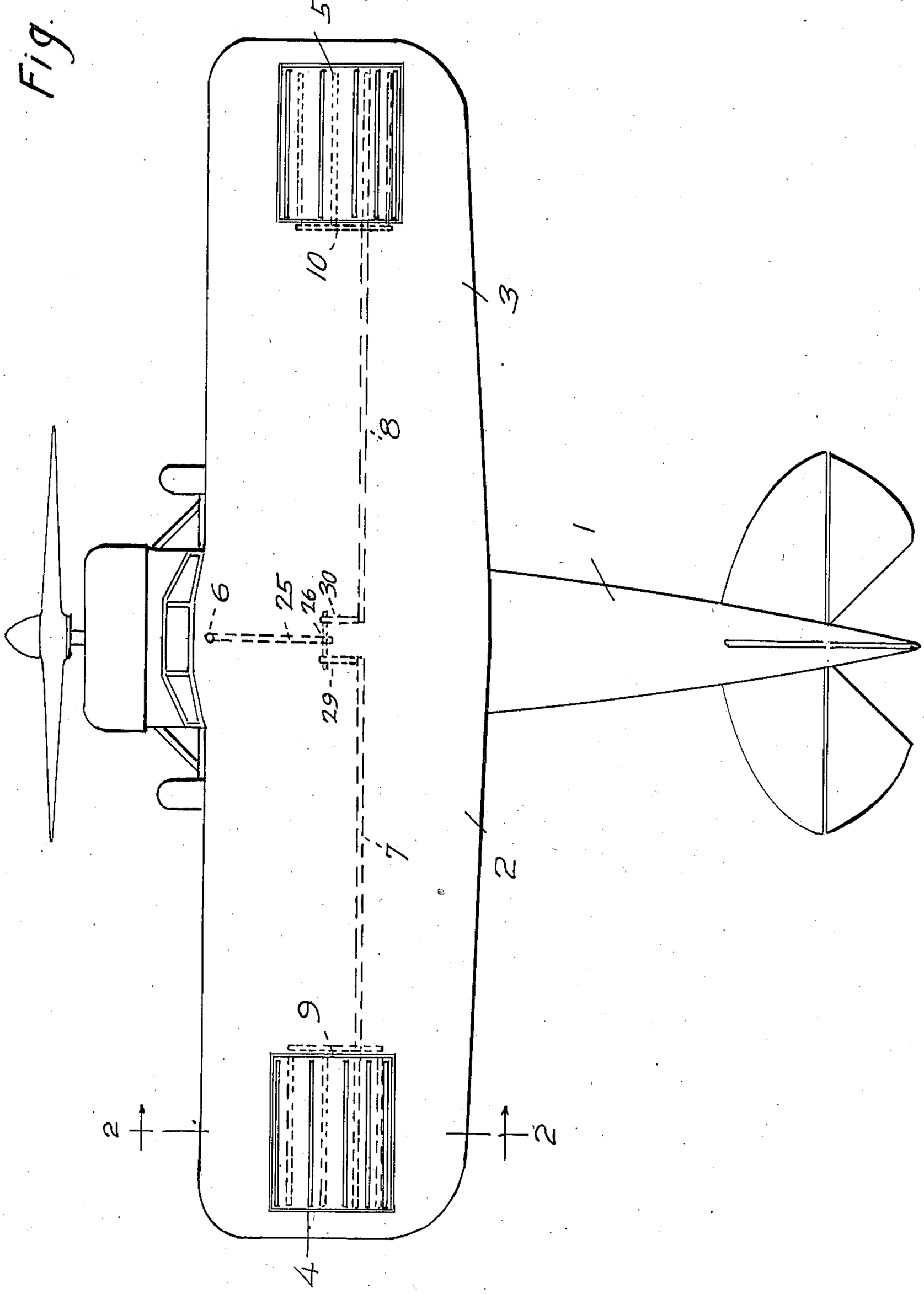
April 13, 1937. W. K. ROSE 2,077,072

AILERON

Original Filed Jan. 15, 1934 4 Sheets-Sheet 1

Fig. 1



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