Safety Spot
By Malcolm McBride

GROPPO/SAUER FUEL AND IGNITION FAIL, THE MORANE SAULNIER ON THE SHORE & ROTAX FUEL PRESSURE ISSUE

The latest LAA Engineering topics and investigations

Well, here we are again. Doesn't time fly? Welcome to *Safety Spot*. Mid-summer is behind us, but we still have plenty to look forward tt. Positive, me? Well, yes, and why not? The alternative isn't anything like as much fun…

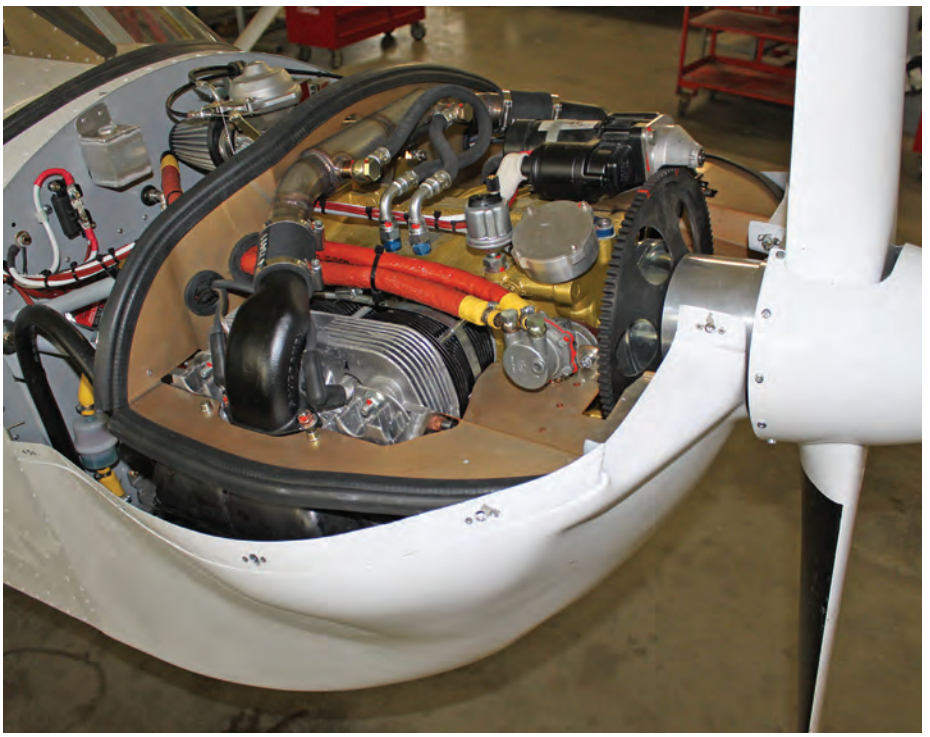
As always, I hope 'you and yours' are in good enough fettle to enjoy whatever area of aviation you're 'into'. The pursuit of flight must be one of the broadest, most diverse interests on, or perhaps more appropriately, off the planet. After all, even when you've spent over half a lifetime working in the aviation business, there's still things to discover and intellectual avenues to explore.

This section of *LA* often ends up describing reasons why it's so important to keep on top of the maintenance and inspection of your aircraft, and this edition is no exception – herein we look at examples of engineering failures. The last few *Safety Spots* have looked at why it's so important to carefully check an airframe after any kind of unusual incident, and this month we're tackling how a failure can result from the smallest thing going wrong, often in a completely unexpected way.

Regular readers will know that I've a minor passion for motorcycles. I know, because readers tell me, that this interest is shared by many aviators. Now, you won't be surprised to learn that, like any human being, my judgements can be flawed. For this reason, I'm a great believer in getting somebody else to check my work – I don't like the idea of one person doing work and then signing it out as being okay. It isn't about the relative abundance of perceived skill levels, qualifications or personal self-believe, it's simply that our brains work in, well, human-like ways. In other words, we can and do miss our own errors.

For this reason, every couple of years, even though I'm a bit of a do-it-yourself addict, I bite the bullet and put my motorbike into a pro workshop. This year happens to be the bike's 'biennial' and a couple of days ago I picked up my machine from the shop.Everything about it feels a little better and I'm really enjoying the increased grip from the new tyres and the very effective brakes. It handles better too, since the shop adjusted the rear suspension and replaced a worn bearing or two!

