Aug. 11, 1931. R. F. HALL 1,818,322

AIRPLANE

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Fig. 1.

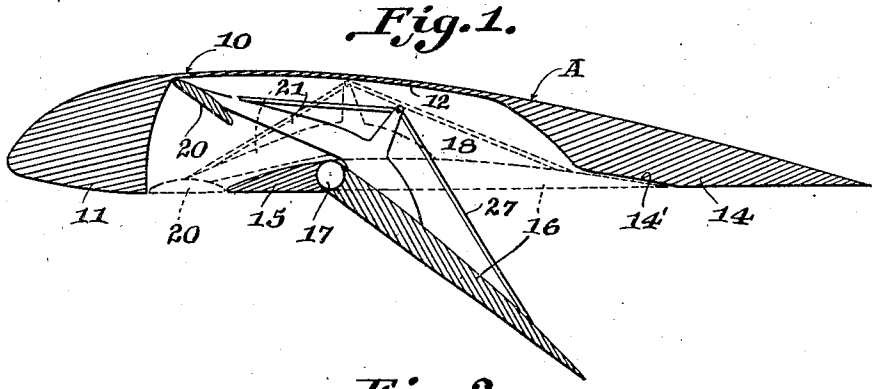
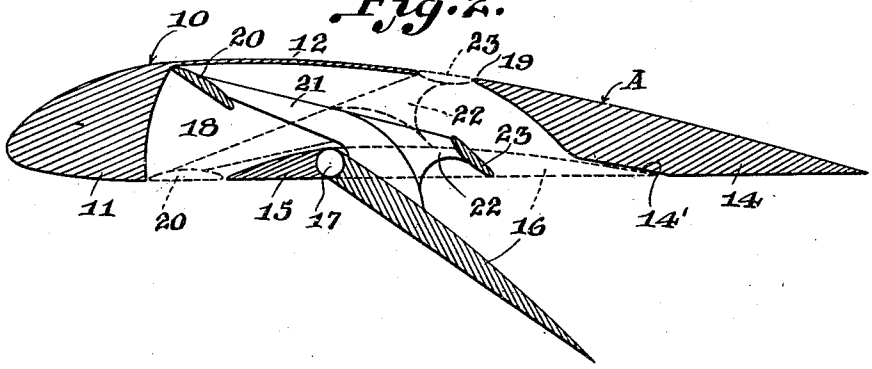


Fig. 2.



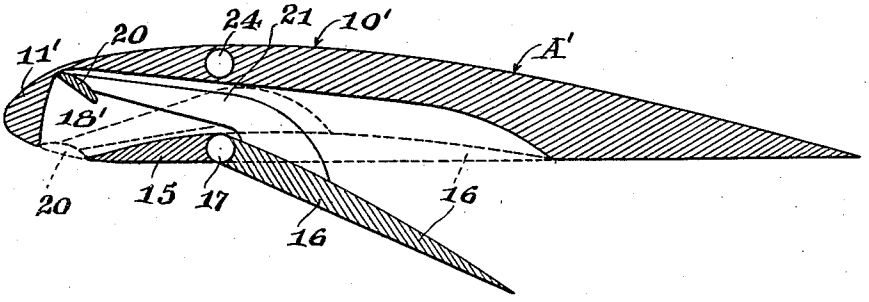


Fig. 3.

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Fig. 4.

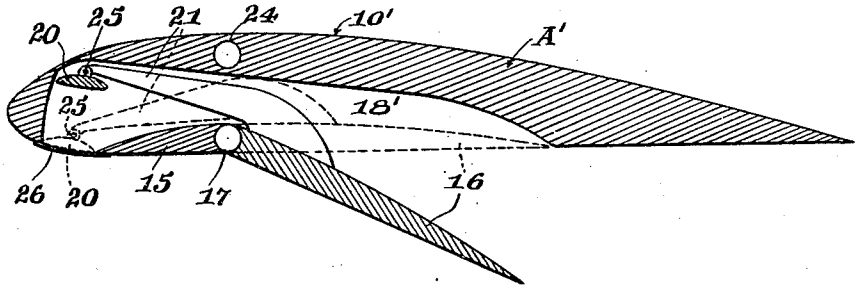


Fig. 5.