AILERON

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Fig. 2

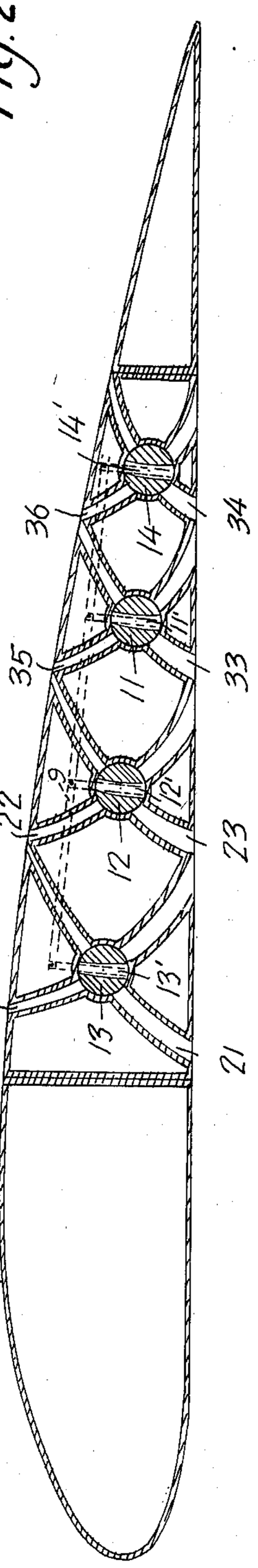
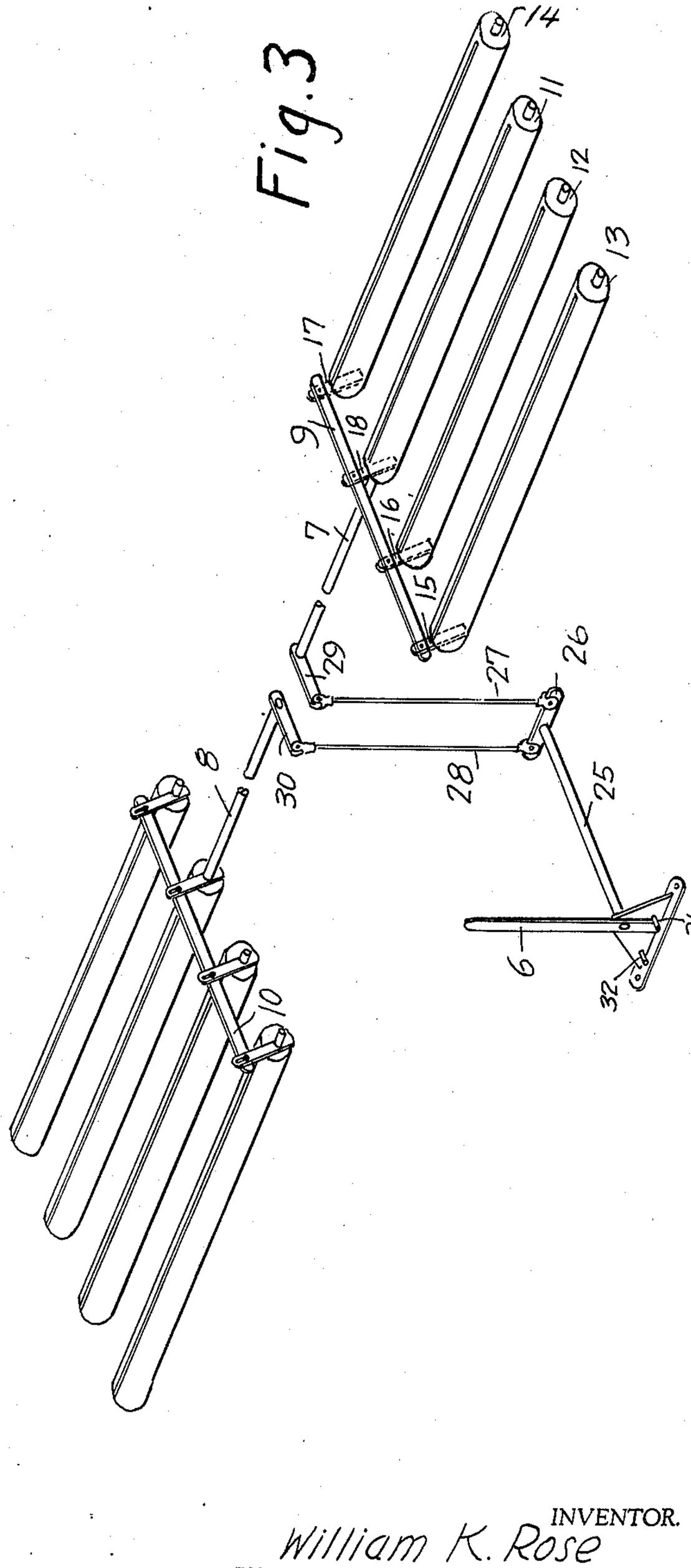


