AAIB Bulletin No: 9/94 **Ref: EW/C94/5/4** **Category: 1.3**

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-NINA	
No & Type of Engines:	1 Lycoming O-320-D3G piston engine	
Year of Manufacture:	1977	
Date & Time (UTC):	31 May 1994 at 0855 hrs	
Location:	Near Blackbushe Airport, Hampshire	
Type of Flight:	Private (Training)	
Persons on Board:	Crew - 2	Passengers - 2
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Separation of propeller, damage to engine and cowlings	
Commander's Licence:	Commercial Pilot's Licence with Flying Instructor Rating	
Commander's Age:	46 years	
Commander's Flying Experience:	2,086 hours Last 90 days - 219 hours Last 28 days - 55 hours	
Information Source:	AAIB Field Investigation	

The aircraft was on a training flight from Fairoaks Airport, in Surrey, to Blackpool. Shortly after passing overhead Blackbushe Airport, en route to the Compton VOR and in contact with Farnborough Radar, the pilot and his accompanying flying instructor both felt the onset of vibration and what they took to be rough running of the engine. They checked and cycled the magnetos and carburettor heat control but without any apparent effect on the engine; the rough running did not seem to be affecting the engine oil temperature or pressure, nor the engine speed, which remained at 2,350 RPM. They turned back towards Blackbushe, which was some 5 nm behind them, and made a 'PAN' call to Farnborough Radar. The vibration continued to increase so the engine was throttled back to 2,000 RPM; there was then a loud bang as the propeller departed from the front of the engine. The crew shut down the engine, made a 'MAYDAY' call to Farnborough Radar and then transferred to Blackbushe. With the instructor handling the aircraft, the fuel was selected off on the downwind leg of the circuit and electrical power switched off on finals; a successful forced landing was made on Runway 26.

After landing, it was apparent that the propeller, which was of fixed-pitch, had separated at the forward end of the engine crankshaft, with some damage to the front end of the engine and to the engine cowlings (Figure 1). A copy of the radar recording from Heathrow was obtained from LATCC. Plotting these data, and using the timings from the ATC tape at Farnborough, it appeared that the propeller had become detached over Bramshill Plantation, near Eversley. This is a substantial area of dense conifers and it is unlikely that the propeller will be located until the timber is harvested.

Detailed examination of the crankshaft showed that the fracture path was helical and had been caused by a torsional fatigue mechanism (Figures 2 and 3). The main crack had run rearwards (Figure 2) from the primary fatigue initiation region (shown as 'A' on Figure 3) towards one of the two holes drilled for the governor oil transfer tube; a smaller crack ran rearwards from the secondary initiation point (shown as 'B' on Figure 2). The primary initiation (A) was associated with a surface pit in the bore of the shaft whereas the secondary initiation (B) was on an undamaged area on the outer surface of the shaft. A large number of surface pits were found within the bore, some containing iron oxide, and it appeared that the pits were the result of long term corrosion.

The shaft was sectioned across its diameter so that the outer and inner surfaces could be examined in detail. It appeared that the surfaces had been carburised and case-hardened but that the case on the outer surface had only about 25% of the thickness found on the inner (bore) surface. This would be consistent with machining of the outer (bearing) surface during rework but the hardness of the case on both surfaces was found to be lower than would normally be expected in this material.

Accident to G-BRDF and other incidents

A similar accident had occurred to another Piper PA-28-161 Cherokee Warrior II, G-BRDF, on 19 October 1993 and an account was published in AAIB Bulletin 6/94. In the case of G-BRDF the propeller also separated in flight and the crack initiation was in a position within the shaft bore almost identical to that in G-NINA. The Bulletin account also noted that a number of similar gross cracks had been found in Lycoming crankshafts in recent years: in fixed-pitch applications the crankshaft bore is 'plugged' at the forward end and is open to the engine crankcase at its aft end. The effect of this, and the reduced bore section behind the oil seal, is to create a 'sump' in which debris and water are centrifugally separated from the engine oil during running and in which these materials are then trapped when the engine is not running.

