Aug. 11, 1931. L. G. YOUNG 1,818,519

AEROFOIL CONSTRUCTION

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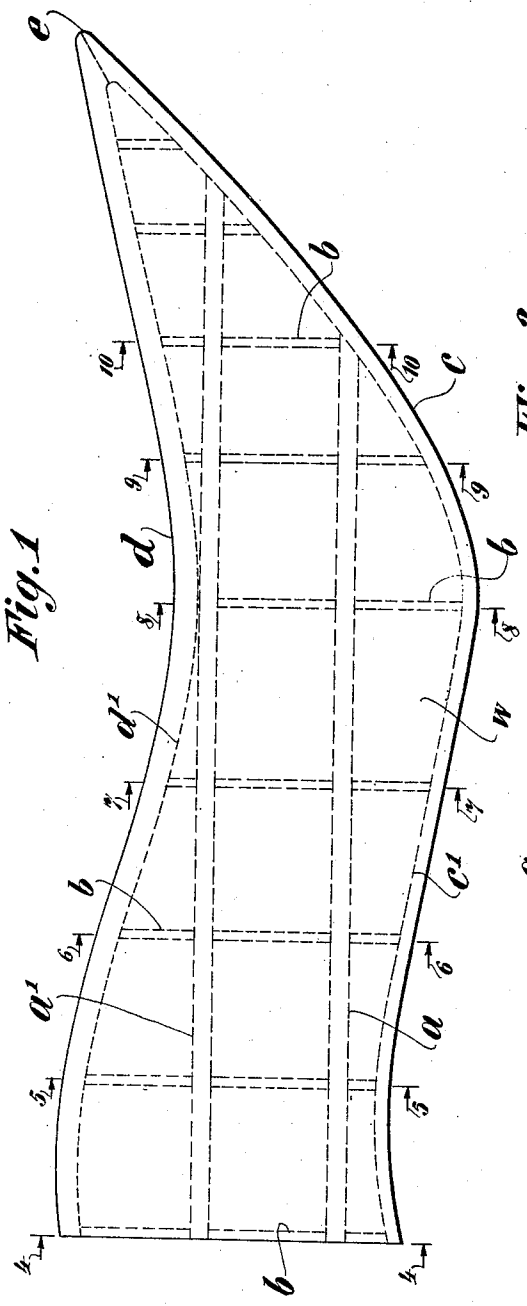


