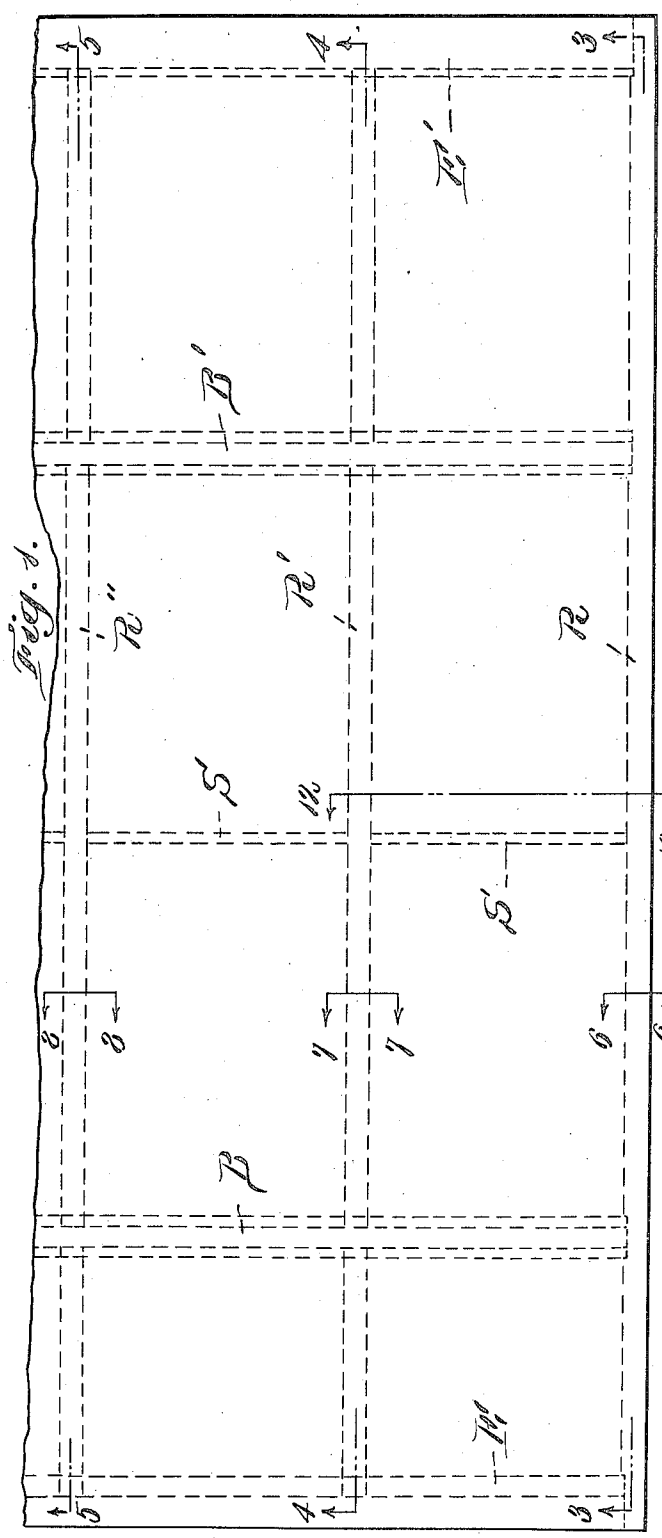
P. SCHWAMB AND P. EBERHARDT.

