

Sept. 6, 1932.

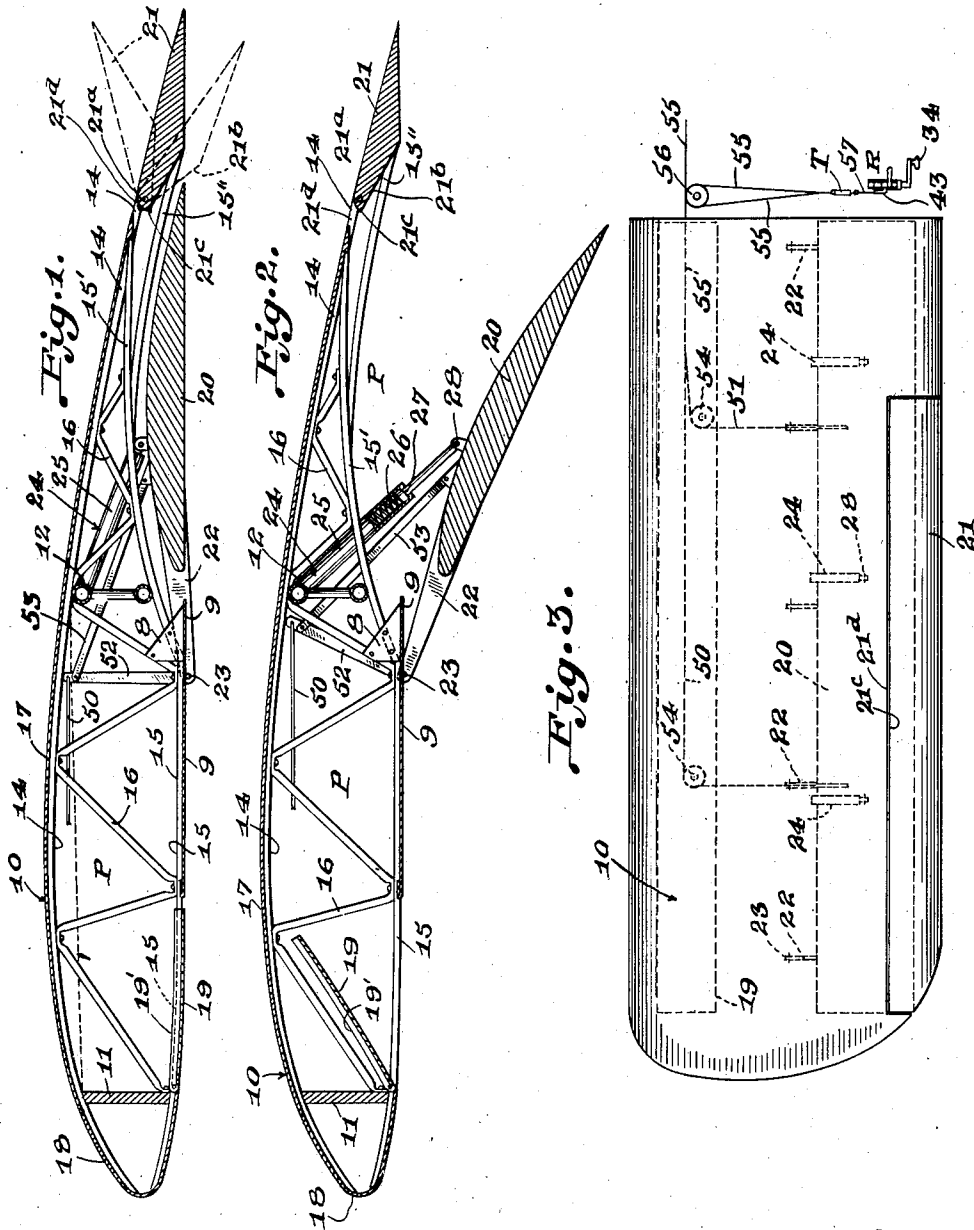
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1,875,593

AIRPLANE

Filed July 31, 1930

3 Sheets-Sheet 1



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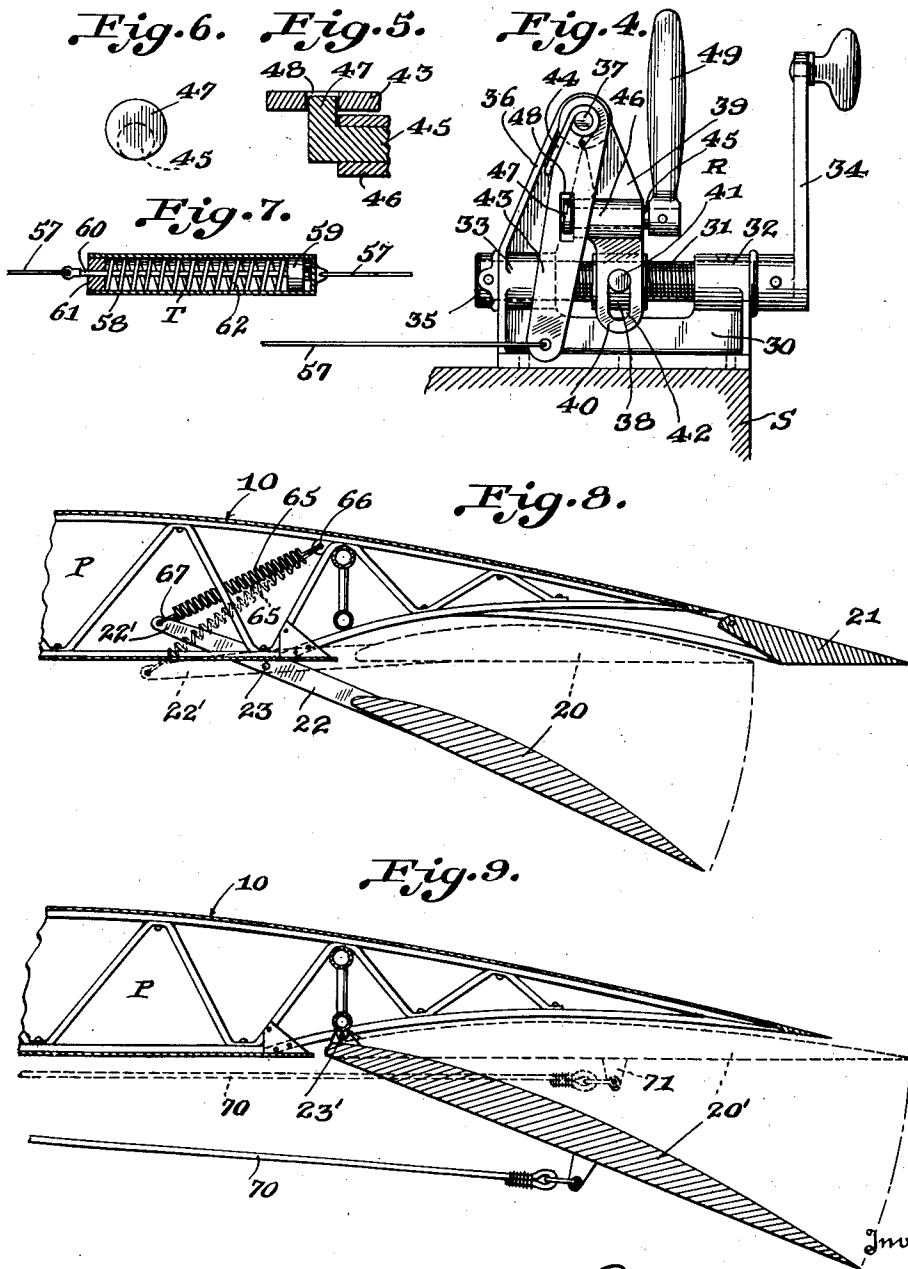
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 10.

