SAFETY SPOT

SPREADING THE WORD

Learning the lessons of others' misfortunes

I HAVE just had a fascinating weekend being re-educated about the historical complexities and various ways of looking at the Battle of Britain. "There's a Hun in the Sun," as Ken Craigie, the LAA Chief Inspector, would (and actually just did) say. Not being particularly impressed by the TV of late, I was pleasantly surprised by the coverage given by the Beeb.

During one discussion dissecting the various events of 1940-41 a clip was shown of the late Group Captain Sir Douglas Bader being interviewed on 'Late Night Line Up' by a very fresh faced Denis Touchy in 1965. It brought back personal memories. I remember being in awe of the great man around White Waltham as a boy in the late 1960s when he was flying a Beagle 206 for Shell.

'Reach for the Sky' held the rank of my favourite film for years, only recently being displaced by 'The Matrix'... I know, weird!

Anyway, he was asked by Denis about what it was like to be a hero. Douglas replied that, "it was jolly nice of people to want my autograph". In an age of celebrity worship it was good to see a real hero on the box for a change.

As I have explained over the years we use Safety Spot to 'close down' some of the investigations into events and occurrences encountered by LAA members. The more people who know about a problem, the less chance there is that this problem will surface unexpectedly in the future, perhaps with disastrous results.

Sometimes, as in this first tale involving the crash of a CASA Jungmann in the spring of last year, we are asked to 'spread the word' by the authorities.

Sadly, in this case, it was the Coroner who asked, at the inquest, how we promulgated the lessons learnt during this AAIB investigation. It was explained that we are able to share safety information with a much wider audience in our monthly safety feature, Safety Spot.

In addition to this we will be sending a copy of the accident report, written by the AAIB, to all our Jungmann owners.

CASA 1-131E Series 1000 Jungmann - engine failure

LET'S start this by explaining that if there's a crash following an engine failure on an aircraft there are different views around about what definitively caused the crash. Some would argue the engine stopping would be to blame, others would make a good case that the pilot's failure to land the aircraft safely should ultimately be listed as the cause. Both sides of this argument, like most I suppose, have merit.

My views about accidents are well known, at least amongst the regular readers of Safety Spot; there is never just one cause for an accident. In this necessarily very brief discussion I shall work backwards through the events of the day and look at some of what was uncovered by investigators subsequently.

The aircraft, a Spanish built Jungmann fitted with an ENMA Tigre engine, crashed during a forced landing into a field, the forced landing was required because the engine stopped, "running down smoothly and stopping" to be more precise, at a height probably around 1000ft. According to the passenger, the pilot, who had owned the aircraft for more than 20 years, turned right towards a "big green lush field" and appeared very calm and in complete control during the event.

The passenger recalls that "as they neared the ground she saw a set of telegraph cables and realised that they would not clear them". The aircraft's wheels and exhaust struck the cables, causing it to decelerate rapidly and pitch nose down. The aircraft impacted nose first and then pitched over inverted.

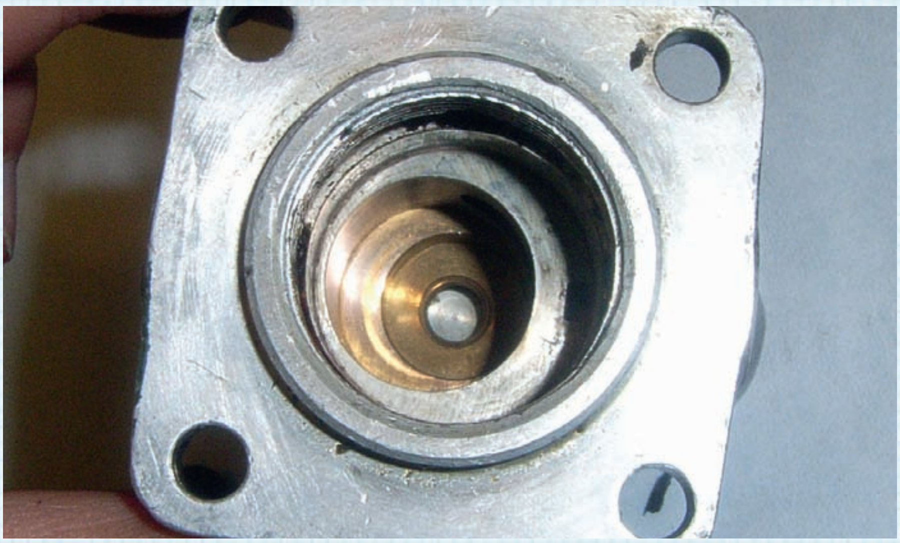
PHOTO AAIB

Just by looking at this housing it is not possible to see the wear that has inevitably accrued of the decades since it was manufactured. Manufacturing techniques employed half a century ago were very different to those available today and, consequently, this pump looks pretty simple to service. Don't be fooled, checking components like this often requires specialist knowledge and tooling; bench testing, a definite 'must do', invariably requires the use of a purpose built test rig.

