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Davidson et al.

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[54] **BOAT STRUCTURE**

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[52] U.S. Cl. **9/6,** 9/7, 114/88

[51] **Int. Cl.** **B63b 3/09,** B63b 3/16

[58] **Field of Search** 9/6, 7; 114/88, 219; 52/573

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[57] **ABSTRACT**

A composite boat structure comprising a hull and a liner fitting therewithin, wherein the hull and liner are formed primarily of materials having substantially different coefficients of thermal expansion, such as, aluminum and ABS plastic, respectively. The hull and liner are secured to each other by means which permit relative movement between the elements in response to differences in expansion and contraction resulting from temperature differentials.

12 Claims, 6 Drawing Figures

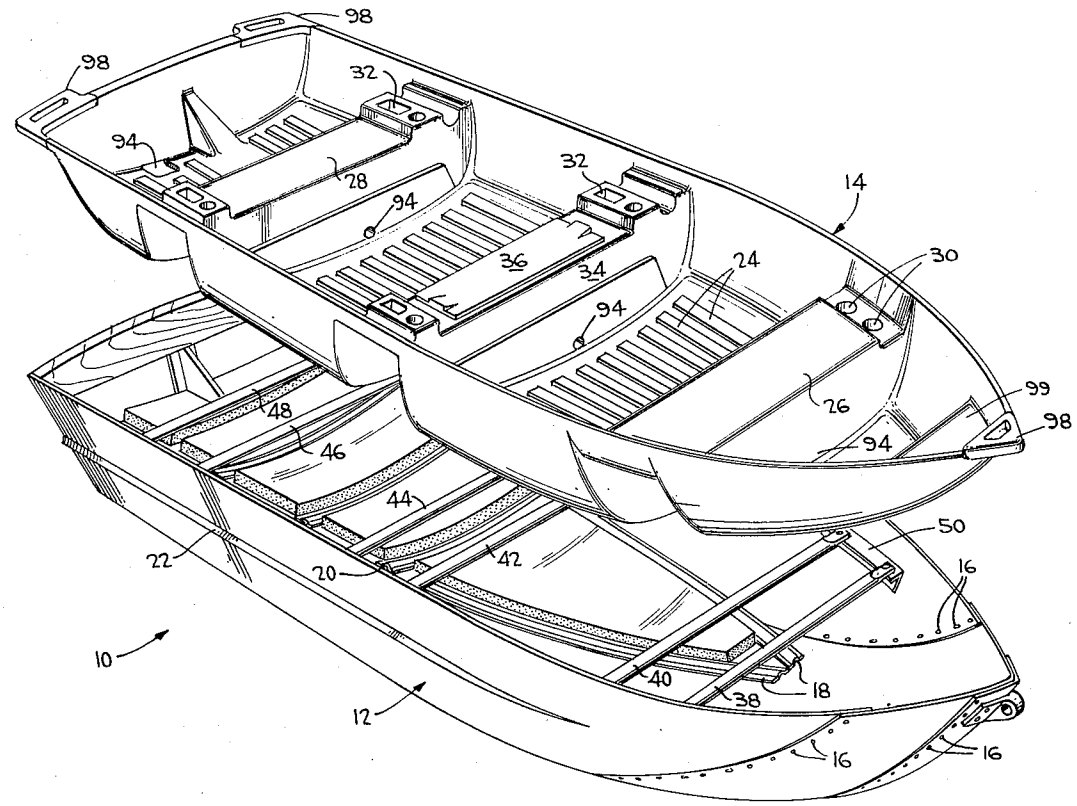
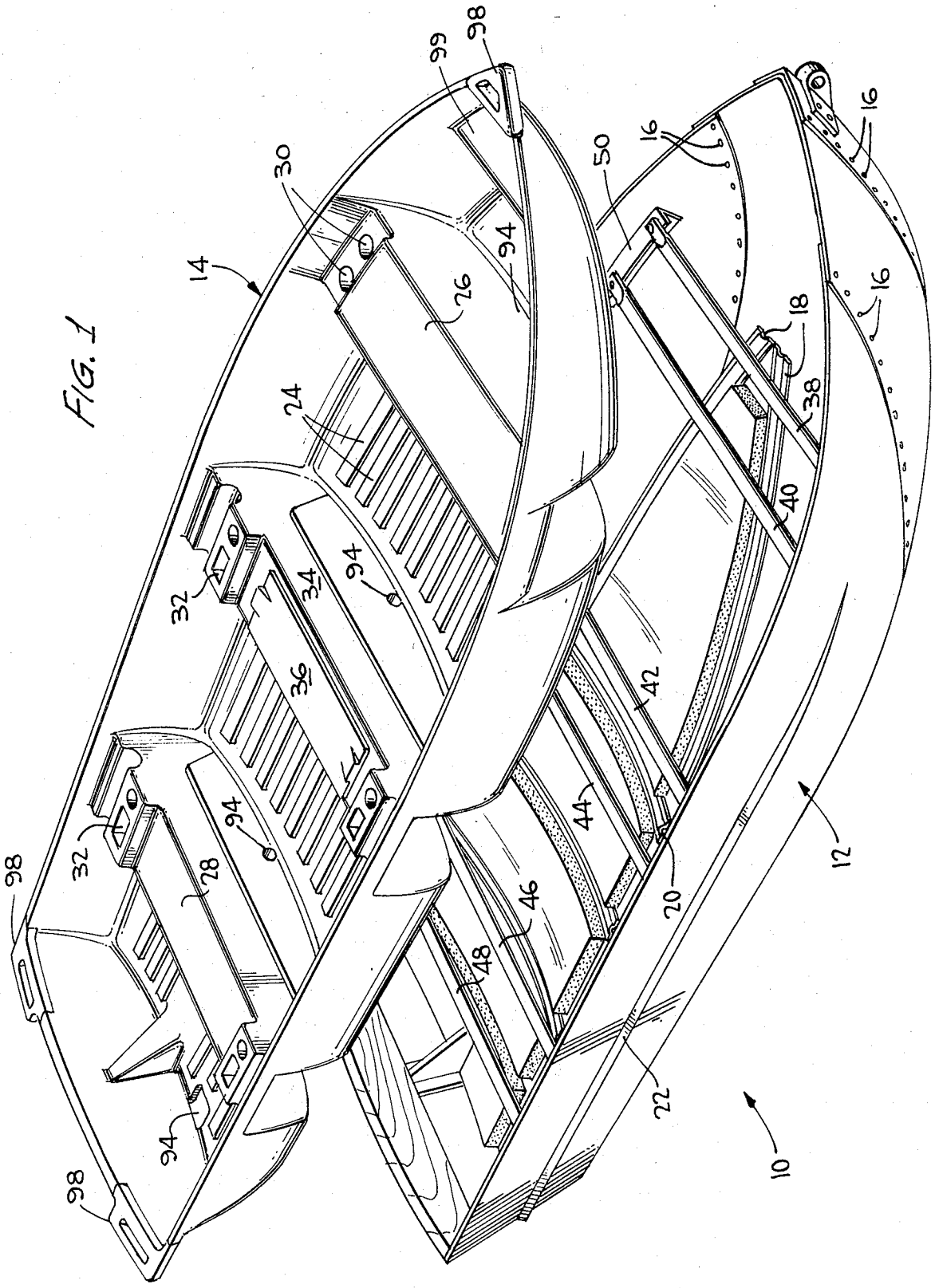


