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Stoeberl

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[54] **PLASTIC SAILBOAT BODY AND KEEL ASSEMBLY**

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[51] **Int. Cl.** **B63b 41/00**

[58] **Field of Search** 114/39, 127, 85, 114/132, 69, 140, 141; 9/6

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Attorney—Benjamin H. Sherman, J. Arthur Gross et al.

[57] **ABSTRACT**

A fiber reinforced plastic boat hull with a tapered bottom recess receiving the upper end of a keel or center board and a floor or partition wall spanning the interior of the hull in spaced relation above the bottom thereof and secured around its periphery to the hull to form a reinforcing strut or stringer. The hull recess and upper end of the keel are of generally frusto-pyramid shape to center the keel in fixed wedged relation with the hull. Foam plastic fills the space between the bottom of the hull and the floor plate. The keel is a hollow molded plastic unit with a weight in the bottom thereof and also filled with foam plastic.

27 Claims, 13 Drawing Figures

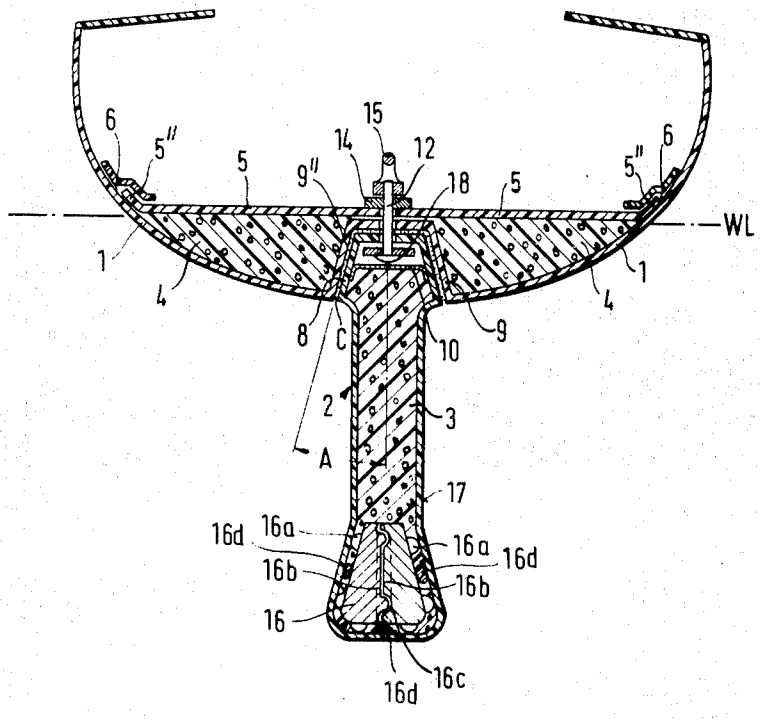


Fig.1

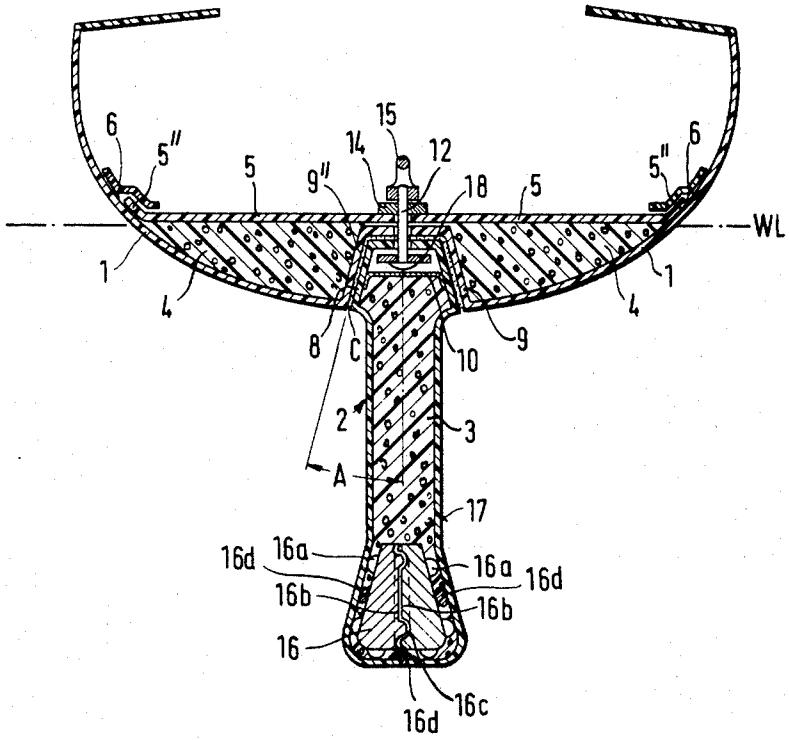
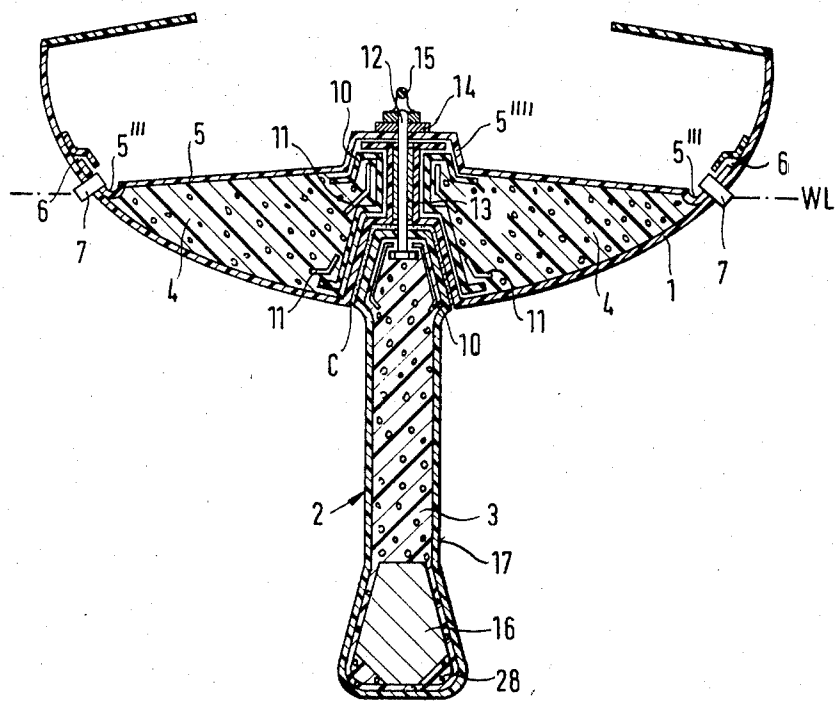

6
5''
5
9''
14
15
12
18
5
5''
6
WL
1
4
8
C
10
9
2
3
A
17
16d
16a
16b
16
16a
16d
16b
16d
16c

