Oct. 8, 1946. A. G. LUISADA 2,408,789

INFLATABLE BOAT AND METHOD OF MAKING SAME

Filed March 11, 1942 3 Sheets-Sheet 1

Fig. 1.

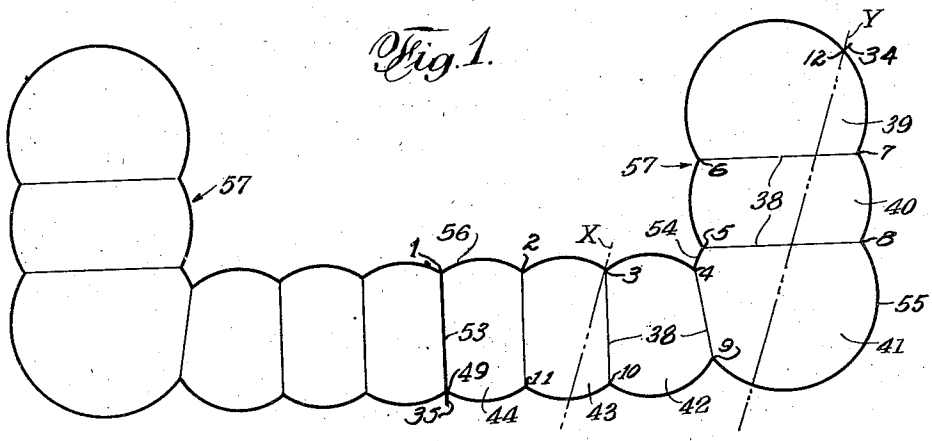


Fig. 2.

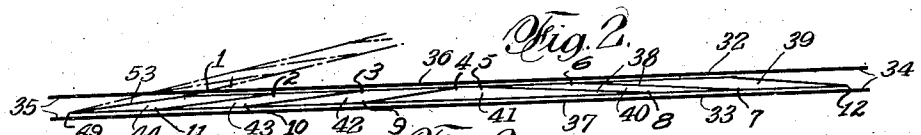


Fig. 3.

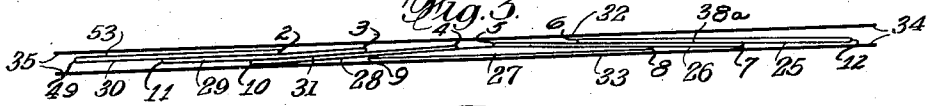
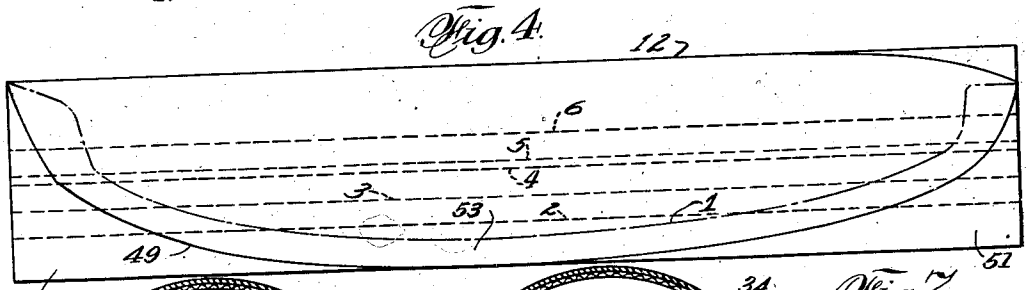


Fig. 4.



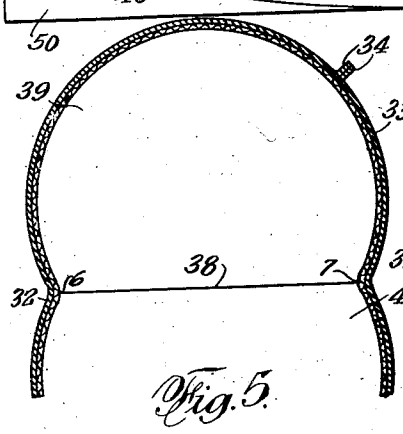


Fig. 5.

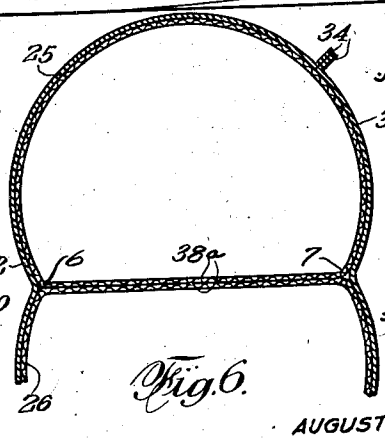


Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

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INFLATABLE BOAT AND METHOD OF MAKING SAME

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Fig. 10.

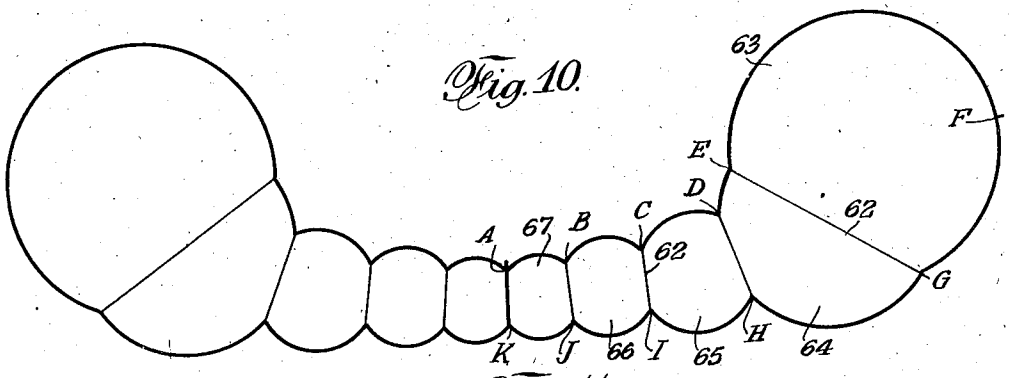


Fig. 11.

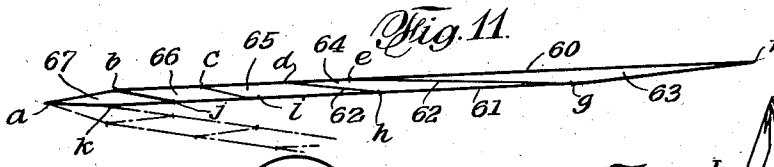


Fig. 13.

