

May 27, 1969

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3,446,172

PONTOON FLOATATION SUPPORT

Filed Oct. 23, 1967

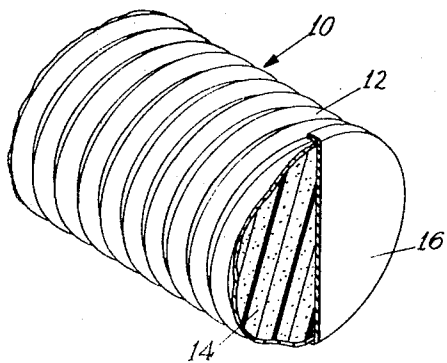


Fig. 1

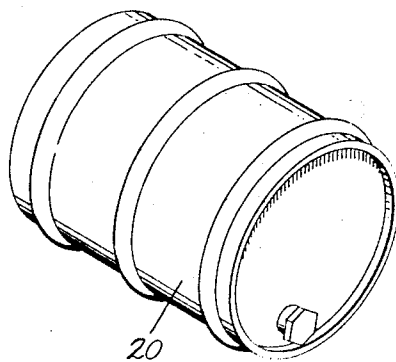


Fig. 2

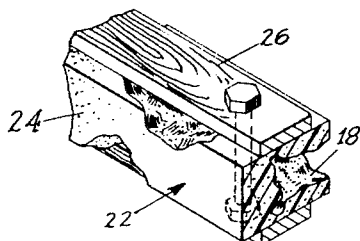


Fig. 3

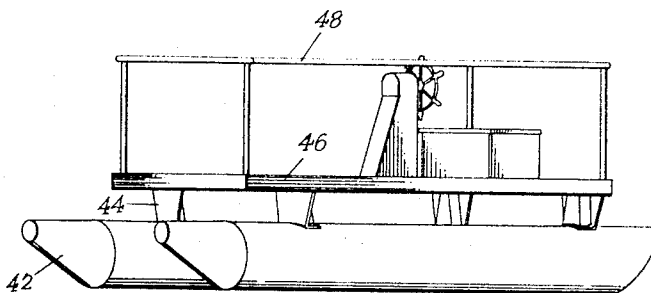


Fig. 5

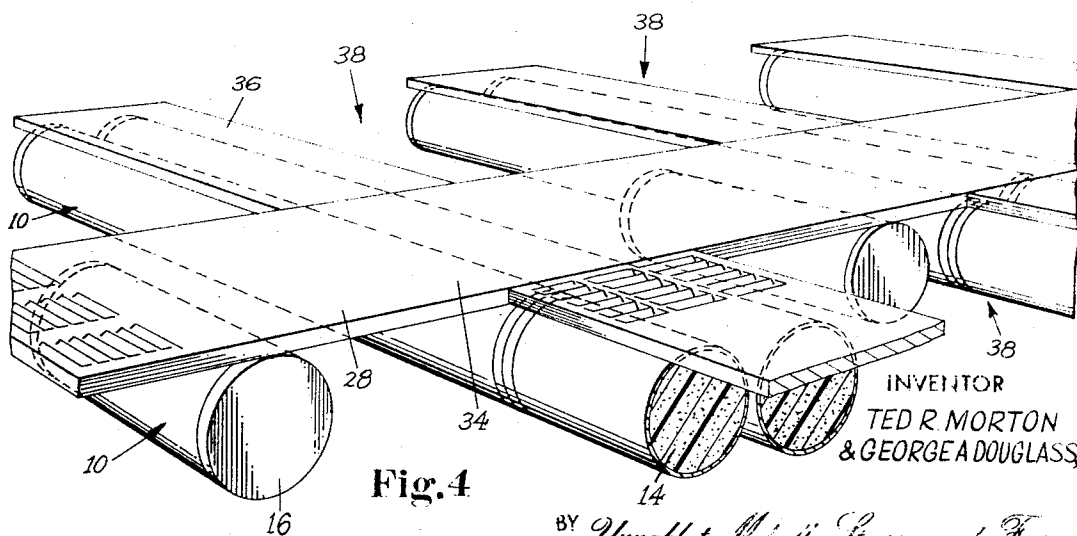


Fig. 4

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PONTOON FLOATATION SUPPORT

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Continuation-in-part of application Ser. No. 533,310, Mar. 10, 1966. This application Oct. 23, 1967, Ser. No. 685,992

