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L. BÉCHEREAU
SUPPORTING SURFACES FOR AIRCRAFTS
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4 Sheets-Sheet 1

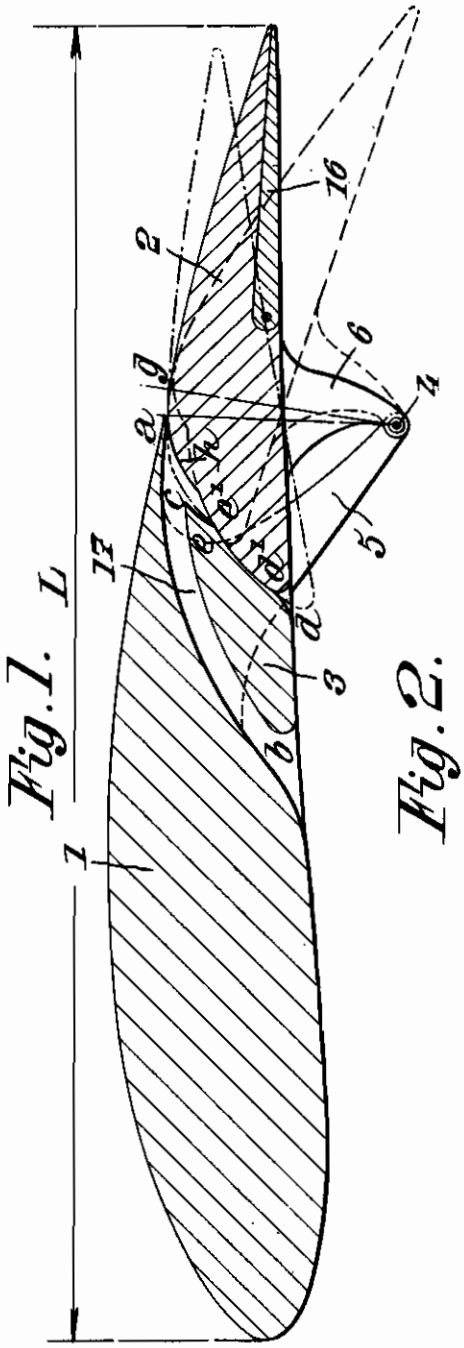

Fig. 1.

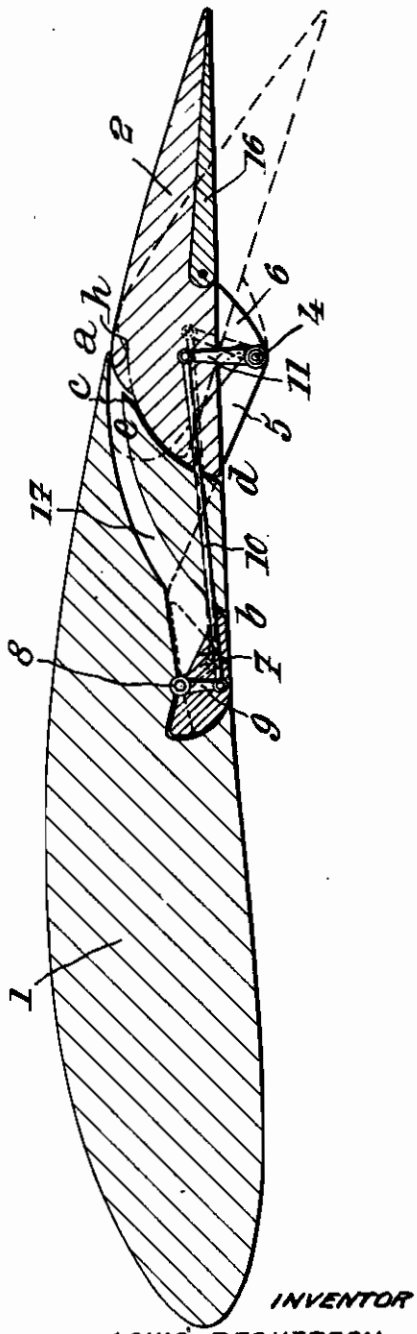

Fig. 2.

