

Feb. 19, 1935.

R. F. HALL

1,992,158

AIRPLANE

Filed Jan. 11, 1934

2 Sheets-Sheet 1

Fig. 1.

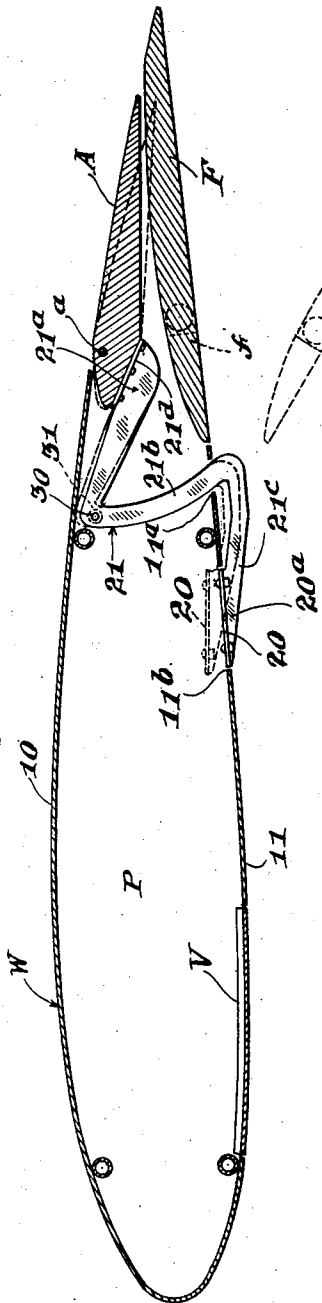
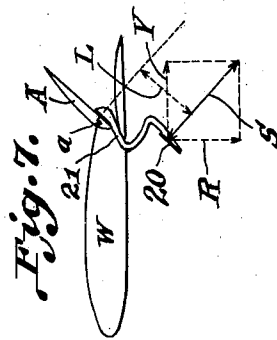
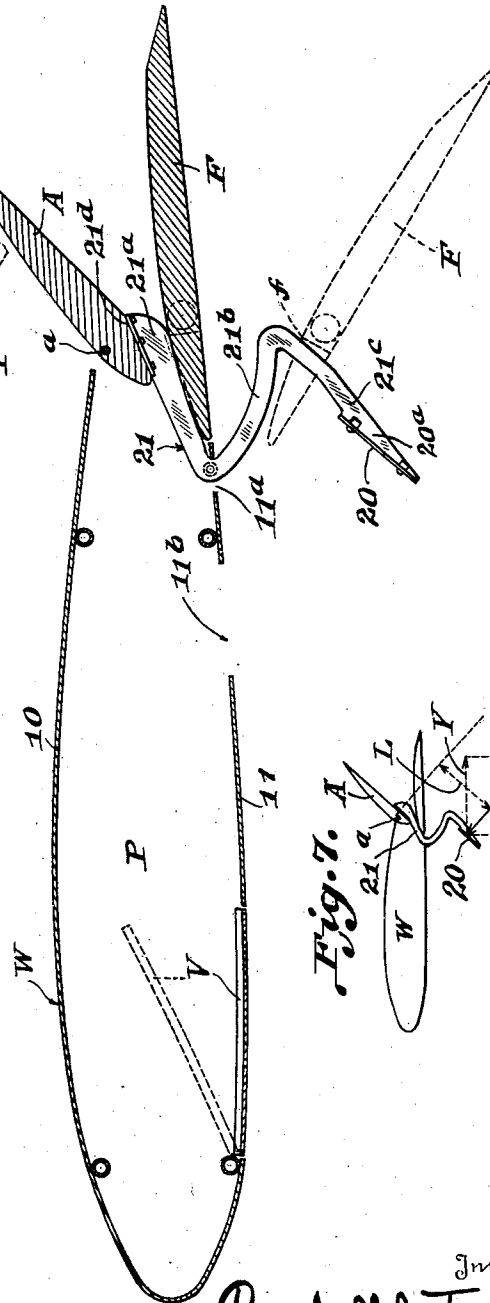


Fig. 2.



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2 Sheets-Sheet 2

Fig. 3.