Int. Cl. B63b 38/00

U.S. Cl. 114—5

7 Claims

ABSTRACT OF THE DISCLOSURE

A load bearing pontoon floatation support for water floatation systems comprising a one-piece tube having the same average diameter throughout its length. The tube is entirely filled with expanded in situ, integral, low density, cellular foam material forming a unitary foamed element within the tube and providing maximum area contact with the interior surface of the tube, and means are provided for holding the foamed element in place within the tube.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 533,310, filed Mar. 10, 1966, and titled Pontoon Floatation Support, now abandoned.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to floatation systems such as, for example, boat docks and piers, and more particularly to load bearing pontoon floatation supports which provide support for such systems in the water.

Description of the prior art

When lake water levels are fixed, docks and the like may be placed on piling driven into the lake bottom. However, if there is a wide variation in the water level, such docks may be submerged and nonusable a substantial part of the year, possibly even being carried away. Even if the dock structures are placed upon very high piling to combat the rise of the water, they would be impractical as they would not accommodate boats most of the year because of their excessive height above the water's surface. This necessitates the use of a floating dock system.

Conventional floating dock systems utilize either drums, welded tanks, pipe or foam billets as floatation supports. Such floatation supports have proven to be impractical because of the myriad problems and difficulties associated therewith.

Drums utilized for floatation supports are commonly of the large metal oil drum variety. Such drums have a limited life as supports—probably about two years—because they rust and sink. Also the total value of the drums as floatation is destroyed when they sustain punctures caused by collision with boats or vandalism such as bullet holes. Naturally, if the rusted or punctured drums are secured under a dock framework, they will become dead weight and appreciably diminish the floatation of the dock. If only partially submerged rusted or punctured drums get free of their dock structure, they become very definite safety hazards to water navigation. In fact, some governmental bodies and specifying agencies require owners of drum supported docks to replace them with permanent type floatation.

Additionally, the utility of drums in dock construction is limited because of the drum size. Since drums are of

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relatively short length, they will not bridge large gaps, thus requiring an endless chain of drums. An endless chain of drums is not very satisfactory because it will not provide the rigidity needed for a good dock structure.

Foam billet floatation supports are generally constructed of a plastic foam placed between two wooden plates. The main problem with this type of floatation support is that it is open and subject to miscellaneous perils. For example, gasoline and oil on the water's surface are particularly destructive, since they tend to dissolve the foam and eliminate its utility. Naturally, the use of foam billets as a floatation support thereupon vanishes. Additional problems also arise from burrowing animals which find the foam a very secure home and from mechanical damage to the foam caused by boats docking, floating ice or debris.

Additionally, it should be noted that prior art disclosures relating to floats or buoys have proven to be generally unsatisfactory for load-bearing floatation structures. For example, United States Patent No. 3,132,417, in the name of H. B. Irwin, discloses a buoy comprising a two-piece plastic shell filled with a rigid, molded plastic foam. Each piece of the shell is somewhat cup shaped, having an open end. After the foam material has been provided in each shell half, the halves are joined together, with their open faces adjacent each other, by means of an elongated bolt extending through the structure, and a resilient bond or bumper extends peripherally around the structure and engages integral peripheral flanges on the two shell halves.

While Irwin discloses a floatable noncrushable buoy, it is not directed to a load carrying structure. In fact, if a number of the Irwin buoys were joined together, end to end, to form a floatation support, a nonrigid support would result. Further, if the Irwin buoys were made in greatly elongated form, and adapted for use as a horizontally oriented, load carrying structure, the two-piece construction would render the resulting floatation support very little better than two or more drums banded together.

Prior art references relating to water craft disclose numerous pontoons, but these pontoons have proven to be generally most unsatisfactory as load bearing pontoons for floatation support systems. For example, United States Patent No. 2,975,747, in the name of J. Opie, discloses a pontoon-type catamarin. The two-piece Opie pontoon comprises a continuous metal sheet in the form of a U-shaped wall with a metal top cover extending the length of the body of the pontoon and formed from one or more suitably connected sheets. The top cover has integrally formed channels along its edges, adapted to receive the top edges of the U-shaped body portion of the pontoon. Opie teaches the filling of the described pontoon with a plurality of flat blocks and pieces of relatively light, relatively rigid, nonabsorbent, waterproof material, such as Styrofoam, Unicrest, foam-glass, or equivalent plastic material. Opie also teaches that a one-piece molded plastic material may be used to fill the interior of the pontoon.

