**AAIB Bulletin No: 2/96** **Ref: EW/G95/08/18** **Category: 1.3**

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| **Aircraft Type and Registration:** | Piper PA-34-200T Seneca II, G-BOUL | |
| **No & Type of Engines:** | 2 Continental TSIO-360-E piston engines | |
| **Year of Manufacture:** | 1976 | |
| **Date & Time (UTC):** | 17 August 1995 at 1142 hrs | |
| **Location:** | Oxford Airport, Kidlington | |
| **Type of Flight:** | Private (Training) | |
| **Persons on Board:** | Crew - 2 | Passengers - None |
| **Injuries:** | Crew - None | Passengers - N/A |
| **Nature of Damage:** | Left landing gear unit and doors, false spar, flap, propeller and dynamic source mast; puncture to wing underside | |
| **Commander's Licence:** | Airline Transport Pilot's Licence with Instructor Rating | |
| **Commander's Age:** | 57 years | |
| **Commander's Flying Experience:** | 7,500 hours (of which 1,525 were on type)<br>Last 90 days - 22 hours<br>Last 28 days - 12 hours | |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot; examination of damaged aircraft, during repair, by AAIB Engineering Inspector; laboratory examination of failed components | |

The aircraft was engaged upon a Combined Instrument Rating Flight Test during which the candidate carried out a landing judged by the examiner to be normal. The examiner stated that he then took control, reset the props, trimmers and flaps, applied power, took off and handed control back to the candidate. He then noticed that the green left landing gear light blinked, just before retraction was carried out.

After retraction had taken place and the after-take-off checks had been carried out, he noticed that the red landing gear unsafe warning was illuminated. Whilst on the downwind leg the examiner requested that ATC report on the status of the landing gear. They replied that the left unit was down whilst the other two units were retracted; they also alerted the fire crew as to the situation. It was decided that the landing would be carried out by the candidate in accordance with briefings from the examiner who planned to take control if he judged it necessary. The examiner pulled out the emergency landing gear selector. On finals, three green lights were seen to be correctly illuminated.

Once on the ground the candidate was not able to retain directional control and the examiner took over, ensured both throttles were closed, feathered both props, turned both fuel cocks off and asked the candidate to turn off both sets of magneto switches and the master switch (all the latter switches being positioned on the left cabin side panel).

The left landing gear collapsed completely allowing the aircraft to gently ground loop to the left. The two pilots then evacuated via the right side door.

Examination of the aircraft indicated that the rear trunnion support fitting had failed on the left landing gear unit. This fitting is an aluminium alloy casting housing the rear of the two trunnion bearings in which the landing gear leg pivots during retraction and extension. The failure took the form of a number of fractures, positioned such that the lower portion of the fitting, surrounding the trunnion bearing, broke away (Figure 1). This allowed the aft pivot pin to displace downwards and the leg to adopt a forward inclination before distortion of, and disengagement from, the forward trunnion support fitting allowed complete collapse to take place.

Examination of the fractures revealed no evidence of a failure mechanism other than overload. It was noted during macroscopic examination, however, that the core of the rear fitting was very porous, resulting from extensive interdendritic shrinkage. It was considered that the degree of shrinkage found would have reduced the load carrying capacity of the fitting, although it could not be established whether the strength would have reduced to a point below the design figure. Some evidence of interdendritic shrinkage was also noted on the exposed fracture faces of the forward attachment bracket.

During a routine inspection of another aircraft from the same fleet, two cracks were found in a rear trunnion support fitting, one of which was in exactly the same position as one of the failures in the corresponding fitting on G-BOUL. This cracked fitting was also subjected to macroscopic examination. Once again shrinkage around interdendritic crystals was evident in the cracked areas.

Over a lengthy period, a large number of failures have occurred to the landing gear trunnion units on PA-34 series aircraft involving cracking mechanisms occurring on the rear face of the leg at a point where the curved web joins the purely cylindrical section of the leg (Figure 2). This cracking has involved both fatigue and stress-corrosion mechanisms and, if not detected, results eventually in a forward bending failure of the leg immediately after a landing.

