SAFETYSPOT

Mystery of the Tipsy sunglasses

The D box hides the answer! Sadly, items in the D box are not usually items of mirth – they have caused loss of control and death

I used to be pretty keen on gliding. Well, obsessed would be a better way of describing it. My love affair started, as with many I suppose, with the Air Cadets.

I thought that I had died and gone to heaven when I was sent off on an A&B gliding course to Halton by the Squadron Commander.

I will never forget the first morning: the weather was absolutely filthy all the way there; I had an ancient moped; I arrived absolutely soaked. Those of you, and again I expect there are many, who started their flying training in this way, will remember what those old uniforms felt like wet – ugh!

I can remember that as I lifted my motorized whizzer up onto its stand alongside 613 Gliding School hangar, the weather suddenly changed and became a beautiful September morning.

In those sadly long-gone days, the idea was training by numbers. It sort of had to be because of the huge numbers of cadets keen to get the coveted A&B gliding badge, but the system worked. Up on the winch to 800ft... turn right 90°... 650ft... turn right 90°... downwind checks (no, I cannot remember them!)... 45° angle with the launch point... turn right 90°. When aligned with the centre of the airfield – yes, you've guessed it – turn right 90°... land straight ahead... middle of the airfield... The use of spoilers was considered 'advanced' training.

After landing, you remained in the cockpit as the glider (in my case an old Kirby Cadet TX Mk 3) was manhandled onto a specially designed trailer and driven back to the launch point.

Each cadet got three goes at a time and, after 12, I was sent up on my own. Twice more and you were shown the door with 15 launches in the log book and a badge. Those were the days!

As I was sitting down to write this article, I was reminded of those days by an email sent to me by one of our Inspectors, Neil Spooner. You might remember Neil's tale where he describes (rather well I thought) a scary moment when his Nipper was reluctant to exit a fully developed spin (Flat Spin Nightmare, *LIGHT AVIATION*, January 2009). Neil had a couple of things to talk about; the first being the very great mystery of his 'lost' sunglasses and the second, the rather harrowing tale of a forced landing in his Tipsy Nipper a few weeks ago. Let's start with the Sunglasses.

NOW, WHERE DID I PUT THOSE GLASSES?

The reason I was thinking about my early days in the gliding community was that I remember a story related to me by a BGA Inspector who was inspecting a K6 wing that I had rebuilt. He wanted to see inside the 'D' box before I closed it up, quite rightly. But I was moaning about this delay, itching, as I always seemed to be then, to get on with it!

He described a time when he had opened-up the 'D' box on an early type (I cannot remember the type of machine now) and found a chap's tea mug glued to the bottom skin. There had obviously been tea in it when it was left in the wing because the staining had spread right up to the next-but-one rib.

A few years later, there was the tragic fatality of the well-known RAFGSA CFI (a couple of near acronyms: Royal Air Force Gliding & Soaring Association Chief Flying Instructor, phew!) Andy Gough. If I remember it correctly, the accident that lead to Andy's death was caused by a tool left in the fuselage jamming the elevator. Andy used to give the gliders under his command a 'bit of stick' and, during one thrashing, he was unable to pull the nose through following a loop and struck the ground.

Regular Safety Spot readers will remember my personal tale of woe about a torch and a stuck-up undercarriage (see *Check, check and check again*, issue 11, if you fancy a laugh). So it can happen to us all.

Neil's glasses were found balancing, like an acrobat, on an elevator control cable dangerously close to the elevator's 'mechanics'. Good spot Neil and thanks for sharing.

PHOTO Neil Spooner

View looking from the pilot's seat, one lens missing!

Spark plug failure

Prompt action after detecting a misfire averted an engine fire in flight. Investigation revealed something LA Engineering hadn't seen before

The main reason for Neil's email was to describe an incident that happened recently during a flight from his home base of AndrewsField (Great Saling).

I have been told that AndrewsField is now famous for its bacon and egg baguette, but I have yet to have the pleasure. Neil takes up the story.