The lesson is, like every other human, over the course of time, I'd accepted and got used to a reduced level of performance from my bike. That's okay, up to a point, but the owner of any machine needs to continually assess whether it's still safely fit for purpose. And sometimes, making that decision needs to be passed on to others…



(Above) **There are numerous VW aero-conversions in service today, some certified for aircraft use like the German Limbach and Sauer engines, and many operating in the world of the amateur-builder. The Sauer 2400UL engine is shown here neatly packaged into a Groppo Trail, a two-seat, high-wing kit-build. Note the position of the mechanical fuel pump and electronic ignition module (Starboard side/front).** *(Photo: Graham Smith)*

GROPPO TRAIL/SAUER 2400UL: FUEL PUMP AND IGNITION FAILURE

A failure of any component in any system can occur at any time but it's a rare thing for a correctly designed and manufactured part to suddenly fail, and there are almost always warning signals on the road to a failure. One of the principle tasks of the aircraft inspector is looking for these warning signals and making judgements about whether, or rather when, corrective work will need to be done.

Regular readers will recall my comment in an earlier issue about not cleaning your aircraft before an inspector has had an opportunity to look around the machine – remember the story of the 'smoking' rivets?

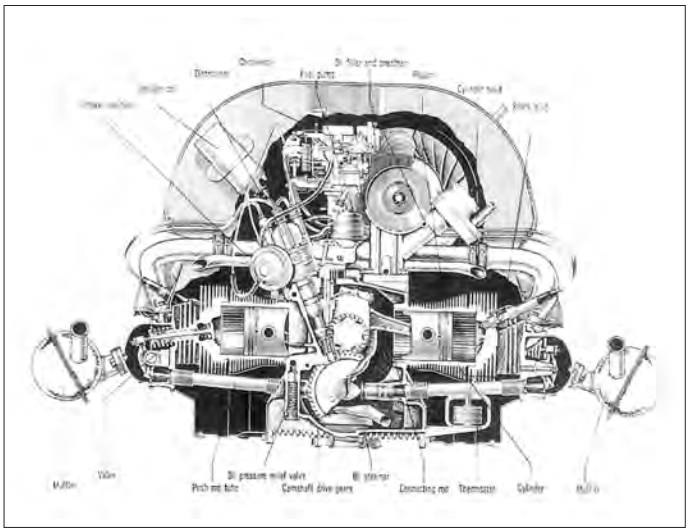
When it comes to engines, inspecting levels of wear, or spotting a failing component, can be more difficult. 'Engine' inspectors use a variety of tools to make their judgement with regard to the continuing airworthiness status of engines. For example, piston ring blow-by and correct valve seating can be measured by completing a cylinder compression check.

In this tale, we're looking at one of the best engine-problem diagnostic tools available, namely a proper examination of the contents of the oil filter at regular intervals, generally during an oil change.

The owner of a Groppo Trail two-seat tandem aircraft didn't do this simple check during his regular oil changes and, therefore, wasn't aware that a component in his fairly new engine was slowly failing. This owner had only seen great performance from his Sauer 2400 UL power unit over the previous six years and 170 or so flying hours. I say 'this owner', because, for unconnected personal reasons, he'd sold the aircraft to someone else who, after only one hour of operation, suffered an engine stoppage during his post-flight magneto check.

Essentially, the new owner noticed that when the electric fuel pump was switched off, the engine initially ran roughly and then stopped. The engine was restarted successfully with the electric fuel pump switched on but immediately stopped

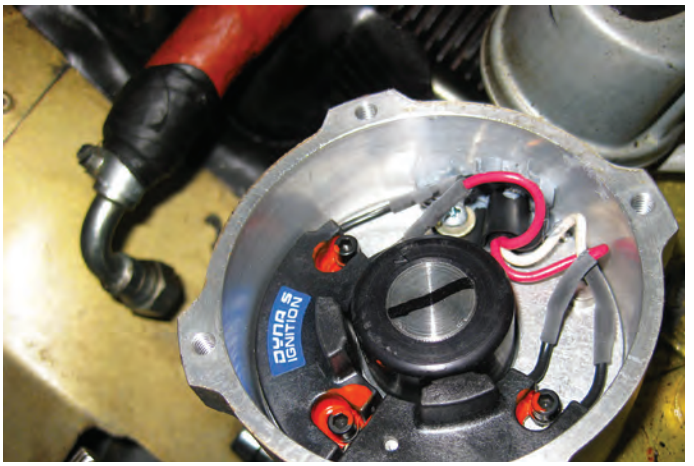
›



(Left) **The original VW distributor drivetrain is taken straight off the crankshaft via a bevel gear. Ignition distributors are almost devices from the past, as electronic ignition systems now predominate – in this type of early system, a large coil generated the high-tension voltage required by the sparking plugs and this charge was 'distributed' to each of them in turn, through a rotating arm.** *(Photo: LAA Archives)*

