United States Patent [19]

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[11] **3,760,439**

[45] **Sept. 25, 1973**

[54] **BOAT AND METHOD OF FORMING SAME**

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[22] Filed: **Aug. 31, 1971**

[21] Appl. No.: **176,518**

[52] **U.S. Cl.** **9/6**, 114/61, 114/123, 244/101

[51] **Int. Cl.** **B63b 3/08**

[58] **Field of Search** ..... 9/6, 2 R, 1 R; 114/61, 69, 123; 244/101

[56] **References Cited**

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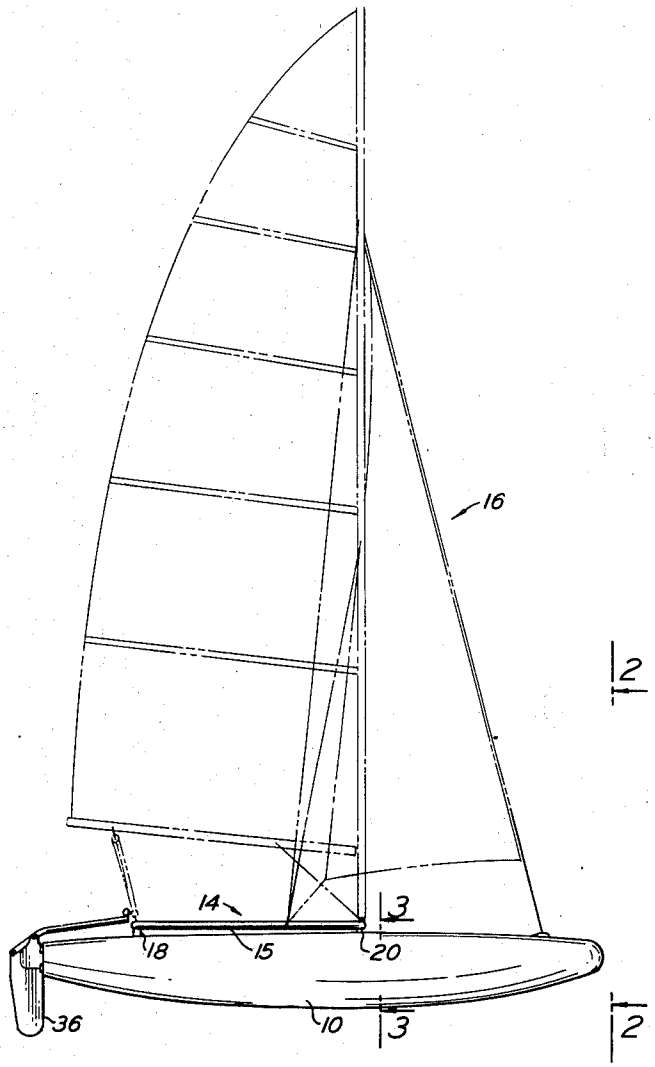
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Assistant Examiner—Carl A. Rutledge
Attorney—Robert J. Fay et al.

[57] **ABSTRACT**

The specification and drawings disclose a load bearing structure and method for forming the same. In particular, the drawings show a catamaran-type sailboat including a pair of hulls having thin aluminum outer skin. The rigging, sails and deck are supported from rigid frame or load distributing members positioned within the hulls and spaced from their outer skin. Plastic is foamed in place in the hulls and encloses the frame members. The plastic foam bonds the frame to the skin of the hulls and serves as the primary media for transmitting the reaction loads from the deck and sails.

