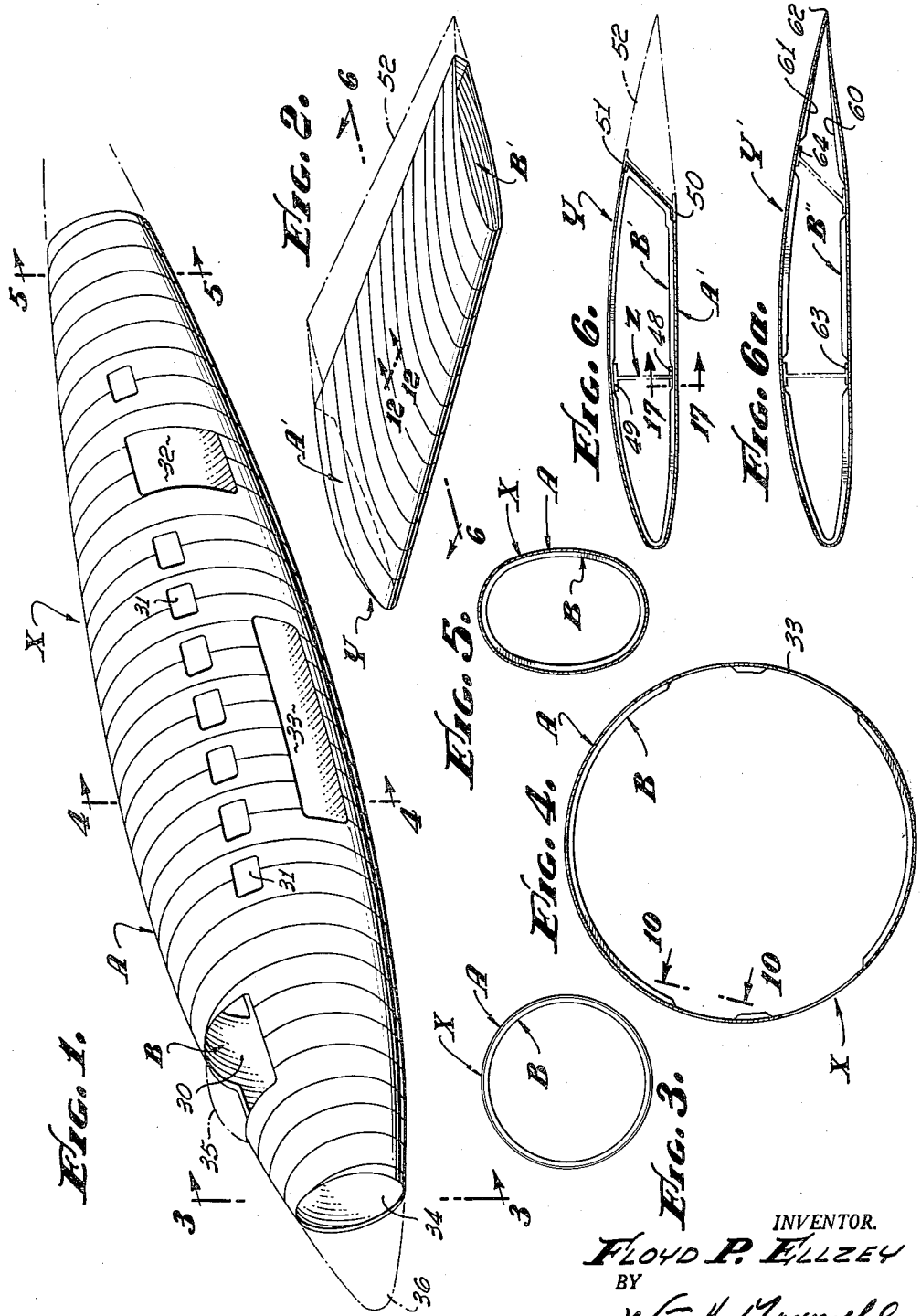
March 6, 1962 F. P. ELLZEY 3,023,860

BODY CONSTRUCTION

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BODY CONSTRUCTION

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FIG. 7.

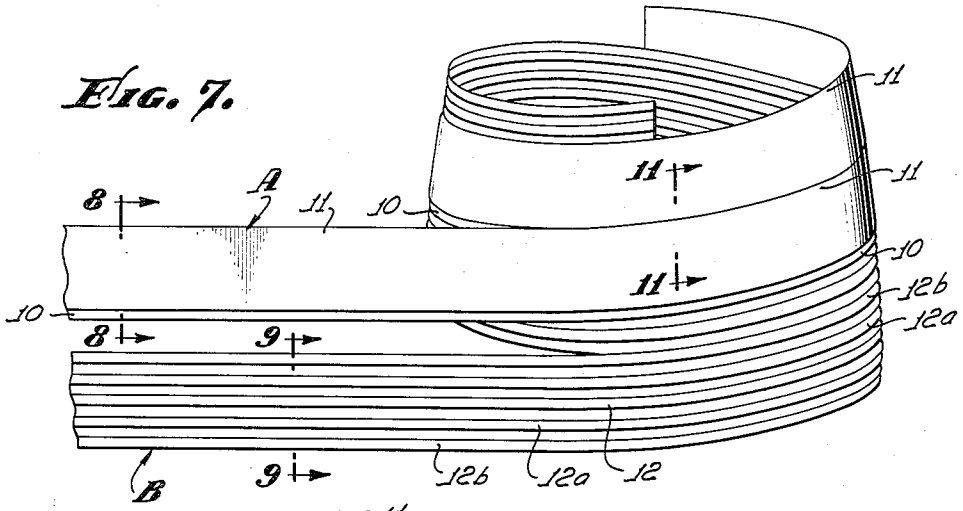


FIG. 8.

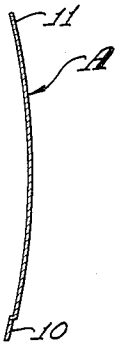


FIG. 9.

