Stampe SV4C(G), G-OODE

AAIB Bulletin No: 10/2004	Ref: EW/C2003/07/08	Category: 1.3
INCIDENT		
Aircraft Type and Registration:	Stampe SV4C(G), G-OODE	
No & Type of Engines:	1 Gipsy Major 10 Mk 1 piston engine	
Year of Manufacture:	1947 (airframe)	
Date & Time (UTC):	26 July 2003 at 1532 hrs	
Location:	Former quarry near Redhill, Surrey	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Separation of propeller, forward portion of crankshaft and forward upper portion of engine crankcase	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	61 years	
Commander's Flying Experience:	1,586 hours (of which 398 were on type)	
	Last 90 days - 4 hours	
	Last 28 days - 1 hour	
Information Source:	AAIB Field Investigation	

History of the flight

The pilot, who was also the owner of the aircraft, departed from Runway 19 at Redhill Aerodrome, turned left onto a northerly heading and levelled off at 1,000 feet, with the engine at 1,900 RPM. The pilot's intention was to practise aerobatics to the north of the M25 but, about one mile to the north of the airfield, the engine faltered and the pilot saw an object fly off from around the propeller hub. This was followed almost immediately by the pilot observing the propeller detach itself from the engine. He closed the throttle, turned off the engine switches and made a MAYDAY call to Redhill, stating that he had lost his propeller and was making a forced landing.

Looking for a suitable landing area, the pilot found his options were very limited by standing crops. He then noticed a green area which was upwind and he was able to make a successful 'three point' landing. He found that he had landed in a former quarry which had been filled and grassed over. The pilot made his way by foot to the security guard at the gate and he was able to contact the airfield by telephone. The police arrived soon afterwards.

Examination

Figure 1 shows G-OODE shortly after its forced landing.

Figure 1 G-OODE after forced landing

Figure 1 - G-OODE after forced landing

It was immediately apparent that there had been a substantial failure at the front end of the engine, resulting in fractures of the crankshaft beside the No 1 cylinder big-end bearing (see Figure 2), the No 1 cylinder connecting rod and the front end of the crankcase.