5 Claims, 9 Drawing Figures



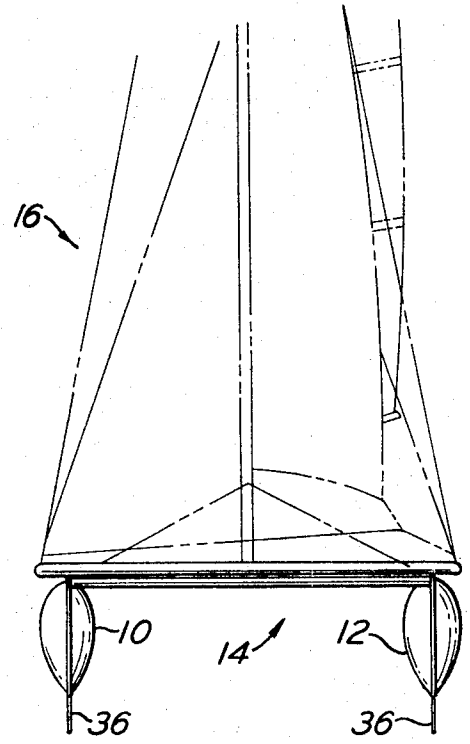


FIG. 2

FIG. 1

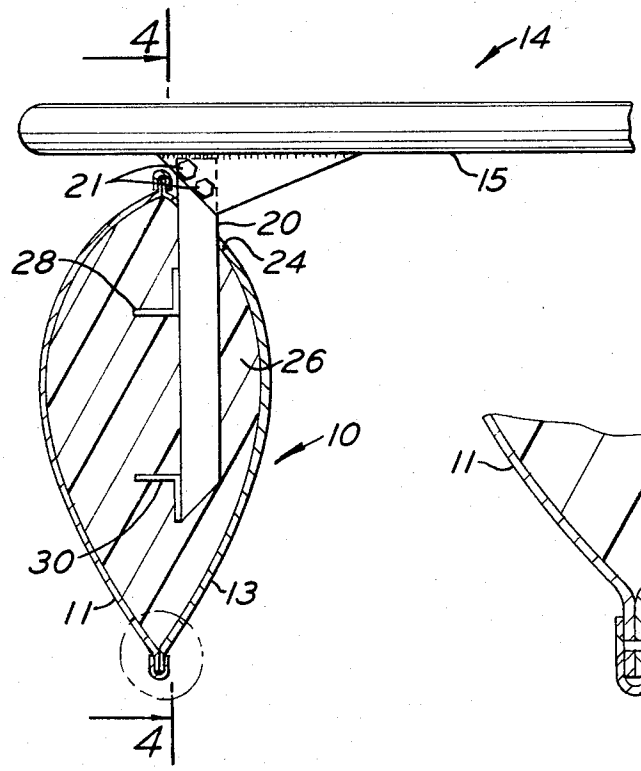
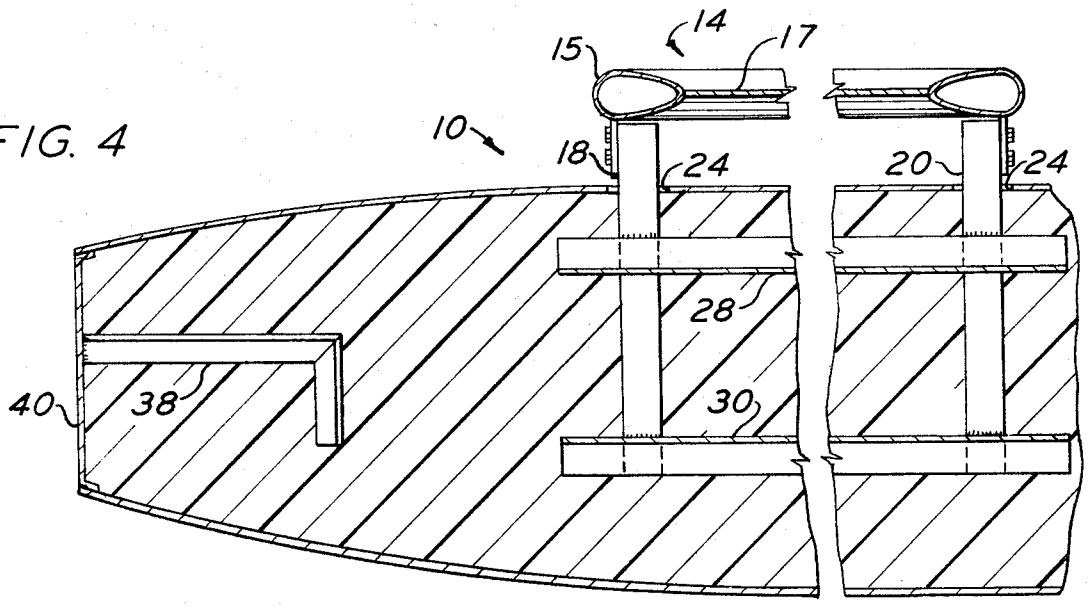