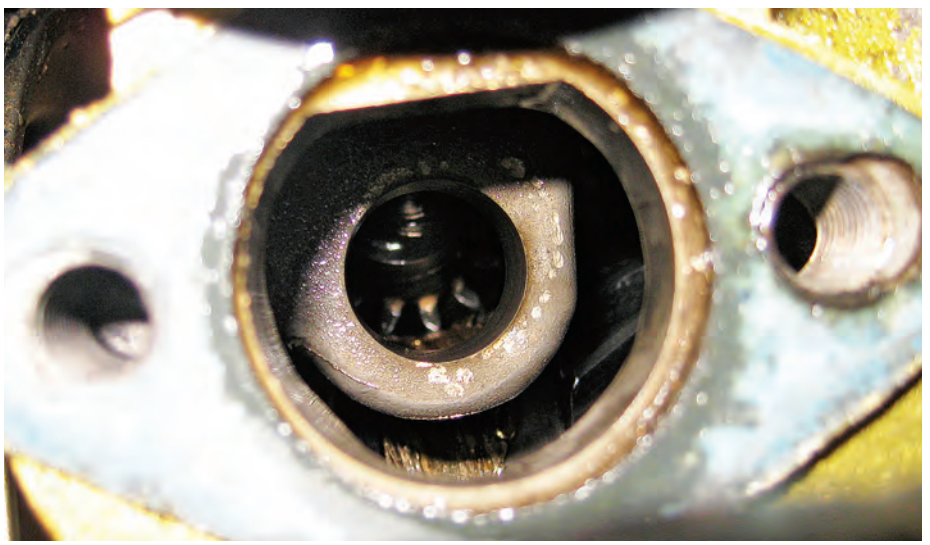
(Below left & right) **Most light aircraft require two independent ignition systems and the pictures below show the Sauer method of providing them. Below left you can see a Champion Aerospace 'Slick' aircraft Magneto – note that it's driven through a rubber cushion, straight off the crank.**

The picture below right shows the electronic ignition's sensor module, in which the distribution rotor arm is replaced by a rotating magnet. To complete the ignition system, two high-tension generating coils are required, and in the Groppo Trail these are mounted on the firewall. This type of ignition system requires a constant 12v supply for it to operate so, unlike the magneto, it isn't completely self-sustaining. *(Photos: Malcolm McBride)*