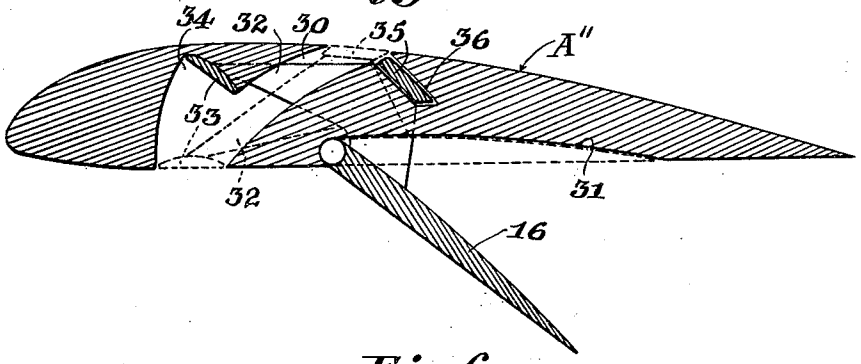
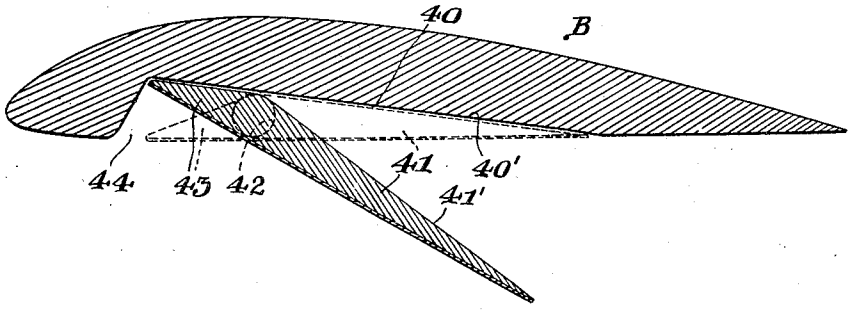


Fig. 6.



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UNITED STATES PATENT OFFICE

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AIRPLANE

Application filed October 12, 1928. Serial No. 312,087.

This invention relates to certain improvements in airplanes; and the nature and objects of the invention will be readily apparent to 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 believe to be the preferred embodiments or aerodynamical and mechanical 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.

More specifically the invention has to do with and is directed to airplane wings, or supporting or lift surfaces of those general types in which variable lift is obtainable through the employment of a pivotally mounted lower or under surface, or so-called wing flap, capable of depression or downward swinging to positions such that through the establishment of pressure differences on increased lift is developed by and from a wing or supporting surface; and a general characteristic of the instant invention resides in the provision of such a pivoted surface or wing flap with a balance portion, which preferably forms a unitary structure therewith, and through the medium of which more efficient operation and control of such surface or flap is made possible, and a tendency of the surface or flap toward automatic functioning or operation to vary the wing lift in accordance with changes in the angle of attack of the wing, obtains.

In certain types of airplane wings, supporting, or lift surfaces, air displacement openings, slots, or passages are provided by which the lift of the wing or surface is varied, through the control of air displacement therethrough, either by means of vanes, flaps or the like, or by the angle of attack of the wing, or by both such means; and a further characteristic and feature of the invention resides in the provision with such general types of wings or surfaces, of the pivoted surface or wing flap having the balance portion, in which the balance portion forms and provides the means or medium for controlling air displacement through a wing opening, slot, or passage, in accordance with the position of the pivoted surface or flap; and in the further feature and characteristic with certain forms of such types of wings, of both the pivoted surface or flap and the balance portion thereof performing the function of controlling the air displacement through the wing slots or passages; such features and characteristics having the attendant objects of obtaining more efficient operation and control of the wing and the pivoted surface or wing flap thereof, and of developing the tendency of the balance portion to cause automatic functioning and operation of the surface or flap.