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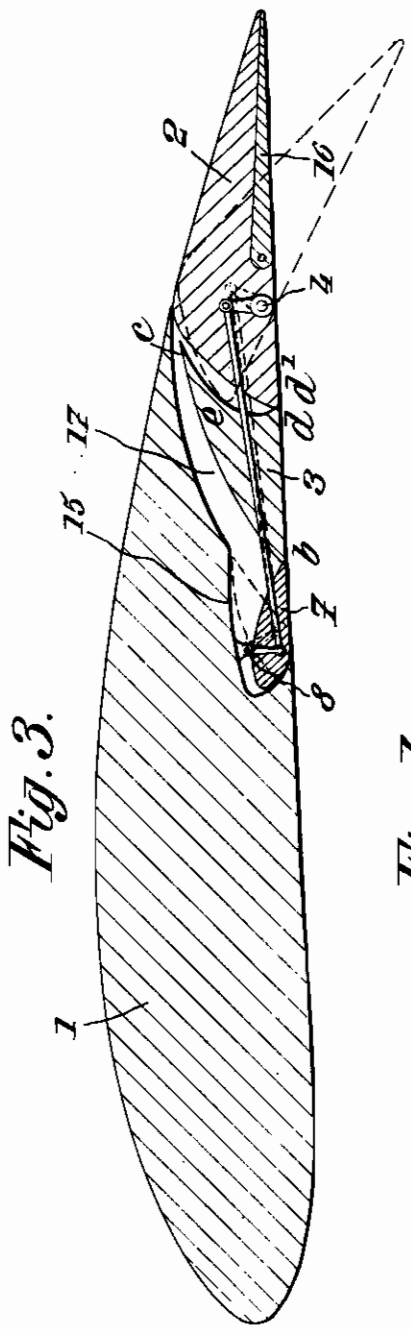

Fig. 3.

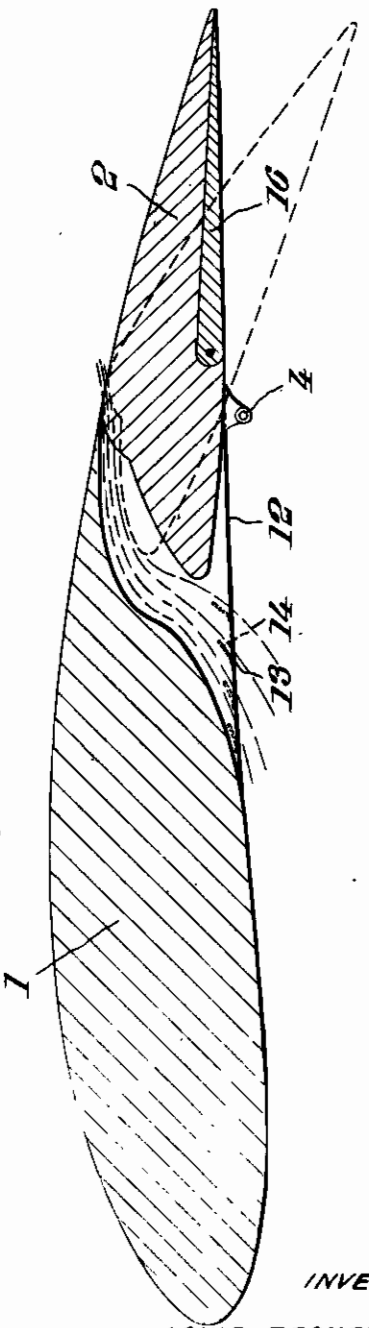

Fig. 4.

