W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 1.

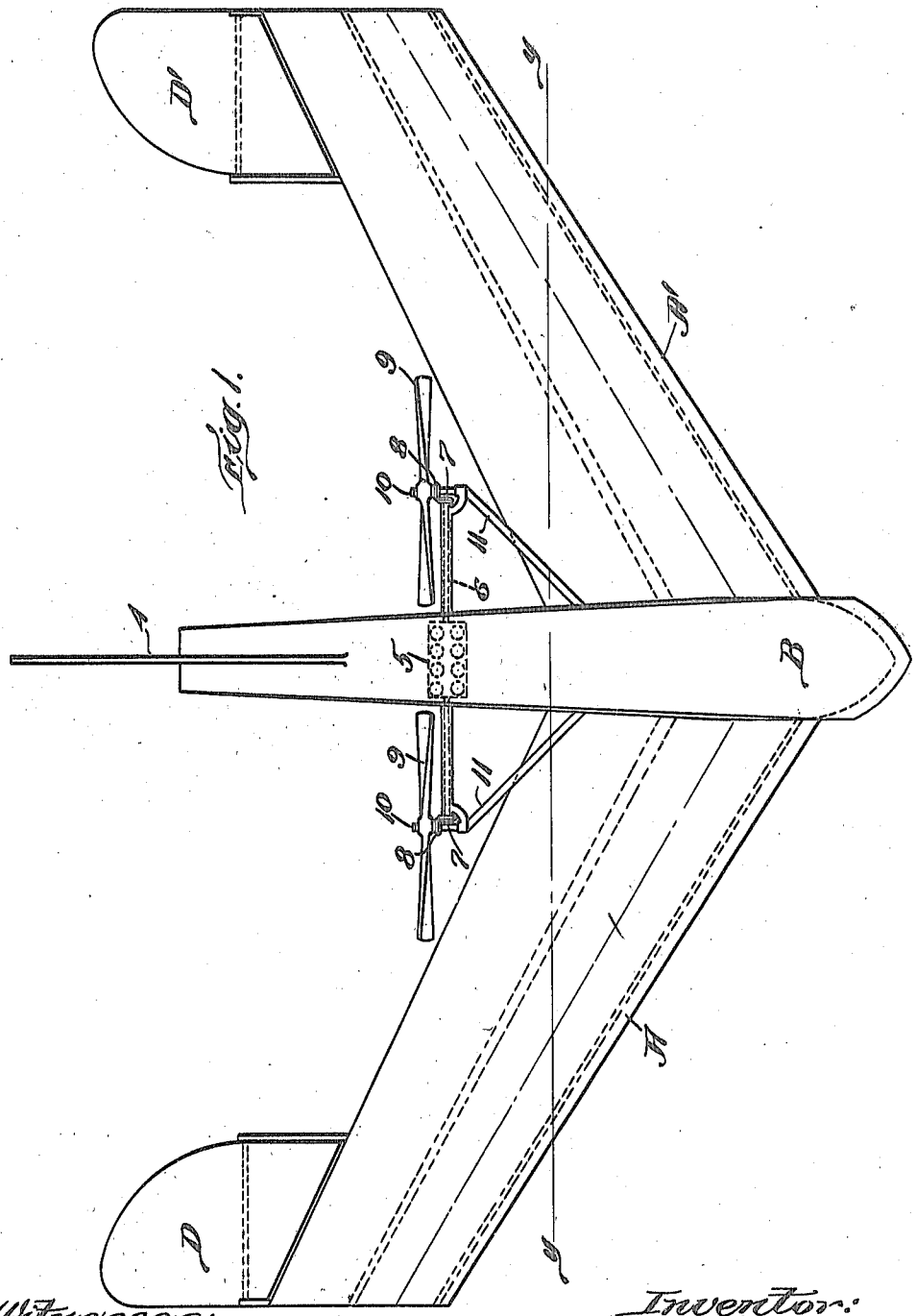


Fig. 1.

Witnesses:
Willard N. Gilman.
Roy M. Hill

Inventor:
William Stevens
by Nathan F. Randall
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 2.

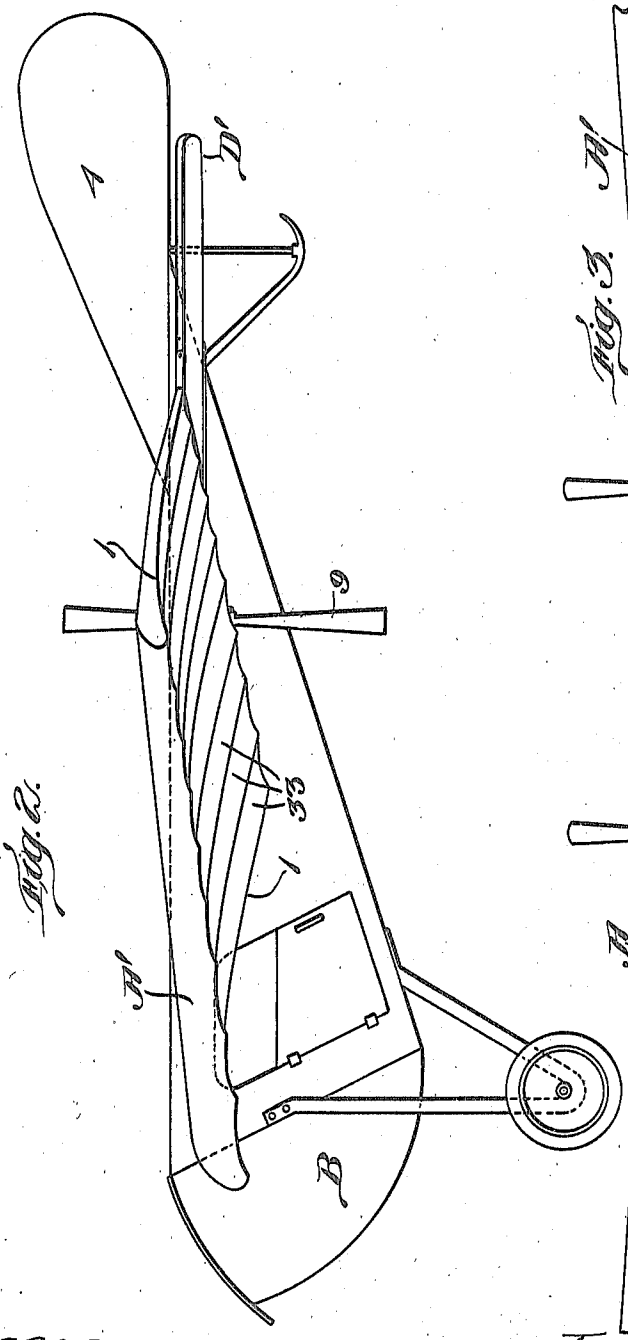


Fig. 2.

