Nov. 18, 1930. H. E. FOX 1,781,723

METHOD OF SHAPING HOLLOW BODIES

Filed Jan. 28, 1930 2 Sheets-Sheet 1

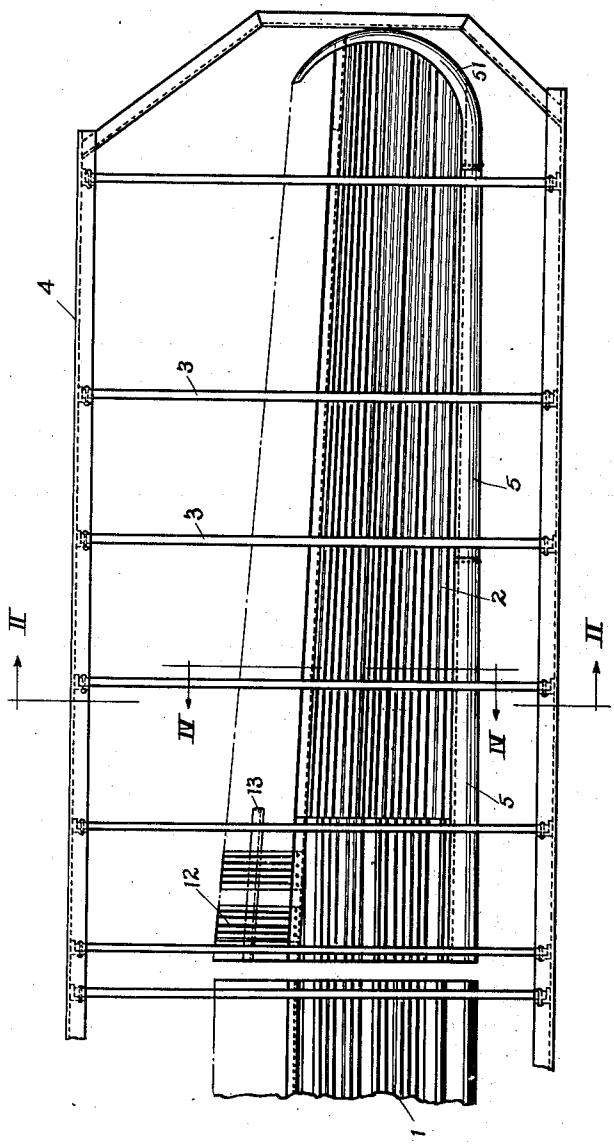


Fig. 1.

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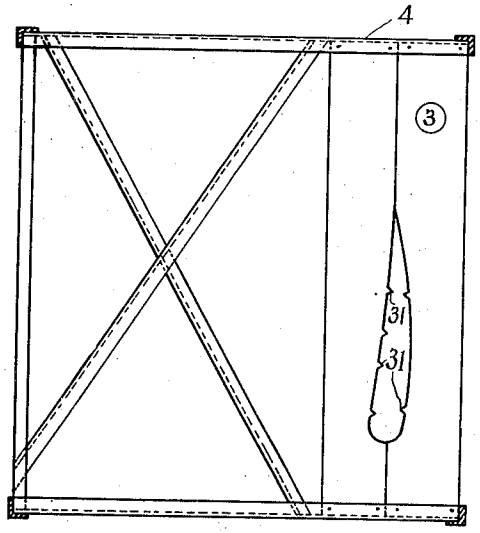


Fig. II.

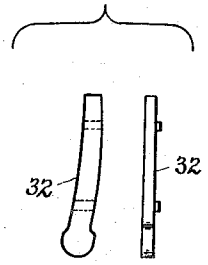


Fig. III.

