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PLANE AND THE LIKE FOR AEROPLANES.

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Fig. 1.

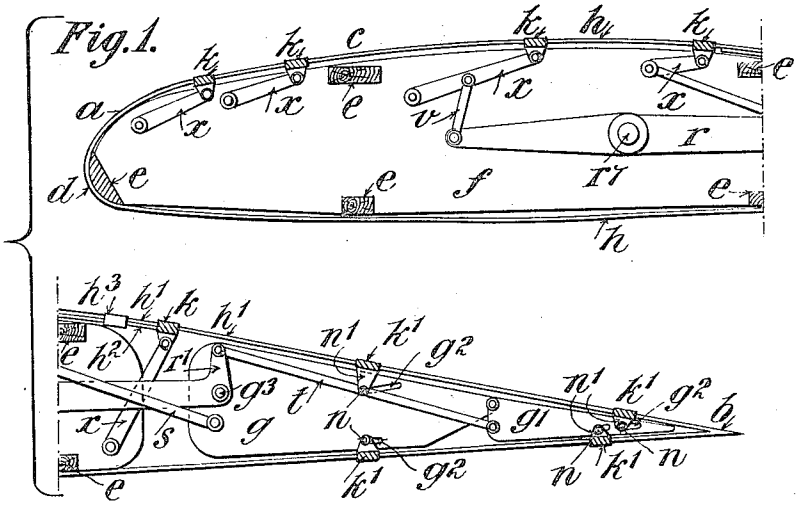
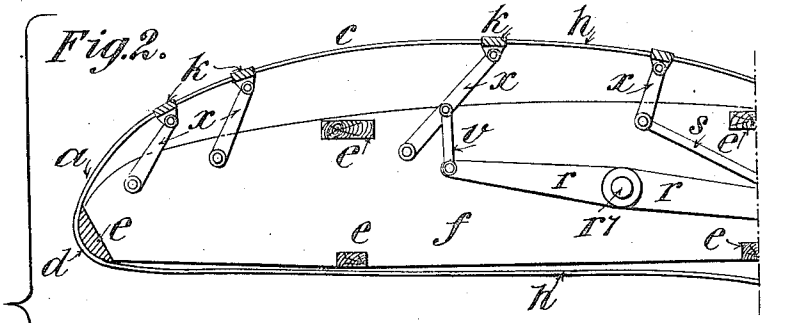
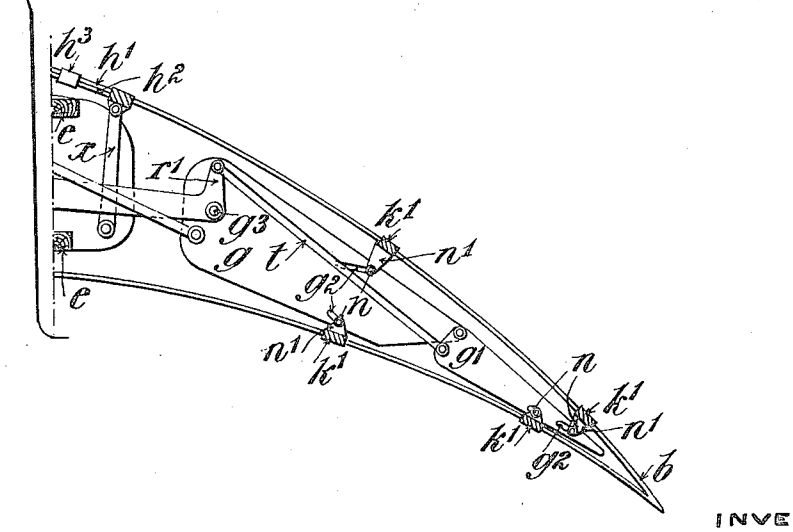


Fig. 2.





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PLANE AND THE LIKE FOR AEROPLANES.

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To all whom it may concern:

Be it known that I, ALEXANDER ALBERT HOLLE, a subject of the Queen of the Netherlands, residing at Bisham Lodge, Speer Road, Thames Ditton, in the county of Surrey, England, have invented certain new and useful Improvements in and Relating to Planes and the like for Aeroplanes, of which the following is a specification.