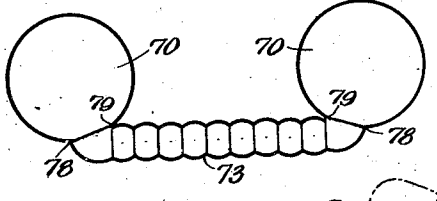


Fig. 14b

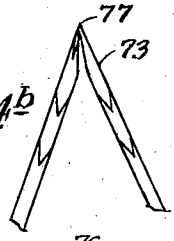


Fig. 14.

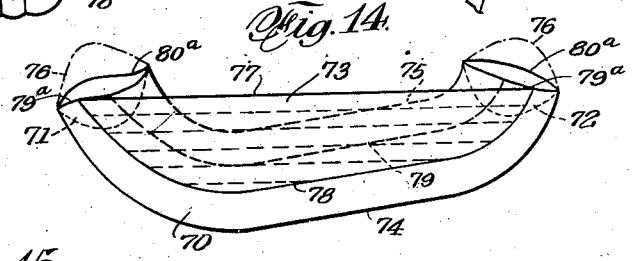


Fig. 14a

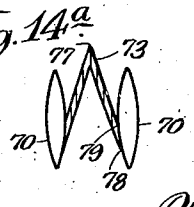


Fig. 15.

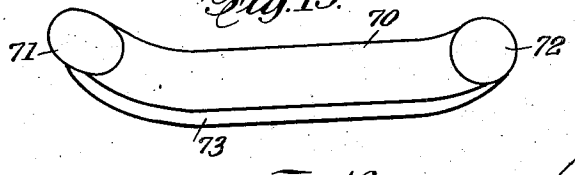


Fig. 16.

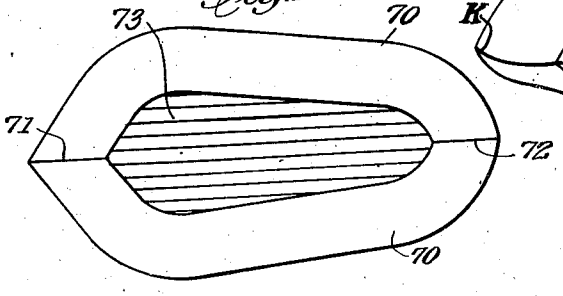
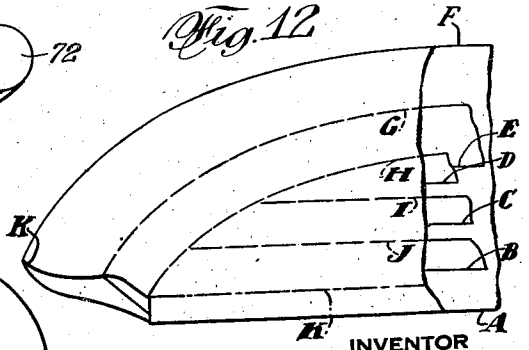


Fig. 12



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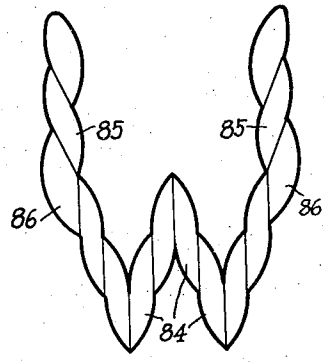


Fig. 17.

Fig. 18.

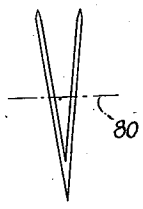


Fig. 19.

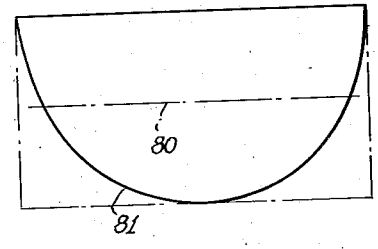
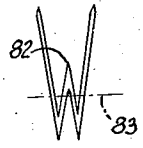


Fig. 20.



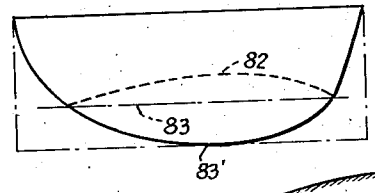
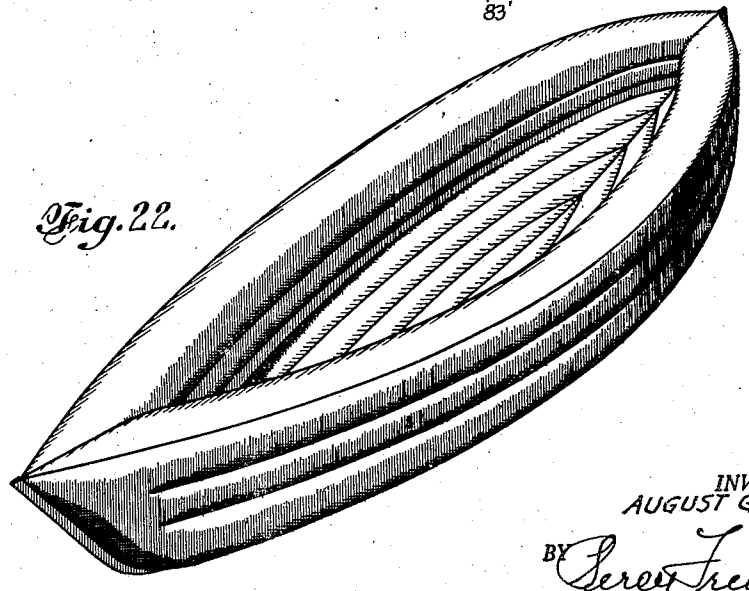


Fig. 21.

Fig. 22.



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UNITED STATES PATENT OFFICE

2,408,789

INFLATABLE BOAT AND METHOD OF MAKING SAME

August G. Luisada, New York, N. Y.

Application March 11, 1942, Serial No. 434,241

29 Claims. (Cl. 9—2)

1

This invention relates to inflatable boats and to methods for producing the same.

A primary object of the invention is to provide a novel method for producing inflatable boats in a simple and inexpensive manner.

Another object of the invention resides in the provision of a method for producing inflatable boats which are stable, have minimum water resistance, and withstand injurious scuffing.

Reference is made to the accompanying drawings in which are illustrated various forms of the invention. Said drawings form the basis for the following specification from which the objects of the invention will be more clearly realized.

In the drawings:

Fig. 1 is a diagrammatic cross-sectional view of one form of inflatable boat according to the invention.

Fig. 2 is a similar view of the right-hand portion of Fig. 1 in deflated condition showing one manner of forming thereof.

Fig. 3 is a similar view of said right-hand portion showing another manner of forming thereof.

Fig. 4 is a side elevational view of said right-hand boat portion in the condition of either Figs. 1 or 2 and indicating the lines of cutting said portion.

