

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Cessna F177RG Cardinal RG, G-BFPZ	
<b>No &amp; Type of Engines:</b>	1 Lycoming IO-360-A1B6D piston engine	
<b>Year of Manufacture:</b>	1973	
<b>Date &amp; Time (UTC):</b>	29 March 2009 at 1610 hrs	
<b>Location:</b>	Popham Airfield, Hampshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Damage to rear fuselage skin, stringers, stabilator tips and reinforcing strips	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	49 years	
<b>Commander's Flying Experience:</b>	294 hours (of which 4 were on type) Last 90 days - 5 hours Last 28 days - 1 hour	
<b>Information Source:</b>	AAIB Field Investigation	

**Synopsis**

The pilot selected the gear for landing, observed that the single DOWN AND LOCKED light illuminated and visually checked that the landing gear was extended. On touchdown, the main landing gear folded rearwards and the aircraft came to rest with the nose landing gear extended. The green DOWN AND LOCKED light remained illuminated. An engineering examination found that both main landing gear DOWN AND LOCKED magnetic proximity switches were 'stuck' in their DOWN AND LOCKED positions due to a lack of lubrication and weak return springs. Two Safety Recommendations are made.

**History of the flight**

The pilot made an overhead join for a right-hand circuit

to land on Runway 26, at Popham. On the downwind leg of the circuit he lowered the landing gear and observed that the green DOWN AND LOCKED light was illuminated. He also made a visual check that the landing gear was extended by using a mirror that was mounted under the starboard wing. He was able to see the nose and starboard landing gear, and both appeared to be extended. After turning onto the final approach the pilot again checked that the green DOWN AND LOCKED light was illuminated and made an RT call "Final two six three greens" (in fact this aircraft is fitted with only one green light). The touchdown was gentle and on the main landing gears but as the aircraft's weight settled onto the landing gear it retracted rearwards.

The aircraft came to a halt on the runway, with its weight on the extended nose landing gear and the rear of the fuselage, the green DOWN AND LOCKED light was still illuminated. Following a successful evacuation the pilot returned to the aircraft and, after assuring himself that it was safe to turn on the electrical system, photographed the cockpit which showed the green DOWN AND LOCKED light illuminated. This was later confirmed by the airfield staff who recovered the aircraft.

### **Description of landing gear and downlock operation**

Retraction and extension of the landing gear is accomplished by a hydraulic system integrated with electrical control and indication circuits. There is one hydraulic actuator for the nose landing gear and one that drives a gear system for both main landing gears and hydraulic fluid is supplied to the actuators by an electrically-powered reversible pump. The power to the electrical pump is controlled by the landing gear selector mounted in the cockpit instrument panel, a pressure switch and the three downlock proximity switches. As the landing gear selector is moved to either the UP or DOWN position, the pump directs hydraulic fluid through a power pack control valve assembly to the landing gear actuators. Mechanical over-centre locks provide up and down locks for the nose landing gear and the main landing gears utilise hydraulic pressure for positive up-lock and hydro-mechanical downlocks.

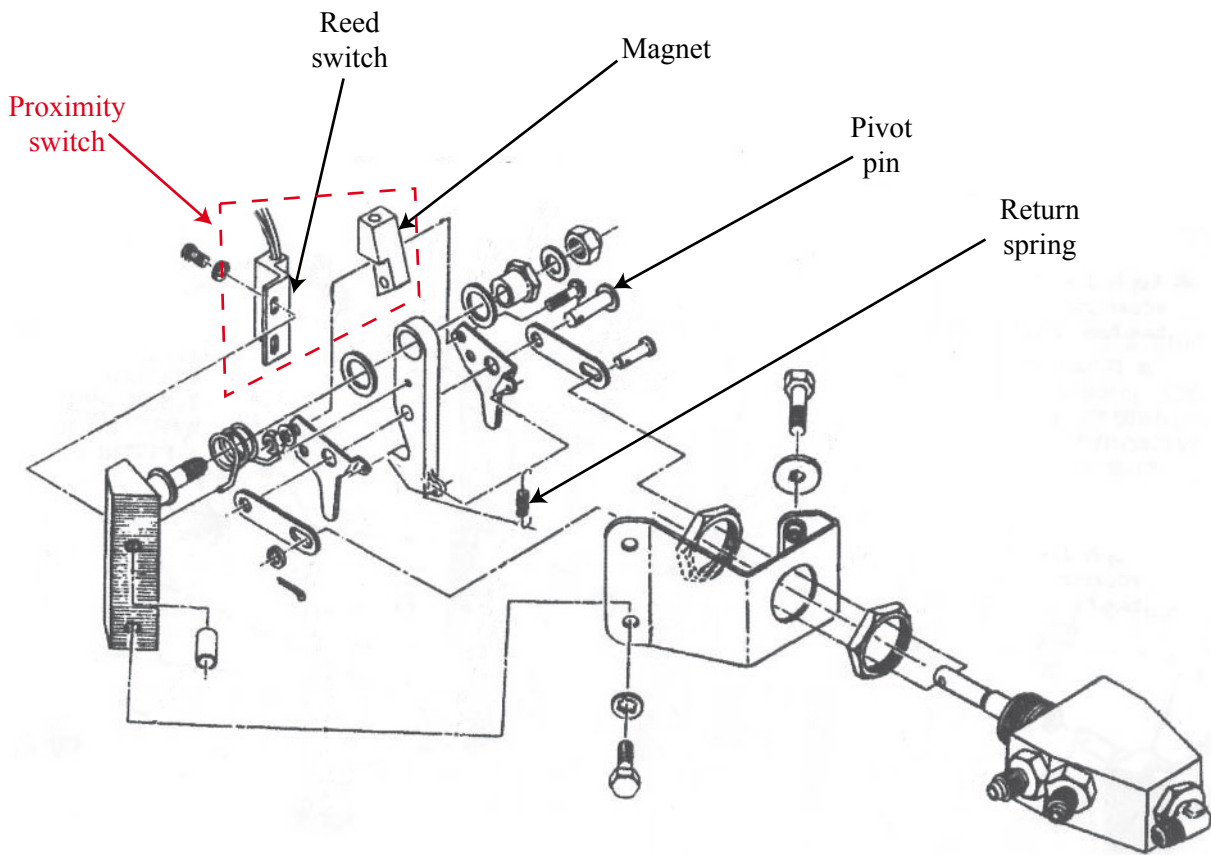
Mounted in the instrument panel are two landing gear position indicator lights. A single amber light illuminates when the landing gear is UP AND LOCKED; a single green light illuminates when it is DOWN AND LOCKED. Each of the three landing gears has a downlock proximity switch and all three proximity switches have to be 'made' to complete the electrical circuit to illuminate the green DOWN AND LOCKED light in the cockpit. In addition to