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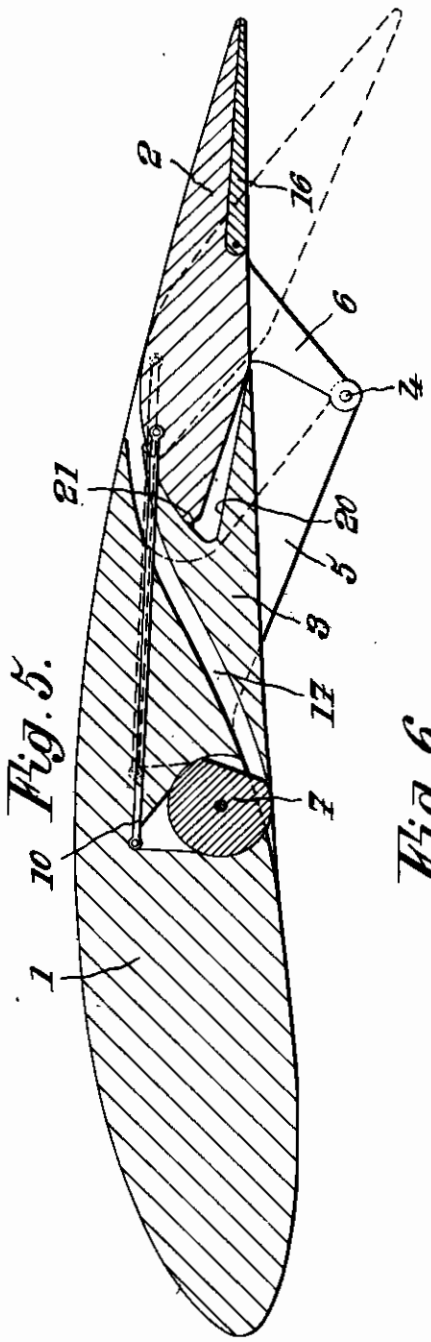

Fig. 5.

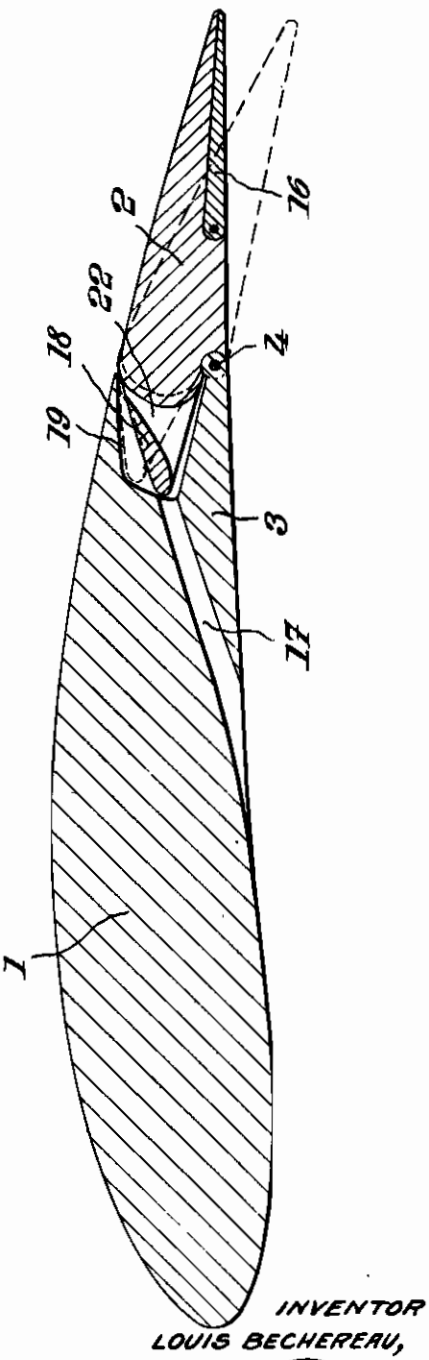

Fig. 6.

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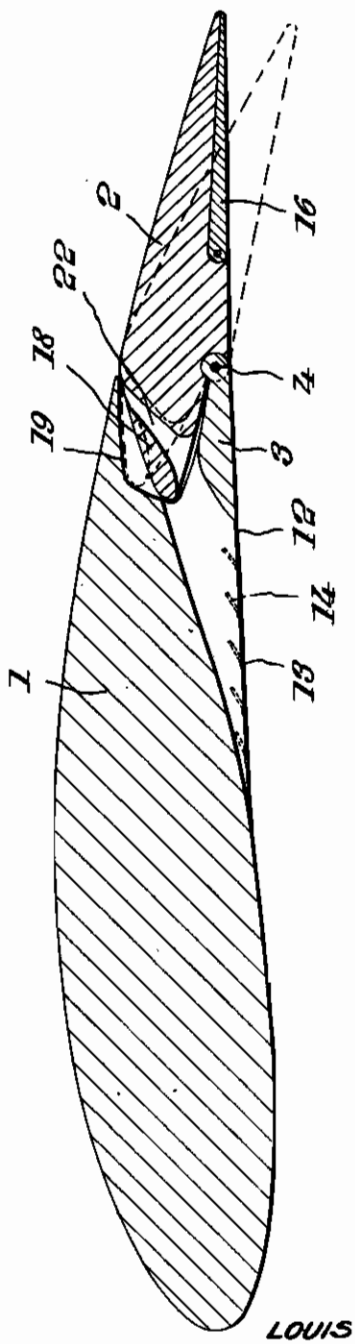

Fig. 2.

