

1,249,593.

Patented Dec. 11, 1917.
2 SHEETS—SHEET 1.

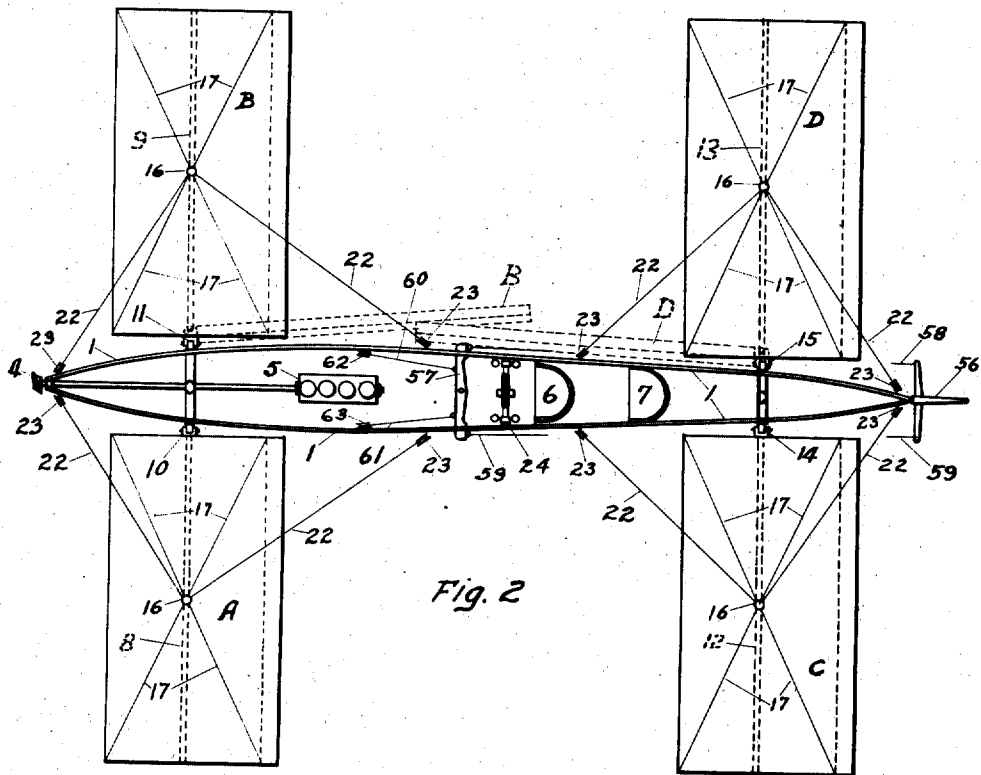


Fig. 2

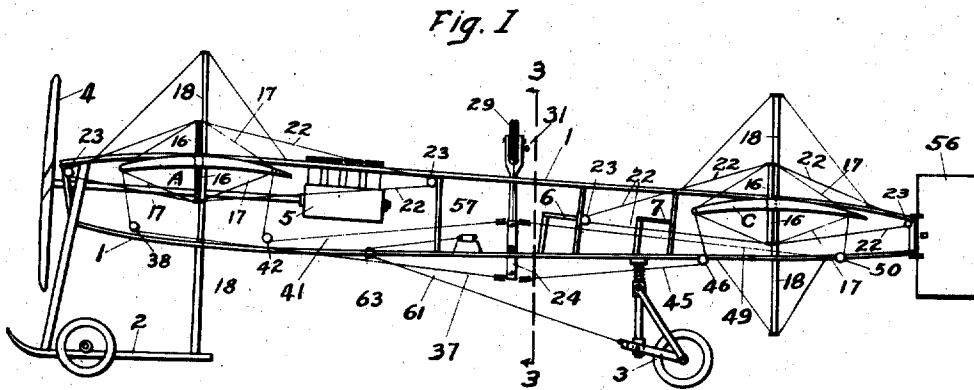


Fig. 1

Witnesses