Fig. 5 is a fragmentary cross-sectional view of a portion of Fig. 1 showing the physical structure according to Fig. 2.

Fig. 6 is a similar view according to Fig. 3.

Figs. 7, 8 and 9 are fragmentary cross-sectional diagrammatic views illustrating types of fabric weave employed in forming the parts of the structure of Fig. 3.

Fig. 10 is a diagrammatic cross-sectional view of another form of inflatable boat according to the invention.

Fig. 11 is a similar view of the right-hand portion of Fig. 10 in deflated condition.

Fig. 12 is a fragmentary deflated bottom plan view of said boat portion.

Fig. 13 is a diagrammatic cross-sectional view of still another form of inflatable boat according to the invention.

Fig. 14 is a plan view, in deflated condition, of either the right or left hand portion of Fig. 13.

Fig. 14*a* is a diagrammatic cross-sectional view thereof.

Fig. 14*b* is a diagrammatic fragmentary view of a modified cross-section but drawn to an enlarged scale.

Fig. 15 is a diagrammatic longitudinal sectional view of the boat shown in Fig. 14.

Fig. 16 is a plan view of said boat.

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Fig. 17 is a diagrammatic cross-sectional view, in partially inflated condition, of yet another form of inflatable boat according to the invention.

Fig. 18 is a diagrammatic sectional view of an inflatable boat such as shown in Figs. 1 and 10.

Fig. 19 is a side view thereof illustrating a comparatively foreshortened boat.

Fig. 20 is a diagrammatic sectional view of an inflatable boat each as shown in Fig. 17.

Fig. 21 is a side view thereof illustrating a comparative foreshortened boat.

Fig. 22 is a perspective view of a complete inflated boat constructed in accordance with the invention and as shown in diagrammatic cross section in Figs. 1, 2, 3, and 4.

The instant method is particularly characterized by the forming of the air chambers and other consituent parts of the boat before they are made air-tight. The invention consists in so designing these air chambers that they lie flat, so that they can be treated as easily as a single fabric, and made air-tight either directly—as one would do for coating a fabric, or superimposing upon the outer surfaces of the air chamber, air-impervious sheets and passing them through a doubling calender or the like. The single units are united together while still unvulcanized and in flat condition to produce a preferably flat-lying deflated boat which can then be vulcanized in this condition. The advantages of this method are obvious when it is realized that tedious assembling and joint tightening are obviated and speeding up of production follows. Costly handwork is eliminated. The work, instead, is performed entirely on the simplest machines such as doubling calenders or the like. The air chambers and other constituent parts of the boat mentioned above may at times hereinafter be referred to as units, and the word unit will be used as meaning any section of a boat which is made up as a component and which has been substantially covered on both sides by impervious material. The flat-lying hollow units or air chambers may be made mechanically without handwork, i. e., by weaving.

To carry out the present method, novel ways are employed to produce flat-lying hollow units which, when inflated, will bend substantially out of the plane in which they were lying when produced, said bending with respect to the finished boat being both longitudinal and transverse. The transverse transition to a bent hollow body, is achieved by so designing the cross-section that the parts of one or more tubes forming the in-

side of a boat are shorter than the parts of the same tubes forming the outside of the boat while the total width of the fabric comprising said inner and outside parts are exactly co-extensive. The manner of constructing such hollow bodies or units will be disclosed in accordance with the chosen examples. The lengthwise deformation of the hollow bodies may be accomplished in other ways. It is not possible to make one of the fabrics of greater extent than the other when making a flat-lying hollow body, but it is possible to so construct such fabric that when inflated one of them will expand under the stress of the air-pressure to a predetermined extent longer than the other, without impairing its tensile strength.

As one example of the invention, a method is explained which enables the construction of a boat by weaving or sewing only straight outlined cells or units or forming tubes of uniform diameter, the outlines of which are run only in the warp or weft direction. Hence, these fabrics can be woven on the simplest looms such as the dobby looms. When the structure is made by sewing, multiple head sewing machines can be used to produce, simultaneously, a plurality of parallel seams. By either method, a streamlined shape may be obtained after inflation of the boat which combines with maximum stability, features superior to that of the existing types. The method provides the possibility of subdividing the air chambers in any number of air-tight compartments that may be desired.

One manner of obtaining such a structure is illustrated in Fig. 1 which is made in the following manner.

Reference is first made to Figs. 3, 4 and 6. A plurality of fabric tubes **25**, **26**, **27**, **28**, **29** and **30** are formed in any well-known manner, but are preferably woven. These tubes may vary in size according to the cross-sectional shape of boat desired. They may then be given a coating of tacky consistency by means of which they will adhere to each other and to outer rubberized sheeting or any air and water-impervious sheeting.

The tubes are arranged in such a manner that the circumference of each tube is divided by folding into two equal parts. Each of these equal parts contains a portion which will combine to form the outside portion of the boat and another portion which will form a diaphragm or a bulkhead of the finished structure; for instance, the distance **49**, **1** plus the distance **1**, **2** shall equal the remainder of the circumference of the tube, i. e. **49**, **11** plus **11**, **2**. In the tube **41** which forms the chine, the folding edges **8** and **9** are so disposed that the sum of the two diaphragms **4**, **9** and **5**, **8** and the portion **4**, **5** equal the remainder of the circumference of that tube or chine **9**, **8**. For any number of adjacent tubes, the same relation must be true throughout the whole structure, for instance, **5**, **8**+**8**, **7** equals **5**, **6**+**6**, **7**. And so the sum of all of the corresponding parts will be equal, as the sum of parts **49**, **1**, **2**, **3**, **4**, **5**, **6**, **12** equals the sum of **12**, **7**, **8**, **9**, **10**, **11**, **49**, so that the structure will lie flat when deflated.

The tubes **25** to **30** are arranged as in Fig. 3 wherein portions **31** thereof are overlapped. It will be noted that tube **25** is overlapped on tube **26** which is overlapped on tube **27** and that tubes **30**, **29**, and **28** are similarly overlapped, the last of these being also overlapped on tube **27**.

This structure is now provided with a seam

along the line **49** and the parts **50** and **51** are cut away. If more than two separate chambers are desired, the structure according to Fig. 3 may be divided into two or more parts, the seams uniting only those parts which together form one air chamber. Between these air chambers, an air-impervious sheet is laid flat, and the unit comprising one-half of the boat, will be laid again co-extensively as illustrated in Figs. 3 and 4, so that the seam **49**, composed now of several independent parts, again forms one continuous line.