"I have never liked Champion spark plugs (based on 21 years of experience) – not that there is an immediate problem with them, I have always preferred NGK or Bosch. Due to the lack of availability of NGK of the correct heat range, I had to settle for some Champions, which I fitted as the lower spark plugs in my Nipper. Shortly after take off (about 100ft AAL), I experienced a very bad misfire and power loss. I immediately carried out a very low-level circuit (not above 100ft!) declaring a PAN, which I upgraded to a Mayday when I could smell burning. I made a normal landing and shut down the engine."

Neil allowed the engine to cool down a bit before removing the engine cowlings. He continues: "It would seem that the exhaust gases had leaked past the insulator and burned their way through the metal side of the body. The hot gases had then started to burn the cylinder head cooling fins and the pushrod tube just below it. (This would have then set fire to the leaking engine oil.) I had fitted a fire retardant/heat insulator cloth around the pushrod tubes to reduce heat soak into the pushrod tubes from the exhaust silencers."

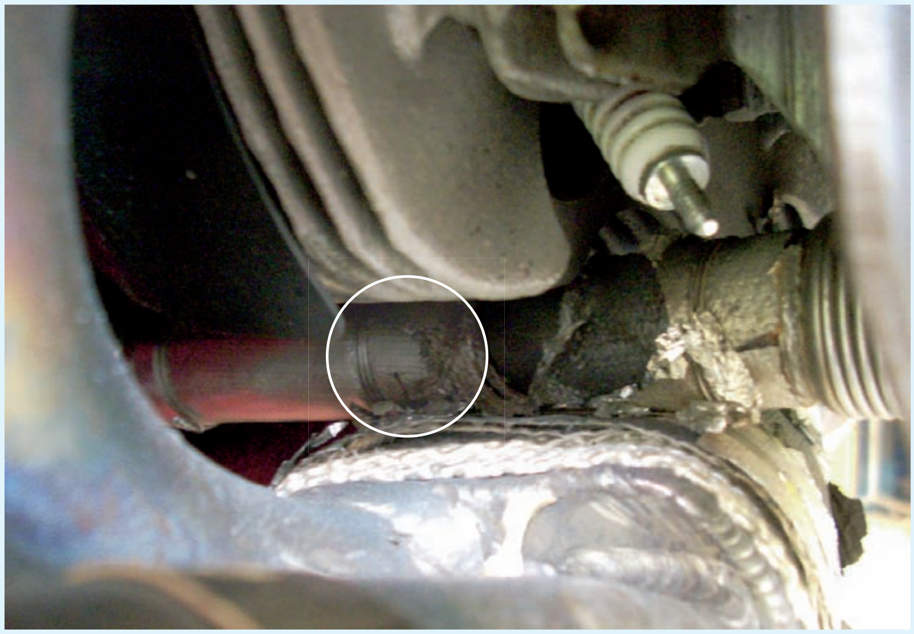


PHOTO Neil Spooner

Gas flame can act like a blowtorch: Damage to push-rod tube shown above.

The reason for the misfire was a more-or-less complete loss of compression on one of the cylinders. The four-cylinder 1835 Volkswagen engine had, in effect, become a 1376 three-cylinder – a bit ahead of its time! The fourth cylinder had been converted to a blowtorch and Neil did a good job of getting back on the ground quickly. As he said earlier, it wouldn't have taken long before he could have been flying with a very serious engine fire, so well done to him.

Neil sent the offending plug to us and I've been showing it around among the engineers here at Turweston. I've certainly never seen anything like this, and neither has the rest of the gang.

Neil sent us another plug from the set, which clearly shows witness marks where gas has been escaping between the metal body and the ceramic insulator and, after a pressure test, is clearly leaking.

Follow the witness marks up a little and a small amount of damage can be seen on the base of the plug cap.

These spark plugs had only been in service for 22 hours. I would definitely be interested if any of you out there reading this have any experience of this type of thing.

PHOTO Neil Spooner

"Err... how did you say one should adjust the plug gap?": Centre electrode and insulator completely missing. The fact that there was no damage to cylinder bore or piston crown suggests that the debris of this failure exited the engine through the exhaust valve.

