April 23, 1929. E. J. DEWOITINE 1,710,350

CONSTRUCTIONAL ELEMENT

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Fig. 1

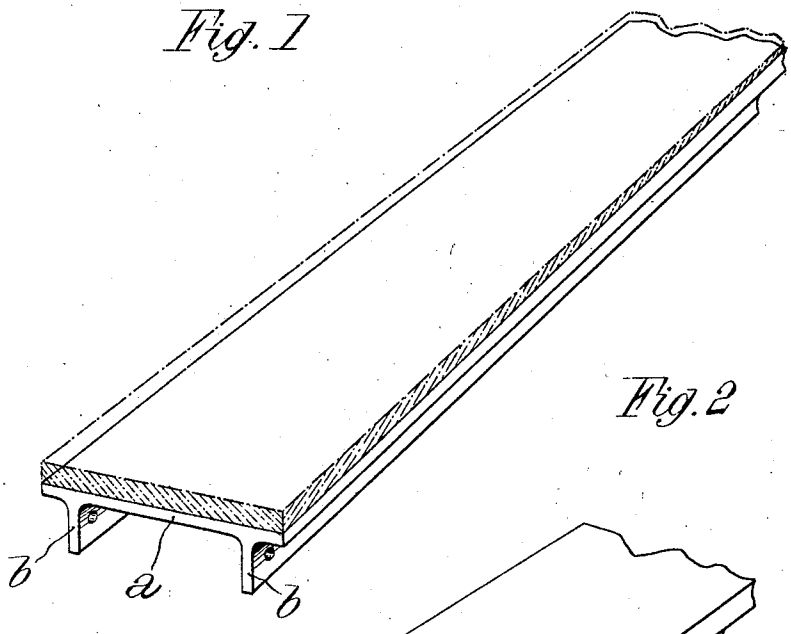


Fig. 2

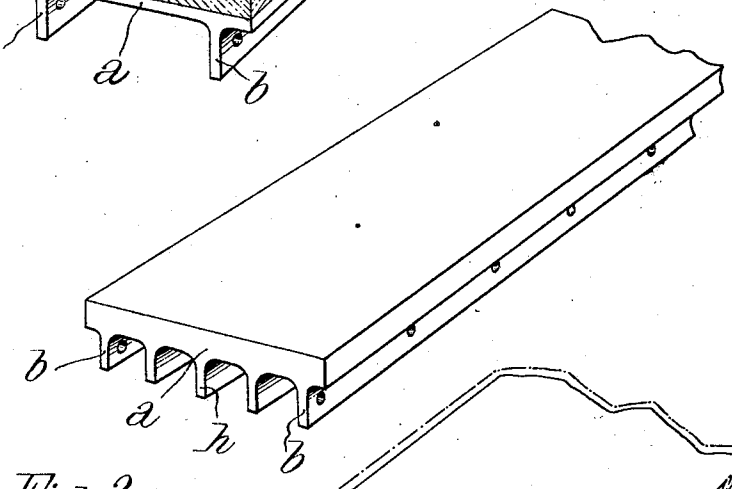
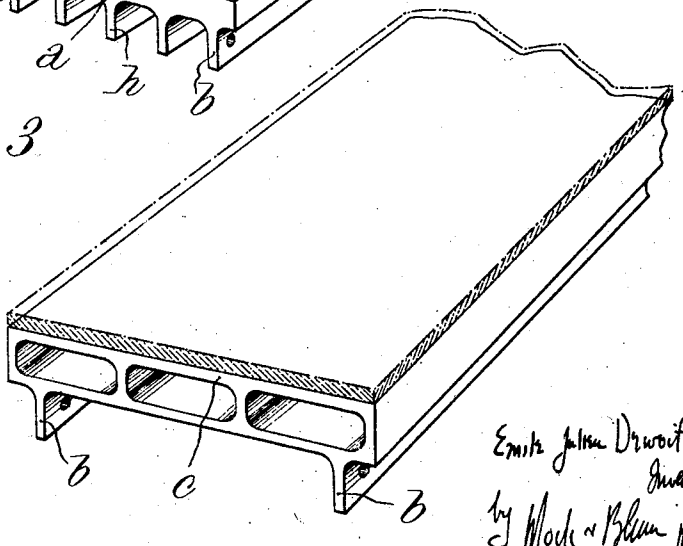


