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O. OECKL ET AL
SYSTEM OF CONSTRUCTING AIRCRAFT ELEMENTS
Filed Nov. 27, 1939

Serial No.
306,424
5 Sheets-Sheet 1

Fig. 1.

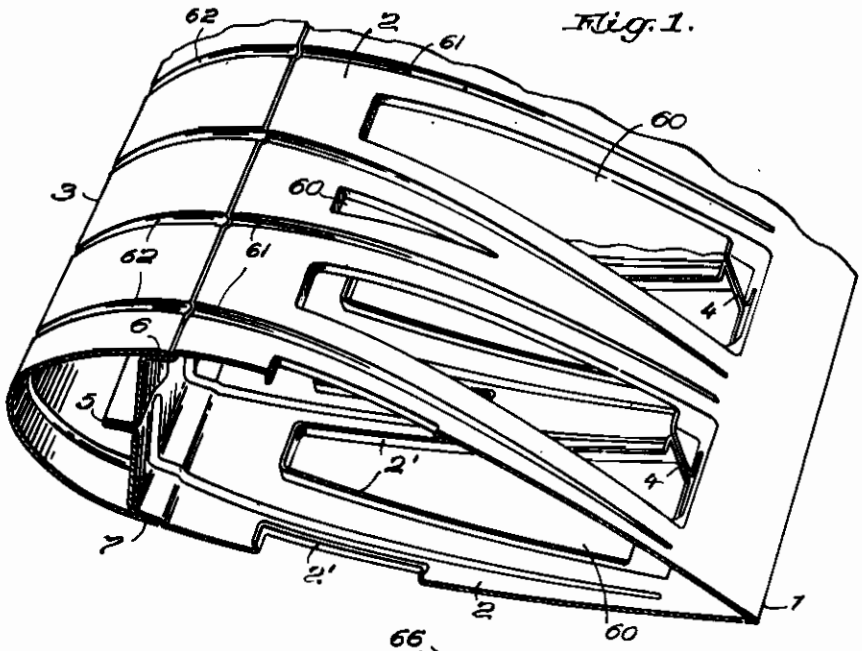
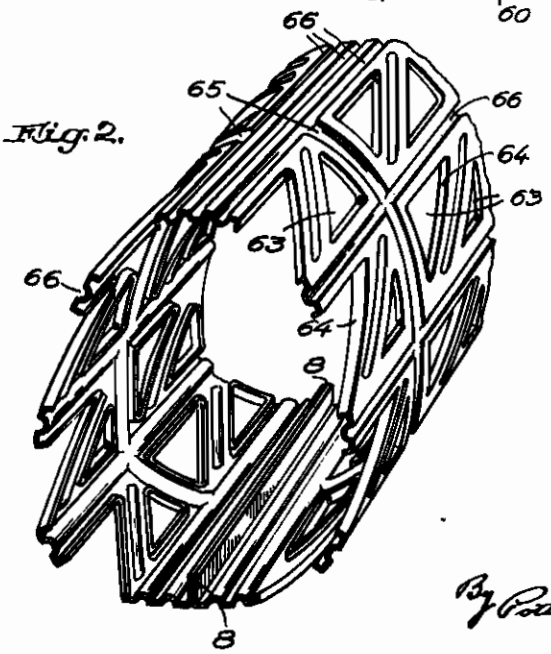


Fig. 2.



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5 Sheets-Sheet 2

Fig. 3.

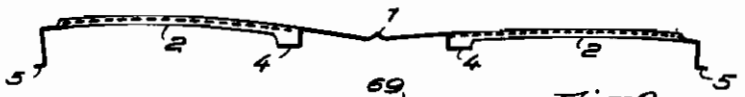

Fig. 4.

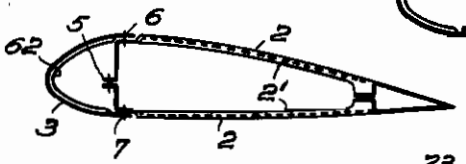

Fig. 5.

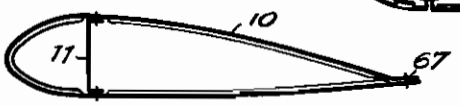

Fig. 6.

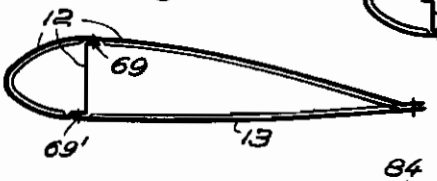

Fig. 7.