Fig. 3



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AILERON

Original Filed Jan. 15, 1934 4 Sheets-Sheet 3

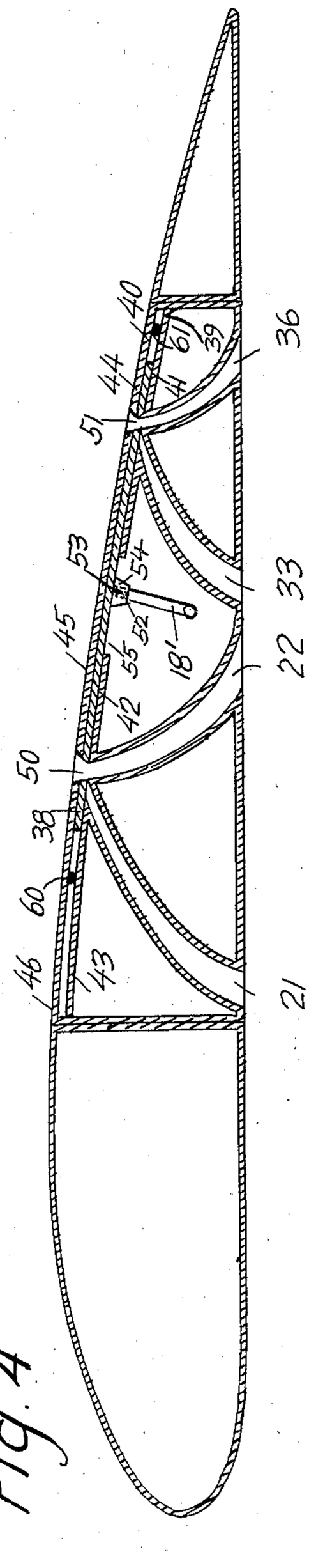

Fig. 4

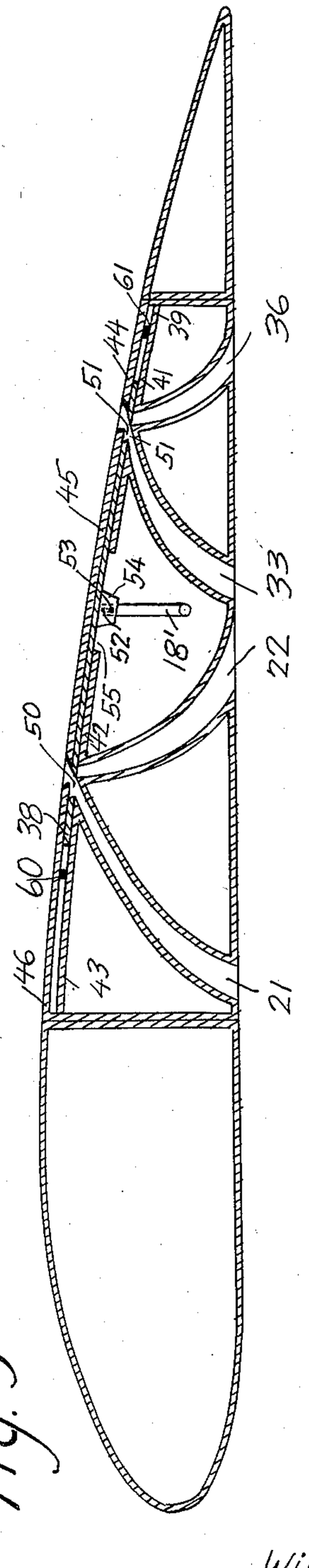

Fig. 5

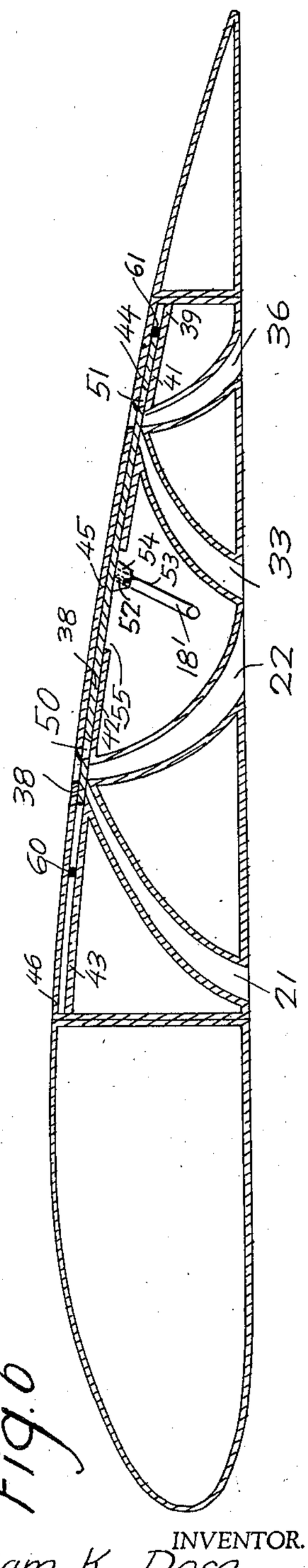

Fig. 6

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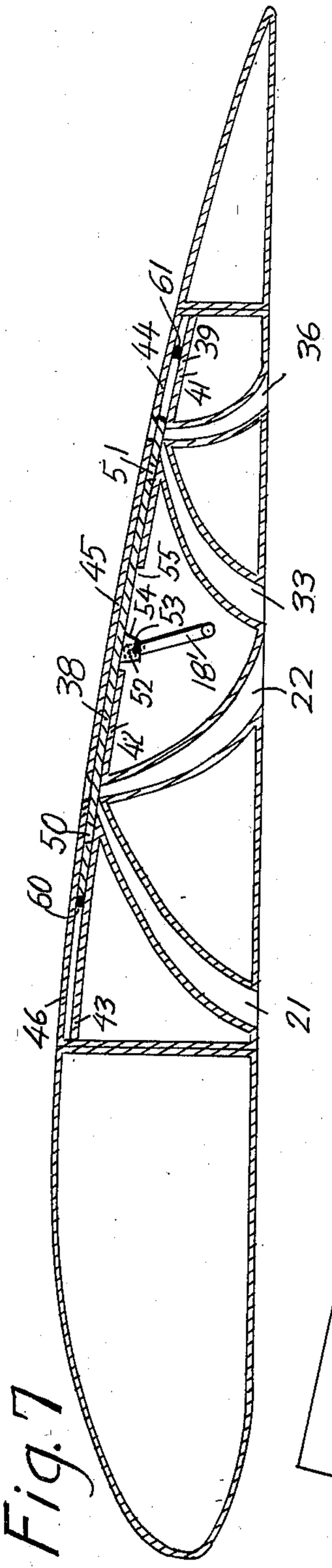