FIG. 1



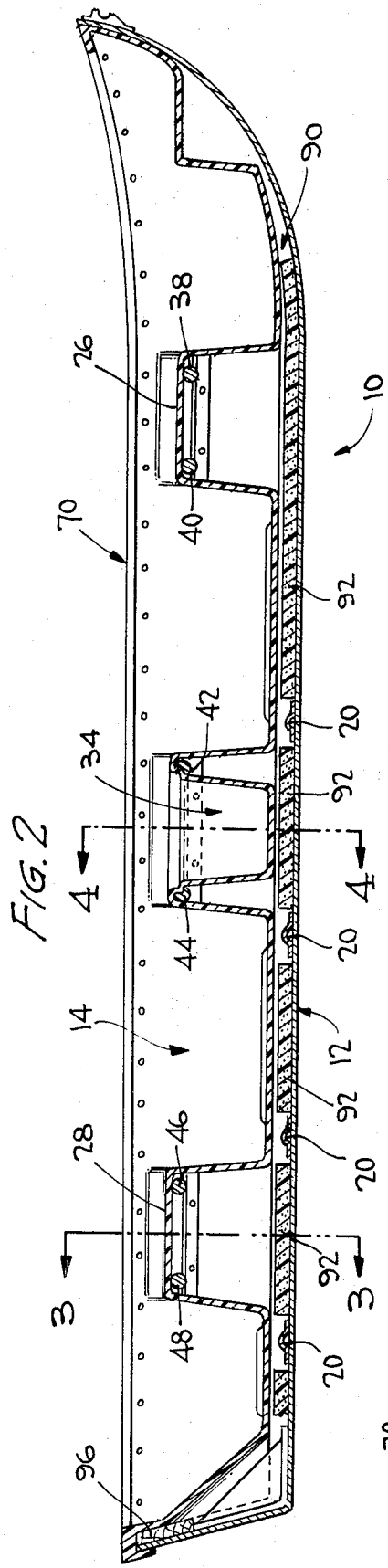


FIG. 2

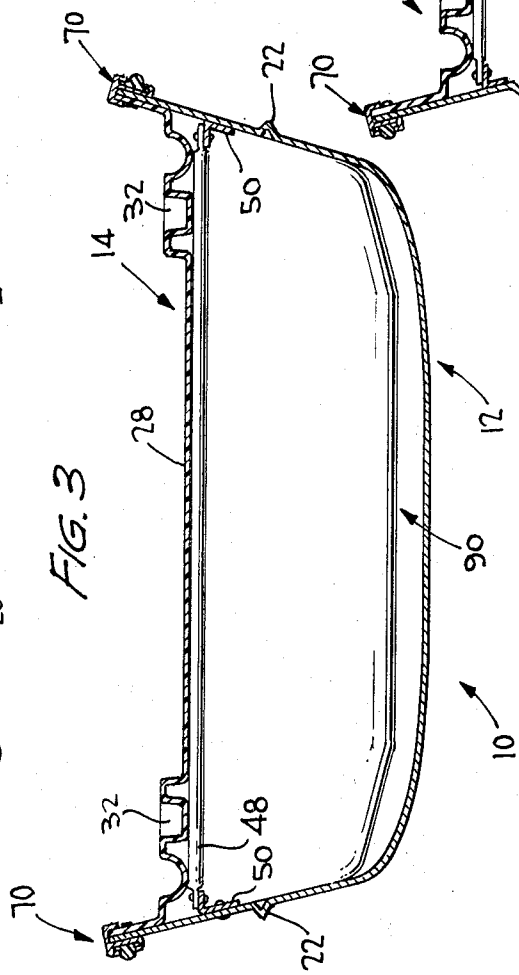


FIG. 3

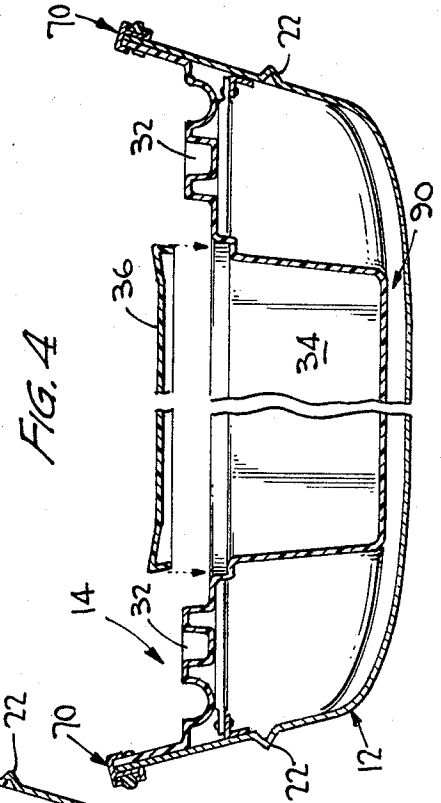


FIG. 4

FIG. 5

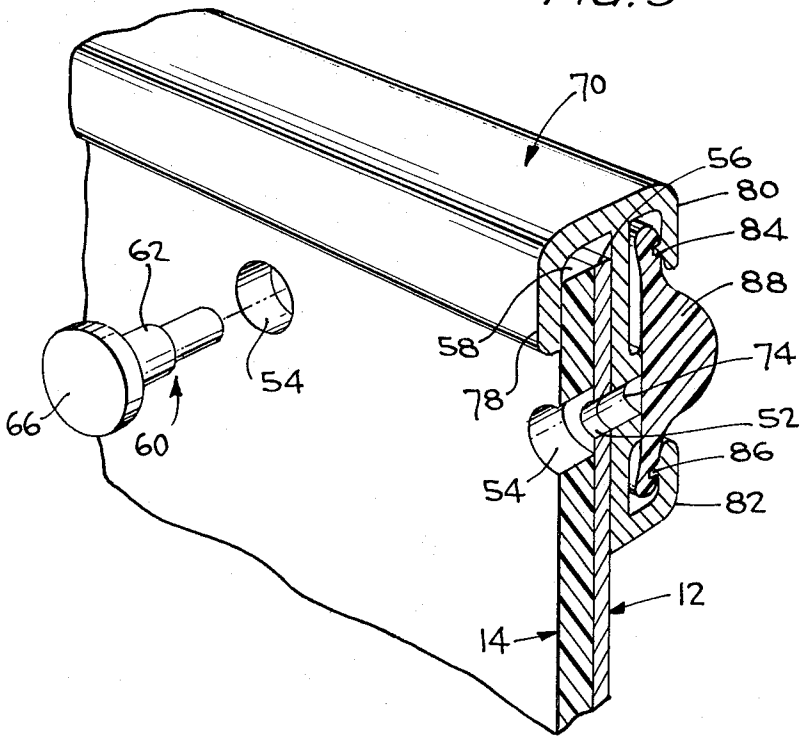
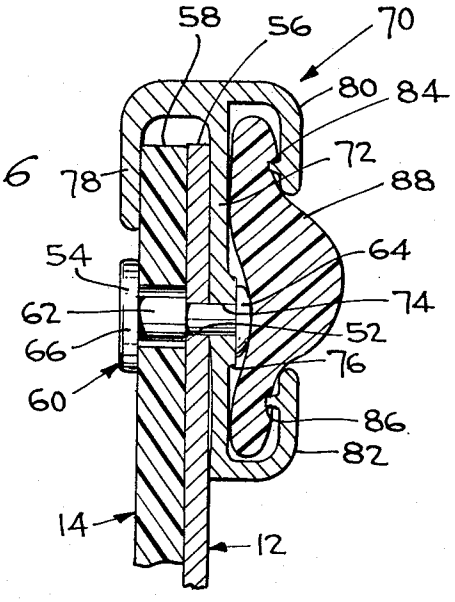

70
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FIG. 6


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BOAT STRUCTURE

This invention relates to a boat construction and relates more particularly to a composite boat formed of a hull and a liner which fits within the hull, with the means connecting the two permitting relative movement therebetween in response to differences in expansion and contraction resulting from the different coefficients of thermal expansion of the materials from which the hull and liner are formed.

Many small boats, such as flat-bottomed boats and the like are presently made from aluminum sheet material, the aluminum being die-cut and formed to the desired shape, and then separate sections being riveted together to produce the final product. Such boats are quite sturdy, but frequently have rough edges and multiple crevices inside, producing places which can snag clothes, catch fish hooks, trap debris, and the like. Also, it is extremely expensive with an aluminum boat to provide for various interior structures such as ice chests, glass supports and the like. In general, the ability to provide an aluminum boat with a highly aesthetic and functional finish has heretofore been impractical.

Such boats have also been made from fiberglass which is strong but relatively expensive, and comparatively, quite heavy. Fiberglass boats can be produced attractively but the weight and price limit the market.

More recently, small boats of this type have been made from molded plastic elements, frequently utilizing separate hull and inner structural elements with a flotation compartment therebetween filled with a flotation material such as polyurethane foamed in situ. Such boats are quite attractive initially, but suffer from various disadvantages. The plastic sheet used for both inner and outer structural components must be relatively thick to provide the required strength and to withstand the normal shocks encountered in use. For example, if the hull is subjected to a sharp impact it might crack, rather than merely denting as would result in an aluminum hull. The extremely high thermal coefficient of the plastic materials commonly used in the manufacture of such boats, such as acrylonitrile-butadiene-styrene (ABS) resins and the like produce a great deal of stress and the post-expansion of the foam material caused by subjection to sunlight or hot locations during shipping or storage produces bubbles, resulting in blistering of the hull or liner at weak spots. Thus, with aluminum boats or fiberglass boats, there are relatively few rejects, but presently available plastic boats have excessive reject rates.

