No: 3/85 **Ref: EW/G84/09/03**

Aircraft type and registration:	Enstrom F28A G-BCFP (single engined light helicopter)
Year of Manufacture:	1974
Date and time (GMT):	9 September 1984 at 1440 hrs
Location:	Nr Theale, Reading
Type of flight:	Private (pleasure)
Persons on board:	Crew — 1 Passengers — 1
Injuries:	Crew — None Passengers — None
Nature of damage:	Damage to main rotor blades and aircraft nose sufficient to make the helicopter uneconomic to repair
Commander's Licence:	Private Pilot's Licence (Helicopter)
Commander's Age:	37 years
Commander's total flying experience:	111 hours (all on type)
Information Source:	Aircraft Accident Report Form completed by pilot and subsequent AIB investigation of the engine failure

After a normal take-off the helicopter, when at a height of approximately 700 ft and some 3 miles west of its point of departure, suffered a total loss of engine power. The pilot reported hearing a loud bang, followed by a violent yawing of the helicopter to the left and right. At the same time smoke began filling the cabin. After successfully entering autorotation an attempt was made to clear the smoke by opening a side vent. As the helicopter passed about 250 feet the pilot realised his first choice of field was unsuitable for a landing so an alternative, out of wind field, was selected.

After touchdown, the helicopter slid for some 50 feet on soft ground whilst slewing to the left, the blades struck the ground and the helicopter turned over.

Subsequent examination of the engine, a Lycoming H10-360-CIA, by maintenance personnel revealed that major damage to the crankcase had occurred and that the No 2 connecting rod was no longer attached to the crankshaft. The engine was removed from the helicopter and taken to AIB Farnborough for further examination.

An engine strip examination revealed that all damage was consistent with the release, under power, of the No 2 big-end cap. No evidence was discovered of any excessive bearing wear or seizure, the engine's condition generally being compatible with its recorded life of some 855 hours TT; the overhaul life being 1250 hours.

During the examination, portions of both No 2 big-end cap bolts (Lycoming Part No 75060) were recovered. Metallurgical examination of these bolts showed their material strength not to be in question but that their fracture faces revealed evidence of fatigue.

The upper one had fractured through the fitted land and the fracture, shown in Figure 1, exhibited clear evidence of fatigue crack growth to a depth of about 30% of the bolt cross section from an origin, arrowed A. This was associated with a small region of fretting on the surface of the land, arrowed B. The fracture surface of the lower bolt, shown in Figure 2, had failed in the waisted length. The fracture surface exhibited evidence of high strain fatigue, and although the region of initiation had been obscured by mechanical damage, it was evident that it had been caused as a direct result of the upper bolt failure.

Examination of the other bolts from this engine revealed further evidence of fretting damage, although in most cases this was confined to the protective cadmium layer. The two worst examples are shown in Figure 3. Signs of wear similar to that shown in this Figure were visible on most of the cap bolts removed from this engine. It was evident that this wear had been induced by side contact of the bolts with the walls of their respective holes through the big-end journals, where comparable signs of wear were visible.

Comparison with bolts taken from another part life engine (of approximately 600 operating hours but which had not failed) showed no signs of wear.

In this model of Lycoming engine, the big-end caps are secured by tightening each cap bolt nut until a specified bolt stretched length is achieved. Prior to the removal of the six remaining cap bolts, the installed length of each was measured and found to conform to the manufacturer's limits of 2.255"/2.256". Subsequent measurement of their free lengths enabled the installed 'stretch' of each to be established and compared with that required. In making this comparison it became apparent that the bolts with the highest installed 'stretch' only just fell within the required limits,

the others falling below. Close examination of the cap bolts did not reveal any signs of permanent bolt stretch, or thread damage, such as is likely to occur if any had been stressed beyond their elastic limits.

In 1978 the manufacturer decreased the free length dimension of the cap bolt (Part No 75060) by .001" whilst retaining the original installed length requirement, resulting in an approximate 16—17% increase in clamping load across the joint. The manufacturer points out, however, that bolts of both specified lengths are still acceptable for use. G-BCFP's engine was built in 1973.

Detailed visual and dimensional checks, within the limits of secondary damage, were also carried out on the big-end journals. Whilst dimensionally they generally conformed to the requirements of the manufacturer's drawings, there was evidence of relative movement between the mating faces of all four connecting rods and their respective caps. This evidence took the form of bruising/polishing of the surfaces and, although it could not be classified as frettage, it was significantly more pronounced than that exhibited on identical components removed from the part-life engine mentioned above.

