**No: 3/85** **Ref: EW/G84/07/17**

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| **Aircraft type and registration:** | Enstrom F28A G-BAWI (single engined light helicopter) |
| **Year of Manufacture:** | 1972 |
| **Date and time (GMT):** | 22 July 1984 at 1446 hrs |
| **Location:** | Netley Marsh |
| **Type of flight:** | Commercial (pleasure) |
| **Persons on board:** | Crew — 1 Passengers — 2 |
| **Injuries:** | Crew — None Passengers — None |
| **Nature of damage:** | Damage confined to engine |
| **Commander's Licence:** | Commercial Pilot's Licence (Helicopters) |
| **Commander's Age:** | 30 years |
| **Commander's total flying experience:** | 360 hours (rotary wing) of which 106 were on type |
| **Information Source:** | Aircraft Accident Report Form completed by the pilot, and subsequent AIB investigation of the engine failure |

Following a normal take-off and climb to 500 ft agl, the helicopter was trimmed for an 80 mph cruise when a loud bang was heard and a smell of hot oil detected by the pilot. This was accompanied by a reduction in the engine note, a moderate vibration, and a reduction in rotor speed. The pilot entered autorotation, from which a successful emergency landing was made.

Initial examination of the helicopter revealed no apparent airframe damage but that one big-end bearing had failed, resulting in a major disruption of the crankcase. The engine, an HIO-360-CIA, was removed from the helicopter and taken to AIB Farnborough for further examination.

The engine strip revealed that all damage was consistent with the release, under power, of the No 1 big-end cap. No evidence was discovered of any excessive bearing wear or seizure, the engine's general condition being compatible with the recorded life of 770 hours.

Sections of the No 1 big-end cap bolts, (Lycoming Pt No 75060), were recovered during the examination and metallurgically inspected. Both bolts had failed in their threaded lengths and one of them had also fractured through a waisted part of the shank. Mechanical damage to the fracture surfaces, shown in Figures (1) and (2), had obscured the origins of both fractures in the threaded lengths, but it was possible to establish the initiation positions, arrowed, by the curvature of the striated crack growth features visible to the naked eye on the surfaces. In the case of the bolt with the single fracture, Figure (1), its general appearance suggested a high strain low cyclic crack growth mechanism, the striation's curvature indicating that initiation had occurred over a length of thread root.

The fracture surface of the other bolt, Figure (2), was quite severely damaged around the outer edge but, again, exhibited striated features over the whole of the undamaged region. It was evident that this failure had occurred after considerable plastic deformation around the thread root although the striated features suggested that the mid-region failed under conditions of low cycle, high strain fatigue. The second fracture through the bolt exhibited features consistent with ductile shear overload and probably occurred as a result of entrapment between the crankshaft and crankcase after separation of the cap.

From the examination it seems likely that the fracture to the bolt shown in Figure (1) occurred first and resulted in the more rapid failure of the second bolt. However, the available evidence indicates that the primary failure also developed rapidly and under conditions of abnormally high loading, no metallurgical reason being found to account for this first failure.

Hardness checks carried out on these two bolts showed both to slightly exceed the value required by the manufacturer, the bolts therefore being slightly greater in strength than required.

Most other cap bolts removed from this engine exhibited signs of wear around their fitted lands, similar in nature to that seen following an engine failure to an identical helicopter, although no signs of frettage were seen in this case. Measurements made of the installed and free lengths of these bolts suggested that, generally, lower than desired clamping loads across the big-end journals were also present in this engine, Ref: AIB Bulletin G/84/09/03, although there was no direct evidence to suggest that this had directly influenced the No 1 big-end cap bolt failures.