An advantageous example in several respects of such subdivision would be along the diaphragm **9**, **4**. The body of the bottom consisting of **49**, **11**, **10**, **9**, **4**, **3**, **2**, **1** would be separated by an airtight sheet or coating along **9**, **4** from the side wall of the boat formed by **9**, **8**, **7**, **12**, **6**, **5**, **4**. In this way, two such structures or units formed each by three tubes with equal length of diaphragm at equal distance, compose one-half of the boat.

To this arrangement of tubes are applied the outer air- and water-impervious sheets **32** and **33** which are preferably rubberized fabric. The edges **34** and **35** of the sheets are preferably extended as shown, so that they may cohere to each other with no intervening fabric layer as shown in Figs. 1, 5, and 6. Thus the inner fabric parts are enclosed completely in the outer rubberized fabric. This application of the outer sheets constitutes a doubling operation that can be performed rapidly and economically on a doubling calender by application of pressure. In order that a doubling calender may be utilized, it is essential that all the parts lie flat.

This structure illustrated in Figs. 3 and 4 forms the right side of the boat of which Fig. 1 is a cross-section. Another such half boat made up in same manner represents the symmetrical left-hand side of the cross section shown in Fig. 1.

In making the tubes **25** to **30**, it is intended that the contacting walls **38***a* be air-pervious to afford circulation of air among the tubes whereby inflation of all of them may be simultaneous. Hence, the tacky coating is of such nature as to facilitate the mentioned coherence without impairing air-perviousness.

In the above manner a structure is formed which is cellular and completely sealed.

Instead of the use of separate tubes, the structure may be woven completely except for the outer sheetings, on a dobby loom. This is best seen in Figs. 2 and 5, wherein the loom is arranged to weave the parallel portions **36** and **37** with carryover threads **38** to form the cells, **39**, **40**, **41**, **42**, **43**, and **44**, each respectively comparable peripherally to the tubes **25** to **30**. Thus the walls **36** and **37** comprise woven fabrics and the portions **38** carry over threads readily affording free air circulation among the cells **39** to **44**. The structure may also be produced on a Jacquard loom, in which case the whole structure shown in Fig. 4 may be completely woven without seams, thus obviating the seam **49**. The rubberized sheetings **32** and **33** are applied as before described.

Fig. 2, of course, has been drawn somewhat opened so the structure thereof may be seen, but it is obvious that its formation is such that the walls **36** and **37** are co-extensive and of the same length, and that the structure will lie flat and that when inflated, the pressures throughout the communicating air chambers will be equalized.

Obviously, a similar structure or unit may be

produced by sewing between two sheets 36 and 37, partitions 38.

It will also be seen that the structure shown either in Fig. 2 or in Fig. 3, while woven or built in flat condition, will inflate to the transversely bent cross-section shown in Fig. 1.

Fig. 4 shows either of the above-described structures in plan view and shows a typical line 49 along which the parts 50 and 51 may be cut away to form the boat shape. Two such structures may then be secured to each other by adhering them along the surface of partition or diaphragm 53. This also is accomplished while all the parts are flat and the entire article may then be vulcanized in flat condition, and the boat is ready for inflation.

While this disclosure deals with a boat which may be inflated in halves, it is apparent that the partition 53 may be eliminated as a bulkhead so that the entire boat may be inflated at one time. In this case the inner air-impervious sheet may end along the line 1, so that the air may communicate through the air-pervious partition 53 of the boat when inflated as shown in Fig. 1.

Because the internal pressure is equal in all directions, the air causes each cell to seek a cylindrical form as shown. The cells are defined by the carryover threads 38. Because of the manner in which the structure is woven, the cell 41 has a shorter exposed side 54 and a longer one 55. Hence the structure will bend, upon inflation, as shown, to form a bottom 56 and sides 57.

Considering the shape of the inflated boat in a geometrical manner, it was desirable to provide the shape which is obtained by rotating the outline of half the cross-section, for instance the right half shown in Fig. 1, around an axis parallel to the lines X and Y. This axis is inclined because an upraised bow and stern are desired in order to imitate or to reconstruct the traditional ship shape. By this bending the portions or arcs which are furthest away from the axis, as for instance 55, will have a greater length than the portions or arcs 56 which are nearer to the axis. The difference in length between the arcs will be greater as we approach the axis, as for instance in boats which are short in proportion to their width. A comparatively longer boat can be made when all parts are woven uniformly if a stretchable fabric is chosen for its construction. Every woven fabric has a certain elasticity. Therefore, a shape like that illustrated in Fig. 4 or longer with respect to its width, may be obtained with any fabric. It may be desirable, however, to make the boat shorter in relation to its width. According to this invention this is possible by providing a greater stretch in those portions of the weave which are to form the portions that are furthest away from the bending axis when the boat is inflated. For instance, such portions are shown at the right of the line Y. A smaller amount of stretch is required between the lines X and Y and no stretch in the portion at the left of X. Thus, the portion left of X can be woven according to Fig. 7, the portion between X and Y substantially according to Fig. 8, and the portion to the right of Y, substantially according to Fig. 9. The warp thread represented in each of these figures will shrink most in Fig. 7, less in Fig. 8, and still less in Fig. 9, so that when they are taken from the same weavebeam, the 1—1 weave in Fig. 7 will be the shortest and the 3—3 weave in Fig. 9, the longest.

In other words, when the fabric is produced, the threads have the same length in all portions, but by changing the width in different portions of the fabric, as illustrated in Figs. 7, 8 and 9, the various portions of the fabric were given different degrees of extendability. The degree of extendability in the three different portions of the fabric had been definitely pre-determined in order to accommodate the fabric when extended to the curvature required by the design of the finished boat. The exact degree of extendability necessary for the purpose can be predetermined and the actual expansion is obtained by inflation of the boat.

It will, therefore, be obvious too, that if the bottom is separated from the sidewall as referred to above, the bottom portion 49, 1, 2, 3, 4, 9, 10, 11, 49 may be made from material with less stretchability than the portions 9, 8, 7, 12, 6, 5, 4, 9. In case of weaving, each of these portions contains connecting threads having the same stress, making it simple to adapt the tensile strength of the used material to the stress, which results in economy of material.

From what is described above, it will be clearly seen that the hollow body which has a cross-section shown on the right side of Fig. 1 and constructed according to Figs. 2 or 3, or in any commensurate manner, will bend when inflated around an axis parallel to the lines X or Y according to the purpose for which made. This feature provides the longitudinal bending referred to above. It is obvious that this effect can be obtained in other manners than by changing the weave pattern as illustrated in Figs. 8 and 9. This method is merely the simplest one than can be performed on an ordinary Dobby loom.