Another feature of the invention is the structural and mechanical simplicity obtained in a wing having the foregoing characteristics, by which practical manufacture is made possible, and a design and structure produced having the required factor of safety with minimum weight and efficient aerodynamically in operation, while retaining ease of operation and control for the pivoted surface or wing flap through simple yet efficient mounting thereof in the wing structure.

With the foregoing general characteristics and objects, as well as certain other objects and results in view, which will be at once apparent from the following explanation, the invention consists in certain novel features in design, and in combinations and construction of elements thereof, as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawings:

Fig. 1 is a transverse sectional view, more or less diagrammatical, through a wing of the air displacement passage type embodying the balanced wing flap unit of the invention incorporated therein.

Fig. 2 is a view similar to Fig 1, in which the displacement passage provides an opening or slot through the upper surface of the wing and controlled by the balanced flap unit.

Fig. 3 is a view similar to Fig. 1, of a modified design and arrangement of wing and balanced flap of the invention.

Fig. 4 is a view of the wing of Fig. 3, show-

ing a modified mounting and arrangement of the wing flap balance portion or member.

Fig. 5 is a transverse, vertical section, more or less diagrammatical, through a design of wing having an air displacement slot therethrough, with a form of balanced wing flap of the invention in which the balance portions of the flap control the slot and the flap is remote from the slot.

Fig. 6 is a transverse, vertical section, more or less diagrammatical, through a wing of a type without air displacement openings, slots, or passages, with a balanced flap of the invention mounted thereon and embodied therein.

Several types, designs, and forms of airplane wings or supporting surfaces have been selected and are disclosed and described herein, together with several forms and arrangements of the invention as adapted to such wings and embodiment and incorporation therein in order to carry out and produce the invention, but these disclosures are by way of example and not of limitation for the purpose of explaining and bringing forth the principles and various features of the invention so that those skilled in the art will understand the same. Other forms and designs of wings than the particular examples here shown are adapted to application and embodiment of the invention thereto and therein, with the necessary changes in design, construction, arrangement and mounting of the elements making up the invention, to conform to the requirements of such wings, and this invention contemplates and includes such other adaptations and embodiments.

One form of wing or supporting surface embodying an adaptation of the invention incorporated therein, is more or less diagrammatically shown in Fig. 1, in which a wing A of the type having an air displacement passage therein and therethrough, is disclosed. This wing A comprises an upper section or aerofoil 10 having the leading edge portion 11, of a thickness or depth to carry the forward spar or longitudinal beam (not shown) for the wing if desired, relatively thin upper intermediate portion 12, and trailing edge portion 14, with a lower section or aerofoil 15 having the pivoted surface or flap forming rear portion 16 pivotally mounted at 17, which is preferably a wing beam or spar for the lower aerofoil 15, along the trailing edge of the forward fixed section of aerofoil 15 and forming with such forward section the complete lower aerofoil 15. The lower aerofoil 15 is mounted and disposed with the forward portion carrying beam 17 in fixed position below the intermediate, thin portion 12 of upper aerofoil 10, with its leading edge spaced rearwardly from the leading edge portion 11, and with the pivoted trailing flap portion 16 in normal raised position (see dotted lines) extending rearwardly from the fixed forward portion of aerofoil 15, to and received in an under recess 14′ in the trailing edge portion 14 of upper aerofoil 10.