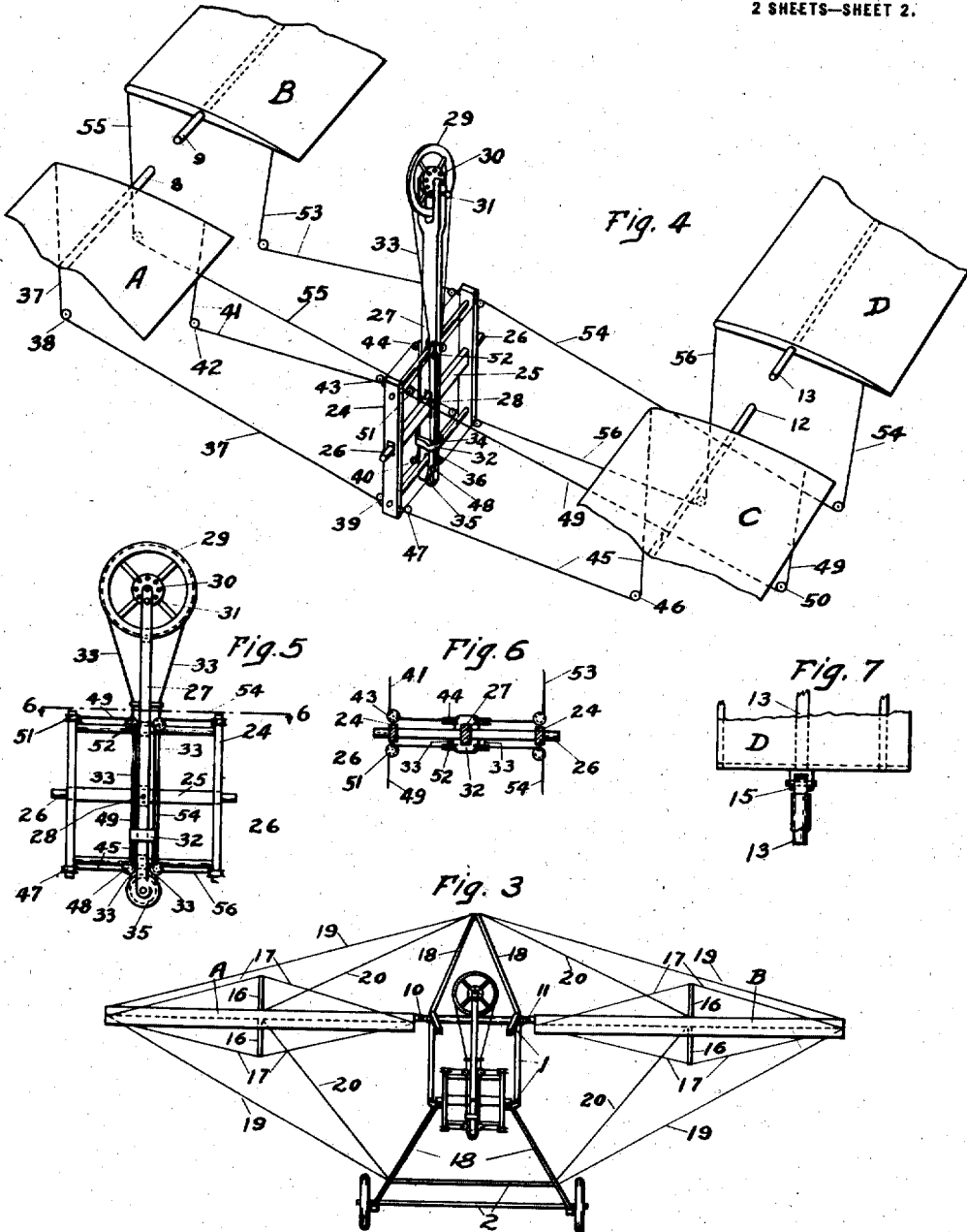
James H. Wainman
Chas. J. Swindells

Inventor:
Frank A. Bullington
Attorney:
H. L. Fitzgerald

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2 SHEETS—SHEET 2.