It was noted that the legs installed on G-BOUL and on the aircraft from which the cracked fitting was removed were of a different design to those involved in all the above mentioned failures. This new leg

design utilises a broad, straight edged reinforcing web on its rear face, in place of the two alternative designs of curved undercut web found on previously examined legs. The practical effect of this modification would be to stiffen the leg as well as to reduce the stress level at the point where previous failures have occurred. The increase in leg stiffness is presumed to increase the level of 'spring back' loading applied to the aft mounting brackets, following a firm landing, above the level of loading experienced at the same point on aircraft equipped with the earlier, more flexible designs of leg.

No previous instances of failure of support fittings have been investigated by the AAIB although the data base held by the CAA contains two instances of cracked fittings having been found during routine inspections and one instance of a backward collapse of a main leg in which failure of support fitting(s) was the originating factor. In addition, the data base shows that the aircraft which suffered the failure was later found to have a cracked support fitting on its other main landing gear unit. All these aircraft were reportedly equipped with trunnions of the earlier types, ie having the curved reinforcing webs. None of the cracked/failed fittings listed in the database were subjected to metallurgical examination.

A study of the technical records of G-BOUL does not indicate that the failed bracket was fitted to the aircraft recently.

Although there does not appear to be an extensive history of failures of support fittings on PA-34 series aircraft, the use of the modified leg with the stiffer web is at present restricted to only a small number of aircraft which have had their earlier standard of trunnions replaced by units of the latest standard. A Service Bulletin issued in August 1993 calls for replacement of the earlier trunnions by the latest design, after a certain number of hours/landings depending on the number of operating hours accrued. The number of aircraft in use with the stiffened trunnion can thus be expected to increase.

**Safety Recommendation**

The following Recommendation has been made to the FAA:

**95-44:** The FAA should require an assessment of the adequacy of the strength of the main landing gear support fittings, together with that of the structure to which they are attached. This assessment should bear in mind the effect, if any, of the latest, stiffer, design of trunnion units on landing loads applied to the fittings and the fact that this failure has finally taken place during deflection of the landing gear in a forward direction. This assessment should also take into account the likely variation of the strength of the cast attachment fittings, evident from the porous states of both the failed component in G-BOUL and of the fitting, from another aircraft, found cracked during the investigation. It should include consideration of the suitability of the material and casting process of the fitting in that application.