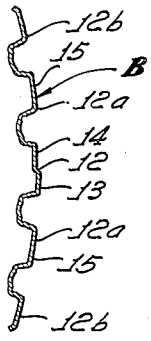
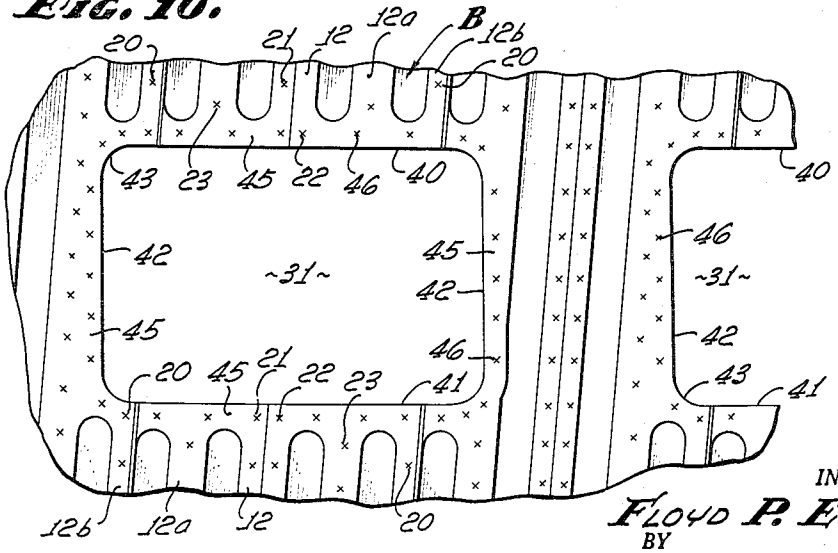


FIG. 10.



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BODY CONSTRUCTION

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FIG. 11.

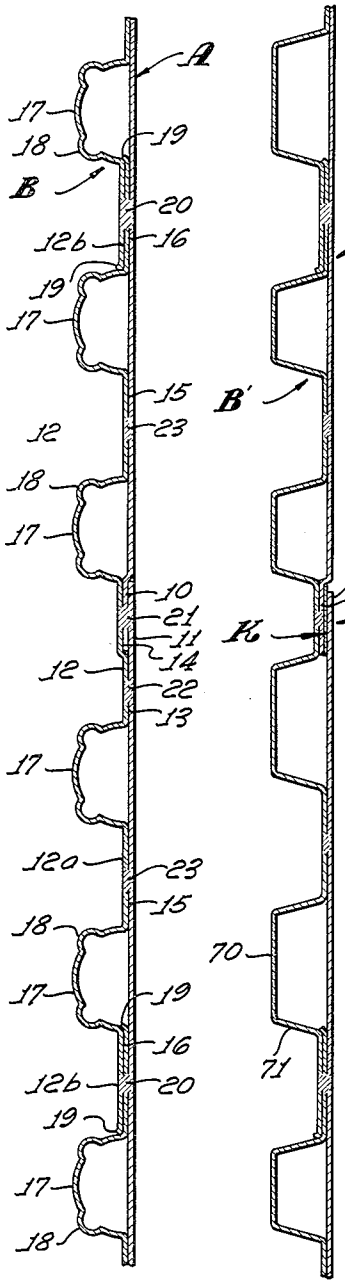
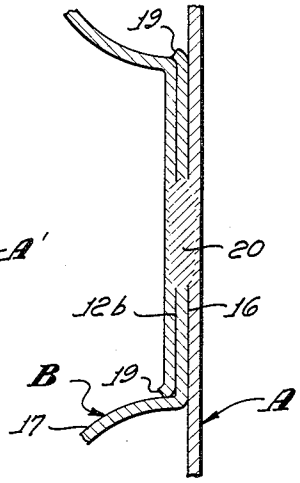
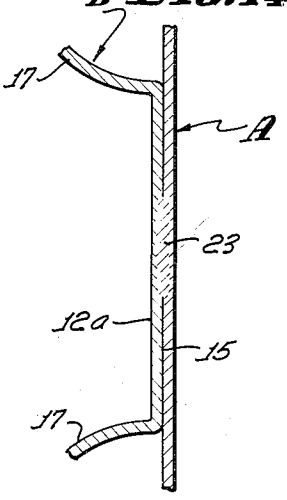


FIG. 12.

FIG. 13.



B FIG. 14.



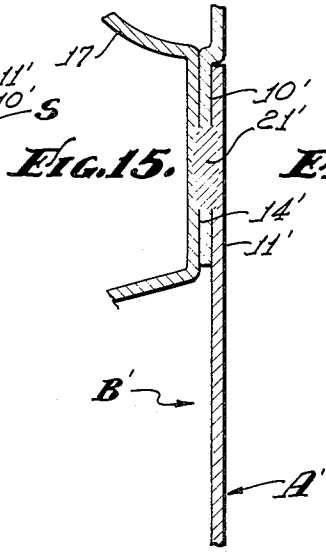


FIG. 15.

FIG. 16.

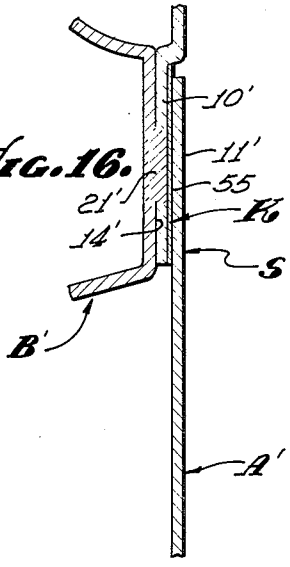
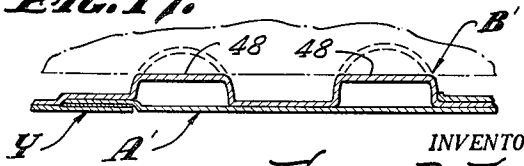


FIG. 17.



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BODY CONSTRUCTION

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FIG. 18.

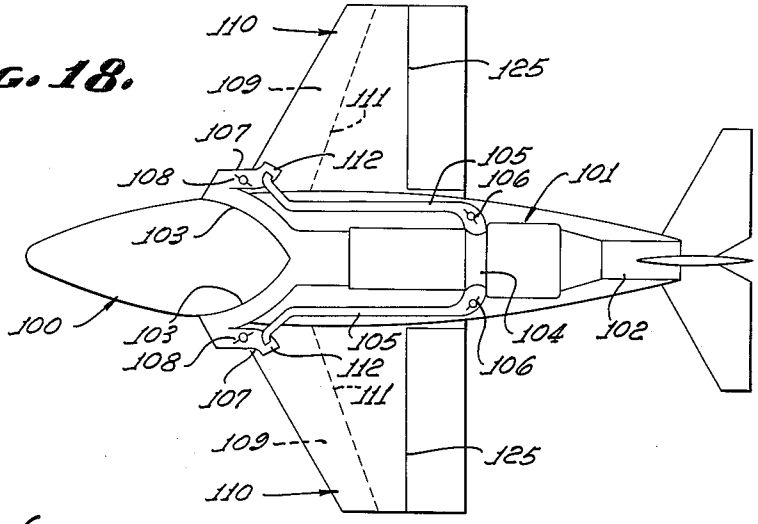


FIG. 19.