FIRST THOUGHTS

My first thought was that there was probably something up with the engine, or perhaps, the fuel. But after chatting to Neil, I am minded to agree with him that this is a problem with the plugs themselves. Spark plugs operate in a complex environment: at the 'action' end they have to deal with a temperature that oscillates massively at each firing, while the 'outside' of the plug exists in the completely different world of 'not far away' from ambient temperatures.

As I am sure you will know, much can be read from the colouration of the hot end of a sparking plug, particularly information regarding the mixture of the fuel/air charge.

It has long been known that there is a problem of balancing the mixtures on the Volkswagen engine due to the arrangement of the induction tubes and, sometimes, strange turbulence within the carburettor body. Often Volkswagen engines have a 'hot' side and a 'cold' side and there have been many discussions over the years as to why this should be. Neil knows about this and has checked the cylinder of the offending plug using a boroscope and found no other problems.

One particularly damaging problem that can occur in four-stroke spark ignition engines is the dangerous occurrence of detonation. The reason I call it dangerous, is that the phenomenon can seriously damage engines. In the automotive world, detonation is known as 'pinking' and can be detected audibly as a pinging (or knocking) sound as the engine is put under load. You may recall various anti-knock substances being marketed for use in fuel for use in so-called high-performance engines.

Detonation in an engine is due to a disturbance in the normal burn during the firing of the fuel air mixture; it is, in effect, an uncontrolled combustion. Engine designers talk about a combustion wave front, which starts at the ignition point (the spark plug) and moves across the combustion chamber smoothly. As the temperature rises fairly steadily, so do the compression forces.

If the compression is too high, or the octane rating of the fuel is too low, the fuel air mix can spontaneously catch fire – in effect, explode. This can happen anywhere in the cylinder and is not necessarily connected to the spark (initiator). Generally, the rate of combustion

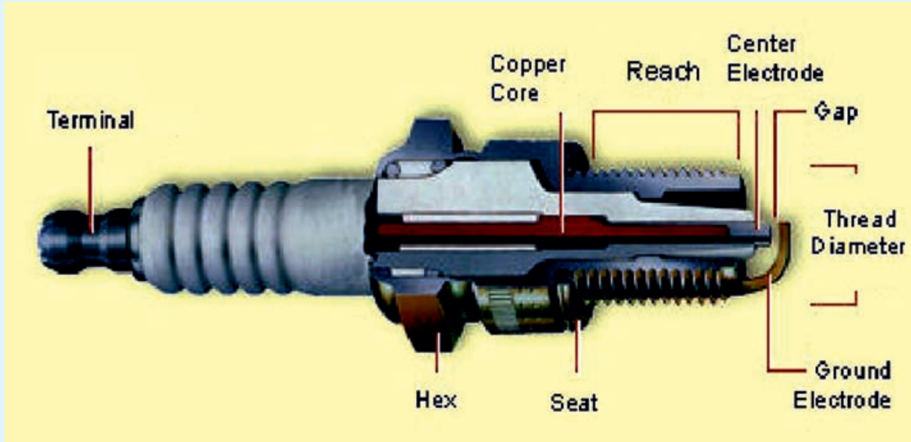


PHOTO Sparkplugs.com

The construction of a typical automotive sparking plug, which has remained unchanged for many years and is usually ultra reliable. Was it just a case of Neil's coming from a rogue batch?