FIG. 3

FIG. 5

FIG. 4



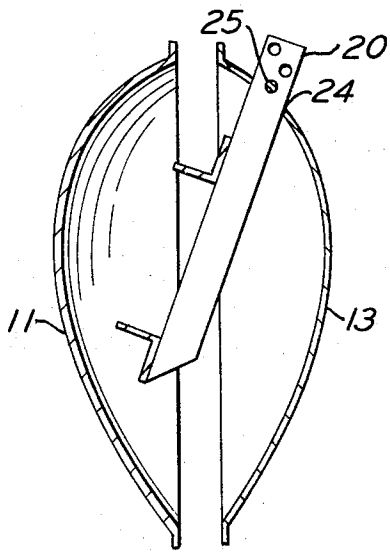


FIG. 6

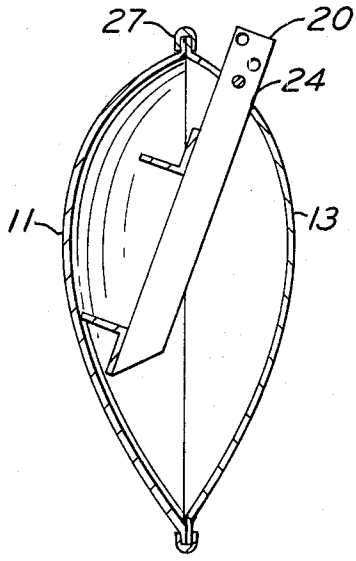


FIG. 7

FIG. 8

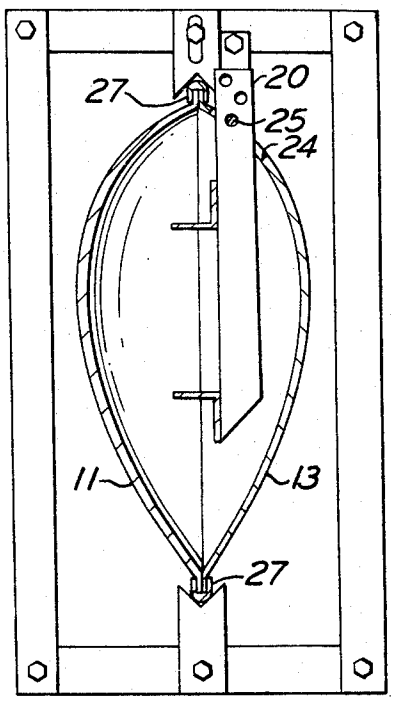
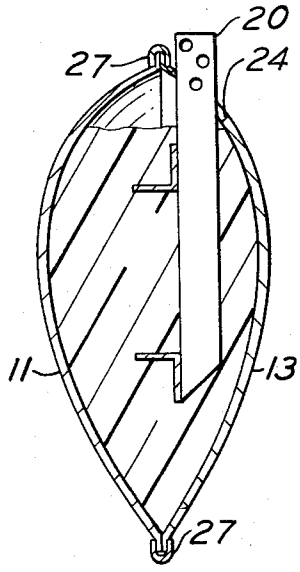


FIG. 9



BOAT AND METHOD OF FORMING SAME

The subject invention is directed toward an improved load bearing structure and a method of forming the same.