I spoke to the AAIB investigator - he's a pilot himself. He said that in his view they were very unlucky to hit these wires. Running close to the hedge, as they were, they would have been very difficult to see under normal conditions, let alone in an emergency landing situation.

To continue our discussion backwards in time, we have to look at what caused the engine stoppage? I can tell you straight away that, despite a thorough investigation by the staff at Farnborough, no specific cause for the engine stoppage was found. The amount of fuel actually in the fuel tanks after the accident was negligible; something like three-quarters of a litre was actually recovered from the tank. But an aircraft that has turned upside down is most likely to lose any fuel that would have been in the tanks pretty quickly especially as the glass fuel gauge, situated on the top of the tank, had broken. It is probable fuel had leaked from the tank into the surrounding area but, and it important to note all the evidence available, there were no signs of fuel leakage. Investigators actually went back to the scene in the weeks following the incident to see whether there were any changes to local vegetation - there were none visible.

Could the aircraft simply have run out of fuel? It is possible, based on the fact there was no post incident evidence of fuel leakage. Also, the engine did not stop due to a catastrophic failure, this was attested both by the witness and by subsequent engineering examination. Certainly, engines do "run down smoothly" when starved of fuel. The AAIB established during witness interviews during the investigation that the fuel drain had been seen leaking earlier in the day but this had been fixed before the day's flying had begun, but a later in-flight leak cannot be ruled out.

There is some evidence against the "running

Here's a picture of one of the pistons from the ENMA Tigre engine that stopped mid flight which lead to the unsuccessful field landing described in the text. The Tigre IVA is nominally rated at 125 HP and is similar in layout to the Gipsy Major engine. Inverted engines like this employ clever design features that prevent oil from the crankcase entering the business end of the cylinders, note the lower oil control ring. Low compressions caused by stuck rings on this type of engine is bad news. Not only will there be the usual difficulties in starting, and an inevitable power loss, but the engine will have the added problem of oiling up the sparking plugs; and this can happen, in some circumstances, during a flight.

PHOTO AAIB

out of fuel" theory. The passenger, not a regular flyer, reported she saw the indicator ball in the float type fuel gauge "bouncing up and down" just before the engine stoppage. One presumes that there must have been fuel in the gauge at least for this to have been seen.

Another compelling reason, and why I personally don't think that this is the cause, is that the aircraft was refuelled just before the previous flight and there are bowser records for this. More importantly in my view, the pilot was well used to the aircraft and was known to be extremely fastidious and careful, it is most likely this pilot would have known exactly how much fuel he had... and it would have been enough for the sortie.

The aircraft was recovered from the scene and taken to Farnborough for examination, the engine was removed and fitted to a test rig. Before I look more closely at what was found during this examination I would like to whizz back in time to the events that started the day.

The object of the day's flying was to give a bunch of friends an air experience flight. The pilot planned to give six flights in all and was assisted during the pre-flight preparations by a friend, who is also a pilot. At the end of the six flights the pilot was planning to have a flight with his regular flying partner. At the beginning of the day, a pre-flight inspection was carried out in the hangar and the fuel tank topped off with about four and a half litres of fuel.

The pilot and his assistant pulled the aircraft out of the hangar and attempted to hand-start the aircraft. To quote the AAIB report, "this proved difficult". This may be a slight understatement as it took the pair of them over 40 minutes to start the engine. Could there be a lesson here somewhere? If there hadn't been half a dozen expectant passengers waiting, would the pilot have called it a day after a sensible period of hand-swinging and call in some engineering expertise? We will never know the answer to that, of course.

'Cylinder compressions were checked and found to be low on cylinders 1, 2 and 3'

Before the engine was stripped for a detailed inspection it was placed on a test bed and the original propeller, which was undamaged in the accident, fitted. The engine proved very difficult to start and, once started, would only be kept running by pumping the throttle and operating the electrical fuel pump (which is part of the test rig). The engine fuel pump was then bypassed and fuel was supplied to the engine using the rig's electrical pump only. The engine ran normally and, during this run the magnetos and fuel consumption were checked, these were both normal. When full throttle was applied however, oil started to leak from the oil filter housing and smoke emanated from the oil breather. This latter problem is often associated with a pressurising crankcase, commonly due to inoperative or seized piston rings.