Thus, wing A presents a structure having the air displacement passage 18 therethrough, between upper and lower aerofoils 10 and 15, with its forward inlet end opening through the under surface of wing A, between the leading edge portion 11 of upper aerofoil 10 and the leading edge of lower aerofoil 15, and with its rear discharge end through the under surface of the wing, but normally closed by the pivoted flap portion 16 of the lower aerofoil in raised position. The pivoted portion 16, in normal raised position forms with the forward fixed portion of aerofoil 15, the lower or under surface carrying out the contour and completing the aerofoil section of the wing A, while in its depressed or downwardly swung position shown in full lines in Fig. 1, the rear or discharge end of passage 18 is opened and formed between trailing edge portion 14 of upper aerofoil 10, and the pivoted flap portion 16 of lower aerofoil 15. This wing A is of the so-called "Hall" variable or high lift type familiar in the aeronautical art and the principles, functions, and results of which are broadly explained and described in United States Letters Patent 1,559,091, dated October 27, 1925, and to which reference is here made.

In accordance with the principles of the instant invention, the pivoted trailing edge, wing flap forming portion 16 of the under surface forming aerofoil 15, of wing A, is provided with a balance portion or member 20 which is formed, in the example hereof, rigid and movable with pivoted flap 16 and forming a unitary structure therewith, but disposed spaced and remote from pivoted surface or flap 16. The balanced flap unit 16—20, of Fig. 1, provides a spaced series of cantilever support members or arms 21, secured to flap 16 adjacent the leading edge thereof and extending upwardly and forwardly therefrom over and across the fixed forward section of lower aerofoil 15, through air displacement passage 18, to points above and substantially in line with the forward inlet end of displacement passage 18, only one of such arms 21 being seen in the transverse sectional view of Fig. 1. The balance portion or member 20, in the present instance, takes the form of a vane of substantially aerofoil section, although not so limited, and is mounted and secured to and extending across and between the forward ends of arms 20, so as to be positioned thereby in normal raised discharge closing position of pivoted surface or flap 16, in position closing the forward inlet end of wing passage 18 and forming a portion of the under surface of wing A, as clearly shown by the dotted line positions of balance member 20 and wing flap 16, in Fig. 1.

The pivoted under surface or wing flap 16 is swingable downwardly to the full line position shown in Fig. 1, any suitable operating and control mechanism (not shown) being of course provided, and in such position opens the discharge end of wing passage 18 and functions to increase the lift developed from and by the wing, it here being noted that in the preferred mounting of flap 16, its axis along 17 is forward of the center of wing A. As flap 16 is swung downwardly, the balance member 20 rigid therewith, through supporting arms 21, is swung upwardly into the wing passage 18, from and opening the forward inlet end thereof through the under surface of the wing, as shown in full lines in Fig. 1, thus permitting the displacement passage to function in cooperation with the lowered flap to increase the lift of wing A. Similarly, from passage opening, lift increasing position, the balanced flap unit 16—20, is swung to raise flap 16 to normal position closing the discharge end of passage 18, and to lower balance portion 20 to normal position closing the forward inlet end of passage 18, with flap 16 and balance member 20, disposed within and forming portions of the under or lower surface of normal wing A.

With wing A in its high speed condition the wing flap 16 and its balance member 20, are in their normal dotted line positions of Fig. 1, but when it is desired to increase the lift of wing A, the flap A is swung downwardly while the balance portion or member 20 swings upwardly to open the inlet end of passage 18, the member 20 being acted upon by the air pressure and affording balance for the flap 16, materially aiding the operation and control of the flap in moving or swinging the same to lowered passage opening and high lift positions. In the reverse or flap raising, passage closing position, balance is also given the flap by the downwardly moving forward and remote balance member 20, with resulting ease and smoothness of operation and control of the flap 16, in swinging the same from lowered, high lift position, to normal raised, high speed condition for the wing A. The balance portion or member 20 thus functions throughout the operation and control of the pivoted wing surface or flap 16, which control and operation is usually manual, to give a greater ease, and uniformity and smoothness of operation, with an increased efficiency for the wing A.

With the mounting and arrangement of the balanced flap unit 16—20, through the usual range of flight angles for the wing A, the relative difference in under pressure upon the balance member 20 and flap 16, is such that the resulting forces tend to depress the flap portion at high angles of attack and develop increased lift, while at low angles of attack the resulting forces tend to raise the flap 16 to decrease the lift for the high speed conditions of the wing. This tendency of the balanced flap unit of and forming a part of the wing A, to automatically function increases the efficiency of the wing as well as giving the desired ease of operation and control of the unit.