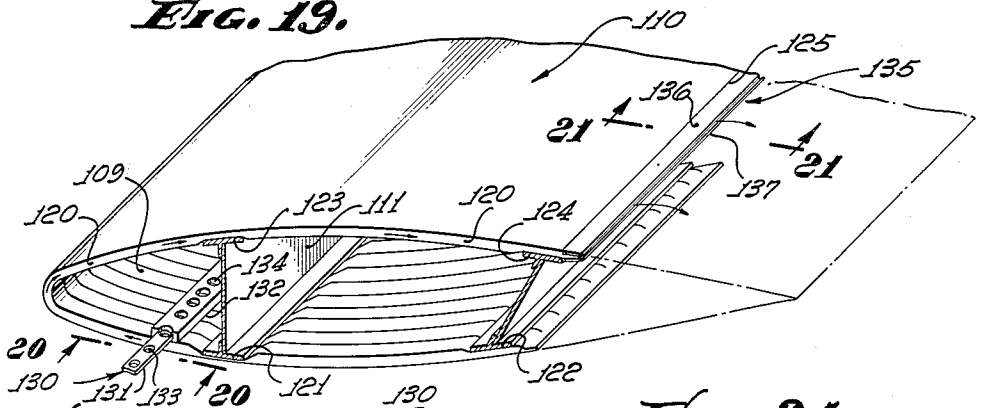


FIG. 20.

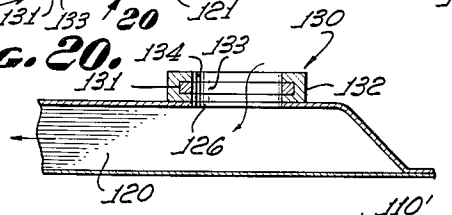


FIG. 21.

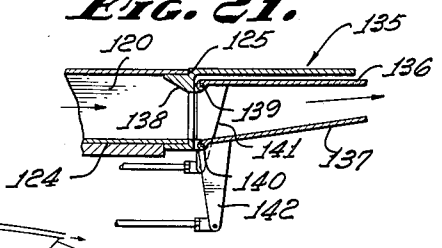
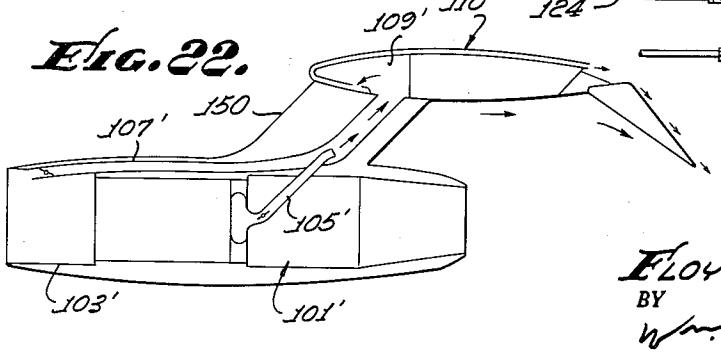


FIG. 22.



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United States Patent Office 3,023,860 Patented Mar. 6, 1962

3,023,860

BODY CONSTRUCTION

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Filed Mar. 18, 1957, Ser. No. 646,756
17 Claims. (Cl. 139—34)

This invention relates to a body construction and in particular it relates to a spirally wrapped multi-layer structure which is in the nature of a fabrication of sheet metal parts, and it is a general object of my invention to provide a simple, practical, inexpensive body construction of sheet metal or the like for use, for example, in the building of vehicle bodies, and fuselages, etc.

This application is filed on even date with my copending application Serial No. 646,587, as a continuation in part of my application entitled, "Method of Making Spirally Wrapped Multi-Layer Tube," filed June 1, 1953, Serial 358,797 and issued into Patent No. 2,786,435, said application being a continuation of application Serial No. 687,768 filed June 24, 1946, now abandoned.

My present invention is concerned primarily with an article in the form of a fabricated structure and in accordance with the broader principles of my invention I may employ said fabricated structure to make or build any body or hollow shell-like structure, for example an aircraft fuselage, or the like. In general I may fabricate the structure of any suitable sheet material. However, my invention is particularly suited for fabrication of sheet metal such, for example, as sheet aluminum alloys and the like.

Further, in accordance with my invention I may form structures of various sizes, shapes and characters, for instance, I may provide round, cylindrical structures such as the bodies of tanks, or round tapered structures such as may form or enter into the fuselage of an airplane, or I may form flattened or elliptical structures suitable for wing sections of airplanes. I do not wish the invention limited in any way to the specific form or construction that I have illustrated, nor do I wish the invention limited to the formation of airplane parts even though I have, in the drawings, illustrated typical aircraft structures fabricated in accordance with my invention.

It is a general object of my present invention to provide a simple, practical body of sheet material, preferably sheet metal, fabricated into a practical permanent strong construction characterized in its finished form by inner and outer sheets, the inner sheet being a reinforcing or stiffening element while the outer sheet forms a smooth exterior element.

It is another object of my present invention to provide a structure of the character described capable of being made of continuous lengths or strips or sheet material and to form a single integral unit of construction thereof.

A further object of my present invention is to provide a body structure of the character above referred to that is essentially mono-coque, or of shell-like character. The body structure that I provide is a single unit shell in the form of a body that is fabricated of two elements, one an inner reinforcing element and the other an outer surfacing element.

It is a further object of my invention to provide a mono-coque body structure of the character above referred to that is rigid and holds and maintains its size, shape and dimensional proportions.