The invention is especially suited for forming and interconnecting lightweight boat hulls with their decks or load carrying components and will be particularly described with reference to its use in constructing a catamaran-type boat. As will become apparent, however, the invention is capable of much broader application and could be used for constructing many different types of structures.

As is well known, in the design of boats, it is particularly desirable that a high strength to weight ratio be achieved. This is accomplished through the use of lightweight materials, careful design and location of internal frames, thin sections where possible, and similar weight cutting techniques.

For example, it has been proposed to form hulls for catamaran sailboats consisting of a skin of relatively thin aluminum sheets. The thin skin alone can adequately resist the load imposed by the hydrostatic pressure due to bouyant forces, and wave reaction. Problems arise, however, in connecting the deck, sails, and rigging to the hulls in a manner which will not produce concentrated loads and high localized stress in the thin aluminum skins of the hulls. Obviously, the problem can be overcome by the use of internal frames in the hulls, load distributing plates, or pads, reinforcing plates and the like. These approaches, however, add substantial weight and greatly reduce any weight advantages obtained from the use of a thin aluminum skin. There are also problems inherent in economically joining relatively heavy reinforcement members or frames to a thin skin.

The subject invention provides a structure and method of forming the same which overcomes the above problems and permits thin walled elements or components to be connected to rigid elements imposing concentrated loads in a manner such that localized high stresses cannot be introduced in the thin walled components.

Broadly, one aspect of the invention contemplates a structure including a hollow structural member having a thin outer skin. A load supporting structural frame or load distributing member is positioned within the hollow member and spaced from the inner surface of the skin. Connected to the structural frame member is a rigid load transmitting member which extends outwardly through an opening in the skin. Preferably, all points of the load transmitting member are spaced from the periphery of the opening and foam plastic material surrounds the frame member. The plastic material is bonded to the frame member and the inner surface of the skin and constitutes the primary media for transferring loads between the frame member and the skin. The frame member may incorporate extended surface and openings to enhance bonding.

A more limited aspect of the invention contemplates that the hollow member forms the skin of a boat hull and that the skin is formed from thin sheet aluminum. Preferably, the hull comprises two separate elements which are joined such that they enclose the frame member throughout its entire length.

Typically, the load transmitting members support the boat deck and/or sails. As a consequence, the concentrated loads imparted from these members are distributed relatively uniformly through the internal foam to the skin of the hull or hulls. Thus, none of the loads are concentrated at any point in the thin aluminum skin.

Accordingly, a primary object of the invention is the provision of a method and apparatus of the general type described wherein high load imposing elements can be interconnected with elements or members having thin outer skins without imposing high localized forces on the skins.

Yet another object is the provision of a method which can be used for constructing thin aluminum skin boat hulls and the like and connecting them to their decks, riggings, and other force imposing components.

The above and other objects and advantages will become apparent from the following description when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevation of a catamaran-type boat which embodies the invention;

FIG. 2 is a view taken on line 2—2 of FIG. 1;

FIG. 3 is a view taken on line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view taken on line 4—4 of FIG. 3; comprising 29

FIG. 5 is an enlarged view of the circled areas of FIG. 3; and,

FIGS. 6 through 9 are cross-sectional views similar to FIG. 3 but showing the sequence of operations performed during assembly of the hull and deck frame structure.

Referring more particularly to FIGS. 1 and 2 of the drawings, there is illustrated a catamaran comprising a pair of spaced hulls 10 and 12 which carry a deck structure 14 and the sail and rigging assembly 16. The details of the rigging and said structures 16 form no part of the subject invention and are illustrated merely for purposes of clarity.

Broadly, each of the hull structures 10 and 12 are identical in construction and only hull 10 will be described in detail. The description of hull 10 is to be taken as equally applicable to hull 12 unless otherwise noted. Broadly, hull 10 is shown as comprising mating half shells 11 and 13 formed from relatively thin sheet material such as aluminum. The half shells are joined about their mating edges in a manner to be described to form hollow, elongated hulls.