It may be desirable to make boats that generally conform to the traditional surrounding tube type. In this case, another example for carrying out this invention is disclosed in Figs. 10, 11, and 12. The right side of Fig. 10 represents a cross-section which when deflated, will lie flat as shown in Fig. 11.

As seen in Fig. 11, a cellular boat portion is formed with outer walls 60 and 61 of equal length and with carryover threads 62 forming the cells 63, 64, 65, 66 and 67. So that this structure and that of Figs. 1 and 2 may be better followed, a point-to-point comparison will be made of Figs. 10 and 11. Starting with point *a* and following around the periphery of Fig. 11, there are points *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j* and *k*. These points on Fig. 10 are respectively A, B, C, D, E, F, G, H, I, J and K. Fig. 12 being in plan, these points become lines and are designated as in Fig. 10.

The transverse bending of this cross-section is obtained by constituting the inner portions of single compartments shorter than the outer portions of the same compartments. This is obtained here by augmenting the dimension of the tubes from the center outwardly so that a relatively thin bottom is obtained which curves up and ends with the comparatively thick surrounding tube 63. This boat presents another example of design of an inflatable unit which is flat when deflated and is bent transversely to a shape substantially different from plane, when inflated. Instead of arranging the partitions to extend in opposite directions, when deflated, as in Figs. 1, 2, 3, 4, they may be arranged to extend all in the same direction as in Figs. 10 and 11, where it will be seen, the partitions or diaphragms are made wider as they progress from the center of the boat outwardly. All the partitions as well as the outer surfaces are plane and therefore, it is

possible to subdivide the structure along any partition to provide a bulkhead if desired.

In order to make it possible to have an inflatable boat assume a flat condition when deflated, the structure must be so designed that any tube is divided by the folds into two equal halves. This feature determines the relationship of the length of the carry-over threads which constitute the partitions or diaphragms to the distances they are spaced apart from each other. Hence throughout the whole structure, the following proportions must be true: AB plus BJ equal AK plus KJ; DE plus EG equal GH plus HD, and the same for each individual tube or cell. And so it follows that

AKJIHGF=ABCDEF

As the desired shape is comparatively short and the surrounding tube is bent in a different manner at different places and also containing straight portions, it is preferable to shape the tube by shaping the fabric. The pattern under discussion is shown in Fig. 12 and may be woven on a Jacquard loom or sewn with seams that are curved.

The geometrical configuration can be made clear by referring to the cross-section formed by the tubes **63** and **64** as a generatrix, and moving it along a predetermined outline of the boat, while the other part of the cross-section formed by the tubes **65**, **66**, and **67** remains straight and disappears when meeting the curved portion of tube **64**. This form of invention also shows how all the cells may differ in contour and yet be formed by the present method.

When an uplift bow and stern are desired, a varying elongation of the fabric as between the points G and K of the cross-section may be provided, as previously described.

It is obvious that the entire unit for a complete boat, including all the cellular structure may be made in one piece by weaving on a Jacquard loom two symmetrical sections, as shown in Fig. 12, the axis of symmetry being along line A. In such case, only the ends of the surrounding structure need be united after folding on line A, to complete a seamless boat.

As in the example illustrated in Figs. 1, 2, 3, and 4, the structure may be subdivided in as many independent inflatable units as desired by the same means as discussed above: by subdividing the inflatable units along any of the diaphragms or partitions shown in Figs. 10, 11, and 12, which may form a bulkhead in the same manner as previously described. The entire unit or component part is then combined to airtight material on both sides to encase it completely. Then two such half structures or units are combined to form a boat.

It may be desirable to produce an inflatable boat that is still nearer to the traditional shape. An example thereof will be described with respect to Figs. 13, 14, and 15. This form has the advantage of being easier sewn or woven, the constituent parts being simpler than in the example just described but the assembly is somewhat more complicated, as the boat is built up of three independent units instead of two as above described. While the above-described boat was made up of two halves each formed by the sidewalls combined with half the inflated bottom, the cross-section represented in Fig. 13 shows two independent surrounding tubes **70** combined with an independent bottom unit **73**.

Fig. 14 shows how the shape, represented in Figs. 15 and 16, with uplift bow and stern, is obtained. The tubes **70** are included within the lines **74**, **75**, and **76**, and are doubled or combined on each side to an air- and water-impervious sheet for making the air chamber. The air chamber, which constitutes the bottom **73**, is folded along the line **77** and has the outline **78** after being doubled on each side to an air-impervious sheet. The folded bottom **73** may be laid flat on top of one of the air chambers and the other air chamber on top of both, as shown in Fig. 14*a*. The conical ends of the air chambers represented by the lines **76** may be tucked in so that the parts **76** assume positions **71** and **72**. While the partitions **38**, **53**, etc., have been described and shown as being in single straight lines, it will be obvious that they may be folded or doubled upon themselves, as has already been described with respect to the bulkheads **76**, or as shown in Fig. 14*b*. The following doubling operation, which may be carried out on a doubling calender, as described above, will unite the right tube to the left tube on both ends along the lines **79**[a] and **80**[a] and the bottom, to each tube in the areas between the lines **79**[a] and **78**[a]. This produces, with one mechanical operation, a boat that simulates the one represented in Figs. 10, 11, and 12. However, it is built up of parts differently arranged and the uplift effect of bow and stern is obtained by shaping instead of weaving the fabric of non-uniform stretchability. The geometrical similarity of the cross-sections in Figs. 10 and 13 is obvious, while the pattern shown in Figs. 12 and 14 differs only in the fact that the fabric forming the surrounding tube is placed more outward than in Fig. 14. The bottom **73** may be woven in different lengths on the bottom and top sides, the bottom side being longer due to its upward bending. But, as its thickness is comparatively small, this bending may be obtained by the natural elasticity of the fabric. Of course, the flat inflated bottom unit can be substituted by a single fabric bottom unit folded along the line **77** and with the outline **78**.

Another method of making relatively short boats will be now described. Such a method is disclosed in Figs. 17, 18, 19, 20, and 21.

It will be noted that the completed boat, in the above forms and best seen in Figs. 2 and 11, is substantially V-shaped when deflated and lies flat as can be understood. When constructing a boat of the proportional form shown in Fig. 4, the V-shaped construction may be readily followed. However, when a boat having a relatively short length with respect to its width is desired some difficulty is encountered. The length of the boat along its chine as at **80**, Figs. 18 and 19, is much shorter, in the flat condition of the boat, than the keel lines **81**.

This condition is exaggeratedly illustrated in Figs. 18 and 19 where **80** is the edge of fold and **81** the keel line. It will be seen, that upon inflation of the boat, the line **80** will seek to stretch and the line **81** to shrink.