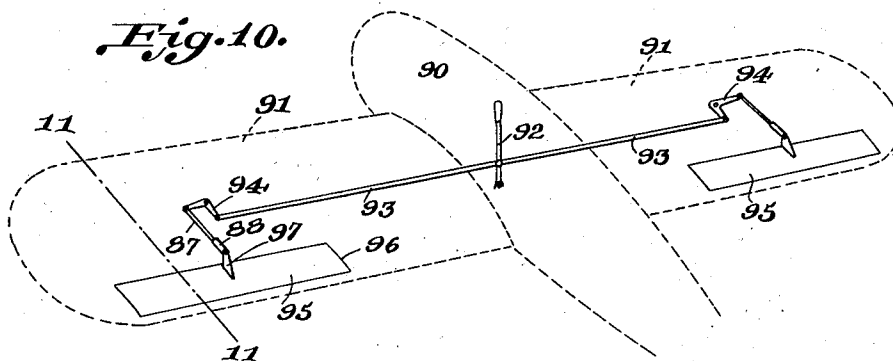


Fig. 11.

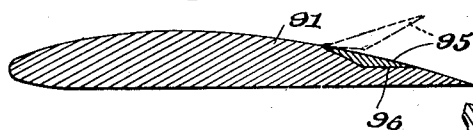


Fig. 12.

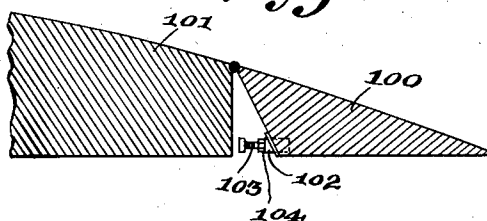


Fig. 13.

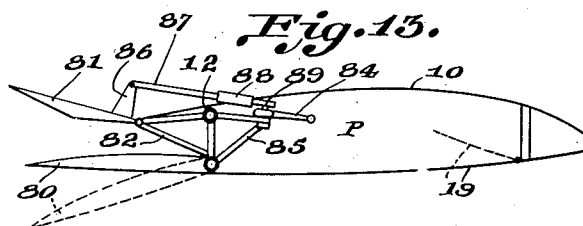
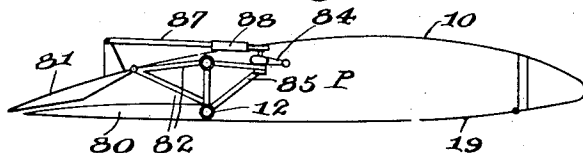


Fig. 14.



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UNITED STATES PATENT OFFICE

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AIRPLANE

Application filed July 31, 1930. Serial No. 472,100.

This invention relates to certain improvements in airplanes; 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 and believe to be the preferred embodiments or mechanical and aerodynamical expressions of the invention from among various other forms, embodiments, designs, arrangements, combinations and constructions of which my invention is capable within the spirit and the scope thereof.

15 The invention concerns the so-called high or valuable lift airfoils or wings of those types which present an air displacement passage through a wing with the displacement of air through such passage controlled by an auxiliary airfoil, vane, or flap, or a plurality of such members, as by opening the passage for displacement of air therethrough to increase or maintain wing lift with a wing under high attack angle or low speed conditions, and closing the passage against or to reduce displacement of air therethrough under low attack angle or high speed conditions. Such broad types of high or variable lift wings take either a form in which the passage flow controlling members are positively arbitrarily operated, as by manual operation and control thereof by the pilot, or a form in which such members are automatically operated by and in accordance with the wing operating and attendant airflow conditions. It is to this latter automatically operating and functioning form of such types of variable or high lift wings that my present invention is primarily directed, although it is to be clearly understood that all features and every phase of the invention are not restricted to such form of variable or high lift wings.

A particular design and arrangement of an air displacement passage high or variable lift wing exemplifying the broad principles of such types of wings, to the improvement of which the invention is especially aimed, is known as the "Hall" type and is disclosed in the United States Patents No. 1,559,091 dated October 27, 1925 and No. 1,723,778 dated August 6, 1929, while an automatically operating form of such wing is disclosed in my pending United States patent application filed February 11, 1928, Serial No. 253,732; and it is a general object of my present invention to materially improve the design and construction of such wings to enable the depth of the air displacement passage being increased to thereby increase the efficiency of the wing without requiring an increase in the overall depth or thickness of the wing section, while at the same time providing such a construction which will enable more efficient production and secure in the wing a high strength factor with a minimum of weight and structural complexity.

In certain of the automatically operating forms of such types of high or variable lift wings, a passage opening and closing and wing camber varying flap or vane member is provided with a force exerting means to assist in the automatic actuation of such member, as by exerting a force tending to move the member to passage opening position, and a further object of the invention is the provision of such force exerting means which will be of simple construction but positive in action, and which will exert such forces and so apply the same to the flap or vane member as to insure efficient automatic functioning of such member under the varying conditions to which subjected in operation and use.

Another main object of the invention is to provide mechanism under the control of the pilot by which an automatically functioning air displacement passage opening and closing member of the type of wing under consideration, can be raised to normal position closing the passage and secured in raised position against automatic functioning, or can be adjusted to control the extent of opening of the flap during automatic operation, and through the medium of which mechanism the flap or vane member can be instantly released from closed position or any adjusted position, by the pilot for instant resumption of full automatic functioning of such member.

A further object of the invention is to provide for taking up slack in the operating

cables of the mechanism for securing and releasing the automatically functioning displacement passage opening and closing member, and particularly to provide for absorbing and cushioning sudden shocks or jars to which the member may be subjected by the operation, especially upon releasing the member, of such securing and releasing mechanism.

Where the air displacement passage opening and closing flap or vane member, and especially in the automatically operating forms, of the wing is located at the discharge end of the displacement passage adjacent the wing trailing edge and forming a portion of the wing under surface, certain problems are encountered in the efficient mounting and operating of lateral control surfaces or ailerons at and along the wing trailing edge; and a further main object of my invention is to provide a design and mounting of ailerons for such a wing which will efficiently function for positive lateral control under all operations of the flap or vane member and which will cooperate with such a member during automatic operation and in passage opening positions with the wing under high attack angle or low speed conditions, to secure from the combined effect of the ailerons and such member, an efficient and effective lateral control for the wing.

A further object of the invention resides in the provision of an efficient design, arrangement and mounting of lateral control surfaces or ailerons for a wing of the foregoing types, as well as for wings of the under flap types generally irrespective of the presence of a cooperating air displacement passage, in which the lateral control of the wing is obtained through upward ailerons movements.

Another object of the invention resides in an efficient lateral control for a wing with ailerons above opposite under wing flaps through the provision for up and down aileron movement when the flaps are in lowered position, and when the flaps are in raised position, but not locked or secured in such position, through the provision of a down aileron action tending to depress the flap therebelow and augmenting the up-aileron control effectiveness.

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

Referring to the accompanying drawings:

Fig. 1 is a vertical transverse section, more or less diagrammatic, through a high or variable lift wing of the air displacement pas-

sage, automatically operating type embodying features of my invention, and showing the flap member in normal raised passage closing position.

Fig. 2 is a view similar to Fig. 1, but with the flap member in lowered and passage opening position, and the flap lowering force applying unit in extended position, a portion of the unit being broken away to show the force exerting compression spring thereof.