This invention relates to planes, wings, or the like—hereinafter referred to as aerofoils—of aeroplanes of the variable camber type, whether same be the main supporting planes or auxiliary planes employed for controlling and stabilizing purposes, and it consists of an improved construction which has for its object to extend the range of speeds of the machine in the horizontal and vertical planes, to extend its range of angles of ascent and descent, to extend its vertical range or maximum attainable altitude, to increase its efficiency as measured by its capacity for carrying a maximum load with a minimum expenditure of power, to improve its stability and maneuvering qualities, and lastly to balance the forces acting on the surfaces of the aerofoil so as to reduce to a minimum the effort necessary for its control.

The object of varying the camber of an aerofoil is to vary its angle of incidence whereby its lifting power is increased. The usual way of increasing the angle of incidence is by tilting it, either with the machine as a whole, or relatively to the body or fuselage of the machine. The objection to tilting the aerofoil—which is mechanically the most simple method—is that the camber of the aerofoil—which is a permanent one—can only be best suited to one particular angle of incidence, and although it permits the aerofoil to deal with a deep stratum of air (at a large angle) for a given chord and to deflect a large mass of air it does so more or less inefficiently at all angles but one. Furthermore, as is well known, the result of varying the angle of incidence by tilting the aerofoil is that the center of pressure moves considerably and in an unstable direction. This, apart from aerodynamical disadvantages, makes the balancing of the effort required for manipulation difficult, if not impossible, in constructions in which the incidence is varied relatively to the body of the machine.

Another way of increasing the angle of incidence is to vary the camber or curvature of the aerofoil. This has been carried into effect in many ways, for instance by curving the aerofoil throughout its entire length, by flexing the trailing edge of the aerofoil downward, by flexing the leading or entering edge of the aerofoil downward, and by flexing both the leading and the trailing edges downward either independently or at the same time. In all these constructions the thickness of the aerofoil throughout its entire length remains constant, and although they enable an increased stratum of air to be dealt with they only slightly increase the angle of incidence and therefore the lifting power, and have the same disadvantages as the tilted aerofoil in that the forces required for manipulation cannot be balanced.

According to the present invention, the aerofoil is constructed with a flexible rear or trailing edge and a rigid front or entering edge, said front edge having a continuous undeformable under surface and a continuous deformable upper surface so that the camber of said upper surface can be varied. The flexible trailing edge and the deformable upper surface of the front or entering part are so connected that at the same time that the rear or trailing edge is flexed downward the camber of the upper surface of the front or entering part of the aerofoil is increased, the under surface of the front or entering part remaining unchanged. The result of this is that the thickness of the aerofoil at its forward part is increased so that at the same time that its angle of incidence is increased its thickness at its front or entering edge is also increased, whereby the depth of the stratum of air swept by the aerofoil and the amount of air deflected is materially increased, said amount of deflected air being dealt with in the most efficient manner for the angle at which it is deflected.

The mechanisms employed to effect the flexing of the trailing edge and the variation of the camber of the upper surface at the front or entering edge are controlled by a balancing beam so that as the camber of the upper surface is increased the trailing edge is flexed downward and vice versa, whereby the positive pressure on the under side and the negative pressure on the upper

side of the trailing portion of the aerofoil is counterbalanced by the negative pressure on the leading portion of the upper surface of said aerofoil.

In the accompanying drawing which shows by way of illustration one construction for carrying this invention into effect:—

Figure 1 is a diagram view—divided into two parts—showing the aerofoil in its stream-like form, and

Fig. 2 is a similar view showing the aerofoil in its cambered form.

In both views similar parts are marked with like letters of reference.

The aerofoil comprises a rigid main frame consisting of a plurality of longitudinally arranged spars e, one of which is shaped to form the nose d of the front or entering edge a, and an articulated frame consisting of a pair of pivoted elements g and g^1. The spars e are carried by plates f, one located at each end of the aerofoil and such others interposed as the length of the structure demands, and said plates carry a series of flexible upper and lower ribs h adapted to carry the material employed for the surfaces of the aerofoil—not shown in the drawings—and arranged transversely in respect to the main frame, and two series of longitudinally arranged girders k and k^1 to which said ribs are fixed.