illuminating the green indicator light, the making of all three downlock proximity switches opens the electrical circuit to the hydraulic pump which switches it OFF. When the hydraulic pump switches off, the pressure in the down lines slowly dissipates over a period of time which is dependant upon the seal leak rates in the landing gear actuators. The hydraulic pump will switch ON when any of the downlock proximity switches open, providing the landing gear selector is to the DOWN position. When a correctly adjusted landing gear is in the DOWN AND LOCKED position no hydraulic pressure is required to maintain it in that condition. When the landing gear selector is moved into the UP position the electrical power is fed directly to the hydraulic pump, not via the downlock proximity switches.

The main landing gear downlock proximity switches consist of a fixed 'reed' switch, part number 2070017, and a magnet, part number 2070026, that is attached to an actuator arm, part number 2041068. The actuator arm is mounted on a pivot, part number MS20392-3C15, and there is a small coil return spring, part number 2041064, attached at the opposite end to the magnet (Figure 1).

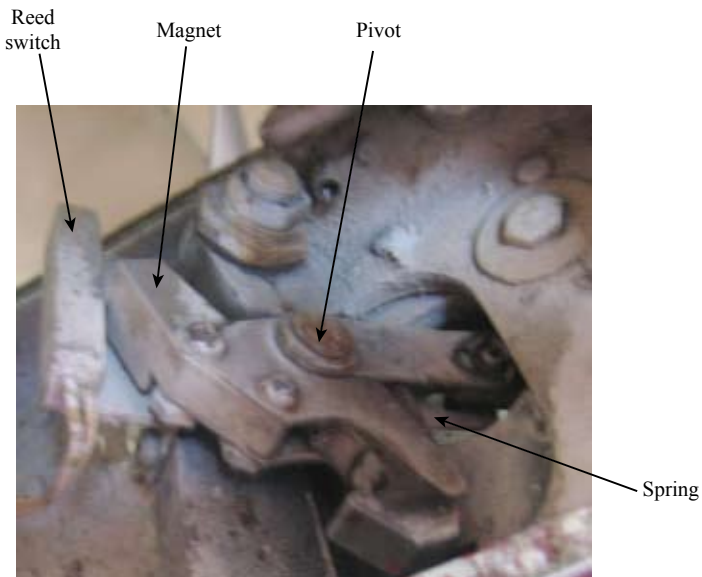
When the landing gears extend and enter the downlocks they mechanically move the lower ends of the actuator arms, causing them to pivot and swing the magnets towards the 'reed' switches. This extends the return springs (Figure 2).

The two electrical contacts within the 'reed' switch are pulled together by the magnetic field of the magnet, completing the downlock electrical circuit. When the landing gear is retracted, the return spring pulls the magnet away from the 'reed' switch (Figure 3) allowing the contacts to separate, breaking the downlock electrical circuit.