As a result of the accident to G-BRDF, and similar occurrences, AAIB made the following safety recommendation (94-7) to the CAA in May 1994:

'It is recommended that the CAA liaise with the FAA and require procedures to be issued, for UK registered aircraft powered by the Avco Lycoming O-320-D3G and for other engines with similar crankshaft design features, for the mandatory inspection of the forward portion of the crankshaft bore aimed at detecting existing significant corrosion and/or cracking before any such effects progress to the point of crankshaft fracture. In parallel, mandatory procedures should be developed aimed at preventing subsequent corrosion.'

A further incident occurred on 11 July 1994 to a Piper PA-28-180, G-DEVS, powered by a Lycoming 0-360-A3A driving a fixed-pitch propeller. The aircraft was climbing away from Halfpenny Green when the pilot's vision was disrupted by a massive oil leak of approximately one quart in four minutes. The pilot turned back immediately and made a successful downwind landing with obscured vision. The progress of the engine strip will be monitored by AAIB but it appears that the source of the oil leak is a helical crack in the crankshaft similar to that seen in G-NINA and G-BRDF.

Partly in response to the AAIB Safety Recommendation (94-7), on 21 July 1994 the CAA issued advance notice of 'CAA Additional Airworthiness Directive 006-07-94, Direct Drive Piston Engines with Hollow Forward Crankshaft, Crankshaft Corrosion Inspection', with an effective date of 15 August 1994. The two-part inspections detailed in the AD apply primarily to Textron Lycoming and Teledyne Continental engines fitted to fixed-pitch propellers and take place with the crankshaft in place. The outer surface of the forward crankshaft is inspected for cracks within 10 flight hours of the effective date and, within 50 flight hours (or six months), there is a dye penetrant inspection of the outer surface and an internal inspection of the crankshaft bore. For engines fitted to variable-pitch propellers, only the second (50 hour) part of the inspection is required, at the sooner of the next propeller removal or Airworthiness Notice No 75 inspection.