Fig. 8.

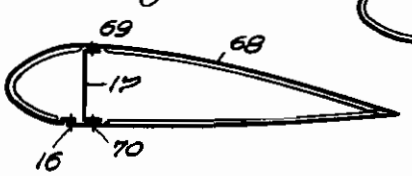

Fig. 9.

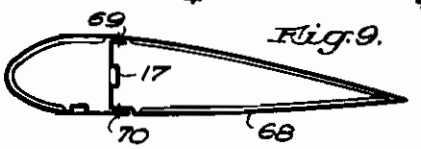

Fig. 10.

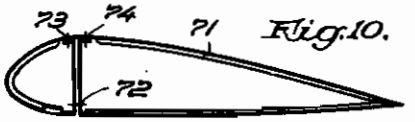

Fig. 11.

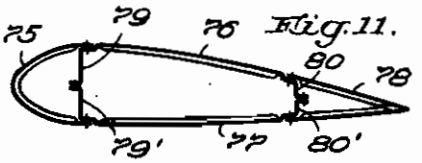

Fig. 12.

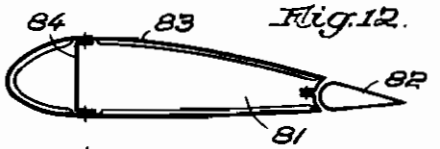

Fig. 13.

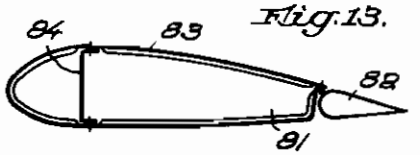

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Fig. 14.

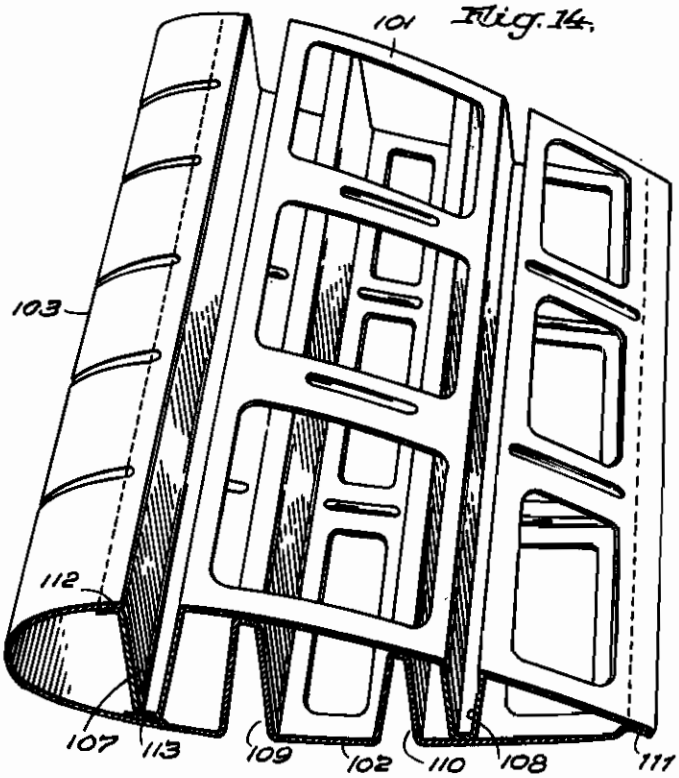


Fig. 18.

Fig. 19.

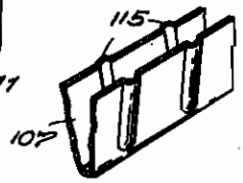


Fig. 15.

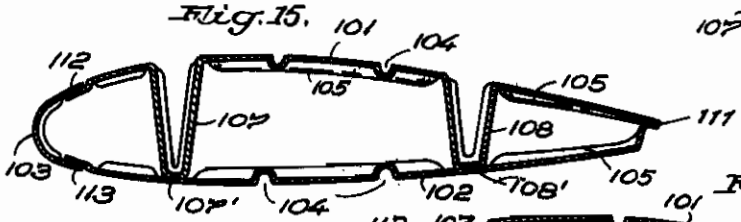


Fig. 16.