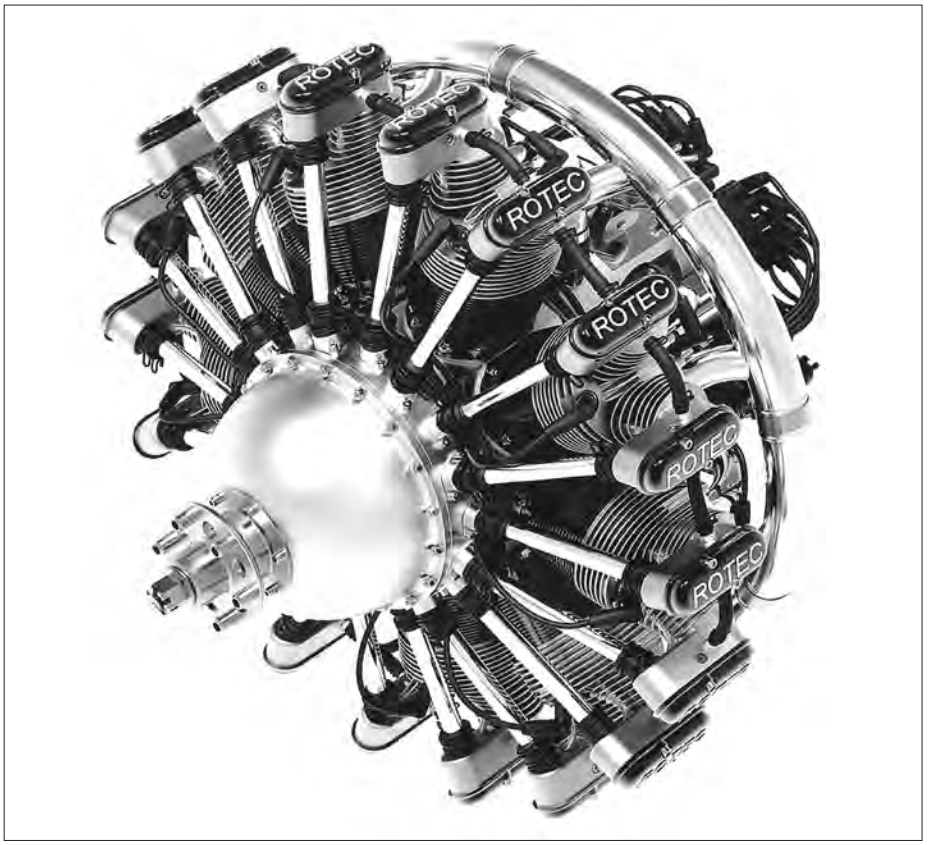


(Left) **Regular inspection of the oil filter element is a normal part of the maintenance schedule on aircraft engines. It isn't uncommon to occasionally find some small amount of debris inside the filter, especially if the engine is fairly new. Careful examination of any debris often acts as a pointer to a potential problem and regular checks could mean that the first signs of an internal mechanical failure will be spotted before something actually breaks.**

It's clear from this picture that something is rapidly failing in the engine which this filter was fitted to. In this case we know that it's the drive gear or associated bush for the fuel pump/electronic ignition module on a Sauer engine. Since the recent failure of this drive, all LAA Sauer engine operators have been asked to remove their oil filters and check for debris. *(Photo: Malcolm McBride)*



(Left) **This is the view into the failed Sauer engine – you can just make out the steel driven gear, which drives the fuel pump/ ignition module drive. Below that you can see the brass driving gear fitted to the crankshaft. It's likely the clearance between these gears wasn't sufficient to ensure good lubrication and also that the gear train had been failing for some time. LAA Sauer owners have been asked to measure the backlash in these gears as soon as is practically possible.** *(Photo: Malcolm McBride)*



(Above) **This is a company shot of the Rotec radial engine – if you've only half the passion for power units that I possess, then you'll simply want to cuddle it! The Morane Saulnier 315 which ended up force-landing on Sidmouth beach was originally powered with a 135hp Salmson but, in the words of its restorer and owner, LAA Inspector Gerry Cooper Snr, "Salmson parts are as rare as hen's teeth these days". That's why, during the renovation of this rare example, he decided on the modern, 150hp Rotec R3600.** *(Photo: Rotec Engineering)*

(Above) **The mystery of the excessive fuel use on the Rotec R3600 Radial engine solved – the loss of a simple spring connection meant that the primer button remained in the 'priming' position, even though the cockpit control lever had been returned to the primer shut position.**

Clearly, a minor design modification was required, so that if a control cable or spring failure occurs the system will fail in safe-mode – in other words, primer off. With the primer button closed, the fuel pressure regulator is effectively disabled, and it's been estimated that the engine could use up to four times as much fuel in this condition. *(Photo: Zac Rockey)*

(Above) **A wise pilot never sets off without some kind of refreshment in their map case (perhaps a soft drink, a sandwich and a chocolate bar), just in case they're forced to land unexpectedly because of a problem. Perhaps, when flying around the coast, the pilot should include swimwear!**

This picture shows one of only three Morane Saulnier MS. 315E D2 aircraft in existence, 'sunning' itself on Sidmouth beach. The pilot, LAA'er Zac Rockey, made a perfect emergency landing on the near-deserted beach after its Rotec R3600 nine-cylinder radial engine started 'playing up', but it didn't take long for crowds to form and the incident soon made most of the social media platforms. Interestingly, the reason for the engine's poor running was that the aircraft was running out of fuel, even though Zac's consumption calculations showed that there should've been half a tank remaining. *(Photo: Zac Rockey)*

again, when the electronic magneto was switched off. It didn't take him long to work out that the primary drive for both the electronic ignition and the mechanical fuel pump is taken from the forward end of the crankshaft via a gear train. After removing the mechanical fuel pump, it was seen that its failure of this gear train had caused a drive failure to both the mechanical fuel pump and the electronic ignition module.

Discussion with the engine's manufacturer revealed that the company had seen this type of failure before. Previous instances had established that the cause was most likely to have been an incorrect clearance between elements of the gear train. The end-float between the driven gear and the driving gear was found to be just 0.004mm, whereas the minimum end float should be 0.1 mm.

Both LAA Engineering and the manufacturer are at an early stage in this investigation, but we both feel it's important to establish that engines operated in our Association's fleet were checked for the first signs of a bearing failure ASAP. Therefore, we wrote to all Sauer engine owners, suggesting that they carry out two simple checks – one, a visual look at the oil filter, and two, a measurement of the backlash in the geared drive train.

Often, as suggested earlier, the first sign of excess wear, whether caused by incorrect clearances or a lack of lubrication, will be evidenced by component breakdown material in the filter. The bevel gear drive and bearing in the Sauer engine are made from a brass alloy which, when starting to fail, can easily be seen – as in the accompanying picture of a filter which has captured brass particles during the initial failure of a bearing.