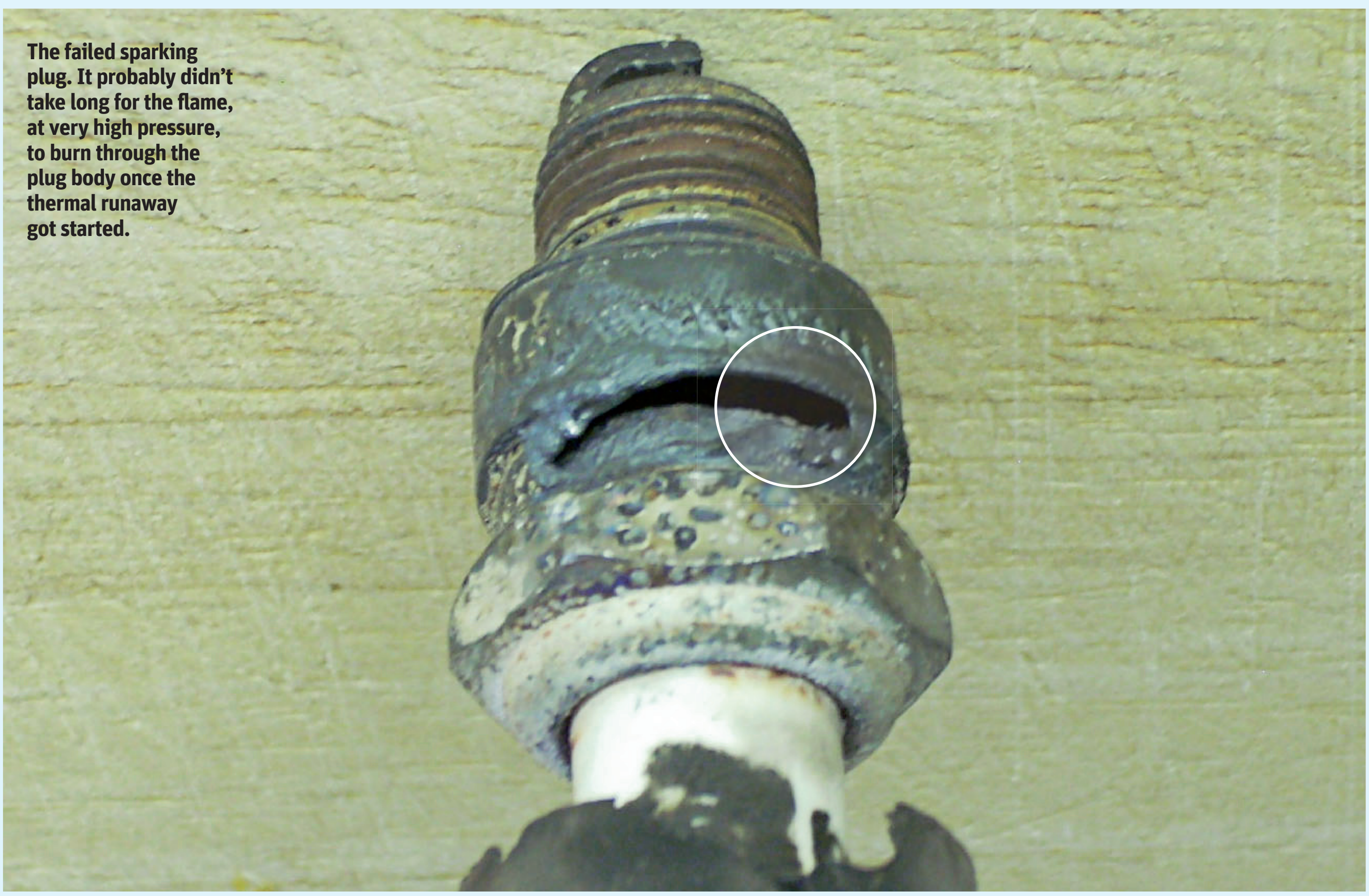
increases with pressure (bomb theory!) – so, couple a faster burn with, perhaps, multiple burn origins and you will arrive at a very different pressure profile in the cylinder than was designed for. Result? Broken engines.

While detonation can be heard in an automobile, I do not think that it would be possible to hear this phenomenon in aircraft, for fairly obvious reasons. However, one other effect of detonation is loss of power – and, of course, bits of cylinder head flying past one's ear.

One engine phenomenon, beloved of aeronautical engine exam setters, is often confused with detonation; this is pre-ignition. The net effect is similar in that there is some considerable loss of power, but it is less damaging to engines. Pre-ignition is sometimes referred to as run-on, as, if the condition exists, the engine continues to run after the ignition has been switched off. It's easy to miss if you always use a 'lean cut' to stop your engine.

