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Patented Mar. 21, 1911.

O. & W. WRIGHT,  
FLYING MACHINE.

Fig. 1

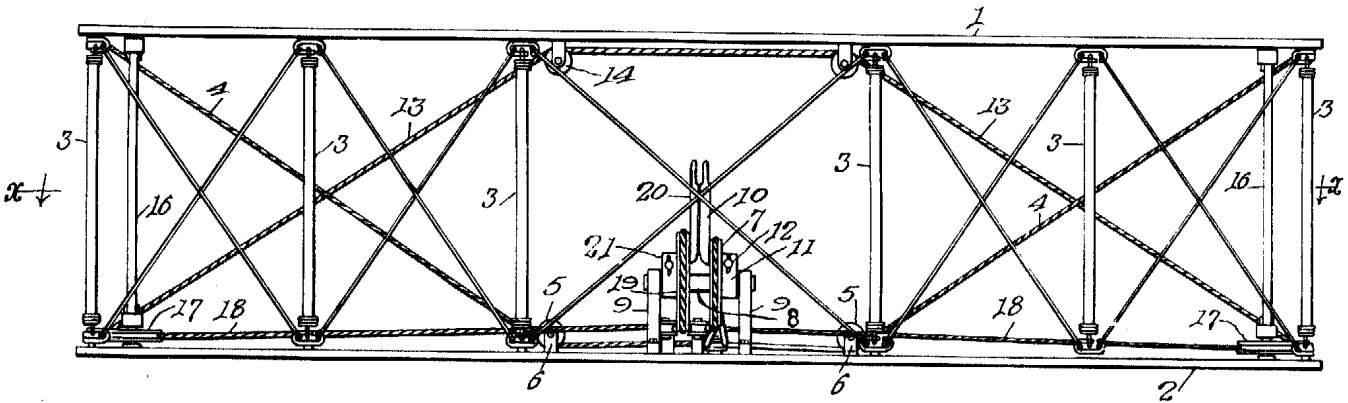
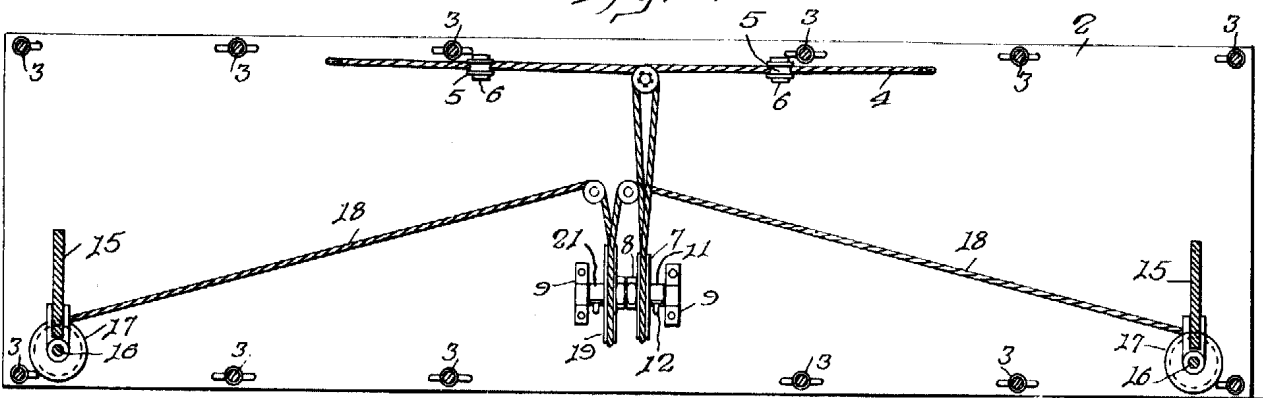


Fig. 2



Witnesses

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# UNITED STATES PATENT OFFICE.

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## FLYING-MACHINE.

987,662.

Specification of Letters Patent. Patented Mar. 21, 1911.

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*To all whom it may concern:*

Be it known that we, ORVILLE WRIGHT and WILBUR WRIGHT, citizens of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Flying-Machines, of which the following is a specification, reference being had therein to the accompanying drawings.

