

(21) Application No 8923962.8

(22) Date of filing 25.10.1989

(71) Applicant
Richard Harry Barnard
 46 Lancaster Road, St Albans, Herts, AL1 4ET,
 United Kingdom

(72) Inventor
Richard Harry Barnard

(74) Agent and/or Address for Service
Richard Harry Barnard
 46 Lancaster Road, St Albans, Herts, AL1 4ET,
 United Kingdom

(51) INT CL⁵
B64C 3/38 3/42 3/54

(52) UK CL (Edition K)
B7W WWD WVE WWK
B7G GCAF GCD G312

(56) Documents cited
GB 1343207 A US 4776542 A

(58) Field of search
 UK CL (Edition K) **B7G GCAF GCD GCM, B7W**
WWD WVE WWJA WWK WWS
 INT CL⁵ **B64C 3/00 3/38 3/42 3/54 23/00**

(54) **Secondary lifting surfaces using separated flow**

(57) A secondary lifting surface 1, 2 which is capable of generating lift by means of conical or separated vortices at high angles of attack is movable so that its incidence may be changed relative to that of the primary lifting surface 3. When raised to an angle of attack sufficient to generate separated vortices, the surface generates a high lift coefficient, and is not prone to stalling in the conventional sense. Additionally, if raised to a sufficient angle of attack, its rate of increase of lift coefficient with change of angle of attack reduces, reducing the sensitivity to disturbance by gusts. The surfaces 1, 2 may be at the ring tips, or may be retractable into the main lift surfaces (Figs 2, 3).

