

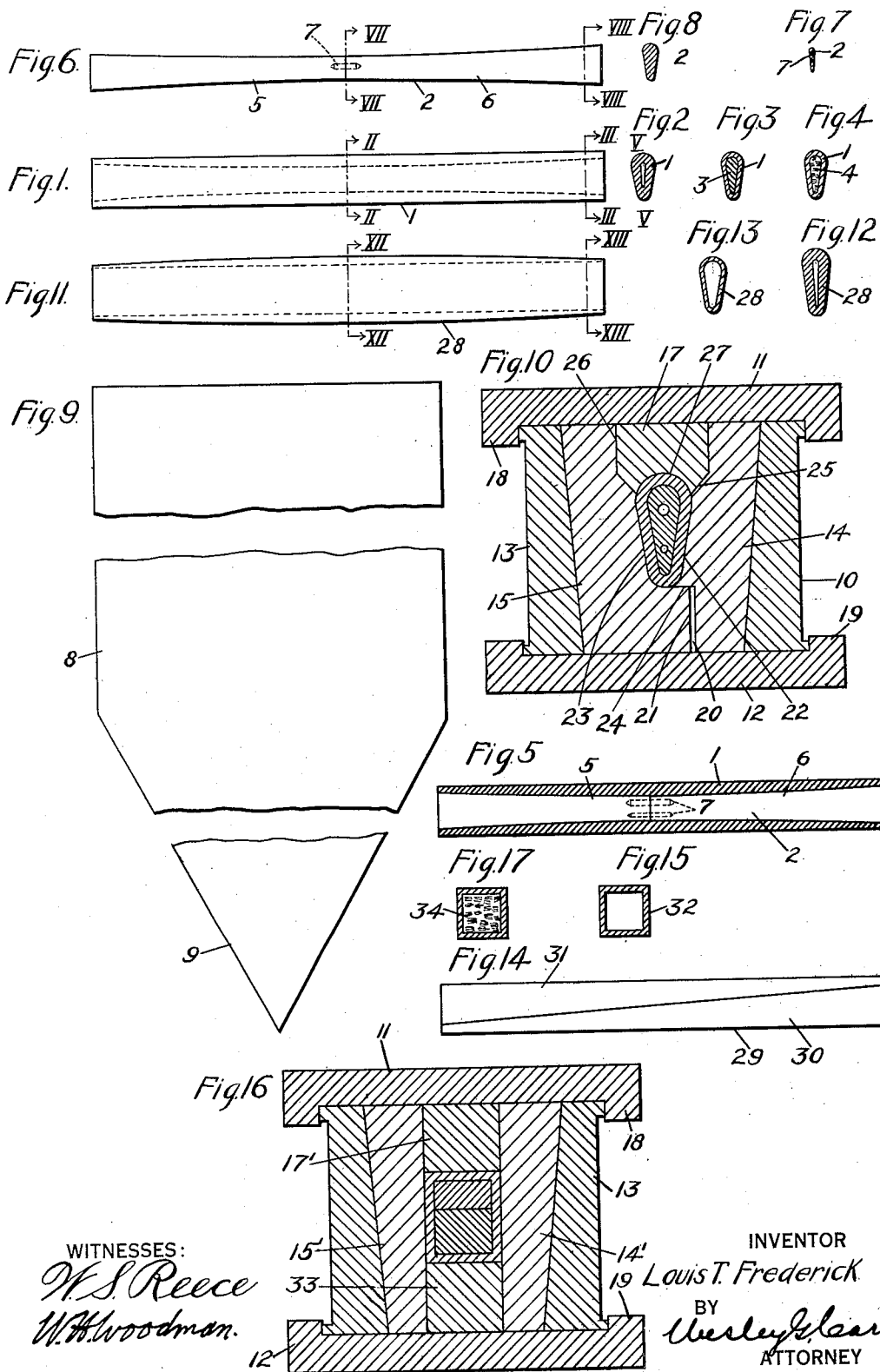
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L. T. FREDERICK

STRUCTURAL ELEMENT

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WITNESSES:

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STRUCTURAL ELEMENT.

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To all whom it may concern:

Be it known that I, LOUIS T. FREDERICK, a citizen of the United States, and a resident of Wilksburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Structural Elements, of which the following is a specification.

My invention relates to tubular structural elements and more particularly to structural elements, such as struts, for use in aircraft construction, and it has for its primary object the provision of a tubular structural element of laminated fibrous sheet material and a hardened binder in which the tubular element is so wound as to insure unusual strength against longitudinal pressure and transverse bending or buckling.

