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(*Under International Convention.*)

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COMPLETE SPECIFICATION.

Improvements in Aeronautical Machines.

We, ORVILLE WRIGHT and WILBUR WRIGHT, both of 1127 W. Third Street, Dayton, County of Montgomery,, State of Ohio, United States of America, Manufacturers, do hereby declare the nature of our invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Our invention relates to improvements in that class of aeronautical machines in which the weight is sustained by the reactions resulting when thin surfaces, or wings, are moved horizontally almost edgewise through the air at a small angle of incidence, either by the application of mechanical power, or by the utilization of the force of gravity.

The objects of our invention are, first, to provide a structure combining lightness, strength, convenience of construction, and the least possible edge resistance; second, to provide means for maintaining or restoring the equilibrium of the apparatus; and third, to provide efficient means of guiding the machine in both vertical and horizontal directions. We obtain these objects by the mechanism shown in the accompanying drawing, in which Fig. 1 is a view in perspective of the machine, Fig. 2 a side elevation, and Fig. 3 a top plan view.

The superposed horizontal surfaces 1, formed by stretching cloth upon frames of wood and wire, constitute the "wings," or supporting part of the apparatus. They are connected to each other through hinge joints by the upright standards 2 and the lateral stay wires 3, which together with the lateral spars 4 of the wing framing, form truss systems giving the whole machine great transverse rigidity and strength. The hinge joints admit of both flexing and twisting movements, and may be either ball and socket joints, or any joint of sufficiently loose construction to admit of the movements specified. The object of joints having both flexing and twisting movements is to permit superposed wing surfaces, or parts thereof, when joined together by upright standards, to be twisted or bent out of their normal planes for the purpose hereafter specified. We do not restrict outselves to the use of any particular form of joint, nor to its use at any particular number of places.

One end of the rope 5 is attached near the rear corner of the upper surface, passes diagonally downward around the pulleys 6, and diagonally upward to the corresponding corner at the opposite end of the machine. The rope 8 is attached to the front corner of the upper surface, passes around the pulleys 7 and back to the opposite upper corner. The movable cradle 9 is attached to

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the rope 5 at the point where the operator's body rests, and provides a means of imparting movement to the ropes 5 and 8. The operator lies prone on the lower surface, his hips resting in the cradle, and his hands grasping the roller 10, which actuates the front rudder. The ropes 5 and 8 maintain the fore and aft positions of the two surfaces 1 with respect to each other, and by their movement impart a twist to the entire structure, including the wings 1, as will be more fully described hereafter. We have shown the operating system by means of ropes, which we now prefer to use, but we do not restrict ourselves to the use of any particular method of imparting this twist to a structure formed in the manner specified.

The main frames of the wings 1 are formed by uniting the lateral spars 4 (Fig. 3) by means of end bows 11. The cloth for each wing, previous to its attachment to the frame, is cut on the bias and made up into a single piece approximately the size and shape of the wing, having the threads of the cloth 12 (Fig. 3) diagonal to the lateral spars 4 and the longitudinal ribs 13, with which they form truss systems. A wide hem is sewed in the rear edge to form a pocket for the insertion of the wire 14. By the combination of a frame work with a cloth covering, each formed in the manner described, we secure a surface of very great strength to withstand lateral and longitudinal strains, but capable of some twisting movement.

When the two surfaces 1 are joined together by the wire stays 3, the ropes 5 and 8, and the upright standards 2, as already described, a system is formed capable of sustaining great weight without distortion. But when the cradle 9 is moved to right or left by the operator, the motion is communicated through the ropes 5 and 8 and the upright standards 2 in such a manner that the wing surfaces are twisted, the rear edge of the wing tips being drawn downward at one end of the machine and drawn upward at the other; thus presenting the left set of wing tips to the wind at a greater or a less angle than the right. When in flight, the end having the greater angle will necessarily rise and the other end will sink, so that the lateral balance of the machine is under control through twisting movements of the wing tips by the operator, by means of the cradle 9.

