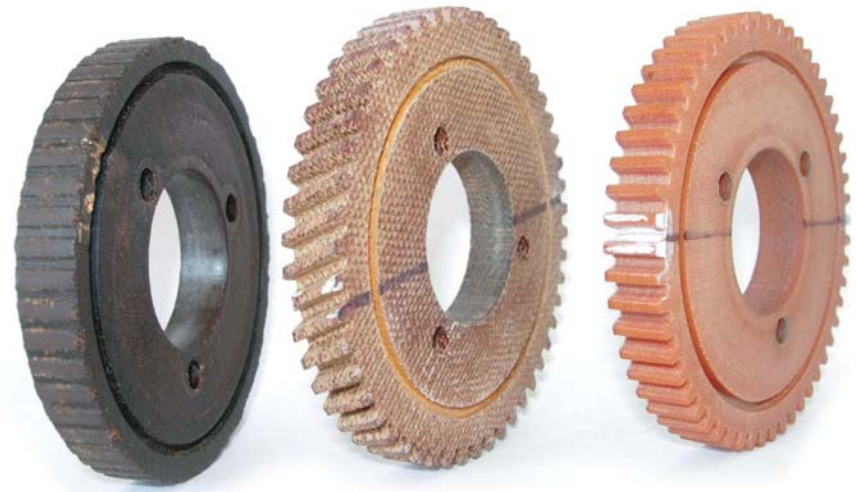
SAFETY SPOT

Malcolm McBride
Airworthiness Engineer

One of the things that I like the most about being an Aircraft Engineer is the variety. OK, as a job the conditions can sometimes be a bit naff, one minute hanging upside down, supported by your ankles from a bulkhead frame, willing your fingers to stretch that centimetre further, then … dropped the spanner, start again. The next and you're holding onto a 'Cherry Picker' at full extension, in a howling gale, trying to change a fin beacon.

I think it's a great job for a person with an enquiring mind, you've got to have a little bit of knowledge about everything – mechanics, structures, materials, theory of flight; even, and I accept that I might be getting a little carried away here, ellllecttrissity! I am continually surprised by the talents of the people that share my Aeronautical World, this is particularly true, in my experience, of the LAA membership. I received a Permit application the other day from an individual that I have known for many years, somebody who definitely exists in the Aeronautical World, Mr. Eddie Clapham, a known, and incurable, aeroholic.

Eddie has been an PFA/LAA inspector for nearly thirty years and is used to solving difficult problems; he's what used to be called a 'bit of an engine man', having spent much of his working life as a development engineer for Rolls-Royce in their Military Engine Division in Bristol. As is usual in these things, the story started a few weeks earlier than Eddie's involvement; are you sitting comfortably?



Photograph: Eddie Clapham

Failed gear | **Angled gears are still available** | **Charles Clapham's home made gear!**