**LANDING GEAR UNIT**
**SHOWING POSITION OF FRACTURES IN AFT SUPPORT FITTING (ARROWED)**

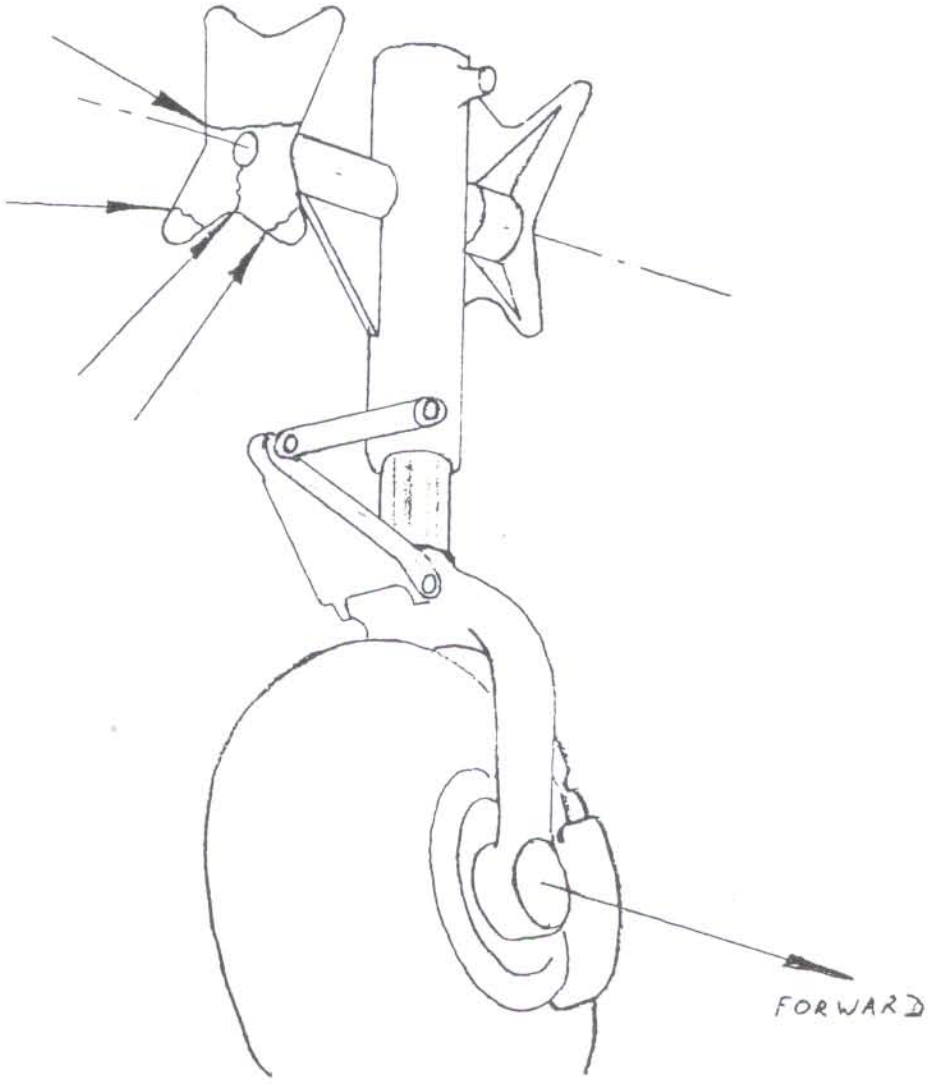


**Figure 1**

**SECTIONAL VIEW OF TRUNNION SHOWING POSITION OF CRACKING AND FRACTURE FOUND IN PREVIOUS FAILURES (A), PROFILE OF MODIFIED STANDARD WEB AS FOUND ON G-BOUL (BROKEN LINE AT B) AND AREA OF FAILED CASTING ON AFT SUPPORT FITTING OF G-BOUL (SHADED REGION AT C)**

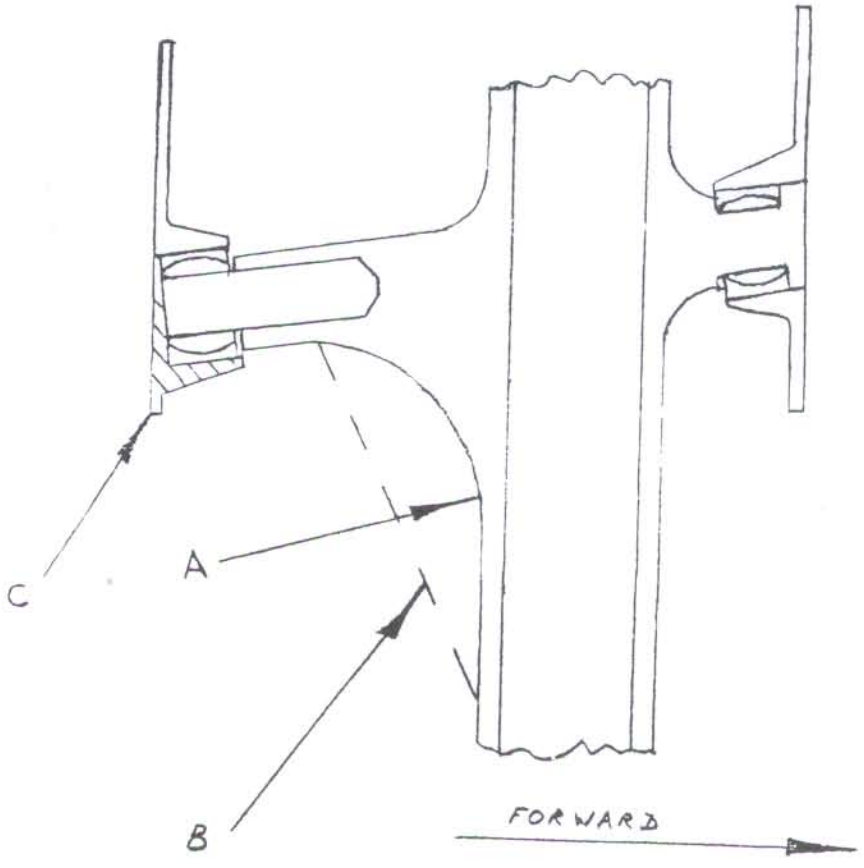


**Figure 2**