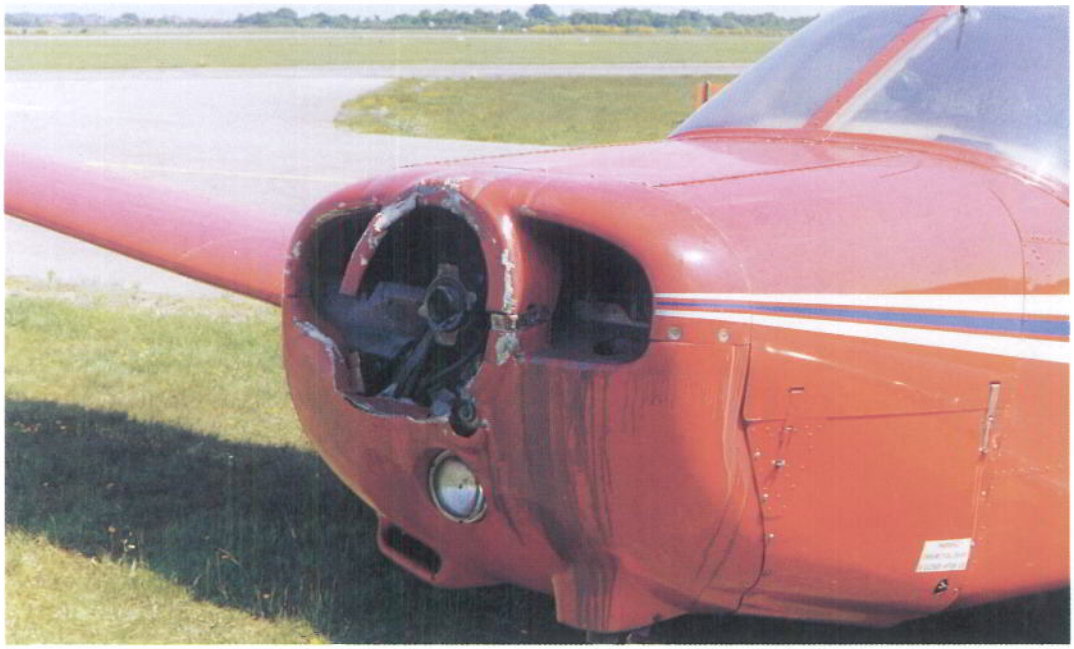

Figure 1 - G-NINA at Blackbushe Airport

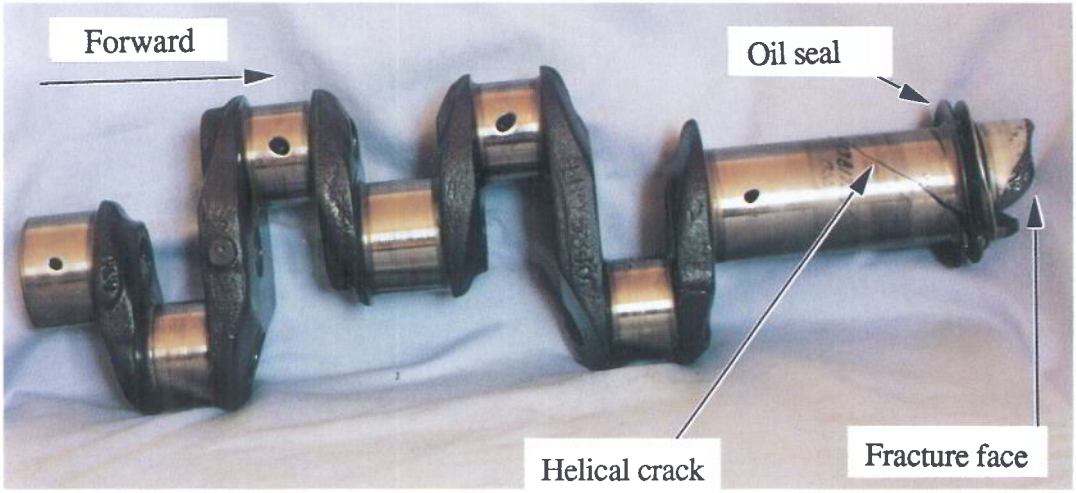

Figure 2 - Crankshaft from G-NINA

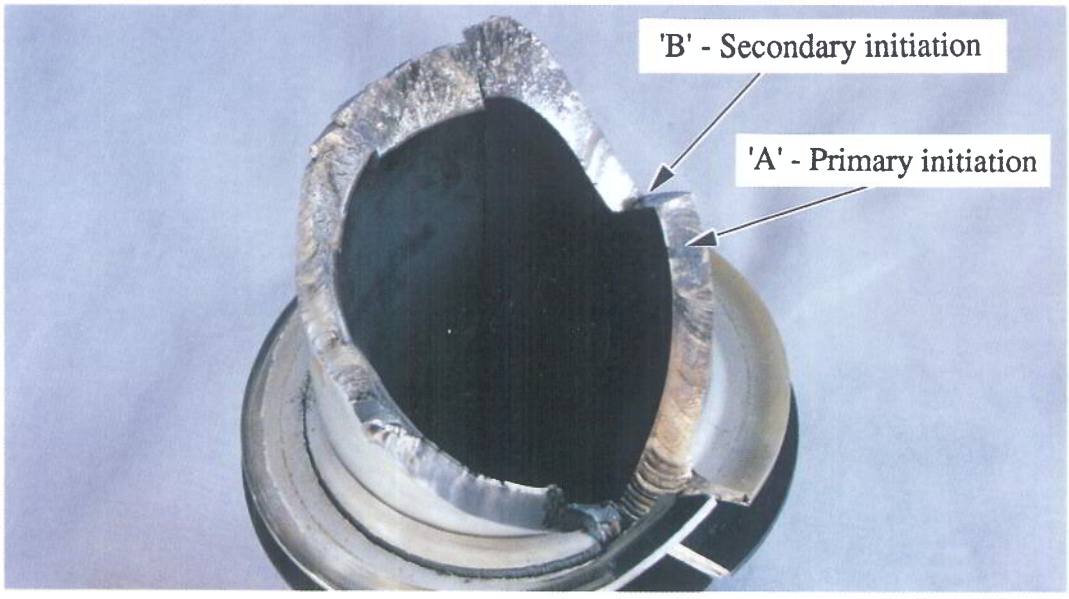

Figure 3 - Fracture face of crankshaft from G-NINA