ACCIDENT

Aircraft Type and Registration:	Tipsy Nipper T.66 Series 2, G-ATBW
No & Type of Engines:	1 Volkswagen 1834 (Acro) piston engine
Year of Manufacture:	1962
Date & Time (UTC):	3 February 2011 at 1530 hrs
Location:	South of Flemings Farm, South Hanningfield, Chelmsford, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller detached from the aircraft
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	394 hours (of which 243 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	AAIB Field investigation

Synopsis

Four of the six bolts that secured the wooden propeller to the engine worked loose causing all the bolts to fail and the propeller to detach from the aircraft in flight. The aircraft landed safely in a field.

The investigation discovered that two of the bolts had not been wire locked and two others had been wire locked incorrectly. While the torque on the bolts had been checked within the recommended hourly maintenance interval, due to the low usage the aircraft had flown for almost two years without the torque having been checked.

History of the flight

The pilot departed Stapleford for a local flight during which he remained on the Stapleford Radio frequency of 122.800 MHz. When just south of Hanningfield reservoir, at a height of approximately 2,300 ft amsl, the pilot felt the aircraft shake briefly from side-to-side and at the same time he heard a thud from the front of the aircraft. The engine rpm increased and as the pilot closed the throttle he realised that the propeller had detached from the aircraft. He established the aircraft in a glide and transmitted a MAYDAY call to Stapleford Radio, but on hearing no response he assumed that the propeller had damaged the aerial. The aircraft subsequently made a safe landing in a small grass field, where the pilot discovered that the radio

had moved in its mounting rack sufficient to cause the electrical connector to disconnect. The pilot reseated the radio and made a relay call through an airborne aircraft informing Stapleford as to what had happened and that he was uninjured.

The operator on duty at Stapleford Radio stated that a second aircraft, airborne from Stapleford, reported that the accident aircraft had had an engine failure and was making a forced landing. The operator informed Southend ATC of the situation, by telephone, who in turn informed the Distress and Diversion Cell. The police and an RAF rescue helicopter were dispatched to the area to search for G-ATBW. Stapleford Radio was subsequently informed by the second aircraft that the pilot of G-ATBW had reported that he was uninjured and passed this unconfirmed report onto Southend ATC. The search was called off once the police made contact with the pilot.

Inspection of the propeller assembly

The propeller, which was relatively undamaged, was recovered by the police and handed to the AAIB. The spinner was still attached and the six bolts that secured the propeller to the attachment plate on the engine crankshaft had all failed at the end of the threaded portion. The remaining threaded portion of the bolts remained in the inserts (lugs) fitted to the attachment plate. An examination of the fracture surfaces on two of the bolts revealed evidence of fatigue cracking emanating from the threads, with the bolt finally failing in ductile overload. Other bolts showed evidence of overload, one of which was covered in a black dust consistent with the oxidisation of fine particles that are generated when a bolt is subjected to fretting. The black dust was also apparent in three of the other holes through which the bolts were fitted, Figure 1.

From a photograph of the heads of the bolts, taken after the spinner was removed, it can be seen that only two pairs of the bolts had been wire locked; however, a small piece of locking wire remained in the hole in the head of one of the unlocked bolts, Figure 2. The wire locking of one pair of bolts was incorrectly routed and the distortion of the wire around the head of one of the bolts indicated that this section of wire had been twisted at least once before. There were approximately 6 twists

