N° 15,290 A.D. 1915

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PROVISIONAL SPECIFICATION.

Improvements in and relating to Planes or the like for Aeroplanes.

We, ALEXANDER ALBERT HOLLE, of Bisham Lodge, Thames Ditton, in the County of Surrey, Gentleman, ARTHUR WILLIAM JUDGE, of "Summerfield," Ashley Road, Thames Ditton, in the County aforesaid, Aeronautical Engineer, and THE VARIOPLANE COMPANY LIMITED, of 34 & 36, Gresham Street, in the City & County of London, Aeroplane Manufacturers, do hereby declare the nature of this invention to be as follows:—

This invention relates to planes, wings or the like of aeroplanes whether same be the main supporting planes or auxiliary planes employed for controlling and stabilising purposes and hereinafter referred to as aerofoils, and it has for its object to extend the range of speeds in the horizontal and vertical planes of the machine, to increase its efficiency and controllability, and to improve its stability.

At present many ways are employed to increase the lift of an aerofoil at a given speed. A common way is to increase the angle of incidence by tilting the aerofoils either with the machine as a whole or relatively to the body of the machine. The objection to this—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. Therefore, although it permits the aerofoil to deal with a deep stratum of air (at a large angle) for a given chord, and deflect a large mass of air, it must do 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 aerofoils is that the centre of pressure moves considerably and in an unstable direction. This, apart from aerodynamical disadvantages, makes the balancing of effort required for manipulation difficult, if not impossible, in constructions in which the incidence is varied relatively to the body of the machine.

The angle of incidence can also be varied by flexing the trailing portion of the aerofoil in a downward direction, one disadvantage of which is that the maximum stratum of air swept by the aerofoil is less than that which can be swept by the same aerofoil (having a given chord) if it is merely tilted. The mass of air deflected is therefore smaller but it is dealt with in a more efficient manner.

It is now however well recognised that the angle of upward deflection bears a definite relation to the angle of final downward deflection, and that any increase in the angle of downward deflection should be accompanied by an increase in the angle of upward deflection.

According to our present invention, we flex the trailing portion of the aerofoil downwards and at the same time increase the upper camber of its front or entering edge. This increase of camber results in a steeper angle of upward deflection and also increases the depth of stratum of air swept by the aerofoil, so that it becomes possible to deflect a mass of air equal to that deflected by a tilted aerofoil of identical chord and to deal with said mass of air in the most efficient manner for the angle at which it is deflected. Further, the centre of pressure can be kept in the same place and the forces balanced.

[*Price 6d.*]

It will be appreciated that the suction on the upper camber near the front or entering edge of the aerofoil will tend to facilitate an increase of camber, and that both the suction above the trailing portion and the pressure beneath it will tend to oppose the downward flexing of same. By suitably apportioning those functions and interconnecting the operating mechanisms these opposing forces can be more or less completely balanced, thereby reducing the effort of control to a minimum.

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

In carrying this invention into practice we articulate the frame of the aerofoil from a suitable position to the rear of its front or entering edge and we mount the top or upper surface of the aerofoil so that it is capable of being raised or lowered to increase or decrease the transverse curvature of said top or upper surface at its front or entering edge and thereby the thickness of same.

The mechanism for varying the curvature of the upper surface of the aerofoil is so connected to the articulated part that as said curvature is increased the rear part is flexed downwards so as in effect to increase the angle of incidence, and inversely as the curvature is decreased the rear part is returned to its normal position whereby the angle of incidence is decreased.

To provide for the increased distance on the upper surface of the aerofoil between the front and rear edges thereof when the camber is increased, provision may be made—most conveniently at or near the rear edge—for the elongation of said surface.

The variation of the camber at the front or entering angle of the aerofoil and the inclination or flexure of the rear part of the plane is effected and controlled by suitable mechanism from any convenient part of the machine.

By suitably selecting the successive cross sections the aerofoil is made to assume, the centre of pressure or sustentation of the machine will remain approximately or entirely in the same place relatively to the centre of gravity, whereby the aeroplane is balanced in flight at all speeds and a consequential improvement in its stability is obtained.

Dated this 29th day of October, 1915.

PHILLIPSS,
Chartered Patent Agents,
70, Chancery Lane, London, W.C.,
Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in and relating to Planes or the like for Aeroplanes.