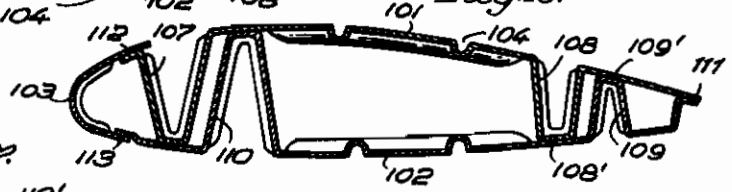
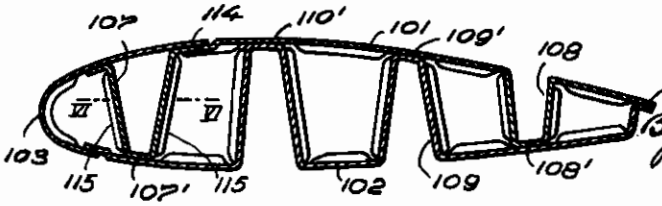


Fig. 17.



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5 Sheets-Sheet 4

Fig. 20.

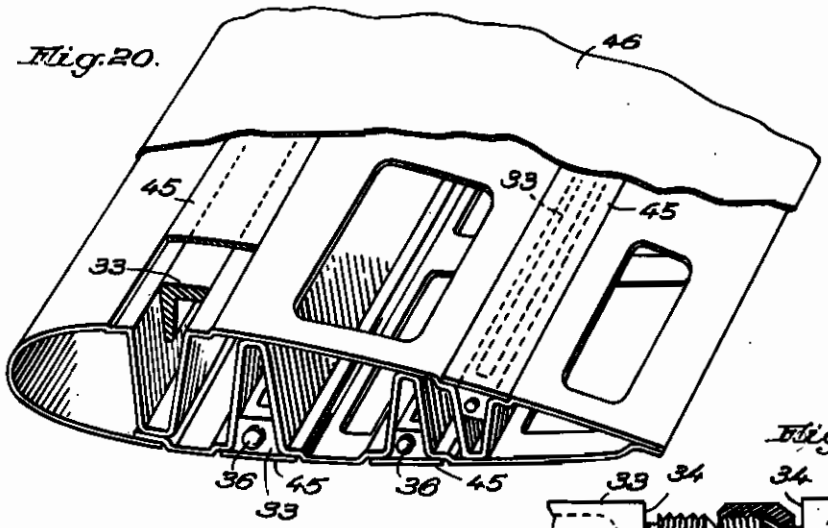

Fig. 22.

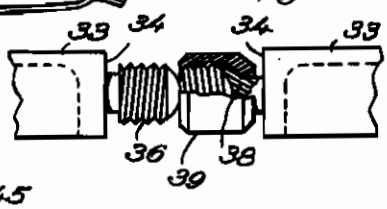

Fig. 21.

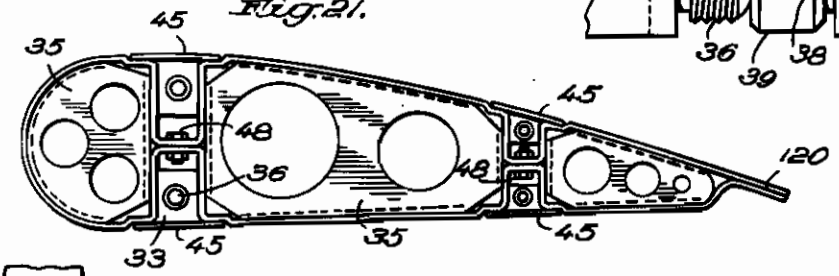

Fig. 23.