While the Opie pontoon is, perhaps, satisfactory for water craft, it has proven to be unsatisfactory as a load bearing pontoon for a floatation support system because it simply provides a complex and expensive pontoon which, although floatable and uncrushable, does not exhibit enhanced live or static load carrying capabilities.

SUMMARY OF THE INVENTION

The present invention provides a load bearing pontoon floatation support for use with dock structures and the like. This support comprises a one-piece tube which has the same average diameter throughout its length and which is entirely filled with expanded in situ, integral, low density, cellular foam material forming a unitary foamed element within the tube and providing maximum area

contact within the interior surface of the tube. Additionally, means are provided for holding the foamed element in place within the tube.

It has been found that when the foam material is pressure expanded in situ within the one-piece tube, to form a unitary foamed element therein, and when means are provided for holding the foamed element in place within the tube, such as depending projections, corrugations, glue, or other adhesives between the inside surface of the tube and the foamed element, the resulting composite structure demonstrates remarkable and unexpected rigidity. This is of significance because the composite structure of the present invention has sufficient strength to span considerable distances and displays a much larger live or static load carrying capability than heretofore achievable except by structures which were considerably heavier, more complex, and more expensive. It should be pointed out that the stiff and rigid pontoon support of this invention is able to support much greater live or static loading because the combination of the one-piece tube, the foam material expanded in situ, so as to form a unitary foamed element therein providing maximum area contact with the interior surface of the tube, and means for holding the foamed element in place within the tube, exhibits the synergistic effect of enhanced shear strength and resisting moment.

The pontoon support of this invention also offers much more utility in the actual construction of floatation systems because it has the same average diameter throughout its length. This enables use in any rotatable position about its longitudinal axis.

Additionally, the pontoon support of this invention also provides an increased transference of force from a point contact on its exterior, i.e., increased bearing strength.

Finally, the maximum area contact of the foamed element with the interior surface of the one-piece tube and the holding of the foamed element in place within the tube increases beam stability, and tends to preclude deflection of the pontoon support.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a fragmentary, partial perspective, cut away view of an exemplary pontoon floatation support according to the instant invention.

FIGURE 2 is a perspective view of a conventional oil drum which is presently much used as a support for floatation systems.

FIGURE 3 is a fragmentary, partial perspective view of a conventional plastic foam billet which is presently much used as a support for floatation systems.

FIGURE 4 is a fragmentary, partial perspective cut away view of a typical boat dock floatation system using the pontoon floatation supports according to the instant invention.

FIGURE 5 is a side elevational view of a water craft using the pontoon floatation supports according to the instant invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

By way of illustration, the means for holding the foamed element in place within the shell, as will be more fully explained hereinafter, is described in terms of an exemplary embodiment utilizing corrugations. However, it should be clearly understood that the shell or tube may be smooth walled, as shown in FIGURE 4, and that the means for holding the foamed element in place within the shell or tube may comprise depending projections, such as dimples, etc., or glue or other adhesives between the inside surface of the shell or tube and the foamed element. Hereinafter, the glue or other adhesives will be referred to as glue.

Turning now to FIGURE 1, it will be seen that the composite floatation support 10 according to the invention comprises a one-piece tube or shell 12 having the

same average diameter throughout its length and having its interior entirely filled with expanded in situ foam material, which forms a unitary foamed element 14 within the tube 12 providing maximum area contact with the interior surface of the tube.

It will be understood that by maximum area contact with the interior surface of the tube 12 it is meant that the expanded in situ foamed element 14 contacts the maximum surface area of the interior of the tube 12 as is possible when utilizing the hereinafter explained method for pressure expanding the foam material. The maximum area contacted may be less than 100% due to localized shrinkage and the like. It will also be understood that when the means for holding the foamed element 14 in place comprises corrugations, as shown in FIGURE 1, the foamed element extends into the corrugations.

The foam material 14 may be characterized as integral, low density, cellular material having uniform small voids, such as, for example, polystyrene. Pressure expansion in situ of the polystyrene foam material may be accomplished pursuant to the method taught in U.S. Letters Patent 3,042,967, filed June 18, 1958.