We, Alexander Albert Holle, of Bisham Lodge, Thames Ditton, in the County of Surrey, Gentleman, Arthur William Judge, of "Summerfield," Ashley Road, Thames Ditton, in the County aforesaid, Aeronautical Engineer, and The Varioplane Company Limited, of 34 & 36, Gresham Street, in the City & County of London, Aeroplane Manufacturers, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

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 stabilising 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 manœuvring 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 centre 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 downwards, by flexing the leading or entering edge of the aerofoil downwards, and by flexing both the leading and the trailing edges downwards 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 so constructed that at the same time that its rear or trailing edge is flexed downwards the upper surface of its front or entering edge is raised, while the under surface of its front or entering edge remains unchanged, whereby 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 or lever so that as the camber of the upper surface is increased the trailing edge is flexed downwards 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:—

Fig. 1 is a diagrammatic view in cross section showing the aerofoil in its stream-like form, and—by way of example suitable mechanism for effecting its change of form.

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 structure consisting of a plurality of longitudinally arranged spars *e*, one of which is shaped to form the nose of the front or entering edge. These spars are carried by two plates or frames *f*, one located at each end of the aerofoil, 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 said structure, two series of longitudinally arranged girders *k* and k^1 to which said ribs are fixed, a rocking beam, or lever *r* pivoted to each of the plates or frames *f*, mechanism 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 mechanism for flexing both the upper and lower surfaces of the rear or trailing edge *b* of the aerofoil.

The flexible ribs *h* at the ends of the aerofoil are arranged over the plates or frames *f* and the intermediate ones are spaced at suitable distances apart, additional intermediate plates or frames *f* being employed when necessary. The girders *k*, which are so arranged that at all curvatures that the upper surface of the aerofoil can assume they remain at right angles to a line tangential to the curved surface, are carried on levers *x* which are pivoted to the plates or frames *f*, and the girders k^1 are carried by brackets n^1 which carry pins *n*.

The mechanism for varying the camber of the upper surface *c* of the aerofoil comprises a link *v* which connects one or more of the levers *x* with the forward end of the rocking beam or lever *r*, and the mechanism for flexing the trailing edge *b* of the aerofoil consists of two plates *g* and g^1 which have slots g^2 with which the pins *n* carried by brackets n^1 engage. The forward end of the plates *g* is pivoted at g^3 to the rear end of the rocking beam or lever *r*, and at a point below said point of attachment the plate *g* is coupled to a link *s* which is pivoted to the plate or frame *f* at a point above the point of pivot of the beam or lever *r* and conveniently—as shown—at the same point that one of the levers *x* is pivoted. The rear end of the beam or lever *r* has an offset r^1 forming a crank which is coupled to the forward end of the plate g^1 below its point of pivot to the plate *g* by a link *t*.

It will be understood that similar mechanism is employed at each end of the aerofoil and that the connections between said mechanisms are solely the girders *k* and k^1. When intermediate plates or frames *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 rocking beams or levers *r*—may be employed for connecting the various mechanisms together.

The actual surfaces of the aerofoil are formed of any suitable material 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, 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 various mechanisms is imparted to the beam or lever *r* on the end plate or frame *f* nearest to the fuselage of the machine, but it may also be imparted to any of the other links or levers 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 shapes.

By suitably selecting the successive cross sections the aerofoil is made to assume, the centre of pressure or sustentation of the machine will remain approximately or entirely in the same place relatively to the centre 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 utilised either exclusively or partially for directional and/or lateral control.

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. An aerofoil of the variable camber type having the characteristic that as its trailing part is flexed downwards the upper surface of its front or entering edge is raised while the under surface of said edge remains unchanged whereby the thickness of the aerofoil at its forward part is increased.

2. A construction of the aerofoil specified in Claim 1, in which a series of longitudinally arranged girders support the upper surface the camber of which it is intended should be varied, said girders having differential relative movements imparted to them.

3. A construction of the aerofoil as specified in Claim 1, in which a series of longitudinally arranged girders carry a series of flexible ribs which carry the supporting surfaces, and in which means is provided to give said girders different relative movements.

4. An aerofoil of the type specified in Claim 1 in which the positive pressure on the under surface at its rear or trailing edge is balanced by the negative pressure on the upper surface at its front or entering edge.