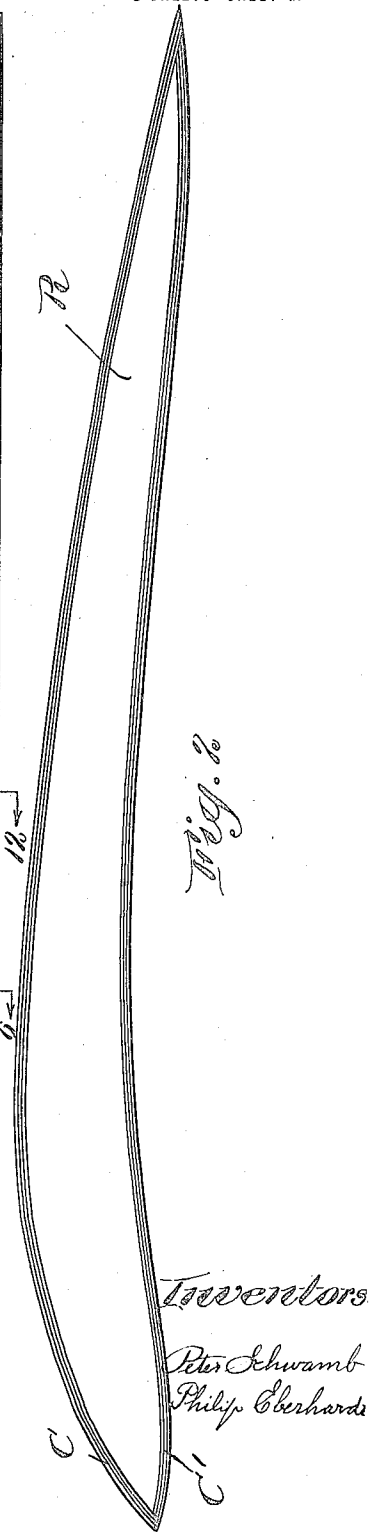
AEROFOIL.

APPLICATION FILED AUG. 9, 1918.

1,428,714. Patented Sept. 12, 1922.

3 SHEETS—SHEET 1.





Inventors

Peter Schwamb

Philip Eberhardt

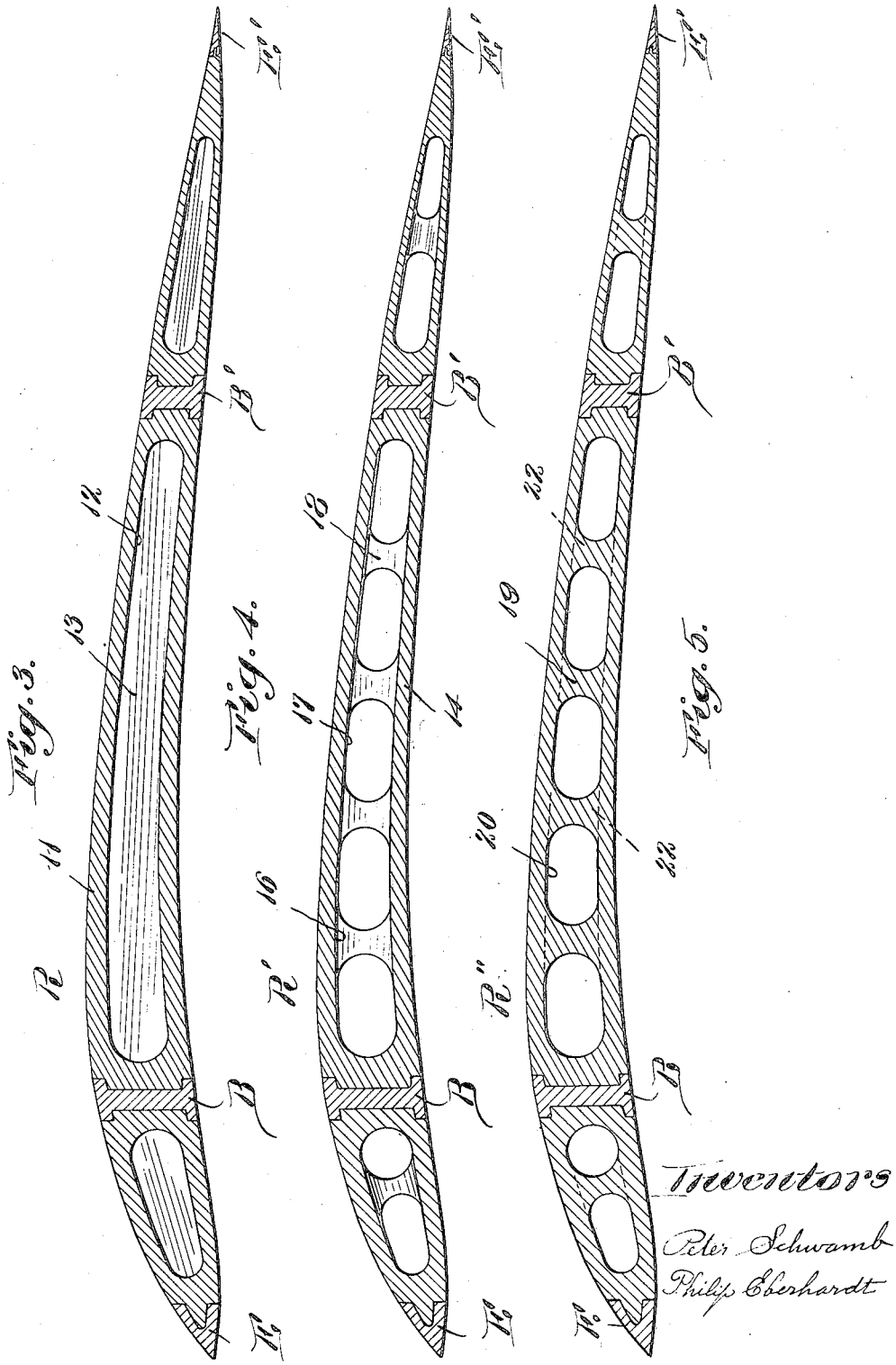
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3 SHEETS—SHEET 2.



