

Cessna F177RG Cardinal, G-BFIV

AAIB Bulletin No: 4/2004	Ref: EW/G2003/09/06	Category: 1.3
Aircraft Type and Registration:	Cessna F177RG Cardinal, G-BFIV	
No & Type of Engines:	1 Lycoming IO-360-A1B6D piston engine	
Year of Manufacture:	1977	
Date & Time (UTC):	5 September 2003 at 1632 hrs	
Location:	Blackbushe Airport, Camberley, Surrey	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to propeller blades and fuselage belly	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	2,031 hours (of which 1,600 were on type)	
	Last 90 days - 27 hours	
	Last 28 days - 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

History of the flight

The aircraft departed Blackbushe Airport for a return flight to Henstridge Airfield. On the downwind leg at Henstridge the pilot selected the landing gear down. He was then surprised by the sound of a mechanical 'graunching' noise from the rear of the aircraft. It became apparent that the main gear had not locked down and that it was partially extended, trailing aft in the slipstream but the nose gear had locked down. The pilot selected the landing gear up and then down again but the main gear remained hanging in trail. No 'graunching' sound was heard on this second attempt at extension. At this point the pilot decided to return to Blackbushe.

During the return journey the pilot tried to persuade the main gear to lock down by manoeuvring at high and low 'g' and by flying very slowly whilst operating the landing gear emergency hand pump. When the hand pump was operated the pilot could feel the hydraulic pressure increasing and he was aware that the nose gear was extending properly. The pilot concluded from these perceptions that the main gear must have been jammed. During a fly-by of the tower at Blackbushe Airport the air traffic controller was able to confirm to the pilot that the main gear was trailing aft in the slipstream.

At this point the pilot realised that he was committed to an abnormal landing with resulting damage to the aircraft. There is no light aircraft maintenance facility at Blackbushe Airport so the pilot's passenger, who was also a licensed pilot, called Blackbushe Information and requested a diversion to Wycombe Air Park where the aircraft was maintained. However, Wycombe Air Park denied the aircraft permission to land there.

The pilot then flew in circles to the north of Blackbushe for approximately 40 minutes to allow Blackbushe based aircraft to return to the airport before the runway was inevitably blocked by G-BFIV. During this period the pilot and his passenger decided on a plan of action for their emergency landing. They had the option of landing with the nose gear extended or retracted. The pilot considered that landing with the nose gear extended would possibly avoid damage to the propeller, engine and forward fuselage, but could result in large bending loads within the fuselage centre if the aircraft's weight was supported only at the nose and rear fuselage. He also thought that a wing would be more likely to drop after touchdown as the aircraft slowed down with the nose gear extended, than if the aircraft were sliding flat on its belly. For these reasons he decided to land on the aircraft's belly with the nose gear retracted.

On final approach at approximately 50 feet agl the pilot and his passenger unlatched the doors, turned the master switch to 'OFF', set the mixture to 'IDLE CUTOFF', turned the fuel selector to 'OFF' and set the propeller pitch to coarse. The aircraft touched down and gradually slid to a stop with, in the pilot's words, "no real drama" apart from the noise. The pilot and his passenger exited the aircraft via the cabin doors. The fire and rescue service arrived quickly on the scene but there was no fire.

Description of the landing gear system

The Cessna 177RG's retractable landing gear is hydraulically actuated. The nose landing gear, which has its own hydraulic actuator, retracts rearwards beneath the engine and the main gear legs retract rearwards into open wheel wells in the aft fuselage. The main gear legs are mechanically linked and move as one unit; they are actuated by a single hydraulic actuator that is attached to the gear by an eye-shaped rod end. The actuator rod is fully extended when the gear is retracted. The rod retracts and pulls on the main gear attachment to extend the gear until the gear engages a lock in the down position. When hydraulic pressure is lost, the gear can free fall but it will not rotate forwards into the locked position by gravity alone. The aircraft has an emergency hand pump to provide hydraulic pressure to fully extend the gear.

Aircraft examination

Following the gear-up landing the aircraft was lifted with air bags. It was then discovered that the main gear could be pulled down by hand until it locked in the down position. An investigation by maintenance engineers revealed that the main gear hydraulic actuator rod end had failed. The actuator was no longer connected to the main gear and so it could not actuate the gear into the extended position.

Actuator rod end examination

The failed actuator rod end (see Figure 1) was sent to the AAIB for examination. The rod end appeared to have failed first at the greasing hole (surface A) and then the remaining attached strap had elongated plastically until it had failed in tensile overload (surface B). The rod end was taken to a metallurgist for further examination. The metallurgist confirmed that the strap fracture at surface B had failed due to overload. He also reported that the fracture surface at A did not show signs of a classical fatigue failure but it was possible that a very low cycle, high-stress fatigue mechanism had been involved. It was the metallurgist's opinion that the strength of the rod end had been decreased by gross machining abuse within the greasing hole (surface A).