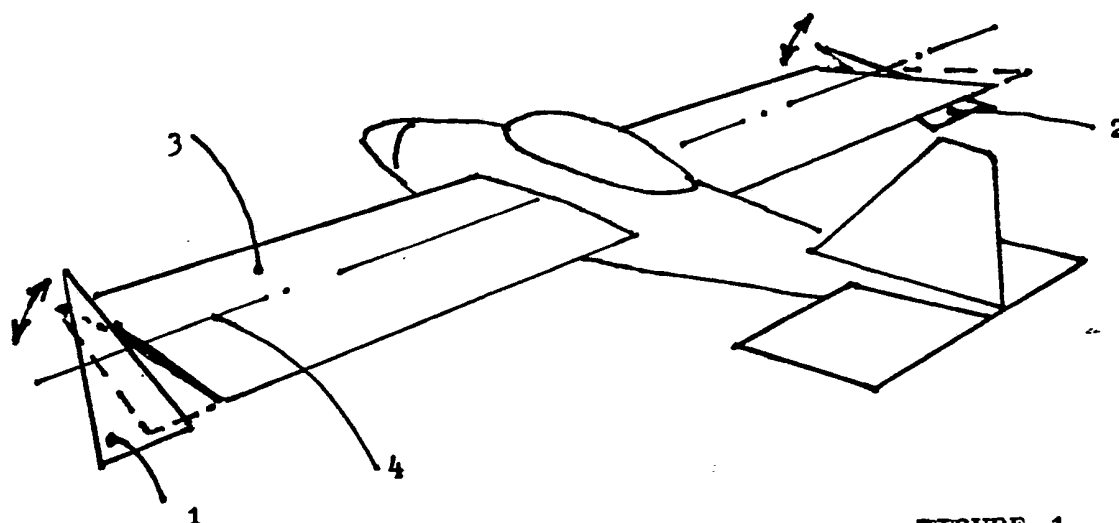


FIGURE 1

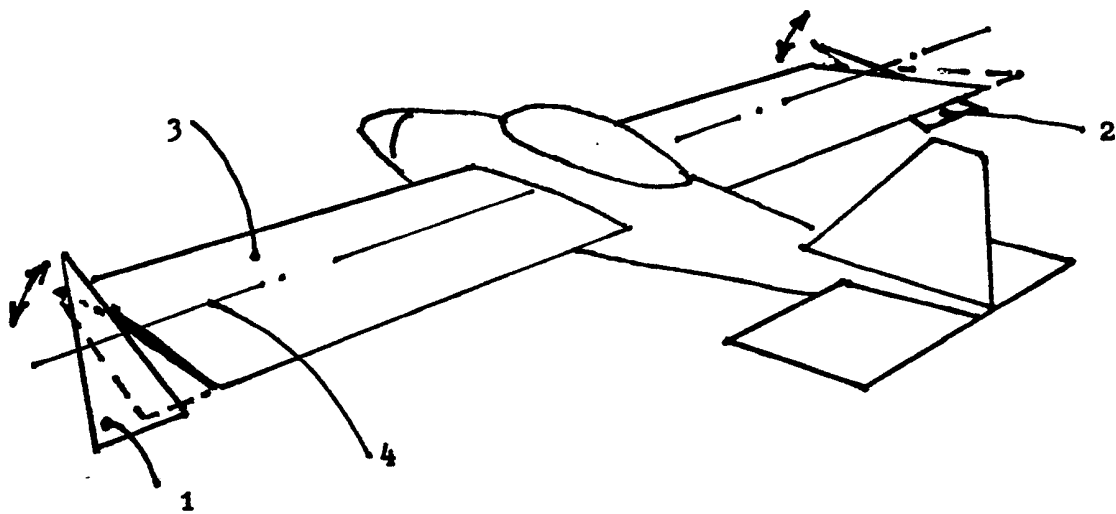


FIGURE 1

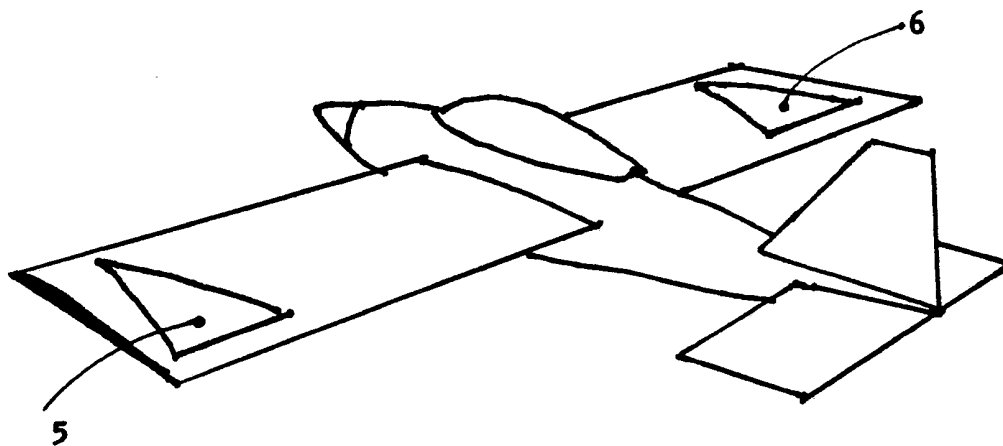


FIGURE 2

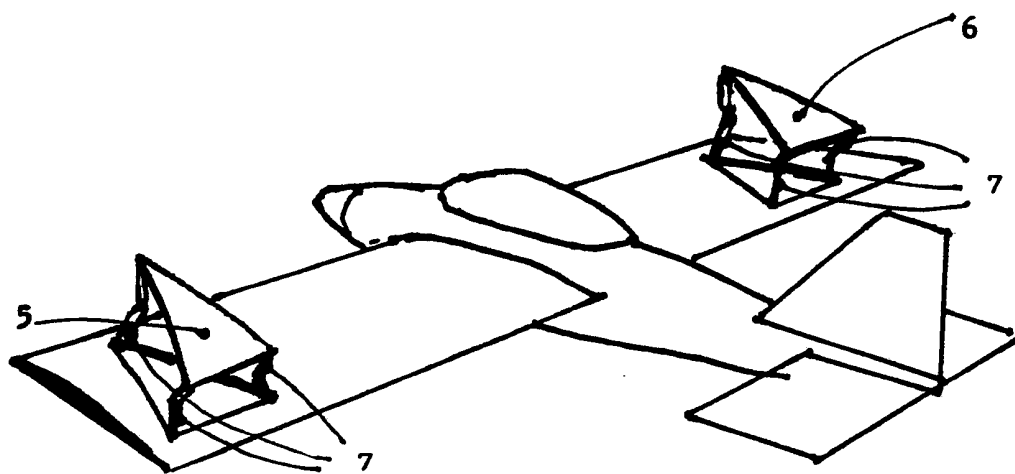


FIGURE 3

AERODYNAMIC DEVICE UTILISING SEPARATED FLOW

This invention relates to a device to modify the stalling and low-speed handling characteristics of an aircraft wing and other aerodynamic lifting surfaces.