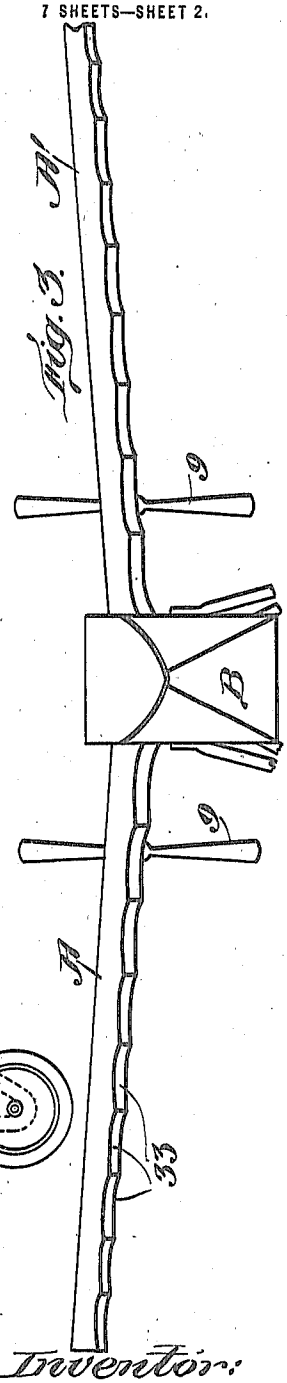


Fig. 3.

Witnesses:
Willard N. Gilman
Roy M. Hill.

Inventor:
William Stevens
By Arthur F. Randall
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 3.

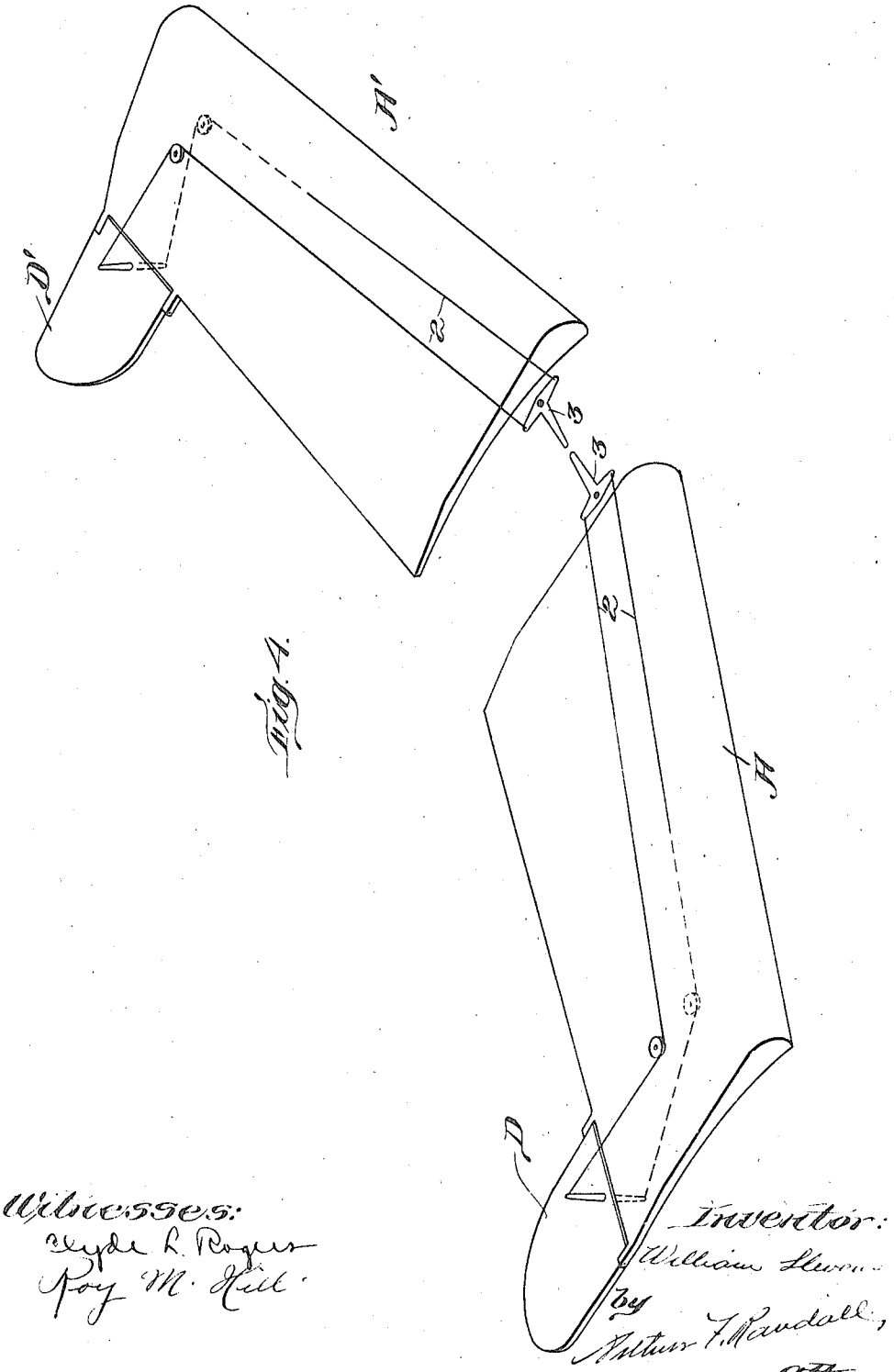


Fig. 4.

Witnesses:
Clyde L. Rogers
Roy M. Hill.

Inventor:
William Stevens
By
Arthur F. Randall,
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 4.