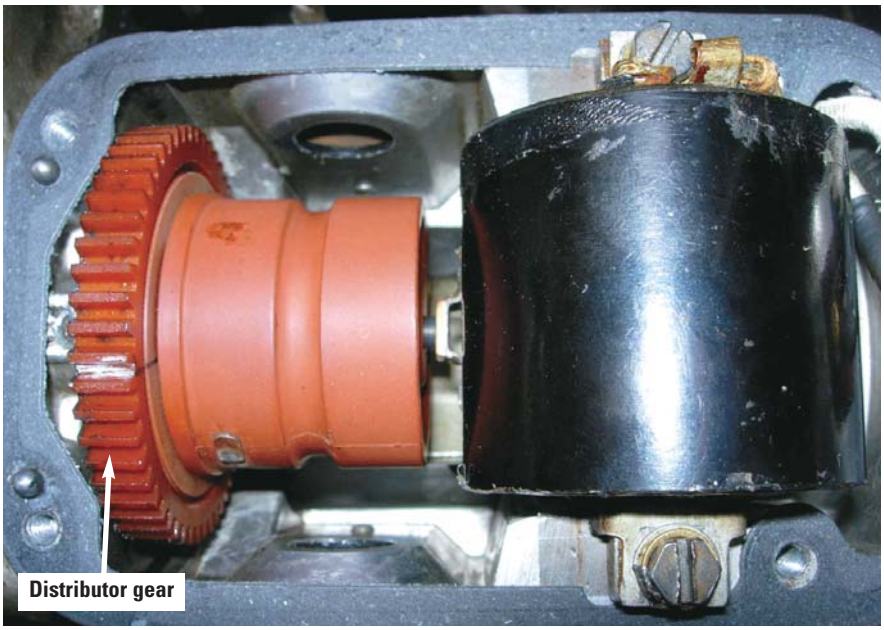
Three gears tell the story

BENDIX MAGNETO FAILURE

This feature concerns an engine failure situation involving one of our members. Actually, the engine didn't stop completely, which often places discussion into the decision making process … which is not good in the cockpit where time runs at a faster pace. You can probably guess from the title that this engine failure concerns one of the magnetos; remember, the pilot wouldn't have known this in the air. I have explored the incident rather more fully than I would normally for two reasons; one, it gives me the opportunity to explain a bit about these mysterious devices and two, ……..

One thing that you definitely must have in a petrol engine is a good spark; diesels, well they work in a different way. Petrol engines need a good splodge of heat just before top dead centre to set fire to the compressed petrol/air mix … Ok, this is the stuff of schoolboys (schoolgirls too!) and I expect (well *hope*) you all know what a spark plug does.

Actually, the production of a spark ignition system was a very high technical barrier at the beginning of the twentieth century. This barrier was successfully jumped (!) by the German philanthropist Robert Bosch in 1897, with a magneto design that he eventually patented. This device solved the problem of producing a high tension (voltage) spark at exactly the right time in the combustion cycle of a four stroke engine. Light aircraft engines still use the device to this day, primarily because it is electrically 'self contained', a complete electrical failure will not stop the engine. Aircraft engines normally have two magnetos which operate completely, or nearly completely, independently.



Photograph: Eddie Clapham

The innards'! The Bendix SF4R-8 Magneto

Our story starts with a short local flight in an Aeronca Chief, somewhere over the beautiful Severn Valley; the engine suddenly started to misfire and the resulting power loss meant that height could not be maintained. Here's a question, what would you do? (Be honest with yourself).

The correct action, in such circumstances, depends on lots of things as each situation is different; The major currencies in an engine-out are height and speed, try to remember this. If you've got plenty of height then one, stay calm and keep the aircraft flying …. Check airspeed, initially you're after winning a bit of time, fly the aircraft at minimum sink airspeed and you won't be chucking height (and time) away. Take the power off the misbehaving engine; this action may reduce the damage caused by vibration and also calms the cockpit situation down a bit. Expect the engine to stop at any time, now is the time to go through the power failure procedure. What I mean by this is make a plan for a field landing; you know, and I hope practice, the drill often enough and this is not the place for commentary on field landings.

When you get to the bit in the checklist that says "establish the cause" try to do just that, if the engine is misfiring regardless of throttle position then there is a very good chance that it's a bad magneto but, as always, check all the systems and select carburettor heat/alternate air to ON. Check each magneto in turn; what I mean is, turn OFF each magneto in turn. If your aircraft has a key type switch then BOTH means running using both magnetos, LEFT means running on the left and RIGHT means running on the right. It's best to get into the habit of always returning to BOTH between each test.

As you select an individual magneto the engine will do one of three things. The first is, as always, no change. The second is that the engine will carry on misfiring, but feel much more likely to (and indeed may) stop. The third is that the engine will stop misfiring and run normally. If this last, very desirable, thing happens then; open the throttle, thank whichever deity in whom you believe, and get back to *terra firma* a.s.a.p. If the engine continues its bad behaviour, then switch this magneto back on and switch the other off. Whew, have I lost you yet … " McBride, as an instructor, you stink".

If playing with, sorry, alternately isolating each magneto, fails to cure the problem, and the carburettor heater hasn't had any effect, and the fuel pump …. etc. etc. then good luck with the out-field landing! If the misfiring stops, then you have isolated a 'wild' magneto, well done.