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ALIEN PROPERTY CUSTODIAN

SUPPORTING SURFACES FOR AIRCRAFTS

Louis Béchereau, Paris, France; vested in the Alien Property Custodian

Application filed December 16, 1939

The present invention relates to variable curvature supporting surfaces for aircrafts, of the kind of those including at least two elementary wings or wing portions, or again at least one wing and one aileron, these two elements being adapted, either, in normal flight, to be conjugated together so as to constitute a main wing, or under lift-increase flying conditions, to be displaced or pivoted with respect to each other so as to improve the lift, with a slot effect.

The invention is more especially, although not exclusively concerned, among these supporting surfaces, with those in which the movable elements thereof are adapted to modify both the lift and the lateral stability.

The chief object of the present invention is to provide a supporting surface of the type above described which is has remarkable lift increase properties while ensuring, in normal flying conditions, a lift to drag ratio as high as possible, and eliminating any disturbance as might result from the slot effect.

According to an essential feature of the present invention, the supporting surface includes at least one slot arranged to form a fixed passage, preferably as oblique as possible with respect to the chord of the wing section and I combine this slot with the elements which constitute said supporting surface in such manner that the pivoting of the movable elements can control the flow of air through the above mentioned passage.

According to another feature of the present invention, which relates to supporting surfaces of the kind above described which include wing elements or ailerons movable by pivoting, the pivot axis is placed as close as possible to the upper side of the supporting surface, eventually at the level of the upper side in question or even in the thickness of the main wing section, the system being arranged in such manner as to ensure, however, the correct flow of air through the slot or slots, when the elements are pivoted so as to increase the lift.

According to still another feature of the present invention, in supporting surfaces as above referred to, and especially, in the case of surfaces including pivoting elements, when the pivot axis is arranged as above explained, I provide means for balancing the aerodynamic reactions on said wing elements or ailerons, when they are pivoted.

According to still another feature of the present invention, in supporting surfaces of the kind in question including, in a broad manner, a slot provided between wing elements, I provide, at the end of said slot which corresponds to the wing under side (or even the upper side), shutting means adapted to restore the continuity of the fore and aft section, under normal flying conditions, and to open a passage, under lift increase flying conditions, these means preferably having their movements combined with those of the movable wing element or elements, eventually in such manner as to cooperate in ensuring the balancing of the elements, according to the preceding feature.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is a fore and aft section of a double wing system according to the present invention, the rear part forming a curvature modifying element, and also an aileron;

Fig. 2 is a similar view corresponding to another embodiment of the invention;

Figs. 3, 4, 5, 6 and 7 are similar views corresponding to other embodiments of the invention, respectively.

The invention relates to wing structures of the kind eonstituted, along at least some portions of the span thereof, by at least two wing elements 1 and 2 adapted to be pivoted with respect to each other in such manner as to produce, by slot effect, a lift increase. This arrangement is, for instance, applied to the case in which the rear wing element 2 is further adapted to act as aileron.

Concerning first the supporting surface, considered as a whole, and also the lateral control means and lift increase control means associated therewith, they are made in any suitable conventional or other manner.

As for the general section of the wing structure thus constituted by the combination of wing elements 1 and 2, I have found that it is advantageous to have recourse to a thick wing section, at least in the center section of the wing (for instance a type 15 section of 25% relative thickness) that is to say thickness in comparison to the length L of the wing section.

It will be advantageous to arrange elements 1 and 2 in such manner that, under normal flying condtions, they join on the upper side, at a about at two thirds of the length of the chord from the leading edge of the wing structure. However, it should be well understood that this condition is not at all necessary according to the invention.

Then, concerning the means for controlling the relative pivoting of elements 1 and 2, and supporting element or elements 1 to be fixed to the body or fuselage of the aircraft, while elements 2 (formed for instance by two parts located on either side of the fuselage) are movable, these means are arranged, according to conventional or other systems, in such manner as to permit the following results:

(*a*) either of simultaneously lowering the two elements 2 in question, for increasing the lift, or

(*b*) of pivoting them respectively in two opposed directions in order to produce the lateral control of the aircraft.