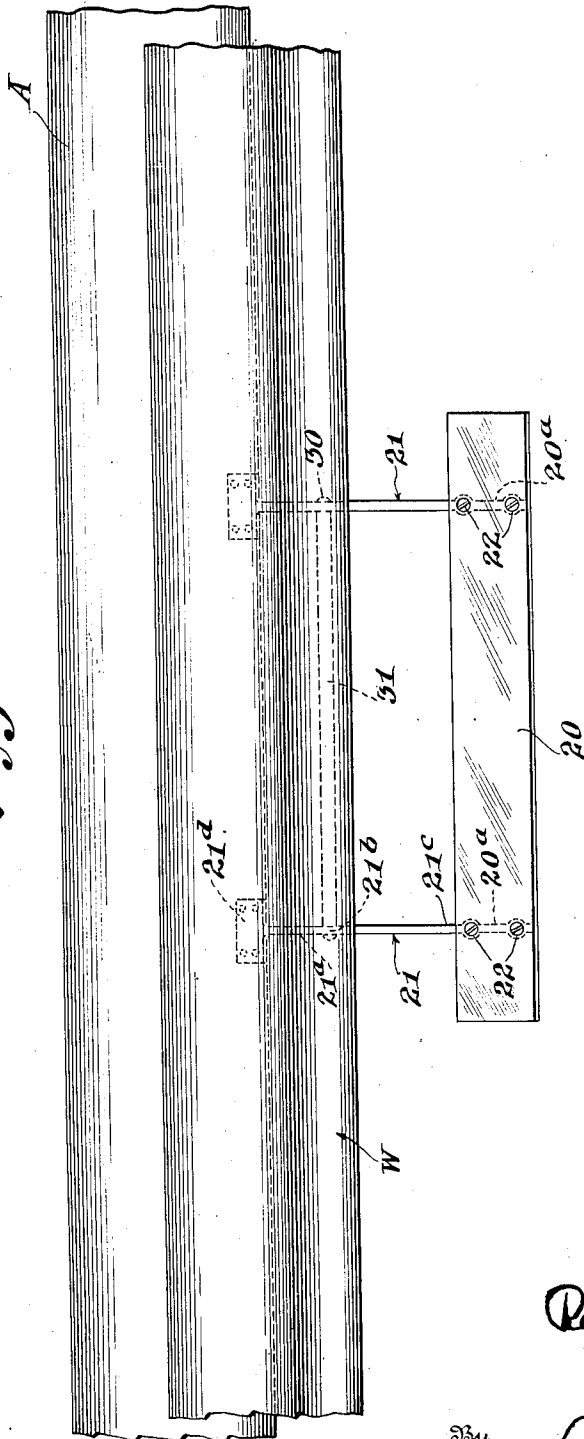


Fig. 5.

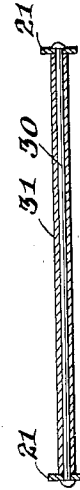
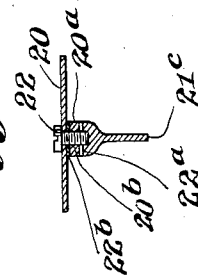


Fig. 6.



Fig. 4.



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UNITED STATES PATENT OFFICE

1,992,158

AIRPLANE

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Application January 11, 1934, Serial No. 706,268

21 Claims. (Cl. 244—12)

My invention relates to certain improvements in airplanes, and particularly to the lateral control thereof; and the nature and objects of the invention will be readily recognized and understood by those skilled in the aeronautical art in the light of the following explanation and detailed description of the accompanying drawings illustrating what I at present consider to be the preferred embodiments or mechanical and aerodynamic expressions of my invention from among various other forms, arrangements, combinations and constructions of which the invention is capable within the spirit and the scope thereof.

A type of lateral control system for airplanes that has been found to be very effective in control throughout the flight range includes lateral control surfaces or ailerons mounted in the upper surface of a wing, and provides for a lateral control operation of such surfaces or ailerons by which lateral control is obtained by mainly up movement or upward swinging of an aileron from a normal or neutral control position, while the opposite control surface or aileron remains substantially without movement or has relatively small downward movement from its normal or neutral control position. However, with such type of control system it has also been found that a considerable force is required to operate or actuate a control surface or aileron to the fully raised or upwardly swung maximum control positions, due to the high control surface or aileron hinge moments developed by the reaction of the airflow at the upper surface of the wing on the raising or upwardly moving aileron. The necessity for large operating forces for actuating such a control system, constitutes a serious problem and a disadvantage that in practical applications of this type or control system tends to offset or nullify the high degree of control effectiveness of which a system obtaining lateral control mainly through its up aileron movement is capable, and especially such a system in which the control surfaces or ailerons are mounted in the upper surface of a wing.