From the foregoing, it will be seen that there are various advantages and disadvantages to each type of boat presently on the market. An aluminum hull is the most durable, merely denting on impact rather than cracking making leaks unlikely. Also, aluminum is quite light. Yet, the interior of most aluminum boats have some significant commercial drawbacks whereas a material such as ABS is quite desirable in that it is easily formed into a variety of intricate shapes, aesthetically attractive and avoids the difficult and relatively expensive manufacturing techniques necessary with fiberglass. Heretofore, however, it has not been possible to produce a composite boat utilizing the advantages of each of these materials, while avoiding the disadvantages of both.

It is therefore, a primary object of this invention to produce a boat structure formed from a hull and a liner

of materials having significantly different coefficients of thermal expansion enabling the use of a metal, such as aluminum, exterior and a plastic, such as ABS, interior. The thermal coefficient of expansion of aluminum is quite low when compared with the thermal coefficient of expansion of most plastic materials such as ABS, high impact polystyrene, polyethylene, polypropylene or the like, all of which may be used according to the instant inventive concepts, although ABS is the preferred liner material. It is not uncommon for a boat to be subjected to temperatures ranging from −20°F to as much as +120°F in storage, shipping and use. Moreover, different portions of the boat may be subjected to different temperatures at the same time, such as when the hull experiences the relatively cool water and the liner experiences the heat from the sun. The instant inventive concepts provide a composite structure wherein the elements are permitted to move relative to each other, enabling the liner to effectively "float" relative to the hull avoiding the buckling or shearing of the liner that would result from a rigid fastening between these elements.

A further object of this invention is to provide a boat which utilizes an aluminum hull as a self-supporting, rigid element with an ABS liner provided primarily for aesthetic purposes, requiring relatively little structural strength in the liner, even enabling the use of thinner sheets of plastic material than have been used heretofore in the production of all-plastic boats.

Yet a further object of this invention is the provision of a metal-plastic composite boat structure wherein the compartment formed between these elements is filled with discrete elements of flotation material, such as blocks or sheets of pre-foamed polystyrene or polyurethane so as to enable free movement of the hull and liner relative to each other, and simultaneously providing spaces in the flotation compartment through which water from the liner can be drained to provide the ability to keep the interior of the boat dry.

The foregoing objects are particularly difficult to realize due to the size and lack of symmetry in an ordinary boat construction, resulting in relatively large distortions caused by differences in thermal expansion, but the instant inventive concepts will be seen to overcome these difficulties and produce a highly commercial, aesthetically attractive and functionally desirable boat construction.

Other objects of this invention will in part be obvious, and in part be pointed out, as the description of the invention proceeds and as seen in the accompanying drawings wherein:

FIG. 1 is an exploded view of a hull and liner therefor according to the instant inventive concepts;

FIG. 2 is a longitudinal cross-sectional view through the assembled hull and liner;

FIG. 3 is a transverse cross-sectional view taken substantially along lines 3—3 of FIG. 2;

FIG. 4 is a transverse cross-sectional view taken substantially along lines 4—4 of FIG. 2;

FIG. 5 is an enlarged fragmentary, partially exploded view showing the means for securing the hull and liner to each other while permitting relative movement between these elements; and

FIG. 6 is a cross-sectional view through the elements shown in FIG. 5.

Like reference characters refer to like parts throughout the several views of the drawings.

The basic inventive concepts of this invention are directed to the production of a boat structure from a hull and liner of any two materials having significantly different thermal coefficients of expansion that would cause a problem if the materials were rigidly affixed to each other. From a practical standpoint, the hull will ordinarily be made of a metal material, specifically aluminum, and the liner will ordinarily be made of a plastic material, a number of which have been mentioned hereinabove, although ABS resins have been found to be most suitable. For this reason, the remaining discussion will be directed to the production of an aluminum-ABS boat, although it is to be understood that other materials could be substituted therefor without departing from the instant inventive concepts. yet, particular advantages are realized with the use of an aluminum hull and a plastic liner, and most particularly an ABS liner.

Reference is now made to the drawings, and more particularly to FIGS. **1–4,** wherein a boat structure according to the instant inventive concepts is designated generally by the reference numeral **10** and comprises basically an aluminum hull **12** and an ABS liner **14.**

The hull **12** is formed of aluminum sheet material, die-cut, formed and secured together by rivets **16** and the like in any conventional manner. The details, shape and size of the hull and liner are not critical to the instant inventive concepts, except as pointed out hereafter, so that it will be seen that the particular design shown in the drawings is merely illustrative. It is common with such aluminum hulls to provide longitudinally and transversely extending floor braces such as shown, for example, at **18** and **20** as well as corrugations or strakes, shown illustratively at **22,** to reinforce the basic structure.