The present invention relates to that class of flying machines, in which the weight is sustained by the reaction resulting when one or more aeroplanes are moved through the air edgewise at a small angle of incidence either by the application of mechanical power or by the utilization of the force of gravity, and is in the nature of an improvement upon the machine shown and described in Letters Patent No. 821,393, granted to us May 22, 1906.

The object of the invention is to provide means for maintaining lateral balance by the use of horizontal surfaces adjustable to face forward at different angles of incidence on the right and left sides of the longitudinal axis of the machine and adjustable resistance surfaces also on opposite sides of the longitudinal axis of the machine, whose relative resistance to forward motion can be varied by suitable adjustments, and means for adjusting these resistance surfaces so as to increase the backward pressure on that wing or end of the machine having for the time being the smaller angle of incidence or least resistance.

With these objects in view our invention consists in certain novel features of construction and in certain parts and combinations hereinafter to be described, and then more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a front elevation of a flying machine embodying our invention; and Fig. 2 is a horizontal sectional view, taken on the line  $x-x$  of Fig. 1 and looking in the direction of the arrows.

In these drawings, we have illustrated a flying machine similar in its general features of construction to that shown and described in the above-mentioned patent and comprising superposed connected aeroplanes, the opposite lateral portions of which are adapted to be moved about a horizontal axis and thus impart to each aeroplane a helicoidal warp or twist, whereby

the angle of incidence presented to the atmosphere by one lateral portion of the aeroplanes is or may be made different from that presented by the opposite lateral portion of the same aeroplane, thus, when coacting with the adjustable resistances presently to be described, enabling the lateral balance of the machine to be adjusted and maintained by adjusting the angles of incidence which are presented to the atmosphere on opposite sides of the center of said aeroplanes. The aeroplanes may be of any suitable construction and may be operated in any desired manner, but we prefer the construction and mode of operation herein shown and described, in which the machine comprises an upper aeroplane 1 and a lower aeroplane 2, connected one to the other by means of suitable rods or rigid bars 3, which are secured at their opposite ends to the respective aeroplanes by means of flexible or universal joints. Each aeroplane preferably consists of a substantially rectangular frame, having its greatest length extending transversely of the line of travel of the machine, and may be composed of any suitable material which combines the necessary strength with the required degree of flexibility, such as a suitable quality of wood or light metal bars. These frames are covered with a suitable fabric which forms the surface of the aeroplane. The opposite lateral portions of these aeroplanes may be moved about a horizontal, transverse axis to impart the helicoidal warp or twist thereto in any suitable manner, but we prefer the means herein shown, which consists of a suitable cable 4 secured at its ends to the opposite lateral portions of the upper aeroplane, preferably near the upper corners thereof, and extending inwardly and downwardly to points on opposite sides of the center of the lower aeroplane, where it passes beneath suitable guides 5 which are preferably supported from the frame of the lower aeroplane in any suitable manner, as by means of the brackets 6, and at a point between said guides the cable is provided with suitable means for moving the same either to the right or to the left. As herein shown, this means consists of a drum 7, about which the central portion of the cable passes, and which is journaled upon a suitable shaft 8 which is rigidly mounted in brackets 9, which are preferably supported from the

lower aeroplane. This drum is provided with a suitable handle 10 and with a suitable friction clamp adapted to engage the shaft and resist the movement of the drum about said shaft. In the form here shown, this friction clamp consists of a split collar 11, secured to one side of the drum 7 extending about the shaft 8 and provided with a thumb-screw 12, by means of which the friction applied to the shaft 8 may be regulated.

