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FLOTATION HULL

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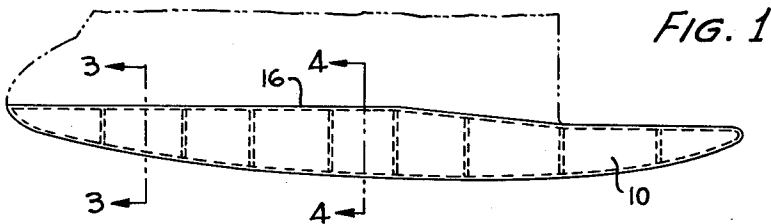


FIG. 1

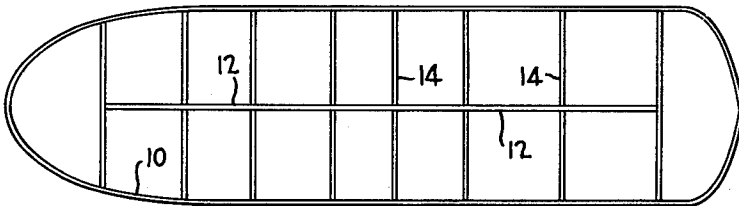


FIG. 2

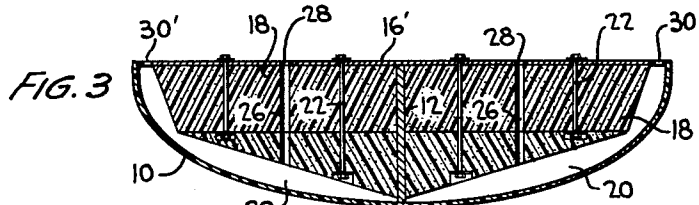


FIG. 3

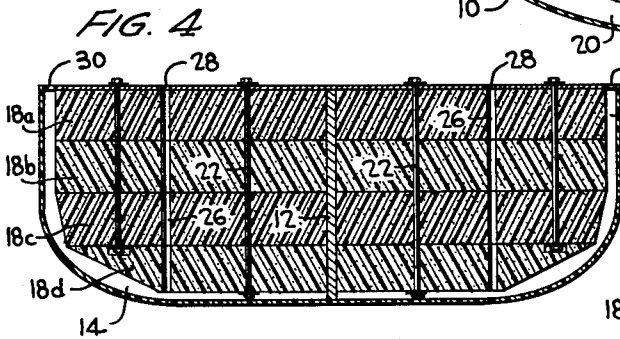


FIG. 4

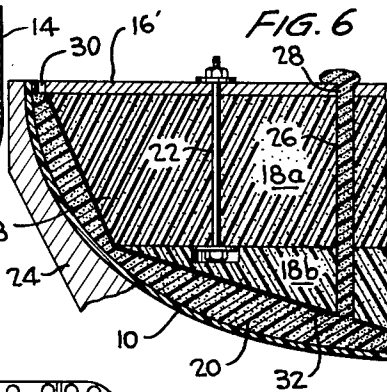


FIG. 5

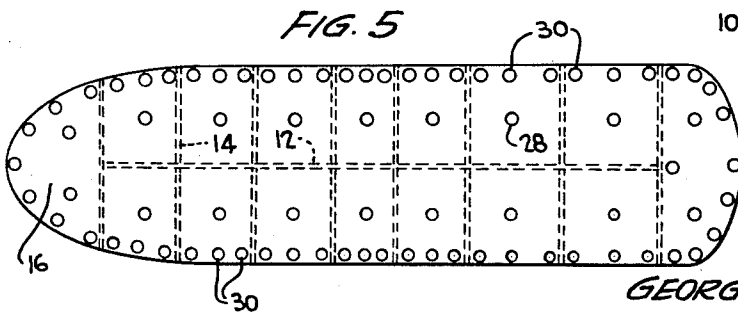


FIG. 6

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FLOTATION HULL

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3 Claims. (Cl. 9-6)

This invention relates to improvements in generally light weight rigid flotation hulls particularly adapted for use in connection with sea planes, amphibious aircraft and the like in which the hulls are filled with and reinforced by a unicellular plastic foam adapted to prevent the entry of water into the hull in case of damage and thereby to eliminate the necessity for providing excess buoyancy for flotation in case of partial flooding, as is necessary in hulls having hollow flotation compartments.

The improvements relate both to such a hull and to an improved process of forming the same.

