Piper PA-34-200T, G-BOCG

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Aircraft Type and Registration:	Piper PA-34-200T, G-BOCG
No & Type of Engines:	2 Continental TSIO-360-EB1 piston engines
Year of Manufacture:	1978
Date & Time (UTC):	31 October 1997 at 1604 hrs
Location:	Fairoaks Airport, Woking, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - None - Passengers - N/A
Nature of Damage:	Propellers damaged and engines shock loaded, nose gear doors and nose-cone deformed and abraded
Commander's Licence:	Commercial Pilot's Licence with Instrument Rating
Commander's Age:	52 years
Commander's Flying Experience:	1,670 hours (of which 400 were on type)
	Last 90 days - 22 hours
	Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had taken the aircraft for a local flight from Fairoaks,which had been uneventful. On returning to the airfield and contactingthe tower, the pilot was given approval for a straight-in approachto Runway 06; the weather was good with a wind speed of less than5 kt, and variable in direction.

A normal approach was made and the pilot observed the 'down-and-locked'landing gear indications. He reported that the flare and touchdownhad appeared to be normal but that he became aware that the nosewas dropping further than usual, despite full back movement ofthe control column. The engines, which were at idle, stoppedafter the propellers contacted the runway as the aircraft droppedgently onto its nose. The aircraft then veered off the runwayto the left and came to rest on the grass with the landing gearwarning horn sounding. The aircraft was shut down and the pilot,who was uninjured, got out unaided.

The aircraft was recovered by a team from a local maintenanceorganisation who noted that, in addition to the nose gear beingpartially retracted, the main landing gear legs were also unlocked,as found. The aircraft's main landing gear was then fully extendedand ground safety locks were fitted. When attempting to lowerthe nose landing gear, it was found that damage to the nose geardoors and their operating mechanism (a passive mechanism drivenby gear movement) was obstructing free movement of the landinggear. The nose of the aircraft was, therefore, supported on atrolley and the aircraft was towed to a hangar.

Recent history of the aircraft

The aircraft, which had been purchased recently by the pilot,had been in regular use by another operator up to 1 December 1995. The aircraft was then flown on two occasions (2 February and4 March 1996), after which it had accumulated a total flying timeof 5316 hrs 07 min. From that date until the end of September1997 the aircraft had been parked, mainly in the open, with storagemaintenance being performed by the same organisation as had maintainedit when it was last in regular use. A C of A renewalinspection was recorded on 2 July 1996, but no test flight wasconducted at that time. The aircraft was then sold and, beforethe present owner took possession, a 'Star Annual' inspectionwas carried out, in conjunction with a C of A Renewal and changeof category from 'Private' to 'Transport'. During this inspectionthe landing gear was lubricated and several retraction test cycles,with the aircraft on jacks, were performed satisfactorily.

On the C of A Renewal flight test (3 October 1997), when the landinggear was retracted after take off, the left main gear green ('down-and-locked')indicator light remained illuminated. The gear was thereforeselected down again and the resulting indications were two 'greens'for the main gear, but nothing for the nose gear. The pilot thenflew past the control tower and the controller confirmed thatthe nose gear appeared to be 'up'. The pilot then attempted tolower the gear using the emergency procedure, but to no avail. He reconfirmed the position of the landing gear by flying pastthe control tower again. The pilot then attempted to free thenose gear by manoeuvring the aircraft, but this was also unsuccessful. The pilot then performed a low pass over the engineering staffof the maintenance organisation who relayed to him their observationthat the nose gear door seemed slightly open and made some suggestionsfor him to try to lower the gear.

The pilot then retracted the landing gear again and although bothmain gears were heard to retract into lock, the left leg greenindication remained illuminated, suggesting that the gear wasstill down and locked. He then lowered the landing gear, butagain obtained no nose gear indication. He then started the emergencylowering procedure again. When he got to the point in the procedurewhen the hydraulic pump circuit breaker had just been disengaged,the nose gear dropped free and a nosewheel green indication wasobtained.

After the subsequent uneventful landing, the aircraft was placedon jacks and a number of retraction tests performed, during whichthe landing gear cycled apparently faultlessly. It was found,however, that the 'down' microswitch for the left main landinggear had failed in the 'made' condition. This microswitch andthe nosewheel shimmy damper, which had also been found to be unserviceable,were replaced and the landing gear lubricated again. During thiswork, no adjustments to the nose landing gear retraction systemwere made. A Mandatory Occurrence Report was sent to the CAAconcerning this incident. A subsequent satisfactory flight testwas performed on 7 October; the accident which is the subjectof this report occurred some 2.5 flying hours later, on the secondflight following this successful flight test.