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3 SHEETS—SHEET 3.

Fig. 6.

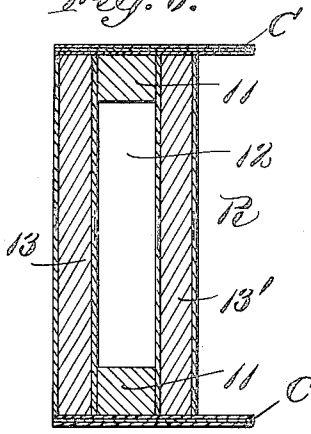


Fig. 7.

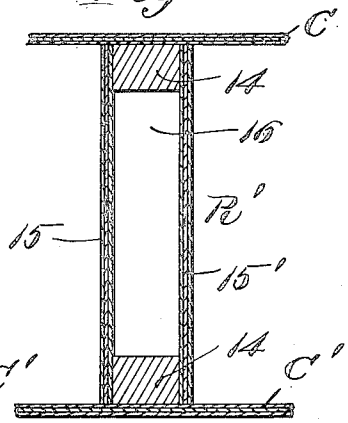


Fig. 8.

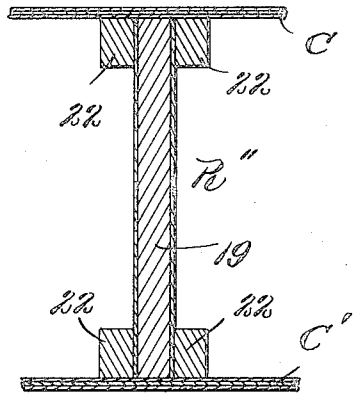


Fig. 9.

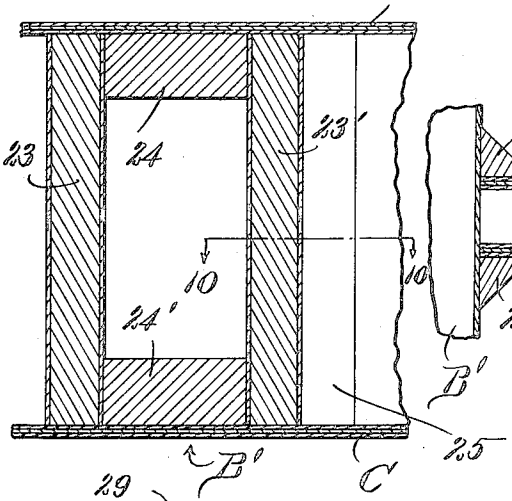


Fig. 10.

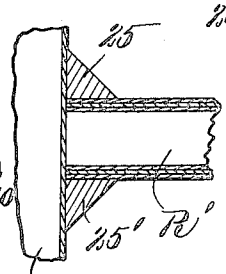


Fig. 11.