Fig. 3 is a top plan view, more or less diagrammatic, of the wing of Figs. 1 and 2, showing the arrangement of the mechanism for control by the pilot for raising and securing the wing flap in normal position against automatic operation, and for instant release of the flap for automatic operation.

Fig. 4 is a view in elevation of a form of pilot operated flap raising and securing, and instant or quick release mechanism embodying the invention as shown in Fig. 3.

Fig. 5 is a detail fragmentary sectional view through the engaged locking cam and operating crank of the flap raising, locking and quick-release mechanism of Fig. 4.

Fig. 6 is a detail end view of the locking cam and bolt member of the mechanism of Fig. 4.

Fig. 7 is a vertical, longitudinal section through the cable slack take-up and shock absorbing unit for the operating cable system of the flap raising, locking and quick release mechanism of Fig. 3.

Fig. 8 is a vertical transverse section through the trailing portion of a wing of the type of Figs. 1 and 2, showing a modified form of a flap lowering force unit in mounted operative connection with the wing flap member, the flap member and force unit being shown in normal raised position in dotted lines.

Fig. 9 is a vertical transverse section through the trailing portion of a wing of the type of Fig. 1, showing another form, arrangement and mounting of flap lowering force unit, the flap and unit being shown in raised position by dotted lines.

Fig. 10 is a purely diagrammatic perspective view of a lateral control system and aileron arrangement of the invention in which lateral control is secured solely by up aileron movements, an airplane to which the system is applied being shown in outline only.

Fig. 11 is a diagrammatic sectional view taken as on the line 11—11, of Fig. 10, showing the manner of mounting the ailerons in recesses in the upper surface of the wing.

Fig. 12 is a diagrammatic vertical sectional view through a design and mounting of trailing edge type of aileron for use with a control system of the type of Fig. 10.

Fig. 13 is a view more or less diagrammatic of an arrangement of aileron system of the type of Fig. 10 applied to an automatic

displacement passage wing of the type of Figs. 1 to 3, the wing flap being shown in full lines in normal raised position and the aileron in upwardly swung control position.

Fig. 14, is a view similar to Fig. 13, but with the aileron in normal downwardly swung neutral position.

One of the general features of the invention is the improvement in the design and construction of that broad general type of variable or high lift wing exemplified by my U. S. Patents Nos. 1,559,091 and 1,723,778, and particularly to the automatic forms of such type of wing. Reference is here made to such patents for an explanation and discussion of the broad principles and the functioning of such type of wing and especially to the advantages of increased air displacement passage depth as discussed and explained in my Patent No. 1,723,778.

A form of automatically functioning high lift wing of the foregoing type, designed and constructed in accordance with my present invention, is illustrated in Figs. 1 and 2, taken in connection with Fig. 3, of the accompanying drawings. The wing 10 is formed to provide the longitudinally disposed air displacement passage P extending rearwardly there-through between the spaced upper and lower skin or covering of the wing (which forms in effect spaced airfoils with the air displacement passage there between), and having its inlet end opening downwardly through the lower covering or surface of the wing adjacent the wing leading edge controlled by a forward vane 19 mounted for inward swinging, and its rear discharge end adjacent the trailing edge and below the upper surface of the wing controlled by the vertically swinging flap member 20. This rear flap member 20 is located forming a portion of the wing under surface with its trailing edge terminating spaced forwardly from the wing trailing edge and in normal raised, passage discharge closing position forming a portion of and carrying out the normal under surface contour of the wing (see Fig. 1). The forward vane 19 in lowered normal passage closing position forms a portion of the wing under surface and carries out the normal contour thereof (see Fig. 1). The front vane 19 and rear flap 20 extend substantially throughout the full span of wing 10 (see Fig. 3) and an aileron 21 embodying certain features of the invention to be hereinafter referred to, is mounted on the wing forming a portion of the wing trailing portion extending inwardly a distance of the wing span from adjacent the wing tip, in position above and extending a distance forwardly and rearwardly beyond the trailing edge of rear flap 20.

In carrying out the improved construction of the invention, the wing 10 includes the forward beam or spar 11, constructed of wood, and the rear open truss or girder type of

metal beam or spar 12. A spaced series of metal ribs are fitted over and transversely across and secured in the usual manner to the front and rear beams 11 and 12, and each of these ribs comprises the upper and lower tubular metal chord members 14 and 15 with the trussing 16 of tubular metal riveted or welded thereto and there between, all in more or less conventional or any other desired manner. The lower chord member 15 of each rib along the span of the aileron 21 has the upwardly arched portion 15' (see Figs. 1 and 2) extending from a point forward of rear beam 12, to and joining the end of upper chord member 14 at a point adjacent the forward or leading edge of the aileron 21, while those ribs inboard the aileron 21 have the lower chord members 15 similarly upwardly arched for a distance but are then curved downwardly and rearwardly to and joining the upper chord members at and defining the trailing edge proper of the wing, such inboard rib lower chord member portions 15'' being shown in Figs. 1 and 2 of the drawings. An under recess is thus formed in wing 10 to receive the wing flap 20 in its normal raised, passage closing position as shown in Fig. 1, with the under surface of the flap forming a portion of the wing under surface and carrying out the normal wing contour.

The upper surface of the wing is preferably formed by a fabric covering 17 extending rearwardly from the forward beam 11 to the wing trailing edge inboard aileron 21, and to the aileron leading edge for the remainder of the wing span, being secured in any of the usual ways known to the art. The leading edge portion of the wing is formed by a metal nose member 18 extending forwardly from beam 11 and secured over and across the forward ends of the wing chord members 14 and 15. The under surface of the wing is as explained formed in part by the front vane 19 and the rear flap 20 when in normal passage closing position of Fig. 1, while the remainder of the wing under surface is formed by a preferably fabric covering 9 secured across the wing rib lower chord members 15 and between the passage inlet opening controlled by front vane 19 and the rear passage discharge opening controlled by rear flap 20. In order to permit of the lower surface forming fabric covering 9 extending further aft a distance below the wing flap recess formed by the arched chord members 15' and 15'', a metal gusset 8 is riveted to each rib at the forward end of the flap recess, with covering 9 extended rearwardly there across and secured to the lower ends of the gussets 8.

The forward vane 19 for opening and closing the forward inlet end of wing passage P, is formed of relatively thin, light weight sheet metal and is freely pivotally mounted at and, along its forward edge for free ver-

tical swinging into the wing to passage opening position and downwardly to passage closing position. The vane 19 is provided with spaced transverse grooves in its under side
 5 formed by pressing ribs 19' upwardly from the body of the vane, and these ribs are spaced to aline with the rib chord members 15 which extend across the passage inlet, so that when
 10 vane 19 is in lowered normal passage closing position, the chord members 15 fit into the vane grooves and permit the vane 19 lying flush with the covering 9 and forming a substantially unbroken portion of the wing under
 15 surface, as clearly shown in Fig. 1. The trussing 16 of each wing rib is formed and secured between rib chord members 14 and 15 so as to bridge and be arched or extend upwardly over and across wing passage P inlet,
 20 thus forming recesses into which the front vane is received without interference when swung inwardly of the wing to passage opening position, as shown in Fig. 2.

The rear wing flap member 20 may be of conventional airfoil or wing construction and is of such depth and contour as to lie within the wing recess with the flap lower surface forming a portion of the wing under surface and contour when in normal raised passage closing position (see Fig. 1). The wing flap
 30 20 is pivotally mounted in position on the wing for vertical swinging, by the remote hinge members 22 extending at spaced intervals along the span of the flap forwardly from the flap leading edge, to special wing
 35 ribs where they are pivotally connected at 23, at points spaced forwardly from rear beam 12, the pivotal connection being preferably made at points of jointure between rib chord
 40 members 15 and rib trussing 16, as will be clear from Figs. 1 and 2. The flap 20 is thus swingable downwardly to the lowered position of Fig. 2 opening the rear discharge end of air displacement passage P and increasing the wing under surface camber, while
 45 due to the remote hinge members 22 a space or air passage is formed between the wing under surface and the leading upper edge of the lowered flap.