In this context 'wild' means that the magneto is creating sparks at random; some of these random sparks may ignite the unburnt fuel in the exhaust manifold, this is the acoustic effect oft. explored by small boys, other sparks may occur at top dead centre and, potentially, cause serious engine damage.

Our man, that's the one that was flying in the Severn valley, did all the above and managed to get the aircraft safely back to base so, well done to him … Good thinking.

Before I explain what the inspector found I think that it is worth spending a bit of time talking generally about magnetos, so here goes.

Magnetos are quite simple devices but, like many 'simple' things, one could spend a lifetime of study and still not fully understand them. Principally though, a magnet is rotated at half

Photograph: Malcolm McBride

Sometimes magnetos are easy to get at …

engine speed by gears in the accessory gearbox, normally located at the rear of the engine. This rotating magnet induces a current in a primary wire, this current flow, essentially low tension, is interrupted by a switch operated off a cam (that's the points, oh dear!). The sudden resulting collapse of the low tension field induces a very large tension (voltage) in the secondary windings which has only one objective … to get back to a low potential state … Earth. The charge is directed by the magneto's distributor gear, via the appropriate plug lead, to the spark plug where it discharges to earth, first by ionizing the gas between the spark plug gap and then, using these charged molecules as a route back to Earth, creating a spark. A magneto is more like a two stroke than a four stroke and this magnetic field can be thought of as an energy wave.

There are almost always two magnetos on an aircraft engine, sometimes called one and two (no really!) but, more usually, left and right. In a 'two plugs per cylinder' engine, like most of the American flat fours or sixes, each cylinder will be fed by both magnetos … left – top, right – bottom or visa versa. Sometimes, because of bottom plug fowling, one magneto may feed the top plugs on one side and the bottom on the other. When both the plugs are operating correctly then you get a better 'burn' of the fuel/air mix in the cylinder, that's why there is an RPM drop when you check your magnetos by isolating each in turn during the power check.

To get the most out of a magneto the device needs to be accurately 'timed', this timing is not related to the time when the spark fires before top dead centre (BTDC) it's about getting the biggest possible spark. This is known as the internal timing and is related to, but not totally dependant on, the points gap. In many magnetos this internal timing is done by adjusting the 'E' gap. I am not sure whether 'E' stands for Energy or Electrical in this context and I suppose it doesn't matter much. Be aware that the internal timing is adjusted by increasing or decreasing the points gap and that you need a special gauge , and no small amount of training, to understand how to adjust this, especially in a worn magneto.

Remember, there is no need for any electrical power to this device, it's a self contained spark producing machine; in fact, the only way to stop the thing from producing sparks is by grounding it, this being done with what has become known as the 'P' lead (I don't know what this stands for either!). Two important points about this; one, you switch a magneto ON by opening the switch (i.e. un-grounding it), which is a weird concept for some people to understand, and two; because this is a grounding wire there can be some considerable back e.m.f's generated in this 'P' lead. What this essentially means is that magneto switches are specifically designed for the application. It is certainly worth checking the electrical operation of these switches as part of the engine inspection cycle if you want to avoid a 'live magneto', and the associated disabilities.

Photograph: Malcolm McBride

… and sometimes they're not

Because the inside of the magneto contains high tension electricity, much of it is made from non-conducting material. A large fibre gear is normally used to direct the charge to the correct plug, modern gears being made of nylon, the older types from an early type of Tufnol. If all the bearings in the system are in good order then there is no real load in this Tufnol gear, but if a bearing is failing, this gear is having to absorb loads for which it wasn't designed and is often the first point of failure.

Incidentally, because many of our LAA aircraft operate with rather 'home made' inspection routines and, perhaps more accurately, magnetos are a bit scary to the un-initiated, they tend to be rather overlooked. The device's reliability, and its redundancy, are in some ways its undoing. If a bearing is starting to fail then the Tufnol (or latterly, Nylon) will probably show signs of distress first; Tufnol, if it's being worked too hard, tends to produce a fine powdery resin which can find its way to the dodgy bearing, accelerating failure of the gear tooth and ..!!!