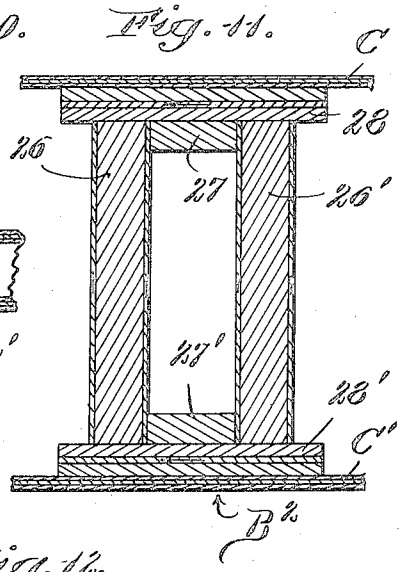


Fig. 13.

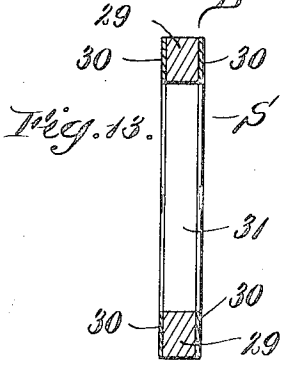
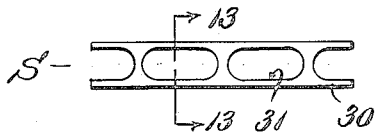


Fig. 12.



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Patented Sept. 12, 1922. 1,428,714

UNITED STATES PATENT OFFICE.

PETER SCHWAMB AND PHILIP EBERHARDT, OF ARLINGTON, MASSACHUSETTS.

AEROFOIL.

Application filed August 9, 1918. Serial No. 249,211.

To all whom it may concern:

Be it known that we, PETER SCHWAMB and PHILIP EBERHARDT, both citizens of the United States of America, and residents of Arlington, in the county of Middlesex and State of Massachusetts, have invented new and useful Improvements in Aerofoils, of which the following is a specification.

This invention relates to aircraft construction and more particularly to the construction of aerofoils adapted to be used as the main supporting wings of airplanes, although the invention may be utilized in the construction of aerofoils adapted for other purposes as for example for rudders or ailerons.

In the construction of aerofoils it has heretofore been the usual practice to construct a framework of longitudinal beams and transverse ribs, to brace the framework by means of wires or rods extending diagonally across the spaces between the beams and ribs, and to cover the framework with canvas, duck, linen or the like, the covering being mounted on the framework by strips secured to the ribs. In this type of construction the fabric covering merely serves as an envelope and contributes practically nothing to the strength and rigidity of the aerofoil. Moreover, in order to make the fabric covering withstand the weather conditions it has been found necessary to impregnate the covering with a composition which usually renders the aerofoil highly inflammable. If the wing strikes even a light obstruction it is easily ripped open, and there are other objections inherent in aerofoils of this type.

The principal object of the present invention is to overcome the difficulties and disadvantages appertaining to aerofoils of the character referred to and to provide an aerofoil in which the covering functions not merely as a covering but also contributes in very large measure to the strength and rigidity of the aerofoil, even to the extent of rendering the usual bracing wires or rods unnecessary.

More particularly the objects of the invention are to render the aerofoil stronger in all respects, viz, in tension, compression and flexure, and especially the latter so that the aerofoil as a whole will be much stiffer; to cause the aerofoil to hold its true shape more invariably; to increase the depth and moment of resistance of the beams and ribs without increasing the overall depth of the aerofoil; and to provide an aerofoil covering which will not tear, which presents a smooth substantially frictionless surface to the air, which lends itself to the shaping of a sharp trailing and entering edges of the aerofoil; etc.