It has heretofore been known to provide a flotation hull in which the various compartments between the bulkheads or ribs have been substantially completely filled with a plastic unicellular foam either of the foam in place type or the type which is formed by being built-up from blocks or slabs of plastic foam material. In either event, however, it has been customary to apply the foam to a completed hull structure in which the various bulkheads or ribs and the skin of the hull have been assembled as a unit prior to the placing of the plastic foam therein. Where the foam is then applied in the form of low density blocks of plastic foam built-up to form the desired filling within the hull, such low density composite filling is incapable of supplying the desired toughness and rigidity immediately adjacent the skin of the hull and furthermore, the process is not well adapted to mass production and assembly methods. On the other hand, where the flotation compartments have been completely filled with liquid foam plastic materials of a nature resulting when cured in a unicellular plastic structure, it has been quite difficult to fabricate such sections because of the large volume and height to which the foam must rise. Accordingly, for providing such foamed in place flotation compartment fillings it has been necessary to use high density foams to achieve the desired homogeneity and strength with the result that it has not been found practical to achieve the degree of lightness of structure originally hoped for.

With the foregoing in mind, one of the objects of the invention is to achieve a new strong and yet light flotation hull construction which is adapted to mass production and assembly methods and yet which will permit the formation or disposition within the flotation compartments of fillings or cores of unicellular plastic of comparatively low density, spaced somewhat from the hull, and in which the resulting spaces are occupied by monolithic slabs of relatively higher density foam adapted to be applied by foaming in place techniques.

It is a further object to provide such a flotation hull construction in which the rigid frame work such as may be comprised by the keel and the ribs or bulkheads, may be preassembled as a unit together with the inner core structure for subsequent application to a separately formed skin or outer shell of the hull.

The novel process of forming the hull structure consists in forming an inner core of substantially uniform low density plastic foam blocks having a rigid frame embedded therein, with portions of the frame projecting outwardly from the foam body of the core; placing said core within a generally similarly shaped but larger hollow shell or skin adapted to engage the projecting frame portions, supporting the core in spaced relation from the

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sides and bottom of the shell by means of these projecting portions and then filling the spaces between the inner core and the shell with a liquid or flowable composition for forming a unicellular plastic foam of greater density than that of the foam core sections. The flowable composition is then cured and bonded to the skin and the projecting portions of the rigid frame.

In order to facilitate the carrying out of the process, the hull shell or skin may advantageously be formed and supported within the cavity of a suitable mold or jig structure and the inner core and frame may be assembled on and temporarily secured to a rigid supporting plate shaped and adapted to function as the top or cover for the mold cavity. The resulting assemblage is formed with suitably disposed filler and vent openings extending through the cover plate to facilitate the pouring of the flowable foam forming composition into the spaces or cavities between the low density foam and the hull shell and to permit the venting of air from such spaces.

In the accompanying drawings there is illustrated, for purposes of exemplification, one form of flotation hull formed in accordance with the invention and from which the process of the invention will be made readily apparent in conjunction with the following more detailed description.

In the drawing:

FIGURE 1 is a side elevation of a flotation hull embodying the features of the invention and constructed in accordance with the process of the present invention, the broken line portion of this view illustrating fragmentarily the outline of a portion of an aircraft cabin which may be supported on the hull,

FIGURE 2 is a plan view of the hull shown in FIGURE 1, prior to application of its deck,

FIGURE 3 is a cross section through the hull structure on the line 3-3 of FIGURE 1,

FIGURE 4 is a cross section taken on the line 4-4 of FIGURE 1,

FIGURE 5 is a plan view of the mold cover plate having the combined inner core and frame of the hull secured thereto for disposition within the outer skin or shell of the hull, and

FIGURE 6 is an enlarged fragmentary cross section on the same plane as FIGURE 3 illustrating fragmentarily a portion of the mold or jig structure in which the outer skin or shell of the hull may be formed and supported and also showing the association therewith of the mold cover plate and the inner core of the hull after the pouring of the relatively denser outer sheathing or monolithic plastic foam sections between adjoining bulkheads has been completed.

Referring now in detail to the accompanying drawing, at first considering the completed hull structure shown in FIGURES 1 and 2, it will be noted that this structure comprises a unitary outer shell or skin 10 formed from a suitable material such as fiber glass reinforced plastic, within which is disposed a rigid reinforcing frame exemplified by the keel or keel member 12 extending within the hull along its longitudinal line of symmetry and a plurality of relatively spaced transverse bulkheads, each designated 14 suitably secured to the keel member 12 at various points along its length. The aforesaid frame structure may be formed of any suitable rigid material having the requisite lightness and strength, as for instance a light weight metal, wood or the like.