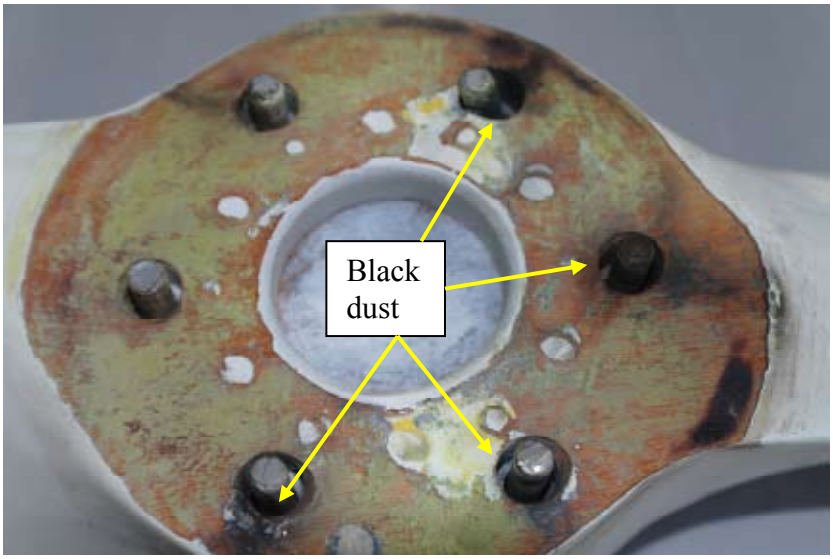

Figure 1

Black dust around bolts.

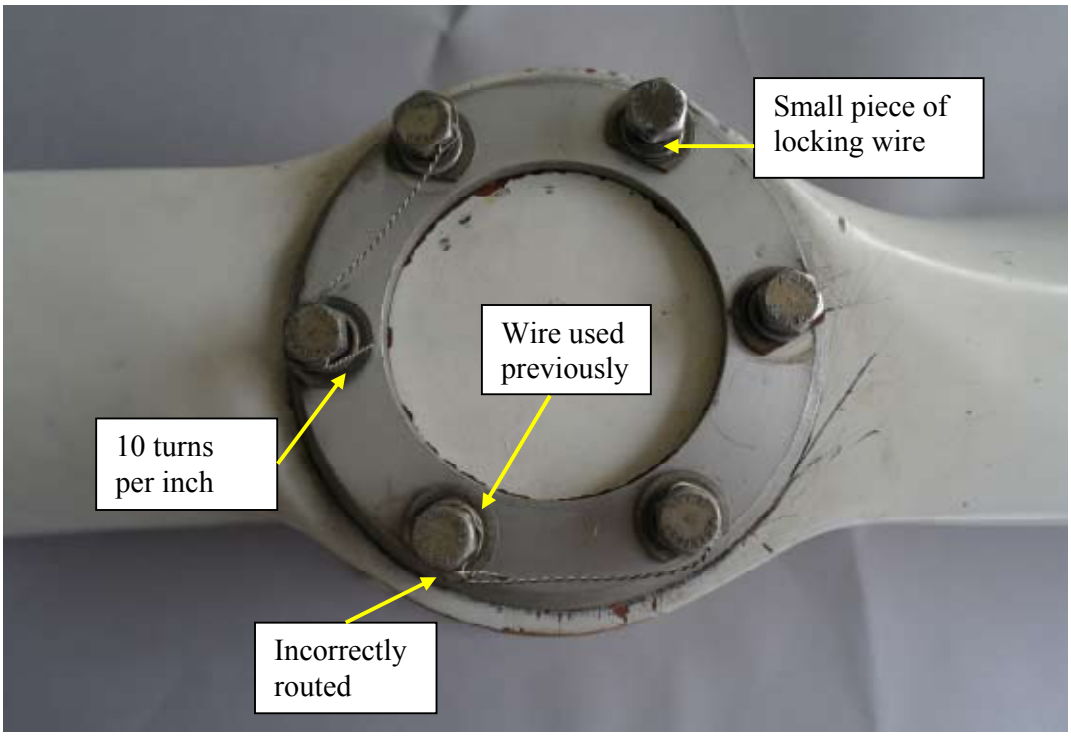

Figure 2

Wire locking on propeller bolt heads

per inch in the wire between each bolt head, which is within the recommendation of 6 to 8 twists per inch for this gauge of wire. However, the number of twists at the tail of the wire on one of the bolts was approximately 10 twists per inch. This over-twisting can result in the wire work hardening such that it becomes brittle and easy to break. Overall the standard of wire locking was assessed as being inadequate to prevent the bolts from becoming loose.