To the aforesaid ends the invention involves, in general, a framework and a covering of rigid sheet material secured to the framework so as substantially to strengthen the framework. The framework may be constructed in any suitable manner but preferably comprises longitudinal beams and transverse ribs. The cardinal characteristic of the covering is its rigidity; and this attribute pertains to veneers comprising sheets of one or more layers of wood or other suitable material glued or otherwise secured together. Another essential characteristic of the invention is that the rigid covering be secured to the framework so that it will brace and stiffen the framework. This characteristic may be attained by securing the covering to the framework substantially continuously throughout the major portion thereof. For example, when employing a wooden framework and a wooden or composition veneer the veneer may be continuously secured to the framework by gluing the veneer to the edges of the beams or ribs or preferably both. When thus constructed the covering braces and stiffens the framework and the customary bracing wires or rods may be omitted. If the rigid covering were secured to the framework only at intervals, as for example with strips and spaced screws as usual, the covering could not be relied upon to stiffen the framework materially inasmuch as the screws would either loosen, shear off, or shear the covering, if the aerofoil were subjected to a heavy flexing or torsioning force or moment.

For the purpose of illustrating our invention we have shown one embodiment thereof in the accompanying drawings, in which,—

Figure 1 is a plan of the base or inner end of the aerofoil;

Figure 2 is an end elevation of the aerofoil;

Figure 3 is a section on line 3—3 of Fig. 1;

Figure 4 is a section on line 4—4 of Fig. 1;

Figure 5 is a section on line 5—5 of Fig. 1;

Figure 6 is a section on line 6—6 of Fig. 1;

Figure 7 is a section on line 7—7 of Fig. 1;

Figure 8 is a section on line 8—8 of Fig. 1;

Figure 9 is a vertical transverse section of a modified longitudinal, together with juxtaposed parts;

Figure 10 is a horizontal section on line 10—10 of Fig. 9 illustrating the junction between the rib and the longitudinal;

Figure 11 is a vertical transverse section through another modified longitudinal;

Figure 12 is an elevational view of a spacer as viewed from line 12—12 of Fig. 1; and

Figure 13 is a vertical transverse section on line 13—13 of Fig. 12.

The particular embodiment of our invention chosen for the purpose of illustration comprises a framework made up of longitudinal beams or longitudinals B and B′, edge pieces E and E′ disposed along the entering and trailing edges of the aerofoil respectively, and transverse ribs R, R′ and R″ extending transversely of the beams and edge pieces, the ribs being divided into sections which fit between the edge pieces and beams respectively. As shown in Figs. 3, 4, and 5 the longitudinal beams B and B′ are I-beams but as will hereinafter appear both the longitudinals and the ribs may be formed in different shapes. The rib sections are made of the same depth as the longitudinals so that their upper and lower edges are flush with the upper and lower surfaces or edges of the longitudinals. When thus shaped and fitted together the upper edges of the ribs and longitudinals are disposed in the same curved surface and likewise the lower edges of the ribs and beams are disposed in the same curved surface.

According to the present invention the covering for the framework is rigid and is secured to the framework substantially continuously throughout the major portion of the length of the ribs and longitudinals. When constructing the framework and covering of wood the upper and lower edges of the ribs and longitudinals are made substantially flat and the rigid covering is glued directly to the ribs and longitudinals substantially continuously throughout the entire length of both the ribs and longitudinals. When forming the covering of veneer we preferably make the veneer multi-ply, for example, three-ply. The multi-ply veneer is built up before being applied to the framework and it may be curved to fit the curvature of the aerofoil either at the time that it is built up, after it has been built up and before it is applied to the aerofoil, or at the time that it is applied to the aerofoil. For the purpose of curving the veneer to fit the curvature of the wings we propose to employ forms which are large enough to shape the covering for an entire aerofoil at a single operation, although it will be understood that the covering might be formed in sections and yet afford practically all of the advantages sought by the present invention.

When employing multi-ply veneer the grain of alternate layers of the veneer preferably runs at right angles to each other so that when employing 3-ply veneer the grain of the two outside layers will run in one direction while the grain of the inside layer will run in a direction at right angles thereto. Such a veneer is much stiffer in one direction than the other, namely, in the direction parallel to the grain of the two outside layers and the veneer is therefore preferably applied so as to give greater strength longitudinally of the aerofoil. Moreover when the veener is made flat it is much easier applied with the grain of the outside layers extending longitudinally of the aerofoil inasmuch as the greater flexibility transversely of the aerofoil permits the flat veneer to be more readily bent to the contour of the framework. In the construction of the veneer and in applying the veneer to the framework we employ waterproof glue or other adhesive which will withstand any ordinary weather conditions. Under certain conditions and for certain purposes alternate layers of the veneer may be composed of cloth and the cloth may be rubberized and then vulcanized between the other veneer layers or the veneer layers may be vulcanized together by means of a suitable rubber compound.