Resort is, therefore, had to a W-shaped structure. As seen in Figs. 20 and 21, the keel line **82** is now comparable in length to the chine **83** and stresses in the fabric are reduced. In Fig. 21, lines **82**, **83** and **83'** are now approximately the same length.

Fig. 17 reveals such a structure which is formed as heretofore described, the cells **84** and **85** being comparable to the like cells on the previous forms and the cells **86** comparable to cells **41** and **64**. The latter cells are the ones which form the

chine as can be understood so that the cells 84 form the boat bottom and the cells 85 the boat sides.

It will, therefore, be seen that though the boat when deflated, is in folded flat condition, it will, nevertheless, when inflated, open up so that the bottom, which is in folded parts, will extend to produce a substantially flat bottom for the boat.

It is obvious that this shape may be combined with the weaving of different lengths and that the combination can give any desired result up to the circular form which hardly will be desired.

The foregoing describes a novel form of inflatable boat in various forms of conception and a novel method for constructing the same. It is obvious that the invention may be practiced in various ways within the spirit of the invention other than those described. No limitation, as regards the following claims, is intended by the specific terms used in the description.

I claim:

1. An inflatable boat having bottom and sides comprising two joined symmetrical units, each unit comprising two superimposed sheets of fabric of predetermined elongated shape, and enveloped between two layers of air-impervious material which are united at their edges to form the unit, one layer constituting the ultimate outside and the other the ultimate inside of half of a finished boat, interconnecting means extending between the sheets from the sheet adjacent the outside layer toward the sheet adjacent the inside layer in a direction inwardly from the longitudinal edges of the layers so that the interconnections form compartments between the sheets, the intermediate compartment which has converging interconnections forming the ultimate chine of the boat, said units being united along a substantial area adjacent the contiguous edges from end to end along the keel line to form a complete boat.

2. An inflatable boat having bottom and sides comprising a plurality of units, each unit comprising two superimposed sheets of fabric of predetermined elongated shape, and enveloped in a casing of air-impervious material, which sheets are united at their edges to form the unit, one side of the casing to form the ultimate outside and the other side of the casing the ultimate inside of a section of a finished boat, at least two of said units having interconnections extending between the sheets, from the sheet adjacent the one side of the casing toward the sheet adjacent the said other side of the casing in a direction away from the longitudinal edges of the sheets so that the interconnections form compartments between the sheets, the intermediate compartment which has the interconnections running in opposite directions forming the ultimate chine of the boat, all of said units being united along an area adjacent the edges of each unit to a similar area on another unit completely around their perimeters except those portions which surround the opening to the boat to form a complete inflatable boat.

3. An inflatable boat having bottom and sides and made up of a plurality of units, each unit comprising two superimposed flat-lying air-impervious sheets united along their edges while in flat condition, and the units being united to each other by joining the adjacent units along a substantial area, the outline of the united units including the contour of the gunnel or sheer, the bow and the stern profiles of the collapsed boat, and all of the units together forming the sides and bottom of the boat, and said boat being adapted to lie flat when deflated.

4. The method of making inflatable boats having bottom and sides and collapsible to flat condition along a longitudinal medial plane, which consists in producing a plurality of units consisting of flat sheets of material, some of which units, at least those intended for the boat sides, being inflatable and contoured so as to provide the gunnel or sheer, the bow and the stern profiles and all the units together forming the sides and bottom of the finished boat; superimposing these units in the flat so that together they produce the outline of the collapsed boat; adhesively uniting portions of the side units to form the bow and the stern, and uniting an area along all the remaining edges of each unit, except for those portions of the perimeter which are to form the top opening of the boat, to corresponding areas on another unit.

5. The method of making inflatable boats having bottom and sides and collapsible to flat condition along a longitudinal medial plane, which consists in producing a plurality of fabric units consisting of flat sheets of material, some of which units, at least those intended for the boat sides, being inflatable and contoured so as to provide the gunnel or sheer, the bow and the stern profiles, and all the units together forming the sides and bottom of the finished boat, and while these sheets are in flat condition, making them water- and air-impervious by applying vulcanizable layers to encase each said unit; superimposing these units in the flat so that together they produce the outline of the collapsed boat; adhesively uniting the portions of the side units to form the bow and the stern, and uniting an area along all the remaining edges of each unit, except for those portions of the perimeter which are to form the top opening of the boat, to corresponding areas on another unit, and then vulcanizing the entire assembly.

6. A method of making inflatable boats which consists in making two inflatable units, each unit representing one longitudinal half of a boat, and having the outline representing the longitudinal profile of the boat when deflated, said units being composed of superimposed sheets of flexible air-impervious material sealed or integrally united at their edges to form an inflatable unit, providing interconnections between the sheets at predetermined locations intermediate the sealed edges thereof, to serve, upon inflation, to limit the expanding of the portions between the interconnections, some of the interconnections being disposed so as to allow a wider area between them on the outside of the boat than between the same interconnections on the inside of the boat, to form the desired chine of the boat; then uniting the two units or halves of the boat, while both are superimposed in flat-lying condition, along their edges which are to represent the keel, the bow and the stern, and for a width equal to the thickness desired for the bow, stern, and bottom of the longitudinal medial plane of the finished boat.

7. The method of making an inflatable boat having bottom and sides and adapted to lie flat when deflated, which consists in making two symmetrical units, each unit comprising two coextensive layers joined together all around their perimeters to make an inflatable unit to form the sides of the boat, said perimeter including the subsequent sheer, bow, and stern profiles; making an additional unit for the boat bottom, folding said bottom in half longitudinally, and unit-

ing the bottom to the sides by laying one upon the other in flat condition with the fold line upwardly and adhering one-half of the bottom rim to one side unit and the other half to the other side unit, then uniting the corresponding, respective ends of the sides by adhering superimposed portions thereof, said fold line of the bottom being so disposed that it connects a point on the outline of said portion at the bow to a point on the outline of said portion of the stern.

8. The method of making an inflatable boat having a flat bottom, and a surrounding tube, which consists in folding a water-impervious flat bottom upon itself along its longitudinal medial line, applying and uniting to the peripheral edges of each fold of the bottom a water- and air-impervious flat-lying tubular member, the contours of which, when deflated, are curved to produce the desired shape of the boat; the peripheral edges of the bottom having been previously shaped so that their contours when lying flat between the flat-lying tubular members, lie within the confines of said tubular members, and uniting the respective ends of the tubular members in the medial plane.

9. An inflatable boat having bottom and sides and collapsible when deflated to flat condition and comprising a plurality of inflatable flat-lying units superposed so that symmetrical parts lie coextensively in flat condition and joined together to produce a foldline at at least each joint, one of said folds being on a vertical plane running through the longitudinal medial line of the inflated boat, the contour of the flat-lying assembly including the sheer, bow and stern profiles of the deflated boat.