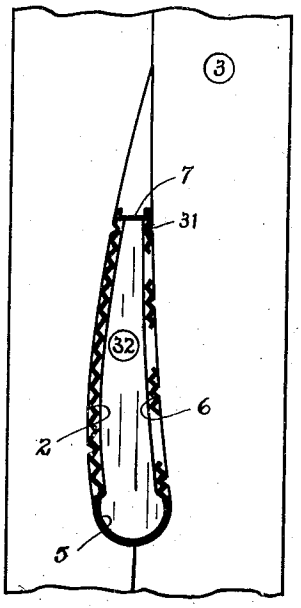


Fig. IV.

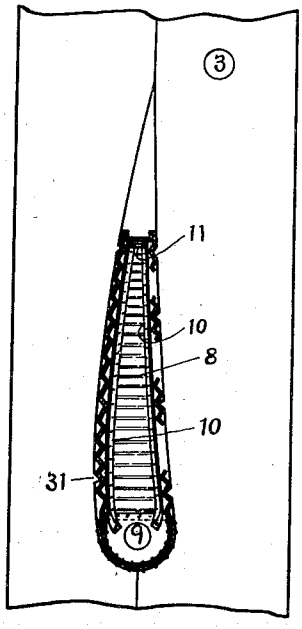


Fig. V.

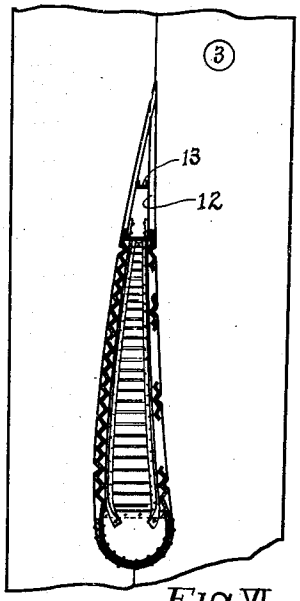


Fig. VI.

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UNITED STATES PATENT OFFICE

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METHOD OF SHAPING HOLLOW BODIES

Application filed January 28, 1930. Serial No. 423,949.

My invention relates to improvement in the method of shaping hollow bodies of sheet material, and finds practical application in shaping from sheet metal the fuselage and the wings of aeroplanes. The primary object in view is economy of production.

The invention is illustrated in the accompanying drawings: Fig. I is a fragmentary view in side elevation of the wing of an aeroplane in course of building, and in position within the "jig" in which it is formed; Fig. II is a view in cross section, on the plane indicated by the broken line II—II, Fig. I; Fig. III shows in front and side elevations one element of the shaping means which may be employed in the practice of the method of the invention; Figs. IV, V, and VI are fragmentary views and to larger scale, on the plane indicated at IV—IV, Fig. I, and illustrate successive steps in the progress of the building of the wing. In that progress the method of the invention is performed.

The "wing" of an aeroplane is, indeed, a pair of wings, built as a unitary structure in a single expanse; to this wing structure the body or fuselage of the aeroplane is united. Conveniently, for purposes of shipment, the wing structure is built in sections, bolted together; but this is a matter of circumstance merely, and when the aeroplane is assembled, the wing structure is, indeed, a unitary thing. Fig. I shows fragmentarily a wing as built in three sections: a middle section 1, and two lateral sections, 2, one of which is shown. The middle section and the lateral section are here shown in their forming frame, spaced apart slightly, but in their permanent space relationship; and the bolted union is completed while the sections are still in their forming frame. After completion, unbolting may be resorted to for purposes of shipment etc., as has been indicated.

The wing of an aerpolane consists of a body and a cover. The cover, formed of any suitable material, is laid upon the completed body. This invention has to do with the building of the body structure, and to this further attention will be directed. Suffice it here to repeat that after the body structure has been completed it is suitably covered.

The body is formed of sheet metal and is hollow, and it is supported from within. The posterior edge of the wing, ordinarily called the "trailing edge", is conveniently formed as a structurally supplemental part, and in this trailing edge the ailerons are included. In the particular case which is here illustrated the sheet metal which constitutes the upper and lower faces of the shell is corrugated, and the corrugations extend longitudinally of the wing. In Fig. I the reference numerals 1 and 2 are applied immediately to these corrugated sheets. Throughout the middle section 1 of the wing, the corrugations which are longitudinal are of uniform width; throughout the lateral sections the longitudinal corrugations taper outwardly, in accordance with the taper of the structure as a whole.