Fig. 2



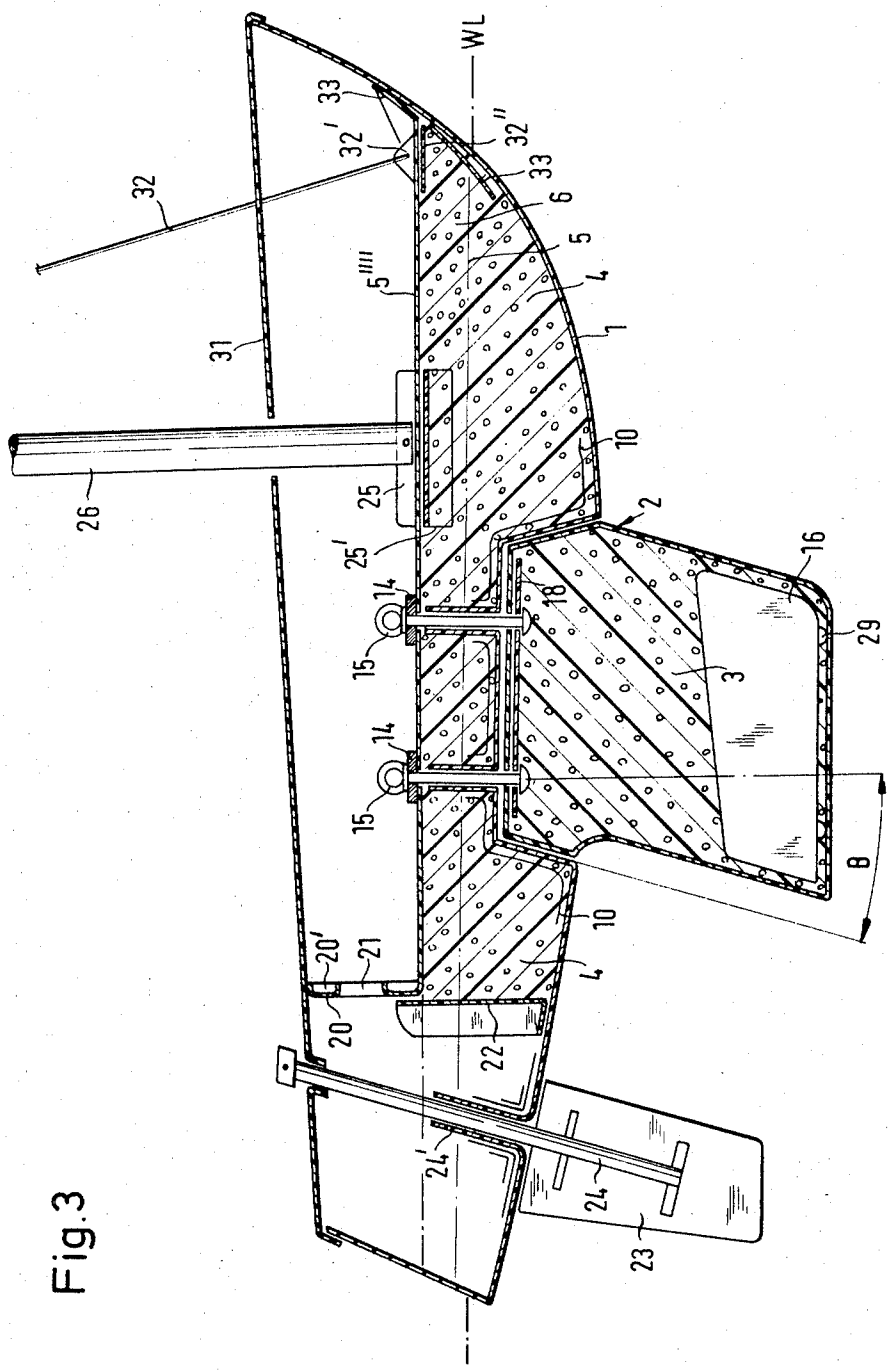

WL
33
32'
32''
33
6
5
5''''
4
1
32
31
26
25
25'
10
2
16
29
14
18
15
3'
14
15