Fig. 7

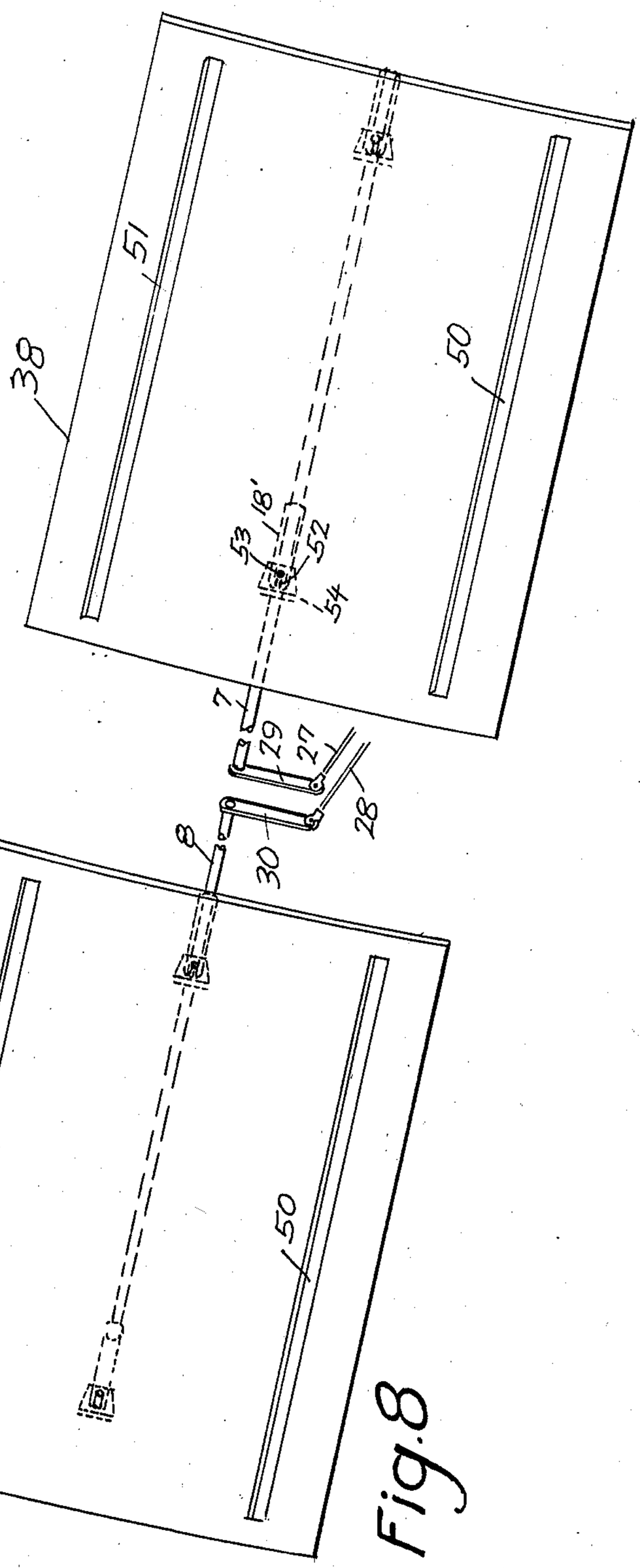

Fig. 8

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2,077,072

UNITED STATES PATENT OFFICE

2,077,072

AILERON

William K. Rose, New York, N. Y.

Continuation of application Serial No. 706,781, January 15, 1934. This application November 10, 1936, Serial No. 110,147

3 Claims. (Cl. 244—42)

This invention relates to airplanes and more particularly to a wing structure therefor, which provides passageways for the movement of air through the airfoil as a means for the lateral control of the plane about its longitudinal axis. Means to this end in present day airfoil construction ordinarily take the form of a hinged or pivoted movable auxiliary surface mounted in the rear of each end of the wing usually as a part of the trailing edge of the wing and termed an "aileron". By reason of the simularity of function between the means for lateral control constituting my invention and the ailerons of the prior art I have adopted that nomenclature as a suitable and convenient name for the means herein set forth and claimed.

This application is a continuation of application Ser. No. 706,781, filed January 15, 1934 and to the end above set forth, incorporates passageways through the airfoil from bottom to top which are broadly disclosed in my application Ser. No. 706,780, filed January 15, 1934, and in the continuation application thereof Ser. No. 110,145, filed on even date herewith. In said application Ser. Nos. 706,780 and 110,145 are presented claims covering said passageways broadly as a means for influencing the lift drag ratio of the wing and more narrowly as a means for increasing the lift and decreasing the drag thereof. Reservation is hereby specifically made of the right to present and procure the said claims in said applications Ser. No. 706,780 and 110,145 and the Letters Patent to issue thereon, no abandonment of the subject matter thereof to be implied from the absence of said claims herein. By reason of this fact the claims of this application are restricted to structures embodying an adaptation of said passageways to the end first above indicated.

On a basis of the foregoing more specifically one object of this invention is to provide a construction which may be used on an airplane either with a landing flap or without, to control the rolling moment on the plane, to develop a favorable yawing moment tending to air in turning the plane, and to air in preventing stall and spins when banking at a high angle of attack.

Another object of the present invention is to provide an aileron for airplanes wherein the aileron is arranged between the leading and trailing edges so that more of the trailing edge may be used for a flap, if desired.

Another object is to provide an aileron for airplanes wherein the aileron is arranged between the leading and trailing edges to secure the necessary results without interfering with the size of the trailing edge, so that, if desired, the aileron may be used in combination with small compensating ailerons to take care of small fluctuations in the rolling moment of the airplane to keep the airplane in steady flight.

A further object, more specifically, is to provide an aileron structure for airplanes wherein the parts are so formed as to be easily actuated, and when actuated to permit air to flow through the wing structure at the respective ends either upwardly or downwardly, and to react on certain members to produce a downward pressure or an upward pressure or lift.

An additional object more in detail is to provide an aileron for an airplane, with oppositely curved passageways extending from the upper to the lower surfaces of the wing structure, with control means to shift the flow of air from one passageway to another according to whether a lift or downward pressure is to be secured.

For simplicity of showing I have selected a conventional airplane wing within which to incorporate ailerons embodying this invention. It must be understood, however, that no limitation on the invention is to be deduced therefrom. This invention may be employed, for example, with the wing structure of my said applications, Ser. No. 706,780, and Ser. No. 110,145, or with any other wing structure in which differential air pressures may be employed for effecting the control characterizing this invention, such, for example, as the wing structure of my application Ser. No. 706,779, filed January 15, 1936, and the continuation thereof, Ser. No. 110,146, filed on even date herewith.

In the accompanying drawings, which form a part hereof and which are to be understood as purely illustrative and which are in large part schematic—

Figure 1 is a top plan view of a conventional airplane provided with ailerons disclosing an embodiment of the invention;

Fig. 2 is a sectional view through Figure 1 on the line 2—2, the same being principally in outline in order to illustrate the construction without interference of the physical structure of the wing members;

Fig. 3 is a detailed perspective view of manually actuated mechanism suitable for controlling the action of the ailerons;

Fig. 4 is a cross-sectional view similar to Fig. 2 illustrating a different embodiment of my invention with the passageways of one aerodynamic

character opened and the passageways of opposite aerodynamic character closed;

Fig. 5 is a view similar to Fig. 4 of the form of my invention therein illustrated showing the passageways of opposing aerodynamic character opened and closed in reverse order to that illustrated in Fig. 4;

Fig. 6 is a view similar to Fig. 4 of the form of my invention therein disclosed showing the passageways of both aerodynamic characters closed on one side of the wing;

Fig. 7 is a view similar to Fig. 4 of the form of my invention therein disclosed showing the passageways of both aerodynamic characters closed on the opposite side of the wing from that illustrated in Fig. 6; and

Fig. 8 is a perspective of the slide valve employed in the form of my invention illustrated in Figs. 4 to 7 inclusive, with a portion of its operating mechanism slightly modified.

Referring now to the form of my invention illustrated in Figs. 1 to 3, a fuselage **1**, which may be of any desired kind, carries substantially mounted thereon wings **2** and **3**, which are shown as merging together, though this is not essential, as far as the present invention is concerned. Ailerons **4** and **5** are suitably mounted in the wing structure near the outer ends or tips of the wings and preferably about mid-way between the leading and trailing edges and preferably with all of the parts of the aileron back of the maximum camber of the airfoil.