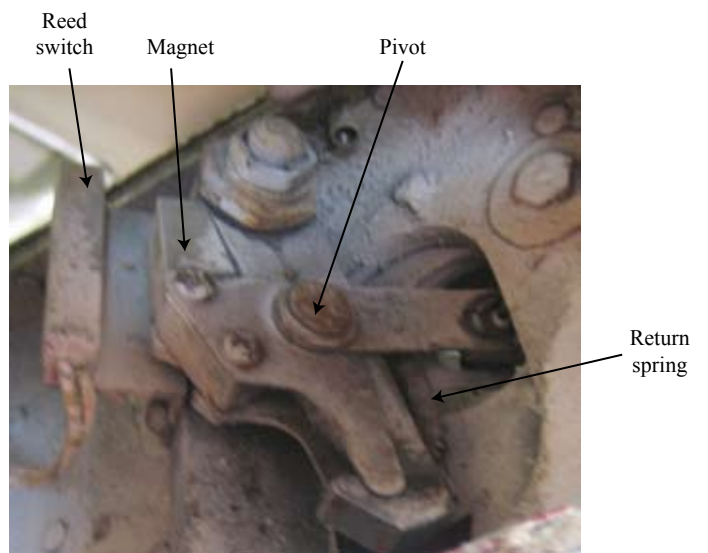
**Figure 1**

Main landing gear downlock mechanism



**Figure 2**

Downlock proximity switch in the 'landing gear extended' position



**Figure 3**

Right landing gear downlock proximity switch in the 'landing gear retracted' position

The nose landing gear downlock proximity switch is similar to the main landing gear switch in that it consists of a 'reed' switch and a magnet. The 'reed' switch is attached to the engine/nose landing gear attachment frame and the magnet to the nose landing gear. The magnet is positioned in the proximity of the 'reed' switch when the nose landing gear leg is in the fully extended position.

All three landing gears swing forward from their retracted positions when they extend to their DOWN AND LOCKED positions. The design of the hydraulic system sequences the landing gear extension, which results in the nose landing gear achieving the DOWN AND LOCKED position before the main landing gears have achieved half their extension travel.

The downlock proximity switches were only fitted to the French manufactured F177RG aircraft. The 177RG aircraft that were manufactured in the USA, have a downlock system that utilises an electro/mechanical mechanism.

### **Engineering examination**

The engineering examination of G-BFPZ revealed that both main landing gear downlock proximity switches remained in the DOWN AND LOCKED position when the landing gear was retracted. Closer inspection found that the pivot points were dry, with no evidence of lubrication, and the return springs were weak.

A number of landing gear retraction and extension cycles were performed and it was found that when performing the extension cycle that the nose landing gear would achieve the DOWN AND LOCKED position and the hydraulic pump would switch OFF leaving the main landing gears in a partially extended position with the cockpit green landing gear DOWN AND LOCKED light illuminated. On

each occasion this occurred it was found that both main landing gear downlock proximity switches were in the DOWN AND LOCKED positions. Movement of either of these switches away from the DOWN AND LOCKED position resulted in the hydraulic pump switching ON, the cockpit green DOWN AND LOCKED light goes out and the landing gears moving to their DOWN AND LOCKED position.

### **Previous accident**

This aircraft was in a previous accident involving main landing gear retraction on landing at Swansea Airport, Wales, in April 2008 (AAIB Bulletin 8/2008). At the time there was no engineering investigation carried out.

### **Previous maintenance**

Following the accident at Swansea Airport, the aircraft, which was based there, was lifted, the landing gear was extended and the aircraft was parked in its normal place. Later in the year the aircraft was sold and the new owner flew it on a 'one-off ferry flight', with the landing gear extended, to an aircraft maintenance organisation based in another part of Wales. This maintenance organisation carried out repairs to the damage caused during the accident and inspected the landing gear system and found no faults. They also carried out an Annual Inspection and Airworthiness Review, in accordance with CAA/LAMP/A/2007 issue 1. During this period of repair and maintenance the landing gear was cycled six or seven times and no fault was found.

### **Other information**

The accident, that is the subject of this report, occurred on the seventh landing following the repair and maintenance.

The aircraft was manufactured in 1973 and at the time of the accident had flown 2,956 hours. A simple calculation

shows that the aircraft had been airborne, generally with the landing gear retracted, for approximately 0.13% of the time since it was manufactured. This means that the main landing gear downlock proximity switch return springs had been in a 'stretched' condition for about 99.9% of the 36 years that they were fitted to the aircraft. This would allow the springs to 'set' towards the 'stretched' position, which would weaken them. There was no indication that these springs had been replaced since the aircraft was manufactured.

#### **Manufacturer's maintenance requirements**

There is no specific requirement to lubricate the main landing gear downlock proximity switch pivot points and there is no replacement requirement for the main landing gear downlock proximity switch return springs.

#### **Safety recommendations**

To help prevent the main landing gear downlock proximity switches staying in the landing gear DOWN AND LOCKED position when the landing gear is retracted the following Safety Recommendations are made:

##### **Safety Recommendation 2010-050**

It is recommended that the Cessna Aircraft Company introduce a specific maintenance requirement for F177RG aircraft to lubricate the main landing gear downlock proximity switch pivot (part number MS20392-3C15).

##### **Safety Recommendation 2010-051**

It is recommended that the Cessna Aircraft Company specify a calendar life for the main landing gear downlock proximity switch return spring (part number 2041064) fitted to F177RG aircraft.