A general object of my present invention is to reduce the operating forces required in the control actuation of a lateral control system in which lateral control is obtained mainly by upward control surface or aileron movement, to a sufficiently low order to enable practical and efficient control operation throughout the full control range, including maximum raised control surface or aileron positions; and further to carry out the operating force reduction in such a manner as to increase the control effectiveness and

to augment the favorable yaw characteristics of the airplane under lateral control, tending to thereby avoid the inadvertent or unintentional spin.

A further object of the invention is to obtain the reduction in control operating forces required for such types of lateral control systems, by providing an aerodynamically efficient and structurally simple aerodynamic balance mounted on each lateral control surface or aileron for downward movement with upward swinging of the aileron into a position such that the reaction of the airflow thereon will exert forces assisting the upward movement or swinging of the control surface or aileron and thereby reduce the operating force that must be applied to the aileron to raise or move it upwardly.

Another object of the invention is to provide a design and mounting of such an aerodynamic balance for a control surface or aileron, to permit of the use of the balance on and with a control surface or aileron mounted in the upper surface of a wing in which a lift increasing member such as a wing flap is mounted on the under surface of the wing below the lateral control surface, without interference between the control surface or aileron balance and the under surface member or flap throughout the operating ranges of both the control surface and the wing flap.

Another object of the invention is to provide such a control surface or aileron aerodynamic balance member and mounting therefor, in which a dynamic mass balance weight can be incorporated and combined therewith, in order to prevent or reduce control surface and wing flutter in high performance or high speed aircraft; and further to so design the balance weight and the aerodynamic balance mounting that the balance weight can be secured on and be carried by the mounting in a manner to brace and strengthen such mounting.

A further object of the invention is to provide such an aerodynamic balance member and its mounting as a separate unit for each control surface or aileron, and which can be readily mounted on or removed from a control surface as a unit for replacement or alteration.

Another object of the invention is to provide a design of aerodynamic balance member and an arrangement for attaching the same to its mounting, by which the member is removable from the mounting for replacement or for adjustment in its position on the mounting.

A further object of the invention is to provide a design and construction of such an aero-

dynamic balance surface in which a minimum of structure with a minimum of weight is possible; and further which can be mounted on a control surface or aileron in the upper surface of the wing in such a manner as to locate the balance member of the unit at the under surface of the wing, remote from the control surface for downward movement by upward control surface movement, but which balance member in normal or neutral control surface positions is disposed at and forms a portion of the normal wing under surface contour.

With the foregoing general objects and results in view, as well as certain others that will be apparent to those skilled in the aeronautical art, my invention consists in certain novel features in construction and design, and in combination and arrangements of elements and parts,—all as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawings in which similar reference characters refer to corresponding parts throughout the several figures of the drawings:—

Fig. 1 is a vertical transverse sectional view, more or less diagrammatic through a wing of the passageway trailing under flap type having an upper surface aileron, with an aerodynamic balance unit of my invention mounted on the aileron, the aileron and balance unit being shown in normal neutral control position in full lines and in lowered or drooped position of the aileron in dotted lines.

Fig. 2 is a transverse vertical sectional view similar to Fig. 1 but showing the aileron in fully raised lateral control position with the aerodynamic balance in its fully lowered operative position at the under side of below the wing, the under surface trailing wing flap being shown in full lines in normal raised position and in dotted lines in lowered lift increasing position.

Fig. 3 is a view in front or leading edge elevation of a portion of a wing of Figs. 1 and 2, with the aileron in raised lateral control position and the aerodynamic balance in its corresponding lowered position, and showing the dynamic mass balance weight in position on the balance mounting, and the attachment of the balance member to its mounting arms.

Fig. 4 is a detail, fragmentary vertical sectional view through one of the balance mounting arms and a portion of the balance member attached thereon, showing particularly one of the balance member attaching screws and its locking wire by which the balance member is removably mounted, and also showing a shim by which the balanced member position may be adjusted on the mounting arm.

Fig. 5 is a longitudinal sectional view through the balance weight in position on the aerodynamic balance member mounting arms, the arms being shown in transverse section.

Fig. 6 is a detail vertical sectional view through a portion of the wing under surface showing a modified formation thereof to receive the aerodynamic balance member when in raised positions.

Fig. 7 is a diagram schematically indicating the forces and their resultants acting on the balance unit with an aileron in raised position, the wing aileron and balance unit being shown schematically in outline.