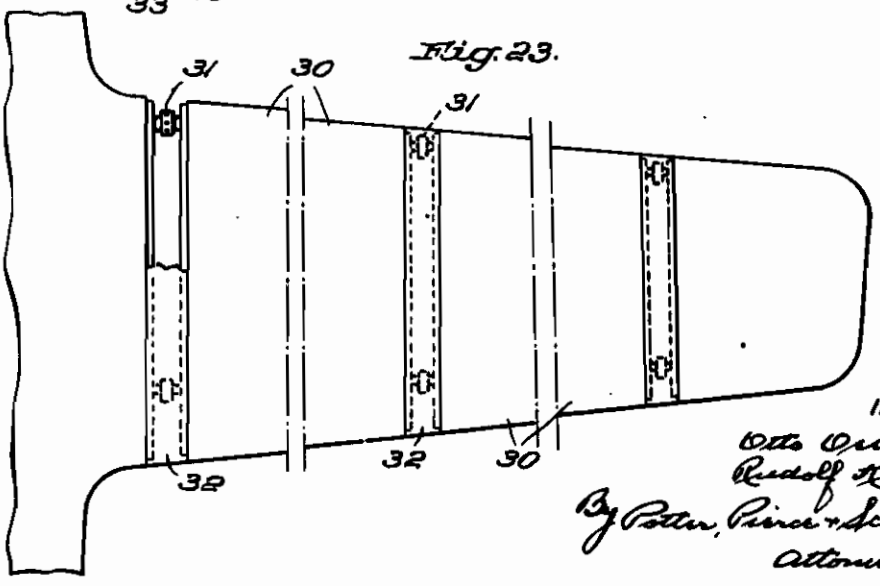

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Fig. 24.

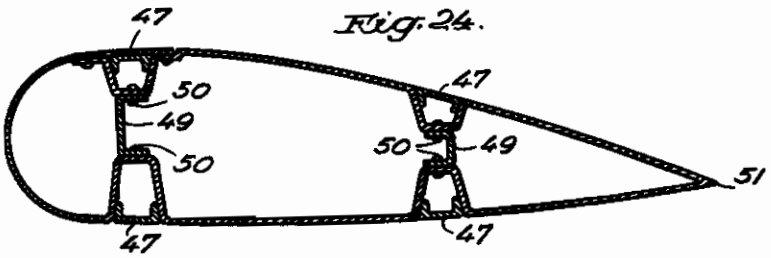


Fig. 26.

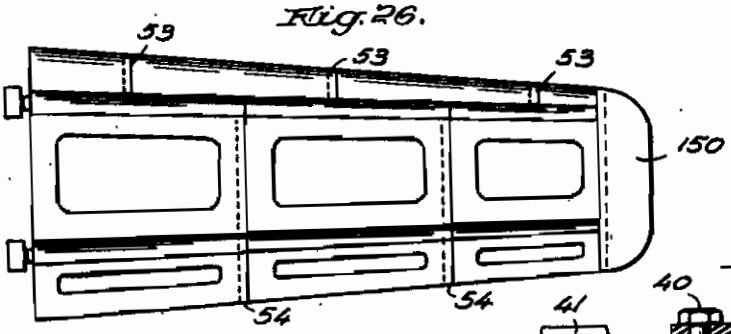


Fig. 25.

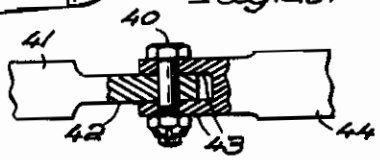
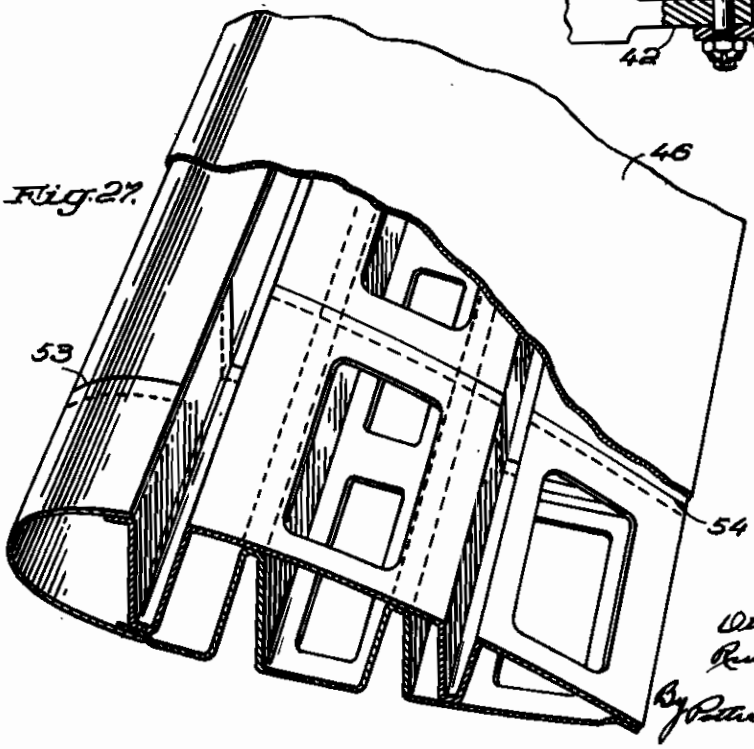


Fig. 27.