Figure 2 Failed crankshaft, No 1 cylinder and fractured connecting rod

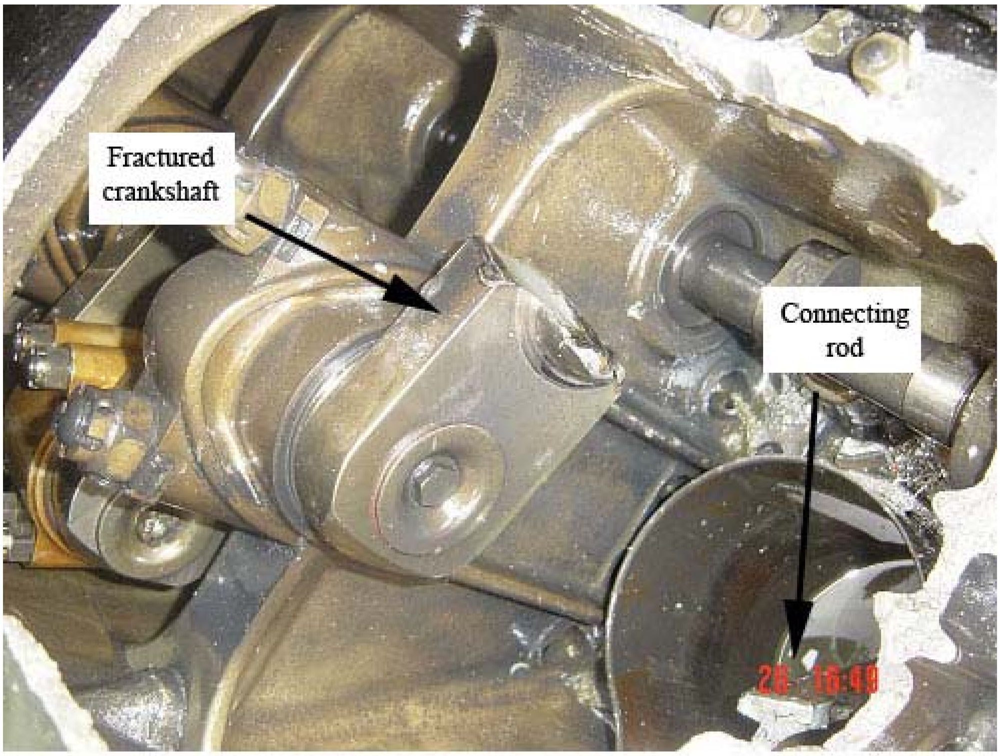

Figure 2 - Failed crankshaft, No 1 cylinder and fractured connecting rod

These fractures had released the propeller, together with the missing forward portion of the crankcase and crankshaft. Most of the No 1 cylinder connecting rod was recovered from the engine compartment although much of the big-end cap and two of the four big-end bolts were missing. The forward portion of the crankshaft and crankcase, the propeller hub and the propeller were found at a later date, having suffered corrosion damage. All the pieces of the wooden propeller were found close together on the ground, indicating that the propeller was broken by the impact with the ground and had been intact in the air.

The engine was later stripped and examined by the AAIB at an overhaul facility. The three major areas of fracture were confirmed: the failures of the big-end bolts, failure of the No 1 cylinder connecting rod and failure of the crankshaft. There were no indications of any excessive wear or lack of lubrication in any part of the engine.

Metallurgical examination

A detailed examination of the fractures was undertaken by a specialist metallurgist. This indicated that the big-end cap was properly in place when it had been subjected to a high twisting load, resulting in the failure of the big-end bolts and separation of the big-end from the crankshaft. This was also consistent with the failure of the connecting rod when it was subjected to a high overload by the failure of the crankshaft and collision between the cylinder skirt and the connecting rod (see Figure 2).

The crankshaft failure showed evidence of fatigue. Figure 3 shows the fractured crankshaft as received, with the fracture at the junction of the No 1 crank pin and its web, the forward portion of the crankshaft having suffered extensive corrosion damage before recovery.