In Fig. 2, the wing A is formed with an additional air discharge slot or opening 19 through the relatively thin intermediate portion 12 of upper aerofoil 10, aft or to the rear of the forward fixed portion of lower aerofoil 15, and above the pivoted surface or wing flap 16. Each of the balance member supporting arms 21 is provided with an upward and rearward extension 22, and a member or vane 23, in this instance similar to balance vane 20, is secured across and to the upper ends of arm extensions 22, in position with respect to flap 16 such that in the normal raised position of flap 16, the vane 23 is disposed in and closing passage discharge slot 19, as shown by dotted lines in Fig. 2, while in high lift, lowered position of flap 16, the vane 23 is in the full line, slot 19 opening position, as shown in the drawings. The vane 23 thus forms an element of the balanced flap unit 16—20, and by designing the vane 23 to vary the shape and proportions thereof, the magnitude and direction of forces thereon can be varied to meet the requirements of operation and control of the balanced flap unit and the wing in which incorporated.

A modified design of air displacement passage wing A′ is disclosed in Fig. 3, the upper aerofoil section 10′ of which is formed with the forwardly extending air displacement passage 18′ terminated at its forward end by the relatively narrow leading edge section 11′, and between the lower aerofoil section 15—16 and the upper aerofoil 10′. The forward inlet end of passage 18′ is through the under surface of wing A′ and between the leading edge of the forward fixed portion 15 and the leading edge section 11′ of upper aerofoil 10′. The lower aerofoil section 15—16, is spaced forwardly a greater distance than in the wing A of Fig. 1, and due to the thickness or depth of the intermediate portion of upper aerofoil 10′, a wing beam or spar 24 is disposed therein spaced approximately above the wing spar 17 of the lower aerofoil section 15—16, so that it becomes possible to interbrace (not shown) between these beams or spars 17 and 24 with the balance member 20 supporting arms 21 of the pivoted wing flap 16 extending forwardly between these spars and such spar interbracing. The foregoing construction and arrangement producing a structure of considerable strength. The operation, function and results of the form of wing A′ and the balanced flap unit 16—20 is the same as described in reference to Figs. 1 and 2.

The balance portion or member for the pivoted wing surface or flap 16, in either the design of wing of Fig. 1 or of Fig. 3 can be pivotally mounted on the supporting arms 21 of the balanced unit for relative movement with respect to such arms. As an example of such a mounting, reference is had to Fig. 4, in which the balance member 20 is freely pivotally mounted on and suspended from the forward ends of arms 21 by means of the pivotal mounting and connection 25. Where this mounting 25 is employed stops or seats 26 are provided extending across and bridging the forward intake or inlet end of the air displacement passage so as to receive and hold the pivoted balance member in proper position across and closing such passage inlet, with the balanced unit in normal passage closing position, for the low angle, high speed conditions of the wing. By the pivotal suspension and mounting of the balance member 20, as described, in the high lift or lowered passage opening position of wing flap 16, the balance member 20 is raised from passage inlet closing position, into the wing passage, and is rotated on its pivotal mountings 25 by the airflow into and through the passage to a position as shown by full lines in Fig. 4, in which the passageway is less obstructed thereby, and a minimum of interference to the airflow through the passage results.

A wing A″ is presented in Fig. 5 of a type having a pivoted wing flap 16 mounted in and forming part of the wing under surface in normal, raised position thereof, with an air displacement slot 30 through the wing A″ forward of flap 16 and extending vertically and rearwardly from the under surface of the wing to and discharging through the upper surface of the wing. The pivoted wing flap 16 is remote from and performs no direct function with slot 30, but is normally disposed in an under recess 31 formed in wing A″, as shown by dotted lines in Fig. 5, for the low angle, high speed condition of the wing, while in lowered, high lift position is swung downwardly from recess 31 to the full line position of Fig. 5.