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ALIEN PROPERTY CUSTODIAN

SYSTEM OF CONSTRUCTING AIRCRAFT ELEMENTS

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Application filed November 27, 1939

This invention relates to a novel system of constructing elements or parts of airplanes of the type comprising an interior skeleton or frame work for the transmission of a substantial portion of the mechanical forces, and an outer cover in the form of a sheet or foil of metal, texture, plywood or artificial material.

It is an object of the present invention to construct the parts of airplanes which must have a favourable aerodynamical shape, such as, wings, fuselage, rudder, tail plane, fin and the like in such a manner that the manufacture is rendered cheap and simple.

A special object of the invention is to render it possible to produce the said elements substantially by a pressing operation, from one or a few pieces of sheet material.

Another object of the invention is to permit the production of large component parts in die presses so as to ensure great accuracy of the parts as to their shape and dimensions.

Still another object of the invention is to reduce the weight of the finished parts, the labour required for their manufacture and assemblage and to avoid or simplify the device required for the assemblage of the parts.

Another object of the invention is to render it possible that all stays or struts of one constructional part or element can be made from a single integral piece of material, in a pressing operation.

Still another object of the invention is to form also the longitudinal spars of profiled parts of airplanes integral with the framework thereof by a pressing operation.

With these and further objects in view, as may become apparent from the within disclosures, the invention consists not only in the structures herein pointed out and illustrated by the drawings, but includes further structures coming within the scope of what hereinafter may be claimed.

The character of the invention, however, may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which—

Fig. 1 is a perspective view of a framework for a wing, having the invention applied thereto.

Fig. 2 is a perspective view of a part of a fuselage framework.

Fig. 3 is a cross sectional view of the pressed piece of material for the wing framework shown in Figs. 1 and 4.

Figs. 4 to 13 are cross sectional views of various embodiments of frameworks for wings or rudders having the invention applied thereto.

Fig. 14 is a perspective view of a part comprising U-shaped spar portions pressed into the upper and lower frame surface.

Figs. 15 to 17 are cross sectional views of various further embodiments of parts provided with integral U-shaped spars.

Fig. 18 is a view of a point where the transverse and longitudinal creases cross each other.

Fig. 19 is a horizontal section, in perspective, through a spar on line VI—VI of Fig. 17.

Fig. 20 is a perspective view, partly in section, of a further embodiment, showing a wing element.

Fig. 21 is an end elevation of a wing part in which the spar portions are pressed into the upper and lower walls, in an opposing relationship.

Fig. 22 is a joint comprising a ball-shaped seat surface and a cap unit.

Fig. 23 is a plan view with parts broken away, of a detachable wing.

Fig. 24 is a cross sectional view of an embodiment comprising U-shaped spar portions pressed into the upper and lower walls of a wing part or the like and U-shaped connecting members between said spar portions.

Fig. 25 is a connecting member for connecting the single wing parts to a composite wing.

Fig. 26 is a plan view of a wing consisting of one piece.

Fig. 27 is a cross sectional, perspective view of the wing shown in Fig. 26.

Similar reference numerals denote similar parts in the different views.

Referring now to the drawings in greater detail, and first to Figs. 1, 3 and 4, it will be noted that the whole frame work consists of two parts only, i. e., a sheet **2** which is folded at the rear edge **1** of the wing and a sheet **3** forming the nose of the wing. As best shown in Fig. 3, the sheet **2** which may be apertured at **60** as shown in Fig. 1 is first formed with the projecting edge **1** and with the bent over portions or flanges **2'**, **4** and **5** in a swage or die, then the two parts of sheet **2** thus formed are folded into the shape shown in Figs. 1 and 4 and connected at **4**, near the rear end of the wing, and at the flanges **5**, by rivetting. The front arch **3** which has been separately pressed is now connected to the member **1**, **2**, **5**, at the points **6** and **7**, where the member **1**, **2**, **5** may be recessed as shown, by means of rivetting.

It will thus be clear that the framework consists of two parts only made by simple die-pressing operations and is formed with a continuous spar **5**, **6**, **7** and a number of ribs **2'**, which are additionally connected spar-fashion at the points **4**. The framework is additionally

stiffened by the creases 61 and 62 provided in the sheets 2 and 3, respectively. The framework thus formed is subsequently provided with the outer covering of thin metal sheet or the like to form the complete wing or like part.