Heretofore, numerous tubular structural elements have been made by winding suitably impregnated fibrous sheet material about cores of the desired cross sectional shape and size to form tubular bodies which, while still on the cores, have been molded or otherwise treated to harden the binder. These tubular elements have, however, been of uniform external and internal perimeters throughout their lengths and their walls have, therefore, been of uniform thickness throughout their lengths. With struts, as commonly employed in aircraft construction, the greatest strength is required intermediate the strut ends and one of the objects of my invention is to provide a strut, or other tubular structure, which may be of either uniform internal perimeter or uniform external perimeter throughout its length but in which the cross sectional thickness of its wall will taper from its central portion to its ends.

Another object which I have in view is the provision of a method for winding a single sheet of impregnated fibrous material in such manner as to accomplish the desired thickening of the central portion of the wall of the tubular member, the method being of such character that the thickening of the wall may be accomplished either internally or externally of the body proper of the strut or other tubular member.

A further object contemplated by me is the provision of a strut of fibrous sheet material which may be formed with an axial opening or in which such opening may be

filled with a permanent core of wood, cork or other suitable material.

In this connection, another object of my invention resides in the provision of suitable cores, either permanent or removable, upon which the struts may be wound and cured and in the provision of a suitable mold for receiving the wound struts, while still upon the cores.

With these and other objects in view, my invention will be more fully described, illustrated in the drawings, in which similar reference numerals indicate corresponding parts throughout the several views, and then particularly pointed out in the appended claims.

In the drawings, Fig. 1 is a side elevation of a stream-lined strut constructed in accordance with my invention, the intermediate portion of the strut being internally thickened or reinforced; Fig. 2 is a sectional view taken on the line II—II of Fig. 1, showing the thickened central portion of the wall as compared with the thinner portion shown in Fig. 3, which is a section taken on line III—III of Fig. 1 and which also shows a permanent core, which may be of wood; Fig. 4 is a section corresponding to that shown in Fig. 3 but illustrating a permanent core of cork; Fig. 5 is a longitudinal sectional view taken on the line V—V of Fig. 2, showing a removable core in place; Fig. 6 is a top plan view of the core shown in Fig. 5; Figs. 7 and 8 are transverse sectional views taken on the lines VII—VII and VIII—VIII of Fig. 6; Fig. 9 is a plan view of a strip of fibrous sheet material properly shaped for the practicing of my invention; Fig. 10 is a vertical cross sectional view of an improved mold capable of use in forming my improved tubular structures, a stream-lined strut upon its core being shown within this mold; Fig. 11 is a side elevation of a modified form of stream-lined strut in which the central portion is externally thickened or reinforced; Figs. 12 and 13 are transverse sections taken on the lines XII—XII and XIII—XIII of Fig. 11 showing variations in the thickness of the wall; Fig. 14 is a side elevation of a modified form of core which may be used, with slight variations, either for molding the strut shown in Fig. 11 or a tubular beam such as is shown in Fig. 15; Fig. 15 is a transverse

sectional view taken through a tubular beam; Fig. 16 is a vertical, transverse, sectional view taken through a mold, of similar construction to that shown in Fig. 10, but adapted for use in molding beams of the type shown in Fig. 15; Fig. 17 is a transverse sectional view of a beam, similar to that shown in Fig. 15, but formed upon a permanent core of wood or cork.

10 In Figs. 1 to 5 inclusive, I have illustrated an improved form of tubular structural element, which, for the sake of convenience, is shown as a stream-lined strut 1 for aircraft constructions, in which the tubular element is of uniform external perimeter but in which the internal perimeter increases from its central to its end portions, with the result that the central portion of its wall is internally thickened or reinforced.

20 The tubular strut 1 may be molded about a removable core 2, such as is shown in Figs. 5 and 6; about a removable core of the same general shape but formed of a fusible metal, such as an alloy of two parts bismuth, one part tin and one part lead, which may be removed after the strut has been completed; about a permanent core 3 of wood, such as is shown in Fig. 3, or about a permanent core 4 of cork or other compressible material such as is shown in Fig. 4. In any event, the core, of course, corresponds to the internal shape of the completed strut, being of stream-line shape in cross section, throughout its length, but increasing in cross sectional perimeter from its central to its end portions, this increase preferably being uniform in both directions. If the core is a permanent one of wood or cork or if it is a removable one of a fusible metal, alloy or other substance which is to be fused and run out after the strut is completed, the core is preferably formed in a single piece. If, on the other hand, the core is of non-fusible material and is to be removable, it is preferably transversely divided at its center into two identical sections 5 and 6 which, in use, are held in alignment with each other by dowels 7 fitting in openings formed in the inner or abutting ends of the sections. Obviously, with a core so constructed, after the molding or curing of the strut has been accomplished, the several sections of the core may be withdrawn from the opposite ends of the finished strut.