In the embodiment shown, the two hulls 10 and 12 are joined by the deck and frame assembly 14 which carries the weight of the mast and rigging structure together with the crew. The deck structure 14 is shown as comprising a generally rectangular frame 15 (see FIGS. 1 and 4) formed from aluminum tubes or the like and carried from pairs of support members 18 and 20 which extend upwardly from the hulls. A trampoline-type deck 17 of canvas or the like is connected within the rectangular frame. Preferably, the frame 15 is releasably connected to the supports 18, 20 such as by bolts 21.

The mast is carried from the frame and the reaction forces exerted by the sail together with the weight of the crew is, of course, substantial. In order that the boat can be of relatively low weight, the hull skins should be made from material as thin and light as possible and with a minimum of internal and external frame structures. As can be appreciated, if the deck structure is directly connected to the hulls 10 and 12, substantial localized forces and stresses are present in the thin skins

of the hull. Because of the high forces, substantial internal reinforcing is required or, alternately, heavy external reinforcing plates would be required on the hulls. Otherwise, the thin hull skins could be subjected to fatigue cracking or outright local buckling.

Because of the interest in relatively low weight for a sailing-type craft, this general solution is unsatisfactory and truly thin skinned, lightweight, high strength aluminum or thin plastic hulls have not previously been available. The subject invention overcomes the above problems and allows an extremely lightweight, aluminum hull to be provided and interconnected with the deck and rigging structure in a manner which eliminates any localized loading of the aluminum hull skin and does not require internal or external framework or strengthening plates.

FIGS. 3 and 4 best show the preferred manner by which the support members **18** and **20** are supported from, and connected to, the hulls. As shown, the supports **18** and **20** extend from the interior of the hulls outwardly through openings **24** formed in the outer aluminum sheet metal skin. Preferably, the supports are not engaged with or positively connected to the aluminum skin of the hulls except indirectly in a manner subsequently to be described. It will be noted that substantially the entire interior of the hulls **10** and **12** are filled with a foamed-in-place plastic foam **26** which completely surrounds the support members **18** and **20.** Additionally, the support members **18** and **20** are provided with horizontally extending angle members **28** and **30** which are positively joined to the support members in any convenient manner such as by welding or the like. The members **28** and **30** are similarly enclosed within the foam plastic **26** and serve as load spreaders to distribute the load forces applied to the support members **18** and **20** throughout a substantial area of the plastic foam.

The size of the internal frame members **28** and **30** can vary widely but depends, in part, upon the load which will be carried by the support members **18** and **20,** as well as the load carrying or crushing strength of the foam **26.** In any event, the members should have substantial horizontal and vertical extent so that they can resist application of forces in any direction and distribute them throughout a substantial area of foam. The preferred method of assembling the structure described will be explained; however, for the present, it is important to note that all of the load applied to the support members **18** and **20** is distributed through the internal foam and none applied directly to the aluminum skin. Thus, there can be no localized high stress points in the aluminum skin.

The particular type of foam used could vary but, in the subject embodiment, a conventional polyurethene resin foamed in place with Freon **11** is preferred. This type of resin can be mixed with various amounts of Freon **11** to produce a foam having a density of from 1 to 10 lbs. per ft^3. Similarly, its crushing strength will vary from 50 to 100 lbs. per $in.^2$. The use of Freon **11** is preferred because when used in low density proportion, its refrigerating effect delays setting and enhances foam distribution via resin flow before setting.

