

No. 55

Scottish Aviation Ltd., Twin Pioneer, G-AOEO, crashed 285 miles SSW of Tripoli in the Province of Fezzan, United Kingdom of Libya, on 7 December 1957.  
Report released by the Director of Civil Aviation, U.K., Libya.

Circumstances

On 7 December the aircraft flew down to Fezzan from Idris Airport to the Esso (Petroleum Ltd.) camp at Atshan - a flight of some 400 miles. From Atshan it made one local flight of 45 minutes duration. The aircraft was then refuelled at Atshan and set off at 1427 hours local time for the return journey to Idris Airport where it was expected to arrive at 1800 hours with 2 crew and 4 passengers aboard. When the aircraft failed to arrive, a series of radio checks were carried out followed by a widespread air and surface search. The wreckage was sighted the next day. There were no survivors.

Investigation and Evidence

The Twin Pioneer is a twin engined high-wing monoplane specifically designed for operating from unprepared surfaces and from small confined landing grounds. Its exceptional take-off and landing performance is obtained by the use of what are known as high lift devices incorporated in the wing. In view of its important bearing on the accident a brief description of the Twin Pioneer wing is given below.

The wing consists of a one piece centre section which carries the fuselage and the two engines, and two outer wing panels. These outer panels are secured by:-

- a) Pin joints connecting the front and rear spars of the outer wing panel to the front and rear spars of the centre section. The spars form the main structural members of the wing.

- b) The lift strut which extends from the base of the undercarriage leg to a connection with an internal bracing structure in each outer wing panel situated half way between the pin joints and the wing tip. This bracing structure is called the "V brace". It is a triangle of steel tubing with its base connecting the front and rear spars. The lift strut is connected by a pin joint to the apex of this triangle. The function of the "V brace" is to act as a strong point in the outer wing structure to which the lift strut may be attached. Flight loads are borne by the lift strut. The pin joints are hinge-like connections which permit the normal and necessary up and down flexing of the wing in flight. This up and down flexing is restrained by the lift strut. In normal flight, due to the lifting action of the wing, the lift strut and the "V brace" are under tension. It follows therefore that failure or disconnection of either the lift strut or the "V brace" in flight would allow the outer section of the wing to move upwards under the influence of the normal lift forces acting on a wing in flight.

A check "A" daily inspection had been carried out at Idris Airport, Tripoli, on 7 December. A check I or 50 hour inspection was carried out at Idris Airport on 5 December and a check II or 100 hour inspection was carried out at Prestwick Airport on 31 October 1957. Check II includes a visual inspection in situ of the "V brace" in each outer wing panel.

The weather conditions had no bearing on the accident. The sky was cloudless, there were light and variable winds, and good visibility. There were no reports of any unusual meteorological phenomena which could have caused the aircraft to crash.

Examination of the wreckage showed that the aircraft had struck the ground at high speed in a vertical attitude and had completely disintegrated. There was no fire. The outer panel of the port wing was missing from the main wreckage, and was found approximately 1 200 yards away, back along the line of flight of the aircraft.

Examination of the detached outer panel of the port wing showed that the forward tube of the "V brace" had failed. This failure transferred all the upward forces of the wing to the rear "V brace" tube, which tore out of the wing, disconnecting the lift strut from the wing. The disconnection of the lift strut allowed the outer panel of the wing to fold upwards and backwards tearing away from the pin joints. There was no damage to the outer panel of the port wing which could not be ascribed to the pulling out of the "V brace" and pin joints, or to its impact with the ground. There was no evidence of any damage attributable to external causes not connected with the aircraft. The lift strut remained attached to the undercarriage leg, and was found in the main wreckage with the broken portions of the "V brace" still attached.

The broken parts of the "V brace" were removed from the wreckage and metallurgically examined by the Royal Aircraft Establishment, Farnborough, England. This examination showed that the initial failure of the forward tube of the "V brace" was due to fatigue. The "V braces" in G-AOEO were built up from 1.5 inch O.D. (outside diameter) 17 gauge steel tubes to specification 4 T 2.

In the "V brace" structure the forward and rear tubes are connected to the pin joint attachment of the lift strut by means of fork ended cadmium plated steel fittings plugged into the end of each tube and secured to the tube by shear bushes and tubular rivets. Two fatigue cracks had initiated in the forward tube at diametrically opposite points on the bore of one of the shear bushes situated about four inches up the tube from the pin joint; the cracks propagated circumferentially around the tube, and final separation had occurred in tension.