Referring now to Fig. 2, this figure represents a fuselage framework. As shown, a length of the said fuselage framework consists of a single sheet of metal material which is formed with apertures 63, flanged portions 64 at the edges of said apertures, flanged portions 8 at the ends of the sheet and with creases 65 and 66 intermediate the apertures, by simple pressing operations. The sheet thus cut and pressed is now bent round to assume the desired shape and the adjacent end edges of the sheet are connected, for instance, by riveting. It will be understood that the cutting and die pressing operations prior to the bending operation can be made with simple tools and especially with a flat die and that the bending operation is also facilitated by the longitudinal creases 66 in the sheet. Thus, a complete rib system is formed of a single, integral piece of material.

Various further modifications of a wing framework of the type shown in Fig. 1 are shown in the Figures 5 to 13. Referring first to Fig. 5, the framework consists of a single sheet of material 10 which is bent at the nose and connected at its ends at 67, by riveting, and a U-shaped spar 11 inserted between the upper and lower portions of the sheet 10 by riveting.

The structure shown in Fig. 6 comprises a sheet 12 which is formed integral with a nose and spar portion and a sheet 13. The two sheets are connected at 69 by riveting, spot welding or the like, and the flange at the upper end of the spar portion is connected to the upper portion of the sheet 12 at 69' in the same manner. The embodiment shown in Fig. 7 is similar, but the portions 12 and 13 of Fig. 6 are in this case formed of a single, integral sheet which is bent over at 1' as at 1 in Figs. 1, 3 and 4. The spar portion is in this case Z-shaped and connected to the wall portions at 14 and 15 in any suitable manner.

In the embodiment shown in Fig. 8, the nose and upper and lower walls are formed of a single, integral sheet 86 while the spar is formed by a separate U-shaped piece of profiled material 17. The adjacent ends of the sheet 68 are connected together at 16 and the spar 17 is connected to the upper and lower walls of the sheet 68 at 69 and 70.

Fig. 9 shows a modification similar to Fig. 8, but the spar is in this case formed at the end of the lower wall of the sheet. According to Fig. 10, each end of the sheet 71 is formed with a spar portion and the two spar portions thus formed are interconnected at 72 and connected to the upper wall of the sheet 71 at 73 and 74.

Referring to Fig. 11, the wing part consists of four pressed sheets 75, 76, 77, 78 forming the nose, the upper and lower walls and the tail of the wing. The upper and lower walls are formed with end portions 79, 79', 80 and 80' thus providing a spar.

Figs. 12 and 13 have special reference to tailplanes comprising stationary fins 81 and movable rudders 82. The stationary fin comprises an integral pressed and curved sheet 83 and a U-shaped spar 84 secured therein. The rear ends of the sheet 83 may be connected by means of symmetrical bent-off portions and flanges on both ends, as shown in Fig. 12, or by means of a bent-off portion and flange on one of the ends secured to a straight face on the other end, as shown in Fig. 13.

It will be noted that in the preceding figures the spar is formed by inwardly bent end portions of the pressed sheet or by additional U- or Z-shaped members inserted therein. According to a further important feature of the invention, the spar may be formed by U- or V-shaped depressions in the pressed sheet whereby the strength of the constructional part is further augmented. Embodiments of this kind will now be described with reference to Figs. 14 to 17 in which the constructional part is formed by an upper frame member 101, a lower frame member 102 and a profiled nose member 103. Longitudinal creases 104 and transverse creases 105 are pressed into the said members to stiffen the same.

The U-shaped depressions in the upper sheet member 101 are designated 107 and 108 while the U-shaped depressions in the lower members 102 are designated 108 and 110. The two members 101 and 102 are connected at their rear ends at 111 and by the bottom walls 107', 108', 108' and 110' of the spar portions which engage the respective opposite member and are secured thereto by riveting, welding or the like. The modifications shown in the Figures 14 to 27 will now be described as to the differences in their construction.

Referring first to Fig. 14, the front or nose member 103 is secured to the free flange of the U-portion 107 and to the bottom portion 107' of the same. According to Fig. 15, in which only the member 101 is provided with spars, the joints 112 and 113 between the nose member 103 and the members 101 and 102 are provided more to the front end while according to Fig. 16 two strong spars are obtained by the spars 107, 110 and 108, 108, respectively, which are arranged close together and only the lower joint 113 is displaced with respect to the bottom 107' of the spar 107 and according to Fig. 17, the nose member 103 extends over the spar 107 and is connected to the member 101 at 114.