Service Bulletin No 439, issued in 1979, highlights that fretting can occur between these faces due to relative motion and that 'fretting on the surface can induce bending in the bolt which could result in bolt failure and/or the connecting rod'.

From this examination it seems likely that the big-end bolts were, generally, providing a lower than desired clamping load across the big-end joints, which in turn has allowed some relative movement to occur between their component parts during the life of the engine.

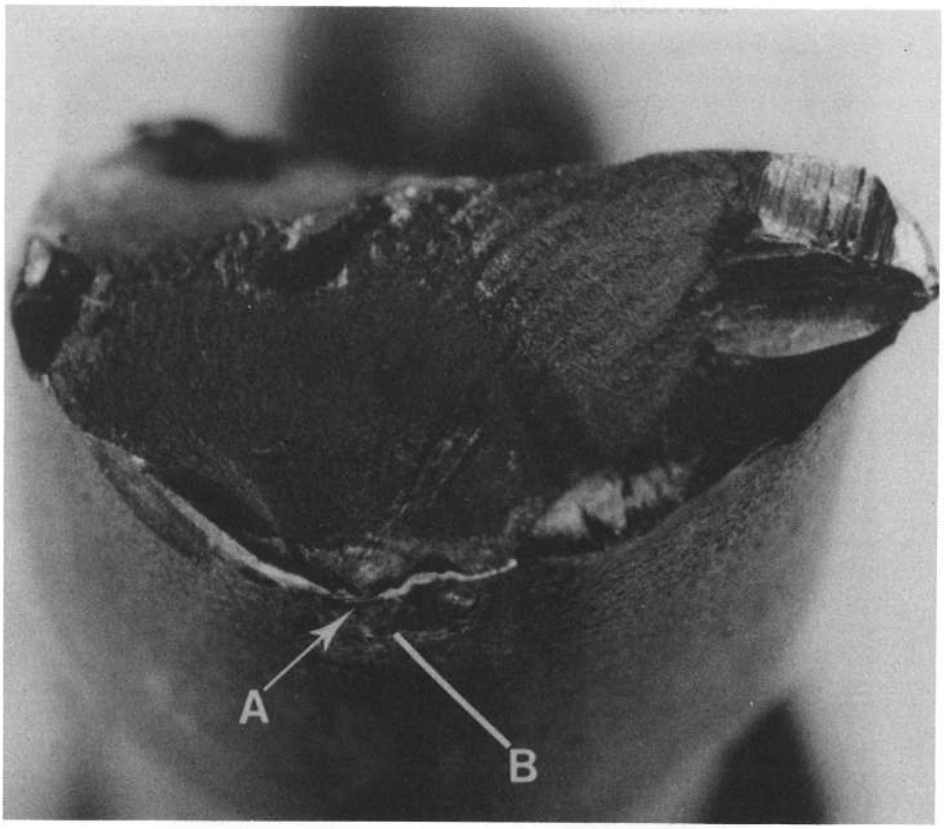

FIG 1 FRACTURE OF NO.2 UPPER BOLT

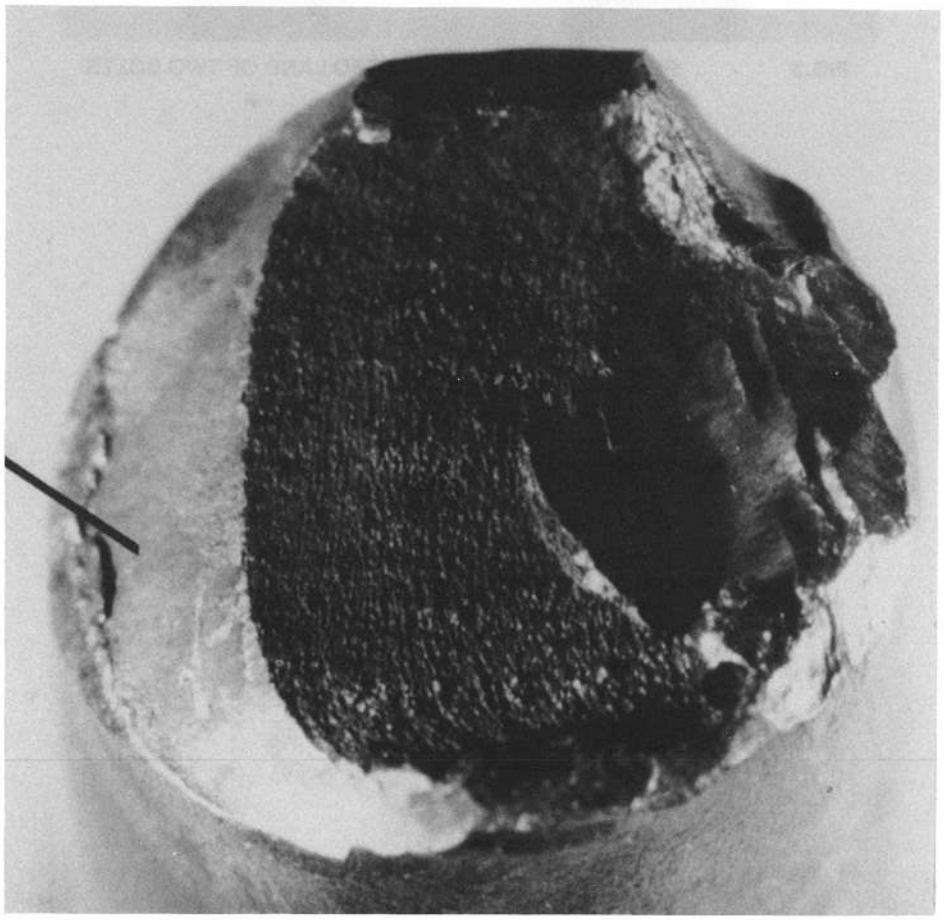

FIG.2 FRACTURE OF NO.2 LOWER BOLT

NO.1 LOWER NO.3 LOWER

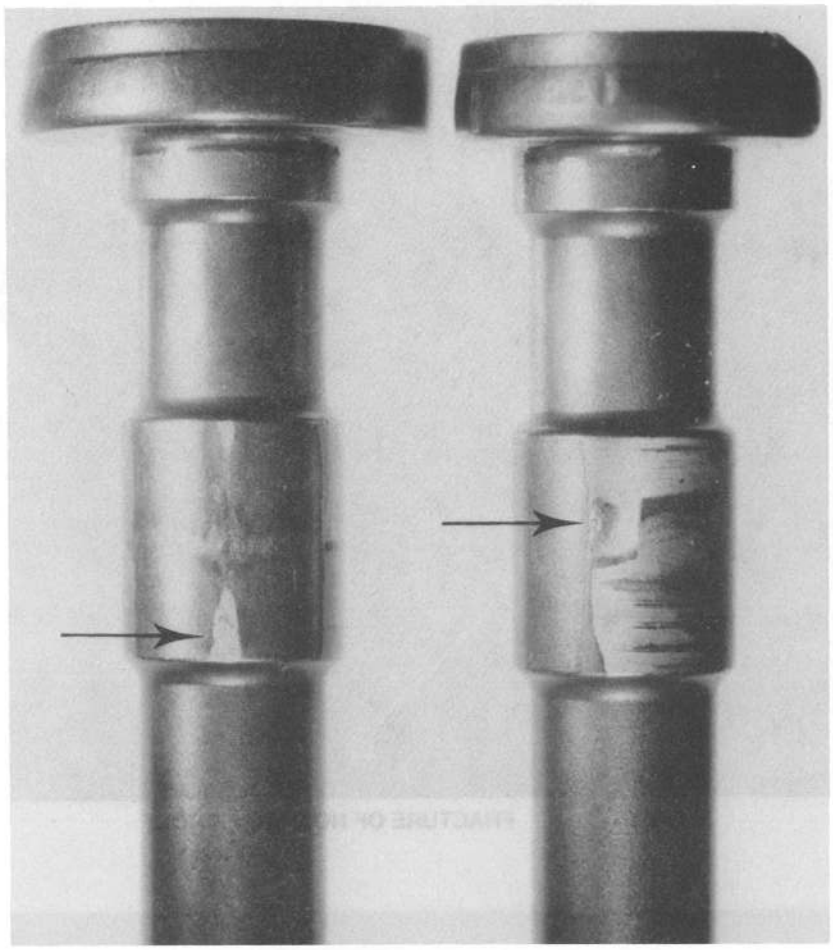

FIG.3 FRETTING DAMAGE ON FITTED LAND OF TWO BOLTS