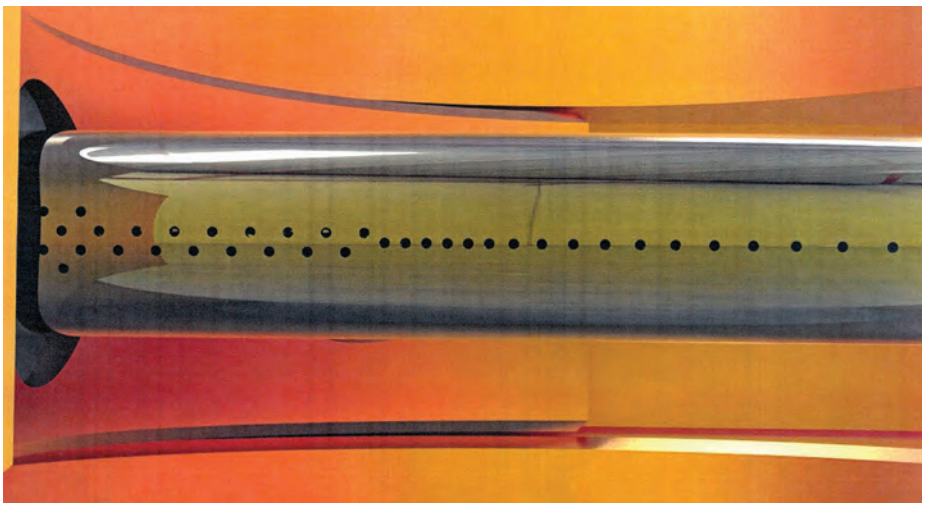
At the time of writing, we've had a number of responses from owners about this and, so far at least, all the filters checked have been clear of debris.

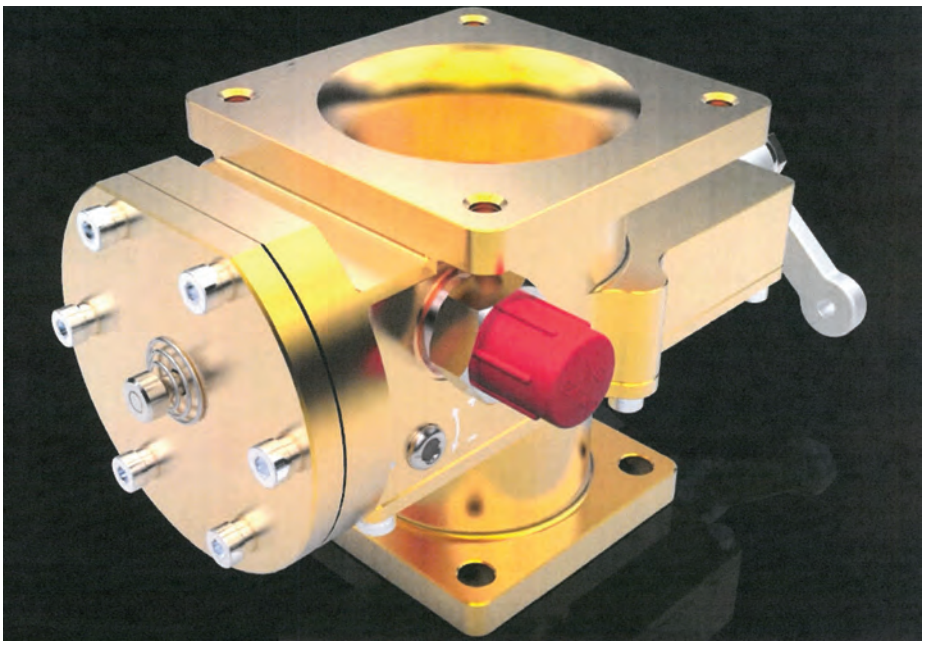
Regarding checking gear train backlash. When an engine is assembled, the individual clearance between moving parts is measured and, if necessary, adjusted. Any adjustment may be accomplished by shimming, changing individual parts or, occasionally, by machining. Once an engine is assembled or reassembled it can be difficult to check individual clearances, though overall backlash can be measured.

We asked owners to measure the overall backlash between the electronic ignition's rotor and the starter ring gear on the crankshaft. This was the method we suggested: firstly, ensure that the ignition and the magneto are both grounded (off) – always treat a propeller as 'live'. Then remove the electronic ignition module's top cover and slowly turn the propeller one way, until the electronic ignition's rotor starts to turn. Keep turning the propeller until a starter ring gear tooth lines up with a fixed feature on the engine, then stop and mark that gear tooth. Then turn the propeller the other way, until the rotor begins to turn again, while counting the number of starter ring gear teeth which pass the fixed feature. Make a note of that number.