The nuclei of the fatigue cracks were associated with areas where fretting had occurred between the tube and shear bush.

No defect was detected in the tube material. The tests carried out indicated that it conformed satisfactorily to the 4 T 2 specification.

#### Probable Cause

The accident was the result of the failure in fatigue of the forward tube of the "V brace" structure in the outer panel of the port wing. This failure led to the breaking away of the outer panel of the port wing from the aircraft in flight. The aircraft was then rendered completely uncontrollable and dived vertically to the ground.

#### Observations

Preliminary fatigue tests of the "V brace" tubes in 1956 had shown that in this type of structure the 85 ton nickel chromium steel, (specification 4 T 2) had a limited fatigue life, depending upon the speed and weight of the aircraft, the type of flying undertaken, and the altitudes flown. These tests were of the simple gust or load reversal variety which assume that the fatigue life of an aircraft's structure may be directly related to the number of 10 ft per second gusts or load reversals it

is likely to experience during its operations. The frequency of such gusts is naturally greater near the ground and decreases with altitude. The tests indicated that the 4 T 2 tubes had a safe life of approximately 2 500 hours provided the aircraft was operated regularly on flights at or above 2 000 ft. The fatigue life increased with altitude, and a safe life of approximately 10 000 hrs was indicated for operations at or above 5 000 ft.

Both from the standpoint of airline economics, and aircraft maintenance, such a restricted life for the 4 T 2 steel "V brace" structure was considered to be unsatisfactory, and in 1957 arrangements were made to incorporate T 50 specification steel tubing in the "V braces" of all subsequent production aircraft and to modify within their safe fatigue life period, all existing Twin Pioneer aircraft fitted with 4 T 2 tubing. Under test the T 50 tubing had been shown to possess in this type of "V brace" structure, considerably better fatigue resisting qualities than 4 T 2 steel.

G-AOEO had not been modified, but arrangements had been made to change the "V brace" tubes before 2 000 hours had elapsed. The aircraft had flown only 563 hours 55 minutes when its 4 T 2 "V brace" tube failed in fatigue.

This apparently premature failure may be attributed to two factors. First, the aircraft flew for most of its life at comparatively low altitude on training, test and demonstration flying and clearly it was not fully appreciated by the Operator that continued flying of this type by the one aircraft would seriously reduce the fatigue life of the "V brace".

A new series of static and in-flight fatigue tests of the modified (T 50 steel) "V brace" are now taking place in the United Kingdom. These latest tests have been designed to cover as far as possible all the foreseeable stresses to which the Twin Pioneer wing may be subjected. It is anticipated that a considerably increased safe fatigue life for the modified "V brace" will be indicated.

Until the results of the tests are known, the modified "V brace" has been cleared for a safe fatigue life of 500 hours only.

#### Recommendations

Where, after tests, a restricted fatigue life is indicated for a particular part of an aircraft's structure and where this fatigue life is dependent upon the type of operations undertaken by the aircraft, it is recommended that detailed records of all flights should be maintained by the Operator.

As a corollary to the above, the safe fatigue life should, if possible, be specified for all altitudes and for all the types of operations likely to be flown by the aircraft.

Second, the preliminary fatigue tests of the simple gust or load reversal variety could not perhaps have taken into consideration all the loads likely to be imposed on the wing of this type of aircraft, especially those loads associated with unusual flight manoeuvres, (stalls and pull-outs), steep angles of approach and climb, and landings and take-offs from rough surfaces.