The interior support for the shell consists of a succession of transversely disposed struts, commonly called "bulkheads." These are preferably formed essentially of corrugated sheet metal, with the corrugations extending transversely of the wing.

The "jig", or structure in which the wing is built, consists of a set of templets 3 arranged vertically, and aligned to the longitudinal contour of the wing. These templets are positioned and secured in a framework 4. The templets are made of wooden planks, each advantageously consisting of two parts. The planks are cut away and the templets are formed with interior openings, and each opening presents in profile the shape of the wing in cross-section, at the point where in the assembly that particular templet stands. The templets, seven of which are shown in Fig. I, are set up in the framework and so aligned that in their assembly they constitute a form within which the wing is to be built. Guiding teats 31 may be left along the margins of the cuts in the templets, and the cut-away portions 32 of the planks may be trimmed marginally, as shown in Fig. III.

When the form has been made ready, the sheets of metal which are to constitute the shell are, in the practice of the invention, brought to place and accurately shaped within the form. These sheets include smooth

and uncorrugated sheets 5 to constitute the leading edge of the wing. These sheets 5, it will be seen, are bent transversely to a curve of relatively short radius. The other sheets of metal shaped within the form are the corrugated sheets 2 which constitute the upper face of the body of the wing and the corrugated sheets 6 which constitute the lower face. The sheets 6 may advantageously be spaced apart transversely of the wing, as appears in Fig. IV, so that the completed wing body is left with spaces or openings in its lower face, through which access may be had to the interior. The leading edges of sheets 2 and 6 underlie the edges of sheets 5, and the sheets 2 and 6 are united to sheets 5 in seams, ordinarily by riveting. Rearwardly, the sheets 2 and 6 do not reach to the end of the templet space; they terminate short of that, and between them a web 7 is introduced. This conveniently is formed of sheet metal, bent to channel shape. The edges of sheets 2 and 6 overlap the flanges of the channel, and there also seams are formed, conveniently by riveting.

As the sheet metal parts 5, 2, 6, and 7 are brought to place within the form, they are shaped upon the edges of the openings formed in the templets 3. The sections 32 which have been cut from the planks from which the templets themselves are formed, having been trimmed peripherally to serve their further purpose, may be introduced, in the position shown in Fig. IV, in continuity with the extent of the boards themselves from which they have been cut. Being so brought to place, they serve to shape minutely the metal sheets within the form and to bring the parts more accurately to position, and to hold the sheets of metal in accurate position. When the sheets of metal have been shaped, and preferably while they are so held, they are riveted, or otherwise secured together along the seams.

The uncorrugated sheets 5 compose, as has been said, the anterior edge of the structure. At the outer end of the wing these plates are united with and terminate in a pre-formed shoe 51 of sheet metal, which defines the tip of the wing and overlies the edges of the terminal sheets 2 and 6.

Each transverse web constituting a strut consists essentially of a sheet 8 of corrugated metal, shaped to the cross-section of the wing at the point where it eventually is to be situated. In the anterior portion of the wing, and within the curved sheet 5, this web may include an uncorrugated portion 9 (see Fig. V). The web, however, throughout the remainder of its extent, will preferably be formed of corrugated sheet metal, as indicated at 8. The sheets 8 and 9 will overlap and will be united in a suitable seam, as by riveting. The otherwise free edges of the sheets 9 may be flanged by cutting and bending, and bent angles 10 and 11, properly shaped, will be secured to the otherwise free edges of the corrugated sheets 8. As the shell structure is progressively shaped within the form and integrated by the securing together of the component sheets of metal, the temporary shaping blocks 32 are removed, and the webs are introduced. The webs, when they are introduced, are by their marginal flanges secured to the sheet metal shell, conveniently by riveting. The webs 8 will ordinarily correspond in number and position to the templets and to the temporary spacing blocks, and as the spacing blocks are removed, one after another, they are replaced, one after another, by the webs 8. This, however, need not be, and the webs may be set at other convenient and desired intervals throughout the extent of the wing structure.