The ailerons are preferably of substantially identical construction. Each aileron is provided with one or more upwardly and rearwardly curved passageways bounded and defined by suitably mounted curved vanes or blades and extending through the aileron structure from bottom to top, i. e., the openings at the top of the passageways are rearward of their respective openings at the bottom and the slope of their curvature is upward respecting the bottom of the airfoil, four of such passageways **21**, **23**, **33** and **34** being illustrated. These passageways lie laterally or spanwise of the aileron and have their inlet and outlet openings respectively substantially parallel. These passageways are curved and operate on the principle of the steam turbine, their curvatures being preferably such that there is no appreciable straight line path for air therethrough. The mean cross-sectional line of each passageway gradually flattens from bottom to top and preferably subtends an angle of approximately 90°, and the passageways preferably are gradually restricted from bottom to top. The formation of the passageways is such as to build up therein a reactive force on the passing of air currents therethrough. With the passageways **21**, **23**, **33** and **34** open the resultant force vector computed at the center of pressure is directly upwardly and forwardly at less than a 90° angle from the reference chord line of the wing passing through the aileron. This increases the normal lift of the wing on the side of the fuselage in which the passageways **21**, **23**, **33** and **34** of the aileron there mounted are opened.

Each aileron is also provided with one or more downwardly and forwardly curved passageways bounded and defined by suitably mounted curved vanes or blades and extending through the aileron structure from top to bottom, i. e., the openings at the top of the passageways are forward of their respective openings at the bottom and the slope of their curvature is downward respecting the bottom of the airfoil, four of such passageways **24**, **22**, **35** and **36** being illustrated. These passageways lie laterally or spanwise of the aileron and have their inlet and outlet openings respectively substantially parallel. These passageways are of substantially the same degree of curvature (although oppositely disposed) as the passageways **21**, **23**, **33** and **34**, and like the last named passageways, operate on the principle of the steam turbine, their curvatures being such that there is no appreciable straight line path for air therethrough. The mean cross-sectional line of each passageway gradually flattens from bottom to top and preferably subtends an angle of approximately 90°, and the passageways preferably are gradually restricted from bottom to top. The formation of the passageways is such as to build up therein a reactive force on the passing of air currents therethrough. With the passageways **24**, **22**, **35** and **36** open the resultant force vector computed at the center of pressure is directed downwardly and forwardly at less than a 90° angle from the reference chord line of the wing passing through the aileron. This decreases the normal lift of the wing on the side of the fuselage in which the passageways **24**, **22**, **35** and **36** of the aileron there mounted are opened.

As the forces developed in the passageways **21**, **23**, **33** and **34** are upward and increase the normal lift, and the forces developed in passageways **24**, **22**, **35** and **36** are downward and decrease the normal lift, the aerodynamic effect of the two sets of passageways is respectively opposite. I have accordingly herein referred to the two sets of passageways as aerodynamically opposing passageways.

There are certain advantages to be gained if the downwardly and forwardly curved passageways intersect the upwardly and rearwardly curved passageways and I have illustrated the ailerons as so constructed. In the form of my invention illustrated in Figs. 1 to 3, the passageways are arranged in pairs and intersect in their middle portions as follows: Passageways **21** and **24** comprising the first pair from the leading edge, passageways **23** and **22** comprising the second pair from the leading edge, passageways **33** and **35** comprising the third pair from the leading edge, and passageways **34** and **36** comprising the fourth and last pair from the leading edge. Furthermore, there is an additional intersection or merging of certain of the passageways on the upper and lower surfaces of the aileron, which is of particular advantage in the form now under discussion in affording as uninterrupted and smooth upper and lower surfaces of the aileron as is possible. Thus as illustrated, on the upper surface of the plane, the openings for the passageways intersect or merge as follows: Passageway **21** with passageway **22**, passageway **23** with passageway **35**, and passageway **33** with passageway **36**. On the lower surface of the plane the openings for the passageways intersect or merge as follows: Passageway **24** with passageway **23**, passageway **22** with passageway **33**, and passageway **35** with passageway **34**.

Similar means are provided in connection with each aileron for opening and closing the passageways, such that all the passageways of the aileron may be closed; or the upwardly and rearwardly curved passageways all opened and the downwardly and forwardly curved passageways all closed; or the upwardly and rearwardly curved passageways all closed and the downwardly and forwardly curved passageways all

opened. The illustration presented with the passageways intersecting midway as above described lends itself well to simplified means to this end. Thus, at the four midway points of intersection of the respective intersecting passageways there are provided respectively four suitably mounted rotary valves, 13, 12, 11 and 14, adapted to act in unison, the valves in one aileron having, however, reverse operation to those of the other aileron. Thus if air is admitted to the aileron passageways of one aerodynamic character in the wing on one side of the fuselage, air will be admitted to the aileron passageways of opposite aerodynamic character in the wing on the other side of the fuselage, and the other passageways of opposite aerodynamic character in the ailerons in the two wings will be closed. On closure of both sets of passageways of one aileron, however, both sets of passageways in the other aileron will likewise be closed.

These valves are provided with diametric ports 13', 12', 11' and 14', which are preferably formed with the same curvature as the passageways through the ailerons, so that when the valve ports are turned to register with either the upwardly and rearwardly curved passageways or the downwardly and forwardly curved passageways the curvature of these passageways will be preserved in the valve structure.

Referring to Fig. 2, the neutral or closed position of the valves is with the ports substantially vertical, in which position all of the passageways are closed. From the neutral position a clockwise rotation will bring the ports into register with the upwardly and rearwardly curved passageways, and a counter-clockwise rotation with the downwardly and forwardly curved passageways, the latter being illustrated in the figure referred to. In the aileron in wing 3 on the opposite side of the fuselage, correlated and reverse movement of the valves takes place, to wit, from the neutral position counter-clockwise rotation brings the ports of the valves into register with the downwardly and forwardly curved passageways, and a clockwise rotation with the upwardly and rearwardly curved passageways.