It is still a further object of my invention to provide a mono-coque body structure of modified construction and of the character above referred to that is expansible in one direction and flexible in one or two planes. This modified form of mono-coque body structure is provided with expansion joints that allow the structure to vary in size, shape and dimensional proportions, to the end that

buckling and wrinkling of the outer skin or element of the structure is eliminated.

It is also an object of my invention to provide a body structure of the character referred to that involves a reinforcing or stiffening element that is adapted to conduct fluids to be used in aircraft for "Boundary-Layer Control," or "Circulation Control," or "Anti-Icing Control," or "Structural Temperature Control," etc. The structure that I provide is readily adapted to conduct the flow of fluids in a variety of manners.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a perspective view of a body in the form of a fuselage and embodying the structure of the present invention. FIG. 2 is another perspective view of a body in the form of a wing section and embodying the structure of the present invention. FIGS. 3, 4 and 5 are sectional views taken as indicated by lines **3—3**, **4—4** and **5—5** on FIG. 1. FIG. 6 is a sectional view taken as indicated by lines **6—6** on FIG. 2. FIG. 6*a* is a sectional view similar to FIG. 6 and showing a modified form of construction. FIG. 7 is perspective view illustrating the manner in which the structure is formed, being a view showing the formation of an elongate tubular tapered structure from two continuous strips of sheet material, which structure when finished has a corrugated inner sheet and a plain smooth outer sheet. FIGS. 8 and 9 are enlarged sectional views taken as indicated by lines **8—8** and **9—9** on FIG. 7. FIG. 10 is an enlarged view of a portion of the structure taken as indicated by lines **10—10** on FIG. 4. FIG. 11 is an enlarged sectional view of the two sheets involved and taken as indicated by lines **11—11** on FIG. 7. FIG. 12 is a view similar to FIG. 11 being a view taken as indicated by lines **12—12** on FIG. 2. FIGS. 13, 14, 15 and 16 are enlarged sectional views of portions of the structure shown in FIGS. 11 and 12. FIG. 17 is an enlarged sectional view taken as indicated by lines **17—17** on FIG. 6. FIGS. 18 to 22 are views illustrating typical manner of employing the body construction of the present invention to be used in aircraft for "Circulation Control," or the like, FIG. 18 being a general plan view of an aircraft, FIG. 19 being a perspective view of a portion of said aircraft, FIGS. 20 and 21 being enlarged sectional views taken as indicated by lines **20—20** and **21—21** on FIG. 19, and FIG. 22 being a view of a portion of an aircraft of modified form.

In accordance with the broader principles of my invention I handle a plurality of sheets of material which I will refer to as sheet metal, although I do not wish to be understood as thereby limited. I prefer, in carrying out my invention, to simultaneously handle or work upon two bodies of metal although the broader principles of the invention contemplate that any suitable number of parts or pieces of metal can be worked upon as circumstances require. In the following description I will refer to a form of my invention wherein I work upon two pieces or bodies of sheet metal and I will, for example, refer to these pieces of metal as elongate strips or ribbons of metal. The said strips or ribbons of metal are designated in the drawings as A and B. In general, I wrap the sheets or strips of metal A and B into an elongate tubular structure with one sheet forming the lining of the structure while the other forms the exterior or skin of the structure. In the case illustrated the sheet A forms the skin of the structure while the sheet B forms the lining of the structure. I prefer to shape one of the strips so that it acts primarily as a stiffening or reinforcing element and ordinarily I prefer to locate this

stiffening or reinforcing element inside of the other element or, in other words, I prefer to make the lining B the stiffening or reinforcing element.

In carrying out my inventtion, I not only wrap the strips of sheet metal into an elongate tubular structure but I prefer to stagger or offset the wrapping of the two strips in order to stagger or offset the joints or seams that occur at adjacent parts of the strips. I preferably wrap each strip so that it is generally spiralled or helical in form, and I relate the turns or convolutions so that the edge portions of each strip adjoin, in fact, preferably overlap slightly as I have shown throughout the drawings.

Referring to the form of the invention illustrated in FIGS. 1 to 5, FIGS. 7 to 11, FIGS. 13, 14 and FIG. 15 or the drawings, I contemplate fixing the adjoining or overlapping parts of each strip together by establishing a seam or joint so that each strip, in and of itself, in the nature of a complete rigid or permanently formed spiralled structure of the desired cross sectional configuration. (See FIG. 11.) Further, in carrying out my invention I prefer to stagger or longitudinally offset the joints of the two sheets so that they do not coincide but rather occur at different points lengthwise of the structure, to the end that there is no point in the structure where a joint is formed from the inside to the outside thereof. Furthermore, it is preferred that where the edges of each strip are joined, that is, along the seam of each strip, the said joint or seam is secured or joined to the overlying or adjoining portion of another strip, to the end that the two strips are joined together along the seams of the strips, with the result that the assembled structure is a permanent integral and, in effect, continuous structure.

Further, in accordance with my invention I preferably wrap the strips into tubular form and to assure tight fitting or adjoining of the overlapping parts of the strips I may initially crown each strip, as shown in FIGS. 8 and 9 of the drawings, so that as the strips are wrapped into cylindrical form the slight crown established in them is flattened somewhat to the end that the edges have a tendency to bear in or toward the center of the structure establishing tight bearing engagement at that point. It is to be understood that said crowning is not always necessary and may be employed only when circumstances require. Furthermore, when I form one strip such as the strip B as a stiffening element in the finished structure, I preferably corrugate it throughout its width and lengthwise so that it is continuously corrugated as will appear from an examination of the drawings.

A feature of my invention is that I may form or shape each strip before wrapping it into the finished form mainly, if not entirely, by bending rather than stretching so that the metal thickness is effected a minimum amount. For instance, in the crowning operation of sheet A I preferably merely bend the sheet into the desired curved or crowned cross section and if, as I have shown in the case of the sheet A, I provide an offset edge portion at one edge of the sheet to facilitate formation of a flush joint, I prefer to do this by bending rather than by stretching the material of the sheet and I thereby avoid work hardening. In the case of corrugating the stiffening sheet or the sheet B which I have shown as establishing the lining of the finished structure I prefer to form the corrugations by establishing bends in the sheet and as a consequence of bending the sheet into the desired corrugated form rather than stretching it into this form the sheet contracts or diminishes in width as the corrugations are established, until it is finally of a narrow finished form such as is shown in FIGS. 7 and 9. It is to be understood, however, that a reasonable amount or degree of stretching of the material is permissible without adverse effect on the finished structure.