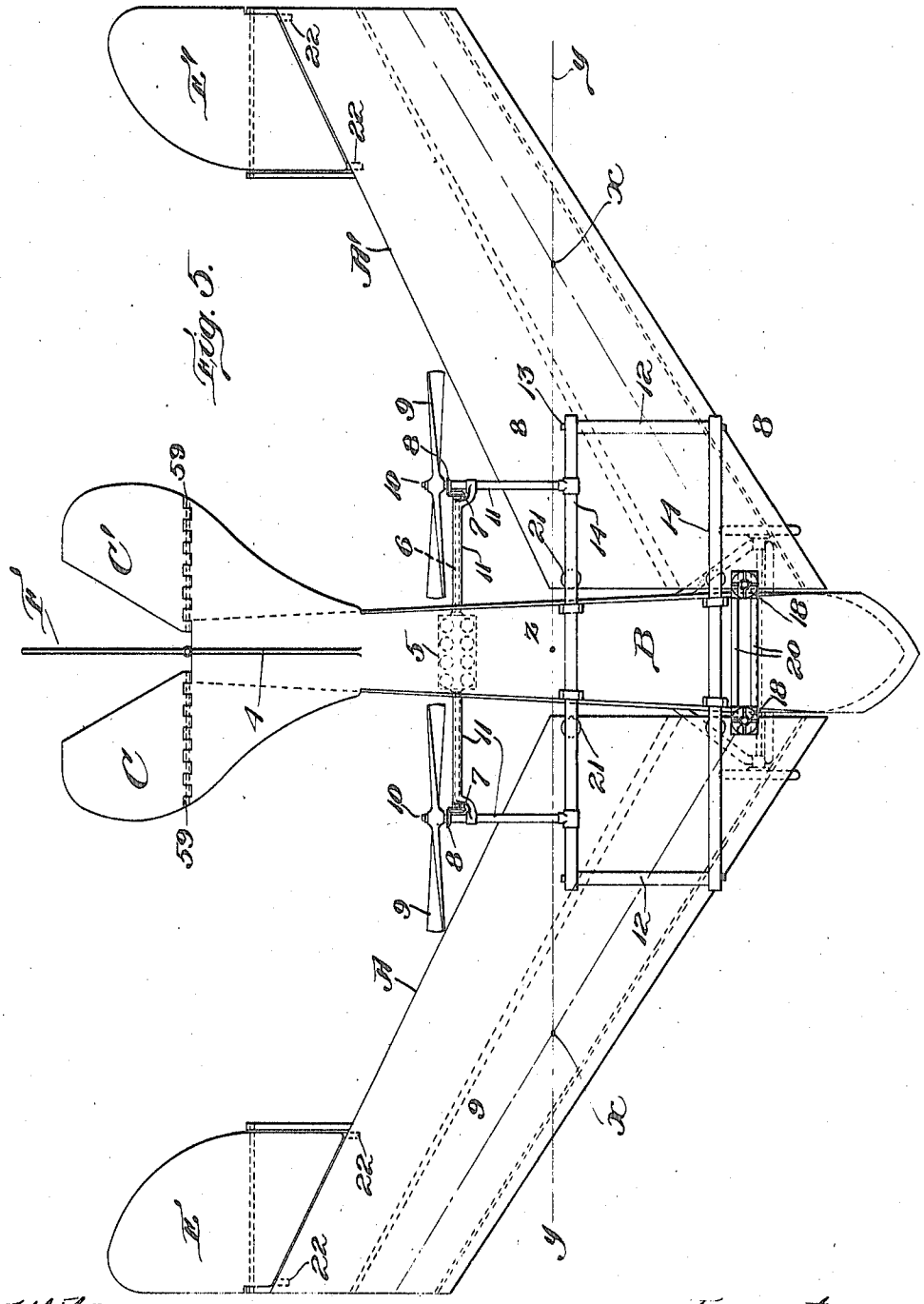


Fig. 5.

Witnesses:
Willard W. Gibbons.
Roy M. Hill

Inventor:
William Stevens
by Wilbur F. Randall
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 5.

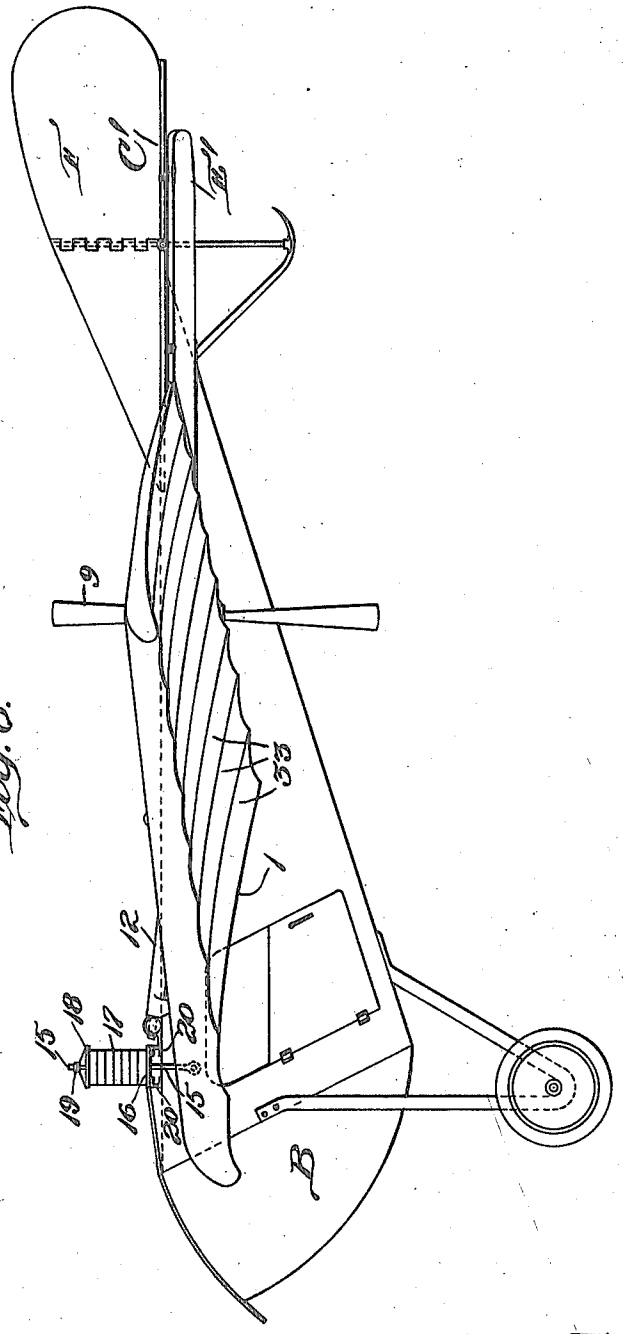


Fig. 6.