A second cable 13 is secured at its opposite ends to the opposite lateral portions of the lower aeroplane, preferably near the rear corners thereof, and extends inwardly and upwardly and passes over suitable guides 14 supported from the upper aeroplane in any suitable manner. This cable 13 is of such length and is connected to the aeroplane in such a manner as to be at all times taut. Thus, it will be seen that, when the handle 10 is operated to move the drum 7 in one direction, the cable 4 will draw downwardly one corner of the upper aeroplane, and, as this aeroplane is connected by rods 3 to the lower aeroplane, the corresponding corner of the lower aeroplane will also move downward, thus imparting to both aeroplanes the desired helicoidal warp or twist. As the cable 4 is moved in a direction to draw down this side of the aeroplane, that portion of the cable connected to the opposite lateral portion of the upper aeroplane becomes slack and the cable 13, which is connected to that portion of the lower aeroplane which has been depressed, is moved toward that side of the aeroplane to which the twist has been imparted and thus raises or elevates the opposite lateral portion of the lower aeroplane, and, through the medium of the connecting rods 3, also elevates the corresponding portion of the upper aeroplane. Thus, it will be seen that a single movement of the handle 10 imparts a helicoidal twist to the opposite lateral portions of both aeroplanes, whereby differing angles of incidence are presented to the atmosphere, and that, by the adjustment of these angles of incidence, the lateral balance of the machine may be restored and maintained, this function resulting from the fact that the side of the machine presenting the larger angle of incidence to the atmosphere will tend to rise or move upward, while the other side of the machine will tend to drop. The increased angle of incidence of the one side of the aeroplane, however, in addition to producing an increased vertical pressure, also presents an enlarged resistance surface to the atmosphere, and, consequently, its forward movement is resisted, and the opposite side of the aeroplane, or the side having the smaller angle of incidence, will move forward more rapidly than the side having the larger angle of incidence. But since the reactions of the air increase in power as the speed becomes

greater, the vertical pressure on the side having the less angle would tend to increase by reason of the greater speed till the vertical effect resulting from the difference in angles of incidence would be neutralized or overcome, and the original object would be defeated. In order to control this secondary effect in such a way as to preserve the primary effect, suitable means must be introduced into the structure to control the relative speeds of the right and left sides of the machine. With this object we provide certain resistance devices which may be adjusted so as to increase the horizontal resistance on the side having the less angle of incidence and less horizontal resistance, thus balancing one increase of resistance directly against another and obviating the formation of turning couples in which the inertia or the momentum of the machine would constitute a factor. These resistance devices may be of any suitable construction, but we prefer to employ that herein shown, in which each resistance device consists of a vane 15, secured at one edge to a shaft or rod 16, which is journaled at its opposite ends in the respective frames of the upper and lower aeroplanes. The shaft is provided, preferably beneath the bottom of the vane 15, with a drum or pulley 17, to which is secured one end of a cable 18 which extends to the opposite side of the machine and has its opposite end secured to the corresponding drum 17 of the corresponding vane 15. At a point intermediate the drums 17 the cable 18 is provided with suitable means for actuating the same to adjust the vanes 15. This actuating mechanism preferably consists of a drum 19, mounted upon the shaft 8 and provided with a suitable handle 20 and with a suitable friction clamp 21, the drum and clamp being preferably similar to the drum 7 and clamp 11. The handle 20 preferably extends parallel and in close proximity to the handle 10 and lies in such relation thereto that both of said handles can be grasped in one hand and both the drums 7 and 19 operated simultaneously. When the handle 20 is moved in one direction, tension is exerted upon one side of the cord 18 and the other side thereof becomes slack, thus moving one of the vanes 15 into the desired position at an angle to the line of travel of the machine and allowing the other vane 15 to return to its normal position, that is, parallel with the line of travel of the machine. The friction clamp 21 serves to retain the vane in its adjusted position until the drum 19 has been positively moved to readjust the same or to allow it to return to its normal position.

The operation of the device has been clearly set forth in the description of the several parts, and it will be apparent that we have provided means for maintaining the balance of a flying machine of this char-

acter by the use of horizontal surfaces, which are adjustable to different angles of incidence on the right and left of the center of the machine, and of adjustable resistance devices also on the right and left of the center of the machine, whereby the resultant, unequal backward pressure on such horizontal surfaces may be compensated or controlled; that we have provided suitable means for adjusting the resistance devices, either alone or in connection with the adjustable horizontal surfaces, and further, that we have provided means for maintaining said surfaces in their adjusted position. It is to be furthermore understood that while the horizontal adjustable surfaces are herein shown as composed of integral portions of the main aeroplanes themselves, they may be otherwise constituted. And so also the resistance surfaces 15 may be otherwise constituted without departing from the spirit and contemplation of our invention. It will also be understood that while the invention is here shown as applied to a biplane it is equally applicable to any flying machine comprising one or more aeroplanes. It will, likewise, be understood that the words "horizontal surfaces", "adjustable horizontal surfaces" and the like, as used in the specification and claims, refer to adjustable wings or lateral surfaces which effect lateral balance, irrespective of whether or not the adjustable surfaces are formed integral with the supporting surface.