Referring to the form of the invention illustrated in FIGS. 2, 6, 12, 16 and 17 of the drawings, I contemplate leaving the adjoining or overlapping parts of the strip A

unfastened and in the nature of a slip joint, to the end that the completed structure is not rigid or permanently formed but is expansible and flexible and suited to construction of wings and the like. It will be readily understood how this modified form of invention can be used in the formation of wing sections, and that the outer skin or element thereof will not buckle or wrinkle.

Referring more specifically to the sheet A that I have shown in the drawings, and which I provide to establish the skin of the finished structure, I prefer to start with a flat sheet that is first bent into the crowned form such as is indicated in FIG. 8 of the drawings, it being understood that in practice a very slight amount of crowning is all that is necessary. Next, or simultaneous with the crowning of the sheet A, I bend the edge portion **10** to offset or joggle it slightly, in fact, to joggle it an amount equal to the thickness of the sheet A so that as the sheet A is wrapped with its edges overlapping the edge portion **11** overlaps or nests with the offset edge portion **10** as clearly shown in FIG. 11 of the drawings.

Referring more specifically to the sheet B I prefer to start with a wide sheet in flat form and which may first be crowned to the desired degree. The corrugating operation or operatons are then performed on the sheet to establish upstanding ridges **12**, **12***a* and **12***b* lengthwise of the sheet. In forming the ridge **12**, at the center of the sheet, I prefer to shape or bend the crest of the ridge **12** so that it has a land **13** for engagement with the sheet A and a slightly depressed or indented land **14** for the reception of the inwardly bent edge portion **10** of sheet A as clearly shown in FIG. 11 of the drawings. In carrying out my invention I prefer to shape or bend two ridges **12***a*, one spaced at each side of the central ridge **12** and I prefer to shape each ridge **12***a* so that it has a flat top or land **15** for engagement with the inner side of sheet A, as shown in FIG. 11 of the drawings. In the particular form of the invention illustrated in the drawings I prefer to shape or bend marginal or edge ridges **12***b* parallel with the ridges **12** and **12***a*, which ridges **12***b* occur at or close to the edges of the sheet B and are preferably proportioned so that each ridge **12***b* has a flat top or land **16**.

The lands **13**, **14**, **15** and **16** are joined with each other by curved valley portions **17**. The marginal edges of the sheet B are provided with a slightly inturned lip portion **19**. As best illustrated in FIG. 11 of the drawings the curved valley portions of the corrugated sheet B may be reinforced by beads **18**. The beads **18** are continuous there being a pair of beads **18** provided at the valleys as shown.

The ridges **12***b* at opposite sides of the sheet B are preferably made slightly different from one another, that is, one of them is not quite as high nor as wide as the other, to the end that they will nest together or lap one over the other to form an overlapping seam or joint as the strip B is wrapped into spiral form. This fitting or lapping of the ridges **12***b* is clearly illustrated in FIG. 11 of drawings. By establishing the ridges and lands substantially by bending of the metal the sheet B is made narrower than the initial wide sheet started with. It is to be observed that I form the several ridges or corrugations in the strip B so that when the strip B is in its final form, as shown in FIG. 11 the tops or lands of the several ridges lie in a common plane and form a seat or rest against which the outer or skin sheet A bears. In practice, the corrugations may be roughly or substantially formed or established in the sheet B before wrapping, or said corrugations may, be so formed simultaneously with said wrapping, however, the final shaping or forming of the finished corrugations is accomplished by shaping or otherwise forming the corrugations into a mandrel or suitable form (not shown).

In accordance with the first form of the invention I permanently join the overlapping edges of the sheets A and B and I preferably join the sheets themselves to each

other to the end that the sheets are fixed together one forming the reinforcement and the other the finished skin of the final rigid structure. I may separately or independently join the sheets together, although I prefer in practice, to establish these connections in one single, continuous operation, as by a welding or any other suitable securing operation, for example, by electrical spot welding. In the case illustrated welds **20** are established joining the overlying portions of sheet A to the underlying land **16** of sheet B. (See FIG. 3.) Further, welds **21** join the overlapping edge portions of sheet A and join these portions of sheet A to the recessed land **14** of sheet B. In addition to the weld **21**, above referred to, further welds **22** may be provided, if desired, adjacent the welds **21** to join the overlying portion of sheet A to the under lying land **13** of sheet B (see FIG. 15). As shown, welds **23** are established joining the overlying portions of the sheet A to the underlying lands **15** of the sheet B. It is to be understood that the welds may not only vary in character or be of different types but they may vary as to extent, for instance, in the drawings I have shown lines of spot welds wherever welds occur, whereas in practice continuous welds may be employed in any number and in any desired pattern, as circumstances require. It is to be understood that other fastening or securing means, such, for example, as rivets, screw fasteners or adhesives, or the like, may be used as desired.

In accordance with my invention I contemplate, primarily the formation of continuous strips such as strips A and B into spirally wound bodies one strip overlying the other and joined into a solid or continuous integral structure (see FIG. 7). I contemplate that such a structure may be of any desired cross section within reasonable mechanical limits, for example, it may be round in cross section, as shown in FIGS. 3 and 4 of the drawings, or it may be elliptical as shown in FIGS. 5 and 6 of the drawings. Further, other shapes may be formed, for example a square wherein the corners are suitably rounded (not shown). Furthermore, the tubular structure that I form may be a straight uniform tubular structure, that is, a structure uniform in size or dimensions throughout its length, or it may be contoured, as shown, and vary in size at different points along its length. Such a condition is illustrated in FIG. 1 of the drawings where I show a typical aircraft fuselage or body X which is round in crosssection and tapered lengthwise. The rear section of the fuselage X may be elliptical (see FIG. 5).

When a contoured or tapered body is formed I may not only crown the sheets as above described but I may also stretch the sheets laterally prior to incorporation in the finished structure so that they lie flat or smooth in the finished structure which they would not do if merely formed as above described and rolled into a spiralled tapered form. By laterally stretching the sheets I mean that I stretch each sheet gradually between its edges, so that it becomes suitably arcuate in shape, leaving the edge toward the small end of the tapered structure unstretched and giving the edge toward the large end of the finished structure a maximum amount of stretch. Such stretching needs to be but slight as circumstances require, and it serves to deflect each strip from a straight elongate strip to a strip slightly curved edgewise so that it has a radius of curvature. For example, a straight cone-shaped body will require a graduated amount or degree of lateral curvature of the sheet as it is wrapped from one end of the body to the other.