Any suitable mechanism may be employed for operating the valves 13, 12, 11 and 14, just described. I have schematically shown in Fig. 3 a suitable operating structure. In this structure a hand lever or control stick 6, positioned convenient to the aviator, is operatively connected with rotatable rods 7 and 8 through suitable mechanism. This mechanism may consist of a rock shaft 25 for rocking a bar 26 rigidly connected therewith and having its ends pivotally connected with the lower ends of suitable rods 27 and 28, which have their other ends pivotally connected with arms 29 and 30 which are similarly mounted as crank arms on shafts 7 and 8 respectively. In this construction it will be evident that when the lever or control stick 6 is in one direction for rotating the rock shaft 25, the shafts 7 and 8 also are rotated, but in opposite directions, one from the other; and when the control stick 6 is moved in the opposite direction, the rotation of the shafts 7 and 8 will be reversed.

The shafts 7 and 8 are intended to be suitably mounted as, for example, in the interior of the wing structure as illustrated in Fig. 1, the shaft 7 extending to the left and the shaft 8 to the right from the center of the plane and both shafts terminating in the aileron structures correspondingly mounted. The mounting of the shafts may conveniently be such that they may be directly connected, the shaft 7 with one of the valves in the aileron 4 and the shaft 8 with one of the valves in the aileron 5. The second valve 11 from the rear of the plane is selected for illustration of this direct connection. As the mechanism is intended to be the same for both ailerons, further description may be confined to the additional mechanism requisite for operating the valves in the aileron 4.

The shaft 7 has rigidly mounted thereon an upwardly extending crank arm 18 which is pivotally connected with a horizontally disposed connecting rod 9. Pivotally connected with the connecting rod 9 and extending downwardly therefrom are crank arms 15, 16 and 17 which are of the same length and character as the crank arm 18. The lower end of the crank arms 15, 16 and 17 are respectively rigidly and operatively connected with the valves 13, 12 and 14. This assures that when the rock shaft 7 is rotated in either direction the valves 13, 12, 11 and 14 will be correspondingly rotated.

By providing a like arrangement of control parts from the shaft 8 through the connecting rod 10 for the aileron 5, it will be apparent, by reason of the reverse action of the crank arm 26, that as the level or control stick 6 is swung from the neutral upright position to the right (as viewed in Fig. 3), the valves in the aileron 5 will be given a clockwise rotation, opening up the upwardly and rearwardly curved passageways 21, 23, 33 and 34, and those in aileron 4 a counter-clockwise rotation, opening up the downwardly and forwardly curved passageways 24, 22, 35 and 36; and that when the lever or control stick 6 is moved from the neutral upright position to the left (as viewed in Fig. 3) the valves in the respective ailerons will be moved to open the downwardly and forwardly curved passageways of the aileron 5 and the upwardly and rearwardly curved passageways of the aileron 4. Stops 31 and 32 are provided for the lever or control stick 6 in such position as to arrest the respective right and left hand movements of the control stick in such position that when moved to the limits thus provided, the ports of the valves will be in exact register with the passageways opened.

By constructing all of the passageways in the manner above described, when any set of passageways is open the forward walls thereof, that is, the walls of the open passageways nearest the leading edge of the wing, will act as curved blades similar to the blades of a steam turbine, whereby there will be produced a lift or downward pressure according to which set of passageways is being used. For instance, if the valves are so set that air will pass through the upwardly and rearwardly curved passageways 21, 23, 33 and 34 of the aileron 4, there will be produced a lift on the left-hand side of the plane. If the valves are set so that air will pass through the downwardly and forwardly curved passageways 24, 22, 35 and 36 of the aileron 4, there will be produced a downward pressure on the left-hand side of the plane. The lift or downward pressure on the right-hand side of the plane, by reason of the reverse action of the valves in the aileron 5, all as above described, will be just the opposite to that on the left-hand side of the plane. Thus, with the invention hereinabove described, means are provided for controlling and overcoming the rolling movement of the airplane.

For example, assume that the plane headed as in Fig. 1 is to be turned to the right and in mak-

ing the turn that the left side of the plane is to be raised and the right side lowered in the banking. In making such a turn the aviator will open the upwardly and rearwardly curved passageways **21**, **23**, **33** and **34** in the aileron **4** and the downwardly and forwardly curved passageways **24**, **22**, **35** and **36** in the aileron **5** by manipulation of the lever or control stick **6** as above set forth. The air currents passing through the downwardly and forwardly curved passageways **24**, **22**, **35** and **36** of the aileron **5** on the right side of the plane, by reason of the downward curvature of the passageways produce a downward pressure, and on emerging from the tops of the passageways produce a drag while the air currents passing through the upwardly and rearwardly curved passageways in the aileron **4** on the left side of the plane produce added lift and less drag. The resultant is a favorable yawing moment on the wing inside of the turn and a favorable rolling moment on the wing outside of the turn.

The prevention to a large extent of a plane equipped with the ailerons hereof from going into a spin is effected by a characteristic functioning of the ailerons, in which the ailerons possess a marked advantage over the conventional ailerons now in use, namely, the characteristic that no matter what the angle of the plane is in flight, the ailerons are never blanketed but always function in the manner above set forth. When their controlling means, for instance the rotary valves as herein shown, are actuated to open the passageways, currents of air will always pass therethrough and operate as above described.

The ordinary cause of spinning is the blanketing of the conventional aileron on the lower side of the plane when the plane is banking in a turn. When this occurs, the plane is thrown out of control and develops a reverse spin. In utilizing the ailerons as above set forth in making a turn, the aileron on the lower side of the plane is never blanketed, regardless of the banking angle, and by reason of this characteristic action, spinning resulting as above set forth is prevented.

As the lever or control stick **6** is designed to actuate only the various valves, the power necessary to move the lever is very small. By reason of this fact, the action of the ailerons may be easily controlled to secure the desired balancing or banking effect at any time. It will be evident that the lever **6** and rods **7** and **8** and associated parts could be of any desired structure, for instance, the ordinary structure now in common use, but they are connected up in such a way that the valves will be rotated back and forth whenever the controlling lever is properly moved. If desired, spring means could be used to bring all the parts back to neutral position whenever the lever **6** is released.