50 A wing 10 of the air displacement passage type referred to, is thus provided of a design and construction in which maximum depth of air displacement passage without increase in overall depth of the wing is secured while
 55 weight is maintained low without sacrificing strength. The construction is further such as to enable efficient and relatively low cost production of the wing.

The wing 10 is of the automatically functioning type in which the vane 19 and rear flap 20 are actuated by and in accordance with flight and attendant air flow conditions, so that, with the wing under low attack angle or high speed conditions the vane 19 and flap
 60 20 assume their normal raised, passage closing

ing position of Fig. 1, while with the wing under high attack angle or low speed conditions the vane and flap swing to their passage opening positions of Fig. 2, for displacement of air through wing passage P and increase in the lift capacity of the wing. In the example of wing of such type here shown, means are provided for applying force to rear flap member 20 when the wing is under high angle of attack or low speed conditions to insure downward swinging thereof to passage opening and wing camber increasing position.

A form of such means is disclosed in Figs. 1, 2 and 3 of the drawings, and comprises, referring to Figs. 1 and 2 a force exerting unit 24 consisting of a cylinder 25 having a compression spring 26 therein, and a headed plunger 27 slidably mounted in and extending through one end of the cylinder with the plunger head bearing against spring 26, so that inward or telescoping movement of plunger 27 compresses spring 26, as will be clear by reference to Fig. 2 of the drawings. A force unit is operatively mounted in the wing with the outer end of plunger 27 pivotally connected at 28 to the upper side of wing flap 20, and the opposite end of cylinder 25 pivotally connected to the rear wing beam 12, as by pivoting the same to the upper chord member of such beam. In mounted position the force unit extends between wing beam 12 and flap 20, so that with the flap raised plunger 27 moves into cylinder 25 and further compresses spring 26, which exerts pressure downwardly of the plunger tending to swing flap 20 downwardly.

In flight operation with the wing 10 under low attack angle or high speed conditions; wing flap 20 is maintained in normal raised position against the force exerted thereon by compressed spring 26 by the air pressures at the under side of the flap, and front vane 19 drops to lowered normal passage inlet closing position, all as shown by Fig. 1. When, however, the wing assumes high angle of attack or low speed conditions, the air pressures at the under side of flap 20 are reduced and the spring 26 of force unit 24 acts through plunger 27 to apply sufficient force to the flap to swing the same downwardly to lowered position, at the same time air pressures at the front vane 19 increase to swing such vane inwardly to passage opening position, all as shown by Fig. 2 of the drawings. Preferably, as shown by Fig. 3 of the drawings, a plurality of force exerting and applying units 24 are provided connected between the wing structure and the flap 20 at spaced intervals along the span of the flap so as to distribute the lowering force applied to the flap.

My invention provides as a further and important feature thereof, means under the con-

5 trol of the pilot by which the automatically
operating flap of a wing of the type here
shown can be raised and secured in normal
passage closing position against automatic
functioning, the extent of automatic opera-
tion and opening of the flap limited and ad-
justed, and by which the flap can be instant-
ly released from raised or adjusted positions
for full automatic operation. A possible form
and arrangement of such means is disclosed
in operative mounting and connection with
wing 10 and flap member 20 thereof in Figs.
1, 2 and 3, while the pilot operated mechanism
R for actuating the arrangement is shown in
detail in Figs. 4, 5 and 6. The pilot operated
mechanism R is mounted at a convenient
point, say the control cockpit of an airplane
as diagrammatically indicated in Fig. 3.

The pilot controlled mechanism R in the
particular form thereof here shown as an
example, includes the base 30 referring now
to Fig. 4 of the drawings, which is secured
to any suitable structure of the airplane, dia-
grammatically indicated at S, and the screw
threaded shaft 31 rotatably mounted and
journaled in the alined and spaced bearings
32 and 33 located at opposite ends of base 30.
An operating crank handle 34 is fixed to one
end of shaft 31 for rotating the shaft in oper-
ating mechanism R. Shaft 31 is confined
against axial displacement by crank 34 at one
end and the cap 35 fixed to the opposite end
of the shaft. A column or standard 36 ex-
tends outwardly from base 30 at the shaft
bearing 33 and is provided with a pivot pin
or stud 37 disposed with its axis at right
angles to the axis of shaft 31. A trunnion 38
is threaded on shaft 31 between bearings 32
and 33 and a crank 39 is pivotally mounted
at one end on pin 37 of standard 36, and ex-
tends inwardly to and terminates in a forked
end 40 fitted over and engaging pins 41 of
trunnion 38 in slots 42. By rotating crank
34, trunnion 38 being restrained against rota-
tion by crank 39, the trunnion is moved in one
direction or the other along threaded shaft 31
and swings the crank 39 on pivot pin 37.

A lever arm 43 is pivotally mounted on piv-
ot pin 37 for independent swinging thereon
and for locking with crank 39 for swinging or
rocking therewith and thereby. The arm 43
extends to one side of base 30 for attachment
of its free end to the flap raising cable system
to be later explained, and at its outer pivoted
end a spring 44 is operatively arranged
around pin 37 and between the arm and in
position shown standard 36 normally tending
to rock or swing arm 43 in a direction away
from the adjacent end of base 30 and toward
trunnion 38 and lever 39. An instant or
quick-release lock for securing and connect-
ing lever arm 43 to crank 39 is provided and
in the form hereof embodies a bolt member
45 journaled in a bearing 46 formed on crank
39 and disposed substantially parallel to shaft

31 and transversely of crank 39 intermediate
the ends thereof. One end of bolt member
45 extends between lever arm 43 and standard
36 and is provided with a locking cam head
47 for engagement in a slot 48 formed in lever
arm 43, to lock and connect the lever 43 and
crank 39 together for simultaneous swinging.
The opposite end of bolt member 45 is pro-
vided with an operating lever handle 49 for
rotating the bolt member to engage and dis-
engage the cam head 47 with lever slot 48.

The flap raising cable arrangement opera-
tively coupled with mechanism R is disclosed
in Fig. 3, in connection with Figs. 1 and 2, and
comprises cables 50 and 51 each connected to
the upper end of a crank 52 extending verti-
cally into wing 10 from the forward end of
a wing flap hinge member 22 (see Figs. 1 and
2). The cranks 52 are each braced by a mem-
ber 53 extending between the upper end of the
crank and the flap member 20. In the ex-
ample hereof, two of such cranks, 52 are pro-
vided, one for each cable 50 and 51, on flap
hinge members 22 which are adjacent opposite
ends, respectively, of flap 20 so as to apply the
lift force to the flap at relatively widely
spaced points. (See Fig. 3). The cables 50
and 51 extend forwardly through wing 10 and
inwardly around pulleys 54 to join together as
a single cable 55 which is extended inwardly
through the wing root and around a pulley 56
to the pilot operated mechanism R. A similar
cable 55 is provided for the opposite wing
flap (not shown) and these cables 55 to op-
posite wings are joined together as a single
length of cable 57 which is connected to the
free inner end of lever arm 43 of mechanism
R. (See Figs. 3 and 4).

