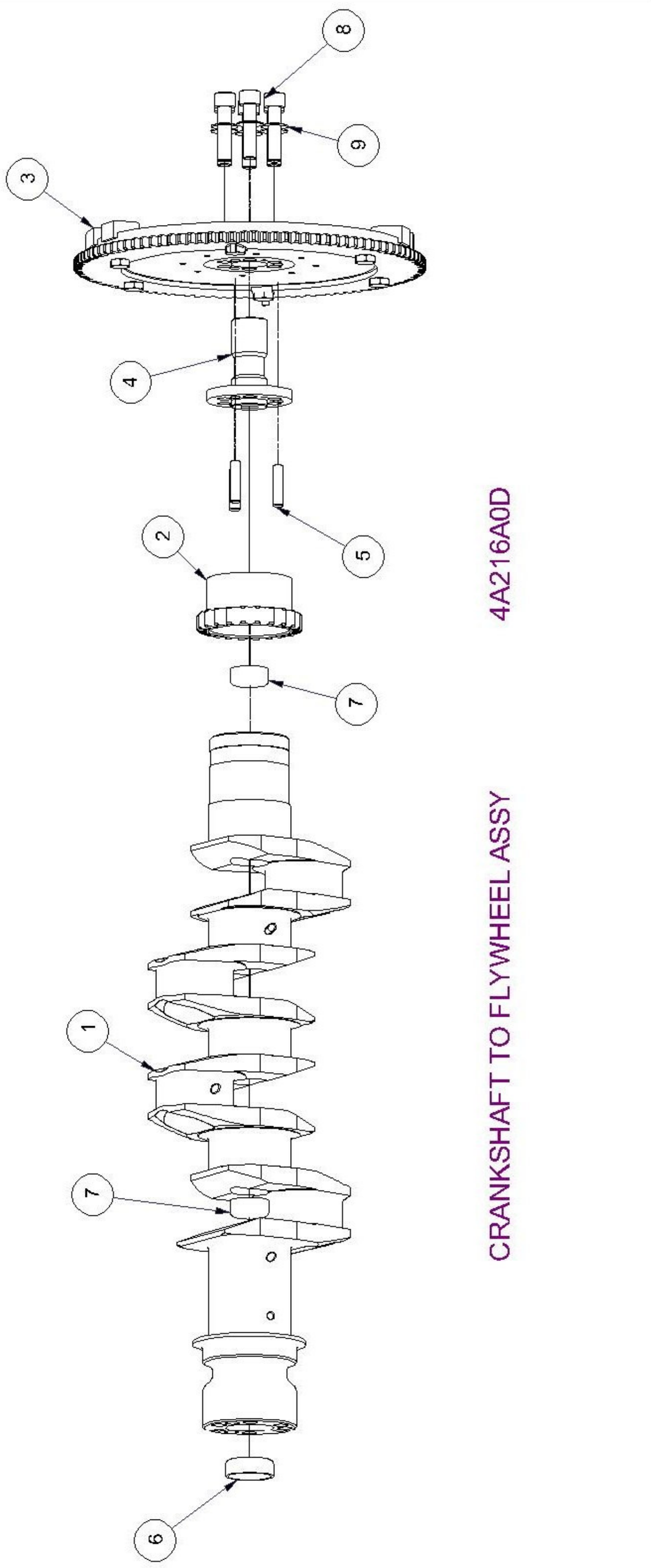


Figure 220 – Flywheel to crankshaft assembly drawing

13 Appendix E – History of Updates

13.1 Engine Serial Number Decode

- All engines are allocated a master serial number at manufacture that is referred to as the “A number”: 2200 engines = 22A-XXXX, 3300 engines = 33A-XXXX, where “XXXX” is a sequential number.
- Certified engines are then allocated an additional sequential number that is referred to as the “B number”, “C number” (or in older engines the “J number”): 2200 engines = 22B-XXX, 3300 engines = 33L-XXX, where “XXX” is a sequential number.
- All engine records require reference to the “A number”.
- The master list of A numbers and the cross-reference to B (C or J) numbers is kept in the Jabiru Engines department, and all enquiries should be directed there: engines@jabiru.net.au

  Please note: Configuration detailed below is at time of new build and may have been changed with service work. Also, Current means at time of issue of this Manual. Changes to this configuration information may have occurred since. This information is a guide only and not a complete list of configuration changes.