However, the essential feature is the aileron structure itself wherein there is no movement of vanes or flaps to secure a lift or downward pressure, but, on the other hand, a shifting of air control means to vary the movement of the air through passageways which are curved in opposite directions, which gives a turbine action for producing either a lift or a downward pressure in proportion to the velocity and amount of air allowed to pass.

In the construction illustrated with the upwardly and rearwardly and downwardly and forwardly curved passageways intersecting in the manner shown, the forward and rearward openings both on the top and on the bottom of the aileron are individual to single passageways. If desired, means may be provided acting to bridge over these openings when their passageways are closed and preserve the smooth contour of the aileron surfaces. Such means as, for example, sliding valves hereinafter referred to may be interconnected with the aileron control mechanism so as to be opened or closed respectively simultaneously with the opening or closing of the passageways which they cover.

In the form of my invention illustrated in Figs. 4 to 7 inclusive, a slide valve is illustrated as a means for opening and closing the passageways in lieu of the rotary valve illustrated in Figs. 1, 2 and 3 hereof, and for simplicity of showing the construction illustrated has been limited to two pairs of intersecting or merging passageways for each aileron. Thus comparing Figs. 4 to 7 inclusive with Fig. 2, it will be observed that in the second form of my invention illustrated, the merging or intersecting passageways **21** and **22** comprise the forward pair, and the merging or intersecting passageways **33** and **36** comprise the rearward pair, and passageways **24**, **23**, **35** and **34** being omitted. It should be distinctly understood that the simplification in the number of passageways is not to be considered as limitative.

The aileron shown in cross-section in Figs. 4, 5, 6 and 7 may be considered, as in the case of that shown in Fig. 2, as the aileron in the left wing viewed on the dot and dash line **2—2** of Fig. 1, it being understood that a similar aileron is to be mounted in the right wing precisely as in the case of the first form illustrated. It should further be understood that the passageways of the aileron illustrated in Figs. 4, 5, 6 and 7 are substantially identical with the similar passageways of the aileron illustrated in Fig. 2, and for that reason no further description thereof is deemed necessary.

The opening and closing of the passageways **21**, **22**, **33** and **36** in the form of my invention now under consideration is effected by a slide valve **38** suitably mounted in the top of the aileron for chordwise reciprocal movement at the intersection or merging of the passageways **21** and **22**, and **33** and **36**, and carried between a lower guide wall **39** and upper guide wall **40** which serve as valve seats. The lower guide wall **39** is formed in three sections, **41**, **42** and **43**, which comprise the upper walls of the vane or blade structure to the rear, across the center, and to the front of the aileron at the top thereof. The upper guide wall **40** is in line with the upper camber of the wing and is in three sections, **44**, **45** and **46** which overlie respectively the sections **41**, **42** and **43** of the lower guide wall. The sections **44**, **45** and **46** are spaced apart at the top at the intersections or merging of the passageways comprising the respective pairs thereof to permit an uninterrupted flow of the air stream coming either from the upwardly and rearwardly curved passageways **21** and **33**, or the downwardly and forwardly curved passageways **22** and **36**.

The slide valve **38** is made with two spanwise slots **50** and **51** of cross-sectional dimension equal to the cross-sectional opening at the top of the respective passageways at their points of intersection or merging, and these slots **50** and **51** are spaced apart the distance between the openings at the top of the upwardly and rearwardly curved passageways **21** and **33**, which as is obvious equals the distance between the openings at the top of

the downwardly and forwardly curved passageways 22 and 36. The result of this dimensioning and positioning of the slots 50 and 51 is, therefore, such that when the slots lie immediately above the openings of the downwardly and forwardly curved passageways 22 and 36 as shown in Fig. 4, these passageways are open to their full extent and the upwardly and rearwardly curved passageways 21 and 33 are closed. Conversely, when the slots 50 and 51 lie immediately above the openings of the upwardly and rearwardly curved passageways 21 and 33 as shown in Fig. 5, these passageways are open to their full extent and the downwardly and forwardly curved passageways 22 and 36 are closed.

The neutral position of the slide valve 38 in blanketing both pairs of passageways at the top may either be with the slide valve moved rearward until the slots 50 and 51 lie immediately to the rear of the top openings of the downwardly and forwardly curved passageways 22 and 36, as illustrated in Fig. 6, or when the slots 50 and 51 lie immediately to the front of the top openings of the upwardly and rearwardly curved passageways 21 and 33, as shown in Fig. 7. These neutral positions, in which all of the passageways are blanketed, are dependent on the form and actuation of the mechanism employed for effecting movement of the slide valves of the two oppositely disposed ailerons on the left and right sides of the fuselage forward and backward in their respective valve seats.

It will obviously be understood that (precisely as in the case of the first form of my invention illustrated in Figs. 1 to 3 inclusive) the aerodynamically opposed passageways in the two oppositely disposed ailerons are to be simultaneously opened and closed, as shown for example in Figs. 4 and 5. The actuating mechanism illustrated in Fig. 3 is adapted for use in controlling the movement of the slide valves 38 in the oppositely disposed ailerons to this end and for blanketing all of the passageways, with the following alteration: Connecting rods 9 and 10 and the crank arms 15, 16 and 17 are omitted; the rods 7 and 8 are moved slightly toward the front of the wings and are suitably mounted in such position that their outer ends extend respectively into the downwardly depending vane or blade structures lying between and bounding and defining the downwardly and forwardly curved passageways 22 and the upwardly and rearwardly curved passageways 33 in the ailerons in the left and right wings, as illustrated respecting the rod 7 in Figs. 4 to 7 inclusive; and the crank arms 18, bearing reference numeral 18' in Figs. 4 to 7 inclusive, are each to be provided with a loose motion slot 52 in which travels a pin 53 fixedly mounted in a downward extending lug 54 rigidly attached to the lower surface of the slide valve 38, the lower guide wall 39 being provided with a suitable aperture 55 through which the lug 54 may travel fore and aft in accommodating the extreme fore and aft positions of the slide valve. The valve seat is provided at front and rear respectively with stops 60 and 61 which limit the forward and rearward movement of the slide valve to its respective neutral or blanketing positions above defined and in so doing cooperate with the stops 31 and 32 of the apparatus shown in Fig. 3.