With the mechanism R and cable system
as above described, to raise wing flap 20 to
normal passage closing position and secure
the same against automatic functioning, lever
43 and crank 39 are locked together by cam
head 47 engaged in lever slot 48, and the
crank handle 34 is actuated to rotate shaft
31 and move trunnion 38 thereon in a direc-
tion to rock or swing lever arm 43 to pull
cable 57 and connected cables 55—50—51, to
draw or raise flap 20 upwardly until the flap
is in normal raised position of Fig. 1. The
flap can be instantly released from this raised
and secured position by swinging operating
lever 49 to rotate bolt member 45 to disengage
its cam head 47 from lever slot 48, whereupon
lever arm 43 is released and free to swing in-
dependently of crank 39 and the flap is in-
stantly freed for automatic operation. After
release of the flap 20 by mechanism R, the
crank 39 can be reengaged with lever 43 by
maintaining wing flap 20 in a steady position,
as by holding the airplane in flight in a steady
attitude, and rotating crank handle 34 until
cam head 47 is alined with slot 48 of lever 43,
and then turning operating lever 49 to en-
gage cam head 47 in the lever slot. The ex-

tent of automatic operation of wing flap 20, that is the extent of downward swinging thereof, can be adjusted or limited as desired by operating mechanism R to partially
 5 raise flap 20, so that the flap can then automatically operate in such adjusted position. From any such adjusted or limited, partially raised position, the flap 20 can be instantly released by operating lever 49, in the manner
 10 hereinbefore described with respect to such emergency or quick-release operation.

Preferably, a cable slack take-up and shock absorbing means is provided in the operating cable system for the flap raising, securing and releasing mechanism. A form of
 15 such means is disclosed in Fig. 7 and embodies a unit T consisting of a cylinder 58 having a piston 59 therein carried on a rod 60 slidably extended through a plug 61 in one
 20 end of the cylinder, and a compression spring 62 within the cylinder around rod 60 between piston 59 and end plug 61. By drawing rod 60 outwardly spring 62 is compressed, the spring normally tending to force piston 59
 25 toward the opposite end of the cylinder, while the pneumatic action of the piston in the cylinder upon quick or sudden movements thereof will act as a shock absorber, the construction providing for slow air leakage past the
 30 piston and around the cylinder end plug. The slack take-up and shock absorbing unit T is preferably connected into the flap raising cable system in the cable 57 adjacent mechanism R by connecting the rod 60 to one
 35 end of cable 57 and the opposite end of cylinder 58 to the other end of cable 57, as will be clear from Fig. 3 of the drawings. If desired a unit T can be connected at other points
 40 in the system or a unit can be provided for each wing, as will be readily understood. By its use such a unit takes-up the slack in the cable system and particularly serves as a shock absorber against shocks and jars to
 45 which the system may be subjected, especially serving to prevent injury or damage to the system or wing flap, in the event the latter is released from raised position with an airplane on the ground.

The flap raising, securing and instant release mechanism is of particular utility with an automatic wing of the type here shown for bringing into operation the lift increasing
 50 function of the wing on taking off with an airplane. The airplane with such wing will accelerate faster with the flap raised and passage way closed (less drag condition) and after suddenly increasing the lift by releasing the flap through the instant release mechanism of the invention, will enable a quick
 55 and short run take-off being made. After the airplane is in the air the flap and extent of passage opening are of course controlled by the flight angle of attack held or speed of flight maintained. Such use of the instant
 60 release of the flap is of great aid for

short fields or runways and heavily loaded craft. Also in flight with flap raised and not functioning, in the event of an emergency, as a forced landing, the flap can be
 70 instantly released for instant lift increasing functioning. Attention is here called to the fact that this feature of the invention is not limited to air displacement passage types of wing but is also intended for and adapted
 75 to wings of the automatically operating flap or variable types without displacement passages.

With the automatically operating wing flap, such as flap 20, and the flap lowering force units of the type of units 24 of Figs. 1
 80 to 3, the force exerted by a unit so designed and mounted will increase as the flap is raised. My present invention includes and provides flap lowering force exerting arrangements in which the moments resulting
 85 therefrom will be decreased as the flap is raised to thus materially reduce the forces necessary to close and maintain the flap in closed position. Such arrangements are of particular utility for the relatively low speed
 90 types of airplanes having wings of the automatically functioning forms.

In Fig. 8 of the accompanying drawings I have disclosed one possible form of a wing flap lowering force applying units as mounted
 95 and arranged on the wing 10 in operative arrangement with the wing flap 20 thereof, in the operation of which unit the flap lowering moment obtained thereby is decreased as the flap raises or swings upwardly to normal raised position on wing 10. The force
 100 unit embodies a coil expansion spring 65 connected at one end 66 thereof to the wing structure, such as a wing beam, above a hinge member 22 of flap 20 and extends forwardly
 105 and downwardly to and is connected at its opposite end 67 with the forward end of the extension arm 22' of hinge member 22. Spring unit 65 normally draws or swings arm 22' upwardly to swing hinge member 22 and wing flap 20 downwardly to lowered
 110 position, but is expanded and placed under increased tension when the flap 20 is raised or swung upwardly, thus applying continuously an initial lowering force to the flap 20, as will be clear from Fig. 8. Now, as the flap 20 swings upwardly the arm 22' expands
 115 spring unit 65 and the force or tension in the spring increases, but due to the considerably decreased leverage by the relation between the flap pivot point 23 and the spring attachment points 66 and 67, as the flap raises the resultant lowering moment applied to the flap is decreased and therefore smaller
 120 air pressures are required to raise and maintain the flap in normal passage closing position. Of course any desired member of the spring units 65 can be mounted along the span of flap 20, and due to their mounting and location entirely within the wing in all

positions of the flap both raised and lowered they offer no air resistance and are protected from the elements and damaging contacts.

Another form and arrangement of such a flap lowering force applying means particularly adapted for a form of wing flap 20' not provided with the remote hinge mounting of flap 20 but pivotally mounted at 23' along its leading edge, is shown in Fig. 9, and embodies the use of elastic or the like cord 70, such for example as the familiar aviation shock absorber cord. A force applying unit is formed of a length of elastic cord 70, or if found expedient a plurality of cords, connected at the rear end to a crank or horn fitting at the under side of flap 20' spaced rearwardly from the flap pivot point 23', and extending forwardly beneath wing 10 to and connected to the wing structure at a point adjacent the wing front beam 11 (see Fig. 1). The cord or cords 70 exert a force lowering or swinging flap 20' downwardly and when the flap is swung upwardly are stretched and placed under increased tension. However, as in the case of Fig. 8, when the flap 20' is raised the leverage falls off due to the rearward point of cord attachment with respect to the flap pivotal point 23', and further the cord is not materially lengthened, as will be clear from the dotted line raised position of Fig. 9, so that lowering moment applied to the flap is not increased as the flap raises but will tend to be reduced. When the flap 20' is in the normal raised position shown in dotted lines, it is to be noted that the cords 70 lie close under the wing to the lower surface and offer small resistance for the high speed, low attack angle condition. Any number of such cord units 70 may of course be mounted spaced along the span of the wing to distribute the initial lowering force to the wing flap.