The problems and difficulties that my present invention has overcome are particularly encountered in those so-called high or variable lift wings for aircraft that include ailerons or lateral con-

trol surfaces in the upper surface of a wing above a lift varying member, such as a wing flap, in the under surface of the wing, and where lateral control is obtained by mainly up movement or upward swinging of an aileron. It has been established that during large angular control movements of such an aileron, the control operating force not only must overcome the positive pressure working against the raising aileron on the upper surface of the wing, but must also overcome a considerable negative pressure below the aileron that tends to hold the aileron down against raising, and in addition where control is obtained in the main from raising of but one aileron, the displacement of such aileron or control surface must be greater than for the conventional aileron operation, thus further adding to the operating forces required for control actuation of an aileron of such a lateral control system.

I have therefor selected for purposes of explaining my invention, a high or variable lift wing of the so-called "Hall" type in which there is present the upper surface aileron with the under surface wing flap and the control system that depends mainly upon up aileron movements for lateral control, and I have illustrated a form and adaptation of my aerodynamic aileron or control surface balance unit designed for use on and with such type of wing to meet the particular conditions there encountered. My invention is not, however, limited to the adaptation here shown or to the particular type and design of wing of the illustrated example but is equally adapted to various other wings and to other embodiments to meet the particular aerodynamic and structural conditions of the wing and control surface thereof with which the invention is to be used.

The wing W of the "Hall" type illustrated in the accompanying drawings is well known and familiar in the art and includes the upper skin or surface 10, the under or lower skin or surface 11 and the longitudinal air displacement passage P extending rearwardly therethrough from a forward inlet through the wing under surface 11 controlled by a vane V, to the trailing or rear portion of the wing. A wing lift and under surface camber varying flap F forms the trailing portion of the under surface 11 of wing W, and lateral control surfaces or ailerons A, only one of which is shown in the present example, are mounted in and form a portion of the wing upper surface 10 above the under surface flap or flaps F.

The flight operation and aerodynamic functioning of this type of wing W is familiar in the art, and may be either automatic in accordance with flight conditions or manually and arbitrarily controlled by the pilot. With the wing in high speed and low attack angle flight, the flap F is raised to the full line position of Figs. 1 and 2, and carries out the normal or high speed contour of the wing, with the passage inlet vane V closed and the rearward air displacement or flow through passage P stopped. In the low speed or high attack angle flight condition and to increase wing lift capacity, the wing flap F is swung downwardly and lowered to the dotted line position of Figs. 1 and 2, opening the rear or trailing end of passage P and increasing wing under surface camber, forward inlet vane V opening for rearward flow or displacement of air through wing passage P.

The trailing under flap F is suitably mounted

for the indicated vertical movement or swinging and it is not deemed necessary to here illustrate such a mounting but, as an example, the mounting can take the form as shown in my U. S. Patent 1,875,593 granted September 6, 1932.

The lateral control surfaces or ailerons A of which only one is here illustrated, are located conventionally on a wing W, that is, at opposite sides of the fore and aft axis of the aircraft of which wing W forms a part, but are mounted in and form trailing portions of the upper surface 10 of the wing W above wing flap or flaps F. Such ailerons A in their normal neutral control positions, that is, the full line position of aileron A of Fig. 1, join with the flap or flaps F therebelow in the normal raised position of the latter, to carry out and define the normal airfoil section or contour of the trailing portion of wing W, as well as to substantially close the trailing or rear discharge end of passage P. In the particular example hereof, each aileron A is mounted for vertical swinging on a hinge or pivotal axis a disposed longitudinally or spanwise of the aileron and located in the upper portion of the aileron adjacent but spaced a distance rearwardly from the leading edge of the aileron.

The lateral control surfaces or ailerons A of the wing W, so mounted and arranged thereon relative to the under flap or flaps F, are actuated for lateral control by a type of lateral control system (not shown) that obtains such control through mainly up movement or raising of an aileron, while the opposite aileron remains substantially without movement from neutral control positions, or has a relatively small downward movement. Any desired or suitable actuating mechanism can be utilized for such control operation of ailerons A, but as illustrative of one possible arrangement of such type of control system, reference is made to my U. S. Patent 1,875,593, granted September 6, 1932.

In accordance with the principles and the broad features of my invention, in order to materially reduce the operating forces required, due to the conditions hereinbefore explained, to raise or swing an aileron A upwardly for lateral control, I provide an aerodynamic balance unit for each lateral control surface or aileron A. Such a balance unit in the embodiment here illustrated as designed for the type of wing W, includes an aerodynamic balance member 20, and a mounting provided by the arms 21 on an aileron by which the balance member is positioned at the under surface of the wing remote from the aileron and for downward swinging by the aileron as the latter is swung upwardly to lateral control positions.