B
10
4
20'
21
20
22
24'
24
23

Fig.3

Fig.4

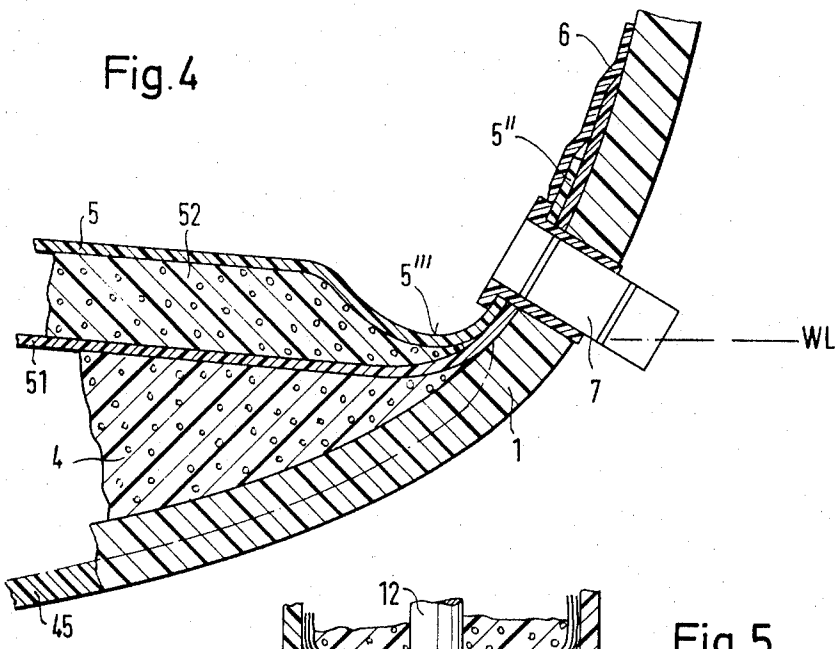
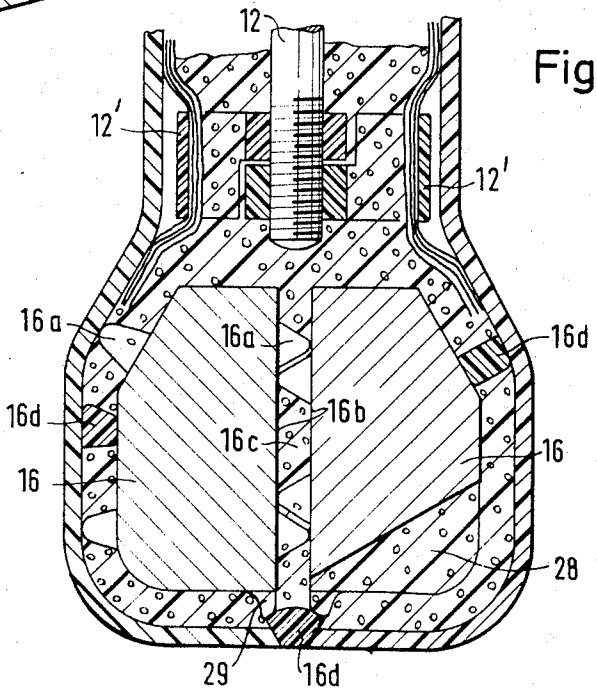