Witnesses.

James H. McManis
Chas. J. Swindells

Inventor:
Frank A. Bullington
By
Attorney.

UNITED STATES PATENT OFFICE.

FRANK A. BULLINGTON, OF PORTLAND, OREGON.

AEROPLANE.

1,249,593.

Specification of Letters Patent.

Patented Dec. 11, 1917.

Application filed October 5, 1912. Serial No. 724,081.

To all whom it may concern:

Be it known that I, FRANK A. BULLINGTON, a citizen of the United States, residing in the city of Portland, county of Multnomah, and State of Oregon, have invented certain new and useful Improvements in Aeroplanes, of which the following is a specification.

My invention relates to aeroplanes, and more particularly to certain improvements in the general plan and design of a heavier-than-air flying machine, and in the controlling mechanism therefor, whereby I make possible a more natural and instinctive control of the machine.

Among the salient objects of my invention are,—

To provide in an aeroplane a plurality of supporting or carrying planes, pivotally mounted to turn about longitudinal axes, with an improved controlling mechanism therefor; to provide in an aeroplane a tandem arrangement of the carrying or supporting planes, with some or all of said planes pivotally mounted to turn upon longitudinal axes, and movable thereon to give direction to, and to control the equilibrium of, said aeroplane; to provide in an aeroplane a plurality of carrying or supporting planes, each of which is composed of oppositely disposed planes or plane sections, pivotally mounted to turn upon their longitudinal axes, either together, or independently of each other; to provide in an aeroplane a construction wherein the use of auxiliary planes, such as ailerons and elevators, is entirely eliminated, as is the attendant resistance of such auxiliary planes; to provide in such a machine a construction wherein the axes of rotation of the several planes, or plane sections, are so disposed and the controlling connections therebetween are so made, that the control is in balance; that is, any unbalancing pressure on one of said planes, or sections, is, by reason of the connections, resisted by a corresponding and counteracting pressure upon an opposed plane; to provide in such a machine a construction whereby the planes, or plane sections, are hingedly attached to the fuselage so as to be turned and swung back along the sides thereof in order to facilitate the transportation or storage thereof; to provide in such a machine an improved and simplified controlling or manipulating mechanism for the control of the planes thereof, and where-

by to make said control as natural and instinctive as possible; that is, the movement of the controlling mechanism in order to restore or correct the equilibrium of the machine is dependent upon and in accord with the natural movement of the body of the pilot in maintaining his equilibrium.

Other features of improvement will appear from the following description of one practical embodiment of the invention, which is given for the purpose of enabling others to understand it. In the present embodiment of the invention I have shown a longitudinal base of support extending from the center of the front plane to the center of the rear plane, and the weight is so disposed that the center of mass falls within the base of support regardless of the angle of inclination of the machine. Again, the pivotal longitudinal axis of each of the planes coincides with the mean center of air pressure thereof, though the said center of pressure varies according to the angle of the plane with relation to the direction of motion.

Referring now to the drawings, I will describe the embodiment of the invention shown for purposes of illustration.

Figure 1 is a side elevation thereof;

Fig. 2 is a top plan view thereof;

Fig. 3 is a vertical sectional view taken on line 3—3 of Fig. 1, with the power mechanism omitted;

Fig. 4 is a diagrammatic view, with parts broken away, showing a controlling mechanism with operating connections to the carrying planes;

Fig. 5 is an enlarged front view of a controlling mechanism;

Fig. 6 is a cross sectional view taken on line 6—6, Fig. 5;

Fig. 7 is a fragmentary view showing hinge connection of one of the planes to the fuselage.