The struts 15, together with the struts 16 (Fig. 2) in combination with the main frame, form trussed skids which prevent the machine from rolling over forward when it lands, and also relieves the jerk on the rope 8. They are also utilized as a part of the front rudder steering system.

The flexible front rudder 17 consists of the stiff cross sticks 18, 19, 20 and the thin ribs 21, over which is stretched a cloth covering. The rudder is mounted upon the struts 15 by attachment to the cross stick 18, which is located near the centre of pressure, so as to form a balanced rudder. The up and down motion of the front edge of the rudder is in part restrained by the springs 23. The rear edge is raised and lowered by means of the axles 10, 22, the bands 24 and the arms 25 and 26, or by any other suitable means. The restraining action of the springs 23 causes the ribs 21 to bend when the rear edge is raised or lowered, thus presenting a concave surface to the action of the wind, and very greatly increasing its power as compared with a plane of equal area. By regulating the pressure on the upper and lower sides of the rudder, through changes of angle and curvature, a turning movement is communicated to the main structure and the course of the machine is directed upward or downward at the will of the operator, and the longitudinal balance maintained.

Contrary to the usual custom, we place the horizontal rudder in front of the main surfaces or "wings" at a negative angle, and use no horizontal tail at all. By this arrangement we obtain a forward surface which is almost free from pressure under ordinary conditions of flight, but which, even if not moved at all, becomes an efficient lifting surface whenever the speed of the machine is accidentally reduced very much below the normal, and thus largely counteracts that backward travel of the centre of pressure on the main surfaces or

wings which has frequently been productive of serious injuries by causing the machine to turn downward and strike the ground head on. We are aware that a forward horizontal rudder of different construction has been used in combination with a supporting surface and a rear horizontal rudder, but this combination was not intended to effect and did not effect the object which we obtain by the arrangement of surfaces here described.

The vertical tail or rudder 27 is attached through universal joints to the two pairs of struts 28, which lie in parallel horizontal planes, and are connected to the rear edges of the main surfaces 1 by hinged joints. This combination secures the tail rigidly in a vertical position, but enables it to turn on a vertical axis, and also to rise bodily in case it strikes the ground, and thus escapes breakage. The cords 29 are tiller ropes which connect the rudder wheel 30 to the rope 8, which in conjunction with the rope 5 imparts the twisting motion to the wing tips as heretofore described. By this method of attachment the same motion of the ropes 8 and 5 which actuates the wing tips also presents to the wind that side of the vertical rear rudder which is toward the tip having the smaller angle of incidence. The wing tip presented to the wind at the greater angle, under the usual conditions of flight, has both greater lift and greater drift, or resistance, than the other. The wing with the greater angle therefore, tends to rise and drop behind, while the other sinks and moves ahead. Under these circumstances the longitudinal axis of the machine tends to turn toward the wing having the greater angle, while the general course of the machine through the air tends toward that wing which is the lowest with the result that a wide divergence soon arises between the direction which the machine faces and its actual direction of travel. By the use of a rear movable vertical rudder, so operated as to present to the wind that side which is toward the wing having the least angle, we obtain a turning force opposite to and greater than that arising from the difference in the resistance of the two wings, and thus are able to keep the longitudinal axis of the machine approximately in coincidence with the line of flight. We do not confine ourselves to the particular construction and attachment of the rear rudder hereinbefore described, nor to this particular construction of surfaces or wings, but may employ this combination in the use of any movable vertical rear rudder operated in conjunction with any wings capable of being presented to the wind at respectively differing angles at their opposite tips for the purpose of restoring the lateral balance of a flying machine and guiding the machine to right or left.

We are aware that prior to our invention flying machines have been constructed having superposed wings in combination with horizontal and vertical rudders; we therefore do not claim such combination broadly.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. In a flying machine, the combination of superposed surfaces or "wings", with upright connecting standards one or more of which has its attachment by means of hinges or flexible joints, substantially as described and for the purpose specified.