Now, following the broad feature of the invention hereinbefore explained, balance means is provided for the wing flap as a unit therewith and is arranged to open and close the air displacement slot 30 as the flap is lowered or raised to and from normal position. This is accomplished in the present example, by the provision of the forwardly extended cantilever support arms 32 fixed to flap 16, and swingable therewith, suitable spaces being of course provided in and through the wing structure to permit movement of the arms, and the balance member or vane 33 secured to and fixed across the forward ends of these arms. The arrangement and relative mounting of arms 32 and balance member 33 is such that, with the flap 16 in normal raised position within wing recess 31, the arms 32 with member 33 are swung downwardly to position balance member 33 in and closing the lower inlet end of slot 30 through the wing under surface, as shown by dotted lines in Fig. 5. The slot 30 is formed with a forward enlargement provided by the recess 34 extending upwardly of and within the wing to receive the balance member or vane 33 when it is swung upwardly to position removed from and opening the wing slot 30, by and with the flap 16 swung to lowered, wing lift increasing position, as clearly shown by the full line positions of these elements in Fig. 5.

If desired, an additional member or vane 35 can be provided on and as a part of the balanced flap unit 31—33, for opening and closing the upper discharge end of slot 30 through the upper surface of wing A″. Suitable upward extensions of the support arms 32 are provided, across the upper ends of which the member or vane 35 is secured so as to be positioned across and closing the upper end of wing slot 30 with the flap 16 swung upwardly and balance member 33 in lower passage end closing position, such position of member 35 being shown by dotted lines in Fig. 5. Upon swinging flap 16 to lowered position and balance member 33 to slot opening position, the upper member or vane 35 of the unit is swung rearwardly and downwardly, so that a suitable recess 36 is formed in the wing structure to receive vane 35 in its position swung or moved rearwardly from slot closing position, and removed from the upper end of and opening slot 30, all as clearly shown in full lines by Fig. 5. In operation, the members or vanes 33 and 36 of the balanced flap unit, are moved to position opening the wing slot 30 with flap 16 swung downwardly for the high lift condition of the wing, and are moved to position closing the inlet and discharge ends of the slot with flap 16 swung upwardly into wing recess 31, for the high speed condition of the wing. The balance functions and results of the balanced flap unit of Fig. 5 will be apparent in view of the description and explanation of such functions and result set forth hereinbefore.

Attention is here directed to the type of balanced flap unit of Figs. 1 to 5, and the fact that for structural strength and rigidity thereof and in the wing in which embodied, cross or interbracing 27 (see Fig. 1) is intended, where desired, between the cantilever balance member supporting and carrying arms 21.

An embodiment and adaptation of the invention is disclosed in Fig. 6, as applied to and incorporated in a wing B of the type which does not have and is not provided with air displacement openings, passages, and/or

slots therein. The wing B is formed with an under side or lower recess 40 therein, intermediate the leading and trailing edges thereof, in this instance, and of gradually decreasing depth rearwardly. Within the wing recess 40, a pivoted surface or wing flap 41 is swingably and pivotally mounted on a longitudinal axis 42 disposed within wing recess 40 adjacent but spaced a distance rearwardly from the forward end of the recess, with the surface or flap 41 extending rearwardly from axis 42, and in normal raised position forming a portion of the wing under surface substantially within and carrying out the wing contour, as will be clear by reference to the dotted line position of this flap shown in Fig. 6.