5. In an aerofoil as specified in Claim 1, coupling the mechanism for increasing the thickness of the forward part of the aerofoil to one end of a rocking beam or lever and coupling the mechanism for flexing the trailing edge to the other end of said beam or lever, as and for the purpose specified.

6. An aerofoil comprising a main rigid structure consisting of two or more plates or frames and a plurality of longitudinally arranged spars, an articulated frame consisting of two plates pivoted together said frame being coupled to said main structure, a series of flexible upper and lower ribs transversely arranged in respect to said structure and said frame, a series of longitudinally arranged girders or the like connected to said ribs, a series of levers pivoted to each of the end plates and connected to the upper parts of each of the end flexible ribs, a rocking beam or lever pivoted on each of the end plates of the main structure and having a cranked arm at its rear end the rear end of each of said beams or levers being pivoted to the front plate of one of the articulated frames, a link

connecting the cranked arm of each of said beams or levers with the forward end of each of the rear plates of the articulated frames below their points of pivot to the front plates of said frames, a link connected to the front end of each of the front plates of the articulated frames below its point of pivot to the rocking beam or lever each of said links being pivoted to one of the end plates of the main structure at or near and above the point of pivot of the rocking beam or lever, couplings between the plates forming each of the articulated frames and the end flexible ribs, and a couple between the rocking beams or levers and the levers supporting the flexible ribs.

7. The improved aerofoil substantially as herein described and illustrated in the accompanying drawing.

Dated this 29th day of May, 1916.

PHILLIPSS,
70, Chancery Lane, London, W.C.,
Agents for the Applicants.

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

Fig. 1.

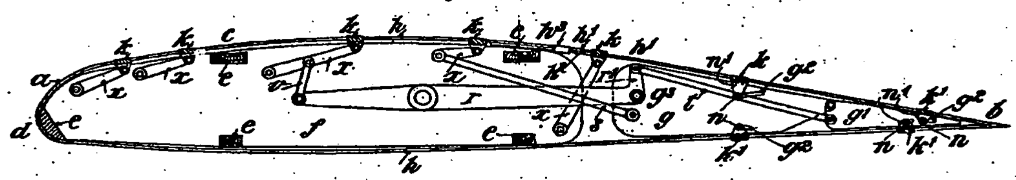

Fig. 2.

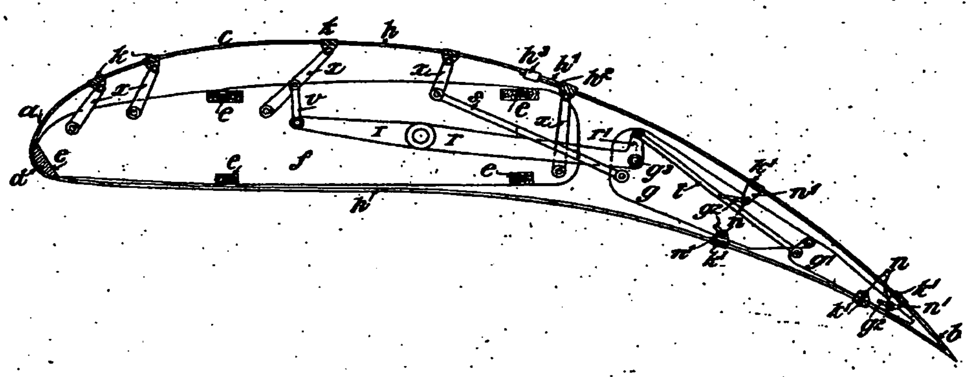

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Fig. 1.