Figure 1 Failed rod end

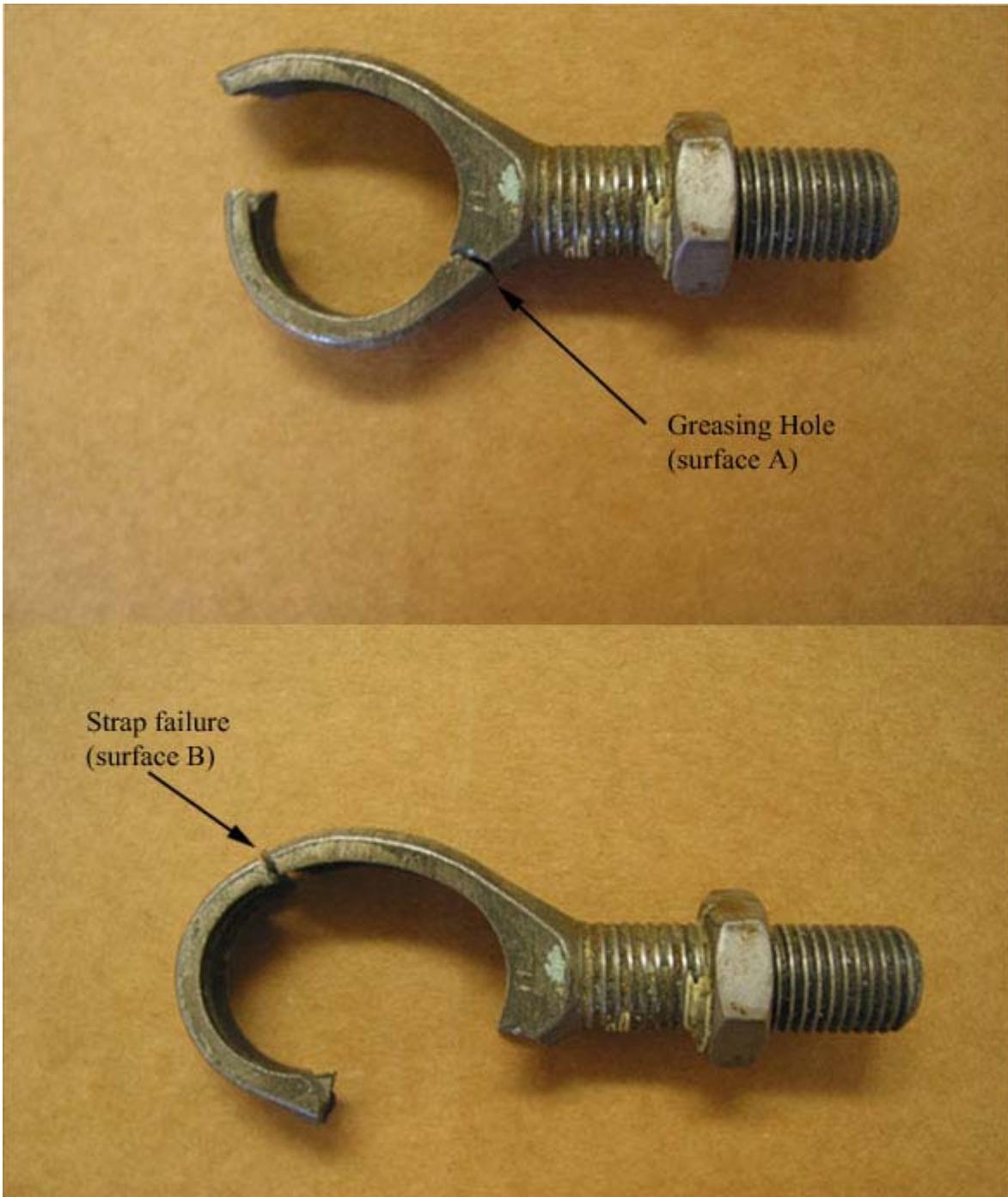


Figure 1 Failed rod end
(greasing hole fracture highlighted above and
strap fracture highlighted below)

Service information letter

On 6 August 1979 the aircraft manufacturer issued a customer care service information letter (SE79-37) concerning the main gear actuator rod end. The service letter affected Cessna 177RG aircraft with serial numbers 177RG0001 to 177RG1366 and F177RG0001 to F177RG0177. G-BFIV with serial number F177RG0161 would have been affected by this service letter.

The service letter stated that a new high-strength main landing gear actuator rod end was now available for the 177RG aircraft. It recommended that the old actuator rod end be replaced with the new higher strength part prior to or at the next annual inspection. The rod end that failed on G-BFIV was the older lower strength type that the aircraft manufacturer recommended be replaced.

The higher strength rod end does not have a greasing hole because it uses a Teflon bearing instead of the previous version's brass bearing. This design avoids the stress concentrations that are introduced by the hole; it also precludes any potential machining errors associated with creating the hole.

Analysis

The main gear failed to lock down because the main gear actuator rod end had fractured. The 'graunching' noise heard by the pilot at the time of the extension was probably the sound of the rod end failing. A metallurgical examination of the rod end revealed that it had possibly failed due to a very low-cycle high-stress fatigue mechanism at the greasing hole. The aircraft manufacturer discovered that there was a problem with the strength of the rod end and issued a Service Letter in 1979 recommending that it be replaced with a higher strength part. It is not known why the recommendation in this service letter was not carried out on G-BFIV. The aircraft was 27 years old and it is possible that the rod end was still the original part. The aircraft manufacturer stated that the company was not aware of any main gear actuator failures on 177RG aircraft that had had the higher strength rod end installed.