Witnesses:
Willard N. Gilman.
Roy M. Hill

Inventor:
William Stevens
by Wilton F. Randall
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 6.

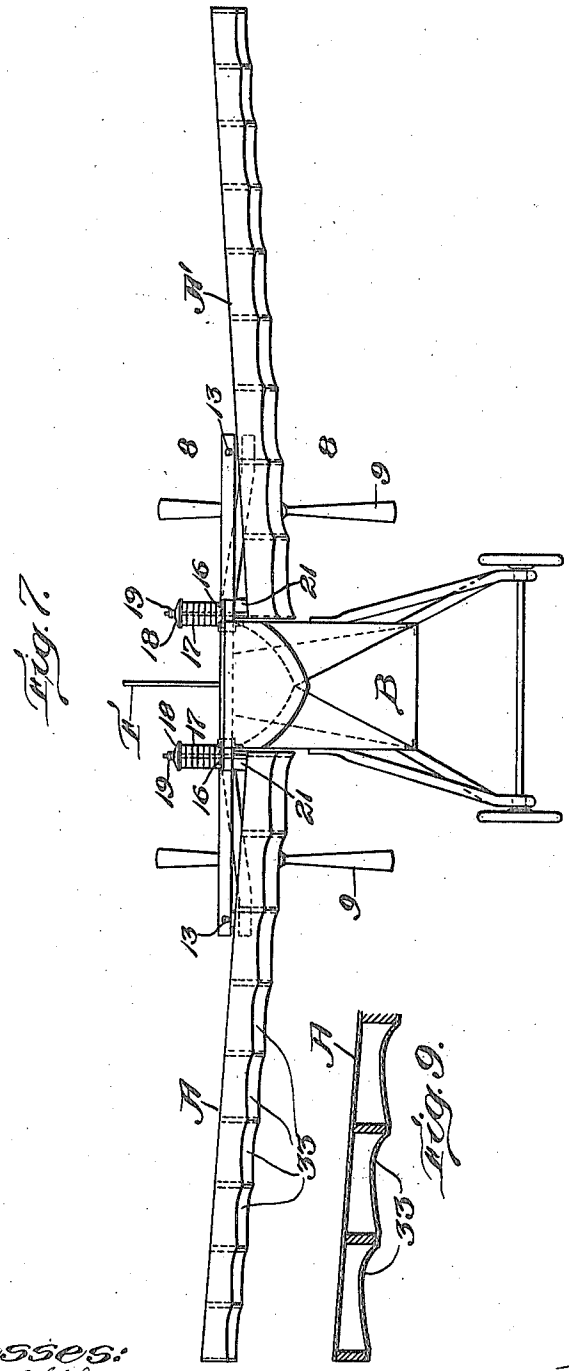


Fig. 7.

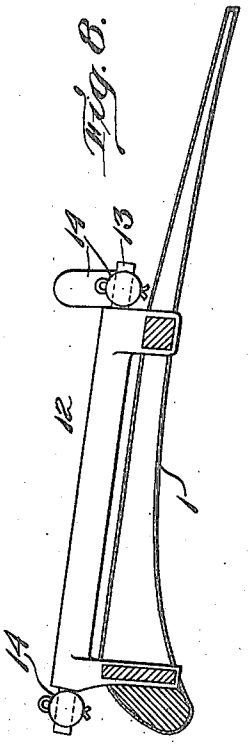


Fig. 8.

Fig. 9.

Witnesses:
Willard N. Fishman
Roy M. Hill

Inventor:
William Stevens
By William F. Randall
Atty.

W. STEVENS.

AEROPLANE.

APPLICATION FILED NOV. 14, 1913.

1,184,890.

Patented May 30, 1916.

