

AAIB Bulletin No: 12/95

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Category: 1.3

Aircraft Type and Registration: Pierre Robin HR100/200B Royale, G-AZKN

No & Type of Engines: 1 Lycoming IO-360-A1D6 piston engine

Year of Manufacture: 1972

Date & Time (UTC): 1 September 1995 at 1242 hrs

Location: Oakley Farm, Long Whatton, Leicestershire

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - 1

Injuries: Crew - None Passengers - None

Nature of Damage: Extensive damage to leading edge of port wing and nose leg; further damage to fuselage and wing panels, canopy, flaps and seats

Commander's Licence: Private Pilot's Licence with IMC and Night Ratings

Commander's Age: 37 years

Commander's Flying Experience: 264 hours (of which 113 were on type)
Last 90 days - 22 hours
Last 28 days - 6 hours

Information Source: Aircraft Accident Report Form submitted by the pilot, subsequent strip examination of engine and metallurgical examination of connecting rod hardware

The flight was from East Midlands Airport, near Castle Donington, and was intended to be local, of approximately one hour's duration. The fuel and oil quantities were checked before takeoff and were found to be ample.

The pilot reports that, about 2 minutes after takeoff, with the aircraft at about 800 feet agl, he and the passenger experienced a high-frequency vibration which lasted for approximately one second. The engine immediately ceased developing power and the propeller stopped abruptly. The pilot made an immediate 'MAYDAY' call to ATC at East Midlands and, as the cockpit filled with what appeared to be blue smoke, the pilot added that the aircraft was probably on fire.

While searching for a suitable field for the forced landing the pilot requested wind speed and direction, the aircraft was trimmed to fly at 90 kt and magnetos, fuel and the electric fuel pump were switched off. On left base leg for the selected field, at about 300 feet agl, it became apparent that the slope was

away from the intended approach path and on finals it appeared unlikely that the aircraft would stop within the boundaries of the field. The pilot lowered full flap and the Master electrical switch was selected 'OFF'.

The initial touchdown was into wind, some six feet into the field. The contact was hard, the surface being stubble on very dry and compacted soil. Full braking was applied but, as the aircraft was clearly not going to stop before the far hedge was reached, the pilot altered heading by some 45° to the right, towards a gap in the hedge. The fuselage passed through the gap but the port wing hit what appeared to be a redundant, but substantial, gate post. As the aircraft turned, the nose leg of the landing gear collapsed but the pilot was able to maintain directional control by differential braking. The aircraft came to a halt and, without fire or injuries, the evacuation was rapid and successful.

Inspection of the aircraft after the accident showed that the sudden engine stoppage had been due to the No 4 connecting rod becoming detached from its end cap (Figure 1). The big-end of the connecting rod had thus been freed from its crankshaft journal and had fractured the camshaft, immediately stopping the engine and knocking out a substantial portion of the upper crankcase.

Engine examination

The engine, which had accumulated 407 hours of operation since a major overhaul in October 1989, was removed from the aircraft and taken to an overhaul agency for strip examination. During this examination it was confirmed that there had been no shortage of lubrication around any part of the engine. The majority of the engine damage was around the No 4 cylinder (Figure 1) and all of the other damage around the engine was consistent with the separation of the big-end cap at the No 4 cylinder being the initial event. Both of the big-end bolts were found in two pieces (Figure 2). On one bolt the nut had become undone to the point where the end of bolt was two threads into the nut; the other bolt had entirely lost its nut and this nut was found in two parts, one outside the engine and the other part impaled on the crankshaft end of the No 2 piston.

In this model of engine the installation pre-load on the big-end bolts is achieved by turning the nut until a prescribed 'stretch' in the bolt is achieved; the achievement of this strain (some .007") is determined by either a micrometer screw gauge or a simple GO/NO-GO gauge. During the strip examination the length of the six remaining big-end bolts was measured. Five of the bolts were within the prescribed limits and the very slight overstretch of the sixth bolt (the upper big-end bolt at the No 3 cylinder) could be attributed to the piston seizure at the No 3 cylinder resulting from mechanical damage caused by the failed No 4 connecting rod.