In order more fully to illustrate the application of the present invention we have shown in Figs. 3, 4 and 5, three types of ribs which are particularly suited to our improved construction. The rib R shown in Fig. 3 is particularly adapted to be used at the inner end of the aerofoil, the rib R″ is particularly adapted to be used immediately above or below the vertical strut extending between the superposed aerofoils of biplanes and the rib R′ is intended to be employed between ribs of the type of R and R″.

The rib R, which is shown in longitudinal central section in Fig. 3 and in transverse section in Fig. 6, is made up of a central part 11 which is hollowed out at 12 and two side pieces 13 and 13′ which are 3-ply, the two outer layers of 13 and 13′ being somewhat thinner than the inner layer and having their grain extending vertically whereas the grain of the inner layer of 13 and 13′ and of the central part 11 preferably extends horizontally. The 3-ply strips 13 are preferably made up separately and then glued to the opposite sides of the central part 11. The ends of the three sections of the rib R, as well as the sections of ribs R′ and R″ are fitted into the I-beams B and B′ and into the edge pieces E and E′ and are glued thereto.

The rib R′, shown in longitudinal central section in Fig. 4 and in transverse section in Fig. 7, is similar to the rib R shown in Figs. 3 and 6, inasmuch as it comprises a central member 14 and side members 15 and 15′ composed of 3-ply material, but differs from the rib R in the following respects. The 3-ply strips 15 are formed of three layers of material which may be of the same thickness and the grain of the central layer runs vertically while the grain of the outside layers run horizontally. The central piece 14 is hollowed out at 16 as in Fig. 3 and the parts 15 and 15′ are provided with a series of openings 17 separated by bridges 18.

The rib R″, shown in longitudinal central section in Fig. 5 and in transverse section in Fig. 8, comprises a central strip 19 formed like strips 13 in Fig. 6, except that it has a series of openings 20 separated by bridges 21 instead of having a continuous opening 13 as in Fig. 3. Attached to the central web 19 are strips 22 which are formed like strips 11 and 14 and are glued to the web 19, these strips being provided to afford more extensive glue surfaces between the rib and the covers.

In Figs. 9 and 10 we have illustrated a longitudinal beam which may be employed in lieu of beams B and B′ in Figs. 1 to 5. This beam comprises 3-ply side members 23 and 23′ separated by upper and lower strips 24 and 24′, this construction being similar to that illustrated in Fig. 6 and illustrating the fact that the rib sections and beam sections may be employed interchangeably with suitable changes in dimensions. When employing a beam such as shown at B_1 in Fig. 9 the ribs such as shown at R_1 are preferably joined to the beams by means of triangular glue blocks 25 and 25′, the blocks 25 and 25′ being glued both to the beams B and B′ and ribs R and R′, and the end of the rib R′ being glued to the rib B′. The beam illustrated in Fig. 9 possesses much greater rigidity for a given weight than a solid beam and is not liable to shear.

The modified beam B_2 illustrated in Fig. 11 comprises 3-ply side members 26 and 26′ and top and bottom members 28 and 28′ glued together. To increase the gluing surfaces between the layers of members 26, 26′, 28 and 28′ strips such as 27 and 27′ may be used. This construction affords somewhat greater rigidity and may be made to supply a larger surface to which to glue the covers C and C′. The grain of the inner layers of members 28 and 28′ prefe: ably runs crosswise of the beam and the grain of the outer layers of these members preferably runs lengthwise of the beam.

In order to support the covers C and C′ in the spaces between the ribs and beams, spacer strips such as illustrated at S in Figs. 1, 12 and 13 may, if desired, be employed. These strips comprise a central member 29 having its grain running horizontally and two side strips 30 and 30′ having their grain running vertically, both the inner and outer members being hollowed out as illustrated at 31, in order to reduce weight.