For instance, referring to Figs. 1 and 2 of the drawings in particular, the mounting for the balance member 20 of a unit is formed in the present example by a pair of the arms 21, each of which is of substantially S-form and includes the upper forwardly and horizontally disposed portion 21a, the depending intermediate connecting portion 21b, and the lower forwardly and horizontally disposed portion 21c that forms at its forward free end the base upon which the aerodynamic balance member 20 is removably mounted and attached. The mounting arms 21 are attached in substantially parallel, spaced relation (see Fig. 3) to the under side of the leading edge portion of an aileron A (see Figs. 1 and 2) by means of the attachment bases 21a formed at the upper rear ends of the arm portions 21a. In attached and mounted position each arm

thereof has the horizontally disposed upper portion 21a extended forwardly through the wing passage P, with the depending intermediate portion 21b of the arm extending downwardly through a suitable slot or opening 11a in the wing under or lower surface 11, and the lower horizontally disposed arm portion 21c positioned at the under side of and beneath the wing lower surface.

The aerodynamic balance member 20 of each balance unit may as in the example hereof, consist of a flat, rectangular plate of relatively thin, light-weight material, such as a suitable metal or metal alloy, and such balance member is mounted on and extending across and between the upper side of the forward free ends of the lower arm portions 21c located beneath the wing lower surface. The forward free ends of arm portions 21c are formed to provide the balance member mounting bases 20a having the flat upper faces to receive the balance member and the internally threaded vertical bores 20b to receive the balance member attaching screws 22 (see Fig. 4). The balance member 20 is removably mounted on the bases 20a of arm portions 21c, by the machine screws 22 threaded through the member into the base bores 20b, respectively. Preferably the balance member attaching screws 22 are also each provided with the usual or other suitable locking wire or pin 22a, referring here to Fig. 4 of the drawings, extended through the base and each screw 22.

For the purpose of permitting adjustment of a balance member 20 on the mounting arms 21, I provide in this instance shims or washers such as 22b between each base 20a and the balance member, referring to Fig. 4, and such shims can either be coextensive with the upper surface of a base or provided as separate shims at each attaching screw 22. By varying the number or thickness of the shims 22b between the arm bases 20a and the balance member 20, such member can be adjusted to a desired position on and relative to the arms 21, as by raising or lowering one end, or raising or lowering both, to adjust the member on the arms.

With a balance unit mounted on an aileron A and with the aileron in a normal or neutral control position as shown in full lines in Fig. 1, the design of the mounting arms 21 is such that the aerodynamic balance member 20 is disposed remote from the aileron A at the under side of wing 20 and forming a portion of the wing lower surface 11, with the major portions 21a and 21b of the arms within the wing removed from the airflow. In order to position the balance member 20 in its normal inactive position as a portion of the wing under surface, a slot or opening 11b (see Figs. 1 and 2) is provided in the wing under surface to receive the balance member.

The slot 11b in the wing under surface 11 for receiving the balance member 20, serves the further purpose of permitting the balance member to swing upwardly from its normal position, to a position within the wing. Where the type of lateral control system used, even though depending for lateral control mainly on up aileron movement, causes a down movement of the aileron opposite an upwardly moving aileron; or where an aileron A is of the type having a limited downward movement or droop for the purpose of adding to the wing lift capacity under certain flight conditions, in accordance with the lateral control surface system of my U. S. Patent 1,916,475, granted July 4, 1933; then the aileron

A may take a dotted line position as shown in Fig. 1 and the balance unit will be swung upwardly to the Fig. 1 dotted line position with the balance member 20 raised through wing opening 11b into the wing without interference.

If the use of a wing under surface opening to receive a balance member 20 is not desired, then the wing under surface can be formed with an inwardly extended or reentrant portion 11c to provide a pocket or recess for receiving the balance member 20, as shown in Fig. 6, of the drawings. Obviously, if deemed expedient such reentrant portion 11c can be of sufficient depth to care for the upward movements of the balance member 20, where the aileron has downward movements imparted thereto under certain conditions.

In a normal neutral control position of an aileron A as shown in Fig. 1, the wing trailing under flap F below the aileron is perfectly free in its vertical swinging between the full line raised position and the dotted line lowered position of Fig. 1, from interference by the balance member mounting arms 21 due to the space provided between arm portions 21a and 21b within the wing forward of and above the flap leading edge portion. When the aileron A is raised or swung upwardly to a lateral control position as shown in full lines in Fig. 2, the balance unit arms are swung rearwardly and downwardly therewith, to a position with the portions 21b and 21c thereof below the wing flap F. In order to provide for operating clearance, the flap F below an aileron A is slotted rearwardly a distance through its leading edge at and in line with each balance unit mounting arm 21, as indicated at *f*, in Figs. 1 and 2, so that when the flap F is swung downwardly to the dotted line position of Fig. 2, the portions 21a and 21b of arms 21 pass into and extend through slots *f* without interfering with the vertical movements of the flap. Similarly with a flap F in normal raised position shown in Fig. 2, with aileron A raised and its balance unit lowered, the slots *f* of the flap may receive the portions 21a of the balance mounting arms and prevent interference between the flap F and such arms.