Fig. 1



Fig. 3

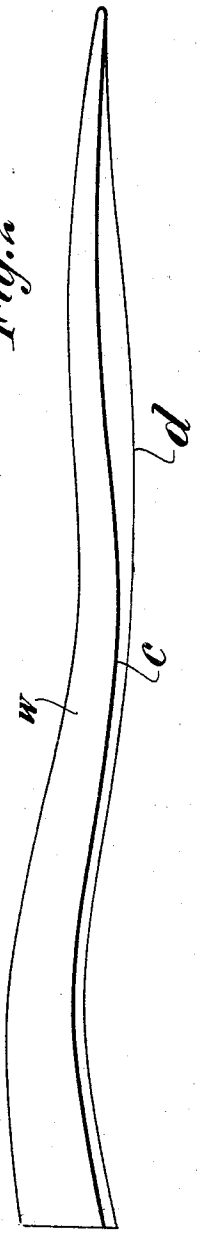


Fig. 2

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Fig. 4

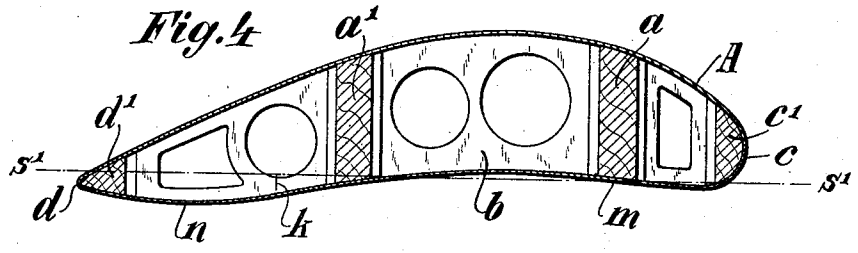


Fig. 5

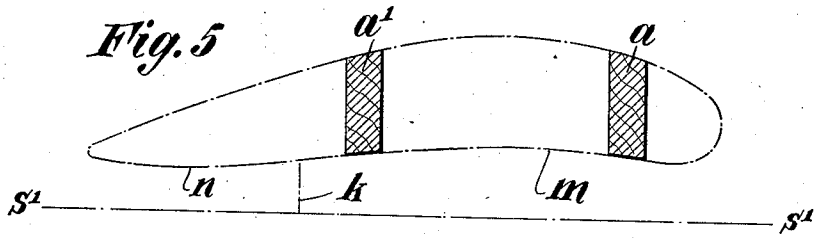


Fig. 6

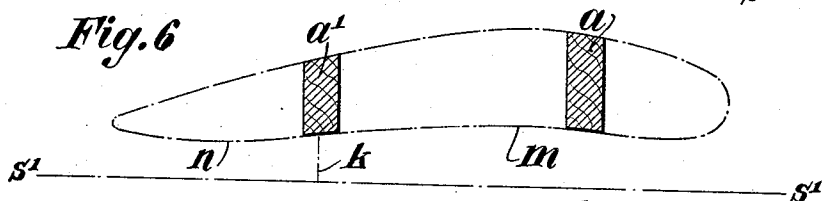


Fig. 7

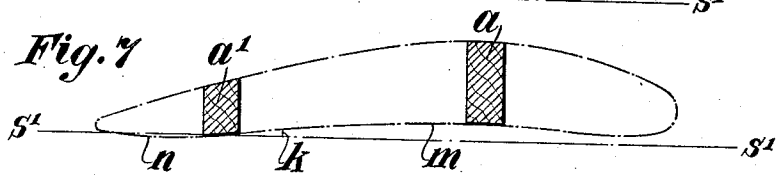


Fig. 8

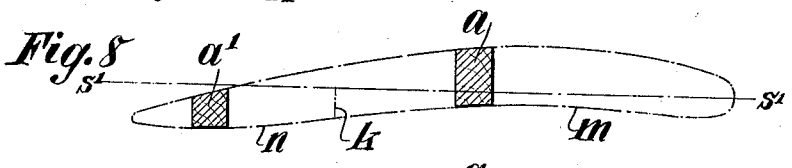


Fig. 9

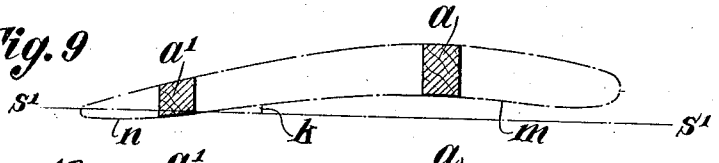
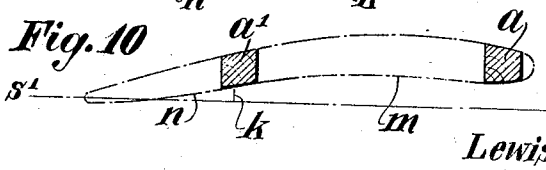