The same general approach as that described above can be used at other points in the structure. For example, referring to FIG. **1,** it will be seen that each of the hulls **10** and **12** include a rudder assembly **36** which is pivotally mounted to the stern of each respective hull. As a consequence, the stern is subjected to comparatively high loading. In order to allow the stern to be made relatively lightweight and without introducing high loading or stressing of the hull skin, a force or load distributing member **38** is welded generally centrally of the stern forming member **40.** Member **38** has both horizontal and vertical extents of substantial area so that loads applied to the stern member **40** are distributed through a substantial section of the plastic foam without requiring the outer aluminum skin of the hulls to carry any sizable localized load. It should be understood that the stern member **40** can be directly connected to the hull forming skins or separate therefrom. In the subject embodiment, it is preferably riveted about its periphery to the skins and sealed therewith through the use of epoxy resin or the like.

By the use of the subject arrangement, the skin of the hulls carries substantially no load at any localized point and the forces are distributed uniformly to the skin through the interior foam. The foam thus, serves as an integral structural element of the hulls and bonds the supporting deck framework and the hull skins into a rigid unit. Moreover, the foam assures that even if the aluminum skin of the hulls is ruptured, the boat retains its flotation characteristics.

As can be appreciated, the described structure could be assembled in many different ways. The preferred form, however, is best illustrated by reference to FIGS. **5** through **9.** FIG. **6** shows the start of the process with the two hull forming half shells **11** and **13** separated. Thereafter, the internal support frame structure is loosely positioned within half shell **13** with the supports **18** and **20** extending outwardly through openings **24** formed therein. The frame is temporarily supported in the half shell such as by a removable pin or bolts **29** extending through the support members and resting on the outer surface of the half shell. Thereafter, as shown in FIGS. **5** and **7,** the two half shells are sealingly joined along their mating flanges. Preferably, the flanges are sealed by the application of an epoxy resin glue to their mating surfaces and riveting. Also, a U-shaped stainless steel strip **27** is preferably driven down over the flanges and riveted. This provides additional strength for the joint and gives a wear surface for the edge of the hulls.

After the hull sections have been joined and sealed, the hull and the deck supporting frames are located in their proper relationship and clamped in a temporary frame, such as shown in FIG. **8.**

With the hull shell and frame in proper orientation, foamed-in-place plastic resin is poured into the shell. Preferable, the shells should be substantially filled; however, at least a sufficient amount should be placed in the shell to enclose the internal members **28, 30,** and **38,** as shown in FIG. **9.**

Although not discussed above, it should be appreciated that the internal surfaces of the hull shells and the surfaces of the internal frame can be primed to increase the adhesion of the foam plastic in accordance with accepted practice in bonding foam plastic and metal surfaces.

The invention has been described in great detail sufficient to enable one of ordinary skill in the art to make and use the same. Obviously, modifications and alterations of the preferred embodiment will occur to others upon a reading and understanding of the specification and it is my intention to include all such modifications

and alterations as part of my invention insofar as they come within the scope of the appended claims.

What is claimed is:

1. A boat comprising:

at least one elongated, hollow hull formed with relatively thin sheet metal walls;

at least one elongated, rigid structural frame member positioned within said hull and extending generally longitudinally thereof, said structural frame member having substantial lognitudinal and lateral extent and at all points spaced from the walls of said hull;

at least one deck support member rigidly connected to said structural frame member and extending laterally outwardly through an opening formed in the walls of said hull;

a deck connected to and supported by said deck support member at a location exteriorly of said hull;

foam plastic material enclosing said structural frame member and extending between said structural frame member and the walls of said hull, and substantially filling said hull and constituting the sole media for effectively transmitting forces between said hull and said structural frame member; and,

the periphery of the opening in said hull through which said deck support member passes being spaced from said deck support member with no rigid mechanical connections therebetween, whereby movements of said deck support member relative to said hull will not result in localized flexure of said hull.

2. The boat as defined in claim 1 including at least two of said deck supporting frame members extending into said hull.

3. The boat as defined in claim 2 wherein each of said deck supporting frame members are rigidly connected to said structural frame member.

4. The boat as defined in claim 1 including a transom member which forms a portion of the hull and a relatively rigid structural member connected to said transom and extending into said foam plastic.

5. The boat as defined in claim 1 wherein said hull is formed from sheet aluminum.

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