The flexible ribs h at the ends of the aerofoil are arranged over the end plates f and the intermediate ones are spaced at suitable distances apart. The girders k, preferably are so arranged that at all curvatures that the upper surface of the aerofoil at its forward part can assume, they remain at right angles to a line tangential to the curved surface. These girders are carried on a plurality of levers x which are pivoted to the plates f. The girders k^1 are carried by brackets n^1 which carry pins n which engage slots g^2 in the plates g and g^1. On plates f are pivoted rocking beams r mounted on a common shaft r^7 for simultaneously operating the mechanisms for lifting the girders k to vary the camber of the upper surface c of the aerofoil at its front or entering edge a, and for flexing both the upper and lower surfaces of the rear or trailing edge b of the aerofoil.

The mechanism for varying the camber of the upper surface of the aerofoil comprises the levers x which are pivoted to the main structure at one end and to the girders k at the other end, the lengths of said levers and their points of pivot being so arranged as to give them the necessary differential movement to produce the required alteration in the camber of the upper surface of the aerofoil and links v by which the forward ends of the beams r are coupled to two of the levers x. Each series or group of levers x may be coupled together if desired. The mechanism for flexing the articulated frame forming the trailing edge of the aerofoil consists of links s which are pivoted to the main frame at points above the points of pivot of the beams r and conveniently—as shown—at the same points as one of the levers x is pivoted, and of links t which connect the plates g^1 with offset arms r^1 at the rear ends of the beams r, said rear ends of said beams being pivoted to the forward ends of the plates g.

It will be understood that the mechanism at each end of the aerofoil is the same and that the connections between said mechanisms are essentially the girders k and k^1 and the shaft r^7. When intermediate plates f are employed intermediate mechanisms may also be employed, in which case means other than the girders—such for instance as continuations of the pivots of the various levers—may be employed for connecting the various mechanisms together.

The actual surfaces of the aerofoil are formed of the usual material which is carried by the flexible ribs, and to provide for the increased distance on the upper surface of the aerofoil between the front and the trailing edges thereof when the camber is increased and to preserve the continuity of said surface, the upper part of each flexible rib h is arranged to overlap at one part as shown, said overlapping parts h^1 and h^2 being guided in relation to one another in suitable guides such as h^3 and the surfacing material is arranged accordingly.

The motion necessary to actuate the two mechanisms is imparted to the beam r on the end plate f nearest to the fuselage of the machine, but it may also be imparted to any other convenient part or parts of the mechanisms in couple with said beam.

In the construction hereinbefore described with reference to the accompanying drawing, the actual shape—in transverse section—of the aerofoil is determined to some extent by the flexibility of the ribs. This in practice would necessitate said ribs being very carefully graded and the aerofoil would only remain perfect so long as no deterioration of the material of which the ribs are made takes place. The preferred construction is one in which the ribs are flexed from one predetermined shape to another predetermined shape independent of the flexibility of the ribs—by positively operating and rigidly holding each at a number of points so that the entire flexible surface is positively guided and rigidly maintained in the requisite position to cause the aerofoil to assume its predetermined shape.

By suitably selecting the successive cross sections the aerofoil is made to assume, the center of pressure or sustentation of the machine will remain approximately or entirely

in the same place relatively to the center of gravity, whereby the aeroplane is automatically balanced in flight at all speeds and a consequential improvement in its stability is obtained.

An aeroplane fitted with aerofoils constructed and arranged according to this invention has the advantage that the fuselage will always remain practically parallel to the line of flight, so that the propeller is always working to the best advantage, *i. e.* with the plane in which the blades rotate constantly at right angles to the direction or line of flight.

It will be appreciated that the suction or negative pressure on the camber of the upper surface of the aerofoil near its front or entering edge will facilitate the operation of increasing the camber, and that both the suction above the trailing edge of the aerofoil and the pressure beneath same will tend to oppose the downward flexing of said edge, so that by suitably apportioning these functions and interconnecting the operating mechanisms the opposing forces can be more or less completely balanced, whereby the effort of control is reduced to a minimum.

The variations of the shape, section and configuration of the aerofoils may also be utilized either exclusively or partially for directional or lateral control or both.