6
5''
5
52
5'''
WL
51
7
4
1
45

Fig.5


12
12'
12'
16a
16a
16d
16d
16b
16c
16
16
28
29
16d

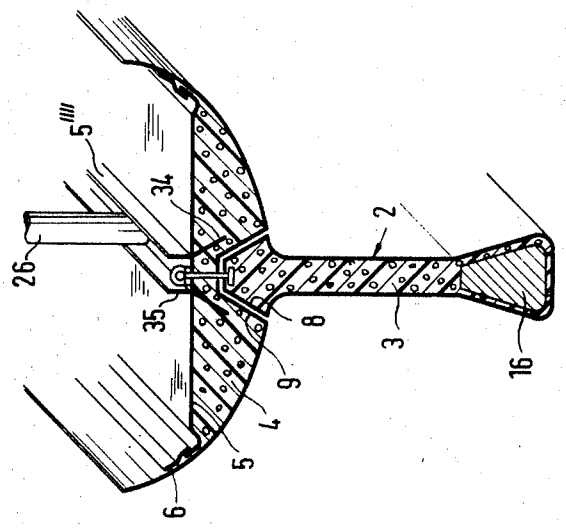


Fig.7

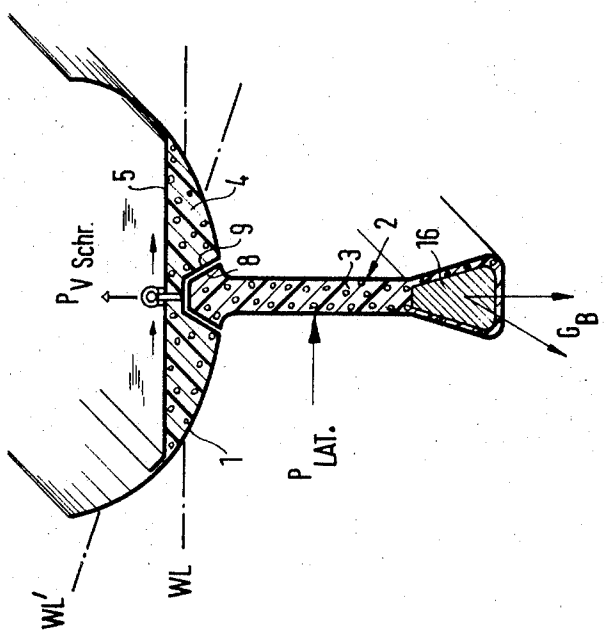
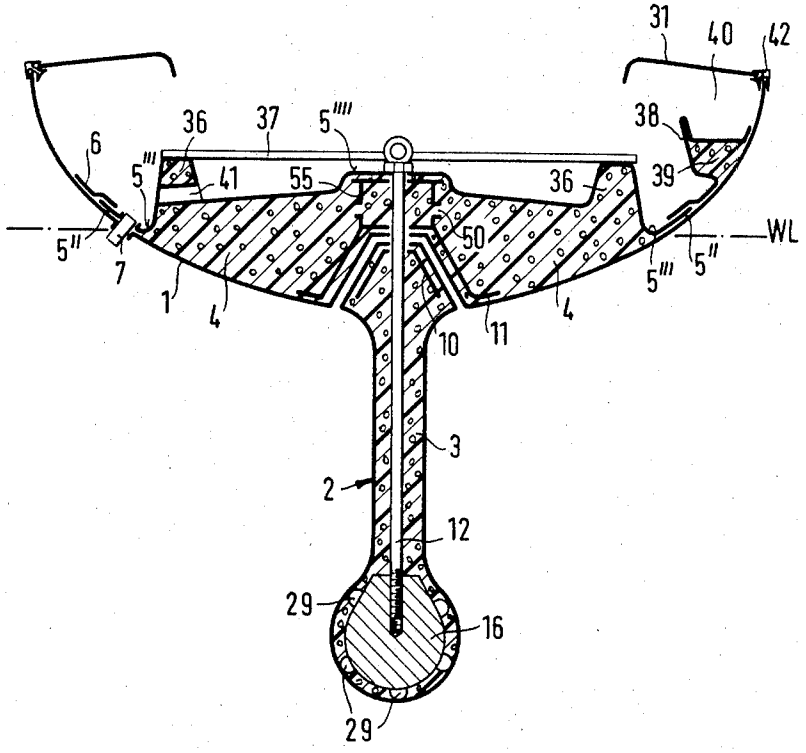