Fig. 3



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Fig. 4

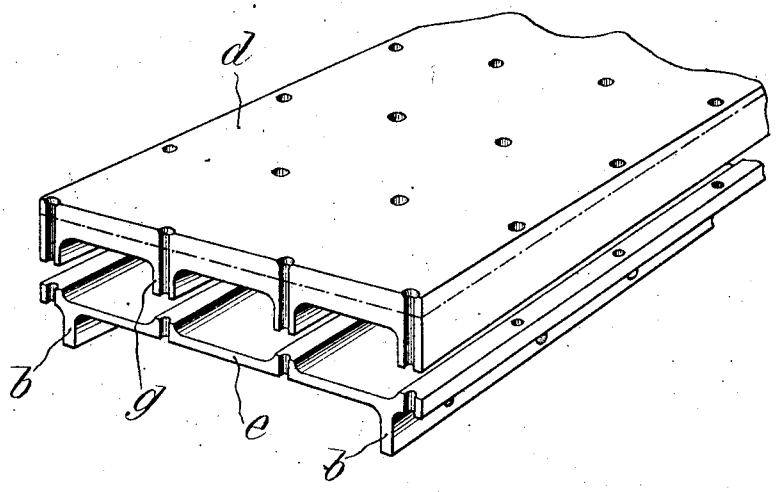
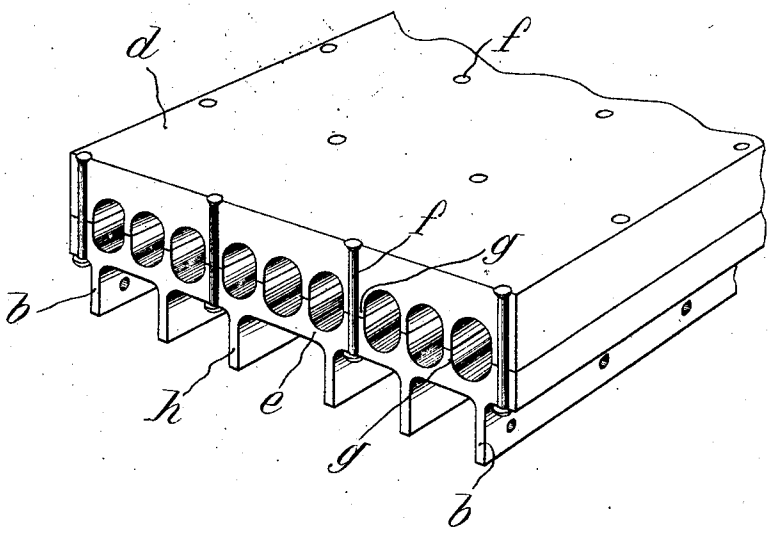


Fig. 5



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Patented Apr. 23, 1929. 1,710,350

UNITED STATES PATENT OFFICE.

EMILE JULIEN DEWOITINE, OF CHATILLON, FRANCE.

CONSTRUCTIONAL ELEMENT.

Application filed March 7, 1925, Serial No. 13,749, and in Belgium April 16, 1924.

My invention relates to a simple and improved construction of spars or longérons or other structural wing elements of aeroplanes and which may be designated as wing flexure members, whereby maximum strength is secured with minimum weight.

The principal object of the invention is so to make constructional elements of the kind in question that the materials of which they are formed are utilized to greater advantage than has hitherto been the case.

The constructional elements or beams are of the kind in which the resisting moment is caused to vary in a continuous manner by so proportioning the height of the beam that at any section the total moment of resistance is as near as possible to the moment of flexion due to the load.

The esssential feature of the invention consists in forming the beams with plates which are thinned away or diminished in the direction of their thickness.

The invention includes various constructional embodiments or arrangements which will be more fully described hereafter, and as new industrial products special parts suitable for their manufacture as well as devices, especially aeroplanes provided with beams or spars of the class in question.

In order that the invention may be more clearly understood, it will now be described with reference to the accompanying drawings, but it is to be observed that the description and drawings are given merely by way of example.

Figs. 1, 2, 3, 4 and 5, included in the drawings are all part perspective views of beams or spars adapted to be fitted in position and to work under flexion, and constructed according to as many methods of carrying out the invention.

In forming the beam or spar intended to work under flexion, and especially suitable for use as a spar in the wing of an aeroplane, or a longéron, the procedure is substantially as follows.

It is known that at each right section of a beam under transverse stress, the material utilized must resist in particular a shearing strain, a torsional strain and especially a force of flexion, the predominant components of which correspond to the flexion in the direction of the length, as for example in the case of the longéron or spar of the wing of an aeroplane, the flexion due to the width of the wing.

The resistance to the shearing force depends upon the section of the material devoted to the work. This condition is usually satisfied by the dimensions imposed by the other forces, at any rate to a certain distance from the junction of the beam.