The subsequent inspection by Eddie discovered that it was indeed this gear that had failed and, as normal, the bearing was found to be shot. Eddie took the magneto to bits and, in the time honoured LAA fashion, set about servicing the device. It should be reiterated here that Eddie has a specialist knowledge about magnetos, I would definitely not advise the unsupervised disassembly of a magneto. Eddie was able to source the new bearings … no problem, the coils checked out O.K. and all that was required to complete the repair was a new distributor gear, and here is where the problems started.

As with many older aircraft and (sometimes) even older components, Eddie found it impossible to find a new part. Faced with the probability of replacing the whole magneto at huge

expense Eddie turned to his Son Charles, an experienced 'hobby' machinist (who, incidentally, makes clocks) for assistance. As you can see from the picture(s) the results are fantastic.

After the design department had assessed and cleared this replacement part I was able to issue the owner with a new Certificate of Validity, I asked Eddie to annotate the logbook specifying 25 Hr checks for the next 100 Hrs and, naturally, to check the other magneto out. It just goes to show that all things are possible ……. As I said earlier, the life of an Aeronautical Engineer is rarely dull.

REPLACING PARTS

There are some parts that can be repaired and some parts that were never designed to be; sometimes, as an aircraft owner, you just have to 'bite the bullet' and shake the cobwebs out of the wallet (as if!). I have just read a Rotax Service Letter (SL-912-014R1 & SL-914-012R1) which discusses the use of 'pattern' parts, in particular, oil filters. This is an old story and I won't bore you with it here except to give you my take on the subject. If your using a £10,000 engine to power your £35,000 aircraft about then you've got to have a screw loose to want to save a couple of quid on a cheap oil filter. So, tighten the loose screw and wirelock it so it doesn't vibrate loose again.

Another Rotax Service Instruction has just been received (SI 914-003 R1) which concerns the checking of waste gates on the 914 engines. I've never operated a 914, but from all accounts, they are a brilliant engine. Remember, the 914 can produce (albeit, only for a short time) 115 Hp and it does this with 74 cu inches; to put this into context the Continental A65 max's out at 64 Hp … and uses 170 cu inches to do it. Nothing comes free, if Rotax say "check your waste gate each pre-flight" , then you would be wise to do just that. Both the above Bulletins can be found on the Skydrive website.

Question: Which one would you fly with?

Photographs: Roger Lewis

Talking about the time to change a part; check out the picture of an air filter sent to me by ST Aviation's Roger Lewis. He found this archaeological artefact in a Jabiru induction system … What's yours like? Roger pointed out in his letter to me *"This filter was removed during a routine service on a Jabiru. We had not seen this aircraft for a while and can only presume that the owner had been doing his own servicing."* Or not, as the case may be. Roger points out that *"a small grass seed of fly may (*will*) cause mixture problems"* . This is something that you don't need especially in an overshoot situation. I know that it is all too easy to put off that service " 'till next week" or "that'll be OK 'till next time". Often the 'next time' never comes ….. what are your field landings like?

UPDATES

I am very pleased to say that the MCR-01 aircraft with the type two brackets have now been cleared for flight (subject to compliance with LAA MOD/301/020 issue 1). As I write, Dyn Aero has announced an in house 'update' for tailplanes of the type one variety; this update essentially changes the tailplane into a type two and has been accepted, at least in principle, by our Design Department as their preferred option. We're waiting for Dyn Aero to submit the complete factory mod to us so that it can be fully approved. Once these aircraft have been modified they will need to be inspected by an LAA inspector against a MOD number issued by the LAA. This will need to be done formally to remove the Mandatory Permit Directive grounding the type. I know that some of the owners have decided to go down this route and have already shipped their tailplane to Dyn Aero.

I have received a couple more *positives* in our bid to rid the World of Rans S6 tailplane cracks. I think we can pat our self on the back a bit with regard to this mandatory inspection. Who knows whether we have actually prevented an accident, it's impossible to prove a negative.

Apologies from me about the delay in getting both the Challenger and Shadow Airworthiness Info. Leaflets out as quickly as I hoped I would; I will not trouble you with detailed excuses, suffice to say that the Challenger AIL is out now and the Shadow AIL will follow over the next few days. *Fair Winds.* ■