J. C. HULBERT.

AEROPLANE CONTROL.

APPLICATION FILED JUNE 21, 1910.

1,151,685. Patented Aug. 31, 1915.

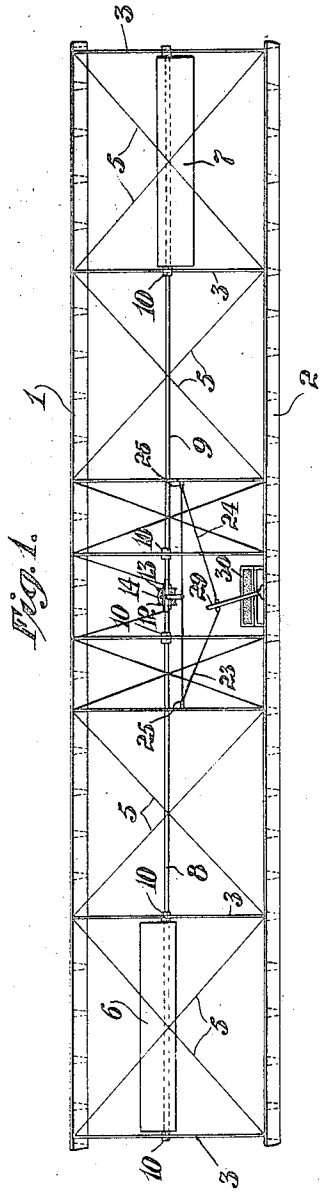


Fig. 1.

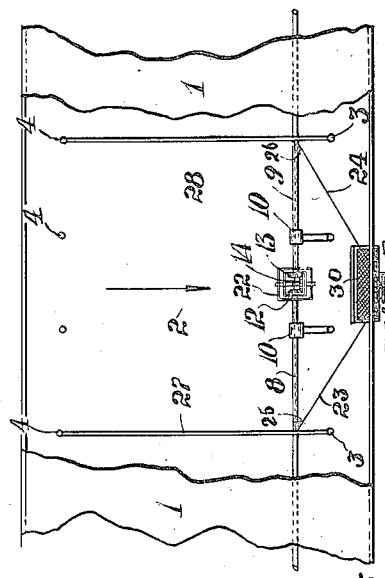


Fig. 3.

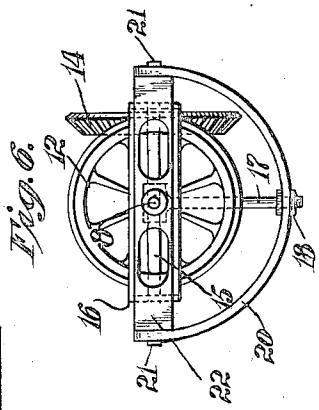


Fig. 6.

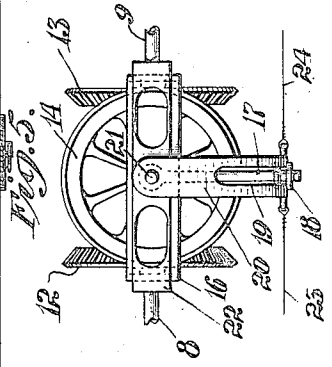


Fig. 5.

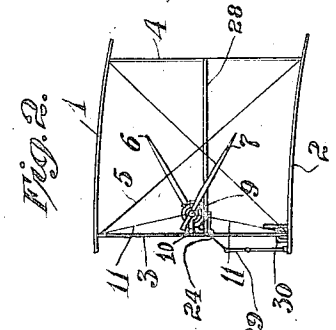


Fig. 2.

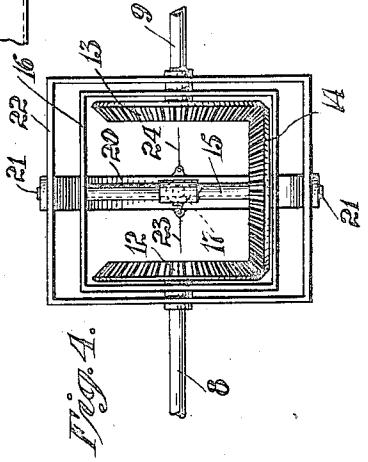


Fig. 4.

Attest:

W. M. Hughes

May Prevert.