While for simplicity of construction I have indicated only a centrally depending lug 54 for operation by a single crank arm 18' for each aileron, obviously a plurality of the depending lugs with like number of crank arms may, if desired, be provided. In Fig. 8 I have indicated for each aileron two of the depending lugs 54 and two cooperating crank arms 18' mounted on their respective shafts 7 and 8 for the ailerons mounted respectively in left and right wings, the lugs 54 in each aileron being well toward the opposite edges thereof to assure a smoothness and regularity in the movement thereof. The following description of the operation applies to the slide valve structure whether provided in each aileron with a single or with a plurality of depending lugs, as will be apparent.

The operation and control of the slide valves 38 by means of the mechanism illustrated in Fig. 3, altered as just described, is for example as follows: Assume as the initial or first position that the slide valve in the aileron in the left wing is at its rearmost blanketing position as illustrated in Fig. 6, and that the slide valve in the aileron in the right wing is in its foremost blanketing position as illustrated in Fig. 7. The control stick 6 will then be in its lowest position toward the left or counter-clockwise with its lower end abutting against the stop 31.

From this first position of the slide valves and control stick 6 a clockwise movement of the control stick will move forwardly the slide valve in the aileron in the left wing and will move rearwardly the slide valve in the aileron in the right wing opening the downwardly and forwardly curved passageways 22 and 36 in the aileron in the left wing as illustrated in Fig. 4, and opening the upwardly and rearwardly curved passageways 21 and 33 in the aileron in the right wing as illustrated in Fig. 5, the other passageways in both ailerons remaining closed. This position of the slide valves and control stick may conveniently be termed the second position.

From this second position of the slide valves and control stick 6 counterclockwise movement of the control stick will close the opened aerodynamically opposed passageways just recited and will result in restoring the slide valves to their original blanketing positions initially assumed. But further clockwise movement of the control stick 6 from the second position will move forwardly the slide valve in the aileron in the left wing and will move rearwardly the slide valve in the aileron in the right wing until the upwardly and rearwardly curved passageways 21 and 33 in the aileron in the left wing are opened as illustrated in Fig. 5, and the downwardly and forwardly curved passageways 22 and 36 in the aileron in the right wing are opened as illustrated in Fig. 4, the other passageways in both ailerons remaining closed. This position of the slide valves and control stick may conveniently be termed the third position.

From this third position of the slide valves and control stick 6 the pilot may, if desired, continue the clockwise movement of the control stick to move the slide valve in the aileron in the left side of the wing forwardly into its front neutral blanketing position as illustrated in Fig. 7, and the slide valve in the aileron in the right side of the wing rearwardly into its rear blanketing position as illustrated in Fig. 6, in which case the control stick will have gone to the limit of its clockwise movement with its lower extension abutting against the stop 32. This position may conveniently be termed the fourth position. Or on the other hand the pilot may, if desired, by reverse movement of the control stick in counterclockwise direction to the limit of its movement,

move the slide valves from their third position, the slide valve in the aileron in the left side of the wing rearwardly, and the slide valve in the aileron in the right side of the wing forwardly, into their neutral positions initially above assumed.

From the foregoing example, it should be apparent that by proper movement of the control stick the pilot may move the slide valves from any one of their four curve illustrative positions into any other one of these illustrative positions as desired. Furthermore, that the automatic control of the ailerons first above referred to now commonly employed in present day aircraft may be employed in like manner to the control of my slide valves **38** and the aileron operation thereby.

As the control of the ailerons in the second form of my invention is thus similar to the control of the ailerons in the first form of my invention and as the functioning of the ailerons of both forms is identical, it is believed that no detailed description of the general operation and functioning of the second form is required, reference being given to the foregoing detailed description of the operation and functioning in the first form.

The foregoing detailed description and illustrations have been given for clearness of understanding and no undue limitation should be deduced therefrom, but the appended claims should be construed as broadly as possible in view of the prior art.

What I claim is:

1. An aileron for airplanes, comprising suitably mounted vanes or blades so disposed as to form two aerodynamically opposing and intersecting passageways extending through the wing from top to bottom near the outer ends and between the leading and trailing edges thereof, one of said passageways being curved downwardly and forwardly and the other of said passageways being curved upwardly and rearwardly, and a manually controlled valve positioned at the intersection of the passageways for shifting air currents from one passageway to the other.

2. An aileron for airplanes, comprising suitably mounted vanes or blades so disposed as to form a plurality of aerodynamically opposing passageways extending through the wing from top to bottom near the outer ends and between the leading and trailing edges thereof, said passageways being arranged in pairs, the two passageways in each pair being aerodynamically opposed and intersecting, one of said passageways in each pair being curved downwardly and forwardly and the other of said passageways being curved upwardly and rearwardly, a valve positioned at the intersection of the passageways of each pair for shifting air currents from the passageway of one aerodynamic character to the passageway of opposite aerodynamic character, and manually controlled means for operating the said valves in unison whereby all of the passageways of one character in the aileron are simultaneously closed and all of the passageways of opposing character are simultaneously opened.

3. In an airplane embodying a fuselage and a wing structure mounted thereon and extending to each side thereof, the combination with the wing structure of ailerons mounted in the wing structure near the outer edges thereof, each aileron consisting of suitably mounted curved vanes or blades so disposed as to form one or more pairs of aerodynamically opposing curved passageways extending through the wing structure from top to bottom, one of said passageways in each pair being curved downwardly and forwardly and the other of said passageways being curved upwardly and rearwardly, the curvature of the vanes or blades bounding and defining the passageways being such that the pressure air passing through the various passageways develops internal forces therein, the forces developed in the passageways curved upwardly and rearwardly operating as a lift and the forces developed in the passageways curved downwardly and forwardly operating as a drag, the passageways of each pair intersecting, a valve arranged at the intersection of each pair of passageways, and means for moving said valves to open and close the respective passageways in reverse relation on the opposite sides of the plane.

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