The multiplicity of flotation compartments into which the interior of the hull is subdivided by the frame structures 12 and 14 and by the overlying deck 16, are completely filled with unicellular plastic foam which, as shown in FIGURE 6, comprises as to each compartment, an inner core section 18 of comparatively low density and

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therefore lightweight unicellular plastic foam comprised of a series of united laminations such as 18A, 18B, 18C and 18D as best shown in FIGURE 4, with the inner core section in each compartment having its outer surface conforming roughly in shape to the adjoining interior of the hull shell or skin 10 and spaced inwardly therefrom. Within the space thus provided there is a monolithic outer sheath section 20 of a comparatively denser and tougher unicellular plastic foam which is preferably formed by pouring it into the space which it occupies and which is united both to the inner surface of the skin 10 and the projecting outer end portions of the several bulkheads 14, as well as to the outer surface portions of the inner core sections 18. The outer edges or profiles of the respective bulkheads which, as usual, conform accurately in shape and dimensions to the internal cross sections of the skin 10 are preferably cemented or bonded to the skin to increase the strength of the resulting structure.

The deck 16 which may be of plastic, metal or other suitable material is preferably applied and cemented or otherwise affixed in place as the final assembly step.

In the process of forming such a flotation hull, the outer skin or shell 10 and the inner core or assembly, consisting of the frame members 12 and 14 and the low density plastic sections 18 are separately formed. The inner core section is formed in inverted condition on an inverted mold cover plate 16' of rigid construction with its undersurface conforming in shape to the shape desired in the deck 16. In assembling these parts, the assembled frame, including the keel 12 and bulkheads 14, is disposed in inverted relation on the inverted top plate or cover plate 16', the laminated and preformed foam sections 18 being disposed between the respective pairs of adjoining bulkheads and cemented both to the bulkheads and the keel, but not being cemented to the top plate 16'.

This assembled inner core structure or assembly is temporarily but firmly secured to the undersurface of the cover plate 16' by means which are exemplified by the slender bolts 22 respectively in the accompanying drawing, but which might equally well comprise wires or other conventional temporary expedients.

The upwardly opening hollow shell or skin 10 in the meantime will preferably have been disposed and rigidly supported within a conformingly shaped cavity, defined by an upwardly opening mold or jig fixture 24 shown fragmentarily in FIGURE 6. Before assembling the separately formed structures, the foam sections 18 will respectively have been formed with filler holes or openings 26 therethrough communicating with permanent filler openings 28 through the plate 16'. The plate 16' also has a series of permanent vent openings 30 disposed therethrough adjacent its outer margin. The filler passages 26 and 28 communicate with the lowermost portions of their respective compartments to deliver the flowable foam forming material between the low density foam 18 and the skin 10, while the air vents or vent openings 30 respectively communicate with the uppermost portions of the spaces between the plastic sections 18 and the skin 10, whereby the rising level of the plastic foam poured through the interconnected passages 28 and 26 will force the air completely out of the spaces through their upper end vents 30. Where the several laminations of the respective plastic sections 18 are shaped by cutting or removing portions of their outer surfaces, the roughened outer surface areas left by this cutting operation preferably are coated with a suitable adhesive composition 32, as indicated in FIGURE 6, prior to pouring of the high density foam material 20, so that after the pouring the ensuring curing of this material 20 to solid foam form will result in strongly securing the resulting monolithic slab or section 20 of foam to the inner core section 18 therewithin, as well as to the skin 10 and the projecting portions of the keel 12 and the bulkheads 14.

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It will be apparent that the portions of the frame members 12 and 14 which project from the inner core structure into engagement with the skin 10 may be united to the skin by a suitable adhesive applied to either or both of these parts prior to positioning the inner core within the skin and, if desired, also the entire inner surface of the skin may have been treated with a suitable cement or bonding agent to cause it to be firmly and strongly united with the subsequently poured and cured foam sheath sections 20. The frame structure thus defined, through its projecting portions will thus obviously serve to support the plastic inner core sections 18 in properly spaced relation from the skin 10 during the operation of pouring the relatively denser sections 20. Also, the engagement between the mold top plate 16' and the skin will assist in this.