13.2 Update History Table

Table 39 – Update History

Component	2200 S/No.	3300 S/No.	Details
Cylinders	01 – 106		Head gasket type.
	107 – 127		Spigot type, 105.5mm long
	128 – 831	01 – 153	Spigot type, 106.5mm long
	832 – 3442	154 – 2289	Spigot type, 107mm long
	3443 – 3595	2290 – 2525	Spigot type, 107.5mm long
	3498 – Current	2391 - Current	Base holes sized to suit 7/16” bolts
	3596 - Current	2526 - Current	Revert back to 107mm long spigot type
Pistons	01 – 436		Suits alloy rods.
	437 – 1003	01 – 223	Suits steel rod. Crown height 64.0mm
	1003 - Current	224 – Current	Suits steel rod. Crown height 65.5mm
Cylinder Heads	01 – 106		Head gasket type
	107 – 224		Spigot type
	225 – 644	01 – 47	Symmetric spigot type
	645 – 657	48 – 52	Fin area enlarged
	659 – 709	53 – 118	Fin area enlarged more, valve seats widened
	710 – 1003	119 – 223	Fin area enlarged more
	1004 - Current	224 – Current	Combustion chamber geometry changed, more fins added beside exhaust port.
	2068 – 2439	-	Rocker cavity venting required
	2553 - Current	961 - Current	Fine finned heads. Altered oil feed tube shape to heads.
	3358 – Current	2210 – Current	Oil feed moved to hollow pushrods
Valve Rockers	01 – 188		10/12mm wide, 7mm lift, 5/16” adjusters
	189 – 307		12mm wide, 3/8” adjusters, 9mm lift
	308 – 658	01 – 52	15mm wide, 3/8” adjusters 9mm lift
	659 – 2552	53 – 960	15mm wide, 3/8 adjusters, 9mm lift offset tips.
	2553 - Current	961 - Current	Increased offset to suit narrow finned heads, Hollow.
Valve Adjusters	01 – 188		5/16” allen key adjuster
	189 – 502	01 – 33	3/8” allen key
	503 - Current	34 – Current	3/8 slotted
Valve Springs	01 – 153		Small type
	154 - 2067	01 – 960	Heavier type
	2068 - 3770	961 - 2737	Hydraulic lifter valve spring
	3771 - current	2738 - current	Double Valve springs
Rocker Blocks	01 – 188		Std block, small valves, 1:1 ratio
	189 – 224		Std block, large valves

Component	2200 S/No.	3300 S/No.	Details
	225 - Current	01 – Current	Block machined as part of head
Oil Pick Ups	01 – 042		Part of crank case
	43 – 307		Pick up from oil pump face
	308 – 325		Same geometry but fitted to sump with a pin
	326 – 793	01 - 150	Pick up part of oil pump face
	794 - Current	151 – Current	Same as above but with strainer added
Oil Feed to Cylinder Heads	01 – 053		Feed rockers from the top of the case at each side
	053 – 069		1 line from oil gallery with above
	070 – 261		Oil feed from oil gallery both sides with restrictor fitting
	262 – 473	01 – 38	Oil feed by machined restrictor (requires oil feeds connected to the heads)
	541 – 3357	38 – 2209	Rubber "T" piece used in feed line.
	3358 – Current	2210 – Current	Pushrod oil feed used.
Connecting Rod	01 – 436		Alloy rods
	437 - Current	01 – Current	Steel rods
Crankshaft	01 – 042		Short crank, ¼" flywheel screws
	043 – 436		Long crank, ¼" flywheel screws
	437 – 2057	01 – 836	Long crank, 5/16" flywheel screws
	2058 – 2731	837 – 1521	Dowels added between flywheel & crank
	2732 – 3533	1522 – 2465	"Starfish" attachment
	3534 – Current	2466 – Current	3/8" flywheel screws
	3499 – Current	2446 – Current	Dowels added 'tween prop flange & crank
Camshaft	01 – 377		Cast cam, 21mm between profiles
	378 – 603		Cast cam, 23mm between profiles
	604 – 2849	01 – 1683	Machined billet steel cam, hardened
	2850 – 3049	1684 – 1900	285 Single Ring Cam
	3050 – 3595	1901 –2538	260 Two-Ring Cam
	3596 – Current	2539 - Current	Roller lifter & Cam.
Through-Bolts & Studs	0 – 3467	0 – 2370	3/8" MS21042-type nuts
	3468 – 3498	2371 – 2390	3/8" 12-Point nuts, extended studs
	3498 – Current	2391 - Current	7/16" nuts
Tacho Pick Up	01 – 1003	01 – 219	Long post, senses starter ring gear teeth
	1003 - Current	220 – Current	Short post, senses 2 tags on rear of flywheel
Flywheel	01 – 340		Resin keyed magnets, ¼ screws to crank
	341 – 436		Steel keyed magnets, ¼ screws to crank
	437 - 2102	01 – 856	Steel keyed magnets, 5/16 screws to crank
	2103 - Current	857 -	Flywheel screws torque to 24 instead of 18 lb.ft
	0 – 2731	0 – 1521	Aluminium flywheel centre
	2732 – 3498	1522 – 2445	"Starfish" flywheel centre, 20mm dowels.
	3499 - Current	2446 – Current	"Starfish" flywheel centre, 24mm dowels.
		2436 – 2573	20° BTDC Ignition timing
		2574 – Current	23° BTDC Ignition timing
			See Crankshaft for intro of 3/8 screws
Oil Pump	01 – 238	01 – 794 – All 20mm wide	12mm wide rotors
	239 – 1957		14mm wide rotors
	1958 - Current	795 - Current	Oil port plate adjusted to reduce pressure spikes
Push Rods	01 – 352		198 / 200mm hollow type
	353 – 2067	01 – 960	Machined from solid.
	2068 – 3357	961-2209	Length changed to suit hydraulic lifter
	3358 – 3595	2210 – 2539	Hollow type
	3596 – Current	2539 – Current	Hollow, shorter to suit Roller lifter & Cam.
Starter Motors	01 – 728	01 – 58	Reworked gold end type
	729 – 1467	59 – 509	Bosch type
	1468 - Current	510 - Current	Nippon Denso type
	01 – 728	01 – 67	Plenum chamber integral with sump