A problem and difficulty encountered with the displacement passage and wing flap type of wing such as shown in Figs. 1 to 3 of the drawings, is in the mounting and operation of the lateral control surfaces or ailerons for such wings, and the invention provides a solution by the design and mounting of aileron 21 of Figs. 1 to 3, to which reference is now made. The aileron 21 is hinged or pivoted to wing 10 along an axis or hinge line 21a above the trailing edge portion of rear flap 20 and extends rearwardly to and forms a portion of the wing trailing edge (see Fig. 3). Aileron 21 is of such a depth and section as to rearwardly carry out the wing 10 normal section and contour when in neutral position and with flap 20 in normal raised position, but is formed with the forward leading portion thereof undercut upwardly and forwardly at 21b to provide operating clearance for the flap 20 and also to deflect the air when the aileron is in normal or lowered positions (see Fig. 1) which will

act to increase the wing lift and control effectiveness of the down aileron positions. The design of aileron 21 also provides a slight nose or leading edge portion 21c extending forward of the pivot or hinge axis 21a. A slot 21d is formed through the upper surface of the wing between such nose portion and the adjacent wing upper covering 14 along the span of aileron 21, so that air is caused to flow above the wing interfering with the airflow at the upper surface of the wing when the aileron 21 is raised (see dotted line position of Fig. 1) which further increases aileron effectiveness.

In connection with the design and mounting of the aileron 21 at the trailing edge of the upper fixed surface of wing 10, the effectiveness of the lateral control is contributed to by the mutual interference between such aileron and the wing flap 20. When aileron 21 lowers the rear flap may also lower, if not interconnected with the opposite wing flap (not shown) of the airplane, which will create additional lift on the desired side. When the aileron 21 raises, due to a reduction in aileron under pressure, the flap 20 is caused to raise slightly reducing the lift and increasing the effectiveness of the aileron in raised positions.

Following the principles of another feature of the invention, lateral control systems of the aileron type are provided in which under certain conditions lateral control is obtained by up movements only of the ailerons, the ailerons being maintained against or restricted in their down movements. One form of such a lateral control system designed and adapted for embodiment in a wing of the air displacement passage-wing flap type, such as the hereinbefore described wing 10, is diagrammatically illustrated in Figs. 13 and 14 of the drawings.

In the arrangement of wing 10 of Figs. 13 and 14, the rear under wing flap 80, is pivotally mounted to the rear wing beam 12, and the aileron 81 is pivotally mounted in position above the rear flap on a rearwardly extending mounting truss 82 carried by beam 12, so that with the flap 80 held or locked in normal raised position the aileron 81 cannot be downwardly swung, but is only free for upward swinging. The aileron control mechanism includes a control crank 84 of the L type horizontally mounted on the front end of a mount 85 carried by and extending forwardly from the wing beam 12 and operatively coupled to the usual or conventional cockpit control such as shown in Fig. 10 and referred to hereinafter. The aileron 81 is provided with a crank or control horn 86 on the upper side thereof which is operatively coupled with the control crank 84 by a telescopic unit embodying a rod 87 pivotally connected to aileron horn 86 and slidably received in a tube 88 which is connected to the control

crank 84 by a universal connection 89. A compressing spring or other resilient member (not shown) is mounted in tube 88 and between the inner end of the rod 87 and the opposite end of the tube. The rod 87 makes positive connection with tube 88 when the latter is moved inwardly to raise aileron 81 but when crank 84 is actuated to move tube 88 outwardly to lower aileron 81, with wing flap 80 locked in raised position blocking down swinging, the rod 87 will telescope with tube 88 against the spring (not shown). With the wing flap lowered the aileron 81 will lower within the limits of the telescoping unit and the spring thereof, which will give increased control at high angles of attack when needed most. If the flap is not held or locked in raised position during actuation of the cockpit control, the tendency of the aileron to go down will by its pressure exerted against the top of the flap underneath cause the flap to lower, thereby increasing control effectiveness. The amount of this flap deflection will depend upon the stiffness of the spring (not shown) in the telescopic unit 87-88.

If desired ailerons 81 may be located in a forward position, the under flap extending beyond the aileron trailing edge. It is also to be here noted that an aileron control embodying features of the invention disclosed by Figs. 10 to 14, inclusive, will by a reduction in drag on the side of down aileron, avoid an unfavorable yawing condition in stalled flight which opposes lateral control effectiveness.

A lateral control system embodying the principles of up-aileron movement and applied to a wing of the conventional types is illustrated in Figs. 10, 11 and 12 of the drawings. In Fig. 10 an airplane is diagrammatically indicated in dotted outline as including body 90 and opposite wings 91. A usual pilot's control stick 92 is shown with opposite push and pull tubes 93 extending therefrom outwardly through opposite wings to the L cranks 94, respectively. An aileron 95 is pivotally mounted in a recess 96, referring now to Fig. 11 of the drawings in particular, in the upper surface of each wing 91 and in normal lowered and neutral control position lies within the recess with its upper surface substantially flush with the upper surface of the wing, but is swingable upwardly from the recess to the raised control position shown by dotted lines in Fig. 11. The crank 97 on the upper side of each aileron is operatively connected with the adjacent control crank 94 by a telescopic spring unit 87-88 similar to that shown in Figs. 13 and 14, and described hereinbefore, so that the ailerons 95 are capable of up movements only, operation of cranks 94 to cause down movements of the ailerons causing telescoping and yielding of the units 87-88

with the ailerons held by the wing against down swinging. Thus, operation of the control stick 92 will raise the aileron 95 of one wing and the opposite aileron will be held in neutral position in its wing recess 96, its operating unit 87-88, yielding and telescoping, the lateral control being secured solely through up movements or raising of the ailerons.

An aileron 100 of the conventional type pivotally mounted on the trailing edge of a wing 101 and adapted for operation by and following the principles of the up-aileron control system of Fig. 10, although limited down movement may be had; is diagrammatically disclosed in Fig. 12. In the illustrated example of the conventional trailing edge aileron 100 is provided with a fitting 102 secured in the lower portion of the forward or leading edge of the aileron spaced from the opposite trailing edge of the wing 101, and is tapped to receive the stop forming set screw 103 which extends forwardly therefrom and is provided with the lock nut 104 for securing such screw in adjusted position. Preferably several of such set screws and fittings are mounted spaced along the leading edge of the aileron 100. In operation the set screw from stops which abut against and engage the adjacent wing trailing edge structure to limit and prevent down swinging of the aileron while permitting the same to swing freely upwardly or raise to various control positions. Such ailerons of suitable proportions when operated with the control system say of Fig. 10, are operated to obtain good lateral control by principally upward swinging or raising, in the same manner explained in connection with the said aileron operating system of Fig. 10.

With the several features, designs and arrangements of the invention as described in the foregoing specification, it is evident that various changes, modifications, variations, substitutions, eliminations and additions might be resorted to without departing from the spirit and scope of my invention, and hence I do not desire to limit the invention in all respects to the exact and specific disclosures hereof.

What I claim is:

1. A high lift wing of the type formed with a longitudinally disposed air displacement passage extending rearwardly therethrough, comprising a front longitudinal beam, a rear longitudinal beam of the open truss type, a series of spaced open truss type ribs secured transversely across and between said beams, an upper surface formed by a relatively thin substantially single thickness covering secured over said beams and ribs, a rear flap member pivotally mounted at the under side of the wing and forming a portion of the under surface of the wing, and the under wing surface forward of said flap formed by a rela-

tively thin substantially single thickness covering, the air displacement passage formed and defined by the space within the wing between such upper and lower relatively thin covering which provide a maximum passage depth within the wing.

2. In a high lift wing of the type providing a longitudinally disposed rearwardly extending air displacement passage there-through formed by the space between the upper and lower fixed wing covering, said upper and lower fixed covering formed of relatively thin material to give maximum passage depth within the wing, said lower covering formed with an opening therethrough adjacent the wing leading edge providing the inlet for said passage, and formed with an opening therethrough adjacent the wing trailing edge to provide the discharge for the passage.