A spirally formed tubular structure involving outer and inner sheets A and B joined edge to edge in spirally lapped engagement is illustrated in FIG. 1 of the drawings. The sheets are in staggered or overlapping relation so that one is corrugated to form a stiffening element while the other is plain to form a finished surface. The fuselage X may be varied in a number of ways to form a useful finished article of manufacture. In FIGS. 1 and 10 of the drawings I have shown how the said tubular structure formed in accordance with my invention may be provided with openings for various purposes.

The usual and typical openings normally employed in fuselage construction are shown in the drawings, there being a cockpit opening **30**, window openings **31**, a door opening **32**, and a wing or spar opening **33**. In addition to said openings, the front and rear ends of the tubular fabricated structure are open as at **34**. In accordance with the invention the above mentioned openings are established by cutouts in the continuously wrapped construction, said cut-outs being made in the desired shape as circumstances require. It is a feature of my invention to work the marginal edge portions of the sheets A and B surrounding said openings so that said openings are adapted to receive frames, and panels, etc. For instance, a canopy **35** covers the opening **30**, and a nose cone **36** covers the front opening at **34**. It will be readily apparent how suitable frames, doors, windows, and cowlings may be provided to cooperate with and cover said above mentioned openings. It will be apparent that said cut-outs may be utilized to form or establish the finished doors or removable panels that are employed to close the openings that are formed. The doors etc., like the openings, may be provided with suitable frames and the necessary fittings, and the like.

The opening **31**, shown in FIG. 10 of the drawings, is typical of said openings, and has top and bottom edges **40** and **41**, and end edges **42**. The said edges of the opening **31** are preferably joined by rounded corners **43**, as shown. In accordance with the invention, the outer sheet A is flat and the inner sheet B is flattened at the marginal portion **45** thereof, at the edges **40**, **41** and **42** by ending the ribs **12**, **12***a* and **12***b* at a point spaced from said edges. Suitable spot welding **46** or other fastening means is provided to secure the sheets A and B together along said marginal portions **45**.

In accordance with the invention, and referring specifically to the second or modified form of the invention shown in FIGS. 2, 6, 12, 16 and 17 of the drawings, the tubular structure may be fabricated in a manner to be expansible and flexible. The wing section Y illustrated in FIG. 2, is a flattened tapered construction adapted to be carried by and to house one or more wing spars Z. The spars Z are beams that bear the load and are rather flexible. Consequently, the upper and lower surfacings of the wing are put under varying tension and compression loadings with the result that ordinary surfacings buckle and wrinkle. The spirally wrapped wing structure that I provide is substantially elliptical in cross section and is flattened to the desired aerodynamic contour. The corrugated inner sheet B′ involves valleys that are shown trapezoidal in form having flat tops **70**, and flat sides **71**. The sides are shown as being pitched or slanted and the corrugations are partially flattened at **48** and **49** where the caps of the spars or other structural parts occur. A rear trailing edge **52** in the form of or including wing flaps and ailerons may be attached (see FIG. 6). The wing structure shown in FIG. 6 houses a main spar Z and is adapted to receive a spar Z′ at the rear edge thereof.

In FIG. 6*a* of the drawings I have shown a third form of the invention in the form of wing or flap, or like construction Y′ that is a flattened tubular construction which includes the trailing edge portion of the wing. In this form of the invention the corrugations of the inner sheet B″ are diminished or tapered toward the rear margin of the wing, the tapered corrugations **60** and **61** terminating at the terminal edge **62** of the wing. The sheet A″ and sheet B″ are both flat at said edge **62** and are bent to form the sharp edge **62**, as shown. In FIG. 6*a* the corrugated sheet B″ is completely flattened at **63** and **64** where the spar caps occur so that the corrugations are, in effect, interrupted.

In accordance with the second or modified form of the invention, and as illustrated in FIGS. 12 and 16 a slip

joint S is provided where the sheet A' is wrapped with its edge portion 10' overlapping its edge portion 11'. In this case, the offset edge portion 10' is slightly wider than the edge portion 11' to the end that said edge portions can move relative to each other in the plane of the sheet A. The marginal portion 10' of sheet A' is joined to the sheet B' by welding, or the like, securing the said portion 10' in the recess formed by the land 14'. However, the marginal portion 11' is left free and unjoined. It will be apparent that provision for said movement by allowing the sheet A to be free at the center rib 12' prevents compressive forces from being imposed upon the sheet A' thereby preventing buckling and wrinkling when the wing Y and spars Z are deflected.

In addition to the foregoing I have provided means K at the slip joint S for sealing between the edge portions 10' and 11' of the sheet A'. The means K involves, generally a bearing strip 55 engaged between said edge portions 10' and 11'. The bearing strip like the sheets A' and B' is a continuous element that is flat and which has the desired frictional and sealing properties. The strip 55 may be of metal having the desired coefficient of friction and sealing characteristics, or it may be of fabric. For example, the strip 55 may be made of "nylon," "Micarta," asbestos, or any suitable material or composition may be employed. The strip 55 may be a woven fabric or extrusion or rolled material impregnated or lubricated with a sealing material and is secured as by cementing to either the inner or outer sheet of the structure. As clearly shown in FIG. 16, the recess and land 14' is of suitable depth to accommodate the strip 55 leaving the exterior of the sheet A' flat and smooth.

In carrying out my invention I provide a jig or fixture (not shown) in the nature of a form, upon which the tubular fabrication that I construct is made. The said jig has the necessary features of construction and holds and supports the instant structure while it is wrapped. After the structure of the present invention is wrapped it is removed from said jig and is joined together permanently by the securing means and methods above referred to. It will be apparent that I have provided an extremely simple and practical body or fuselage construction composed of but two simple elongate strips of metal or the like. The structure of said invention may be made rigid or may be made flexible as circumstances require and which may be designed and proportioned so as to be very light, strong and durable. The structure that I provide is adapted to be supplemented by various structural members for example stringers, stiffeners, floor sections, beams, box-sections and bulkheads.