7 SHEETS—SHEET 7.

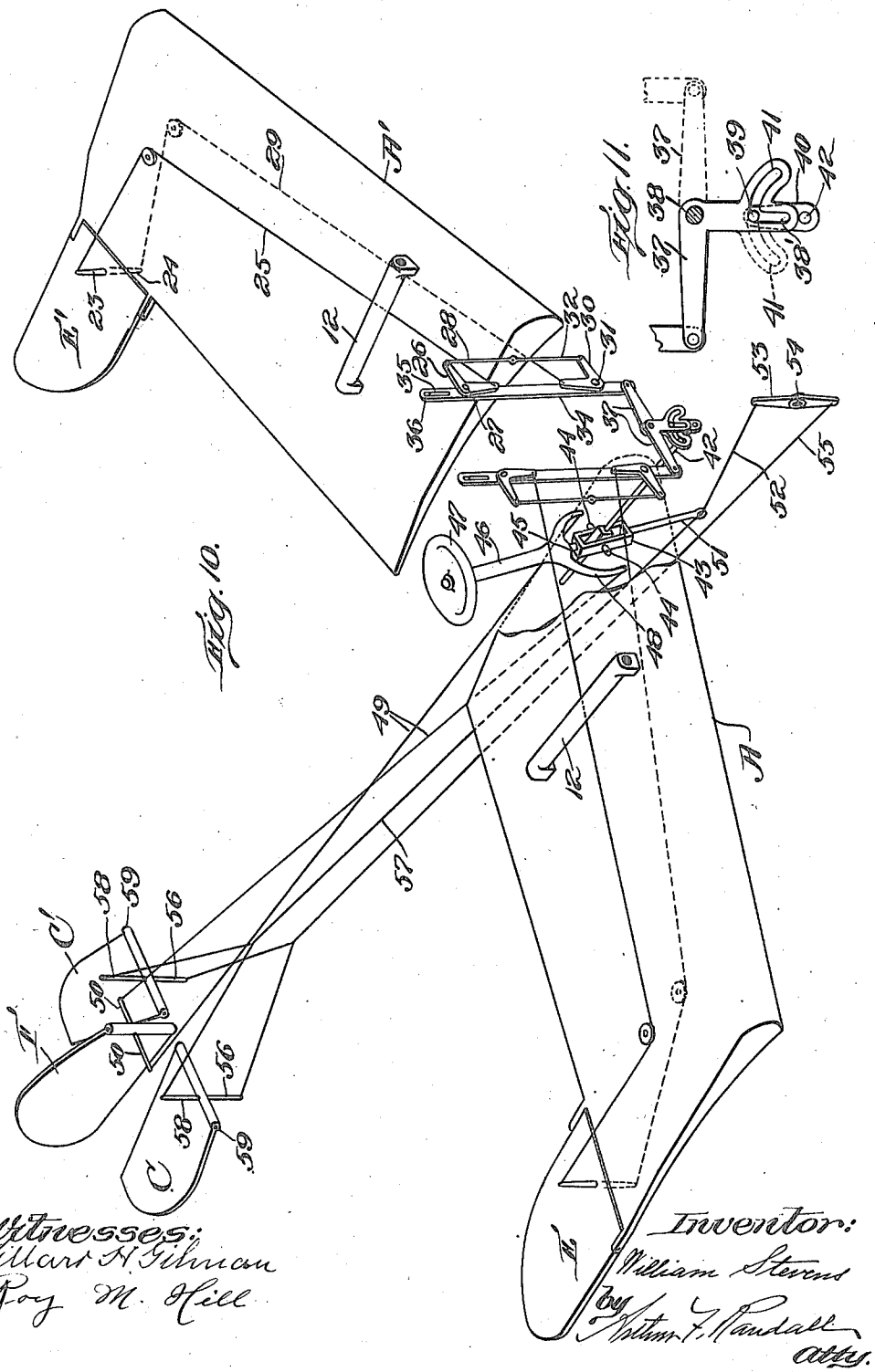


Fig. 10.

Fig. 11.

Witnesses:
Willard H. Gilman
Roy M. Hill

Inventor:
William Stevens
by Wilton F. Randall
Atty.

UNITED STATES PATENT OFFICE.

WILLIAM STEVENS, OF BOSTON, MASSACHUSETTS.

AEROPLANE.

1,184,890. Specification of Letters Patent. Patented May 30, 1916.

Application filed November 14, 1913. Serial No. 800,913.

To all whom it may concern:

Be it known that I, WILLIAM STEVENS, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Aeroplanes, of which the following is a specification.

My invention relates to aeroplanes and it has for its object to provide an improved flying machine of this class.

The invention consists of the novel features of construction and mode of operation set forth in the following description and particularly pointed out and defined in the claims at the close thereof.

Figure 1 is a plan view of an aeroplane embodying one form of my invention. Fig. 2 is a side view of the machine shown in Fig. 1. Fig. 3 is a front view, on smaller scale, of the machine shown in Fig. 1. Fig. 4 is a diagrammatic perspective view illustrating the control for the machine shown in Figs. 1, 2 and 3. Fig. 5 is a plan view of an aeroplane embodying other features of my invention. Fig. 6 is a side view of the aeroplane shown in Fig. 4. Fig. 7 is a front view of the aeroplane shown in Fig. 4. Fig. 8 is a section fore and aft through one of the wings. Fig. 9 is a sectional view of a portion of one of the wings taken longitudinally thereof near the tip. Fig. 10 is a diagrammatic perspective view showing the control for the machine shown in Figs. 5, 6 and 7. Fig. 11 is a detail of part of the control shown in Fig. 10.

In Figs. 1, 2 and 3 the two wings A and A′ are rigidly connected with the body B near the front end of the latter and each not only extends outwardly from the body but, diagonally rearward also. Each wing is made concaved on its under side throughout its length from body to tip, and this concaved under surface 1 is formed, longitudinally of the machine, on a parabolic curve such as is shown in Fig. 8. That is to say, any cross-sectional view of the wing taken at any point between the body and the tip in a direction longitudinally of the machine presents a parabolic concaved under surface which, in order to provide for the necessary "lift," I arrange or dispose so that its chord sets at a positive incident flying angle as usual which may be of three degrees, or thereabout, to horizontal when the machine occupies its normal flying position as shown in Fig. 2. A peculiar and distinguishing feature of my invention is that the two wings A and A′ are secured to the body B so that together they form a positive dihedral angle as viewed from the front of the machine, Fig. 3, the inner end of each wing being lower than the outer end thereof. As herein shown this rearward upward slope is arranged at about an angle of five degrees to horizontal when the machine occupies its normal flying position. The dihedral angle formed by the two wings together insures marked lateral stability, while the diagonal disposition of the two wings as viewed in plan and their relation to the center of gravity of the machine which is in the plane *y*—*y*, Fig. 1, affords a degree of longitudinal stability which is greatly enhanced by the upward slope of the wings toward the rear. This upward slope of the wings toward the rear together with their positive incident flying angle provides a composite positive dihedral angle at each side of the body extending fore and aft, that is longitudinally, which affords great stability in that direction. In other words the wings are shaped and disposed so that the two wings jointly provide a lateral stabilizing positive dihedral angle while at the same time the positive incident angle of each wing is combined with the upward and rearward slope thereof to produce a positive longitudinal composite stabilizing dihedral angle in each wing.

Heretofore flying machines of this class have been constructed so that their wings formed a lateral positive dihedral stabilizing angle but so far as I am aware I am the first to construct and dispose the wings so that while flying each presents a positive longitudinal stabilizing dihedral angle without at the same time causing the negative or rear side of said longitudinal angle to produce a negative drag. Also so far as I am aware I am the first to provide a construction wherein the same slope of the wings which makes the lateral positive dihedral stabilizing angle also produces the longitudinal stabilizing positive dihedral angle. The reason no negative drag is produced is because each wing not only slopes upward but also extends diagonally across the wind so that when the machine is in flight the wind passes diagonally across the top of the wing without being at all opposed by the up slope

which forms the negative side of the composite dihedral angle of each wing because of the positive incident angle presented by all parts of the wing to the wind. This will be clear from Fig. 8.

When flying horizontally the front edge of the parabolic wing swirls the wind upward under the wing throughout the length of the latter and causes it not only to produce the necessary lift but also to act from below against the rear side of the longitudinal composite dihedral angle, or in other words against the slope of the wing, in a direction to assist the forward progress of the machine owing to the fact that there is, as is the case with all aeroplanes, a region of compression under the wing produced by the positive angle of incidence, and this region of compression, with my machine, is of wave like form conforming to the slope of the wing which is the rearward side of the longitudinal positive dihedral angle. This region of compression exists at all times along this slope, while the machine is aloft, and in my machine the slope of the wing is acted upon by said region of compression in a manner due to the direction of this slope to urge the machine forward when flying under power and to compel the machine to descend in a forward direction in the event that it becomes powerless while aloft. Thus the elevating rudders C and C′ of the machine shown in Figs. 4 to 10, or the wing flaps D and D′ of the machine shown in Figs. 1, 2 and 3, will not be resorted to to maintain fore and aft equilibrium to the extent that has heretofore been necessary, with a corresponding lessening of drag and a corresponding increase of speed as the result.