The flap 41 is extended a distance forwardly from axis 42 in continuation of and forming a rigid, unitary structure with the flap, to provide a balance portion or member 43, the lower surface of which is a substantial straight continuation of the lower surface of flaps 41, but the upper surface of which is tapered or inclined downwardly and forwardly, as will be clear by reference to Fig. 6. The forward or leading edge of the balance portion 43 is spaced rearwardly from the forward side of wing recess 40, with the wing flap and balance portion in the normal dotted line position as shown, to provide the gap 44 into the space formed by the recess above the inclined upper surface of balance portion 43. For economy of weight and structure, the upper or inner side 41′ of the flap 41 is not provided with a skin or covering, and similarly the under side of the recess thereabove to rear of member 42 is not provided with a skin or covering, although it is to be understood that the invention is not necessarily restricted to such arrangement, for if desired a covering can be provided over such portions of the structure.

In operation, the wing B of Fig. 6 is in its high speed, low angle condition with wing flap 41 swung upwardly to position within recess 40 and the balance portion 43 thereof swung downwardly, the entire balanced flap unit 41—43 disposed within the wing with the under side thereof providing and being a portion of the wing under surface. To increase the wing lift, the flap 41 is swung downwardly to the full line position of Fig. 6, and this movement is balanced and rendered more easy and smooth by the balance portion 43. Upon upward swinging of the flap 41 to return the same to normal position, the balance portion 43 functions by the action of the forces thereon to steady and balance the flap and render the operation and control thereof easier and smoother.

The invention in accordance with the principles and features thereof as exemplified in the drawings and explained above, thus secures a balance for, and ease and smoothness in the operation and control of, lift increasing surfaces or flaps of airplane wings or supporting surfaces, through the provision of a unitary structure forming a balanced surface or flap unit, which unit is structurally simple and lends itself to mounting and incorporation in a wing without material structural complications. While wings or supporting surfaces are specified herein, such terms are to be interpreted in a broad, generic sense to cover and include any and all aircraft elements or structure having equivalent characteristics.

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

What I claim, is:

1. In an airplane wing, a balanced flap unit pivotally mounted at the under side of the wing, said unit embodying a flap member and a balance member therefor, and in normal position forming a portion of the wing under surface and said unit swingable from normal position to operative position with the flap member extended downwardly from the under side of the wing.

2. In an airplane wing, a balanced flap unit pivotally mounted at the under side of the wing and forming a portion of the wing under surface in normal position thereof, the unit embodying a flap and a balance portion, said wing formed with a recess in which said balance portion is disposed for movement, and the flap unit swingable to operative position with the flap extended downwardly from the wing and the balance portion swung upwardly in the recess within the wing.

3. In an airplane wing, a balanced flap unit pivotally mounted at and disposed on the under side of the wing and forming a portion of the wing under surface in normal position of the unit, said flap unit including a flap and a forward balance portion, the wing provided with an inwardly extending recess for receiving said balance portion with the unit serving to extend the flap downwardly from the wing.

4. In an airplane wing, a balanced flap unit pivotally mounted at the under side of and forming a part of the under surface of the wing with the pivotal axis of the unit forward of the center of the wing.

5. An airplane wing formed with an air displacement passage therein having its inlet end opening through the under side of the wing, a wing flap pivotally mounted at the under side of said wing remote from the passage inlet, and a balance portion carried by said flap, said balance portion opening or

closing said passage inlet in accordance with the position of said pivoted wing flap.

6. An airplane wing formed with an air displacement passage therein having its inlet end opening through the under side of the wing, a pivoted wing flap at the under side of the wing spaced rearwardly from the passage inlet and swingable vertically to and from normal position forming a portion of the wing under surface, a balance member carried by and movable with said flap as a unit but spaced forwardly therefrom, said balance member positioned by the flap in normal position thereof closing the passage inlet and moved to position opening the inlet with the flap swung downwardly from normal position.

7. In an airplane wing, a pivotally mounted wing flap at the under side of the wing, and a balance member for the flap rigidly carried thereby as a unit therewith and disposed at the underside of the wing but spaced from the flap.

8. In an airplane wing, a pivotally mounted wing flap at the under side of the wing, a balance member for the flap spaced forwardly therefrom and rigidly carried thereby as a unit therewith, and said balance member disposed at the under side of the wing.