As a rough guide, the engine manufacturer has measured this backlash as five full teeth in a newly-assembled powerplant, though no maximum or minimum figures have been established at this point in time.

We asked owners to send a picture of their filter and let us know their backlash number – the work required falls into the ›





(Top & above) **Originally, Rotec Radial engines used a standard Bing carburettor. However, after trying the Ellison Throttle Body Injector (TBI) system on one of their models, and noticing an immediate improvement in performance, Rotec decided to design a TBI of its own. Don't confuse a TBI system with conventional injection, it's more akin to a carburettor, in that the TBI introduces fuel to the engine via a centre-mounted spray bar (*shown at top*), rather than directly (or indirectly) into the cylinder via a metering unit. The early Rotec units had a remote fuel pressure regulator, which controls fuel quantity, but the newer units (*shown above*) place the fuel regulator on the side of the TBI itself. Note the 'priming' button, far left, in the centre of the regulator's diaphragm housing.** *(Photos: Rotec Engineering)*

(Left) **This picture shows where LAA Inspector Robin King found the position of the priming lever while investigating where all the fuel had gone – he was immediately suspicious when he saw that the cable appeared rather slack.** *(Photo: Zac Rockey)*

category of pilot allowed maintenance, so they're able to carry it out without the support of an LAA Inspector.

It's early days with this investigation but, to widen out the continuing airworthiness lessons, it does highlight why checking the oil filter for debris during routine maintenance is so important and, although it's a messy procedure, shouldn't be missed out.

MORANE SAULNIER MS.315E D2: ENGINE FAILURE

If you're a keen follower of aviation-oriented social media (I'm not, and rely on others for briefings about this or that story) you'll have seen the picture of a lovely Morane Saulnier 315 stranded on a beach in sunny Cornwall. Here's the story, in Zac Rokey, the pilot's own words, as to how the aircraft ended up there.

"The day started at Branscombe Airfield, where the machine is now based. I'd lubricated, prepared and flown the aircraft twice the evening before, so hoped thart my 'A check' on the Saturday morning wouldn't show any surprises. The aircraft stood on the apron outside for refuelling and was filled to the brim – 135 litres. That should've given around five hours' duration at normal cruise, so I knew from experience that I was good for four hours, even at a high power setting.

"The planned return trip to Bodmin was only going to be about two hours total – I knew that fuel would be awkward to obtain, which is why we went full from home base. The oil was topped up to 14 litres (max is 15) and the aircraft was cleaned by giving a last wipe over with a rag to make her look nice.

"The take-off run at Branscombe took some while to get going, my longest yet in this machine but, as I'd never been out of there with full tank and passenger, I wasn't surprised by the performance drop. I set the throttle for 3,500rpm (the bottom of the yellow arc, as suggested by the owner for running in). During the flight I changed the power setting briefly, at intervals, as part of the running-in process. I noticed that I could achieve a set rpm with a fraction less throttle than I recalled from previous flights.

"I had flown the previous ten hours the same way and had gotten used to the engine mildly changing characteristics as it was running in, so again I wasn't in any way concerned. Oil consumption had been around a litre an hour throughout, and flight time to Bodmin was calculated to be 52 minutes.

"On the way back, we decided to take in some landmarks roughly en-route and then fly along the coast back to Branscombe. We were terrain-following along the cliff line and just after Budleigh we began a climb to 1,200ft. As we approached Peak Hill near Sidmouth, which is a 700ft cliff, the engine felt 'different' and I noticed that the rpm had dropped. I reduced power a bit and levelled the aircraft as we weren\t far from Branscombe and at a suitable height.

"With the engine appearing to be playing up, I started looking around for suitable landing fields so, when it finally spluttered and lost total power, I'd already discounted the inland option. The most favourable landing site was the beach at Jacobs Ladder, Sidmouth.

"The long, straight, low-tide beach was clear of people and easily achievable at first sight. As we approached its western end, there were a few people (from memory, I'd estimate five) who watched from the lower edge of the beach, at the water line. We passed north of them and continued to a short landing on a surface of cobbles and sand. This was exactly one hour after setting off from Bodmin. My passenger and myself were unhurt and exited the machine, which was switched off and made safe.

"Help arrived shortly after and the aircraft was manoeuvred up the beach above the high tide line, for its own safety. Emergency services were in attendance, to record details, and helped discuss our plan for recovering the aeroplane.