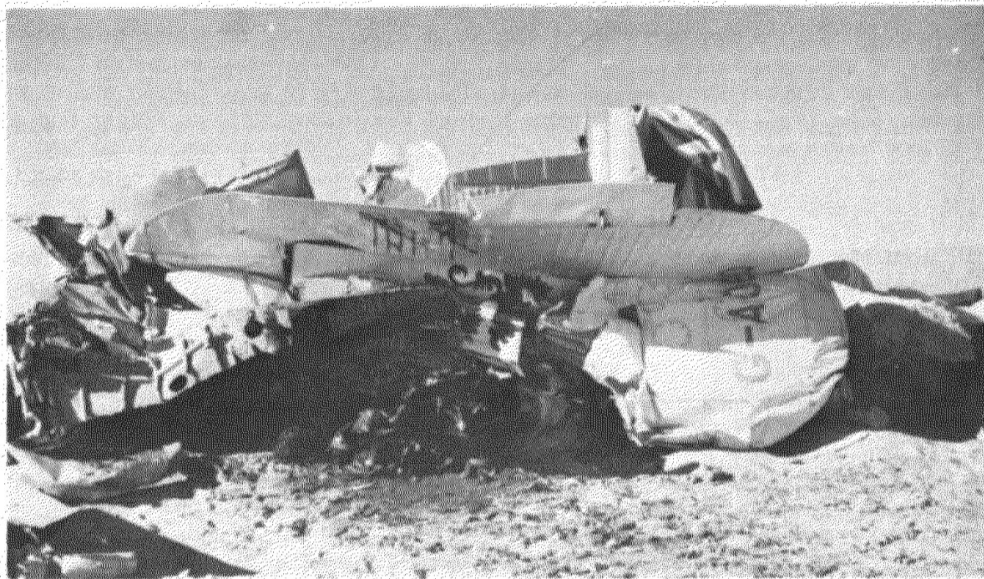


FIGURE 38

THE WRECKAGE OF TWIN PIONEER G-AOEO OF SCOTTISH AVIATION WHICH CRASHED IN THE PROVINCE OF FEZZAN, U.K. OF LIBYA ON 7 DECEMBER 1957

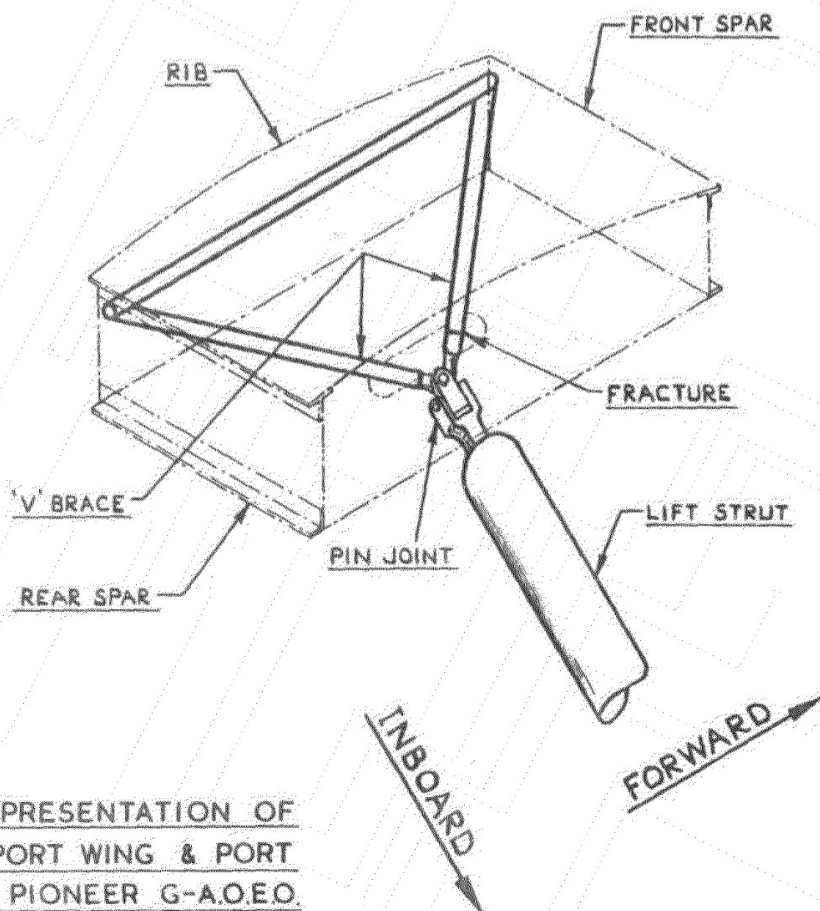


FIGURE 39

DIAGRAMMATIC REPRESENTATION OF  
V' BRACE, OUTER PORT WING & PORT  
LIFT STRUT. TWIN PIONEER G-AOEO.