The invention as here embodied and illustrated, comprises a long fuselage or body 1, of substantially the form and design shown, and having a two-wheeled chassis, as 2, in front, with a companion caster or steering wheel 3, toward the rear, upon which said machine can be moved and directed upon the ground. For the purpose of clearness in the drawings, I have purposely omitted the brace members and many of the guy wires from said fuselage. A propeller 4 is provided in the front of the machine, as indi-

cated, and is driven from the engine 5, mounted substantially as indicated. A pilot's seat, as 6, and a passenger's seat, as 7, are also shown in place in the fuselage and in the rear of the engine 5.

An important feature of the invention is the construction and arrangement of the carrying or supporting planes, which are arranged tandem fashion, one in front and one in the rear. In the form here shown, each plane is composed of two oppositely disposed planes, or plane sections, at opposite sides of the fuselage, both in front and in the rear, each of said planes being movably mounted to turn about a longitudinal axis, at one end of which it is hingedly attached to the body or fuselage. The two front plane sections I will designate as A and B, and the two rear plane sections, I will designate as C and D. The planes A and B are provided, respectively, with the main longitudinally extending members or axes, designated 8 and 9, and hingedly connected to the fuselage 1, as indicated at 10 and 11, and the rear planes C and D are provided with similar members or axes, designated 12 and 13, and hingedly connected to the fuselage, as indicated at 14 and 15. By thus hingedly connecting said planes, or plane sections to the fuselage, as indicated, they can be turned into vertical planes and swung around upon their hinge connections along side of the fuselage or body 1, for transportation or shipping purposes, it being understood, of course, that the various operating and guy wires, hereinafter referred to, have been disconnected. I have indicated this folded position in dotted lines, Fig. 2, as to planes B and D. Said planes, or plane sections, are each provided through its middle with a rigid guy mast, as 16, from the ends of which are the guy wires 17—17, from corner to corner, as indicated both above and below each of said planes.

Mounted upon the fuselage, at points between the oppositely disposed planes, are rigid A-frame masts, as 18—18, extending above and below said fuselage, in front and in the rear, as indicated. From these masts are guy wires 19—20, the wires 19—19 extending from the outermost ends of the planes, and the wires 20—20 extending from the bases of the plane guy masts 16—16 to said A-frames, as indicated in Fig. 3. All of said guy wires are attached to the planes at their longitudinal axes, whereby to permit of the free movement of said planes, or plane sections, in either direction, about their longitudinal axes.

The opposite ends of each of said masts 16—16 of the planes are also provided with brace wires, as 22—22, extending from the ends thereof through pulleys, as 23—23, upon the fuselage, both forwardly and rearwardly of each plane section, as clearly indicated in Figs. 1 and 2, whereby to guy said planes and

their masts 16—16, to the fuselage 1, front and rear, and at the same time permit them to be freely moved about their longitudinal axes.

Referring now to Fig. 4, I will describe the controlling mechanism by means of which the pilot can manipulate the planes in the control of the machine. In the present form, this comprises a rocking frame or element, 24, pivotally mounted by means of a middle member 25, having bearing ends 26—26, in the fuselage 1, whereby to be rocked forwardly and backwardly, from and toward the pilot. This rocking element 24 is moved by means of an upright operating lever 27, pivotally mounted, as at 28, upon the middle member 25, in the rocking element 24. This lever, it will be noted, moves upon an axis extending transversely of the axis of the rocking element 24. Upon the upper end of the lever 27, is a grooved operating hand-wheel 29, having a middle portion, as 30, provided with a series of holes, as shown adapted to receive a holding pin 31 in the upper end of the lever 27, whereby said operating hand wheel can be secured, or held against movement. Mounted to slide up and down upon the lower end of the lever 27, is an operating block or element, 32. This sliding element is moved by means of a cable 33 passing over the hand wheel 29, with one end thereof attached to the upper side of said element, as at 34, and with its other end extended downwardly and around a pulley 35 at the lower end of said lever 27, and thence up to the underside of said operating block or element 32, as indicated at 36. As said hand wheel is turned, said operating block or element 32 is raised and lowered upon the lower portion of said lever 27.

