

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Hawker Cygnet replica, G-EBJI	
<b>No &amp; Type of Engines:</b>	1 JAP J.99 piston engine	
<b>Year of Manufacture:</b>	1977 (Serial no: PFA 077-10240)	
<b>Date &amp; Time (UTC):</b>	16 April 2012 at 1700 hrs	
<b>Location:</b>	Old Warden Aerodrome, Bedfordshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Crankshaft fractured at propeller attachment hub	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	59 years	
<b>Commander's Flying Experience:</b>	1,553 hours (of which 100 were on type) Last 90 days - 15 hours Last 28 days - 9 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

**Synopsis**

The aircraft's propeller detached in flight but the pilot was able to execute a successful forced landing at Old Warden aerodrome. The cause of the propeller detachment was determined to be fatigue cracking of the engine's crankshaft, originating from a machined keyway feature that had previously been identified, by the engine manufacturer, as a site for fatigue crack initiation. The Light Aircraft Association (LAA) will update its guidance material for LAA Inspectors in relation to this problem and will also define a suitable non-destructive test and inspection interval for similar in-service engines.

**History of the flight**

The aircraft was a newly built replica of a 1924 design and was 2 hours and 30 minutes into a flight test programme, operating under the provisions of an LAA Permit Flight Release Certificate due to the experimental nature of the airframe, engine and propeller combination. After an uneventful 30 minute flight the pilot positioned the aircraft at 800 feet aal on a left hand downwind leg to Runway 21 at Old Warden aerodrome. Approximately halfway along the downwind leg, the pilot felt a momentary vibration before he saw the propeller detach and fall away from the aircraft. He closed the throttle, switched the ignition to OFF and performed a successful forced landing on Runway 21. The propeller was observed to fall to the ground but, despite an extensive search, it was not recovered.

### Design of the crankshaft

The two-cylinder JAP J.99 engine is rated at 36 hp and features a tapered crankshaft, onto which a mating propeller hub is fitted. The propeller hub is restrained in rotation by means of a propeller hub key, which locks into machined keyways in the propeller hub and the crankshaft (Figure 1). The crankshaft, minus the missing tapered portion that was lost with the propeller, is shown in Figure 2.

### Metallurgical investigation

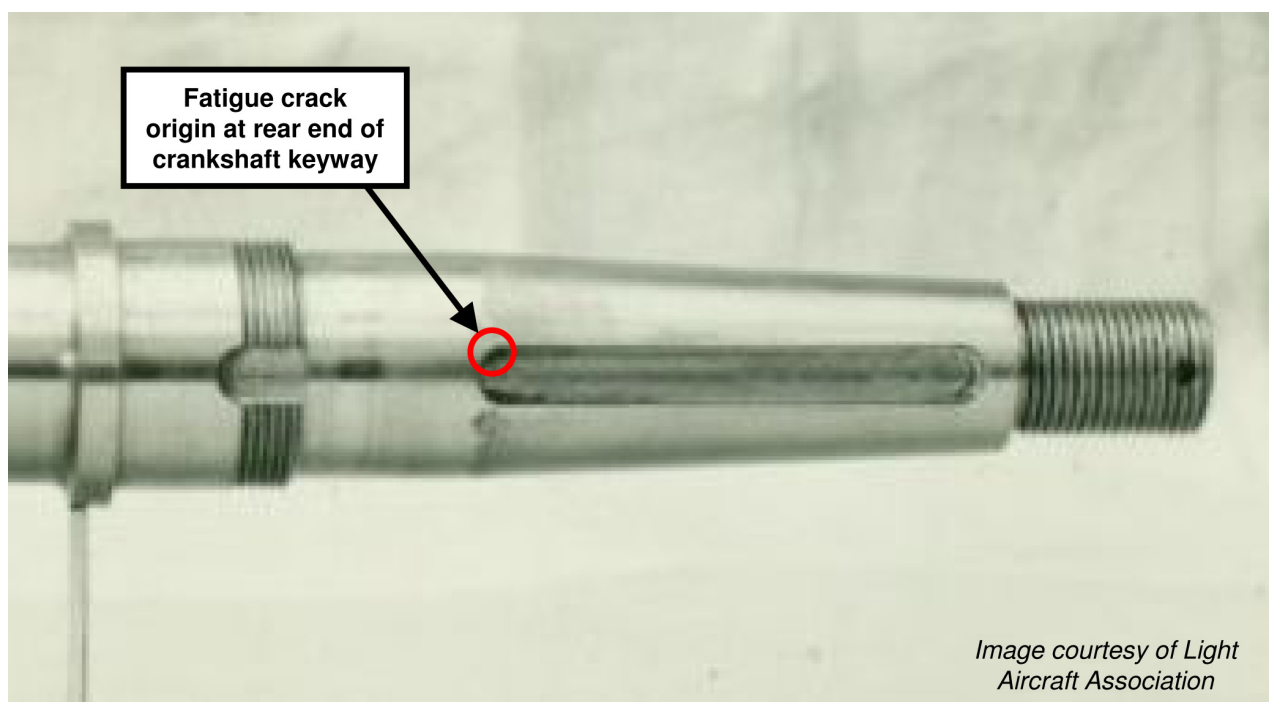
The fractured crankshaft was sent to the AAIB for detailed visual examination.