"Once we'd recovered the aircraft back to base, we started to investigate what had gone wrong. The first thing to note was that there were only about two litres of fuel left. The engine had clearly stopped because it'd run out of fuel. I was extremely surprised by this, as there was no evidence of any leak or loss. I'd flown the aircraft one time before, for three hours, and it still had considerable fuel left when subsequently drained, so something had gone wrong."

Well done to to Zac for getting himself, his passenger and, naturally, the aircraft back to terra firma in good shape – if much to the amusement of the beachcombers around at the time.

Of course, with the benefit of hindsight, the rapidly dropping fuel level should have been picked up by regular checks on fuel level while en-route, along with the Ts and Ps. However, the fuel gauges on vintage aircraft aren't always that easy to use and one can understand why the pilot felt that relying on a known endurance was a good alternative.

The outside of the fuselage bore witness to an extremely smoky exhaust after the incident flight, which suggests that the engine had been running with a very rich mixture. The reason for the excess fuel usage was discovered to be a disconnected priming lever spring, which meant that the priming button on the Rotec Throttle Body Injector (TBI) remained 'on' even though selected 'off' in the cockpit.

The lesson here of course, is that in any Bowden cable-operated system relying on a spring to return it, the failure mode should be the safe condition, if the spring should break or become detached. One other interesting feature of this incident which I should share is that, when the aircraft was checked through at Branscombe there was almost no oil in the engine at all. That was a mystery, but one engineer, LAA'er Robin King, suggested that the excess fuel was cooling the pistons such that oil was being pumped through the engine and out through the exhaust, which sort of makes sense when you think about it.

EUROFOX: FLUCTUATING FUEL PRESSURE

British Microlight Aircraft Association member and EuroFox flyer Adrian Whitmarsh reads Safety Spot – sensible chap. Even though he flies a BMAA machine, Adrian felt that a recent

(Left) **BMAA EuroFox flyer, Adrian Whitmarsh, had a problem with the fuel pressure on his aircraft earlier this year and thought it a good idea to let other owners know about what he eventually found to be the cause.**

This picture shows the condition of the fuel pump's vent pipe. A restriction in the vent will significantly reduce the pump's ability to supply fuel. Adrian spent many months trying to solve the problem of intermittent low fuel pressure but didn't notice this restriction, as it was part of a bundle of wires and pipes coupled together inside a tie wrap.

Thanks to Adrian for sharing his engineering adventure with us – that is, after all, what this column all about.
(Photo: Adrian Whitmarsh)

safety issue affecting his EuroFox should be shared more widely.

Here's Adrian's tale, after which I hope you take a close look around the engine-bay of your aircraft, whatever badge you fly under!

"I'm a BMAA member, but my local Inspector suggested, quite rightly, that I send you a note about the recent issue I had with the Rotax 912UL engine on my kit-built EuroFox, since it might well be something you want to alert your members to. My aircraft and engine are now thirty months old, with approximately 180hr on the engine at the time this issue occurred.

"I suddenly had a low fuel pressure indication in late March this year. Pressure dropped from one day to the next, from normal (0.35-0.4 bar) down to less than the minimum 0.14 bar. This happened after a winter of little activity – initially, it was erratic and after a while of running the engine, the pressure gradually came back up to normal. However, after take-off, the pressure dropped again, to less than 0.2 bar.

"I sought advice from EuroFox UK's Production Manager, Steve Williams, who initially suggested checking for a blockage. The first check was the in-line fuel filter, and this had a small quantity of black particles and a small amount of a gluey-looking substance. This could have been water, although a fuel drain showed no signs of it from the header tank.

"On removing the filter, a few more particles came out of the hose from the header tank to the filter. I replaced the filter, only to find a few more particles showing.

"With hindsight, this may well have been caused by the insertion of the tight-fitting filter into the hose but, at that point, I began to suspect some degradation of the latter, possibly due to ethanol, especially since the aircraft hadn't been used for a couple of months during the winter.

"I checked the carb bowls and they were clean. I consulted further, this time with CFS Aero, the BMAA technical office and EuroFox again. There had been some reports of badly-manufactured batches of Semperite fuel hose, so I checked the serial number and mine wasn't affected. However, at that point I felt at least part-hose replacement was necessary, and also to trace through the fuel supply system to see if there was a blockage anywhere else. Since fuel hoses are now a five-year life item in the BMAA system, replacing part of them didn't seem sensible. So I bit the bullet and decided to replace all the hoses as I traced through the system. As it turned out, it wasn't a quick job but I found no evidence of blockage anywhere, and the fuel pressure gauge checked out fine.