It will be understood that any one or more of the different types of ribs or beams may be employed or that other suitable types of ribs and beams may if desired be employed. It will also be understood that the spacing between the beams and between the ribs can be varied to suit the conditions under which the aerofoil is to be used. For example, by spacing the ribs somewhat closer together the spacing members S would be rendered useless. Furthermore, we desire to have it understood that the grain in the various layers of our 3-ply parts may be disposed in any desired direction.

The rib and beam members which constitute the framework of the aerofoil are characterized by laminated parts of which the planes of lamination are at a wide angle, substantially and preferably at right angles to the laminations of the covering. In order to secure the full values of our improvement, the surfaces of the ribs and beams which lie parallel with the covering should all be flush with each other, so that the surfaces of junction between the frame-members and the covering shall be as ample as possible, and preferably coextensive with the area presented by said frame-surfaces. Partial values, nevertheless within the scope of our invention, may be obtained even though the surfaces of such juncture be not coextensive with the entire top and bottom surfaces of the framework, as when, for instance, the covering is secured to rib surfaces only, or to beam-surfaces only, or to portions of both rib and beam surfaces.

From the foregoing it will be evident that the rigid covering performs a two-fold function, i. e., it functions as an envelope for the framework and also to strengthen and stiffen the framework. The veneer can be effectively waterproofed and treated so as to render it non-inflammable either before or after the parts are glued together. The veneer is much stronger than canvas or linen and is not as easily torn and if broken by a heavy impact it can readily be repaired by gluing on a section of light 3-ply veneer over the break. Owing to the rigidity of the covering it does not flap inwardly and outwardly under varying air pressure but maintains its true shape at all times. The internal bracing wires may be eliminated, thus simplifying the construction and tending to reduce the weight. When well polished the wood veneer presents a smooth substantially functionless surface to the air thereby reducing

the drag. The rigid veneer lends itself to the shaping of a sharp trailing and entering edge inasmuch as the upper and lower coverings may be caused to meet at an acute angle and may be firmly glued together and to the edge pieces, this being of particular importance in the thin trailing edge. If desired a thin strip of metal may be folded over either the entering edge of trailing edge or both to protect the edge.

The cardinal feature of the present invention involves bracing and strengthening the framework of an aerofoil with a rigid covering. When securing the edges of the longitudinals to the rigid covering continuously along the edges of the longitudinals the covering functionally becomes a part of the framework. With the upper and lower coverings rigidly united with the beams, the sections of the coverings in the region of the respective beams together with the beams themselves virtually constitute I-beams, the beams constituting the webs of the I-beams and the covering sections constituting the flanges of the I-beams. The covering sections here referred to extend from each beam half way to the next adjacent beams on either side. With the portions of the coverings in the region of each beam functioning as described the moment of inertia or moment of resistance of the beams is greatly increased. The covering sections function as I-beam flanges for the beams whether or not the longitudinals themselves are in the form of I-beams, as will be particularly apparent from Figs. 6 to 11.

Heretofore it has been customary to interpose strips between the covering and the framework, the strips usually extending along the ribs, and to secure the covering to the strips. In the present construction the covering is secured directly to the framework and the aerofoil may therefore be made thinner for a given depth of beam and therefore for a given strength. Moreover, the aerofoil may be made still thinner for a given strength owing to the fact that the coverings greatly stiffen and strengthen the framework as fully explained above.

We believe it to be basicly new to construct and arrange an aerofoil covering in conjunction with the frame-members thereof so that it serves substantially to stiffen and strengthen the aerofoil as well as cover the framework thereof.

We claim:

An aerofoil comprising a framework and a stiff wooden covering extending from the leading edge to the trailing edge on both sides of the framework, the framework comprising longitudinal spars and transverse ribs, the stiff wooden covering being glued to both the spars and the ribs substantially continuously throughout the length of the spars and ribs respectively, thereby to afford the stiffness usually supplied by trussing and bracing and at the same time serving as the exterior air surface of the aerofoil.

Signed by us at Boston, Massachusetts, this first day of August, 1918.

PETER SCHWAMB.
PHILIP EBERHARDT.