The Design of Sailplane Dive Brakes

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In recent years the aerodynamic efficiency of high performance sailplanes has increased to such an extent that they may easily reach speeds at which the stresses exceed the existing strength. Failures have been particularly frequent in dives following loss of control during cloud flight. Raising the strength requirements would not provide an adequate solution, as the high structural weight of large span cantilever sailplanes already constitutes a serious problem. Apart from this, there are two ways of increasing the safety of these aircraft; improvement of the stability, or the use of some controllable drag-increasing device to limit the speed.

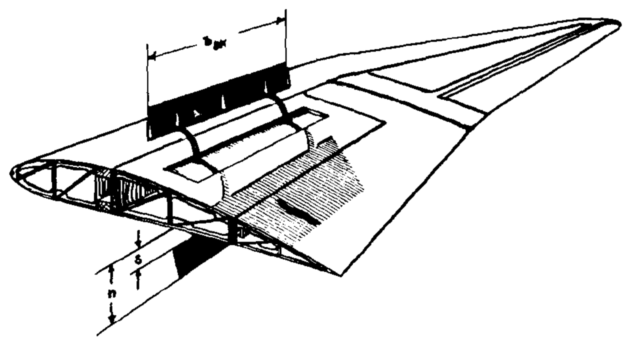
Improved stability and control will undoubtedly contribute to safety, but will not prevent the attainment of high speed through pilot error, particularly in blind flight. The purpose of the drag-increasing device is to keep the terminal dynamic pressure within the limits specified in the design. The drag brakes which have been developed for this purpose have also proved valuable as a means of increasing the sinking speed for flight under clouds, and to spoil the gliding angle as an aid to landing in small fields.

Dive brakes, or spoiler flaps, originally used on sailplanes, have more recently been adapted to military aircraft, and are used to reduce the terminal velocity of dive bombers, permitting them to be pulled out of their dive at a reasonably low height, to reduce the speed of torpedo dropping aircraft so that the missile may be safely released, and to decelerate fighters in order to increase the firing time available during an attack. The results of the aerodynamic and structural research which has accompanied these military developments are in many cases useful in the design of similar brakes for sailplanes, and they will be summarized below.

The main functions of sailplane dive brakes are to reduce the terminal velocity and to spoil the gliding angle at low speeds. This may be done by increasing the parasitic drag, the induced drag, or both. Of the many types of brake that have been suggested for the purpose, most suffer from one or more of the following disadvantages: a turbulent wake, causing tail or wing buffeting, which reduces the control effectiveness and may induce flutter; rotation of the zero lift direction, which may impair visibility in the dive; change of lift, which would prevent their use for glide control at low altitudes; change of wing pitching moment and of downwash over the tail, which would increase the torsional stresses of the wing and the tail loading, and alter the trim; and high operating or structural loads, which further complicate the wing structure, increase the weight, and prevent rapid operation.

Thus the qualities desirable in dive brakes are in many ways opposed to those required of normal flaps, which are sometimes used on sailplanes to increase the lift coefficient of highly loaded types, permitting slow speed flight at low sinking speeds, but which are of little value as a landing aid, or to reduce the terminal velocity.

The only type of brake which has been found suitable for sailplane use is the spoiler flap, which was first proposed by Jacobs of the German Research Institute for Soaring Flight (DFS) in 1935, and has since been adopted almost universally by designers of high performance sailplanes. These spoilers consist of small plates or slats, normally housed in each wing, but which may be extended at will by the pilot to a posi-



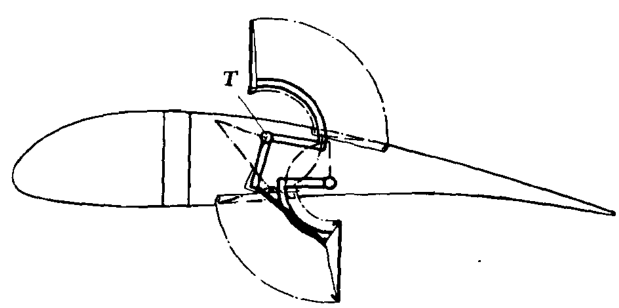


Fig. 2. Rotating type of dive brakes shown in the extended position. T is the torque tube by which they are operated.

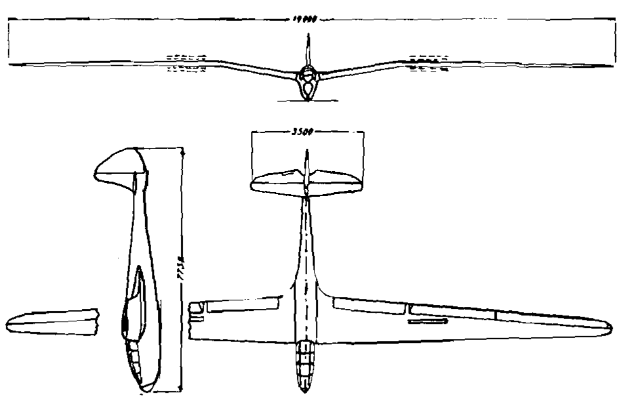


Fig. 1. General arrangement drawing of the DFS "Reiher" sailplane showing dive brakes.