When, with either form of machine herein shown, the power is shut off during horizontal flight, gravity tends to cause the machine to descend against the air beneath it, thus in effect producing an upward wind and the region of compression referred to, which acts in the manner just described. Heretofore, under these circumstances, the upward wind acted only upon the positive incident angle of the wings with the result that it tended to force the machine rearward as it descended. This has been a feature of the constructions heretofore proposed which has been highly objectionable because of its resulting in many fatal accidents through falling backward, particularly when the machine became powerless while ascending. In my machine, while the positive incident angle is acted upon by the upward wind as heretofore, the region of compression simultaneously acts upon the slope of the wings in a manner to oppose the rearward action of the upward wind on the positive incident angle and thereby prevent the machine being forced backward on a downward curve as heretofore. Thus should my machine become powerless while aloft, or while ascending, the opposing effects of the wind on the positive incident angle of each wing, and on the sloping under surface thereof, automatically maintain the machine in its proper normal flying position as it descends, compelling it to descend in a forward direction in its normally balanced condition. It will be clear, therefore, that these two elements, viz., the positive incident flying angle and the upward slope, coöperate at all times to automatically control the longitudinal balance or equilibrium of the machine and to prevent rearward falling movement.

In the event that either machine herein shown becomes powerless while flying against a strong head wind the longitudinal composite dihedral angles of the wings will hold the machine balanced longitudinally while the lifting effects of the wind on the wings will, if the wind be sufficiently strong, counterbalance the weight of the machine or lift it. If, under these circumstances, the wind is not strong enough to produce sufficient lift to support the weight of the machine, then the latter will be compelled to glide downward in a forward direction while the longitudinal composite dihedral angle maintains the machine balanced longitudinally.

Since each diagonal wing is formed with a parabolic concaved under surface there will exist, when either machine is in flight, a center line of pressure extending lengthwise of the wing along the deepest part of the parabola, and about midway of the length of this center line of pressure there is a point, indicated at x, which I call the "focal" point of the wing. The two focal points of the wings are in the same vertical transverse plane y—y with the center of gravity z of the machine when the latter is in flight, and the wings are so constructed and disposed that with a uniformly distributed wind impinging on each wing the wind pressure and lift on that portion of each wing forward of its focal point x, that is, in front of plane y—y, is the same as the wind pressure and lift on that portion of the wing to the rear of the focal point x, or to the rear of plane y—y. It will thus be seen that so far as the center of gravity is concerned the lift due to the incident angle when the machine is flying under power, and the upward pressure on the wing occasioned when descending powerless, is equally distributed to the front and rear thereof so that the wind pressure in either case does not tend to disturb the longitudinal balance of the machine. Further, it will be clear that with the machine balanced in this fashion with respect to the focal points of the wings and its center of gravity, the incline of the top of the region of compressed air on which each sloping wing rides will

compel the machine to move forward as it descends when it becomes powerless while aloft thus preventing its descending tail first.

The rigidly connected wings of the machine shown in Figs. 1, 2 and 3 may be provided at the rear of their outer ends with pivoted control flaps D and D′ adapted to be swung into positive or negative angles with relation to the wind to steer the machin both laterally and vertically. These flaps D and D′ are connected by wires or the like 2 with control members 3 that are manually operated by the aviator. No other rudders than the flaps D and D′ are necessary with this form of my invention but it is desirable to provide the rear portion of the body B with a vertical keel 4.

In both forms of my invention herein shown the motor 5 is mounted within the body B with its crank shaft 6 crosswise of the axis of the latter and extending to the outside of said body. At each end shaft 6 carries a bevel gear 7 that drives a bevel gear 8 connected with a propeller 9. The propellers 9 are mounted on studs 10 carried by extensions 11 forming part of the frame of body B.

In the form of my invention shown in Figs. 5 to 11, inclusive, each wing A and A′ has secured to it near its inner end an upwardly extending bracket 12 which is pivotally secured by means of a pintle 13 to a pair of transverse bars 14 rigidly secured to the body B. Also to the inner end of each wing there is pivoted the lower end of the stem 15, Fig. 6, which extends upwardly through a plate 16 and a series of rubber washer springs 17 to a head 18 adjustably secured to said stem by means of nuts 19. The washers 17 are supported by the plate 16 which rests upon and is secured to two transverse bars 20 fastened to the frame of the body B. The washers 17 serve as springs to yieldingly hold the inner ends of the two wings against stops 21 secured to the under sides of the bars 14. The wings A and A′ are provided, respectively, with flaps E and E′, each of which is made with stops 22 which engage with the under side of their wing to hold the flap against movement into a positive angle with relation to the wind so that said flap can only be shifted from a position parallel with the wind upwardly into a negative angle, or vice versa.

As shown in Fig. 10 each flap E and E′ is provided with arms 23 and 24, the former connected by a wire 25 or the like with one arm of a bell crank 26 fulcrumed at 27 and having its other arm connected by a cord or wire 28 with the inner end of the wing of said flap. The other arm 24 of each flap is connected by a wire 29 or the like with one arm of a bell crank 30 fulcrumed at 31 and having its other arm connected by a cord or wire 32 with the inner end of the wing of said flap. When the outer end of either wing is swung upward on its pintle 13 as hereinafter described, the downward movement of the inner end of the wing acts through connection 28, bell crank 26, connection 25 and arm 23 to swing the flap upward into a negative angle and at the same time slack is given to the connections 32 and 29 through this downward movement of the inner end of the wing to permit of this movement of the flap. When the outer end of the wing swings down on pintle 13 to its normal position again the flap is returned to its normal position through the upward movement of the inner end of the wing acting through connection 32, bell crank 30 and connection 29. It will thus be seen that so long as either wing occupies its normal position the control just described holds the flap of that wing parallel with the wind but that said flap is automatically shifted into a negative angle with relation to the wind or returned to its normal position when the wing is swung on its pintle 13.