Fig. 10



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Fig. 11

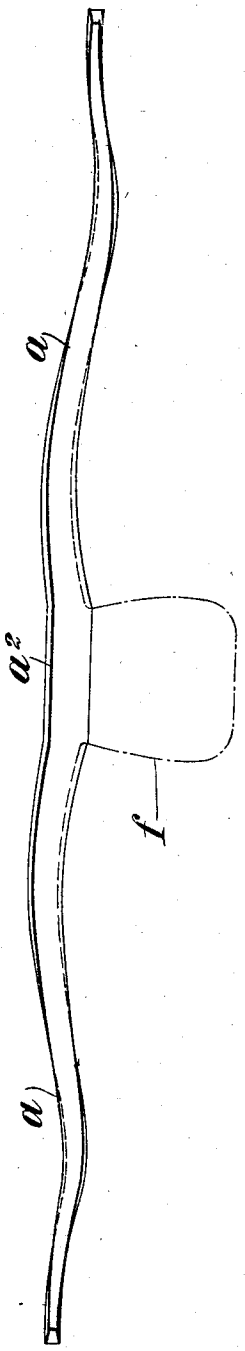
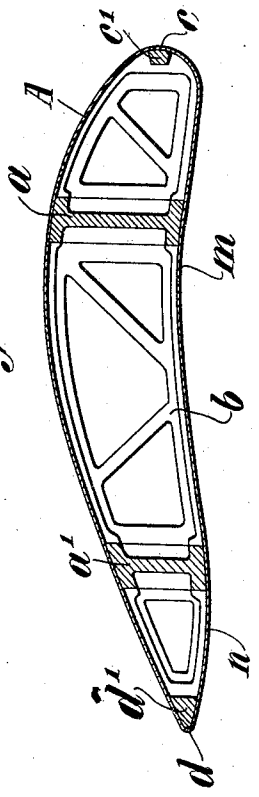


Fig. 12



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Patented Aug. 11, 1931 1,818,519

UNITED STATES PATENT OFFICE

LEWIS G. YOUNG, OF BRONXVILLE, NEW YORK

AEROFOIL CONSTRUCTION

Application filed June 21, 1929. Serial No. 372,650.

This invention relates to the construction of aerofoils or aeroplane wings, and is particularly concerned with the provision of a spar for internally bracing a wing which is curved along its span.

It has been found that a laterally curved wing which has its main lifting surface relatively near the fuselage of the aeroplane, and which has a stabilizing surface merging with the lifting surface and extending laterally therebeyond, is very difficult to construct, especially when a dihedral angle exists between said surfaces. In fact it has hitherto been thought impossible to brace adequately such a wing merely by the use of internal bracing. The present invention resides, therefore, in the provision of spars for wings whose surfaces are curved laterally, which spar is light in weight and easy to manufacture, which has a high factor of safety, which is wholly internal of the wing, and which takes such form that the wing surfaces conform to the upper and lower edges thereof, whereby the wing may assume the best outward contour for lift as well as stability.

Specifically, the main feature of the invention consists in a spar for internally bracing a wing whose main lifting surface makes a dihedral angle with the stabilizing surface, whereby the control of the plane becomes practically automatic, without at the same time any sacrifice of speed, lift, or safety, and avoiding external or insufficient bracing.

Other objects and advantages will be apparent from the following detailed description of a preferred embodiment of my invention in connection with the accompanying drawings, wherein:

Figure 1 is a plan view of a wing constructed according to the present invention.

Figure 2 is a front elevation of the wing.

Figure 3 is a front view of the forward spar shown in Figure 1.

Figures 4 to 10 inclusive, are cross sections of the wing taken on the lines 4—4 to 10—10 inclusive, in Figure 1, and looking in the direction of the arrows.

Figure 11 is a front view of a single wing spar extending on both sides of the fuselage.

Figure 12 is a cross section of the wing taken on the line 4—4 of Figure 1, and showing a modified form of construction.

It will be understood that throughout the description the term "longitudinal" refers to a dimension fore and aft of the aeroplane, while "lateral" means widthwise or along the wing span thereof.

In a general sense each wing has a supporting surface adjacent to the body and to the front edge of the wing, with a longitudinally stabilizing surface to the rear of the supporting surface and a laterally stabilizing surface at the side or toward the tip of the wing remote from the fuselage. The supporting surfaces are so curved that the pressure resultants of the two surfaces, whether the flying machine be inclined in one direction or the other, meet at a point in a line above the center of gravity of the machine, and although the distance of the center of pressure of one wing from the longitudinal axis of the machine varies inversely as the distance of the center pressure of the other wing in a bank, the resultant of the upward pressure against the lowermost wing is increased while that against the uppermost wing is decreased, and the machine is therefore returned to a position of equilibrium. Moreover it has been found, in the present instance, that it is desirable to preserve in the structure of the machine a definite relationship; thus, if the main part of each wing, as will be explained hereinafter, has a ratio of length (in a lateral direction from the fuselage) to chord (in a longitudinal direction) of two to one, then the distances of the center of pressure of the laterally stabilizing surface and of the center of upward pressure on the underside of the wing from the longitudinal axis should also be in the ratio of two to one, and the distances of the center of pressure of the longitudinally stabilizing surface and of the center of upward pressure on the supporting surface from the lateral axis should also be in the ratio of two to one.