> "After about five hours of engine running time and halfway across Belgium, guess what?"

"However, on starting the engine (after all that work!), the fuel pressure came up to 0.4 bar. 'Well, great', I thought, 'something must've sorted it!' I went for a short flight, stopping over at another airfield for a little while, and on start up the fuel pressure indication again showed only 0.2 bar, and during the return flight this dropped to less than 0.1bar!

"So it was back to the drawing board and more discussions. Although everyone had said the current BCD mechanical fuel pumps are reliable, that was the next thing everyone I spoke to suspected. Steve Williams loaned me a pump which he knew was in working order and I sent mine back to CFS Aero, which said it'd be returned to Rotax for investigation. A couple of weeks later, CFS very kindly sent me a replacement pump, free of charge.

"Meanwhile, the replacement pump from Steve seemed to have cured the problem, as fuel pressure indication was good on several occasions. However, at that point, and with an overseas touring trip pending, I wanted a back-up and so I installed an electric boost pump.

"Off we went to the Continent. After about five hours of engine running time and halfway across Belgium, guess what? Yes, the fuel pressure indication dropped to 0.2 bar and gradually a little less! Thank goodness for the back-up boost pump, although the EuroFox configuration with high-wing tanks does provide a small amount of gravity feed.

"During and after that trip we did a lot of head scratching. Both Steve Williams and my local BMAA inspector, Tim Gayton-Polley, suggested checking the cam driving the pump shaft. That Tim and I did, and although there were a couple of scratches on the cam face, the pump shaft seemed to be driving adequately. So, I fitted the brand-new pump from CFS, which had arrived in the meantime. Upon reassembly, Tim noticed that the pump vent hose, of the clear plastic type, was cable-tied very tightly to an oil hose.

"When I removed this hose, we could see that it was badly restricted, and Tim explained that this could be the problem! When I fitted it to the removed pump and tried to hand operate it, indeed it was clear that, when badly restricted, pump operation was impeded.

"On close examination of the restricted plastic hose, it appears that, over time, the hose has been softened by contact with the hot oil hose during engine operation. I believe that, during the very cold winter, it'd hardened into the softened but restricted shape.

"That process was gradually becoming worse, which explained the intermittent nature of the problem. I fitted a replacement length of Semperit fuel hose, which is much thicker, walled and somewhat heat-resistant, and thus far less likely to become restricted. Since reassembly, the engine fuel pressure has been perfect."

Thanks for this tale, Adrian – if nothing else, you now know that the fuel system fitted to your aircraft is in top-quality condition. Certainly, a restriction in any required vent will significantly reduce fuel flow. That's why it's important to ensure the vents on fuel tanks aren't in any way clogged up. Also, as this interesting case shows, it's equally important to make sure the vent on the Rotax 912 fuel pump isn't impeded. If the pump can't vent, it can't pump, and that can cause a problem, even with a back-up electric system fitted, when the two are plumbed in series, rather than in parallel.

Well I hope that you've enjoyed the read. Remember, *Safety Spot* is only as good as the tales you tell, so if you've got a story that's been bugging you for a while, don't be shy, get writing. Fair winds… ■

LAA ENGINEERING CHARGES – PLEASE NOTE, NEW FEES HAVE APPLIED SINCE 1 APRIL 2015

LAA Project Registration	
Kit Built Aircraft	£300
Plans Built Aircraft	£50
Issue of a *Permit to Test Fly*	
Non-LAA approved design only	£40
Initial *Permit* issue	
Up to 450kg	£450
451-999kg	£550
1,000kg and above	£650
***Permit Renewal* (can now be paid online via LAA Shop)**	
Up to 450kg	**£155**
451-999kg	**£200**
1,000kg and above	**£230**
Factory-built gyroplanes (all weights) *Note: if the last Renewal wasn't administered by the LAA an extra fee of £125 applies*	**£250**
Modification application	
Prototype modification	minimum £60
Repeat modification	minimum £30

Transfer	
(from *C of A* to *Permit* or *CAA Permit* to *LAA Permit*)	
Up to 450kg	£150
451- 999kg	£250
1,000kg and above	£350
Four-seat aircraft	
Manufacturer's/agent's type acceptance fee	£2,000
Project registration royalty	£50
Category change	
Group A to microlight	£135
Microlight to Group A	£135
Change of G-Registration fee	
Issue of *Permit* documents following G-Reg change	£45
Replacement Documents	
Lost, stolen etc (fee is per document)	£20

Latest SPARS – No 17 April 2018

PLEASE NOTE: When you're submitting documents using an A4-sized envelope, a First Class stamp is insufficient postage.