When during flight under power either wing receives more wind pressure than the other it is swung on its pivot sufficiently to throw the flap E or E′ of that wing into a negative angle relatively to the wind thus causing the flap to oppose upward movement of said wing and prevent that side of the machine from being lifted and also causing said flap to restore the wing to its normal position when the wind pressure on the latter returns to normal. Thus when one wing receives more wind pressure than the other the wing flap thereof automatically opposes lifting movement of the wing and thereby automatically maintains the lateral balance of the craft against that excess wind pressure and at the same time makes it impossible for excess pressure concentrated at one or both of the wing tips to lift the rear of the machine, so that said flaps also act automatically to maintain the longitudinal balance of the machine at the same time.

For the normal speed of the machine there is a definite normal wind pressure on the wings for which the springs 17 of the latter are adjusted to hold the wings in their normal positions with the wing flaps neutral, and for continued horizontal flight there is also a definite position of the elevating rudders C and C′. The normal positions of the wing flaps and the elevating rudders will be parallel with the direction of flight.

When during flight under power both wings receive a sudden increase of wind pressure the rear ends of said wings will be lifted relatively to the body thereby increasing the slope of the wings, which tends to cause the machine to point downward, but simultaneously with this movement of the wings the flaps E and E′ thereof are auto-

matically shifted into proportionate negative angles of incidence so as to produce a negative drag which counteracts this tendency of the machine to dive when subjected to a sudden increase of wind pressure in this fashion. The wings and flaps will act automatically in this fashion when the increased pressure is due to a sudden gust applied to any portion of the wings outside of their pivots from any direction which affects both wings simultaneously, except when applied from above upon the rear portions of the wings. In the latter case the effect is the same as a preponderance of pressure upon the front portions of the wings acting from below. This is due to the relation of the center of gravity to the "focal" points of the wings. When the flaps E and E′ are shifted out of normal positions, their negative angles produce a negative drag at the rear of the wings, which counteract the tendency of the rear of the machine to lift relatively to the front end and serves to maintain the longitudinal equilibrium of the machine as a whole.

Should the machine shown in Fig. 5, etc., become powerless while in flight and start to sink, the upward wind pressure on the wings will increase above normal and lift the wings relatively to the body B. This movement of the wings increases their slope and thereby increases the effect of said slope upon the direction of movement of the machine with the result that the latter will tend to glide forward as gravity causes it to descend this preventing rearward movement and producing a speed checking lift. At the same time this upward movement of the wings shifts the wing flaps E and E′ into negative positions thus counteracting the tendency of the machine to dive under the influence of the increased angle of the slope so that in falling the machine will descend in a series of volplanes. That is, whenever the forward speed of the machine reaches a definite rate where the pressure on the wings exceeds normal, the flaps will be operated and produce sufficient negative drag to the rear of the center of gravity to right the machine and check its descent after which it will again automatically point downward until its speed reaches that point again whereupon the checking action of the flaps will be repeated.

Assuming a normal, uniformly distributed and unvarying degree of wind pressure on the wings and the wing flaps E and E′ as occupying their normal positions, the wind pressure effects on that part of each wing back of the focal point will be the same as on that part of the wing in front of the focal point because of the fact that the areas of these two parts of each wing are made to be the same, and so long as this condition exists the machine will proceed horizontally under power without any alteration in the positions of its parts. Under these conditions any increase in the speed of the machine which would be the same in effect as an increase in the wind would only tend to cause the machine to ascend without disturbing its longitudinal balance.

A current of air striking a surface like the surface of a wing tends to spread laterally and in the case of an aeroplane wing of the kind described the lateral movement of the air is considerable, particularly toward the outer end of the wing. Heretofore only the movement of the air across the wing from front to rear has been utilized for producing lift. In accordance with my invention, however, I utilize the lateral movement of the air after it strikes the wing to produce additional lift by forming upon the concaved under surface of each wing a plurality of relatively small curved surfaces or cells 33, preferably parabolic in form, extending more or less crosswise of, or at right angles to, the main parabolic curve 1 of the wing. These supplemental parabolic surfaces are herein shown disposed with their greatest depth of camber nearest the body of the machine so as to act upon the laterally spreading air to exert a lifting force in addition to that exerted by the main longitudinal parabolic curve 1. In other words the main parabolic concaved under surface of each wing is formed with crosswise parabolic corrugations 33 which supplement the lift produced by the main parabolic curve through the action thereon of the laterally spreading air as it strikes the wing.

In addition to the elevating rudders C and C′ I provide a vertical rudder F for directing the machine laterally.

By making the flaps E and E′ so as to occupy only negative angles of incidence I avoid the necessity of operating the vertical rudder F to maintain the lateral balance of the machine when either of the flaps E or E′ is thrown into a negative position.

The fulcrums 27 and 31 of each pair of bell cranks 26 and 30 are herein shown as carried by a vertically movable slide 34 made at its upper end with a slot 35 to receive a guide pin 36 on the frame of the machine, and pivotally connected at its lower end to one arm of a bell crank lever 37 fulcrumed at 38 on the frame of the machine. The depending arms of the bell cranks 37 are formed with slots 38′ into both of which extends a pin 39 carried by an arm 40. Each slot 38′ has a straight portion disposed radially with respect to fulcrum 38 and a curved portion 41 concentric with relation to the axis of a shaft 42 on which arm 40 is fixed. The curved portions 41 are oppositely disposed relatively so that by swinging arm 40 and pin 39 sidewise in one direction or the other either bell crank can be

operated independently of the other. The shaft 42 extends rearwardly through a yoke 43 which is pivotally mounted on trunnions 44 projecting from shaft 42. The yoke 43 has an upwardly extending spindle 45 on which is rotatably mounted a sleeve 46 made hollow to receive said spindle and carrying a hand wheel 47 at its upper end. It will thus be seen that sleeve 46, spindle 45 and yoke 43 can be swung bodily fore and aft on trunnions 44 or that sleeve 46 can be independently rotated on spindle 45. Also by swinging sleeve 46 sidewise the operator can rock shaft 42 in its bearings to vibrate arm 40 and thereby operate either bell crank 37. When either bell crank 37 is thus operated its slide 34 is moved vertically carrying with it the fulcrums 27 and 31 of bell cranks 26 and 30 thereby manually producing the same relative movement between the bell cranks 26 and 30 and their wing as is produced by automatic movement of the wing on its pintle 13. It will thus be clear that the flaps E and E′, although automatically controlled and operated by their wings, can at any time be manually operated.