10. An inflatable boat having bottom and sides comprising two joined coextensive units which lit flat when deflated, each unit being inflatable and so contoured as to provide the gunnel or sheer, the keel line and the bow and stern profiles, a plurality of interconnecting means within the unit walls, said means extending from lines on one wall inwardly to lines nearer the center of the other wall so that the interconnections form compartments therebetween, the intermediate compartment which has converging interconnections forming the ultimate chine of the boat, said units being united along a substantial area adjacent the contiguous edges of the stem, the stern and the keel to form a complete boat.

11. An inflatable boat having bottom and sides comprising two joined symmetrical units, each unit comprising two superposed layers of predetermined identical shape, the perimeter of which includes the gunnel or sheer and at least portions of the bow and stern profiles; and an additional unit folded upon itself, the fold constituting the ultimate keel line, and with the two halves of the ultimate outside face of the additional unit confronting each other, the edges of the unit on the ultimate inside of the said additional unit all round its perimeter being united while in flat condition between and to the first said units, with the fold line upwardly, said additional unit constituting at least a portion of the bottom of the inflated boat.

12. The method set forth in claim 4 in which the sheets of at least one of the units are interconnected at spaced intervals by a plurality of interconnections between the sheets to limit their spaced-apart relation when the unit is inflated, the spaces between at least some of the interconnections on one sheet being different from the spaces between the same interconnections on

the other sheet, the part of either sheet having the greater spaces between the interconnections, becoming the outcurve portion of the boat when inflated.

13. The method set forth in claim 4 in which the sheets of at least one of the units are interconnected at spaced intervals by a plurality of interconnections between the sheets to limit their spaced-apart relation when the unit is inflated, said interconnections being secured to the respective sheets along lines, all of which are straight and parallel.

14. The method set forth in claim 4, in which at least one of said units has a series of overlapped tubular members sandwiched between the sheets forming the units, those portions of the tubes which are overlapped being adhered and constituting interconnections between the sheets when inflated to limit the spaced apart relation and control the shape of the inflated unit.

15. Method of producing inflatable articles constituted by a plurality of tubular units in which each unit is brought to a flat position so that both halves of the circumference of the tube are separated by two foldlines, and on one half of one unit two other units are superimposed and adhered in overlapped arrangements, each on the same face of the first unit along two portions adjacent the two foldlines of the first unit so that upon inflation when the unadhered parts of all units form cylindrical surfaces, the planes through the axes of the cylinders form an angle having its apex in the axis of the unit having both other units adhered on the same face.

16. An inflatable boat having bottom and sides and made up of a plurality of units, each unit comprising two superimposed flat-lying air-impervious sheets united along their edges and said sheets being further united by means of interconnections between the sheets, and the units being united to each other by joining adjacent units along a substantial area, the entire boat being adapted to lie flat when deflated, and each unit being so constructed and arranged that when inflated a transverse cross-section would present a series of intersecting circles with the interconnections serving as common chords between the intersecting circles, with the two arcs of at least one of the intersecting circles being of different length, and with a line extending through the center of the circle having non-uniform arcs, and two intersecting circles adjacent said first circle forming an angle with a line drawn through the centers of the said first circle and the intersecting circle common to its other chord, the outside circles presenting one arc and one chord, while all intermediate circles are bounded by two arcs and two chords.

17. Method for producing inflatable structures consisting of two or more units, wherein each unit consists of a pair of configural sheets of flat material superimposed one upon the other and united substantially along their perimeter so that the resulting unit lies flat when collapsed, and wherein at least one of said units has interconnections between the sheets attached along lines to each sheet to form rows to limit the expansion of the article upon inflation between said lines of attachment to the length of the interconnections and allows the portions between said lines of each sheet to form cylindrical surfaces upon inflation; which consists in superimposing two or more such flat units in flat condition and uniting them along a portion of the adjacent surface of each unit so that upon inflation said por-

tion forms an interconnection between two final surfaces of the finished inflated structure, the outlines of said portion being so disposed in relation to said means of attachments between the sheets to provide a wider cylindrical portion on one side of the structure between the attached portion and the adjacent line of connection than the opposed cylindrical portion on the other side of the structure so that upon inflation of the article the planes described through the axis of the cylinder having unequal cylindrical portions and the axes of the two adjacent cylinders form an angle having its apex on the axis of the cylinder having the unequal cylindrical portions.

18. In an inflatable structure having two superimposed flat sheets of material united substantially around their edges as well as by interconnecting means disposed in rows and attached along lines to each of the sheets with the interconnecting means being so dimensioned as to allow the structure to assume a flat condition when deflated and when inflated to allow the portions of the sheets between the lines of attachment to form cylindrical surfaces of incomplete cylinders with the interconnecting means constituting chordal planes common to adjacent cylinders, a first incomplete cylinder having two non-parallel chordal planes, a second incomplete cylinder having at least one chordal plane which is contiguous and coextensive with and common to a chordal plane of the first incomplete cylinder, a third and a fourth incomplete cylinder each having two parallel chordal planes one on each side of its axis, one of said chordal planes of the third cylinder being contiguous and coextensive with and common to the other of the chordal planes of said first incomplete cylinder and the other of its chordal planes being common with that of the fourth cylinder, all of said incomplete cylinders being so disposed relative to each other that when inflated, an extended plane passing through the axes of the third and fourth incomplete cylinders forms an angle with the plane passing through the axes of the first and second incomplete cylinders.

19. The method of producing inflatable articles of a plurality of units, each unit of which is made up of a plurality of tubular members which consists in flattening all the members, in superimposing and adhering a second member upon a first member to lie substantially parallel to the first member in overlapping offset arrangement, overlapping and adhering a third member to the second member in the same manner so that when the so formed unit is inflated a series of incomplete cylinders are formed, the adhered portions forming chordal planes, each common to a pair of adjacent cylinders, substantially closing the units around their perimeters, superimposing two such symmetrical units, and adhesively uniting them on a band adjacent a coextensive portion of their edges, so that this band unites at least the last member of each unit and the uniting band forming a chordal surface common to each pair of symmetrical cylinders covered by the band so that the folded V-like structure will open up upon inflation to form a body composed of all the members arranged in one continuous surface.

20. The method of producing inflatable articles which comprises a plurality of tubes, which consists in flattening the tubes, superimposing upon and adhering to one of the tubes two other tubes on the same face of the first tube so that the second and third tubes extend outwardly in opposite directions from said first tube, then superimposing and adhering part of a fourth tube upon part of the upper face of the third tube and extending outwardly therefrom, so that upon inflation the unadhered parts of all the tubes assume cylindrical surface forms, and the adhered portions form chordal planes between the intersecting cylinders, and the plane extending through the axes of the third and fourth cylinders forms an angle with the plane extending through the axes of the first and second cylinders.