Fig.6

Fig.8



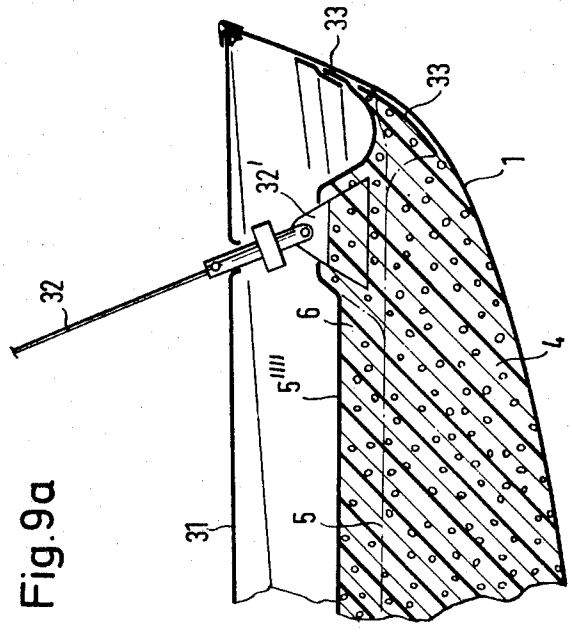


Fig.9a

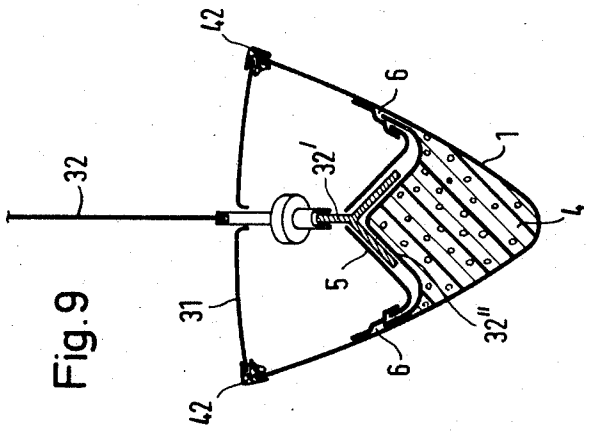


Fig.9

Fig.10

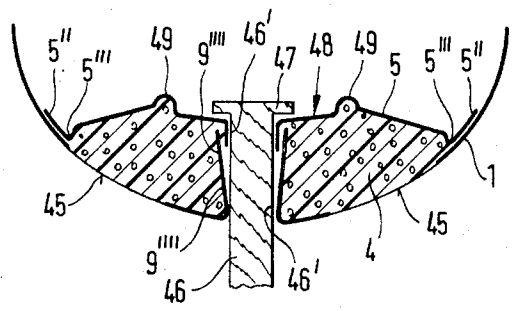


Fig.11

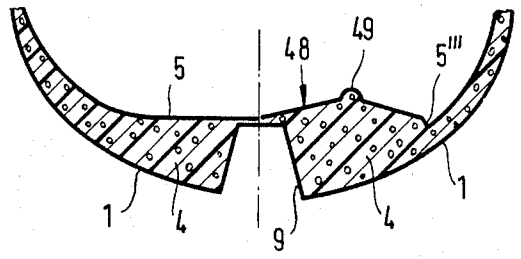
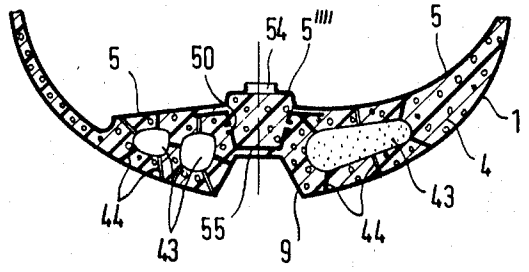


Fig.12



PLASTIC SAILBOAT BODY AND KEEL ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fiberglass type boat hulls and particularly deals with a reinforcing floor or partition wall arrangement to stiffen the hull and to a simplified keel mounting arrangement.

2. Description of the Prior Art

Fiber reinforced plastic or so-called fiberglass boat hulls or bodies are known in the art, but heretofore they had to be stiffened by a sandwich construction composed of shaped, stacked sheets or plates secured to the inside of the shell and covered with further layers of plastic. The stacked or sandwiched construction greatly increased the weight of the hull, provided spaces in which water could enter, causing damage, especially in winter, due to ice formation, and would not accommodate deformation that might result from water pressure, keel and mast loads and weight of the crew. Attempts to further reinforce such sandwich type plastic boat hulls with additional frames, stringers and the like was not satisfactory because such additions materially add to the weight and production costs of the hulls.

SUMMARY OF THE INVENTION

The present invention now provides fiber reinforced plastic, or fiberglass, boat hulls which are inexpensive to manufacture and maintain, light in weight, high in strength and resistance to deformation, provide a low center for the mast in the case of sailboats, and have an improved keel mounting.

Sailboat hulls according to this invention provide easy removal of mast, keel, and rudder units so that they may be easily transported on trailers or stored in minimum space. The removable keels for the hulls are quite thin with weighted bottom ends.

The floor or partition wall is preferably molded with an upturned flange around its periphery that is bonded to provide a rigidifying stringer and the floor or partition is preferably bowed to provide a gutter immediately adjacent the flange for draining water. Drain valves extending through the hull can be provided at convenient locations for draining the gutter. The flange is preferably stressed into conformity with the hull to stress the partition or floor, creating a stretched beam effect for stiffening the assembly. It is also preferred to bow the floor sheet or partition wall to provide a draining pitch toward the gutters and to present a substantially horizontal floor for the crew when the hull is tilted during sailing due to wind pressure on the sails.

The floor sheet or partition wall may span the entire length and width of the interior of the hull or may terminate forwardly of the stern in a vertical wall behind which is provided a trailing hull fin for mounting the rudder.

Plastic foam material filling the space between the floor sheet and bottom of the hull and also filling the hollow keel body can be of graduated density to provide weight where desired.

Suspension bolts have nuts threaded on the upper ends thereof bottomed on the floor or partition wall suspend the keel from the hull and draw it tightly into its recess. The nuts are easily removed from the bolts to drop the keel from the hull.

It is then an object of this invention to provide a lightweight, inexpensive, strong, fiberglass boat hull having a stressed tray or floor sheet reinforcing and stiffening the hull.

Another object of the invention is to provide a fiber reinforced plastic sailboat hull with a bottom recess receiving the upper end of a detachable keel.