Referring to FIGS. 18 to 22 of the drawings, I have illustrated the usefulness of the present invention in connection with the construction of aircraft wherein the corrugated construction that I provide may be adapted to duct the flow of fluids used to improve operation of said aircraft. For example, the fluids may be handled to be used in "Boundary-Layer Control," or "Circulation Control." or "Anti-Icing Control," or "Structural Temperature Control," etc. In all of the above mentioned "Controls" it is necessary to direct the flow of air or other fluid, and to distribute it over wide areas of the body construction of the craft. In "Boundary-Layer Control" the air is handled so that it issues from a multiplicity of ports in the outer surface of the craft's body. In "Circulation Control" the air is handled so that it issues as a sheet of air over the trailing portion of the aircraft wing. In "Anti-Icing Control" the fluid is handled so that it is circulated at critical structural points to radiate heat which is absorbed from the fluid. In "Structural Temperature Control," which is analogous to "Anti-Icing Control," the fluid is handled so that it affects the temperature of the structural elements involved.

In FIGS. 18 through 22 of the drawings I have shown the application of my body construction to an aircraft employing "Circulation Control." In FIG. 18 I have shown an aircraft 100 having a jet type propulsion unit 101 that normally delivers a stream of fluid from a nozzle 102. One or more intake ducts 103 are provided to receive ram air as the aircraft moves forwardly and to direct said ram air to the intake of the propulsion unit 101. The unit 101 is usually provided with a diffuser manifold 104 at the rear of the compressor section thereof and there is provided one or more pressure bleeds 105 adapted to receive a substantial portion of compressed air from the unit. The bleeds 105 are under control of suitable valves 106. Additional ram air intake ducts 107 are provided at the ducts 103, preferably within said ducts, as shown, and are adapted to receive a substantial portion of ram air. The ram air ducts 107 are under control of suitable valves 108.

In the application of the invention under consideration the bleed 105 and duct 107 are employed to direct the flow of air, under suitable pressure, to a duct 109 that extends longitudinally of the wing 110. In accordance with the invention, the duct 109 is established by appropriate location of the wing spar 111, which, together with the body structure that I provide, forms said duct (see FIG. 19). Since air delivered by the bleed 105 will be under greater pressure than the air delivered by duct 107, there is provided a jet at 115 which acts to induce the flow of air from the duct 107. It will be apparent how the flow of air can be controlled by regulating the valves 106 and 108, as circumstances require, so that the desired volume and pressure of air is introduced into the duct 109. Also, it will be apparent that the desired temperature of air can be determined by the regulation of the two valves.

In accordance with the present invention, the corrugations in the inner sheet of the body construction forms ducts 120 that extend transversely of the longitudinal axis of the wing 110. In the particular case illustrated fluid is handled to be discharged rearwardly over the upper side of the wing 110. However, it is to be understood that the fluid handled can also be discharged rearwardly from the underside of the wing, or from both the top and bottom of the wing. It is also to be understood that the fluid can be handled to be discharged from or through perforations or openings in the outer sheet or skin of the wing or body structure.

The corrugations forming the said ducts are flattened at 121 and 122 to receive the lower spar caps, while the corrugations are but partially flattened at 123 and 124 to receive the upper spar caps. The corrugations are completely flattened at 121, however, they may be but partially flattened at 122, as shown. Therefore, and it will be apparent, the ducts 120 are uninterrupted from a point just ahead of the forwardmost spar to a point aft of the rearmost spar.

In practice, the upper part of the wing construction can be cut off along a line 125 to the end that the ducts 120 open to discharge rearwardly along said line. A port 126 (see FIG. 20) is provided in each corrugation, preferably just ahead of the front spar 111 so that air enters the ducts 120 from the duct 109. It will be apparent that air flows forwardly and then rearwardly in the case illustrated, and acts as an "Anti-Icing" means, and as well it issues from the ducts at line 125 to form a sheet of controlling air that flows over the trailing element or portion, or flap, of the wing.

In FIGS. 19 and 20 of the drawings I have illustrated a valve means 130 for controlling the flow of air into the ports 126. As shown, the means 130 is in the form of a slide valve 131 shiftably carried in a channel member or guide 132. The slide valve 131 has a plurality of spaced openings 133 adapted to similtaneously register with the ports 126 in the plurality of corrugations. The guide 132, also, has spaced openings 134 that register with the ports and with the openings in the slide valve so that shifting of the slide valve causes opening and closing of the

openings 134. The degree of shifting of the slide valve 131 determines the volume of air that enters the ducts 120.

In FIG. 21 of the drawings I have illustrated a nozzle means 135 that controls the direction and restriction of air flow from the ducts 120. The nozzle means 135 normally restricts the flow of air to some degree and is a structure that is secured to the wing 110 along the line 125. The means 135 receives air from the plurality of ducts 120 and involves upper and lower plates 136 and 137 that are movable to cause variation in the nozzle effect of the said means. There is a base element 138 secured to the wing along the line 125 the forward edges of the plates 136 and 137 being pivotally secured to the base 138 as by pivot pins 139 and 140. The plates 136 and 137 are under control of suitable levers 141 and 142 and the rear edges of the plates are free. Movement of the plates relative to each other causes variations in restriction of air flow, while movement in unison causes change in direction of the nozzle opening formed by the two plates. The nozzle formed by the two plates 136 and 137 directs a flat sheet of air over the trailing element, or portion, of the wing 110.

In FIG. 22 I have shown a modified form of aircraft construction wherein the propulsion unit 101' is carried on a strut or pylon 150 that depends from the underside of the wing 110'. It will be apparent how the ducting 103', 105' and 107' are easily adapted to direct the flow of air upwardly through the pylon 150 and into the duct 109' that extends longitudinally of the wing. The wing 110' may incorporate the features above described in connection with the wing 110, as clearly indicated in FIG. 22.