Therefore, each element 2 is capable of being pivoted either upwardly or downwardly from an intermediate position corresponding to normal flying.

Concerning now the means for obtaining the slot effect, it is known that, up to the present time it was held sufficient to provide a slot directly between, on the one hand, the front element 1 and, on the other hand, the rear element 2. Such a solution did not permit, as a rule, of providing for the mean line of the slot the best possible conditions, and, further, the section of flow could happen to be throttled, when increasing the angle of relative rotation, by the displacement of the nose of element 2.

According to an essential feature of the present invention, the above mentioned means are provided in such manner as to comply with the following conditions:

a. There is at least one slot, arranged in the form of a passage of fixed section (that is to say of a section uninfluenced by the relative pivoting of the elements) on at least part of its length, this passage being made of any suitable inclination, preferably as great as possible with respect to the chord of the sections of the main wing (the inlet of the slot on the under side being as close as possible to the first third from the front of the fore and aft section of the main wing, or being eventually located in this first third).

b. the section of flow of the air at the outlet (or even at the inlet) of this slot can be adjusted in accordance with the pivoting of the corresponding movable element 2.

For this purpose, for instance, this passage or slot 17 is arranged between, on the one hand, the front element 1 and, on the other hand, in intermediate element 3, which is preferably fixed in position, this last mentioned element being arranged in any suitable manner and combined in such manner with the rear element 2 that it bears in a substantially fluidtight manner against said rear element, for at least part of the pivoting of said last mentioned element (although the invention would apply as well to the case in which a portion of the air could pass between elements 3 and 2).

On the underside of the front element 1, this intermediate element is provided for instance (Figs. 1 to 3 and 5 to 7) with a section *bc* arranged in such manner, with respect to the outline of said under side that is located opposite, as to form a passage, of fixed or variable section along its length, preferably, this section *bc* and the corresponding outline above mentioned are substantially inclined with respect to the chord of the main wing structure.

On the side of the rear element 2, this intermediate element is of a section corresponding to the kind of displacements resulting from the relative rotation of parts 1 and 2. It, as it will be hereinafter supposed, this rotation takes place about an axis 4, the last mentioned section will be, for instance circular at *de* (Figs. 1 to 3) with the center on said axis 4, so that the front portion of the upper side of element 2 can, in the course of the rotation, slide along surface *de*.

This sliding displacement can take place between, on the one hand, this surface, and, on the other hand, either another surface of the same outline d^1e^1 (Fig. 1) carried by the front part of the upper-side of movable element 2, or merely the front nose of this element 2 (Fig. 3).

Besides, it should be well understood that any other arrangement within the scope of the invention can be employed. For instance, as in Figs. 6 and 7, the intermediate element may merely include a bearing surface on which the under side of the movable element comes to rest in straightened position. I might also, as in Fig. 5, combine the respective arrangements of Figs. 1 and 6.

The provision of an intermediate element such as 3 facilitates the adoption of another feature of the invention, which consists in positioning the pivoting axis 4 as close as possible to the under side of the main wing section, or even at the level of this underside or on the inside of the section thereof. The advantage of such an arrangement is that it reduces the projection formed under the wing by parts such as arms 5, 6 for connecting together elements 1 and 2 (Figs. 1, 2 and 5) or even it eliminates these parts (Figs. 3, 4, 6 and 7).

When use is made of arms 5, 6 with a pivot 4 on the outside, it is of interest to arrange the whole in such manner that arms 5 do not extend through the rear element 2, as shown by Fig. 5.

Whatever be the arrangement that is chosen, the whole is completed by means for regulating or controlling the flow of air, through the slot or passage, in accordance to the relative pivoting of the rear element.

Such means may act either at the outlet of the slot on the upper side of the outline of the general wing structure, as shown by Figs. 1 and 6, or at the inlet, on the underside of said outline (Fig. 5), or again both at the inlet and the outlet, as shown by Figs. 2, 3 and 7. But of course, these means might be of a different nature and position.