Briefly, the above referred to method comprises the steps: Partially inserting steam probes into a molding cavity, blowing partially expanded cellular polystyrene particles capable of further expansion into the cavity so as to substantially fill it, further inserting the probes substantially all the way into the mold cavity, injecting steam into the mold cavity, and after the elapse of a length of curing time, simultaneously stopping the steam injection and removing the probes from the mold cavity at a desired rate of removal. Essentially, the described method causes the cellular polystyrene particles to be heated to a temperature wherein they will be softened and expanded so as to take the shape of the mold cavity.

As the best results are realized with the composite floatation support 10 of the invention when there is maximum area contact between the expanded in situ foamed element 14 and the interior surface of the shell 12, the aforementioned method should be carefully administered so as to attain the best possible result.

The shell 12 is of uniform cross-section from one end to the other and may be made of galvanized pipe, as shown in FIGURES 1 and 4, so as to be inexpensive and maintenance free in most applications. Such pipe may, of course, be of the corrugated variety, including helical corrugations as shown in FIGURE 1, if additional rigidity is required. It will be understood, however, that other materials, corrugated or uncorrugated, such as plastic, plastic-coated metal, or fiber glass may also be utilized for the tube 12, so long as means are provided to hold the foamed element providing maximum area contact with the interior surface of the shell in place within the tube.

It is important to this invention that the foamed element 14 be held in place within the tube 12. The means to accomplish this end may comprise corrugations, which may be helical, as shown in FIGURE 1, or projections which depend from the interior surface of the tube 12, such as dimples and the like, or glue between the inside surface of the tube 12 and the foamed element 14. The gluing operation preferably extends over the full length of the interior surface of the tube 12. While the holding means may comprise corrugations, or depending projections, or glue between the interior surface of the tube 12 and the foamed element 14, it will be obvious that a combination of the aforementioned elements may be utilized.

The fact that the foamed element 14 is very light and provides maximum area contact with the interior surface of the tube 12 is of importance, because the composite support 10 is light, buoyant and substantially non-crushable.

The cap 16 may be used to close the ends of the composite support 10. This protects the foam element 14 from undercutting by gasoline, oil, or burrowing rodents. Such undercutting 18 is a current problem with conventional foam billets as shown in FIGURE 3.

It should be pointed out that the aforementioned operation of gluing between the interior surface of the tube 12 and the foamed element 14 is also of importance for waterproofing purposes. The glue can, in fact, be utilized primarily as a waterproofing agent, as opposed to being utilized for both waterproofing and as means to hold the foamed element 14 in place within the shell 12, and best waterproofing results are realized when the glue is utilized for at least one and one-half feet on each end of the pontoon. However, even when glue is used as a waterproofing agent, the use of end caps 16 is still desirable in order to protect the ends of the foamed element 14 from undercutting and mechanical damage.

The aforementioned gluing operation, whether for a portion of for the entire length of the pontoon 10, also is of importance in safeguarding against localized shrinkage and the like of the foamed element 14 as foam material is pressure expanded in situ within the shell or tube 12. This is so because the use of glue in this manner improves maximum area contact between the foamed element 14 and the inside surface of the shell or tube 12.

Inherent in the composite support 10 of FIGURE 1 are the best properties of the tube 12 and the polystyrene foamed element 14. The tube 12 supplies strength and rigidity, while at the same time is protects the polystyrene foamed element 14. The polystyrene foamed element 14 supplies the necessary floating capabilities and rigidizes the tube 12. Obviously, the composite support 10 may be punctured and still retain its floatation characteristics because the polystyrene foamed element 14 assures that it will not sink.

Additionally, it should be noted that a result of the composite pontoon floatation support according to this invention is that it is a much more permanent and durable load bearing support than the old-fashioned drums

20 of FIGURE 2, or the foam billets 22 of FIGURE 3.

As was previously explained, an existing problem with conventional floatation supports is their inability to span distances. For example, a chain of the drums 20 is required to span the smallest of distances. While it is true that a structure so supported will float, it is also true that such a structure will not be the least bit rigid because each drum rolls and sways in its own manner. Although the foam billets 22 of FIGURE 3, composed of the foam 24 in sandwich form between the wooden supports 26, are capable of spanning larger distances than the drums 20, they are not adequate structurally. Also, gasoline, oil and other perils readily destroy the foam 24, making it inevitable that it will be replaced.

