

ACCIDENT

Aircraft Type and Registration:	Spitfire Mk.T IX (Modified), G-CTIX	
No & Type of Engines:	1 Packard Motor Car Co MERLIN 224 piston engine	
Year of Manufacture:	1944 (Serial no: PT462)	
Date & Time (UTC):	27 February 2019 at 1255 hrs	
Location:	Denham Airfield, Buckinghamshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Broken propeller blades, left undercarriage detached and minor structural damage	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	12,992 hours (of which 101 were on type) Last 90 days - 113 hours Last 28 days - 43 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The landing gear warning horn sounded during the approach to land. The undercarriage had been selected down and the green light indicating it was safe was illuminated, but the right undercarriage leg collapsed towards the end of the landing ground roll. Neither occupant was injured. The operator has provided additional information to its pilots concerning the landing gear systems on each of its aircraft and the aircraft will be modified to standardise system functionality with its other Spitfires.

History of the flight

The pilot was operating the aircraft at Denham Airfield. A passenger was seated in the rear of the two cockpits.

Surface wind was reported to be from 230° at 5 kt, with visibility more than 10 km and no significant cloud. The runway surface was dry.

In preparation for landing on grass Runway 24, the pilot selected the undercarriage DOWN at an indicated airspeed of approximately 140 mph. The red UP indicator light extinguished, he felt the undercarriage lower and "clunk" into place, and the green DOWN indication illuminated. He then tested the brakes, reduced power and lowered the flaps for landing.

At this point the undercarriage warning horn sounded but the pilot observed that the green undercarriage DOWN indication remained illuminated.

On two previous occasions in G-CTIX, the pilot had heard the undercarriage warning horn sound on takeoff with the undercarriage raised, flaps up and high power selected; a configuration in which the horn would not normally sound. Consequently, he trusted the DOWN indication and the sensation of the gear lowering as evidence that the undercarriage was down, and he continued the landing.

The aircraft touched down in a 3-point attitude¹ and decelerated normally until, at around 30 mph, the pilot noticed the right wingtip lowering. At first he suspected that a seal in the undercarriage oleo had failed, which would result in the wing being lower on that side. However, the wing continued to drop and he realised that the right undercarriage leg was in the process of retracting. He immediately turned off the magnetos to minimise damage to the engine when the propeller hit the ground and turned off the fuel.

At the end of the accident sequence the aircraft slowly tipped forward and gently yawed to the right, coming to rest upright and facing approximately 170° right of the landing direction. As it stopped moving the pilot instructed the passenger to leave the aircraft immediately and turned off the battery switch. He then unstrapped himself, vacated the aircraft, and assisted the passenger to leave the rear cockpit and move away.

Neither occupant was injured. Aerodrome fire and rescue personnel arrived promptly, and there was no sign of smoke or fire.

Aircraft information

G-CTIX was built in 1943 as a single seater Mk HF.IXe. After a period of inactivity it was converted to two-seat configuration and restored to flight in 1987, with a Packard Merlin 224 engine and Mk PR.XI wings.

Undercarriage system

The Spitfire Mk IX is fitted with two main undercarriage legs and a tail wheel. The main undercarriage legs retract outwards by hydraulic actuators mounted within the fuselage on the engine firewall. An emergency gas discharge system is fitted to extend the undercarriage in the event of hydraulic system failure. The system is operated by the undercarriage control lever (Figure 1) on the right side of the cockpit and there is a panel mounted indication system for UP (red) and DOWN (green) (Figure 2).

Footnote

¹ In which the aircraft lands on both main undercarriage and the tail wheel simultaneously.



Figure 1
Undercarriage control lever



Figure 2
Undercarriage position indicator

Extension / retraction system

To extend the undercarriage the control lever is moved to the left out of a retaining gate and rotated aft by approximately 130°. During this motion the UP side of the hydraulic system is powered to take the weight of the undercarriage off the undercarriage locking pin (Figure 3) so that it can be rotated to the DOWN position. The locking pin is rotated by a series of pulleys, cables and chains connected to the control lever and is sprung loaded so that it can retract and allow either the yoke or eye to disengage or engage as required. A combination of gravity and the DOWN side of the hydraulic system powers the legs until the yoke engages with the locking pin. Once fully down, the hydraulic system pressure increases until a cut-off plunger in the control unit is activated and system pressure is diverted through a bypass circuit and IDLE is indicated on the control lever unit.