The fracture surface was found to be inclined at approximately 45° to the longitudinal axis of the crankshaft, which is characteristic of crack propagation under torsional loading. Clear metal fatigue ‘beachmarks’ were visible on the fracture

surface (Figure 3) and by tracing the pattern of these beachmarks it was possible to identify the origin of the fatigue crack, at the left side of the rear end of the crankshaft’s machined keyway. The fracture surface was heavily discoloured, consistent with the crack having been present for a considerable period of time.

### History of the engine

The engine was manufactured in April 1937 and had accumulated a total of 227 hours 40 minutes in service before being removed and placed into long-term storage in January 1969. During this initial period of service, the engine had been subjected to a propeller strike in May 1965 and also an incident in June 1967 in which the propeller bolts loosened in flight, damaging the propeller and bolts. It was acquired by the present owner in 1997 and, following a strip inspection, it was rebuilt with new pistons, piston rings, valve springs and valve guides. Both the magnetos were replaced by a dual electronic ignition system, the original carburettor



**Figure 1**

An intact JAP J.99 crankshaft, showing location of G-EBJI's fatigue crack

was replaced by an alternative carburettor and a custom-built 59-inch diameter wooden propeller was fitted. Following installation of the engine in G-EBJI it had completed 22 hours 20 minutes of ground running and 2 hours 40 minutes of flight, prior to the crankshaft failure occurring.

### Previous crankshaft cracking

The JAP J.99 engine was a licence-built version of the Aeronca E-113c engine, with the only significant difference being the installation of a dual ignition system on the JAP J.99. Instances of crankshaft cracking on E-113c engines prompted Aeronca to issue Service Memorandum M-36 in October 1939 which required removal of the propeller, at 25-hour service intervals, and inspection of the crankshaft for presence of a fatigue crack located at the rear end of the crankshaft keyway.

The existence of Service Memorandum M-36 became apparent during the course of the investigation but no reference to it was listed in SPARS, the LAA document containing information on Airworthiness Directives, Mandatory Permit Directives and Service Bulletins for reference by LAA Inspectors. Since Service Memorandum M-36 was not the subject of an Airworthiness Directive or a Mandatory Permit Directive, compliance with its instructions were not mandatory, even if Service Memorandum M-36 had been listed in the LAA SPARS document.

### Analysis

The aircraft's propeller detached due to fatigue cracking of the engine's crankshaft. The crankshaft fatigue crack initiated from the rear end of the machined crankshaft keyway and discoloration of the fracture surface indicated that the crankshaft had been cracked for a considerable period of time. Despite two recorded events in the engine's history, some 45 and 47 years previously, it was