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

1. In an aerofoil for aeroplanes, the combination of a rigid frame carried by the fuselage of the machine, a nose piece carried by said frame forming the front or entering edge of the aerofoil, a continuous or unbroken undeformable under surface carried by said frame, a continuous or unbroken deformable upper surface carried by said frame, and a flexible trailing edge carried by said frame.

2. In an aerofoil for aeroplanes, the combination of a rigid frame carried by the fuselage of the machine, a nose piece carried by said frame forming the front or entering edge of the aerofoil, an articulated frame connected to said frame, a continuous undeformable under surface carried by the rigid frame, a continuous deformable upper surface carried by the rigid frame and mechanism coupling the articulated frame with the deformable upper surface of the forward part of the aerofoil, so that as the trailing edge of the articulated frame is flexed downward the camber of the deformable upper surface is increased and as the trailing edge is flexed upward the camber of the deformable upper surface is decreased.

3. In an aerofoil for aeroplanes, the combination of a rigid frame carried by the fuselage of the machine, a nose piece carried by said frame and forming the front or entering edge of the aerofoil, an undeformable under surface carried by said frame, a deformable upper surface carried by said frame, an articulated frame forming a flexible trailing edge carried by said frame, a rocking beam mounted on the rigid frame, mechanism operated by one end of the rocking beam for flexing the trailing edge, mechanism operated by the other end of the rocking beam for raising and lowering the upper surface of the front or leading part of the aerofoil so that as the trailing edge is flexed downward the camber of the upper surface is increased and as the trailing edge is flexed upward the camber of the upper surface is decreased.

4. An aerofoil comprising a rigid frame carried by the fuselage of the machine, an articulated frame coupled to and forming an extension of the rigid frame, a series of flexible upper and lower ribs transversely arranged in respect to and carried by said frames, a series of longitudinally arranged girders connected to said ribs, mechanism for raising and lowering said girders and ribs, mechanism for flexing the elements of the articulated frame, rocking beams pivoted on the rigid frame said beams being connected at their front ends to the mechanism for raising and lowering the upper surface of the front part of the aerofoil and at their rear ends to the mechanisms for flexing the articulated frame forming the rear or trailing edge of the aerofoil.

5. An aerofoil comprising a main rigid frame carried by the fuselage of the machine and consisting of two or more plates and a plurality of longitudinally arranged spars, an articulated frame consisting of a plurality of elements pivoted together said frame being coupled to the main or rigid frame, a series of flexible upper and lower ribs transversely arranged in respect to and carried by said frames, a series of longitudinally arranged girders connected to said ribs, a series of levers pivoted to the rigid frame and connected to the upper parts of the flexible ribs, links connecting the elements of the articulated frame to the main frame, rocking beams pivoted to the main frame the forward parts of said beams being connected to the levers operating the upper surface of the forward part of the aerofoil and the rear parts of said beams being connected to the inner elements of the articulated frame forming the flexible trailing part of the aerofoil.

6. An aerofoil comprising a rigid frame carried by the fuselage of the machine and consisting of a plurality of plates and a plurality of longitudinally arranged spars, an articulated frame consisting of a plurality of elements pivoted together said frame being pivotally connected to the rigid frame, a plurality of flexible upper and lower ribs transversely arranged in respect to and car-

ried by said frames, a plurality of longitudinally arranged girders connected to said ribs, a plurality of levers pivoted to the rigid frame and connected to the upper parts of the flexible ribs, rocking beams pivoted on the rigid main frame and having cranked arms at their rear ends said beams being pivoted at their rear ends to the front elements of the articulated frame, links connecting the cranked arms of each of the beams to the forward ends of the rear elements of the articulated frame below their points of pivot to the front elements thereof, links connecting the front ends of the front elements of the articulated frame—below their point of pivot to the rocking beams—to the rigid main frame above the points of pivot of the rocking beams to said frame, couplings between the elements of the articulated frame and the flexible ribs of the trailing edge of the aerofoil, and couplings between the rocking beams and the levers supporting the flexible ribs of the forward part of the aerofoil.

In testimony whereof I have signed my name.

ALEXANDER ALBERT HOLLE.