A further object of the invention is to provide a fiberglass sailboat hull with a frusto-pyramid shaped keel recess in the bottom thereof centering a mating keel top which is tightened in the recess by suspension bolts depending from the hull.

A further object of the invention is to provide a molded plastic sailboat hull with a bottom recess or well in the exterior thereof accommodating a removable keel.

Other and further objects of the invention will become apparent to those skilled in this art from the following detailed description of the annexed sheets of drawings which, by way of preferred examples, illustrates several embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat schematic transverse cross-sectional view through the boat hull and keel of a first embodiment of this invention;

FIG. 2 is a view similar to FIG. 1 but showing a second embodiment of the invention;

FIG. 3 is a schematic longitudinal cross-sectional view through the boat body and keel of the first embodiment;

FIG. 4 is an enlarged fragmentary transverse cross-sectional view illustrating details adjacent the water line of the boat hull;

FIG. 5 is a fragmentary cross-sectional view of a keel according to this invention;

FIG. 6 is a schematic view illustrating stresses on the boat hull occurring during normal and heeling conditions;

FIG. 7 is a transverse cross-sectional view similar to FIG. 1 but illustrating a further enbodiment;

FIG. 8 is a view similar to FIG. 1 but illustrating a still further embodiment;

FIG. 9 is a schematic transverse cross-sectional view of a front stay mounting;

FIG. 9*a* is a longitudinal view of the mounting of FIG. 9;

FIG. 10 is a view similar to FIG. 1 with a further modification of the keel or center board mounting;

FIG. 11 is a schematic transverse cross-sectional view of two different floor sheet or tray contours;

FIG. 12 is a schematic transverse cross-sectional view with different embodiments of floor sheet or tray contours and foam arrangements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, the herein listed legends and reference numerals designate the following:

A. Transverse centering angle of the keel mounting
B. Longitudinal centering angle of the keel mounting
C. Keel attachment bed
WL. Water line
WL' Water line during heeling
KB Ballast force, effective during heeling
GB Ballast weight, effecting during plane position
PL*at* Lateral plan forces

1 Outer shell of boat body
2 Fin or keel
3 Foam filling in the fin or keel
4 Foam filling in the boat body
5 Bottom floor tray
5' Bottom tray recess
5'' Stringer flange of the bottom tray
5''' Drain channel of the bottom tray
5'''' Center support piece of the bottom tray
6 Connection strip between bottom tray and boat body
7 Drain valve
8 Keel centering member
9 Centering mounting in the boat body
9'' Centering mounting bottom piece
9''' Longitudinal centering mounting surfaces
9'''' Centering mounting for removable keel
10 First reinforcing brace
11 Second reinforcing brace
12 Keel attachment bolt
12' Attachment lugs
13 Spacing tube
14 Nut
15 Eye
16 Ballast
16*a* Spacing projection
16*b* Center surfaces of the ballast
16*c* Interspace
16*d* Plastic bales
17 Lateral plane surface of the keel
18 Load distribution plate
20 Transverse bulkhead or partition
20' Flange of the transverse bulkhead
21 Opening in the transverse bulkhead
22 Closing plate for transverse bulkhead
23 Rudder blade
24 Rudder shank
24' Mounting bearing for rudder shank
25 Mast base
26 Mast
27 Core
28 Filling channel
29 Supporting protrusion for the ballast
30 Ballast foam
31 Deck
32 Front stay pivot
32'' Front stay anchor
33 Impact protector
34 Braces of the center supporting piece with downturned flanges
35 Braces of the center supporting piece with upturned flanges
36 Hump
37 Main sheet traveler track
38 Longitudinal profile wall
39 Foam insertion
40 Storage compartment
41 Passage
42 Edge connector
43 Foam displacement member
44 Spacing member
45 Fin area of the outer boat body shell
46 Removable keel
46' Mounting area
47 Upper plate
48 Depression
49 Stiffening and calking ledges

50 Passage openings
51 Lower covering layer of the bottom shell
52 Foam inter-layer of the bottom shell
53 Stringer flange of the bottom shell
54 Filling opening
55 Center supporting piece