Supposing first that it is desired to control the passage at the outlet thereof, at *a*. It will suffice, as shown by Fig. 1, to provide, for instance between the upper side of element 2 and the nose d^1 e^1 of said element, a suitable notch or recess, this notch or recess being such that, when the rear element is pivoted downwardly, in order to obtain lift increase flying conditions, as shown in dotted lines by Fig. 1, the section of flow between the trailing edge *a* of element 1 and the surface of said recess *h* tends to increase.

On the contrary, it would be advantageous to provide a fluidtight connection at *a* for pivoting conditions intended to provide the lateral control of the airplane, at least when pivoting the rear element upwardly. For instance, the upper side of element 2 is given a circular outline *fg*, having its center at 4, which ensures fluidtight contact from the normal flight conditions (solid line of Fig. 1) to the limit position of upward rotation for lateral control (dash-and-dot line of Fig. 1).

If it is desired to control the passage at the inlet, at *b*, use will be made, for instance, of a

flap such as 7 (Figs. 2, 3 and 5) the position of which will be controlled, in accordance to the angular position of element 2, through connecting means such as those those from 9 to 11, between, for instance, this flap and movable element 2, or in any other suitable manner, either mechanical or not.

Such flaps 7 permit, under normal flying conditions, of fully restoring the continuity of the underside outline of the general wing structure. They might eventually be utilized at the outlet, at *a*, on the upper side.

I might also, still for the same purpose, provide, in the cover surface at the inlet of the slot, orifices 13 fitted with valves 14, which would open automatically when turning the parts into the lift increase position, as a consequence of the suction existing at *a*, and therefore in the slot.

Such an arrangement would make it possible to eliminate the intermediate element 3 (Fig. 4) and might be applied to all kinds of wing structures.

Finally, the wings as above described may further include means for balancing the aerodynamic reactions with respect to axis 4, such means being preferably arranged as it will be hereinafter explained.

Whatever be the particular embodiment that is chosen, I obtain a device the operation of which results sufficiently clearly from the above explanations for making it unnecessary to enter into further details. This device has, over the existing devices many advantages, among which the following may be cited:

The device has very remarkable aerodynamic properties, that is to say the lift-to-drag ratio is high under flying conditions and the lift is very great when flying with the lift increase means in the operative position

Furthermore, all the parts of the device are simple and strong.

The lift can be further increase, if so desired. by making use of upper side flaps 16 carried by the rear element.

The invention further includes the following features, which can advantageously be combined with those above described.

According to one of these features, I combine, with the movable elements of the wings, means adapted to coact with the slot for balancing, at least partly, the aerodynamic efforts which tend to create torques preventing or opposing the rotation of the wing elements.

Such an arrangement is particularly useful when axis 4 is located close to the under side. As a matter of fact, in this case, it will be located ahead of the center of thrust of the corresponding element 2, thus producing a couple which opposes rotation of the elements.

In order to provide these means, it suffices, as a rule, to expose to the aerodynamic actions acting on the slot, suitable surfaces which are conjugated in a suitable manner to elements 2.

If, in particular, use is made of flaps such as 7 (Figs. 2 and 3) it is advantageous to make use of the torque resulting from the action of said suction on said flap with respect to its axis 8, in order to balance the torque produced by the aerodynamic forces and other forces which act on element 2. It will suffice the calculate the transmission from 8 to 11 in a suitable manner.

The axis itself may be positioned in such manner as to be suitably eccentric with respect to the center of thrust of the flap, so as to increase the balancing torque. A recess 15 will be provided in the wing for the housing of said flap.

According to another embodiment, which is shown by Figs. 6 and 7, I provide compensating surfaces of elements 2 themselves.

Each of these elements includes, for instance, for this purpose, a kind of flap 18 at its front part, and it is separated from said flap by a slot 22 arranged in such manner as to prolong passage 17, when the parts of the device are pivoted in such manner as to correspond to the lift increase conditions.

It will be readily understood that, with such an arrangement, the action of air through this slot produces a force which exerts, with respect to axis 4, a torque opposed to that created by the aerodynamic actions on the under side of element 2, when the element in question is pivoted. A complementary compensating force can also be produced by the action of the suction existing in a recess 19 provided in the wing above flap 18 and acting on the upper side of said flap.

The fixation of this flap 18 to element 2 will be obtained through any suitable means.

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