Fig. 18 shows a crossing point of a transversal and a longitudinal crease 105 and 104 in a member 101 or 102 and Fig. 19 shows similar creases 115 in the spar 107 of Fig. 17.

It will be understood that in the embodiments in which the spar are formed by U-shaped depressions of the pressed sheets proper, the frame thus formed in order to form a closed static system for withstanding torsional forces requires additional means closing the upper gaps of the U- or V-shaped spars. Various embodiments illustrating such additional means are shown in Figs. 21, 22, 25 and 27.

The torsional strength of the constructional part may be obtained, for instance, by the covering 46 which is riveted to the frame elements, as shown in Fig. 20. However, in order to reduce the weight of the part, we prefer to use a very light covering and to provide additional strips 45 inserted in, and secured to, suitable recesses or depressions of the pressed sheet and forming a box spar or girder together with the U-shaped portions.

Fig. 21 shows a modification in which an integral pressed sheet is bent round to form the profile and formed with U-shaped depressions in the upper and lower walls having half the total depth of the profile only and engaging each other half way between the outer walls for connection

by bolts and nuts **48**. The two free ends of the pressed sheet are connected at **120**.

Where the profile is very high, or it is intended to use relatively flat pressed sheets, intermediate spar members may be inserted between the U-shaped depressions in the pressed sheet, as indicated at **49** in Fig. 24, and connected thereto by rivets **50**. In this embodiment, profiled U-shaped section members **47** are inserted in the U-shaped spar portions to close the same and the element is formed of an integral pressed sheet which is bent at **51** while the seam is provided at **52**.

The interconnection between the single constructional elements thus formed and between the unit of said elements and the body or fuselage of the airplane may be effected in various manners.

For example, as shown in Figs. 20 and 22, U-shaped fitting members **33** secured within the U-shaped spar portions may be formed with threaded projections **36** at their ends for engagement with a threaded sleeve member **39** which by means of an inner flange engages over an outer flange of a projection **37** on the opposing U-shaped member **33** of the adjacent constructional element.

By way of alternative, or in addition to the said joints **33**, **34**, **36**, **37**, **38**, **39**, there may be provided fitting members **41** and **44**, Fig. 25, formed with eyelets or lugs **42** and forked lugs **43**, respectively, which are connected by bolts and nuts **40**. Advantageously, each wing element is provided on the front spar with a joint of this kind having a horizontal connecting bolt and on the rear spar with a connecting bolt having a vertical connecting bolt.

It is also possible, moreover, to transmit the torsional forces from the covering to the connecting points by means of ribs **35** as shown in Fig. 21.

As shown in Fig. 23, the constructional elements **30** forming the wing may be connected with each other and with the fuselage by joints **31** as shown in Fig. 23, in such a manner that a gap is left between the adjacent elements which is then closed by additional covering strips **32** or in the manner shown in Figs. 26 and 27 where the constructional elements are provided in an overlapping relationship. In this case, the joints of the main elements are arranged at **54** while the joints of the supplementary elements are arranged at **53** in a staggered relationship. End pieces **150** are provided to complete the wing or like part of the airplane.

It will thus be understood that the invention discloses a novel system of constructing box shaped elements or frame structures forming the support for the foil covering of parts of aircrafts, such as, wings, tail planes, rudders, fins, fuselage and the like which covering bears directly on the respective support. The particular features of the invention reside in the fact that the support consists of a single sheet, or a few sheets, the main surface of which is accommodated to all faces of the aircraft part and forms coherent surfaces on which the thin foil representing the covering may be supported. Moreover, the sheet or sheets are reinforced by one or a few longitudinal girders or spars which are preferably formed of inwardly bent-off portions of the sheet, in a pressing operation, or of separate girder members connected to such bent-off portions. Furthermore, it is an important feature of the invention that the transverse stiffening members or ribs are also formed of the said sheet, by inwardly pressing the sheet in the form of creases or flanges at the edges of cut out portions. This novel construction offers the advantage that the constructional element consists of one or a few parts only and that the foil covering may be very thin since it is well supported over its whole surface.

The method and apparatus of the present invention have been described in detail with reference to specific embodiments. It is to be understood, however, that the invention is not limited by such specific reference but is broader in scope and capable of other embodiments than those specifically described and illustrated in the drawing.

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