9. The combination with an airplane wing having an air displacement passage therethrough, of a pivotally mounted wing flap having a balance portion rigid therewith, said flap opening and closing the discharge end of said passage, and said balance portion opening and closing the inlet end of said passage.

10. The combination with an airplane wing having an air displacement passage therethrough, of a pivotally mounted wing flap swingable to open and close the discharge end of said passage, and a balance member carried by and swingable as a unit with said flap to open and close the inlet end of said passage.

11. The combination with an airplane wing having an air displacement passage therethrough with the inlet and discharge ends of said passage at the under side of the wing, of a pivotally mounted wing flap at the under side of the wing closing the discharge end of the passage in raised position and opening the same in lowered position, and a balance member for said flap supported spaced therefrom and movable as a unit therewith, the said balance member closing the inlet end of said passage with the flap in normal raised position and opening said inlet with the flap in lowered position.

12. In an airplane wing formed with an air displacement passage therein having its inlet end opening through the under side of the wing, a wing flap pivotally mounted at the under side of the wing spaced rearwardly from the passage inlet, support members rigidly carried by and extending forwardly through the wing from said flap member to the wing passage, and a balance member for the flap on said support members within the passage, said balance member movable with the flap to close the inlet end of said passage with the flap in raised position and to open said inlet with the flap in lowered position.

13. In an airplane wing formed with an air displacement passage therein having its inlet end opening through the under side of the wing, a pivotally mounted wing flap at the under side of the wing spaced rearwardly from the passage inlet, support members carried by, movable with and extending forwardly through the wing from said flap member to the wing passage, and a balance member for the flap freely pivotally suspended on said members within the passage, said balance member movable with the flap to close the inlet end of said passage with the flap in normal raised position, and swung upwardly by the flap in lowered position to open said inlet, the balance member in raised passage inlet opening position freely swingable by air pressure in the passage to minimum passage obstructing position.

14. In an airplane wing, a balanced wing flap unit embodying a flap and a balance portion remote from the flap, and said flap unit pivotally mounted and disposed at the under side of the wing.

15. An airplane wing formed with a recess in and opening through the under side thereof, the recess covered at its upper side by the wing, and a balanced flap unit emboding a flap and a balance member therefor, said flap unit pivotally mounted and disposed at the under side of the wing within the wing recess.

16. An airplane wing having an air displacement passage therethrough, a wing flap pivotally mounted and disposed for downward swinging movement from normal position closing the discharge from said passage to position extended downwardly from the wing opening the discharge from the passage, and a member carried by said flap and swung therewith to close the intake to said passage with the flap in normal position, and to open the intake with the flap in downwardly swung passage discharge opening position.

17. An airplane wing having an air displacement passage therethrough, a wing flap pivotally mounted and disposed at the under side of the wing for opening and closing the discharge end of the passage, and a member carried by said flap and swung therewith for opening and closing the inlet end of the passage.

18. An airplane wing having an air displacement passage therethrough, a pivotally mounted wing flap for swinging movement to open and close the rear discharge end of said passage, and a member carried by and disposed forwardly of the wing flap and

swung with the flap to open and close the forward inlet end of the passage.

19. In an airplane wing of the variable lift type having an air displacement passage for flow of air therethrough to increase the lift developed by the wing, a wing camber and lift varying flap movable from normal position to position increasing the camber and the lift of the wing, and a member carried by said flap and moved therewith for closing the wing passage against lift increasing flow of air therethrough with the flap in normal position, and for opening the passage for lift increasing airflow therethrough with the flap in camber and lift increasing position.

20. An airplane wing having an air displacement passage for flow of air therethrough to increase the lift developed by the wing, a flap mounted on the wing for vertical swinging to open and close the discharge end of the passage, and a member carried by said flap and swung therewith to open the passage with the flap in passage discharge end opening position and to close the passage with the flap in passage discharge end closing position.

Signed at Ithaca, New York, this 9th day of October, 1928.

RANDOLPH F. HALL.