To the posterior edge of the shell so built the marginal portion is built within the form. This marginal portion consists of sheets of metal 12 (see Fig. VI) secured to the edges of sheets 2 and 6, converging rearwardly, and united in a marginal seam. The sheets 12 are preferably corrugated, and the corrugations extend transversely of the wing as a whole. This marginal portion is preferably reinforced by an angle 13, formed of bent sheet, and situated intermediate the length of sheets 12, and to it the sheets are secured. As is indicated in Fig. I, the sheets 12, arranged in pairs, need not extend in continuity throughout the length of the wing, but the successive pairs may be spaced apart. As has been said, the continuity of this posterior margin of the wing may be further interrupted by the introduction of the usual ailerons.

I have described the procedure of bringing the sheet metal parts 5, 2, 6, and 7 to place within the openings of the templets 3, and introducing the forming sections 32 to shape minutely and to hold the metal sheets within the form while the several sheets are riveted, or otherwise secured together along the seams. The forming sections are removed, and the struts or webs substituted for these forming sections and secured to the so formed metal sheets. It is to be understood that, as a modification in procedure, the struts or webs may be used in place of, and may serve as the forming sections. That is to say, each of the webs may be introduced (instead of the forming sections 32) and brought to position in substantial continuity with the extent of the templets 3, and in so coming to position may serve to shape the metal sheets within the form. The sheets are then secured along the seams, and the webs are secured to the sheets in their ultimate position. The webs may, therefore, comprise the forming members, as well as the trusses for the wing body.

When the body of the wing has been built

within the form, the templets are opened; one of each of the pairs of planks which constitute the templets is taken away; the body structure of the wing then may be taken out.

The cover material may be such as is desired. Sheet metal is preferably employed, and the sheet metal may be smooth or corrugated.

The metal employed throughout may advantageously be one of the light, strong alloys of aluminum which have been worked out for the very purpose. One of these alloys rolled to sheet form, with a surface coating of pure aluminum, is the best of known materials for the purpose.

It is manifest that the method which has been described of shaping the wing structure is susceptible of use in shaping the fuselage of the aeroplane, and is generally applicable in the shaping of hollow bodies of sheet metal.

I claim as my invention:

1. The method herein described of building a hollow sheet-metal, interiorly trussed structure which consists in shaping sheet metal to a shell within a series of aligned cut-out templets, introducing truss members within the so shaped shell, and securing the introduced truss members within the shell.

2. The method herein described of building a hollow, sheet-metal, interiorly trussed structure which consists in shaping sheet metal to a shell within a series of fixed cut-out templets and over a series of removable forming sections, introducing truss members within the so shaped shell, and securing the introduced truss members within the shell.

3. The method herein described of building a hollow sheet-metal, interiorly-trussed structure which consists in shaping sheet metal to a shell within a series of fixed cut-out templets and over a series of removable forming sections, substituting truss members in place of said forming sections, and securing said truss members within the so shaped shell.

4. The method herein described of building a hollow, sheet-metal, interiorly-trussed airplane wing which consists in arranging and securing a plurality of cut-out templets with the edges of their cut-out spaces in coincidence with the surfaces to which the sheet metal is to be shaped, shaping sheet metal to a shell within the templets, securing truss members within the so shaped shell, and applying a covering to the shell.

5. The method herein described of building a hollow sheet-metal, interiorly-trussed airplane wing which consists in arranging and securing a plurality of cut-out templets with the edges of their cut-out spaces in coincidence with the surfaces to which the sheet metal is to be shaped, shaping sheet metal to a shell over forming members and within the templets, securing truss members within the so shaped shell, and applying a covering to the shell.

In testimony whereof I have hereunto set my hand.

HAROLD E. FOX.