Figure 3 Fractured crankshaft

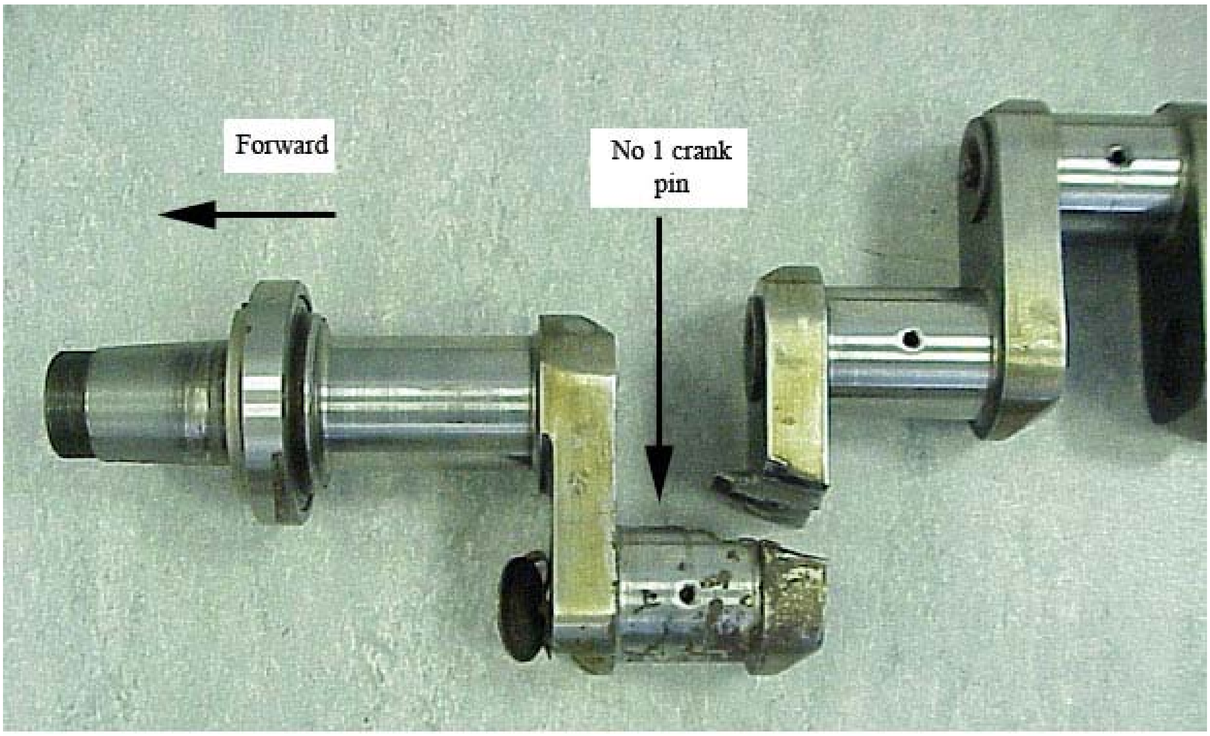

Figure 3 - Fractured crankshaft

The fracture surface (Figure 4) of the main portion of the crankshaft showed hemispherical beach markings on both sides of the bore, characteristic of fatigue cracking. On one side of the bore (the left side in Figure 4) the presence of a shear lip at the bore and the direction of the ridges running across the beach markings (at approximately 90°) indicated that the fracture had initiated in the radius of the No 1 crank pin. On the other side (the right side in Figure 4) the direction of these ridges indicated that the fatigue crack had originated at the surface of the crank pin bore.

Figure 4 Detail of crankshaft fracture surface

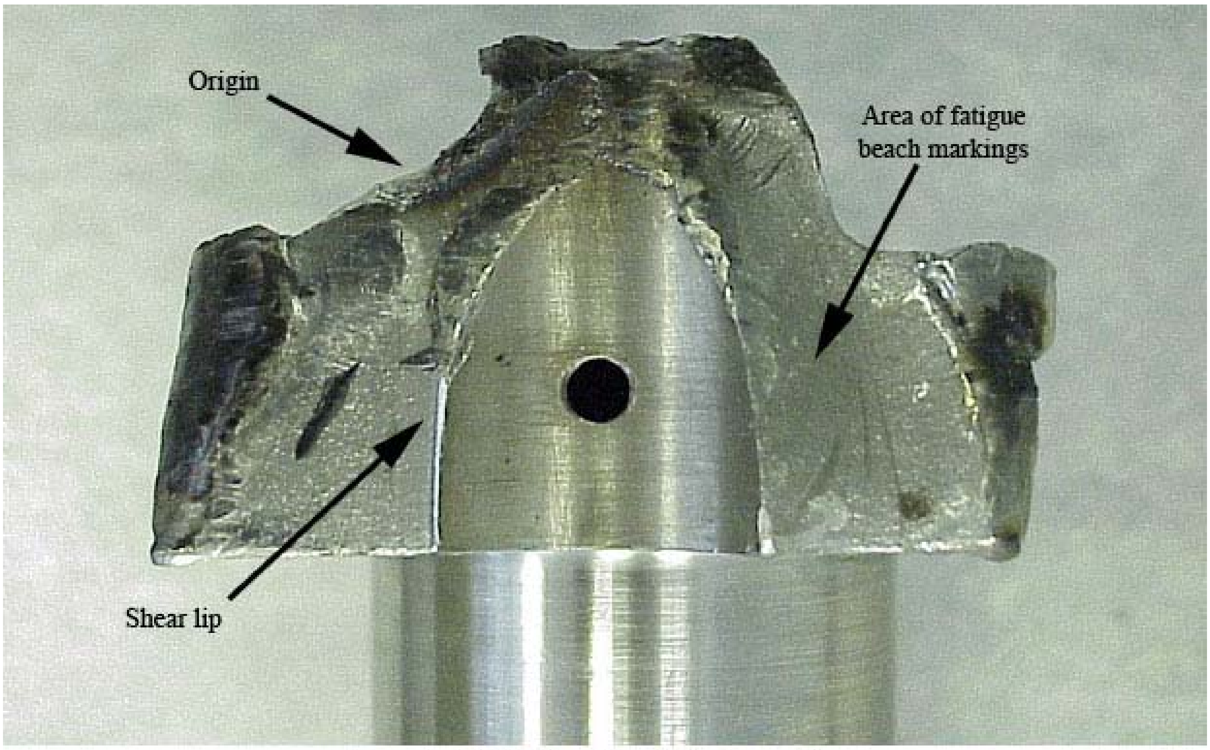

Figure 4 - Detail of crankshaft fracture surface

The radii of the No 1 crank pin were examined in detail and showed a small amount of circumferential cracking. On the forward radius of the No 2 crank pin a small crack at 45° was found, in a similar position relative to the web to that of the origin of the fatigue crack on the No 1 crank pin. A significant amount of corrosion pitting was apparent in and around the radii and the crack was centred on one such pit. Further pitting was present on other crank pins but its severity decreased along the crankshaft. The only other significant damage to the crankshaft was along the key-way in the tapered front end, suggesting that an undersize key had been installed at some time.