Metallurgical examination of the bolts from the No 4 big-end showed that the failures of these bolts had resulted from the unscrewing of the nuts from their threads. The big-end failure in the No 4 connecting rod appeared, therefore, to be consistent with the initial loosening of one of the big-end nuts, followed by the progressive unscrewing of both of the nuts

Possible causes

One explanation for the initial loosening of one of the big-end nuts would have been a deficiency in the bolt or nut material. Hardness tests were, therefore, conducted on the nuts and bolts, both from the No 4 position and from elsewhere in the engine and compared with the material specifications obtained from the engine manufacturer. These tests showed that, although there was some variation in material hardness, all the nuts and bolts met the appropriate material specification.

The engine manufacturer suggests three possible mechanisms which might account for this type of failure, initiated by the loosening of a big-end retaining nut:

- 1) incorrect torque tightening of the retaining nuts on assembly,
- 2) a previous ground strike of the propeller, resulting in sudden stoppage of the engine,
- 3) a problem of 'joint integrity'; for instance, with foreign material present between the mating surfaces of the big-end assembly.

In this particular case, none of these explanations appears particularly likely. There was no evidence from the maintenance records or individual memories of a previous propeller strike, particularly since the previous overhaul, and the quality of the overhaul agency's work, supported by the correct 'stretch' found on the other bolts, does not indicate a 'maintenance-induced' problem.

Discussion with the engine manufacturer has shown that there have been similar, occasional, occurrences. One such occurrence, already known to the AAIB, was the failure of the Lycoming IO-540-C4D5D engine in Socata TB20 Tobago, G-TRIN, on 5 June 1995 and reported in AAIB Bulletin 10/95; the engine failure, at the No 1 cylinder position, was almost identical to that in G-AZKN, even to the degree of loosening of the retaining nuts. No positive reason was found for this failure.