Component	2200 S/No.	3300 S/No.	Details
Induction Passage	729 - Current	68 – 2330	Separate "Swept" plenum
		2331 - Current	Series III Induction Body
Carburettors	01 – 698		Bin 32mm
	699 – 1883	01 – 722	Bing 40mm
	1884 – 2849	723 – 913	Bing 40mm with economy tuning
	2850 – 2919	914 – Current	Tuning per JSB018 (richer economy kit)
	2920 - Current	914 – 1419	Modified carby needle fitted, tuning unchanged
	-	1420 - Current	Fuel float needle seat port increased to 2.4mm
Alternators	01 – 2661 10-pole alternator Low output	01 – 163	3-phase type
	2662 - Current	164 - Current	12 pole Single phase high output
Engine Mount Plate		01 – 47	Std mount plate (common with 2200)
		48 – 856	Top mount holes raised 15mm
	01 – 2086	48 - 856	Plates suit 99 tooth ring gear
	2087 - Current	857 - Current	Plates suit 101 tooth ring gear
Distributor Rotors		01 – 139	Red rotors
		140 - Current	Black rotors (GB73)
Distributor Plates		01 – 208	Std type posts
		209 - Current	Shortened posts
Exhaust Manifold		01 – 117	Std exhaust system
		118 – 561	Manifolds lengthened by 15mm
	1597 – Current	562 – 756	Gasket-less exhaust introduced
		757 – Current	Extractor type exhaust introduced
Valve Lifters	0 – 2067	0 – 960	Solid lifters
	2068 – 2849	961 – 1683	Hydraulic high-leak lifters, 0-ring cam
	2850 – 3094	1684 – 1900	Hydraulic slow-leak lifters, 1-ring cam
	3095 - 3595	1901 – 2538	Hydraulic slow-leak lifters, 2-ring cam
	3596 – Current	2539 - Current	Roller lifter & Cam.
Sump	01 – 1399		Original finned sump
	1400 –	462 - 792	Extra cap screws under gearbox cover holding sump to engine mount plate
	2553 - Current	-	Deep sump fitted. Rocker chamber venting not needed with this sump
Starter Ring Gear	01 – 2086	01 – 856	99 Tooth
	2087 - Current	857 - Current	101 Tooth
Ignition Leads	2552 - Current	1206 - Current	Black, spiral wound type
Slimline Bridging Washer	1669 - Current	572 - Current	New washer for cylinder head screws
Intake Gaskets	01 – 2146	01 – 876	3 hole type
	2147 - Current	877 - Current	2 hole type
Vacuum Pump Drive	01 – 2731	01 – 1521	Inbuilt
	2732 - Current	1522 - Current	Push-in type