I will now describe the controlling connections from the various planes, or plane sections, to the controlling mechanism. From the front edge of plane A, a cable 37 passes around a pulley 38, on the fuselage and thence to a pulley 39 on the lower left hand corner of the rocking frame 24, thence to the pulley 40, mounted upon the lower end of the lever 27, and thence upwardly to the sliding element 32. From the rearward edge of plane A, an operating cable 41 passes around a pulley 42 upon the fuselage, thence to and around a pulley 43 upon the upper left hand corner of the rocking element 24, thence to a pulley 44 upon the lever 27, thence downwardly to the operating block or element 32. Plane C is connected in similar manner, but to the opposite or rear side of the rocking element 24. An operating cable 45 from the front edge thereof extends around a pulley 46 upon the fuselage thence to a pulley 47 attached to the lower left hand corner of the rocking frame 24, thence to a pulley 48 upon the lower end of the lever 27, and thence upwardly to the

operating block or element 32. A cable 49, attached to the rear edge of said plane C, extends downwardly to a pulley 50 upon the fuselage, thence to a pulley 51 upon the upper left hand corner of the rocking element 24, thence inwardly to a pulley 52 upon lever 27 and thence downwardly to the operating block or element 32.

Planes B and D are connected in the same manner to the front and rear of the rocking element, at the right hand side, and it will not be necessary to follow these connections through in detail, as they are clearly indicated in the drawings. It will be noted, however, that these operating cables from the various planes, are connected to the rocking element, and also to the lever, at points above and below their pivotal axes, whereby as said elements are moved, some of the cables are drawn and others are paid out, thereby moving the planes upon their pivotal mountings. The operation of the various plane sections by means of the operating mechanism and the connecting cables may be briefly described as follows:

By turning the hand wheel 29 in opposite directions, I have one control, or movement, of the planes. By moving the rocking frame or element 24 forwardly and backwardly, I have another movement or control of the planes. By moving the lever 27 laterally in either direction upon its pivotal mounting at 28, I have another movement or control of the planes. And by moving said lever forwardly and laterally in either direction, or backwardly and laterally in either direction, I have still another movement or control. Thus I have a universal movement upon horizontal axes, and by means of the vertically slidable element 32, as a part of said controlling mechanism, I can make every movement possible. Therefore, by turning the hand wheel 29 to the left, the operating block or element 32 is moved downwardly by the cable 33. This movement operates to draw cables 41, 49, 53 and 54, and to pay out cables 37, 45, 55 and 56, thereby operating to draw down the rear edges of all the planes and to raise the forward edges thereof in unison, and thus direct the planes upwardly. By turning the hand wheel 29 in the opposite direction, an opposite movement of all the planes is effected. By this movement of the hand wheel it is possible to move the planes simultaneously for rising or descending on a horizontal keel, or with the fuselage in a horizontal position.

Now by rocking the frame 24 forwardly and away from the pilot, cables 37 and 55 are drawn by the lower portion of said rocking frame, thereby drawing downwardly simultaneously the forward or advancing edges of planes A and B. This same movement of the rocking element 24 draws cables

49 and 54, by its upper portion, which operates to simultaneously draw downwardly the rearward edges of the rear planes C and D, and to raise their forward or advancing edges. With the planes in these positions, it will be understood that the forward end of the machine is directed downwardly, and the rearward end thereof is directed upwardly. The opposite or reverse movement of the rocking element upon its pivotal mounting, operates to direct the forward planes upwardly and the rearward planes downwardly. By reason of this control movement, it is possible to correct or restore and maintain the longitudinal equilibrium of the machine.

Now by moving the operating lever 27 laterally to the right, for example, upon its pivotal mounting 28, cables 41 and 49 are drawn, and cables 37 and 45 are paid out, which manipulation operates to direct planes A and C upwardly. By this same movement, cables 55 and 56 are drawn, and cables 53 and 54 are paid out, which operates to draw planes B and D downwardly. Thus the planes on the right hand side are directed downwardly and the planes on the left hand side are directed upwardly.