In accordance with the invention each wing or aerofoil has adjacent to the fuselage

or longitudinally of the machine and its own forward edge a supporting surface, concave below, curved both in a longitudinal direction and in a lateral direction, with a reversely curved longitudinally extending stabilizing surface to the rear and a reversely curved laterally stabilizing surface at the side remote from the body, the centers of pressure of these surfaces having, as already indicated, substantially the same ratio of distances from the longitudinal axis and from the lateral axis as that which the length of the wing portion has, in a general sense, to its width.

It will be understood that the two wings are symmetrical with respect to the longitudinal axis of the machine and a description of one will suffice for the other.

There is shown at *w* a wing constructed in accordance with the present invention. This wing consists, generally, of a lifting portion, being the part between the lines 4—4 and 8—8 of Figure 1, and a stabilizing portion being the part shown between 8—8 and the wing tip. This wing is connected to the fuselage of the plane at 4—4, and is provided with supporting spars *a* and *a'* and with ribs *b*. The leading edge of the wing is at *c* and the trailing edge at *d*, the usual supporting members *c'* and *d'* being provided adjacent the leading and trailing edges. The wing is shown as tapering, generally, to a point *e* at the wing tip. In the cross sectional views in Figures 4 to 10 inclusive, there is shown a wing tapering in thickness and having a particular surface as will be described in detail below.

As the particular curvature of the wing along its span is of the utmost importance, the exact positions of the wing with reference to a given plane determined by the lines *s*—*s* in Figure 3 and *s'*—*s'* in Figures 4 to 10 is shown in great detail. It will be seen that the wing makes between its ends what may be termed a dihedral angle. That is, looking at the front elevation of the wing, there is at first an upward curve. The wing then curves downwardly to form a depressed portion between its ends and then curves up slightly, preferably not reaching, however, a height as great as the first raised portion assumes. This is shown best in Figures 4 to 10, wherein the reference lines *s'*—*s'* are horizontal and in a plane passing through the lower front corner of the spar *a*.

Since it is the particular construction of the spar which constitutes the main feature of the present invention, the spar *a* is shown in detail in Figure 3. The spar *a'* is similar in construction to the spar *a* and takes positions relative to the latter as shown in Figures 4 to 10.

The upper and lower wing surfaces are, of course, designed with generally stream line form, but the lower surfaces have more particularly a concave portion *m* and a convex portion *n*, the former being forward of the point *k* at which the curve reverses and the latter being to the rear of said point. It will be noted that the curve *m* is approximately twice the length of the curve *n*, though this proportion is not absolutely essential. However, when these curves are in a given ratio at one wing section, the ratio should be preserved at the other wing sections. For convenience in description of the definite relationship between the lifting portion of the wing and the stabilizing portion, it may be noted that the lifting portion between lines 4—4 and 8—8 is of trapezoidal shape with long sides of approximately twice the length of its short sides. This approximate ratio of two to one between the length and the width of the lifting section is the ratio which determines the locations of the centers of pressure, whereby the plane is properly balanced. It will be understood, of course, that this definite relationship is approximate only and is not absolute. The other portion of the wing, from the line 8—8 to the wing tip comprises the stabilizing portion of the wing and has a leading edge which sweeps back to the wing tip which is approximately in line laterally with the trailing edge of the wing at the fuselage.