Post accident investigation

Having been towed to a hangar, the aircraft was placed on jacks,the trolley removed and the obstructing nose gear doors and mechanismcleared. The nose gear dropped to a nearly fully extended conditionand the locks of the main gear released again. The landing gearwas cycled repeatedly and appeared to operate correctly; all extensionsresulting in a safe down-and-locked indication. It was noted,however, that with the gear extended and a safe down-and-lockedindication showing the nose landing gear drag brace stops didnot appear to be hard abutted (see Figure 1) as required in theService Manual. It was also found that, if the drag brace centrepivot were lifted by hand, it took very little force to move itinto an 'unsafe' condition and there was no spring action eitherresisting the movement or trying to return the brace to a 'safe'position.

A series of tests was conducted with the aircraft still on jacks,applying forces to the nosewheel axle in the fore and aft direction. When a forward force was applied, attempting to force a retraction,the drag brace stops could be seen to close up as the drag bracemoved into a more positively 'overcentre' condition. When theforward force was released the drag brace appeared to relax slightly. If the wheel was forced aft, the drag brace stops opened as thecentre pivot was drawn into line with the two end pivots and whenthe rearwards force was relaxed, the drag brace did not returnfully to the overcentre condition achieved after gear extension. When snatch loads were applied to the wheel, the drag brace wasseen to move out of, and then back into, an 'overcentre' condition. During this series of tests, the electro/hydraulic unit whichshould, by design, activate when the down microswitch 'unmakes'and return the landing gear to the 'down' position, did not operate.

It was observed, however, that if some residual forward forcewas maintained on the nosewheel following the application of asnatch load, the gear would occasionally come to rest with thedrag brace in an unsafe condition; the downlock spring not beingsufficiently effective to force it back into a safe condition(see Figure 2). It was found that if a reasonable forward force(as might arise from the forward component of vertical load onthe raked nose leg) were then applied to the nosewheel, the nosegear could be retracted. During this process the down microswitchoperated and the hydraulic pump started. It was, however, notdifficult to retract the gear against the force of the actuator.

Inspection of the nose gear operating mechanism showed that boththe actuator link and the upper eyeend of the downlock springlink had become bent. This appeared consistent with the effectsof the forces required to force the landing gear to retract byweight being applied to the nosewheel when the drag brace wasin an 'unsafe' condition; the spring link being put into compressionby the folding of the drag brace and consequently forcing theactuator link to swing forwards. It was not possible to determinewhether the bending of the linkage had first occurred at the timethat the nose gear had collapsed during the landing, during thesubsequent testing or had been present for some time.

Further inspection of the spring link (see Figures, 3a, b, c &d) revealed that, at some time whilst the sliding spring-end washerhad been resting on the top of the pin head, its outer sleevehad become 'belled' out, as a result of the link being overcompressed,and the spring-end washer had jammed on the top of the belledsection. This had prevented the spring from extending the linkto ensure that the drag brace was positively biassed into the'overcentre' condition. The loss of the spring action of thelink was the reason that the drag brace was able to be moved intoan 'undercentre' condition by snatch loads on the nosewheel. The degree of polishing of the wear mark where the washer hadjammed indicated that it had probably been in this state for sometime.

An independent survey of the nose landing gear, conducted at AAIB'srequest, concluded that although there was wear in the nose landinggear mechanism, it was not abnormally slack apart from the deficienciesin the spring link and a weak actuator.

Analysis

The link can only become overcompressed to the extent that thepin can distort the upper end of the slot in its outer sleeveif the top eye-end is adjusted to make the link too long in itsfully compressed state. Such maladjustment can only occur ata time when the nose landing gear retraction mechanism is beingset up, since any in-service wear at pivots will reduce the tendencyof the pin to come hard up against the end of the slot in itsouter sleeve. If the initial distortion of the upper end of theslot had occurred with the spring-end washer correctly locatedon the pin and the washer had become jammed on the outer sleeveat that time, it is possible that the pin head could move underthe washer when the spring link extended slackly during a subsequentretraction or extension cycle. Once the pin head was under thewasher it would lift the washer to the position in which it wasfound at the next occasion on which the strut was fully compressed.

Examination of the instructions, in the manufacturer's ServiceManual, for setting up the nose landing gear retraction system,showed these to be unclear and not supported by informative diagrams. They appeared to be particularly unclear with respect to theadjustment of the spring link and gave no indication of the actionof this link during the process of extension and retraction ofthe landing gear. The nose gear linkage had not been adjustedduring recent maintenance and had not caused any concern untilthe flight test on 3 October. Since, even after this occurrence,it was not examined critically, it has not been possible to establishthe time at which the downlock link spring became ineffectiveas a result of the jamming of the sliding washer.

The belling of the spring link outer sleeve could only occur asa result of overcompression of the link. The possible occasionson which this might have happened were at the time the link lengthwas adjusted, when it might have been made too long at the intermediateadjustment, and at the time the landing gear was driven up intothe retracted position. It was thought unlikely that this latteroccasion was relevant because if the spring link had been operatingcorrectly, the drag brace should not have been able to flick intothe unsafe 'undercentre' condition necessary for the gear to beforced up against the action of the hydraulic actuator.