By moving said lever 27 to the left, or in the opposite direction, an opposite movement of the planes is produced. That is, the planes on the left hand side are directed upwardly, and the planes on the right hand side are directed downwardly. By this movement or control of the operating lever, the lateral equilibrium of the machine can be corrected and maintained.

Now in order to move diagonally opposite planes together, the pilot makes a combination forward, or backward, and lateral movement of the operating lever 27. For example, if said lever 27 is moved forwardly and laterally to the right at the same time, cables 49 and 55 are drawn, and cables 45 and 53 are paid out, thereby operating to direct plane B downwardly and the diagonally opposite plane C upwardly. Thus, if the forward right hand corner of the machine (that is, plane B) should be suddenly lifted, the pilot would instinctively lean forwardly and to the right, or to the high side, thereby unconsciously causing the adjustment of the planes just described; that is, plane B is directed downwardly and plane C is directed upwardly, thus operating to right the machine by action at opposite corners. If the pilot should move the lever backwardly and to the left, an opposite result would be produced, and plane B would be directed upwardly by the drawing of cable 53 and the paying out of cable 55, and plane C would be directed downwardly by the drawing of cable 45 and the paying out of cable 49.

This forward movement, or change in the

relative position of the operating lever and the pilot's body, operates to direct the forward planes downwardly in unison and to direct the rearward planes upwardly. As soon as the horizontal or longitudinal equilibrium has been thus restored, the operating lever and the pilot's body assume their normal positions relative to the machine, and the machine assumes its regular direction of flight. If the forward end of the machine is tilted downwardly and the machine starts down head first, the natural tendency of the pilot is to lean backwardly, thereby moving the rocking frame with him, which movement operates to lift the forward edges of the front planes, and to lower the forward edges of the rearward planes, thereby quickly bringing the machine to a horizontal balance or control. If one side of the machine is, from any cause, raised or lowered unduly, the natural tendency of the pilot is to lean toward the high side and thus move the operating lever 27 toward the high side. This movement operates, through the connections, to direct the front and rear planes on the lower side upwardly and to direct the front and rear planes on the upper or high side downwardly, thus righting the machine and restoring the lateral equilibrium. This same thing is true of the corners of the machine. If one corner is raised unduly, the pilot naturally leans forwardly and laterally toward that corner, or if one corner drops, he naturally leans toward the high corner, moving the rocking element and the operating lever toward the high corner, which movement operates to direct the upper plane downwardly and the diagonally opposite plane upwardly, thereby correcting or restoring the equilibrium of the machine. This natural or instinctive control is of very great importance and advantage to the aviator in the control of his machine, as it insures greater safety and becomes almost an automatic control.

By reason of the tandem arrangement of the planes, pivotally mounted to turn upon longitudinal axes, together with the controlling connections therefrom to the controlling mechanism illustrated and described, it will be understood that the longitudinal and the lateral balance and control of the machine is made possible and convenient, and at the same time is natural and instinctive.

From the foregoing description of the various movements of the controlling mechanism, it will be understood that there are many movements and combinations of movements which can be made by the operator or pilot without taking his hands from the hand-wheel. For example: Turning the hand wheel to the right or to the left operates to direct all of the planes simultaneously upwardly or downwardly. Moving the

rocking element forwardly or backwardly operates, respectively, to direct the forward planes downwardly and the rearward planes upwardly, or to direct the forward planes upwardly and the rearward planes downwardly, as the case may be. Moving the operating lever 27 laterally to the right or to the left, operates to direct planes A and C upwardly and planes B and D downwardly, or to direct planes A and C downwardly and planes B and D upwardly, depending upon the direction in which the lever is moved. There are also the four combination movements in which the rocking element 24 and the lever 27 are both moved in either direction upon their pivotal axes. In other words, the operating lever 27 can be moved toward any one of the four corners and thereby operate to simultaneously direct two diagonally opposite planes in different directions, as hereinbefore described.