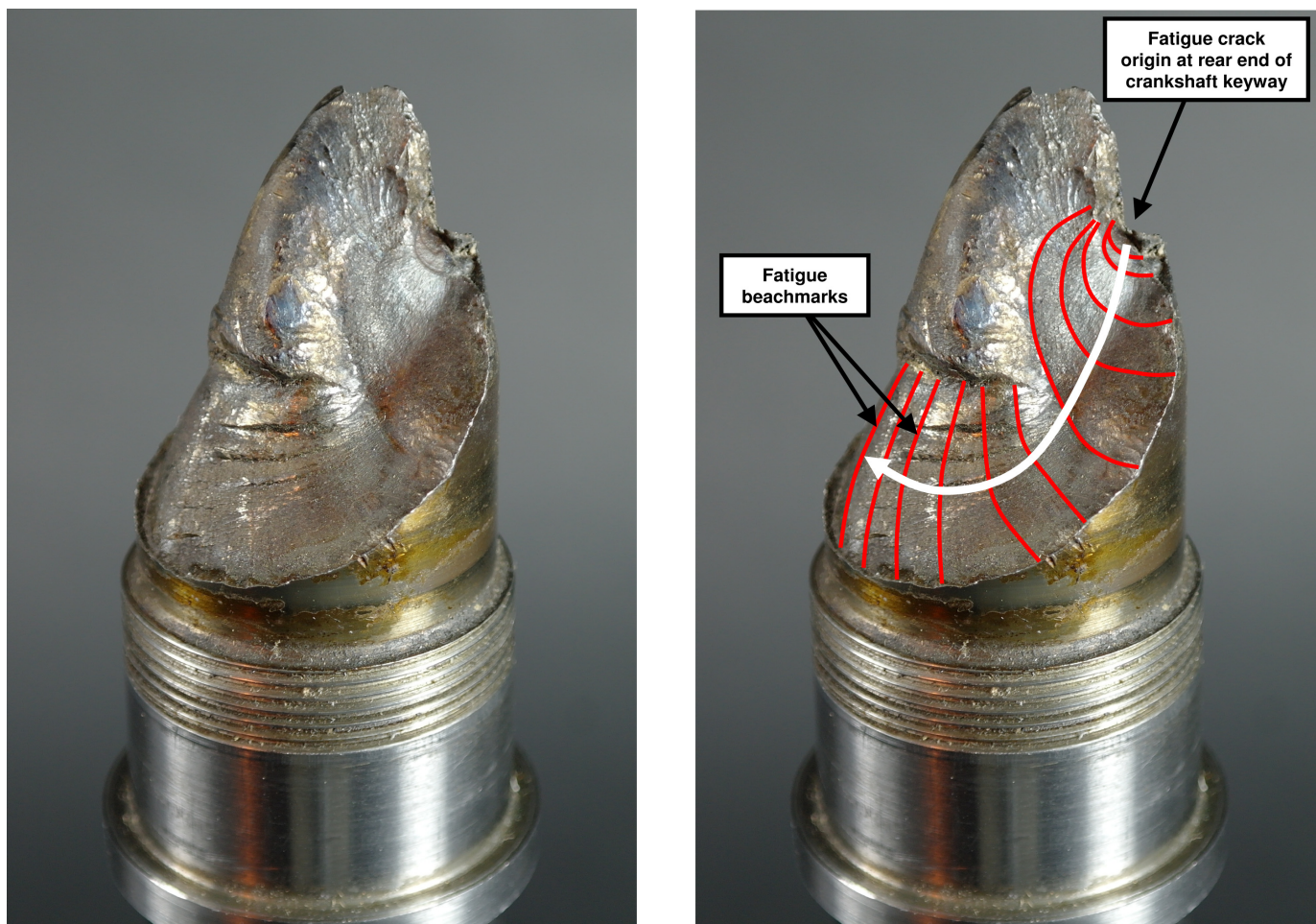
**Figure 2**

Recovered portion of the fractured crankshaft, following disassembly of the engine

not possible to ascribe the cause of the crack to either of these events and it is possible that the fatigue cracking began from an unrecorded event, or through normal engine running.

The existence of Aeronca Service Memorandum M-36 became apparent during the course of the investigation. This 1939 document described previous instances of similar crankshaft fatigue cracking and





**Figure 3**

Crankshaft fracture surface

also contained instructions for recurrent inspection of the crankshaft at 25-hour service intervals. The LAA SPARS reference document for LAA Inspectors did not list Service Memorandum M-36 under the entry for the JAP J.99 engine and therefore an LAA Inspector assessing the engine during rebuild would not have been prompted to look for cracking at the crankshaft keyway.

### **Safety actions**

The LAA Engineering department will alert owners of aircraft fitted with JAP J.99 and Aeronca E-113

series engines to the potential for crankshaft fatigue cracking and additionally will include a reference to Service Memorandum M-36 for affected engines on the Type Acceptance Data Sheet (TADS) section of the LAA website. This is currently being updated to reflect the aircraft-specific technical information currently contained in the LAA SPARS document. LAA Engineering is also in the process of defining the inspection interval and method for non-destructive testing of in-service J.AP J.99 and Aeronca E-113 series crankshafts.