James Cowan Hulbert Inventor:

by Wm. B. Whitney Atty

UNITED STATES PATENT OFFICE.

JAMES COWAN HULBERT, OF ST. LOUIS, MISSOURI, ASSIGNOR OF ONE-THIRD TO WILLIAM B. WHITNEY, OF NEW YORK, N. Y.

AEROPLANE CONTROL.

1,151,685. Specification of Letters Patent. Patented Aug. 31, 1915.

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To all whom it may concern:

Be it known that I, JAMES COWAN HULBERT, a citizen of the United States, and resident of the city of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Aeroplane Control, of which the following is a specification.

My invention relates to aeroplane control, and more particularly to means and methods for securing lateral stability in flying-machines of the aeroplane type.

The aeroplanes which have thus far proved most successful in operation have been kept in lateral balance while in the air by giving as required different angles of incidence to movable horizontally disposed surfaces located on opposite sides of the machine at some considerable distance from its longitudinal axis, as by differentially warping the lateral margins of the main sustaining planes or wings, by moving down into varying angular relations therewith one or the other of two supplementary surfaces or "ailerons" hinged to the rear edges of the wings on either side of the machine, or by rocking in opposite directions and to the same extent above and below a plane parallel to the planes of the wings two independent balancing planes mounted at or near the opposite ends of the wings to rotate on axes transverse to the line of flight. As the balancing surface having the greater lifting angle offers a proportionately greater resistance to forward movement, this operation necessarily unbalances the head resistances on its two sides and so gives the machine a tendency to turn about a vertical axis, which, if not properly met, will, instead of restoring it to balance, ultimately overturn the machine and cause it to fall. In all cases, therefore, the balancing operation, to be effective, requires, at times at least, the coöperation with the movable horizontal balancing surfaces of a vertical rudder which could be so moved as to present its compression or resisting surface on that side of the machine on which the balancing surface presents the smaller angle of incidence and so offers least head resistance, thus counteracting the tendency of the machine to turn; and, as this rudder is required for steering as well as balancing the machine and must therefore be capable of independent operation, the maintenance of the machine in lateral balance requires on the part of the aviator the simultaneous manipulation of separate means controlling the operation of the movable balancing surfaces and the rudder.

The object of the present invention is to remedy this defect and, by simplifying the operations required, to render more efficient and certain the control of the machine.

The invention consists, broadly stated, in so mounting and connecting the movable balancing surfaces employed that they may be brought into any desired angular relationship to each other by the movement of a single lever or other operating means and at the same time are free to rock together on their axes so that, whatever their angular relationship and whatever the flying angle of the machine, the air-pressures thereon will at all times and automatically cause them to present such opposite angles of incidence as will equalize and balance the pressures and resistances thereof, thus producing a balanced tilting or righting couple about the longitudinal axis of the machine.

It also comprises the methods and features and combinations of parts hereinafter described and more specifically pointed out in the claims.

Means embodying one specific form of my invention, as applied to the control of a biplane flying-machine, are illustrated in the accompanying drawings, in which, similar reference numerals being used throughout to indicate like parts, Figure 1 is a front view of a biplane truss provided with means for maintaining its lateral balance according to my invention; Fig. 2, an end view of the same; Fig. 3, a broken plan view, on an enlarged scale, of the central portion thereof, with a part of the upper main plane cut away; and Figs. 4, 5, and 6, enlarged details showing in plan and in front and side elevation, respectively, the differential gearing here employed as the means for operating the movable balancing surfaces.

As here illustrated, the upper and lower planes 1 and 2 are supported and held apart by forward and rear uprights or posts 3 and 4 and braced by diagonal wires 5, forming the well known biplane truss which is provided with the usual elevating and steering rudders (not shown) and is or may be equipped with any suitable propelling mech-

anism. The balancing planes 6 and 7, occupying respectively the right and left (from the operator's point of view) outer panels of the truss and located midway between the upper and lower planes, are mounted on and rotate with the concentric shafts 8 and 9, preferably of light hollow tubing, which are journaled in brackets 10 secured to the rear sides of and extending backwardly from the front uprights of the machine and braced by wires 11. Bevel gears 12 and 13 are mounted on the inner adjacent ends to rotate the shafts 8 and 9, respectively, and a third bevel gear 14, meshing on opposite sides with the gears 12 and 13, is mounted to rotate with the shaft 15 bearing at its two ends in the front and rear sides of a rectangular frame 16 the two connecting sides of which are suitably journaled upon the shafts 8 and 9 immediately back of the bevel gears.