In lateral control operation of a control surface or aileron A provided with the aerodynamic balance unit of my invention as hereinbefore described, when the control surface A is in a normal neutral control position shown in Fig. 1, or in the lowered dotted line position of Fig. 1, the aerodynamic balance member is inactive, but when the aileron is actuated by the lateral control system to raised control positions, then the balance member 20 becomes operative to apply forces to the raising aileron to aid in its upward swing and reduce the operating forces that must be applied by the control system. The raising or upward swinging of an aileron A causes the balance unit carried thereby to swing downwardly and lower the balance member 20 from the wing. As the balance member 20 moves downwardly away from the wing under surface 11, the airflow at the under side of the wing flows against the balance member and creates a pressure or force thereon to move the balance member 20 rearwardly, which force is transmitted to the aileron as a force acting to swing or move the aileron upwardly around its hinge axis *a*. In this manner the actual high operating forces that must be applied to an aileron A of the type and mounting disclosed are substantially reduced by the action of the balance member 20. While at

the very start of the upward aileron movement the balance surface or member 20 will not be greatly effective, the operating force required at the start of the up aileron movement is also not large but increases as the angular movement of the aileron increases, whereupon the balance member 20 then becomes effective in reducing the required operating forces.

The balance unit with the balance member 20 not only reduces the operating forces required for raising an aileron A to lateral control positions but also increases control effectiveness and augments the favorable yaw characteristics to thereby reduce the possibilities of the unintentional spin. I have diagrammatically indicated in Fig. 7 of the drawings the force components and resultants developed by the aileron and its balance unit when in lateral control positions by which the operating forces for the aileron are reduced and the increase in control effectiveness obtained. Referring to Fig. 7, with the aileron A raised and the balance member 20 in lowered, active position beneath the wing under surface, the force acting on the substantially flat surface of the balance member will be nearly normal to the surface and the vertical component *R* of which increases the rolling control, while the rearwardly acting component *Y* of such force tends to slow the wing *W* at the proper side to augment the favorable yaw characteristics to avoid the tendency to fall into the inadvertent spin. The resultant force *S* acts, of course, to swing or raise the aileron A and thereby reduce the operating forces that must be applied by the control system to raise an aileron A, but this raising force resulting from the airflow reaction on balance member 20 is also aided by the leverage resultant *L* between the aileron hinge axis *a* and the remote position of balance member 20 on arms 21.

With the aerodynamic balance, my invention also includes as an element incorporated in and as a part of the balance unit, although not essential to the operation and results of the aerodynamic balance, a mass balance weight in order to reduce the possibility of wing flutter, especially with the ailerons A and their aerodynamic balance units mounted on a wing of high performance aircraft. Attention is directed to the fact that the weight of the aerodynamic balance surface or member 20 and its mounting tends to and may afford a sufficient mass counter balance weight for certain installations without the necessity for providing an additional balance weight.

Such a mass balance weight in the example hereof, takes the form of a tie rod 30, referring now to Figs. 3 and 5, of the drawings, in particular, mounted extending across and between the aerodynamic balance arms 21 and extended through such arms with the opposite ends of the rod spliced to secure the rod in position. The balance weight proper is in the form of a tube 31 fitted over and carried by tie rod 30 between the arms 21. In this instance the balance weight 30—31 is mounted on the arms 21 at the upper ends of the arm portions 21b, although of course the location of the balance weight on the arms is dependent upon each particular design of balance unit and the aileron and wing arrangement on which installed.

In addition to its function as a wing flutter reducing mass balance, the weight 30—31 serves as a bracing and strengthening unit between the balance unit arms 21.

Due to the large leverage provided by the design of the balance unit, the area of the aerodynamic balance member or surface 20 thereof need not be large, thus reducing weight and while

5 two arms 21 are shown in the illustrated example, a greater number of such arms may be provided where required. Also, where desired or found expedient, more than one balance unit can be provided for each control surface or aileron.
10 The balance units are each removably mounted by the arm bases 21d to the ailerons or lateral control surfaces and can thus be individually removed and replaced as desired, while the arms 21 of each unit are so designed and shaped as to reduce to a minimum the size of the cut-outs or slots in the under surface of a wing, as well as in a wing under surface flap. By the removable mounting of the aerodynamic balance surface or member 20 on its mounting arms 21, provision is made for interchanging such members as well as for replacement by balance members of various sizes.