The cylinder compressions were checked and were found to be low on cylinders 1, 3, and 4 and there was no, or at least almost no, compression on cylinder number 2. Further checks did not find any other faults except that the engine was "very oily" in the barrels. The engine had accumulated 2,754 hours since new (1952) and 436 hours since overhaul (in 1984, by the Spanish Air Force). A point noted in the AAIB report was that in Spain the recommended TBO for this engine is 450 hours but, when operated by the military, engine overhauls were carried out in the region of 200 to 300 hours. This engine was therefore within its TBO using one measure, but well outside using another. This is often the problem when assessing the airworthiness of vintage or veteran aircraft... which rule do you follow?

To return to the engine inspection. It will be noted by the reader that we have two separate problems here, the first being an unserviceable fuel pump and the second, a general low compression. During the engine strip inspection the fuel pump was removed from the engine. The pump's drive was intact and the pump rotated freely. When the pump was tested it was only able to produce 1.5 psi at full rpm, the book figure for this pump is 4.26 psi.

Before I expend a little ink discussing these findings and, bearing in mind my earlier comments about causes and responsibilities, I will write here the AAIB's conclusion:

"The accident was caused by the aircraft striking telegraph cables during an attempted forced landing following an engine failure. No single cause could be determined for the engine stopping. The hazards of unplanned off field landings are considerable, however, wire strikes during forced landings are fortunately very rare occurrences and therefore no Safety Recommendations are considered appropriate."

Personally, I've never had a Tigre engine to pieces, so I gave LAA'er Mike Vaisey of Vintech, the vintage engine specialists based at

Little Gransden, a call to see what thoughts he had about this failure. He agreed that, failing an obvious single cause for the engine failure, we will probably never know why the engine stopped as it did. I did though, get a great 'primer' about the engine type and the problems they see with the engine.

I noted with interest that the AAIB included the ubiquitous Carb Icing Prediction Chart implying, if not actually stating, that ice may have been a factor.

Perhaps, as I have previously said, this accident was the focal point for a number of separate factors that, individually, may have passed unnoticed.

During my discussions with the investigators at the AAIB it was interesting to hear the viewpoint that, had this accident not been a fatality, the engine failure would probably not have been investigated by them. We've started to look into all the reported engine failures suffered by LAA aircraft which is improving the resolution of the overall picture. Herein lies the problem associated with every accident/incident/event statistic published: the quality of the result can only ever be as good as the quality (and in this case quantity) of the data.

I also spoke to Mike's colleague at Vintech, another LAA'er of course, Paul Sharman. Paul has had a lot of experience with these vane type fuel pumps and explained that the problem of low pressure output can normally be traced to wear in the shaft's bushes and not the vanes themselves. This is because the vanes are normally well lubricated with fuel and the bronze bushings are less well served.

The pump, as you can see from the photo, is a fairly complicated device in its own right and requires specialist tools (and knowledge) to take apart. The fact that this pump produced a low pressure on the subsequent engine test, and the extent of the wear in the pump itself, points to the fact that this pump had been operating below par for some time.

It's easy to overlook a low pressure reading in the cockpit, especially if the engine is running fine. If it ain't broke, why touch it?

LESSONS TO LEARN?

1. If an engine's starting behaviour changes don't ignore it.

2. If you are going to take a few friends flying then make the most of the occasion, maybe it would be better to fly them on separate days. Spend some time really showing them what's it's like owning and operating an LAA aircraft, and perhaps finish the day with a pub lunch. Promising a large group of people a flight, even for the best of reasons, simply piles on the pressure.

3. If you see fuel, or anything else for that matter, leaking from an aircraft over an extended period of time there's probably something wrong, don't ignore it.

4. Never become over-familiar with an aircraft's foibles, this may lead to complacency with regard to a 'particular behaviour'. "Oh, it always bangs and coughs every few minutes, well, it's forty years old, don't you know?" is not a professional approach to managing an aircraft. If the engine manual says the limits for something or other are X then don't fly the aircraft unless the indications given are within these limits. If you don't trust the gauge, then replace it, or get it fixed.