The resistance to the force of torsion depends upon the polar moment of inertia of the section, which is also generally sufficient.

It is the resistance to the force of flexion in the predominant direction which must give the principal factors in the structure of the beam, the consideration of the other forces being most often without influence, or only modifying some factor, sections and polar moment of inertia.

From what has just been stated, it will be seen that the beam must be constructed in such a way that whilst the material is judiciously utilized both as regards price and weight, the resisting moment of the whole shall vary in a continuous manner from the point of attachment to the other extremity, and so that the strain on the material shall in all cases be as near as possible to the admissible limit.

It is also known that with equality of the modulus of section for the same rectangular frame, it is desirable to distribute the mass as far as possible from the neutral line, but in order to avoid buckling of a plate, it is important that the breadth shall have to the thickness an appropriate minimum ratio. In practice the tendency to buckle is diminished by the addition of one or a plurality of plates or extra thickness.

In what follows a simple construction is described permitting plates or the like to be utilized the thickness of which can be lessened at will and having a variable moment of inertia.

For this purpose the constructional element or beam may with advantage comprise, and as shown at Figs. 1 and 2 which illustrate a method of manufacture especially suitable for relatively small spars—a solid drawn plate *a* having in the neighbourhood of its longitudinal edges and on one of its surfaces two longitudinally extending reinforcing webs or ribs, adapted to have attached thereto one of the ends or edges of

the side members which are relatively thin and adapted to resist the shearing moment, the members being fixed at their other extremities to like reinforcing webs or ribs comprised by a similar element.

In the case more particularly of relatively strong beams or constructional elements demanding a certain inertia and where weight is to be avoided and the structure must be lightened to save material, the arrangement may be that shown at Figs. 3, 4 and 5, where hollow structures are employed which in this case also comprise ribs *b* for the purposes already described. The structures may be formed from plates *c* in a single piece as indicated at Fig. 3 when facilities for making such plates are available, but preferably the practical construction is that indicated at Figs. 4 and 5 where each constructional element comprises two parts *d* and *e*, one superposed above the other and attached together by means of rivets *f*. When actually fitted together, longitudinal spaces are formed bounded laterally by a certain number of inner ribs *g*.

These different kinds of elements are uniform in width and are reduced in transverse thickness by sawing or planing as the case may be so that their sections diminish regularly in the desired manner from the point of attachment to the free extremity of the beam as shown at Figs. 1 and 3. This reduction in thickness is effected on the surface opposite to that carrying the reinforcing webs or ribs and also if necessary at the extremities of the said rib. Hence the wing flexure members may have substantially the same width throughout, but their transverse thickness decreases, so that the portion of the member directly adjacent the point of attachment to the frame of the aeroplane has the greatest moment of inertia. As shown in the drawings, the width of a member is greater than its thickness. As previously stated, the diminishing thickness of the flexure member may be secured by shaping the main portion thereof, or the ribs, or both.

In some cases the element may comprise, whatever may be the arrangement adopted, and as shown at Figs. 2 and 5, between the ribs *b*, a certain number of extra ribs *h* which may be sawed away or planed like the ribs *b*.

In the foregoing manner a constructional element is obtained adapted to be applied whenever a beam or spar is required intended to work either under flexion as in the case for instance with the spar of the wing of an aeroplane projecting outwards; or under flexion and compression as in the case of a wing with several supports, and the constructional element is found to fulfill requirements as already stated.

It is to be understood that the invention is not limited to the particular application or the constructional embodiment which have been more particularly described, but that all modifications are included falling within a fair interpretation of the claims.

What I claim and desire to secure by Letters Patent of the United States of America is:—

1. A structural element for aeroplane wings comprising a hollow rigid member decreasing in transverse thickness from the point of attachment thereof to the free end thereof, the hollow portion of said rigid member having reinforcing web means, said rigid member having a plurality of longitudinal external reinforcing ribs.

2. A wing flexure member for aeroplanes comprising two body portions having contacting longitudinal ribs adapted to hold said body portions spaced and to divide the space between said body portions into a plurality of hollow longitudinal cells, connecting means adapted to connect said body portions, one of said body portions having longitudinal reinforcing ribs, the combined thickness of said body portions decreasing from the point of attachment of said member to the free end thereof.

3. A structural element for aeroplane wings having greater width than thickness, said element decreasing in thickness from one extremity to the other, said member having reenforcing ribs associated therewith and extending externally thereof in the direction of its thickness.

In testimony whereof I have hereunto set my hand.

EMILE JULIEN DEWOITINE.