While a balance unit of the invention is particularly adapted to high lift wings having lateral control surfaces above an under flap of any desired design or function, such a balance unit is applicable to aircraft, including the autogyro types, and the wings thereof generally, and in broad principle includes the use of a balance surface in the airflow about a wing, and acted upon by such flow, to assist the operation of a control surface remote from the balance surface and with which it is directly or indirectly connected.

It is also evident that various changes, modifications, additions, eliminations, substitutions and variations, might be resorted to without departing from the spirit and the scope of my invention, and hence, I do not desire to limit my invention in all respects to the exact and specific disclosures hereof.

What I claim is:

1. In an airplane wing, an aileron in the upper surface of the wing removed from the wing lower surface, and an aerodynamic balance for said aileron at the lower surface of the wing with the aileron in a normal neutral control position, said balance operatively associated with the aileron and lowered from the wing into the airflow beneath the wing as the aileron is moved upwardly against the airflow at the upper surface of the wing.

2. In an airplane wing, an aileron in the upper trailing surface of the wing removed from the wing under surface, and an aerodynamic balance operatively associated with said aileron for movement from the wing into the airflow beneath the wing as the aileron is moved upwardly against the airflow above the wing, said balance in normal position of the aileron in position on the wing removed from the airflow.

3. In an airplane wing, an aileron mounted in the upper surface of the wing removed from the wing lower surface and an aerodynamic balance remote from the aileron but operatively associated therewith, said balance positioned at the wing when the aileron is in a normal position and moved from the wing into the airflow about the wing and acted upon thereby as the aileron is moved upwardly to assist upward movement of the aileron.

4. In an airplane wing, an aileron in the upper surface of the wing removed from the wing under surface, an aerodynamic balance carried by the aileron and spaced forwardly therefrom at the under surface of the wing, and said balance

moved downwardly and rearwardly from the under surface of the wing into the airflow beneath the wing as the aileron moves upwardly against the airflow above the wing.

5. In an airplane wing, an aileron in the upper surface of the wing, an aerodynamic balance carried by and disposed below the aileron and in a normal neutral position of the aileron positioned in the wing, and said balance moved downwardly from the wing into the airflow beneath the wing as the aileron is moved upwardly to lateral control positions.

6. In an airplane wing, the combination of an aileron mounted in the upper surface of the wing for upward movement to lateral control positions, with an aerodynamic balance remote from the aileron and in normal position at the wing under surface, and said balance moved from the wing into the airflow beneath the wing by upward movement of the aileron to lateral control positions.

7. In combination, an airplane wing, an aileron mounted in the upper surface of the wing removed from the wing under surface, and an aerodynamic balance unit mounted on and carried by the aileron, said balance unit embodying support arms extending forwardly and downwardly from the aileron through the wing to the under side thereof, and an aerodynamic balance member mounted on the forward ends of said arms at the under side of the wing remote from the aileron, said balance member moved downwardly from the wing under surface into the airflow by upward movement of said aileron.

8. In combination, an airplane wing, an aileron mounted in the upper surface of the wing, and an aerodynamic balance unit removably mounted on and carried by the aileron, said balance unit embodying a support means removably mounted on the under side of the leading edge portion of the aileron and extending forwardly and downwardly through the wing to the under side thereof, and a balance member removably and adjustably attached to and mounted on the support means at the under side of the wing.

9. An aerodynamic balance unit for an aircraft control surface, embodying spaced substantially parallel support arms for removable attachment to a control surface in position extending downwardly therefrom, an aerodynamic balance member secured on and across the lower end portions of said arms, and a mass balance weight mounted on and extending between said arms above said aerodynamic balance member.

10. In an airplane wing, an aileron in the upper surface of the wing, an aerodynamic balance unit carried by the aileron and including an aerodynamic balance member disposed at the lower surface of the wing, said balance member lowered into the airflow beneath the wing by upward movements of the aileron, and a mass balance weight mounted on said aerodynamic balance member.

11. In an airplane wing, an aileron in the upper surface of the wing for up movements to lateral control positions, an aerodynamic balance for said aileron beneath the wing and operatively associated with the aileron for downward movement into the airflow beneath the wing as the aileron moves upwardly from neutral control positions to raised lateral control positions, and said balance with the aileron in a neutral control position disposed at and forming a portion of the under surface of the wing.