In the flight of aircraft, there are numerous situations where it is necessary for the lifting surfaces to generate high values of lift coefficient, examples being the landing approach at low speed, and when pulling out of a dive. Due to the large angle of attack required in such situations, there is a danger that stalling of all or part of the wing may occur. In addition to causing a loss of lift, such stalling may also produce difficult or dangerous handling problems. In the latter respect, it is the stalling of the wingtips or outboard portions of the wing that is particularly significant.

Lifting surfaces with a high degree of leading-edge sweep such as slender delta wings generate stable separated flow in the form of conical vortices, and do not stall in the conventional sense. Therefore, if a proportion of the overall lift force is generated by means of surfaces which produce conical vortex flow, then at high angles of attack, only the regions of conventional attached flow are susceptible to stalling.

A further feature of conical vortex-flow lift generation is that at high angles of attack, the rate of change of lift coefficient with angle of attack is relatively small in comparison with that for conventional attached-flow lift generation. The variation of lift due to gusting of the relative wind is therefore correspondingly smaller, and the aircraft response is less severe.

Wings utilising a mixture of conical vortex and conventional attached-flow lift are found on some existing aircraft types, but the the angle of attack of the surfaces generating the conical vortex flow can not be increased relative to that of the conventional attached-flow lifting surfaces. For this reason, the conical vortex flow lift can not reach anywhere near its maximum value without the likelihood of the flow separating over most of the other parts of the lifting surfaces. Furthermore, the angle of attack will not be sufficient to fully exploit the advantages of a low rate of change of lift coefficient with angle of attack outlined above.

Movable surfaces capable of generating stable conical vortex flow are sometimes employed, but for the purposes of control or for improving the flow over the main wing, not for generating a significant amount of the overall lift.

In the present invention, movable lifting surfaces are employed, the incidence of which may be varied relative to the incidence of other lifting surfaces. The movable surfaces may be adjacent to the tips of the other lifting surfaces, or may be disposed at any spanwise position.

The movable surfaces have a planform in which the spanwise width increases towards the trailing edge, thus presenting swept leading edges in the manner of a delta wing. The degree of sweep is such that when the surfaces are raised to sufficiently large angles of attack, they generate stable conical vortices. Suitable sweep angles and the general geometric requirements for the generation of such conical vortex lift are well known in the art.

Such movable surfaces would normally be held at approximately the same incidence as the other lifting surfaces when the aircraft is flying at or near its normal cruising speed, but could be given a greater relative incidence in low speed flight in order to generate strong conical vortices.

Figure 1 shows one embodiment in which the surfaces are located at the outboard ends of the primary wing.

Figure 2 shows an alternative embodiment in which the surfaces may be retracted into the main wing.

Figure 3 shows the same embodiment as in figure 2, but with the surfaces extended out of the main wing.

In the first embodiment shown in figure 1, the surfaces 1 and 2 are located at the ends of the primary wing 3, so that the region of conical vortex flow can be obtained at those outboard positions. The surfaces may be rotated about an axis 4. This axis need not necessarily be in the direction of the wing major axis as shown, and the two surfaces need not rotate about the same axis.

In figure 1, the surfaces are shown inclined in incidence relative to the main wings, as would be the case when a high lift coefficient is required. The dotted lines indicate the positions that the surfaces would normally occupy in cruising flight.

In a second embodiment shown in figures 2 and 3, the surfaces 5 and 6 may be retracted so as to lie flush with the surface of the main wing in normal cruising flight, as shown in figure 2, or extended and inclined in incidence relative to the main wing so as to generate a high lift coefficient, as shown in figure 3. The surfaces are attached to the main wing by any suitable support and attachment mechanism 7 indicated in figure 3. Suitable mechanisms are well known in the art.

CLAIMS

1. A surface which forms part of the lift-generating surfaces of an aircraft or other vehicle, and which by virtue of its geometrical shape generates lift substantially by means of conical or stable separated vortices when inclined at large angles of attack, and for which, the incidence may be varied in relation to the incidence of the primary lifting surfaces.
2. A movable surface as claimed in claim 1, being located outboard of the primary lifting surfaces.
3. A movable surface as claimed in claim 1, being retractable into the primary lifting surfaces.
4. A movable surface substantially as described herein with reference to figures 1,2 and 3, but for which the planform is not necessarily triangular.