The composite floatation support 10 according to this invention is extremely stiff and rigid. Actually, the tube 12 will supply stiffness or rigidity. However, when the polystyrene foam is pressure expanded in situ within the shell 12 forming a foamed element 14 providing maximum area contact with the interior surface of the tube, and when means are provided which hold the foamed element in place within the tube, the composite support 10 has much greater rigidity. This rigidity enables the composite support 10 to be of utility for structural construction of floatation systems because it can span distances with ease (see FIGURE 4) and still give the system the rigidity which is required.

It should also be pointed out that the stiff and rigid composite pontoon support 10 of this invention is able to support much greater live or static loading because the combination of the one-piece tube 12, the foam material expanded in situ, so as to form a foamed element 14 therein which provides maximum area contact with the interior surface of the tube 12, and the means for holding the foamed element in place, exhibits the synergistic effect of enhanced shear strength and resisting moment.

Both compression and beam tests have been performed on the composite pontoon support of this invention, and the following results were obtained:

TABLE I.—PONTOON COMPRESSION TESTS USING 4-INCH SQUARE STEEL PAD LOADING

Test No.	Specimen	Nominal diameter, in.	Pad location	Max. load, lb.	Percent increase of pontoons over same size shell, percent	Def. at max. load, in.
5	Steel shell	18	9" from end	800		7.0
6	Pontoon	18	Seam center 9" from end	4,380	450	4.9
7	do	18	Seam center 11" from end	6,800	750	2.7
8	do	18	Seam center on beam center	4,150	420	3.6
3	Steel shell	21	9" from end	2,740		6.4
4	Pontoon	21	do	3,400	370	2.3
9	do	21	Seam center 9" from end	3,500	380	3.0
11	Steel shell	21	do	715		5.5
1	do	24	9" from end	580		5.5
2	Pontoon	24	do	3,850	570	1.8
10	do	24	Seam center 9" from end	4,350	650	3.0

¹ Test was stopped at this point due to the severe deflections of the metal which caused the shell to bear against the machine to such a degree that any further results would have been invalid. Test was delayed at 5,700 lbs. to increase load pad height and at 4,990 lb. to switch load range.

² Test stopped when shell deflected to bear against test machine. When shell was repositioned and reloaded, max. load was 520 lb. at a deflection of 4.4 in.

TABLE II.—PONTOON BEAM TESTS USING 4-INCH SQUARE STEEL PADS AT THE HOOD AND REACTION POINTS

Test No.	Specimen	Nom. I.D., in.	Length, ft.	Span, ft.	Max. load, lb.	Percent increase of pontoons over same size shell, percent	Third point deflection at max. load, in.
1	Steel shell	18	12	11	2,300		³ 7.0
2	Pontoon	18	12	11	3,850	67	5.6
5	Steel shell	21	12	11	2,500		10.2+
6	Pontoon	21	12	11	4,900	96	5.8
7	do ¹	21	12	11	5,200	108	4.2
3	Steel shell	24	12	11	2,050		(?)
4	Pontoon	24	12	11	5,900	188	5.8
6	do ¹	24	12	11	6,300	207	4.9

¹ Polystyrene filler glued along entire pipe length.

² Head deflected 11 in., its maximum, where load was removed and crosshead lowered before reloading and deflected 7.5 in. when test was halted due to buckling beyond capacity of machine.

Typical failure in unfilled pontoon specimens was by buckling and in filled pontoon specimens by seam splitting.

³ Third point deflection was 7.0 in. when deflection transducer was at end of the range and recorder had to be turned off. Estimated deflection at max. load was 7.5 in.

The tests of Tables I and II disclose the superiority of the pontoon floatation supports of this invention, along with the fact that the expanded in situ foam material adds considerable strength to the shell by primarily confining deformation to local distortion at load points.

The series of compression tests of Table I were performed with the load applied through 4 inch square steel pads located 9 inches from the pontoon end. The pontoons tested had the foamed element glued to the inside surface of the steel shell for approximately 1½ feet from both ends. Many of these specimens failed by a split seam on top of the steel shell at the edge of the load pads. In order to minimize this type of failure, the remaining specimens were positioned with a seam centered under the load pads.