What's happening with pre-ignition is that a point within the cylinder is acting like a glow plug. This point may be anything from particles of carbon to the wrong temperature grade of sparking plug. Either way, if you detect pre-ignition you must investigate.

If you're thinking about giving me the benefits of your thoughts about this, and I would be very glad to receive them, then I should tell you that Neil's engine has recently been fitted with a Leburg ignition system. Chaps have told me that the spark emitted from this device is pretty powerful – is this something we should be aware of?



The failed sparking plug. It probably didn't take long for the flame, at very high pressure, to burn through the plug body once the thermal runaway got started.

Investigating on-going power loss

Never ignore the gradual loss of power experienced as an engine gets older – it could cause a fatal failure

One of the main reasons the LAA asks for a climb performance check at max take of weight allowable, or as close to as is possible, is to keep an eye out for developing engine problems.

I've been moaned at by quite a few aircraft owners when I've sent their annual Permit inspections back unsigned because the flight test was carried out too light.

OK, I've got a fair amount of discretion when it comes to what sort of climb I can accept (thank goodness), but it's the relative climb rate I'm really looking at. If I think that a climb is a bit 'down', then I always have a look at the previous year's figures and, quite often, a trend (normally downward) can be seen.

The very distressing accident in August 2007 which took the lives of four people, three of them LAAers, serves to remind us all that engine performance can decline over time. In this incident, a PA28-140 crashed after take off at Sandown (IOW) primarily due to a reduction in power caused by a worn-out camshaft.

The aircraft concerned was not an LAA machine and held a full Certificate of Airworthiness, so I will not dwell on it here, but the excellent AAIB report (EW/C2007/08/01) should be required reading for pilots, especially if they intend to operate their aircraft at (or close to) maximums.

Detecting camshaft wear is a difficult one and, with a fixed pitch prop, the first sign may be that full rpm cannot be achieved on the ground – a small rpm decrease may reflect a large power reduction.

Keep an eye on your climb rate; any continued reduction needs to be investigated. I received an email from a fairly new member recently, which worried me a little. This chap, Neil Dykes, has a fairly recent PPL and is the proud owner of a FRED, which many of you will have seen and lusted after (I really like FREDS).

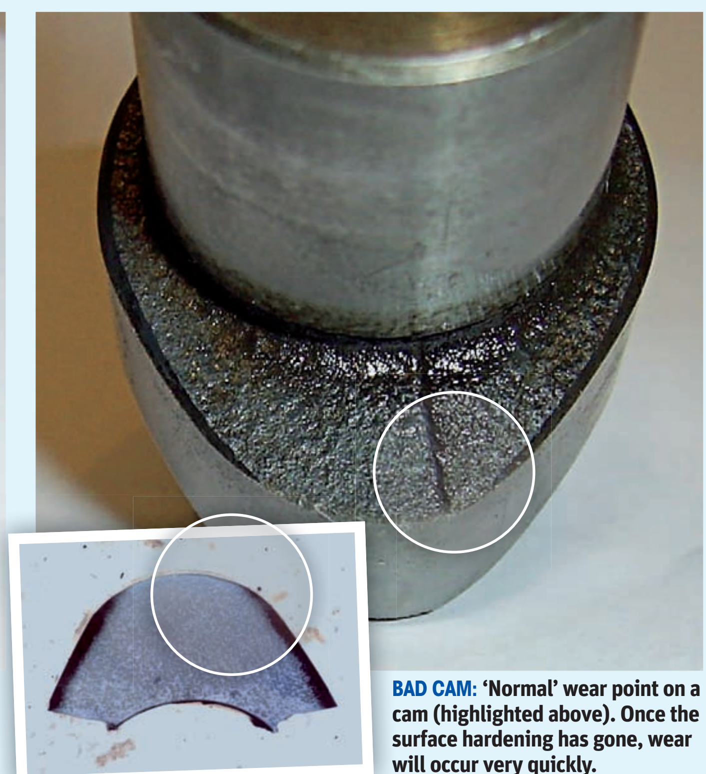
It turns out that this particular FRED had not flown since about 2002 and had been 'retired' due to a very poor climb rate. I should point out quickly that, like the Tipsy Nipper tale above, the noisy bit at the front of this FRED is also a Volkswagen conversion.