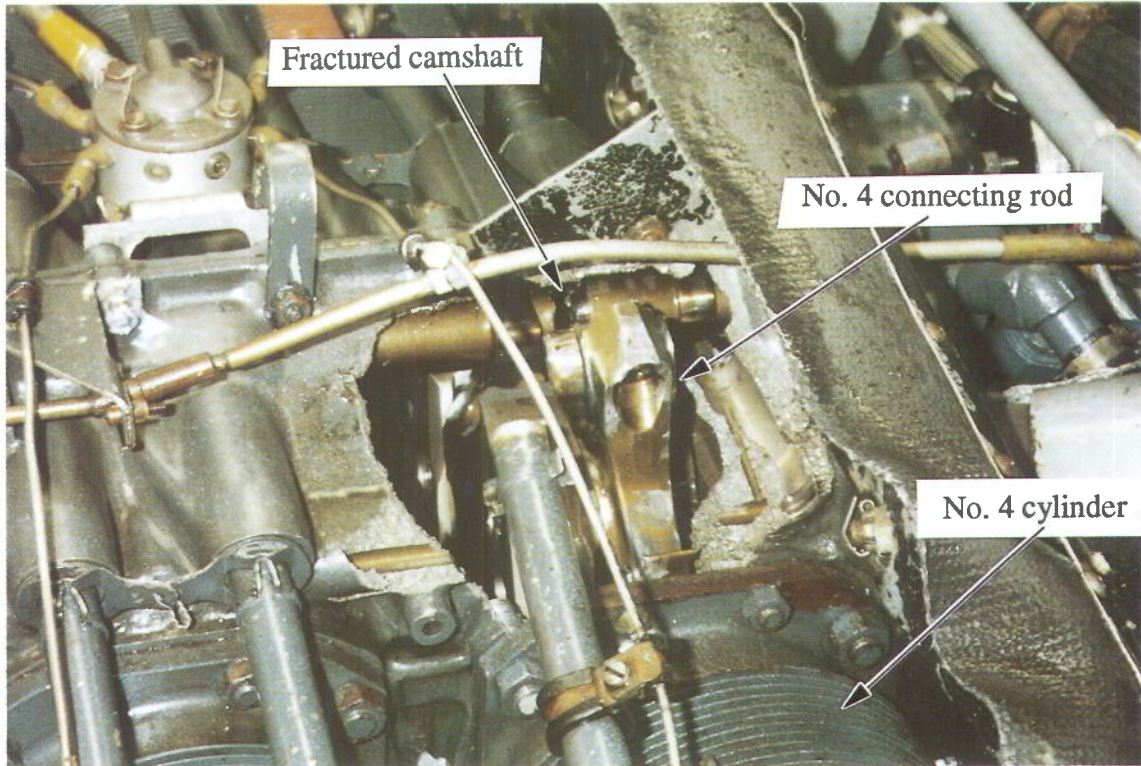


Figure 1 - Big-end failure at No. 4 cylinder, G-AZKN, 1/9/95

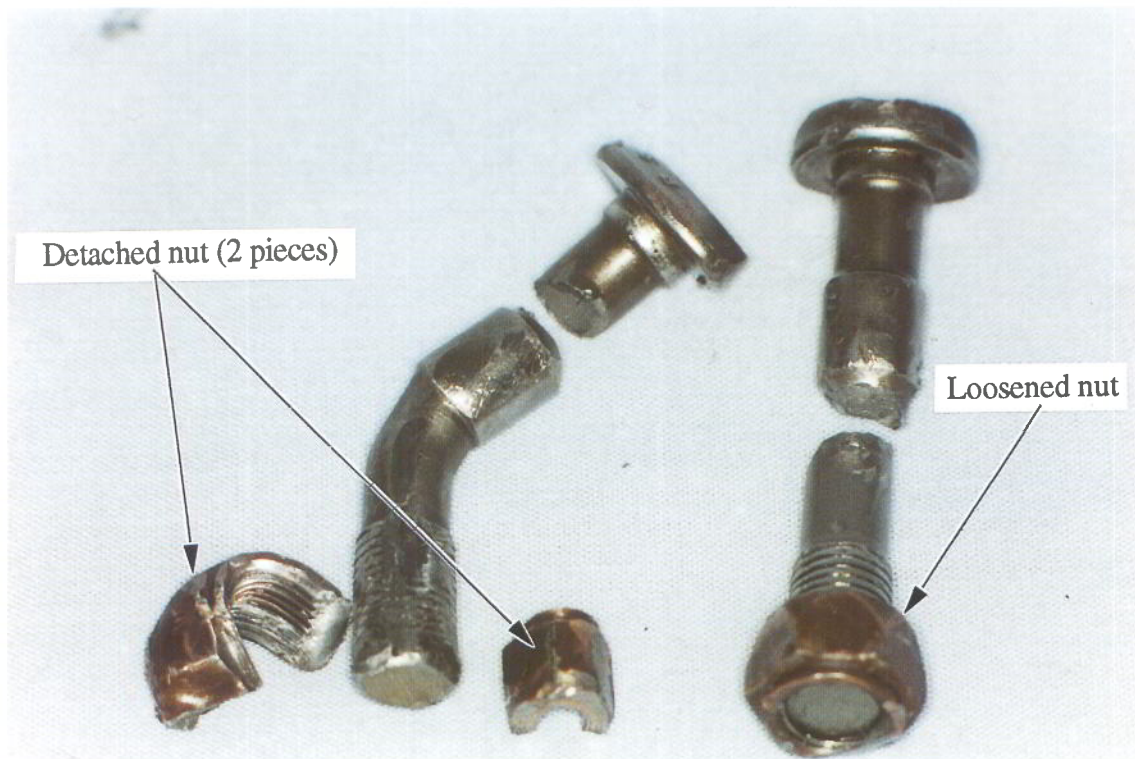


Figure 2 - Big-end bolts and retaining nuts, No. 4 connecting rod, G-AZKN, 1/9/95