The ABS liner **14** is preferably vacuum formed from a single sheet of material according to well known techniques and, due to the particular construction of this invention, may be formed from sheet material of a thickness as little as 3/16 of an inch without detrimentally affecting its functional characteristics. Due to the highly moldable nature of such plastic materials, the liner can be readily provided with intricate functional and decorative configurations such as decking ribs **24,** front and rear seats **26, 28,** a bow seat **99,** glass holders **30,** small depressions **32,** an ice chest or live well **34** and the like. A separate and removable cover such as shown at **36** may be provided for the ice chest **34.**

Bracing means in the form of a plurality of longitudinally spaced, transversely extending, aluminum bars **38, 40, 42, 44, 46** and **48** preferably span the aluminum hull and are secured at their opposite ends as by angular elements **50** and rivets or the like to the hull to further rigidify the hull and simultaneously to provide a support for the seats **26, 28** and the ice chest **34** of the liner **14** effectively permitting the liner to rest on these rods so that the liner itself is not a structural component and need not be particularly strong. Yet, the fact that the liner **14** merely rests upon, and is not rigidly secured to, the bracing means, enables the liner to "float" or move slightly relative to the hull due to differences in expansion caused by the variation in the thermal coefficients between the materials from which these elements are made.

However, it is obvious that the elements must be secured to each other in some manner in order to produce the final assembly. Yet, if the securing means were rigid the difficulties pointed out hereinbefore would render the boat construction useless. Reference is now particularly made to FIGS. **5** and **6** for details of the means by which these elements may be secured to each other for all intents and purposes, while still permitting sufficient relative movement to preclude difficulty caused by the differences in thermal expansion of the materials. The securing means is provided by a multiplicity of spaced pairs of aligned apertures **52, 54** defined in the hull and liner, respectively, adjacent to the peripheral edge portions **56, 58** of the hull and liner, with securing elements **60** having shank portions **62** passing through each pair of aligned apertures **52, 54** and head portions **64, 66** on opposite ends of the shank portions **62.** The size of the apertures **54** in the liner **14** is larger than the diameter of the shank portions **62** of the securing elements **60,** this differential in size permitting the liner to move relative to the hull without shearing or tearing the liner material due to the stresses that would otherwise be caused. The amount of oversize provided to the apertures **54** depends upon the relative movement that must be accommodated, but it has been found convenient to use an aperture approximately 1½ times the size of the shank portion diameter with the materials specified hereinabove. Of course, the head portions **66** of the securing elements, which are preferably rivets, should be sufficiently large to cover the apertures **54** in the final assembly.

Preferably, an extruded aluminum gunwale designated generally by the reference numeral **70** covers the peripheral edge portions **56, 58** of the hull and liner. The gunwale **70,** as shown in FIGS. **5** and **6** particularly, has a central web **72** formed with an aperture **74** through which the shank portion **62** of the securing means **60** passes, with a boss **76** supporting the head portion **64** of the securing means **60.** Integral with the upper edge of the central web **72** is an inwardly and downwardly extending flange **78** covering the peripheral edge portions **56, 58** of the hull and liner. Additionally, there is an integral outwardly and downwardly extending flange **80** and an integral outwardly and upwardly extending flange **82** secured to opposite ends of the central web **72** with ribs **84, 86** utilized to secure a resilient plastic trim element **88** slid along the length of the gunwale.

In this manner, the elements are secured to each other with the ability of relative movement therebetween, while still providing an aesthetically attractive assembly.

The hull **12** and liner **14** define between them a flotation compartment **90** which will be seen particularly in FIGS. **2–4.** In this flotation compartment discrete elements **92** of flotation material, such as blocks or slabs or pre-expanded polystyrene or polyurethane are provided. These elements may be cut to any desired shape and as much flotation may be provided as is necessary for the particular boat. While it is possible to provide a flotation material expanded in situ, the use of discrete elements has several advantages. First of all since such elements are pre-expanded, difficulties with post-expansion bubbles are precluded. Moreover, with such discrete elements, spaces may be provided between the elements so that any water within the liner **14** may pass through drainage openings **94** and along the length of the hull to escape from the boat through a drainage plug (not shown).