2. In a flying machine, the combination of superposed surfaces or wings with upright connecting standards attached through flexible joints, and laterally extending stay wires, substantially as described.

3. In a flying machine, the combination of one or more supporting surfaces or wings with a device for imparting a twist to the said surfaces or wings for the purpose stated.

4. In a flying machine, the combination of superposed wings, upright standards attached by flexible joints, and laterally extending stay wires, with a device for imparting a twisting to the wings for the purpose specified.

5. In a flying machine, the combination of superposed wings, upright standards attached by means of flexible joints, and laterally extending stay wires, with actuating ropes attached and operated substantially as described.

6. In a flying machine, the combination of wings having their right and left tips capable of being adjusted so as to be presented to the wind at respectively differing angles, with a vertical adjustable rear rudder operating in conjunction therewith in the manner and for the purpose specified.

7. In a flying machine having wings capable of being twisted by actuating ropes, the combination therewith of a movable vertical rear rudder having tiller cords attached to said actuating ropes, substantially as described.

8. In a flying machine, the combination of superposed surfaces with a vertical rear rudder, and hinged connecting arms in parallel planes substantially as described.

9. In a flying machine having surfaces or wings composed of a cloth covered frame, the combination of laterally extending spars and longitudinal ribs, with a covering having the threads of the cloth diagonal to the main lines of the framing, substantially as set forth.

10. In a flying machine the combination of superposed surfaces with forwardly extending struts arranged in the manner and for the purpose specified.

11. In a flying machine, the combination of supporting wings with a smaller inert surface which becomes a supporting surface when the speed of the machine is greatly diminished, substantially as described and for the purpose specified.

12. In a flying machine, the combination of supporting wings and a horizontal rudder, having stiff lateral sticks, thin longitudinal ribs, and cloth covering, and a device for imparting a slight curvature to the rudder in the manner and for the purpose specified.

13. In a flying machine, the combination of supporting wings with a flexible horizontal rudder and a device for simultaneously regulating the angle of the rudder with the wind and imparting to it a slight curvature, substantially as described and for the purpose specified.

14. In a flying machine, the combination of superposed surfaces capable of being twisted with a forward horizontal rudder and an adjustable vertical rear rudder, substantially as described and for the purposes specified.

Dated this 19th day of March 1904.

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WRIGHT & *another's* COMPLETE SPECIFICATION. *(1 SHEET)*

Fig. 1.

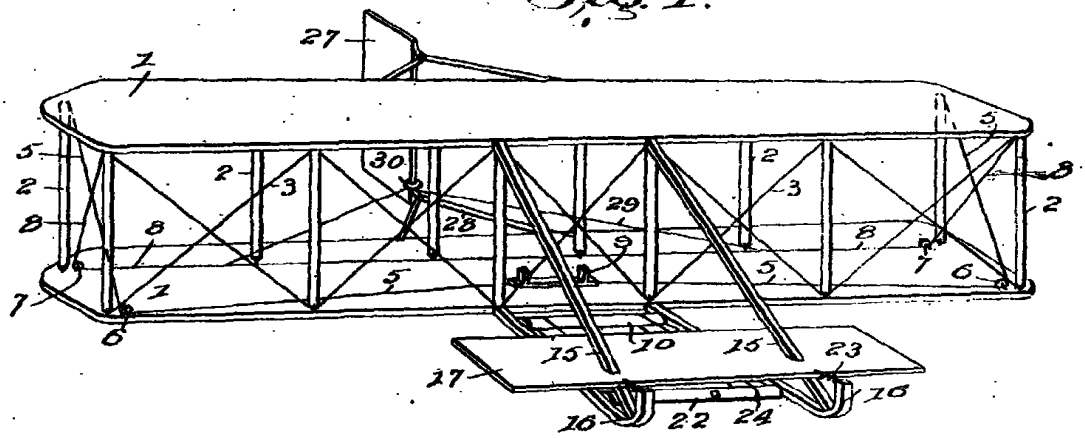


Fig. 2.