It was also noted that the marking on the head of the bolt heavily coated in black dust had different markings from the other five bolts. The marking indicated that it was an aircraft standard, high strength steel bolt. The other bolts were identified as UNF 4037 high strength alloy steel. An LAA inspector informed the AAIB that the bolts were the correct length and had not bottomed out. The use of different bolts was not considered to be a factor in this accident.

Maintenance on propeller assembly

The AAIB was provided with an extract from the aircraft maintenance manual that called for the torque on the propeller securing bolts to be checked with a calibrated torque wrench at the 25 hour inspection. In addition, at the 50 hour inspection, there was a requirement to remove and examine the propeller assembly and to check the tightness of the securing bolts again after the first flight.

The aircraft log book recorded that the propeller had been changed on 8 March 2008, approximately 37 flying hours before the accident. While there was an appropriate entry in the aircraft log book, by the owner and an LAA inspector, recording the replacement of the propeller, there was no record of the propeller securing bolts having been checked following the first flight.

The owner reported that the torque on the bolts was checked during the annual LAA inspection carried out in March 2009, approximately 24 flying hours prior to the accident. However, there was no entry in the log book or any worksheets to indicate that this work had been carried out. The LAA recommend in their SPARS[1] procedures that all work carried out on PFA [LAA] aircraft must be described and recorded. The owner stated that both he and the co-owner were present during the fitting and torque of the propeller bolts, and were supervised by an LAA inspector who wire locked the heads of the bolts. The owner recalled that the LAA inspector was not satisfied with the standard of the locking wire and so he redid it.

The owners advised the AAIB that the propeller securing bolts had not been checked or disturbed following the annual inspection carried out in March 2009 and were unable to explain the reason for the condition of the wire locking.

Propeller securing bolt torque

It is important to ensure that the propeller securing bolts are kept at the correct torque, otherwise vibration and flexing of the bolts can result in fatigue cracking. Wooden propellers are susceptible to changes in temperature and humidity, which can cause a change in the thickness of the hub resulting in a reduction of the torque on the securing bolts. G-ATBW had been kept in a heated hangar and there should not have been a large change in the temperature and humidity.

The maintenance manual calls for the torque on the propeller securing bolts to be checked every 25 hours. While the bolts had been checked within the 25 hour frequency, due to the low usage of the aircraft at the time of the accident it was almost two years since the torque had last been checked.

Audit of LAA inspectors

In 2004 the LAA (formally the PFA) introduced a four-yearly audit cycle of their inspectors. However, during this investigation it was noticed that the LAA had not yet completed the first audit cycle. Following discussions, the CAA and LAA undertook to develop and introduce a more robust and sustainable system for the auditing of LAA inspectors.

Comment

The damage to the failed portion of the bolts is consistent with them having failed as a result of a loss of torque to a number of the bolts. The damage to the ends of each bolt and the location of the black dust indicates that probably four of the bolts had worked loose leaving the remaining two bolts to take the load. It was not possible to establish if the bolts had been correctly torqued or had worked loose as a result of the inadequate wire locking or a change in moisture content in the wooden propeller hub. While the re-torque had been carried out within the required hourly maintenance interval, the low usage of the aircraft meant that the torque had not been checked in almost two years. Therefore, for such low usage aircraft, it might be more appropriate to base the re-torque of the propeller securing bolts on a calendar basis.

The LAA has published information on the maintenance of wooden propellers. They have also advised the AAIB that they will use this accident to inform their members of the necessity to check regularly the torque of the bolts used to secure the propeller to the engine, the correct way to wire lock bolts and the requirement to maintain complete records of work carried out on aircraft.

Footnote

[1] SPARS is the LAA guidance document for LAA inspectors.