Having described only the typical preferred forms of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. A spirally wrapped body of the character described including, a corrugated sheet having a plurality of ribs and with its edge portions in lapped engagement, means fastening together the lapped edges of the corrugated sheet, a flat sheet overlying said corrugated sheet to engage said ribs and with its edge portions in lapped engagement, and means fastening at least one edge portion of the flat sheet to a rib of the corrugated sheet, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

2. A spirally wrapped body of the character described including, a corrugated sheet having a plurality of ribs and with its edge portions in lapped engagement, means fastening together the lapped edges of the corrugated sheet, a flat sheet overlying said corrugated sheet to engage said ribs and with its edge portions in lapped engagement, and means fastening the flat sheet to the ribs of the corrugated sheet and fastening together the lapped edge portions of the flat sheet, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

3. A spirally wrapped elongate tubular body including, a reinforcing inner sheet having continuous marginal and intermediate ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet and with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

4. A spirally wrapped elongate tubular body including, a reinforcing inner sheet having continuous marginal and intermediate ribs and with its edge portions in lapped engagement, a flat outer sheet overlying said inner sheet and with its edge portions in lapped engagement and with its inner side engaged with said ribs, and means fastening together the lapped portions of the sheets and one sheet to the other, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

5. A spirally wrapped elongate tubular body including, a reinforcing inner sheet having continuous marginal and intermediate ribs and with its edge portions in lapped engagement, a flat outer sheet overlying said inner sheet and with its edge portions in lapped engagement and with its inner side engaged with said ribs, and means fastening together the lapped portions of the inner sheet and fastening at least one edge portion of the outer sheet to a rib of the inner sheet, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

6. A spirally wrapped elongate tubular body including, a reinforcing inner sheet with its edge portions in lapped engagement and with marginal ribs at said edge portions and a rib intermediate said edge portions, and a flat outer sheet overlying said inner sheet to engage said ribs and with its edge portions in lapped engagement at said intermediate rib and with its inner side engaged with said rib, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

7. A spirally wrapped elongate tubular body including, a reinforcing inner sheet with its edge portions in lapped engagement and with marginal ribs at said edge portions and a rib intermediate said edge portions, a flat outer sheet overlying said inner sheet to engage said ribs and with its edge portions in lapped engagement at said intermediate rib and with its inner side engaged with said rib, and means fastening together the lapped portions of the inner sheet and fastening the said rib to the inner side of the outer sheet, the two sheets being continuously wrapped and the edges thereof being offset longitudinally of the body.

8. A spirally wrapped elongate tubular body including, an elongate inner sheet wrapped with its edge portions in lapped engagement, a rib extending longitudinally of said inner sheet intermediate the edge portions thereof and having a continuous land thereon, an elongate outer sheet wrapped with its edge portions engaged with said land, and means fastening together the lapped portions of the inner sheet and one sheet to the other.

9. A spirally wrapped elongate tubular body including, an elongate inner sheet wrapped with its edge portions in lapped engagement, a rib extending longitudinally of said inner sheet intermediate the edge portions thereof and having a continuous land thereon, an elongate outer sheet wrapped with its edge portions overlapped and engaged with said land, and means fastening together the lapped portions of the sheets and one sheet to the other.

10. A sprially wrapped elongate tubular body including, an elongate inner sheet wrapped with its edge portions in lapped engagement, a rib extending longitudinally of said inner sheet intermediate the edge portions thereof and having a continuous land thereon and having a continuous recess adjacent the land, an elongate outer sheet wrapped with its edge portions in lapped engagement, one of said edge portions of the outer sheet being offset and carried in the said recess and the other said edge portion being carried in the offset portion, and means fastening together the lapped portions of the sheets and one sheet to the other.

11. A spirally wrapped elongate tubular body including, an elongate inner sheet wrapped with its edge portions in lapped engagement, a central rib extending longitudinally of said inner sheet and ribs between said central rib and the edges of the sheet, said ribs having continuous lands thereon and the central rib having a continuous recess adjacent the land, an elongate outer sheet wrapped with its edge portions in lapped engagement, one of said edge portions of the outer sheet being offset and carried in the said recess and the other said edge portion being carried in the offset portion thereof, and means fasten-

ing together the lapped portions of the sheets and the inner side of the outer sheet to the lands on the inner sheet.

12. A spirally wrapped elongate tubular body including, an elongate inner sheet wrapped with its edge portions in lapped engagement, a central rib extending longitudinally of said inner sheet and intermediate ribs between said central rib and the edges of the sheet, said ribs having a continuous land thereon and the central rib having a continuous recess adjacent the land, an elongate outer sheet wrapped with its edge portions in lapped engagement, one of said edge portions of the outer sheet being offset and carried in the said recess and the other said edge portion being carried in the offset portion, means fastening together the lapped portions of the outer sheet and the recess of the inner sheet and the offset portion of the outer sheet, and means fastening together the lands of the intermediate ribs and inner side of the outer sheet.

13. A spirally wrapped elongate tubular structure of the character described, including a reinforcing inner sheet having a plurality of continuous ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and fastened together with the edges thereof offset longitudinally of the body, said body being rounded in cross sectional configuration.

14. A spirally wrapped elongate tubular structure of the character described, including, a reinforcing inner sheet having a plurality of continuous ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and fastened together with the edges thereof offset longitudinally of the body, said body being rounded in cross sectional configuration and tapered longitudinally thereof.

15. A spirally wrapped elongate tubular structure of the character described, including, a reinforcing inner sheet having a plurality of continuous ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and fastened together with the edges thereof offset longitudinally of the body, said body having a cut-out forming an opening therein.

16. A spirally wrapped elongate tubular structure of the character described, including, a reinforcing inner sheet having a plurality of continuous ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and fastened together with the edges thereof offset longitudinally of the body, said body having a cut-out forming an opening therein, and said ribs terminating at points spaced from said opening.

17. A spirally wrapped elongate tubular structure of the character described, including, a reinforcing inner sheet having a plurality of continuous ribs and with its edge portions in lapped engagement, and a flat outer sheet overlying said inner sheet with its edge portions in lapped engagement and with its inner side engaged with said ribs, the two sheets being continuously wrapped and fastened together with the edges thereof offset longitudinally of the body, said body having a cut-out forming an opening therein, and a frame engaged and carried in said opening.

References Cited in the file of this patent

UNITED STATES PATENTS

1,095,080	Chayne	Apr. 28, 1914
1,338,564	Elmendorf	Apr. 27, 1920
1,781,574	Frederickson	Nov. 11, 1930
1,935,323	Kemp et al.	Nov. 14, 1933
2,351,152	Schick	June 13, 1944
2,514,105	Thomas	July 4, 1950
2,786,435	Ellzey	Mar. 26, 1957