The flotation material may be secured as by an adhesive to the hull or may be loosely carried therewithin. The other advantage in utilizing discrete elements of pre-expanded flotation material results from the fact that such material is not secured to both the hull and the liner, again enabling the liner to "float" freely for relative movement between the elements under conditions of thermal differential.

A wooden transom element is shown at **96** at the stern to assist in supporting an outboard motor (not shown) as is conventional.

Other conventional elements, such as the molded plastic eyes **98** and the like may be provided as desired.

The hull and liner will be designated herein as being formed "primarily" of aluminum and ABS, respectively, although each element may have small portions formed of different materials or may have secured thereto extraneous items of different materials for special purposes. For example, while the liner is formed primarily of plastic it is shown as carrying the wooden transom element **96.** Additionally, metal inserts (not shown) such as bearings for oar locks or the like may be used if desired. Moreover, the ABS sheet is preferably coated with an acrylic coating of the type conventionally used to protect the ABS from the destructive ultra violet rays of the sun. Similarly, although the hull is formed primarily of metal, minor plastic or other items may be incorporated for decoration or particular functional purposes without departing from the instant inventive concepts. However, it will be readily recognized that the hull and liner may be considered for purposes of this invention as formed of metal and plastic, respectively, notwithstanding such minor departures therefrom.

It will now be seen that there is herein provided an improved boat construction which enables the provision of a boat having all of the advantages of an aluminum hull and a plastic liner, with none of the disadvantages of either. The construction disclosed herein satisfies all of the objectives of the instant invention as set forth above, and others, including many advantages of great practical utility and commercial importance.

What is claimed is:

1. A boat construction comprising, in combination, a hull and a liner therefore each of which has upstanding side wall portions, said liner being smaller than, and having at least a major portion of its side walls fitting within said side walls of said hull, said hull and said liner being formed primarily of materials having different coefficients of thermal expansion, bracing means carried by said side walls of said hull and spanning said hull and supporting at least portions of said liner intermediate said side walls of said liner while permitting said liner to move relative to said hull in response to differences in expansion and contraction resulting from temperature differentials, and connecting means securing portions of said side walls of said liner and said hull, said connecting means also permitting said hull and said liner to move relative to each other in response to differences in expansion and contraction resulting from temperature differentials.

2. The boat of claim **1** wherein said hull is formed primarily of aluminum and said liner is formed of plastic.

3. The boat of claim **2** wherein said plastic is an acrylonitrile-butadiene-styrene resin.

4. The boat of claim **2** wherein said hull and said liner each have peripheral edge portions, said peripheral edge portions of said liner fitting closely within said peripheral edge portions of said hull, said connecting means comprising spaced pairs of aligned apertures in said hull and said liner adjacent to said peripheral edge portions, and securing elements having shank portions passing through each pair of aligned apertures and head portions on opposite ends of said shank portions, the apertures in one of said hull and said liner being larger than the shank portions of said securing elements to permit said hull and said liner to move relative to each other.

5. The boat of claim **4** wherein said securing elements are rivets.

6. The boat of claim **4** wherein the apertures in said liner are approximately 1½ times as large as the diameter of said shank portions of said securing elements.

7. The boat of claim **4** further including a gunwale means covering said peripheral edge portions of said hull and said liner.

8. The boat of claim **2** wherein said hull and said liner define a flotation compartment therebetween, and flotation means contained within said flotation compartment, said flotation means being secured to no more than one of said hull and said liner.

9. The boat of claim **8** wherein said flotation means comprises discrete elements of flotation material with spaces therebetween.

10. The boat of claim **9** further including drainage apertures defined in said liner to permit water in said liner to flow into said flotation compartment.

11. The boat of claim **2** wherein said bracing means extending laterally between opposed sides of said hull.

12. A boat construction comprising in combination a hull formed primarily of aluminum and a liner therefor formed primarily of plastic, said liner being smaller than, and having at least a major portion thereof fitting within said hull, said hull and liner being formed primarily of materials, having substantially different coefficients of thermal expansion, and means securing said liner to said hull while permitting said hull and said liner to move relative to each other in response to differences in expansion and contraction resulting from temperature differentials, bracing means extending laterally between opposed sides of said hull, said liner including portions supported by said bracing means, said bracing means comprising a plurality of longitudinally spaced, transversely extending aluminum bars secured at their opposite ends to the sides of said hull below the peripheral edge portions of said hull, said portions of said liner supported by said bracing means including portions defining seats for said boat.

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