A microsection of the web and crank pin showed the material to be a quenched and tempered low-alloy forged steel. There was no evidence of surface hardening of the crank pin or its radius. There appeared to be no material defects that might have contributed to the failure.

It appeared, therefore, that the mechanism of the crankshaft failure was fatigue cracking, initiated in the rear radius of the No 1 crank pin, at 45° to the axis of the crankshaft. The crack had propagated through to the crank pin bore and had combined with a secondary crack initiated on the opposite side of the bore, parallel to the initial crack. Because of the impact damage to the initiation region in the radius of the No 1 crank pin (see Figure 4), it was not possible to confirm that the crack had initiated at a corrosion pit. However, the pitting and fatigue cracking identified on the No 2 crank pin indicates that this was probably the case.

The orientation of the cracking indicated torsional stress in the crankshaft and it is possible that this was related to the damage to the key-way. Measurement of the diameters of the crank pins and the main bearing journals indicated that the crankshaft surfaces had not been reground since new.

Engine history

Examination of the airframe and engine logbooks showed that the engine had accumulated some 1,192 hours since its last full overhaul and 140 hours since its most recent top overhaul in March 1998, at 1,051 hours. The engine logbooks available commenced with the engine at 233 hours in 1978, installed in G-OODE and it could not be determined when the engine had last been fully overhauled. According to its present owners, this Stampe airframe was imported from France around 1970 with the Gipsy engine already installed instead of the original Renault engine. One engine logbook showed the engine's year of construction as 1947 so it is very likely that it had been overhauled at least once before being installed in G-OODE.

CAA technical policy on piston engines is set out in CAA Airworthiness Notice No 35 *("Light Aircraft Piston Engine Overhaul Periods"*). At Issue 18 (October 2001) this allows normal operation beyond the manufacturer's recommended overhaul periods, both for operating time and calendar time. Beyond these periods, continued operation is allowed for operating time extensions up to 20% of the normal overhaul period, subject to certain inspections, and calendar time may also be extended, subject to the same inspections. Beyond the 20% operating time extension, continued operation is allowed for aircraft operated in the Private category but not for aircraft operated in the Public Transport or Aerial Work categories.

The normal operating overhaul life for the Gipsy 10 engine is 1,000 hours. The 20% operating time extension would allow operation in any category to 1,200 hours. Unlike some other types of piston engines, the Gipsy does not have a calendar time recommended for overhaul.

Discussion

In this serious incident to G-OODE, the failure of the crankshaft was clearly due to a fatigue mechanism. It is most likely that this fatigue originated in an area of corrosion pitting similar to that found in other areas of the crankshaft.

From the logbooks it was clear that G-OODE was being operated at a low utilisation rate, with an average of less than 40 hours per year between 1978 and 2003. This included some lengthy periods of inactivity, particularly during the winter months, typical for vintage aircraft. It was being operated in accordance with Airworthiness Notice No 35 which would allow, therefore, the top overhaul to be performed (in 1998) at 1,051 hours, beyond the 1,000 hour nominal life for a full overhaul.

Notice No 35 acknowledges that the inspection regime beyond the nominal overhaul life for a light aircraft piston engine is a valid concept where the inspections give warning of impending failure. It also acknowledges that there are aspects (such as crankshaft cracking and counterweight wear) for which predictive checks are not possible other than by major disassembly. This incident to G-OODE, with corrosion pitting and associated cracking, illustrates this limitation. Only a physical examination of the crankshaft, by stripping, would have shown the crankshaft damage and the Gipsy engines do not currently have a calendar time limitation.

Safety Recommendation

CAA Airworthiness Notice No 35 appears to strike a reasonable balance between preventive inspections and the ability to operate light aircraft safely. This balance particularly applies in the case of vintage aircraft in the Private category, where the aircraft are normally operated by experienced pilots in weather conditions benign for a forced landing. It is, however, still a concern that long calendar periods can elapse between inspections of areas within piston engines where predictive inspections are not possible. Therefore, the AAIB makes the following Safety Recommendation:

Safety Recommendation 2004-75

It is recommended that the UK Civil Aviation Authority specifies a calendar time limitation for Gipsy engines, at least for those aircraft operating in the Public Transport and Aerial Work categories, to cover areas where periodic predictive inspections are not effective.