35 Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:—

1. In a flying machine, the combination, with an aeroplane comprising horizontal surfaces adjustable to different angles of incidence on right and left sides of the center of said machine, of adjustable air opposing resistances on the right and left sides of the center of said machine, and means for controlling said adjustable air opposing resistances.

2. In a flying machine, the combination, with an aeroplane comprising horizontal surfaces adjustable to different angles of incidence on the right and left sides of the center of the machine, of adjustable air opposing resistances on opposite sides of the center of the machine, and means for adjusting said air opposing resistances to equalize the backward pressures on the right and left sides of the center of said aeroplane when the horizontal surfaces are differently adjusted.

3. In a flying machine, the combination, with an aeroplane, and means for imparting a helicoidal warp thereto, of adjustable air opposing resistances on the right and left of the center of the machine, and means for adjusting said resistance devices to balance the unequal backward pressures on the right

and left of the center of the machine resulting from said warp.

4. In a flying machine, the combination, with an aeroplane comprising horizontal surfaces adjustable to differing angles of incidence on the opposite sides of the center of said machine, of vanes adjustably mounted on the opposite sides of the center of said machine, and means for adjusting one of said vanes at an angle to the direction of movement of said aeroplane.

5. In a flying machine, the combination, with an aeroplane comprising a horizontal surface adjustable to differing angles of incidence on opposite sides of the center of said machine, of vanes mounted on the opposite sides of the center of said machine, a cable connected at its opposite ends to said vanes, and means for actuating said cable to adjust one of said vanes and to allow the other to swing free.

6. In a flying machine, the combination, with superposed connected aeroplanes comprising horizontal surfaces adjustable to differing angles of incidence on the opposite sides of the center of said machine, of adjustable air opposing resistance surfaces mounted between said aeroplanes on the opposite sides of the center of said machine, and means for controlling the position of said adjustable air opposing resistances.

7. In a flying machine, the combination, with superposed connected aeroplanes comprising horizontal surfaces adjustable to differing angles of incidence on the opposite sides of the center of said machine, of vertical shafts journaled in said aeroplanes on the opposite sides of the center of said machine, vanes secured to said shafts, and means for rotating said shafts to adjust said vertical vanes.

8. In a flying machine, the combination, with superposed connected aeroplanes comprising horizontal surfaces adjustable to differing angles of incidence on the opposite sides of the center of said machine, of vertical vanes extending between said aeroplanes on the opposite sides of the center of said machine and pivotally connected thereto, a drum connected to each of said vanes near one end thereof, a cable connected at its opposite ends to each of said drums, and means for actuating said cable, whereby one of said vertical vanes is moved to an angle to the direction of movement of the machine and the other of said vertical vanes is allowed to swing free.

9. In a flying machine, the combination, with superposed connected aeroplanes, and means for imparting a helicoidal adjustment to the right and left portions thereof, of adjustable air opposing resistances, and means for simultaneously adjusting said aeroplanes and either of said resistance devices.

10. An aeroplane flying machine having

horizontal surfaces adjustable to different angles of incidence on the right and left sides of the longitudinal axis of the machine, means for controlling the same, and adjustable air-opposing resistances also on the right and left sides of the longitudinal axis of the machine, and means for controlling the same.

11. In a flying machine, horizontal surfaces adjustable to different angles of incidence on the right and left sides of the center of the machine, means for controlling the same, and adjustable air opposing resistances also on the right and left sides of the center of the machine, and means for controlling the same.

12. An aeroplane flying machine having substantially horizontal surface portions adjustable to different angles of incidence on right and left sides of the center of said machine, adjustable air opposing resistances

on the right and left sides of the center of said machine, and means for controlling said adjustable air opposing resistances.

13. A superposed aeroplane flying machine having substantially horizontal surface portions adjustable to differing angles of incidence on the opposite sides of the center of said machine, adjustable air opposing resistance surfaces mounted between aeroplanes on the opposite sides of the center of said machine, and means for controlling the position of said adjustable air opposing resistances.

In testimony whereof, we affix our signatures in presence of two witnesses.

ORVILLE WRIGHT.  
WILBUR WRIGHT.

Witnesses:

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LADOSKIE MILLER.