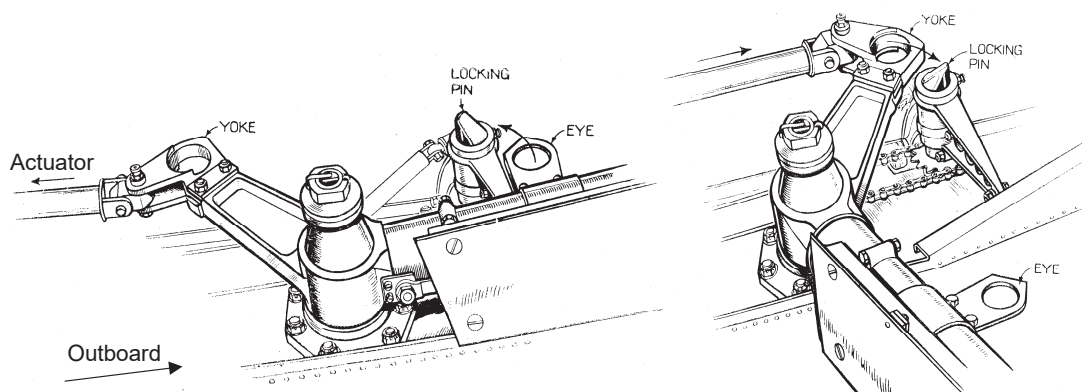


Figure 3

Undercarriage locking pin

Left – Undercarriage UP. Right – Undercarriage DOWN

Source: Haynes Supermarine Spitfire Manual / Crown Copyright

Experience has shown that in certain circumstances it is possible that the undercarriage is not locked down despite indications to the contrary. For example, if the undercarriage is lowered with enough sideslip², the airflow on the undercarriage fairing can prevent one leg from engaging with the locking pin and activate the hydraulic cut-off plunger. Additionally, if the control lever is not moved into the DOWN gate properly, the undercarriage will free fall and (one leg) may not lock down, and the hydraulic system will remain at IDLE. In both cases the DOWN indication will not be lit and so the undercarriage should be fully recycled (raised and then lowered) to ensure both legs are fully locked down before landing.

Indication system

There are several switches in the undercarriage bay which are used to indicate to the pilot the undercarriage position. There is a single switch fitted to each locking pin which indicates if the pin is in the fully locked position. Further switches are mechanically activated when the undercarriage leg is either in the fully UP or fully DOWN position (Figure 4). To illuminate the UP caption in the cockpit, the locking pin must be fully engaged and the UP position switch made. Consequently, for the DOWN caption to be illuminated the locking pin must be engaged and DOWN position switch made. When these conditions are not met (ie during undercarriage retraction or extension) no captions will be lit. Each caption is lit by two bulbs in case of bulb failure.

Footnote

² A sideslip is an aerodynamic state where an aircraft is moving sideways, as well as forward, relative to the oncoming airflow or relative wind.



Figure 4

down position and undercarriage warning horn switches (partially disassembled)

Flap system

The trailing edges of both wings are flitted with pneumatically operated flaps for low speed flight. They are operated by an electrical switch on the left side of the instrument panel and there is a warning horn fitted which sounds if the flaps are extended and the undercarriage is not locked DOWN. On G-CTIX there is a second, separate, switch located adjacent to the undercarriage DOWN position switch which is activated by the same mechanical means for the undercarriage warning horn system. There is a modification which has been embodied on some Spitfires to replace the individual undercarriage DOWN and warning horn switches with a single dual-pole switch to increase reliability (Figure 5). The modification was not fitted to G-CTIX.

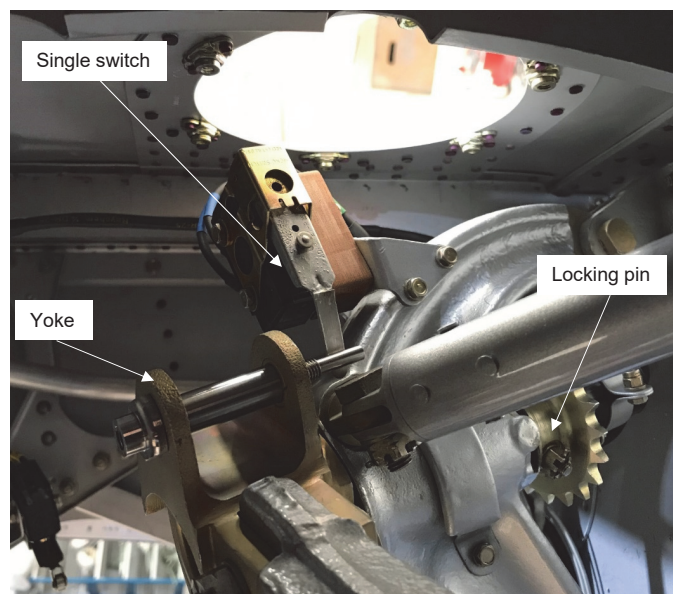


Figure 5

Single dual-pole switch for DOWN position and flap horn (not fitted to G-CTIX)

Some Spitfires are fitted with an additional switch on the throttle control which results in the undercarriage warning horn sounding if the throttle is not closed when the flaps are deployed, and the undercarriage is not locked down (Figure 6). This additional switch was not fitted to G-CTIX.