12. In an airplane wing, an aileron in the up-

per surface of the wing, a wing lift increasing member in the lower surface of the wing beneath said aileron, and an aerodynamic balance for the aileron beneath the wing at the under surface thereof and operatively associated with the aileron for downward movement from the wing under surface and into the airflow beneath the wing as the aileron moves upwardly to control positions.

13. In an airplane wing, an aileron in the upper surface of the wing movable upwardly to lateral control positions, a wing flap in the under surface of the wing beneath said aileron and vertically movable to wing lift varying positions, an aerodynamic balance for the aileron located beneath the wing and operatively associated with the aileron for downward movements into the airflow beneath the wing as the aileron moves upwardly to control positions, and said balance in normal neutral control positions of the aileron disposed forwardly of the wing flap at the wing under surface.

14. In an airplane wing, an aileron in the upper surface of the wing and movable upwardly from neutral control positions to raised lateral control positions, a wing flap in the under surface of the wing beneath said aileron and vertically movable to wing lift varying positions, an aerodynamic balance for the aileron located beneath the wing, a support means for said balance carried by the aileron and extending therefrom downwardly through the wing to the under side thereof, said balance moved downwardly with said support means by upward movements of the aileron to lowered positions in the airflow beneath said wing flap, the wing flap formed for unobstructed downward movements past said balance support means, and said balance in normal neutral control positions of the aileron disposed forwardly of the wing flap at and forming a portion of the wing under surface.

15. In an airplane wing, an aileron in the upper surface of the wing for up movements from a neutral control position to raised lateral control positions, an aerodynamic balance member for said aileron beneath the wing and operatively associated with the aileron for downward movement into the airflow beneath the wing as the aileron moves upwardly to raised lateral control positions, said balance member with the aileron in a neutral control position disposed at and forming a portion of the under surface of the wing, and the wing under surface formed for upward movement of the balance member upon downward movement of the aileron from a neutral control position.

16. In combination, an airplane wing, an aileron mounted in the upper surface of the wing, a wing flap in the lower surface of the wing beneath the aileron, and an aerodynamic balance unit mounted on and carried by the aileron, said balance unit including a support arm extending downwardly from the aileron through the wing to the under side thereof forwardly of said lower surface wing flap, and an aerodynamic balance member mounted on the forward end of said arm at the under side of the wing remote from the aileron.

17. In an airplane wing, an aileron in the upper surface of the wing for movement to lateral control positions, an aerodynamic balance for said aileron disposed beneath the wing and operatively associated with the aileron for downward movement into the airflow beneath the wing as the aileron moves upwardly from neutral control position and for upward movement as the aileron is lowered, and said balance with the aileron in a neutral control position disposed at and forming a portion of the under surface of the wing.

18. In an airplane wing, an aileron on the wing for vertical lateral control movements, an aerodynamic balance for said aileron beneath the wing and operatively associated with the aileron for downward movement from the wing into the airflow beneath the wing as the aileron moves upward from neutral control position and for upward movement within the normal contour of the wing as the aileron moves downwardly from neutral position, said balance disposed at and forming a portion of the wing under surface when the aileron is in a neutral control position, and the wing formed to receive said balance in position forming a portion of the wing under surface and in position moved upwardly within the contour of the wing.

19. In combination in an airplane wing, an aileron mounted on the wing for vertical movements, an aerodynamic balance for the aileron mounted on the wing remote from the aileron and in normal position disposed at and forming a portion of the under surface of the wing, and said balance operatively associated with the aileron and moved downwardly from the wing into the airflow beneath the wing by upward lateral control movements of said aileron.

20. In an airplane wing, an aileron in the upper surface of the wing and vertically movable for lateral control, a vertically swingable wing flap beneath said aileron and forming a portion of the under surface of the wing, an aerodynamic balance for the aileron disposed beneath the wing forward of said wing flap, a support for said balance mounted on and carried by the aileron and extending forwardly and downwardly through the wing to the under side thereof, said balance moved downwardly by said support means into the airflow beneath the wing when said aileron moves upwardly, said downwardly and forwardly extended balance support means formed for unobstructed independent operation of said vertically swingable flap in any position of said support and balance, and said wing flap formed for unobstructed downward and rearward movement of said support means when the flap is in positions swung downwardly from the wing.

21. In a wing, in combination, an aileron on the wing, a wing flap on the wing beneath said aileron, an aerodynamic balance for the aileron at the under side of the wing forward of said flap, and means operatively associating said balance with the aileron whereby the balance is moved downwardly from the wing into the airflow by upward lateral control movements of said aileron.

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