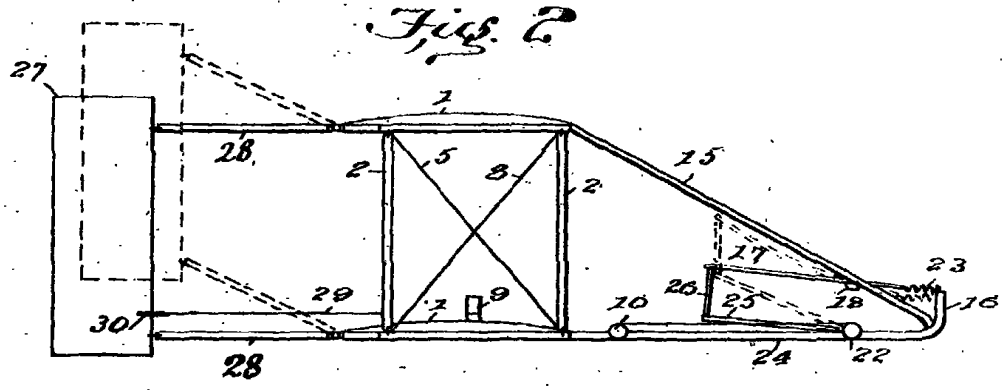
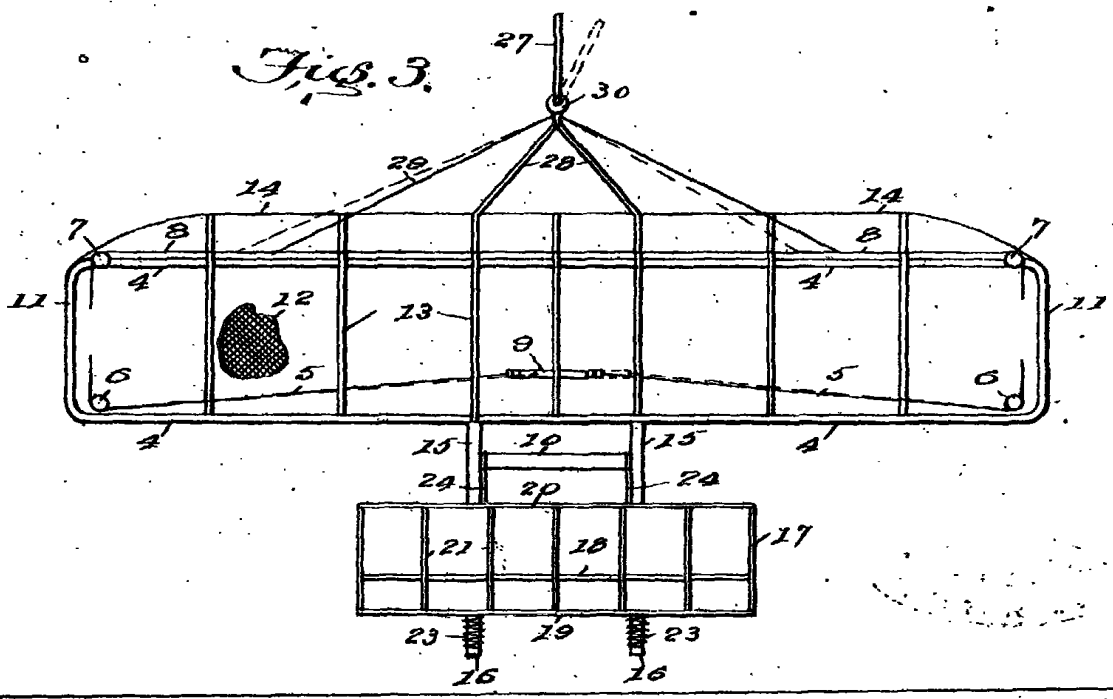


Fig. 3.



Malby&Sons, Photo-Litho.

[This Drawing is a reproduction of the Original on a reduced scale.]