The aircraft's resurrection started last year when the cause of the poor climb (low power) was investigated. Barrels were changed and the ignition system upgraded to a Leburg electronic system, all to no avail. So drastic action was called for – a couple of inches were taken off the tips of the propeller! At this point the story descends into the kind of madness 'oft found in despair' but, eventually, Neil had a chat with an engine expert who suggested that the 'bottom end' should be inspected. The engine casings were duly split in half and the cause of the low power became very clear; the camshaft was worn out.

A camshaft is one of those components that need to demonstrate different – and in some ways rather conflicting – properties. On the one hand, the material needs to be extremely tough so that it performs its basic function in opening the poppet valves (which, therefore, creates a fluctuating stress), but is resistant to fatigue (ie at the lower end of the s-n curve). On the other hand, the wear surfaces, particularly the cams themselves, have to be extremely hard. There are a number of ways in which these qualities are imparted into the material and it is worth spending a couple of moments describing this cleverness!

Those of you who have had any technical training will probably have heard of case hardening. As a boy, I can remember heating a mild steel chisel (the result of much bashing, filing and fettling!) to cherry red in a furnace and 'plunging' the tip into case-hardening

GOOD CAM: Note even chamfer around the edge of the cam lobe on this example of a new camshaft.



BAD CAM: 'Normal' wear point on a cam (highlighted above). Once the surface hardening has gone, wear will occur very quickly.

PHOTO Neil Dykes and HT Consultants

With Malcolm McBride
Airworthiness Engineer

compound – essentially Carbon – then heating it again and 'quenching' the tip in cold water. There's no better pursuit for a 13 year old, but I bet kids wouldn't be allowed near a forge these days! In the case of my chisel (which still works) similar properties to those needed in the camshaft are required (ie lots of whacking, yet a very hard face).

There are three normal ways camshafts are heat treated; the most common is induction hardening. In this process, a high(ish) frequency-alternating magnetic field heats the surface of the material extremely quickly before being quenched. The depth of hardening achieved can be as much as 0.080in (80 thou!). The problem with this method of hardening is that, due to massive variances in mass and shape, it is difficult to achieve even heating and cooling.

The other two methods use chemistry to achieve a hard surface: tuftriding uses hot cyanide and nitriding uses nitrogen gas. Both of these methods avoid imparting internal stresses into the material, but the downside is a much shallower surface hardening (between 5 and 10 thou typically).

Interestingly, German engineers have come up with a system called 'chill hardening', whereby the camshaft is cast in a special mould designed to cool the surface of the cams very quickly, causing the carbon on the surface to create the appropriate hard surface, but I think that Neil's camshaft is probably a little old for this sort of technology.

It will have been noticed, by the astute reader, that once the surface hardening on cams is damaged, cam wear will happen very quickly indeed. For this reason, corrosion (particularly on the cam lobes) needs to be avoided and, if found during inspection, carefully investigated.

Francis Donaldson, our Chief Engineer, relates a story about a Volkswagen engine that 'lived' in a scout hut for five or six years before he purloined it. The engine was duly fitted into the front of his shiny new VP-2 but, for reasons described above, the engine didn't last long.

Kit-built aircraft often sit out the winter within the relative safety of a hangar, but it doesn't take long for corrosion to start in our very variable UK climate. Often pulling the propeller through a few times 'to get the oil moving' may cause more harm than good because cylinder walls, piston rings, cams and cam followers receive their lubrication from 'splash' and vapour created by the crank. It's important to know that just a couple of pulls through will wipe off the oil film and allow corrosion to start.

I have recommended before that it is a good idea to run an engine every couple of weeks *UP TO TEMPERATURE* if you want to avoid internal corrosion. Lycoming Service Instruction L180B gives advice about longer-term storage of engines. You can download a copy off the web.

Fair winds.

A FRED to lust after – that of Alistair Sutherland from the Scottish Highlands.