Therefore, without the use of any auxiliary planes, such as ailerons or elevators, the pilot is able to fully control and direct his machine at will by the manipulation of the carrying or supporting planes. It should be noted, too, that the controlling mechanism; that is, the rocking element 24, the operating lever 27, pivotally mounted therein to move transversely thereof, and the hand wheel, 29, mounted upon the upper end of the lever 27, are so mounted and so connected to the four supporting or carrying planes, which occupy, as it were, the four corners of the machine, that the manipulation or movement of said controlling mechanism corresponds in each case to the natural or instinctive movement of the pilot's body relative to the changing position of the machine. For example, if the front of the machine is suddenly lifted, the body of the pilot and the rocking element 24 naturally moves forwardly, or maintains a perpendicular position, though the front end of the machine is raised.

I have also provided my machine with the usual vertical steering plane or rudder 56, operable from a foot lever 57, pivotally mounted upon the fuselage in front of the pilot's seat 6, as indicated. The rudder 56 and the steering wheel 3 are both operable together from this foot lever 57, by means of suitable operating cables. Cables 58 and 59 connect said lever 57 with the rudder 56, whereby the latter can be moved at will in either direction. Cables 60 and 61 extend from the foot lever 57, through pulleys 62-63 and thence rearwardly to the steering wheel 3, and are so connected therewith that the steering wheel and the rudder are moved together, whether in flight, or on the ground.

I am aware that many changes and modifications can be made in the embodiment of

the invention here shown for purposes of illustration without departing from the spirit thereof, and I do not, therefore limit the invention to the showing here made and described, except as I may be limited by a broad interpretation of the hereto appended claims.

I claim:

1. In an aeroplane, in combination with a fuselage, a plurality of carrying planes arranged in tandem, each of said planes comprising two independent plane sections oppositely disposed and pivotally mounted to turn upon their longitudinal axes, a rocking element pivotally mounted on said fuselage, an operating lever pivotally mounted on said rocking element, an operating hand wheel upon said lever mounted to turn upon a horizontal axis, and operating cables from said planes to said rocking element and said lever with connections to said hand wheel, for operating said planes.

2. In an aeroplane, in combination with a fuselage, a plurality of carrying planes arranged in tandem, each of said planes comprising two independent planes oppositely disposed and pivotally mounted to turn upon their longitudinal axes, a rocking element pivotally mounted on said fuselage, a sliding element on said rocking element, an operating element with connections for moving said sliding element in opposite directions, and operating cables from said supporting planes to said rocking element and said sliding element.

3. In an aeroplane, in combination with the fuselage and a plurality of movable plane members, a controlling mechanism for moving said plane members comprising a rocking element pivotally mounted on said fuselage, an operating lever pivotally mounted on said rocking element and movable independently thereof laterally in the plane of said rocking element, an operating hand wheel mounted upon said lever to turn in a vertical plane, and operating cables from said plane members to said rocking element, lever and hand wheel and operable by either or all of them to move said planes.

4. A controlling mechanism for aeroplanes, comprising in combination, a rocking frame pivotally mounted to turn upon an axis in the plane of said frame, operating cables connected to the opposite sides of said frame, both above and below its axis, an operating lever pivotally mounted upon said frame and movable laterally in the plane of said frame independently thereof, and movable therewith, said operating cables being also connected to said lever at opposite sides thereof, both above and below its pivotal axis, and means for drawing in and letting out said cables independently of the different movements of the rocking frame, and the

pivoted lever thereon, substantially as described.

5. In an aeroplane, in combination with the fuselage, supporting planes arranged in tandem, and each plane comprising oppositely disposed plane sections, of a controlling mechanism for said planes comprising a rocking element pivotally mounted on said fuselage, a lever pivotally mounted on said rocking element to turn upon an axis extending transversely of the axis of said rocking element and of its own longitudinal axis, and operating cables extending from said plane sections and connected to the opposite sides of said rocking element and to the opposite sides of said lever at points above and below their pivotal axes, whereby to move said planes by the movement of said rocking element and said lever together or independently upon their pivotal axes.