55 According to my present invention, the strut body is formed of a suitable fibrous sheet material, such as paper, fabric or cotton batting, previously impregnated with a suitable binder, such as shellac, copal, casein, marine glue or a phenolic condensation product, which will harden, or which may be hardened by molding or other suitable means.

65 In practicing my invention, a sheet 8 of suitably impregnated fibrous material of the desired kind may be closely wound about a

core of proper cross sectional shape and size, after which the wound body, while still on its core may be treated in such manner as to harden the binder and transform the entire body into a hard and homogeneous mass. One end of the sheet 8 is tapered uniformly from opposite sides to a point, as indicated at 9 in Fig. 9, and this end is first wound about the core, its pointed terminal being placed against the central portion of the core, so that successive layers of the wound sheet material project at their edges nearer and nearer to the ends of the core with the result that the wall of the wound body gradually increases in thickness internally from its ends to its central portion, the amount of this increase being dependent upon the number of laminations formed about the core by the tapered terminal of the sheet and consequently being dependent upon the degree of taper given such terminal.

After the tubular strut or other structural element has been wound upon its core, in the above described manner, it is heated, or otherwise treated, to harden its binder. For instance, if the binder, as is preferably the case, is a phenolic condensation product, or other adhesive, which will harden under the application of heat and pressure, the wound tubular element, while still upon its core, may be placed in a suitable mold 10 and there subjected to heat and pressure by any desired means. The mold 10 comprises top and bottom clamp plates 11 and 12, side clamp plates 13, side molds 14 and 15 and a plunger 17. The top clamp plate 11 has downwardly depending marginal flanges 18 at its longitudinal edges while the bottom clamp plate 12 has corresponding upwardly projecting flanges 19, these flanges engaging against the outer faces of the side clamp plates 13 when the mold is assembled, as shown in Fig. 5, to prevent movement of the clamp plates 13 away from each other in order that the side molds or splits 14 and 15 and the plunger 17 may be held in place.

The inner walls of the side clamp plates 13 are inclined, downwardly and inwardly, as are the outer walls of the side molds or splits 14 and 15, so that, as these splits are forced downwardly into the mold, they will be moved toward each other. The inner face of the split 14, near its lower end, is undercut to provide a longitudinal channel or recess 20 and the corresponding portion of the side mold or split 15 is provided with an extension 21 adapted to be forced into the recess 20 when the splits engage the bottom clamp plate 12. Immediately above the recess 20 and the extension 21, the inner faces of the splits are shaped to correspond to the desired shape of the greater portion of the tubular element to be molded between them, these molding faces

being indicated at 22 and 23. At this point, it should be noted that the wall forming the face 22 of the split 14 terminates, at its lower end, in an outwardly directed lip 24 which slides along the upper face of the extension 21 as the splits are moved toward each other and which will, therefore, prevent any of the material being molded from escaping into the recess 20. Immediately above the molding faces 22 and 23, the splits are formed with upwardly diverging faces 25 which merge into vertically disposed faces 26 extending to the tops of the splits. The plunger 17 is proportioned and cross-sectionally shaped to fit snugly between the faces 25—26 of the two splits, and, along its lower face, is longitudinally grooved and transversely concaved, as shown at 27, to form a molding face cooperating with the faces 22 and 23 of the splits to give the desired external contour to the tubular element being molded.

In practise, the side clamp plates are positioned upon the bottom clamp plate, the tubular element to be molded, while still upon its core, is positioned between the side molds or splits 14 and 15 which are then lowered into place between the side clamp plates, the plunger 17 is positioned between the upper edges of the splits and the top clamp plate is placed with its depending flanges 18 engaging against the outer faces of the side clamping plates. Under these circumstances, due to the amount of wound material about the core, the splits 14 and 15 will be spaced somewhat above the bottom clamp plate, and the inclined faces of the plunger 17 will be held somewhat above the corresponding faces 25 of the splits while the top clamp plate 11 will rest upon the plunger 17 but will be spaced somewhat above the tops both of the side clamp plates and the splits. Pressure exerted against this top clamp plate will, however, cause such compression of the sheet material wound about the mold as will bring the parts of the mold to the position shown in Fig. 10 to properly compact and shape the wound material about its core. The manner of removing the finished element from the mold is obvious and needs no explanation.