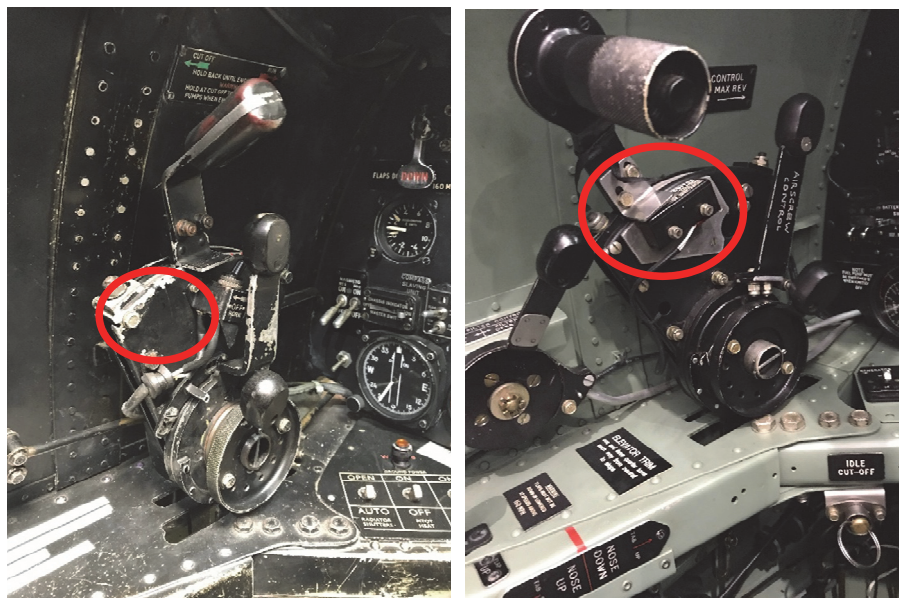


Figure 6

Comparison of throttle controls showing the undercarriage warning switch.
G-CTIX shown in left image

Aircraft examination

At the accident site it was confirmed that the right undercarriage leg was not locked down and subsequently on landing, had retracted back into the wing. The left undercarriage leg had been locked down but the leg had folded underneath the fuselage during the landing sequence. The aircraft came to rest on the left undercarriage leg (Figure 7).



Figure 7

G-CTIX after landing

The aircraft was recovered from Denham Airfield to the Repair Organisation where it was inspected by the AAIB. The primary undercarriage attachment and the locking pin fitting were detached however, as the attachment bolts had failed, there was minimal damage to the wing spar. The inboard end of the left wing had been deformed by the landing leg. There was further damage to the hydraulic retraction actuators and their attachment to the fuselage firewall. The various indication system switches were inspected, and it was found that the DOWN position switch on the right undercarriage was stuck in the closed (DOWN) position. Manipulation of the switch released the switch, but the fault could not be replicated.

Operation

There are several different undercarriage position indicating systems fitted to Spitfires, which may or may not be the same as the systems originally fitted.

The pilot commented that his knowledge of the undercarriage warning horn system fitted to G-CTIX was not complete. The system was not described in the Spitfire Mk T. IX handling notes he used, and the RAF *'Pilots' Notes'* to which he occasionally referred stated:

'The horn, fitted in early aircraft only, sounds when the throttle lever is nearly closed and the undercarriage is not lowered. It cannot be silenced until the throttle is opened again or the undercarriage is lowered.'

Consequently, he viewed the cockpit indicator lights as the "master system" and believed that the horn was dependant on throttle position and undercarriage selector position only, as in other aircraft he had flown. His belief that the gear was down and locked was further reinforced because the horn did not sound when he selected the undercarriage down, but only subsequently when he selected the flaps down. He assumed it had done so spuriously. He considered that, had he known how the horn system on this aircraft worked, he would have discontinued the approach to assess the situation.

Analysis

Following an earlier retraction of the undercarriage, the right DOWN position switch became stuck in the closed (DOWN) position and during the accident landing sequence, the pilot was unaware that the right undercarriage leg was not locked down.

The right locking pin had not been displaced by the yoke and the left leg was fully locked down, resulting in the DOWN indication being lit in the cockpit.

Conclusion

The right main undercarriage was not locked down, and retracted under the weight of the aircraft on landing.

It is likely the undercarriage was serviceable and capable of operating correctly, but excessive air load or incomplete selection of the undercarriage lever to the DOWN position meant that the hydraulic system returned to IDLE before the undercarriage was locked down.

The undercarriage warning horn operated as intended but the right undercarriage DOWN switch was stuck closed, providing an incorrect indication that the undercarriage was safe. The pilot's previous experience and incomplete knowledge of the systems fitted to G-CTIX led him to believe that the green DOWN indication alone confirmed that the undercarriage was safe.

Safety actions

As part of the repairs and return to service, the Operator has taken the following safety action to standardise the operation and functionality of its Spitfires:

Individual switches for the undercarriage DOWN position and the warning horn have been replaced with a single switch for both purposes.

A switch has been added to the throttle quadrant so that the undercarriage warning horn will sound if the throttle is closed, flaps are DOWN and the undercarriage position switch is not closed.

Having reviewed the circumstances of the accident, the operator held a safety briefing for its pilots aimed in part at improving their awareness of the various undercarriage operating and indication systems fitted to its aircraft.

Recognising the differences between different marks of the same basic design, and the fact that aircraft have been fitted with a variety of systems that are not necessarily original, the operator intends to provide its pilots with handling notes for each aircraft that correctly describe the systems currently fitted to it.