21. An inflatable boat having bottom and sides and collapsible to flat condition, and comprising two or more units, each unit comprising two superimposed impervious sheets of predetermined shape, one sheet constituting the ultimate outside and the other sheet the ultimate inside of a part of a finished boat, connecting means extending between the sheets and so disposed as to permit the sheets to lie flat upon each other, all of said units being united along a substantial area adjacent the edges of each unit to a similar area on another unit, completely around their perimeters except for those portions which surround the opening to the boat, to form a complete inflatable boat, said united areas constituting additional connecting means between the inside of the boat and the outside of the boat, the space between some of the connecting means on the inside of the boat being different from the space between the same connecting means on the outside of the boat, those portions which have the non-uniformly spaced connections defining the bent portions of any section of the inflated boat.

22. The method of making inflatable boats having bottom and sides and collapsible to flat condition along a longitudinal medial plane, which consists in producing a plurality of units consisting of flat sheets of material, some of which units, at least those intended for the boat sides, being inflatable and contoured so as to provide at least part of the outline of the collapsed boat, and all the units together forming the sides and bottom of the finished boat; superimposing these units in the flat so that together they produce the outline of the collapsed boat; uniting portions of the side units to form the bow and the stern profiles, and uniting an area along all the remaining edges of each unit, except for those portions of the perimeter which are to form the top opening of the boat, to corresponding areas on another unit.

23. The method of making inflatable boats having bottom and sides and collapsible to flat condition along a longitudinal medial plane, which consists in producing a plurality of fabric units consisting of flat sheets of material, some of which units, at least those intended for the boat sides, being inflatable and contoured so as to provide at least part of the outline of the collapsed boat, and all the units together forming the sides and bottom of the finished boat, and while these sheets are in flat condition, making them water- and air-impervious by applying vulcanizable layers to encase each said unit, superimposing these units in the flat so that together they produce the outline of the collapsed boat; uniting the portions of the side units to form the bow and the stern profiles, and uniting an area along all the remaining edges of each unit, except for those portions of the perimeter which are to form the top opening of the boat, to corresponding areas on another unit, and then vulcanizing the entire assembly.

24. An inflatable structure or part thereof

formed by two layers of fabric united substantially around their perimeters and being further united by interconnecting means so dimensioned as to allow the fabric layers to assume a flat condition when deflated and arranged in rows, so that when inflated the structure forms a series of incomplete cylinders, the interconnecting means forming chordal planes, each common to a pair of adjacent incomplete cylinders, the whole structure being constructed and arranged to bend, upon inflation, around an axis, portions of both said fabric layers being located at different distances from said bending axis and said portions being separated from each other by imaginary surfaces each at constant distance from said bending axis, each of said portions being woven in different weave patterns which cause the fabric portions to change their length perpendicular to and circumferentially around said axis under the inflation stresses to a limited extent different for each weave pattern and so arranged that a section of equal length in deflated condition of each of said portions, will when inflated, assume various lengths, proportional for each portion, to the mean distance of this portion from the bending axis, so that upon inflation the structure will bend, the center of the bending curve being said bending axis.

25. An inflatable structure formed by two layers of fabric united substantially around their perimeters, and being constructed and arranged to bend, upon inflation, around an axis which forms an angle with a plane through the edges of said layers, portions of both said layers being located at different distances from said bending axis, and being separated from each other by imaginary surfaces, each at constant distance from said bending axis, each of said portions being woven in different weave patterns which cause the fabric portions to change their lengths perpendicular to and circumferentially around said axis under the inflation stresses to a limited extent different for each weave pattern and so arranged that the ultimate length of a section of each of said portions having equal lengths in deflated condition will when inflated, assume various lengths, proportional, for each portion, to the mean distance of that portion from the bending axis, so that upon inflation the structure will bend, the center of the bending curve being said bending axis.

26. An inflatable structure or part thereof formed by two impervious layers united substantially around their perimeters, and being constructed and arranged to bend, upon inflation, around an axis which forms an angle with a plane through the edges of said layers, portions of both said layers being located at different distances from said bending axis, and being separated from each other by imaginary surfaces, each at constant distance from said bending axis, each of said portions being of different structure, which cause the portions to change their lengths perpendicular to and circumferentially around said axis under the inflation stresses to a limited extent, different for each structure and so arranged that the ultimate length of a section of each of said portions having equal lengths in deflated condition will assume various lengths when inflated, proportional, for each portion, to the mean distance of that portion from the bending axis, so that upon inflation the structure will bend, the center of the bending curve being said bending axis.

27. An inflatable boat having bottom and sides and made upof a plurality of units, each unit being composed of a plurality of flattened tubular members superimposed and united in the flat on a substantial area along at least one edge of each tubular member to a superimposed area of another tubular member, half of the perimeter of the ends of each tubular member being joined to another superimposed half of the perimeter of a tubular member, and the units being united to each other to form a complete boat by joining adjacent units along a substantial area, the outline of all the units together forming the outline of the collapsed boat including bow and stern, and all of the units together forming the sides and bottom of the boat and said boat being adapted to lie flat when deflated.

28. The method of producing an inflatable article of the type consisting of two or more units, in which each of at least two of the units consists of a pair of substantially configural sheets of flat material superimposed one upon the other, and united substantially around their perimeters and as well as by interconnecting means arranged along lines to limit the expansion of the article upon inflation and to allow the portions between said lines of each sheet to form cylindrical surfaces, and in which the interconnecting means are so disposed that the units lie flat when deflated; which consists in superimposing at least two such units in deflated condition and uniting them on a portion adjacent to part of the outline of at least one of the units, said part of the outline being at an angle to the lines of attachment of said interconnecting means of said latter unit, said attached portion forming an additional interconnecting means between the final sheets forming the article; the difference between X and Y determining the relative angularity between the two units when deflated, where X is the distance from an interconnecting means of said latter unit to the nearest edge of the attached portion of said latter unit, and Y the distance from the same interconnecting means to the nearest edge of the attached portion on the other sheet of said latter unit.

29. An inflatable boat having bottom and sides and made up of a plurality of units, each unit comprising two superimposed flat-lying partly congruent air impervious sheets united along their congruent edges while in flat condition; and the units being united to each other by uniting all the remaining edges of the sheets of each unit to corresponding remaining edges of the sheets of another unit, the outline of all the units together forming the outline of the collapsed boat, and all of the units together forming the sides and bottom of the boat, and said boat being adapted to lie flat when deflated.

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