6. In combination, an aeroplane having a plurality of horizontally disposed carrying planes, a rocking element, an operating lever pivotally mounted thereupon to turn upon an axis transversely thereof, an operating hand wheel mounted upon said lever, operating cables from the opposite sides of each of said carrying planes and connected to the opposite sides of said rocking element, and also to the opposite sides of said pivoted lever, whereby as said rocking element is rocked, or said operating lever is moved upon said rocking element, said carrying planes are moved together, or in pairs, and operating connections from said hand wheel to said cables, whereby said planes can be moved in pairs by the operation of said hand wheel independently of the movements of said rocking element and said lever.

7. In combination with an aeroplane and its movably mounted planes, a controlling mechanism therefor comprising a rocking element, a pivotally mounted lever thereupon and turning upon an axis extending transversely thereof, an operating hand wheel mounted on said lever upon a horizontal axis, a movable element operable by said hand wheel, and operating cables from said movable planes connected through said rocking element, and said lever to said movable element, whereby to move said planes in the control of said aeroplane.

8. An aeroplane, comprising in combination, a fuselage, supporting or carrying planes arranged in tandem and pivotally mounted to turn on their longitudinal axes, each of said planes comprising oppositely disposed and independently movable plane sections, a universal controlling mechanism therefor, comprising two connected pivoted members movable upon axes extending at right angles to each other, one of said members moving at right angles to the other, one of said members moving with the other,

but being itself movable independently of the other, operating cables from said carrying planes connected to the opposite sides of said pivoted members above and below 5 their pivotal mountings, and means for drawing in a part of said cables and letting out others of said cables independently of the pivotal movement of either of said pivoted members, whereby said plane sections 10 can be operated simultaneously in pairs.

9. In an aeroplane, in combination with the movable planes thereof, a controlling mechanism therefor comprising a pivotally mounted operating lever, mounted to be 15 moved universally, an operating hand wheel upon said lever and locking means therefor, an operating cable upon said lever extending longitudinally thereof and around said hand wheel, and operating cables from said 20 movable planes attached to said lever and to said operating cable, whereby to operate said movable planes.

10. In an aeroplane, in combination with the movable planes thereof, a controlling 25 mechanism therefor comprising a universally movable operating lever, an operating hand wheel upon said lever and turning upon an axis transversely thereof, a pulley upon said lever, an operating cable upon said lever 30 and around said hand wheel and said pulley, and operating cables from said movable planes attached to said lever and to said operating cable, whereby to operate said 35 movable planes by the movement of said lever, or of said hand wheel upon their pivotal axes, independently or together, for the purpose described.

11. An aeroplane controlling mechanism

comprising, in combination with the movable planes thereof, a frame pivotally 40 mounted to rock on an axis extending flatwise thereof intermediate its upper and lower edges; a lever pivotally mounted upon said frame to move in the plane thereof 45 upon an axis extending transversely thereof, a hand wheel upon said lever turning upon an axis transversely of the longitudinal axis of said lever, and operating cables from said 50 movable planes connected through said frame and lever at points above and below their pivotal axes and to said hand wheel, whereby said planes can be moved by said 55 frame, lever and hand wheel independently of each other or together, substantially as described.

12. In an aeroplane, in combination with the movable supporting planes thereof, a 60 controlling mechanism therefor comprising a rocking element, a lever pivotally mounted upon said rocking element to turn upon an axis extending transversely thereof, and 65 a hand wheel mounted upon said lever to turn upon an axis extending transversely thereof, said rocking element, said lever and said hand wheel being movable upon their 70 pivotal axes independently of each other or simultaneously or in pairs, and adapted to have operating cables from said supporting planes attached thereto at opposite sides of their pivotal axes.

Signed at Portland, Oregon, this 28th day of September, 1912.

FRANK A. BULLINGTON.

In presence of—

JAMES H. McMENAMIN,
CHAS. J. SWINDELLS.