Following completion of the pouring and curing, the hull structure will be substantially completed, except that it will be desirable to remove the comparatively heavy and rigid plate 16' by removing the nuts from the upper ends of bolts 22 and lifting off the plate 16'. Preferably a lighter permanent deck structure 16 of any suitable material such as wood, metal or fiber glass reinforced plastic, conforming in shape and configuration to the plate 16' is then substituted for plate 16. It will be apparent that the plate 16' will have tended to confine the upper edges of the foam plastic sections 20 to the desired level determined by its under surface, except at the locations of the several openings 26 and 30 at which points any projecting flash may be removed down to the level of the surrounding surface before application of the permanent deck 16.

It will be obvious that if desired the mold cover plate 16' may be retained as the permanent deck of the resulting structure. Obviously the entire hull structure will have been completed and may be removed from the mold 24 after setting and curing of the foam plastic sections 20. The deck 16 may be applied either before or after removal of the structure from the mold 24.

It will be apparent therefore that there has been described a novel structure, including a relatively tough and high density foam sheath between the outer skin and an inner core of relatively lower density occupying the greater internal volume of the hull.

The monolithic high density plastic sheath sections 20 interposed between the skin 10 and the lower density plastic core sections 18, and united to both, will obviously serve to greatly reinforce and strengthen the resulting hull structure at the locations where reinforcement is most desirable, while occupying but a comparatively small proportion of the total volume of the hull. The major portion of the volume will be occupied by the relatively lower density inner core sections 18.

It will be readily apparent also that the invention comprises a new process of forming and assembling such a hull which process is well adapted for mass production of hulls in accordance with the invention.

Although the drawing and description in the present application are directed only to the preferred embodiment of the invention, I am well aware that the invention is capable of other and different embodiments and that certain details of both the hull structure and the process of forming same are subject to modification without departing from the invention. Because of this the accompanying drawings and description are intended to be merely illustrative in nature and not as limiting or restricting the invention in any way other than as required by the express terms of the accompanying claims.

Having thus described my invention, I claim:

1. The process of forming a flotation hull comprising the steps of forming an inner core of substantially uniform low-density plastic foam having a rigid frame embedded therein, comprising the steps of embedding portions of said frame in said low density plastic foam, while causing other portions of said frame to project

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from said plastic foam, placing said core and frame within a hollow hull shell, supporting said core in spaced relation from the sides and bottom of the shell by means of said projecting frame portions, fixedly securing said projecting frame portions to the shell by filling all space between the inner core and said shell with a flowable composition for forming a unicellular plastic foam of greater density than said foam of the inner core, curing said flowable composition to solidify the foam formed thereby, and bonding said last mentioned foam to said inner core, said shell and said projecting portions of the rigid frame.

2. The process of forming a flotation hull comprising the steps of forming a sheet material skin to the desired external configuration of the hull, supporting said skin in an upperwardly opening mold cavity of similar configuration to the skin, securing to a rigid mold cover plate an inverted rigid open frame identical in overall configuration and dimensions with the interior of said skin, and including a plurality of relatively longitudinally spaced transverse rigid bulkheads having profiles respectively similar to the cross sections of the skin interior at corresponding longitudinal locations, disposing in the spaces between adjacent bulkheads inner core sections each comprised of a unicellular laminated plastic foam of comparatively low density, and adhesively securing each said core section to said frame to form a composite frame and foam inner core structure in which the sides and bottom surfaces of the plastic foam sections are made to conform roughly to the corresponding inner surface areas of the skin but are spaced inwardly from the profiles of the sides and bottoms of said bulkheads, disposing said cover plate in operative relation over the mold cavity with said inner core received within the skin and with the bulkheads engaging said skin and supporting the plastic core sections in spaced relation therefrom to define between the skin and said sections a series of

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cavities of predetermined proportions and conformations, and fixedly securing said frame to the skin by pouring into said cavities a liquid composition for forming a unicellular plastic foam of greater density than said foam core sections, curing said compositions and bonding same to said core sections, said skin and the exposed portions of said frame.

3. A flotation hull structure comprising an inner core of low density unicellular plastic foam having a rigid frame imbedded therein, with portions of the frame projecting outwardly from said core, a sheet material shell defining an upwardly opening cavity receiving said core, said projecting frame portions supporting said core within the cavity in spaced relation from the sides and bottom of said shell, and being united at their areas of contact to the said shell, and unicellular plastic foam of greater density than said foam of the inner core interposed between said inner core foam and the skin and united to both, said greater density foam affording a sheath of relatively denser and tougher material than the inner core foam between the latter and the shell.

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