It should be noted that test number 8 of Table I was performed on the center of the 18 inch pontoon where the foamed element was not glued to the inside surface of the shell, and a 5.3% lower load than the standard 9 inch test was obtained.

The results of the compression tests demonstrate that the foam material, expanded in situ within the shell so as to form a foamed element providing maximum area contact with the interior surface of the shell, and the means (corrugations) for holding the foamed element in place within the shell, are beneficial under concentrated loading (average of 510% increase with the foam material). This is considered significant because in actual use the pontoon loads are transferred by concentrated loading similar to the test conditions.

The series of concentrated beam tests of Table II were performed using 4 inch square steel pads at the load and reaction points. The pontoons tested, except for tests 6 and 7, had the foamed element glued to the inside surface of the steel shell for approximately 1½ feet from both ends. Typical failure of a tested pontoon occurred by buckling at the load points, or by a heart-shaped buckling at the ends at the reaction points.

As seen in Table II, the foamed element and the corrugations which hold the foamed element in place within the shell increased the maximum load an average of 133%. It should also be noted that as the diameter of the pontoon increased the foamed element became significantly more important. Tests 6 and 7 were especially prepared specimens to test the importance of both the foamed elements being glued to the inside surface of the shell for the entire length of the pontoon and the use of corrugations. As can be seen, the pontoons of tests 6 and 7 withstood approximately 6% more load than the other pontoons which only utilized glue for 1½ feet at each end.

A typical floatation system utilizing composite floatation supports 10 (smooth walled shell with gluing and/or depending projections) according to the instant invention is shown in FIGURE 4. It will be seen that the composite supports 10 have been topped with the deck 28. The deck 28 may, of course, be of any suitable material and construction, the only general restriction being that it should preferably be perforated to permit surface water drainage. It has been found that the preferable decking is a galvanized steel interlock grating. This eliminates the disadvantages of wooden decks: thousands of splinters, the danger of burning, the tendency to rot out after a few seasons of use, nail protrusion, and warping and swelling. The main deck 34 runs the length of the entire structure and the side decks 36, substantially normal to the main deck 34, make up the individual boat portals 38. Of course, roofed dock structures which utilize the pontoon floatation supports of the instant invention also may be constructed.

The typical floatation system of FIGURE 4 generally will utilize pontoon floatation supports, the shells 12 of which are of cylindrical 20-gauge galvanized pipe of a 24 inch diameter. The length to diameter ratio of such a support will normally be 4 to 1 or greater. It should be noted, however, that, depending on the specific application, the diameter of the shell 12 may vary from 12 inches to 36 inches or greater and be of .0375 to .25 inch wall thickness.

It will thus be apparent that tee docks, head docks and finger docks, in all sizes and shapes may be built with easily assembled floatation supports according to the present invention.

Additionally, the pontoon floatation support 10 may be used in water craft, as shown in FIGURE 5. Essentially, the pontoon floatation supports 10 are fitted at their ends with the partial cone heads 42. The struts 44 are mounted on top of the pontoon supports 10 and hold the platform 46. A deck railing 8 along with power means completes the water craft.

It will thus be seen that the myriad of uses for a floatation support 10 according to the instant invention are limited only by imagination.

What we claim is:

1. A load bearing pontoon floatation support for water floatation systems comprising a one-piece tube capable of withstanding shock without rupture and permanent deformation, said tube having the same average diameter throughout its length and being entirely filled with expanded in situ integral, low density cellular foam material forming a unitary foamed element within said tube and providing maximum area contact with the interior surface of said tube, and means for holding said foamed element in place within said tube, said holding means comprising circumferential corrugations in said tube extending substantially the length thereof, each said corrugation providing a break in the interior surface of said tube, and wherein said foamed element extends into said corrugations.

2. The pontoon floatation support according to claim 1, including end caps secured to and closing the ends of said tube.

3. The pontoon floatation support according to claim 1, wherein said corrugations are helical.

4. The pontoon floatation support according to claim 1, wherein said holding means includes adhesive material between the inside surface of said tube and said foamed element.

5. The pontoon floatation support according to claim 4, wherein said adhesive material is provided for the full length of said tube.

6. The pontoon floatation support according to claim 4, including end caps secured to and closing the ends of said tube.

7. The pontoon floatation support according to claim 3, including end caps secured to and closing the ends of said tube.

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U.S. Cl. X.R.

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