REGION OF INITIATION

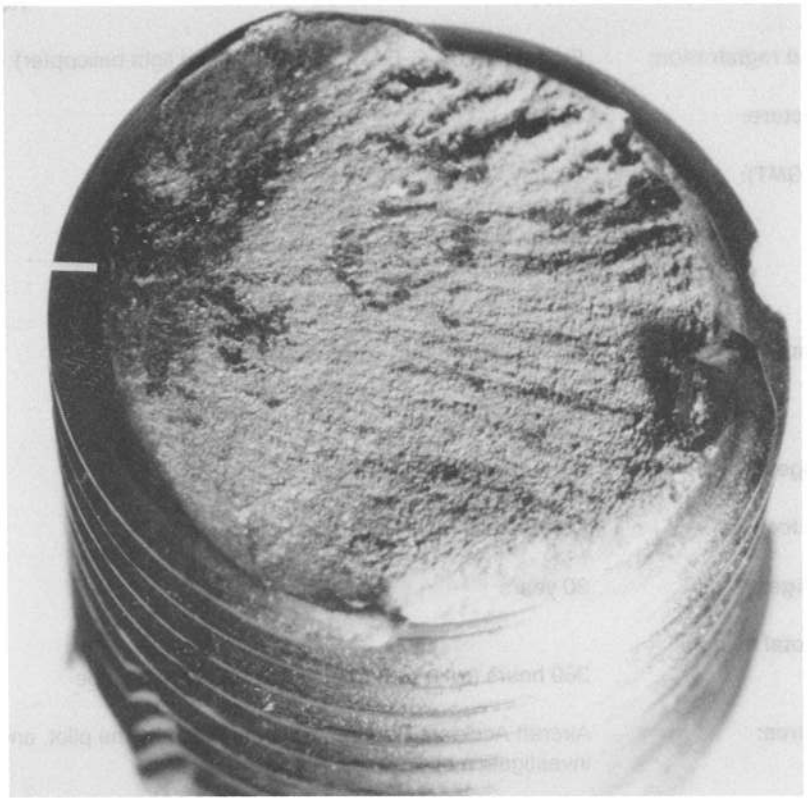

FIG.1 FRACTURE OF FIRST BOLT TO FAIL

REGION OF INITIATION

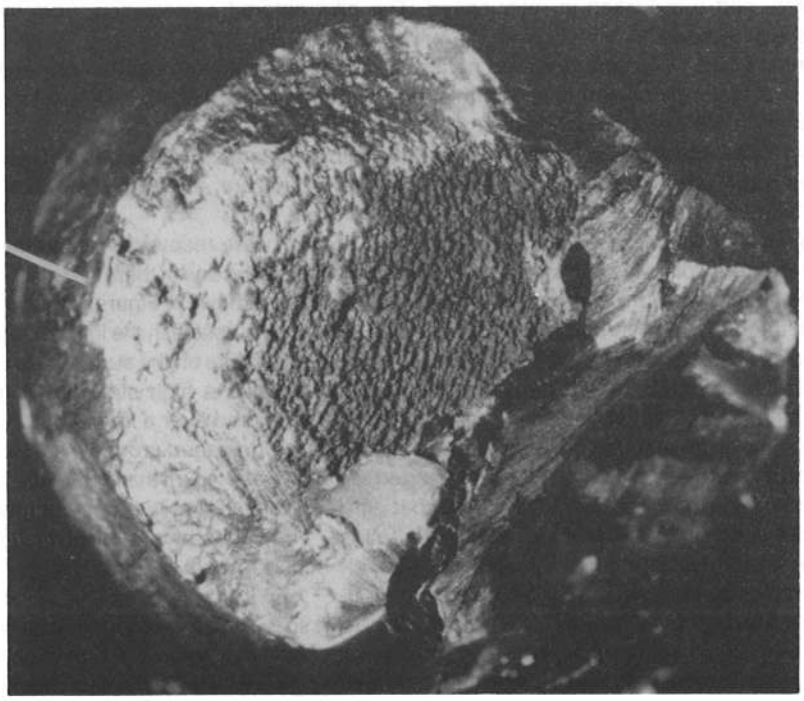

FIG.2 INITIAL FRACTURE OF MATING BOLT