5. Finally, looking after old things, especially engineered old things, is both a privilege and a responsibility. If you are like me, and get a tightening in the chest when you see a beautifully restored engine fire into life, then you will understand my concerns when I see people operating with a 'reduced' maintenance requirement on their engines because the aircraft is 'now operating on a Permit'. Pilots wouldn't have flown an aircraft 40 years ago with a suspect engine regardless of who certified the machine. We mustn't even think of doing so now just because, perhaps more especially because, it might be getting a bit 'long in the tooth'.

The subject of engine overhaul is a complicated one naturally. The LAA uses the phrase 'On Condition' regularly when defining whether an engine is fit, or not fit, for service. 'On Condition' implies that as long as the condition of the engine appears ok then it is ok. This is only partially true.

Actually, the definition is rather more specific in that an engine is considered fit for service if it complies with the requirement of GR 24, more especially, Appendix 3 of GR 24. This Generic Requirement superseded the UK's Airworthiness Notice Number 35.

GR 24 allows for the continued use of some aero engines after their published overhaul period subject to demonstrating the engine is in every respect fit for service. This requires that the engine, and its associated components, all function adequately and that the engine has good compressions on all cylinders. Oil consumption is also a factor as is corrosion, especially internal corrosion for reasons we have many times discussed.

It's a very sad day when somebody gets killed in an aircraft accident; this sadness can only be multiplied when nothing is learnt from it. This particular incident has many of the features I see in day to day reports as they cross my desk. Individually, these reports become 'only so much paper'; I try hard to let you know about them, as you know.

Just occasionally, there will be a supernatural conspiracy which will end in a few of the events, normally just destined to a report, causing an accident. Pete Harvey, the LAA Chief Executive likes to use the Swiss cheese analogy, I expect you've heard it. "If there are enough holes in a block of cheese every now and then they will line up."

I list above a few of the lessons, as I see them. I expect you will have a few ideas of your own about how this particular incident could have been avoided. I am not suggesting that any of my thoughts are directly associated with the loss of the Jungmann, the conclusions of the AAIB report speaks for itself, and I don't own a crystal ball... they're lessons nonetheless.

PHOTO AAIB

You can see here how complicated this disassembled vane type fuel pump is. Vane pumps work by transferring the energy from the vane into the fuel, pressurising it. The method of operation is rather like a backwards water wheel, perhaps a paddle steamer would be a better analogy. Output pressure is regulated by an adjustable spring type relief valve. For these pumps to operate well they need to be in good condition.

PHOTO AAIB

In this picture the shaft and bearing can clearly be seen. Normally the problem of a low output from a pump can be traced to wear or leakage due to wear. In the case of a 'vane type' pump the wear is not generally found where you would expect it, at the vane/cylinder interface. This is normally very well lubricated by the fuel, the problem, as in this case, is wear in the bearing which caused the vanes to run 'skew' in the cylinder. Turbulent flow is the result reducing pressure output.

Pulsar XP - fuel pump leak

ACTUALLY the title of this necessarily brief section of Safety Spot is a little misleading as the leak was never really witnessed, the hole was spotted first. Let me explain.

Our story begins at the LAA Rally a couple of weeks ago at Sywell. What a great event it was, reminiscent of days gone by and well done to everybody for making it a really safe event. Just as an aside, I never got further than about 10 metres from the engineering stand, but it was great to spend the day chatting to you all about various airworthiness issues. I learnt a lot, thanks for spending time letting me know about your airworthiness concerns. Back to the hole.

If you were lucky enough to attend the Rally you may recall the Pulsar that was used as a 'spot the problem' aircraft on the GASCo display. Well, I introduced myself to the aircraft's owner, Dave Stansfield, and had a bit of a chat about the various issues; you can imagine the sort of thing. "What's the response like"? "Brilliant"! "Do people find all the 'built in' issues? "Er, yes... well, yes and no".

I asked Dave what he meant and he explained that the one built-in thing that everybody, or at least, nearly everybody missed was a pair of pliers lying on the floor by the central console. I took a quick picture and thought that it would be useful to remind Safety Spot readers about the dangers of leaving tools about!

It should be noted here that this sort of quiz is good fun, and it's always good to test oneself. The important lesson (especially if you miss something) is that you know there are problems and are looking hard to find them. It's a bit like the 'where's Wally' pictures I used to show my kids when they were younger. You knew there was a 'Wally' but just where? The real problem with daily inspections, and we have alluded to this elsewhere in this Spot, is complacency. I don't need to look at this very closely because I know that it's ok, "it's my blooming aircraft after all!" Human factors being what they are you're not likely to look too hard if you're not expecting to find a problem. Especially, and here's the rub, when the last thing you want to find is a problem. Anyway, back to the Pulsar.