3. In a high lift wing of the type providing a longitudinally disposed rearwardly extending air displacement passage there-through formed by the space within the wing between the fixed upper and lower wing surfaces, said upper and lower surfaces defined by a covering of approximately a single thickness of material, the inlet end of said passage formed through the lower wing surface defining covering, and a vane for opening and closing the passage inlet formed of relatively thin material of substantially the thickness of the wing lower surface defining covering, said vane in normal position closing the passage disposed substantially flush with and forming a portion of the wing lower covering and swingable upwardly into the wing to open the passage inlet.

4. In a high lift wing of the type providing a longitudinally disposed rearwardly extending air displacement passage there-through formed by the space within the wing between the wing upper and lower surfaces, a forward longitudinal wing beam, a rear longitudinal wing beam of the open truss type, a series of spaced open truss type wing ribs secured transversely across and between the said longitudinal beams, each of said ribs including an upper and a lower wing contour defining chord member, a wing flap pivotally mounted and disposed at the under side of and forming a portion of the wing under surface at the trailing portion of the wing, said flap vertically swingable from normal raised position closing the rear end of the passage to lowered position opening the passage and increasing the wing under camber, and the lower chord members of said ribs above the flap upwardly arched to fit over and across the upper side of and form a recess receiving the flap in normal raised position thereof.

5. In a high lift wing of the type providing a longitudinal disposed rearwardly extending air displacement passage there-

through formed by the space between the wing upper and lower surface forming covering, the trailing portion of the lower surface of the wing formed by a vertically swingable wing flap which in normal raised position closes the rear end of the displacement passage and in lowered position opens the passage and increases the wing under surface camber, and an aileron pivotally mounted at the trailing edge of the wing upper surface above and extending rearwardly beyond said flap, the aileron formed of a section rearwardly carrying out the normal wing contour and having its forward under surface upwardly and forwardly inclined above and to provide operating clearance for the flap trailing portion and forming an air deflecting surface for the airflow from the passage with the flap in lowered position, the trailing edge of the wing upper surface and the aileron leading edge spaced apart to form a slot through the upper surface of the wing along the span of the aileron.

6. In a high lift wing formed with a longitudinally disposed rearwardly extending air displacement passage therethrough, a freely floating air pressure actuated vane controlling the forward inlet end of the passage, and an automatically operating wing flap controlling the rear discharge end of the passage to close the passage with the wing under low attack angle or high speed conditions and to open the passage under high attack angle or low speed conditions, said vane floating to positions opening and closing the passage inlet as the flap opens and closes the discharge end of the passage.

7. In a high lift wing having an air displacement passage therethrough discharging through the under surface of the wing at the wing trailing edge, a vertically swingable automatically operating rear flap forming a portion of the wing under surface at the passage discharge, said flap raised under low attack angle or high speed conditions to normal position closing the passage and lowered under high attack angle or low speed conditions to position opening the passage and increasing the under surface camber of the wing, and yielding means maintaining the flap lowered against high angle of attack air pressures, the flap raised and maintained against said means by air pressures at low angles of attack.

8. In a high lift wing formed with an air displacement passage therethrough discharging adjacent the wing trailing edge, a rear flap pivotally mounted for vertical swinging and forming a portion of the wing under surface, said flap operating automatically to raise to normal position closing the discharge end of the passage under low attack angle conditions and to lower to position opening the passage under high attack angle conditions, and yielding means main-

taining said flap lowered against air pressures acting on the flap under high angle of attack conditions.

9. In a variable lift wing having an automatically operating vertically swingable wing flap member actuated by variations in the airflow conditions acting thereon, yielding means applying forces to said flap tending to lower the same, and means for raising said flap and securing the same in raised position against automatic operation.

10. In a high or variable lift wing having a vertically swingable, wing camber varying flap member automatically actuated by variations in the airflow conditions acting thereon, yielding means applying lowering forces to said flap, and means for limiting the extent of lowering of said flap and for raising said flap and securing the same in raised position against automatic operation.

11. In a high lift wing having vertically swingable flap member automatically actuated by variations in the airflow pressures acting thereon, yielding means applying forces to said flap tending to lower the same from raised position, and means for raising and securing the flap in normal raised position against automatic actuation, said means including a quick-release mechanism for instantly releasing the flap from raised secured position for resumption of automatic operation.

12. In a high lift wing having a vertically swingable wing flap automatically actuated by variations in the airflow pressures acting thereon, means applying forces to said flap tending to lower the same from normal raised position, and means for raising said flap and securing the same in raised position against said lowering force means, the said flap raising and securing means embodying an operating mechanism, flap raising cable system operatively coupling the flap with said mechanism, and cable slack taking-up and shocking absorbing means operatively interposed in said flap raising cable system between the flap and said operating mechanism.

13. In a high lift wing having a vertically swingable wing flap automatically actuated by variations in the airflow pressures acting thereon, means applying forces to said flap to lower the same from normal raised position, means for raising and securing said flap in raised position against said force applying means, said raising and securing means including a quick-release mechanism for instantly releasing said flap from secured position for resumption of automatic operation, and shock absorbing means operatively associated in said raising and securing means for protecting said flap against shocks occasioned by operation of the quick-release mechanism.

14. In a high lift wing having a vertically

swingable wing flap automatically actuated by variations in airflow pressures acting thereon to vary the lift capacity of the wing, a force applying unit operatively coupled with the wing flap for maintaining the flap lowered against air pressures at high angles of attack and yielding under the increased air pressures at low angles of attack for upward swinging of the wing to normal raised position, and the said force applying unit mounted and confined entirely within the wing in all positions of the wing flap.

15. In a high lift wing having a vertically swingable wing flap automatically actuated to vary the lift capacity of the wing by variations in airflow pressures acting thereon, means applying forces to the flap for lowering and maintaining the flap lowered against air pressures with the wing under high angle of attack conditions, said force applying means overcome by increased air pressures acting on the flap with the wing under low angle of attack conditions for upward swinging and maintenance of the flap in raised position, and the said means so arranged and operatively associated with the flap that the lowering forces applied to the flap decrease as the flap swing upwardly to raised position.

16. In a high lift wing having a vertically swingable wing flap automatically actuated by variations in air-flow pressures acting thereon to vary the lift capacity of the wing, a force exerting unit operatively coupled between the flap and the wing structure applying a force to the flap for lowering and maintaining the same lowered against the air pressures with the wing under high attack angle conditions, the force applied by such unit overcome by the air pressures with the wing under low attack angle conditions with the flap swung upwardly and maintained in raised position, the said unit connected to the wing structure and to the flap at such points with respect to the axis about which the flap swings that the force applied to the flap decreases as the flap swings upwardly.

17. In a high lift wing having an air displacement passage therethrough discharging at the trailing edge of the wing, a wing flap pivotally mounted on the wing forming a portion of the wing under surface and vertically swingable to positions opening and closing the discharge end of said passage, an aileron mounted for vertical swinging on the wing above said flap and held against downward swinging by the flap when the latter is in raised passage closing position, aileron operating mechanism, and a yielding connection operatively coupling said mechanism with the aileron, said yielding connection raising the aileron to upwardly swung lateral control position by said mechanism but yielding when the mechanism is actuated to swing the aileron downwardly.

18. In a wing having an air displacement passage, an automatically operable flap for opening and closing the discharge end of said passage in accordance with wing operating conditions, spring means normally tending to swing said flap to open position, and said flap maintained in closed position against the said spring means by air pressure acting on the wing, said flap swung to open position by said spring means upon reduction in air pressure on the wing.