A rock-lever 17 is secured at its upper end to the shaft 15 midway of its length and at its lower end is provided with a roller bearing 18 adapted to run loosely in a longitudinal slot 19 formed in the circular swinging frame 20 the ends of which are pivotally mounted on pins 21 projecting outwardly from the front and rear sides of an outer rectangular frame 22 which is in turn supported by having its two connecting sides journaled centrally on the shafts 8 and 9. If desired, the swinging frame 20 may be pivotally connected to suitably positioned fixed standards or hangers, or the rectangular frame 22 may be secured against rotation around the shafts 8 and 9 in any suitable way. The wires 23 and 24, attached at one end centrally to opposite sides of the swinging frame 20, lead respectively around the pulley-blocks 25 and 26 secured to the crossbars 27 and 28 and are attached at the other end to the pivoted operating lever 29, which is located conveniently with respect to the operator's seat 30. It is desirable that the two balancing planes shall balance as nearly as possible on their respective shafts and this may be effected by making their front sections of heavier construction than their rear sections or by suitable balancing springs, the weight of the gear 14 aiding in securing the desired result.

The operation of the balancing mechanism described is as follows: When it is desired to raise one side of the aeroplane, the left for example, either to restore the lateral balance of the machine or when steering it around a curve, the operator throws the handle of the lever 29 over toward the opposite side, or to the right, and thus draws the lower side or bottom of the swinging frame 20 and with it the lower end of the rock-lever 17 to the left, thus rocking the shaft 15 and gear 14 and causing the differential gears and their respective shafts to rotate in opposite directions to tilt the plane 6 to a lifting and the plane 7 to a depressing angle, as shown in Figs. 1 and 2, the angular relationship of the two planes depending upon the extent to which the operating lever is moved. As the lower end of the rock-lever 17 is free to swing forwardly or backwardly in the slotted lower side of the swinging frame 20, the two balancing planes and their shafts and the differential gearing by which they are operated are always free to rotate together as a unit in either direction, whatever may be the position of the operating lever and the angular relationship of the two planes to each other, and consequently the action of the air upon these two planes will at all times and automatically cause them to assume positions presenting such opposite angles of incidence, the one positive and the other negative, as will equalize and balance the air-pressure and resistances on the opposite sides of the aeroplane, at whatever angle it is flying and to whatever extent the wind velocities may vary at the opposite ends of its wings.

A perfectly balanced righting or tilting couple is thus obtained, which, as it in no way disturbs the balance of its head resistance, entirely eliminates the rudder as an element in the maintenance of the lateral balance of an aeroplane.

While I have illustrated and particularly described my invention only with reference to one specific form of operating mechanism and in connection with a single type of flying-machine, it is to be understood that it is equally applicable to other types and that it may be variously modified in its mechanical details without departing from the spirit or sacrificing the advantages thereof. For example, the balancing surfaces may either form integral parts of the main sustaining wings or be entirely independent thereof, their form and the positions in which they are placed may be changed, and any suitable mechanical means by which they may be moved into varying angular relations to each other while maintaining in balance the air-pressures and resistances thereof may be substituted for those shown and described. Such other modifications may be made as fall within the scope of the appended claims.

What I claim as new, and desire to secure by Letters Patent, is:—

1. In a flying machine, the combination of balancing planes located on opposite sides of the machine, operating shafts therefor, differential gears connecting said shafts, and means for rotating the central of said differential gears while permitting said planes, shafts, and differential gears to rotate freely as a unit about the axis of said shafts.

2. In a flying machine, the combination

with the main supporting surfaces of auxiliary movable balancing surfaces located on the opposite sides of the machine, means operatively connecting said balancing surfaces and including a train of differential gears, and means for rotating one of said differential gears to move said balancing surfaces to varying angular relationship one to the other while permitting said balancing surfaces and said differential gears to move freely as a unit.

In testimony whereof I have hereunto signed my name in the presence of two witnesses.

JAMES COWAN HULBERT.

Witnesses:
WM. B. BRINTON,
MAY FREVERT.