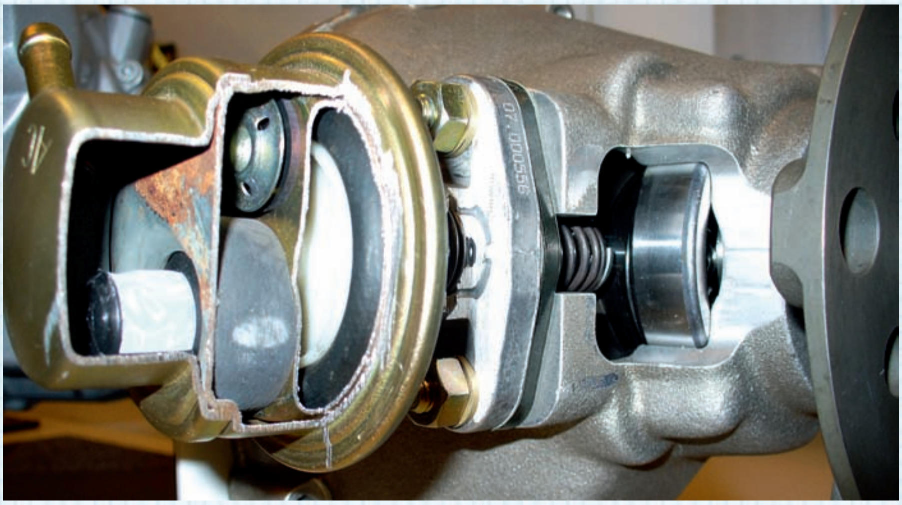

PHOTO Conrad Beal

Later Rotax engines use an AC fuel pump but the 'workings' are essentially the same as the Pierburg featured in the text. This pump operates using the principle of positive displacement. A cam, on the gearbox output shaft forces a transfer shaft up through the body of the pump to the diaphragm which moves reducing the volume in the cylinder. A spring keeps the shaft pressed against the cam. There are two non return valves fitted, an inlet and an outlet. This sort of pump has proved very reliable but a leak in the diaphragm will stop it working completely as will the failure (perhaps through debris) of either valve. Wear in the cam/or shaft will reduce output and therefore delivery pressure. It's always a good idea to have a fuel pressure gauge, they are cheap and easy to install.

Dave went on. "You haven't heard about the fuel pump then?" Actually I had as, just a few minutes earlier, a chap popped over to the engineering stand with a great big grin on his face exclaiming that he had found a problem with the GASCo Pulsar that hadn't been introduced, in other words 'A REAL ONE'!

The enthusiastic chap, almost needless to say, was the Rotax aficionado, Conrad Beale. Well done to Conrad for spotting this fault which would have probably led to an in-flight event on David's flight home, perhaps an out field landing or a fire. The pictures tell their own story here so I won't go on about it except to say that it is often the case that the softer material will wear out the harder one. Here, the soft fibreglass wore straight through the steel casing of the fuel pump. I also ought to point out that Conrad was really reluctant to let me use the photo of the cutaway fuel pump because, as he rightly points out, it's full of corrosion.

Conrad pointed out that this is just a demonstration pump that lives in his garage, hence the corrosion. I promised to remove the traces of corrosion using Photoshop but, as the result of this photo editing looked like an attempt at a drawing of a cat by a three year old, I decided to discount the picture and enrol on a night school course in photo editing!

Fair winds.

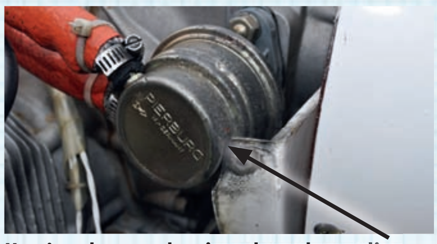

PHOTO Malcolm McBride

Here's a close up showing where the cowling was rubbing against the fuel pump. Often a soft material will wear straight through a hard material. This goes against the grain somehow. In this case of course the glass filaments in the glass fibre mat acted as a perfect abrasive.

PHOTO Malcolm McBride

You can see the exposed diaphragm clearly in this picture. The pierced chamber is on the pressure side of the pump.

PHOTO Malcolm McBride

Where's Wally? Can you see the offending tool? Most people didn't see it at the GASCo find a fault competition held during the Rally at Sywell.