After removing the element from the mold, the core, if it is of the removable type shown in Fig. 6, may be withdrawn. On the other hand, if the core is of a low-melting-point alloy or other readily fusible substance, it may be removed, after the molding operation, by additionally heating the molded element, either while it is still in the mold or after it has been removed, to a sufficient extent to fuse the core so that it may be run out. In some instances, this core may be of such an alloy or substance as to fuse at the curing temperature employed, under which conditions, means may be pro-

vided for preventing escape of the core at the ends of the element during the molding operation, such means, which may be caps closing the ends of the mold, being then removed to permit escape of the fused core.

In Figs. 11 to 13 inclusive, I have illustrated a modified form of stream-lined strut which is similar to that shown in Fig. 1 and which may be constructed in a somewhat similar manner. The sole difference between these struts resides in the fact that the one shown in Fig. 11 is externally instead of internally thickened at its central portion, this being accomplished by winding the untapered end of the strip 8 of sheet material about the core face, instead of the tapered end, and by employing a core of uniform cross sectional shape and perimeter throughout its length. With this exception the strut 28 may be made in the same manner as the strut 1 and may, of course, be made upon a removable core, either of permanent form or fusible, or upon a permanent core of wood, cork, or other material.

A non-fusible removable core formed in one piece may be employed as it may be pushed out from the finished strut but I prefer to employ a core, such as that shown at 29 in Fig. 14, which is divided diagonally and longitudinally to form wedging sections 30 and 31, as these sections may be separately and readily removed from the completed strut, thereby doing away with any binding action which may occur between the strut and a one-piece core.

Obviously, tubular elements of any desired cross sectional shape and size may be constructed in accordance with my invention, either with or without permanent cores of any suitable materials. Furthermore, and particularly if permanent cores are employed, the thickness of the walls of such elements may be uniform throughout their length. For instance, in Fig. 15 I have shown a tubular element or beam 32 which may be square or rectangular in cross section and which may be formed by winding suitably impregnated fibrous sheet material about a mandrel of corresponding cross sectional shape. For instance, a mandrel of the type shown in Fig. 14 may be employed for forming the tubular element 32, such a mandrel being shown in cross section in Fig. 16 in which the various parts of the mandrel are given reference numerals corresponding to the same parts of the mandrel 29, the two mandrels being identical save in cross sectional shape.

Fig. 16 illustrates a manner of adapting a mold structure, shown in Fig. 10, for molding a tubular element which is square or rectangular in cross section. As there shown, the mold is identical with that previously described with the exception that the side molds or splits 14' and 15' have parallel,

vertically disposed, inner faces, that the plunger 17' is longitudinally in cross section to slide freely between the inner faces of the splits and that a bottom plunger or anvil 33 is provided to seat the tubular element. Of course, in place of employing the two-part removable core, as shown in Fig 16, a removable core of fusible material may be employed or a permanent core of wood or cork 34, such as shown in Fig. 17, may be provided.

By practising my invention, it is possible to cheaply and uniformly manufacture tubular structural elements of any desired cross sectional shape and size, either with or without permanent cores of wood, cork or other materials. It is further possible to vary the cross sectional thickness of the walls of such elements from their central to their end portions and to accomplish this by thickening such walls either internally or externally, as desired. For these reasons, I do not wish to be limited, in any way, to the specific details illustrated and described or to the particular methods set forth, but reserve the right to make any changes in methods, apparatus employed or materials used which may come within the scope of the claims.

I claim as my invention:

1. A structural element comprising a tubular body of uniform external perimeter throughout its length, the wall of which tapers in thickness from its center toward its ends.

2. A structural element comprising a bind-

er indurated sheet material providing a tubular body of uniform external periphery throughout its length, the wall of which tapers in thickness from its center toward its ends.

3. A structural element comprising a core of cellular material and a covering, tapering in thickness toward its ends, of wound laminated sheet fibrous material impregnated with a binder which has been molded and hardened about the core by the application of heat and pressure.

4. A method of forming a tubular structural element that comprises winding a sheet of impregnated fibrous material about a suitably shaped core and treating the wound body, while still on the core, to harden and compact it, that end of the sheet first wound about the core being tapered, whereby successive layers will project at their edges beyond the next adjacent inner layers to produce a tubular body, the wall of which varies in thickness.

5. A method of forming a stream-lined strut that comprises assembling duplicate core sections in line with each other, winding a sheet of impregnated fibrous material about the assembled core, subjecting the body so wound to heat and pressure to harden it and withdrawing the core sections from the opposite ends thereof.

In testimony whereof, I have hereunto subscribed my name this 30th day of April, 1918.

LOUIS T. FREDERICK.