19. In a wing having an air displacement passage, an automatically operating member for opening said passage for flow of air therethrough and for closing said passage against flow of air therethrough to vary the lift developed by the wing in accordance with airflow conditions acting on said member, means exerting a force on said member normally tending to move said member to position opening said passage with the wing under high attack angle conditions, and said member maintained in passage closing position against said force exerting means by air pressure established with the wing under low attack angle conditions, said member moved to passage opening position by said means upon reduction in air pressure acting on the member.

20. In a high lift wing of the type providing a rearwardly extending air displacement passage therethrough, the trailing portion of the lower surface of the wing formed by a vertically swingable wing flap which in normal raised position closes the rear discharge end of the displacements passage and in lowered positions opens the passage and increases the wing under surface camber, and an aileron pivotally mounted at the trailing edge of the wing upper surface above and extending rearwardly beyond said flap, the aileron formed of a section rearwardly carrying out the normal wing contour and having its forward under surface upwardly and forwardly inclined to form an air deflecting and guiding surface for the airflow from the passage with the flap in lowered positions.

21. In a variable lift wing having a vertically swingable wing camber varying flap member automatically actuated by variations in the airflow conditions acting thereon, means continuously applying forces on said flap tending to lower the same, and means for adjustably limiting the extent of lowering of said flap.

22. In a variable lift wing having an air displacement passage therethrough, a flap member automatically actuated by variations in the airflow conditions acting thereon for opening and closing said passage, and means for adjustably limiting the extent of opening of the passage by said flap member.

23. In a variable lift wing having a vertically swingable wing camber varying flap member automatically actuated by variations

in the airflow conditions acting thereon, in combination with, means for raising said flap and releasably securing the same in raised position against automatic operation.

24. In a variable lift wing, a vertically swingable wing flap member, means applying forces to the flap tending to swing the same downwardly to lowered positions, and said means applying forces to the flap of decreasing magnitude as the flap is raised from lowered positions.

25. In a high lift wing having a vertically swingable wing flap pivotally mounted on the wing, an arm fixed to the flap extending forwardly from the pivotal axis of the flap, and an expansion spring connected to the forward end of the arm and extended rearwardly therefrom and fixed to the wing structure at a point above the flap, said spring exerting a force tending to swing the arm upwardly and the flap downwardly, the relation between the points of connection of the spring with the flap arm and the wing, and the pivotal axis of the flap, causing the force exerted on the flap to decrease as the flap is raised and the spring is expanded by downward swinging of the flap arm.

26. In a high lift wing having a vertically swingable wing flap pivotally mounted on the wing, an elastic member connected at one end to the flap and extending forwardly therefrom and connected at its forward end to the wing at a location spaced forwardly from the flap, said elastic member exerting a force continuously tending to swing the flap downwardly, the relation between the points of connection of said member to the flap and to the wing and the pivotal axis of the flap, being such that the force exerted by such elastic member on the flap decreases as the flap is raised from downwardly swung positions.

27. In a high lift wing having a vertically swingable wing flap automatically actuated by variations in the airflow pressures acting thereon, means for raising said flap and releasably securing the same in raised position against vertical swinging, the said flap raising and securing means including a pilot controlled operating mechanism, and a flap raising cable system operatively connecting the flap with said operating mechanism.

28. In a high lift wing having an automatically operating vertically swingable wing flap, means for raising said wing flap and releasably securing the same in raised position against vertical swinging, the said flap raising and securing means including a pilot controlled operating mechanism, operative connections between said mechanism and the wing flap, and means associated in the operating mechanism for releasing the flap from raised position for immediate resumption of automatic operation.

29. In a high lift wing having an automatically operating vertically swingable wing flap, means for releasably securing said flap in normal raised position against automatic operation, and means operatively associated with said flap for absorbing shock upon release of the flap from raised position.

30. In a variable lift wing having an automatically operating vertically swingable wing flap member, means applying forces to said flap tending to swing the flap downwardly, mechanism for releasably securing the flap in raised position against said force applying means, and means associated with the flap for absorbing shock upon release of the flap from raised position by said securing mechanism.

31. In a high lift wing having a wing flap pivotally mounted thereon for vertical swinging and forming a portion of the wing under surface, an aileron mounted for vertical swinging on the wing above said flap and held against downward swinging by the flap when the flap is in raised position, aileron operating mechanism, and a yielding connection operatively coupling said mechanism with the aileron, said yielding connection raising said aileron to upwardly swung lateral control position by said mechanism but yielding when the mechanism is actuated to swing the aileron downwardly.

32. In a wing, an under flap member, an aileron substantially above the flap member and mounted for vertical swinging, and control mechanism operatively associated with said aileron, said mechanism including means for positively swinging the aileron upwardly and yieldingly swinging the aileron downwardly.

33. In a variable lift wing, a vertically swingable automatically operating wing flap at the under side of the wing, an aileron vertically swingably mounted on and forming a portion of the wing upper surface above said flap, and control mechanism for vertically swinging said aileron, down swinging of said aileron cooperating with said flap to cause increase in wing lift.

34. In a variable lift wing, a vertically swingable wing flap forming a portion of the wing under surface, an aileron pivotally mounted on the wing for vertical swinging above said flap, the pivotal axis of said aileron located to the rear of the flap axis, and control mechanism for vertically swinging said aileron, said mechanism including means positively swinging the aileron upwardly and yieldingly swinging the aileron downwardly.

35. In a wing, said wing formed with recesses in the rear upper surface thereof, an aileron pivotally mounted in each of said recesses for upward swinging therefrom but held against downward swinging from normal lowered position therein, and control mechanism operatively coupled with said

ailerons for swinging either of said ailerons upwardly, said mechanism including a yielding connection with each aileron which gives upon actuation of the mechanism tending to lower the aileron when the opposite aileron is swung upwardly.

36. In a lateral control system for aircraft, opposite control surfaces each mounted for upward swinging to and from a predetermined substantially neutral position and each held against downward swinging below such predetermined position, operating mechanism for said control surfaces, including a connection to each control surface, said connections simultaneously differentially actuated, and means in each connection which yields upon actuation of a connection to lower its respective control surface below the predetermined position therefor, as the opposite control surface is simultaneously, positively swung upwardly by its connection.

37. In a lateral control system, a wing, opposite ailerons pivotally mounted on the wing for upward swinging, stop means engaged by each aileron to positively limit the degree of downward swinging of the ailerons from substantially neutral positions thereof, aileron operating mechanism operatively coupled with said ailerons for simultaneously differentially actuating the same, and said operating mechanism including a yielding connection with each aileron which yields when the mechanism is actuated to swing an aileron downwardly against said stop means, upon simultaneous upward swinging of the opposite aileron by said mechanism.

38. In a wing, an under flap member, an aileron substantially above the flap member and mounted for vertical swinging and control mechanism operatively associated with said aileron, said mechanism including means for positively swinging the aileron upwardly to control position.

39. A wing provided with recesses in the upper surface thereof, ailerons pivotally mounted in said recesses, respectively, for upward swinging therefrom but held against downward swinging from normal lowered position therein, and pilot control mechanism operatively coupled with said ailerons for positively swinging either of said ailerons upwardly, said mechanism including means whereby either aileron is caused to remain substantially without movement from normal lowered position upon actuation of the mechanism to swing the opposite aileron upwardly.

40. A wing, ailerons pivotally mounted thereon for upward swinging relative thereto but held against downward swinging from normal lowered position, and pilot control mechanism operatively coupled with said ailerons for positively swinging either of the said ailerons upwardly, said mechanism in-

cluding means whereby either aileron is maintained substantially without movement from normal lowered position upon actuation of the mechanism to swing the opposite
5 aileron upwardly.

Signed at Rochester, Monroe County, New York, this 26th day of July, 1930.

RANDOLPH F. HALL.