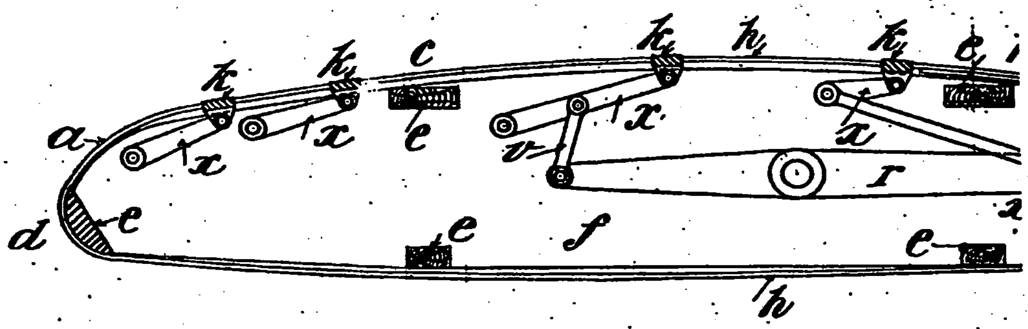
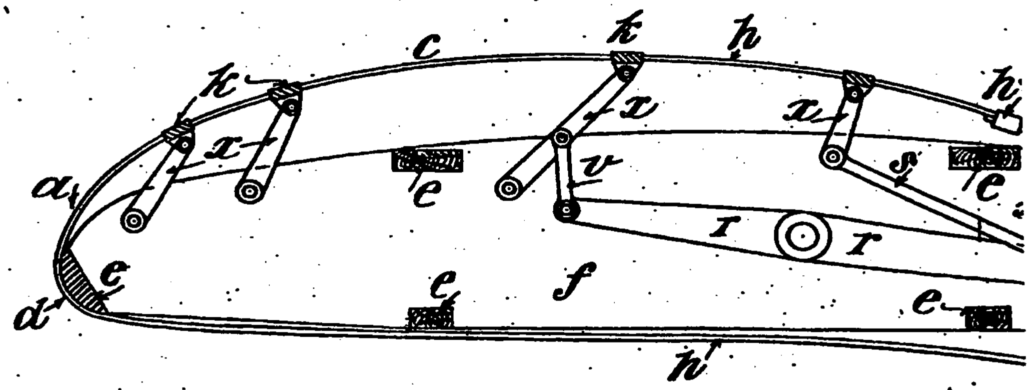
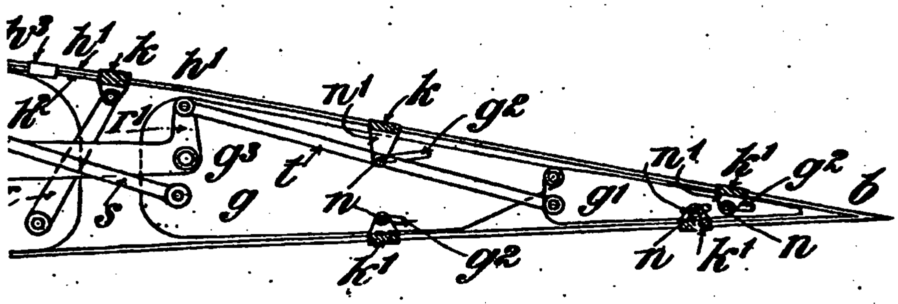
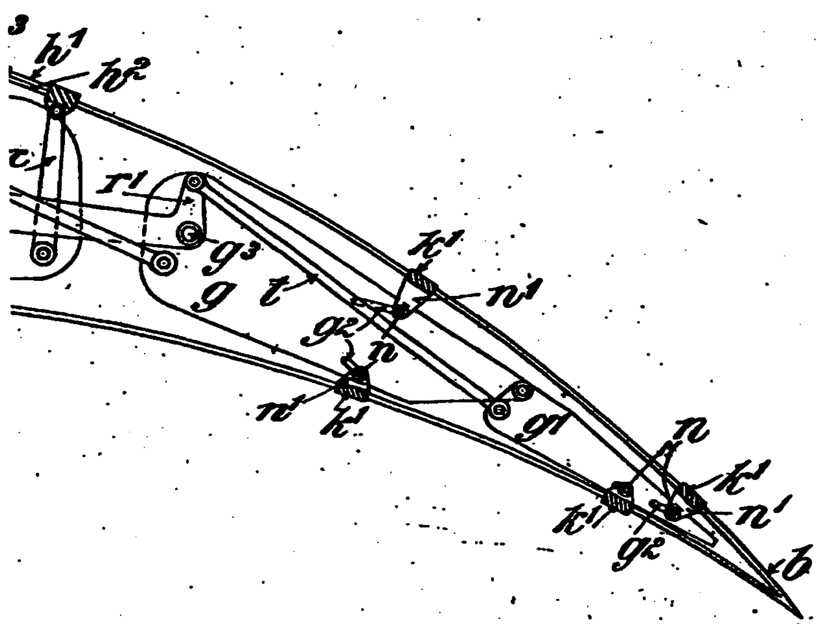


Fig. 2.







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