The lower end of sleeve 46 is made with two depending arms 48 whose lower ends are in line with the axis of trunnions 44. To said lower ends is connected the forward ends of cords or wires 49 which are connected at their rear ends to a pair of arms 50 forming part of vertical rudder F. By partially rotating sleeve 46 on post 45 rudder F may be swung sidewise to steer the machine laterally.

Projecting downwardly from yoke 43 is an arm 51 connected by a cord or wire 52 with one arm of a lever 53 fulcrumed at 54 on the body B. The other arm of this lever 53 is connected by a cord or wire 55 with two depending arms 56, one of which forms part of horizontal rudder C, and the other part of horizontal rudder C′. The lower end of arm 51 is also connected by a cord or wire 57 with two upwardly extending arms 58, one of which forms part of horizontal rudder C and the other of horizontal rudder C′. By swinging the control member made up of parts 43, 45, 46, 47 and 51 fore and aft on trunnions 44 said member will act through the connections just described to swing the rudders C and C′ up and down on their pivots 59 to direct the course of the machine vertically. The lower ends of the arms 48 are arranged in line with the axes of trunnions 44, as above described, so that when the control member is swung fore and aft on said trunnions its movement in this direction will not disturb the connections between said control member and rudder F.

The control above described is of the so-called "instinctive" type and is, I believe, more of this character than others heretofore proposed. If one side of the machine rises higher than the other side the operator will instinctively swing the control member sidewise in the direction of the high side thereby lifting the flap E or E′ of said high side and causing said flap to return the higher wing to its proper position, the operator instinctively returning the control member to its neutral position as the lateral balance of the machine is restored. Should the machine tend to descend or dive the operator instinctively checks it by backward movement of the control member on trunnions 44. So also, should the machine tend to ascend the operator instinctively checks it by forward movement of the control member on trunnions 44. In directing the machine toward the left the operator rotates wheel 47 in a left hand direction, and toward the right by rotating said wheel in a right hand direction.

What I claim is:—

1. An aeroplane comprising a body; two diagonally disposed wings pivotally connected with the body at their inner ends so that the outer rear end of each wing is movable relatively to said body independently of the other in a direction substantially perpendicular to the direction of flight and having their inner ends disposed forward of the center of gravity of said body and their outer ends disposed to the rear of said center of gravity; means yieldingly holding the wings in their normal positions, and means for controlling the direction of flight.

2. An aeroplane comprising a body; two diagonally disposed wings each comprising a rigid frame pivotally connected near its inner end with the body so as to be independently movable relative to said body, and each wing normally sloping upward toward the rear with their inner ends forward of the center of gravity of the body and their outer ends to the rear of said center of gravity; means yieldingly holding each wing against swinging upward from its normal position whereby the slope of the wing is controlled and varied by the air pressure thereon, and means to control the direction of flight.

3. An aeroplane comprising a body; two diagonally disposed wings each comprising a rigid frame pivotally connected near its inner end with the body so as to be independently movable relative thereto; means yieldingly holding each wing in its normal position; lateral and longitudinal stabilizing means movably mounted on each wing and controlled by movement of the latter relative to the body, and means for controlling the direction of flight.

4. An aeroplane comprising a body; two diagonally disposed wings each comprising a rigid frame pivotally connected near its inner end with said body so as to be independently movable relative thereto; means

yieldingly holding each wing depressed in its normal position relative to the body; a stabilizing flap movably mounted upon the outer portion of each wing so as to act both laterally and longitudinally; means through which the movement of each wing relatively to the body operates the flap of said wing, and means for controlling the direction of flight.

5. An aeroplane comprising a body; two diagonally disposed wings, each wing being a rigid structure pivotally connected near its inner end with the body so as to be independently movable relative thereto; and normally sloping upward toward the rear; means yieldingly holding each wing in its normal depressed position relatively to said body; a stabilizing flap movably mounted upon the outer portion of each wing adapted to occupy only neutral and negative positions and to act both longitudinally and laterally upon the machine; means through which the movement of each wing relatively to the body operates the flap of said wing, and means for controlling the direction of flight.

6. An aeroplane comprising a body; two diagonally disposed wings each of which is a rigid structure pivotally connected near its inner end with said body with its inner end disposed forward of the center of gravity of the body and its outer end disposed to the rear of said center of gravity; means yieldingly holding said wings in their normal depressed positions; stabilizing devices mounted on said wings in positions to the rear of the center of gravity of said body and automatically operated by movement of said wings; a rudder for directing the machine up and down, and means connected with the rudder and stabilizing means through which said parts are manually operated.

7. An aeroplane comprising a body; two diagonally disposed wings each pivotally connected with the body so as to be independently movable relative thereto; means yieldingly holding said wings in their normal positions; stabilizing devices connected with and operated by movement of the wings; a rudder for controlling the direction of flight; a single control member, and means connecting the control member with the rudder and stabilizing devices through which the latter are operated by said member with provision for exclusive automatic control of the stabilizing devices by the wings while said member is held stationary.

8. An aeroplane comprising a body; two diagonally disposed wings connected with said body so as to be independently movable relative thereto; said wings sloping upward toward the rear; two normally neutral planes each movably connected with one of the wings near the tip of the latter and adapted to be shifted back and forth from its normal position and a negative position only, and automatic means for operating said planes to maintain lateral and longitudinal balance.

9. An aeroplane comprising a body; two diagonally disposed wings connected with said body and sloping upward toward the rear; two normally neutral planes each movably connected with one of the wings near the tip of the latter and adapted to be shifted back and forth from its normal position and a negative position only, and automatic means for operating said planes to maintain lateral and longitudinal balance.

10. An aeroplane comprising a body; two diagonally disposed flexible wings connected with said body; two normally neutral planes each movably connected with one of the wings near the tip of the latter and adapted to be shifted back and forth from its normal position and a negative position only; means through which said wings automatically operate said planes, and means wherewith to manually operate said planes independentlv of their automatic control by the wings.

11. An aeroplane comprising a wing having an under surface formed with a main parabolic curve whose chord is disposed longitudinally of the machine and with a multiplicity of parabolic curves whose chords are disposed substantially at right angles to the chord of the main parabolic curve.

12. An aeroplane wing having its under surface made up of a multiplicity of compound parabolic cells.

13. An aeroplane wing having its under surface made up of a multiplicity of compound parabolically curved surfaces.

In testimony whereof I have affixed my signature in presence of two witnesses.

WILLIAM STEVENS.

Witnesses:
CLYDE L. ROGERS,
ARTHUR F. RANDALL.