Although the wing is shown as tapering in thickness from the fuselage to the wing tip, a wing of constant thickness is also within the scope of this invention. It will also be apparent that the wings may form a dihedral angle between them or lie in generally the same plane, and may have sweep back or make any desired angle with the line of flight. The wing spars, of course, need not be located exactly in the position shown nor have the same relative lateral dimensions but may be varied providing the wing curves shown are generally maintained. Although wooden spars are shown in Figures 4 to 10 inclusive, metal spars as shown in Figure 12 could be used instead. The particular type of rib used forms no part of the present invention.

In Figure 11 there is shown a single spar extending on both sides of the fuselage *f* and having a section a^2 connecting the two sections *a*, each of which latter is constructed according to the present invention.

The tendency of forces applied to the wings of the usual straight winged machine, when equilibrium is disturbed, is to tip the machine farther in the same direction. In the present machine, however, by reason of the curvature of the wing not only do the centers of sustaining pressure of the two wings that is, the points at which the sustaining pressures act, shift with varying positions of the machine but the resultants of the sustaining pressure that is, the pres-

sures themselves exerted against the undersides of the two wings are also varied although the resultants still meet in a line drawn vertically through the center of gravity of the machine and above the center of gravity, so that the machine continues in a condition of indifferent stability but with an increased pressure resultant against the lower wing which tends to restore the machine to a position of equilibrium. Of course, as the machine tilts upward on one side the center of sustaining pressure on that side moves farther from the longitudinal axis of the machine and its leverage increases, although the resultant of the sustaining pressure on that wing still meets the resultant of the sustaining pressure on the other wing in the vertical line drawn through the center of gravity of the machine, and such resultant is relatively reduced.

Although the machine still remains in indifferent stability after its equilibrium has been disturbed, with a tendency to return to a position of equilibrium, as already explained, it is desirable to provide other means to restore the equilibrium. This is accomplished automatically by the stabilizing surfaces. The direction of pressure, upward or downward, on the stabilizing surfaces, or rather the preponderance of pressure upward or downward, depends upon the inclination of the machine. If the machine dips downward from the predetermined angle of normal flight, so that the preponderance of pressure is exerted upon the upper side of the longitudinally stabilizing surface, then the center of pressure downward will be located in rear of the center of sustaining pressure and at a distance in rear of the lateral axis, as compared with the distance of the center of sustaining pressure, in the predetermined relationship, that is, in the wing shown, in approximately the ratio of two to one. With its greater leverage of two to one the stabilizing pressure will quickly correct the disturbing factor of pressure and restore the machine to its position of equilibrium. In like manner, if the machine tilts upward too much, the preponderance of pressure on the stabilizing surface will be exerted against the underside of the wing and in the same relationship so that the machine will be returned to its position of equilibrium. It will be understood that by reason of the curvature of the sustaining surface of the wings in a longitudinal direction, the resultants of the sustaining pressures exerted against the two wings continue to meet in a vertical line drawn through the center of gravity of the machine, for all ordinary disturbances of position, whether the machine dips downward or upward in a longitudinal direction.

In like manner when the machine is tilted laterally to one side a pressure is exerted against the upper laterally stabilizing surface of the wing on the upper side and as the center of such surface has a definite relation through the supporting and stabilizing surfaces on the other side of the plane, the leverage through which the laterally stabilizing pressure acts is greater than that of the sustaining pressure on the same side and the machine will be thereby restored to its position of equilibrium. The action of the laterally stabilizing pressure against the higher wing, when the machine is tipped laterally, is supplemented by an increase of sustaining pressure on the lower side through the direction of the flow of air, in the manner hereinbefore explained, under the lower wing into the region of the sustaining surface adjacent to the body of the machine.

The plane may be positively controlled by ailerons, rudder and elevators, not shown. Other details of the construction of the plane are not shown as they do not form any part of the present invention.

Further, applicant does not wish to be limited to the specific embodiment shown, save as defined in the appended claim.

I claim as my invention:

In an aeroplane, a unitary spar internally disposed in the wing, said spar being laterally straight and being alternately raised above and depressed below a given horizontal plane, the portion adjacent the fuselage being raised with respect to the fuselage.

This specification signed this 5th day of June, A. D. 1929.

LEWIS G. YOUNG.