In FIG. 1 a molded fiber reinforced plastic outer shell or hull 1 suspends a thin hollow keel 2 filled with plastic foam 3. The interior bottom of the hull 1 is filled with plastic foam 4. A plastic floor sheet or tray 5 spans the interior of the hull 1 above the bottom thereof providing a recess therebeneath receiving the plastic foam 4. The floor 5 at the water line level WL has an upturned peripheral lip or flange 5'' around the periphery thereof seated on the hull 1. A plastic stringer strip 6 overlies the lip or flange 5'' and is bonded to both the flange 5'' and the hull. In addition, the flange 5'' is bonded to the hull. The foam 4 supports the floor 5 and reinforces the hull 1 to provide stiffness and strength without added stringers and frames. The foam may be mixed with fibers or laminated with mats and the like for added strength.

The upper end of the keel 2 has a frusto-pyramid shaped head 8 seated in a mating recess 9 molded in the hull. The head 8 is reinforced with a first reinforcing brace 10.

A suspension bolt 12 extends through the deck sheet 5, top wall of the recess 9 and top wall of the head 8 and through a floor plate 14 and a head plate 18. A nut 15 with a ring-head is threaded on the upper end of the bolt 12 to draw tightly so that the plates 14 and 18 will be seated against their respective supports and the keel head will be drawn tightly into the recess.

The keel 2 mounts a heavy weight 16 in the bowed lower end thereof. The weight 16 is preferably spaced as shown at 16*c* from the walls of the bowed or humped bottom of the keel by means of plastic packs 16*d*.

As shown in FIG. 2, the deck sheet or floor plate 5 has depressions 5''' molded therein around the sides thereof providing gutters for water drainage and flap valves 7 extend through the hull to drain these gutters.

In the enbodiment of FIG. 2, the deck sheet 5 has a raised hump 5''''. Strengthening ribs and tubes 10 and 11 surround the hull recess defining portion and extend into the hump 5'''' of the deck sheet.

As shown in FIG. 3, the deck sheet 5 terminates in an upstanding wall or bulkhead 20 forwardly from the stern of the hull and this upstanding wall has a flange 20' secured to the hull together with an opening 21 to the space behind the wall. A wall 22 is also provided to close the space under the deck adjacent the wall 20.

A rudder 23 is mounted on a rudder shaft 24 carried in a bearing tube 24' provided in the hull behind the closure plate 22.

The back wall 20 extends to the level of the deck 31 and the compartment behind this wall receiving the rudder shaft can be hollow and sealed to provide buoyancy. Since the space between the hull shell 1 and the deck floor 5 is filled with foam sufficient uplift will be maintained even though the ship is filled with water. Even though the hull and floor 5 are damaged and punctured the foam filling will float the boat.

Because of the foam filling, as shown in FIG. 4, the hull 1 can have a very thin section 45 in the bottom thereof which is completely reinforced by the foam filling 4. Further, if desired as shown in FIG. 12, the foam can have incorporated therein so-called foam replace-

ment bags 43 filled with air, and these bags may extend over a part or over the entire range of the interspace between the bottom floor 5 and the hull 1. Spacing members 44 can be provided to maintain the bags in position during the filling of the spaces therearound with foam.

The recess 9 in the hull for receiving the head 8 of the keel is designed with side walls converging to a top wall 9'', but it should be understood that the recess could be divided to receive divided heads on the keel. The inclined side walls of the recess are at a transverse angle A with the longitudinal center plane of the boat which is selected so that forces are favorably transmitted to the boat hull with a minimum of deformation. Angles between 30° and 60° are preferred.

The depth of the recess 9 is such that the wall 9'' is adjacent the floor 5 so that the two surfaces can contact and be connected as by means of a plastic layer.

As shown in FIG. 6, an underframe thus results with the recesses 9 guiding the forces into the right or left sides of the boat hull depending on the wind pressure direction, while in the vertical direction the mounting 9 is supported by the bottom shell 5 and push-and-pull loads are transferred as indicated by the arrows. The forces which affect the keel 2 from the outside and which have to be transferred into the boat body consist essentially of forces PL*at* which have a lateral effect of a bending moment. The static forces GB resulting from the weight of the keel and the dynamic forces resulting from the keel mass during rough seas are directed downwardly and pull the boat therewith. Thus the component parts are triangularly connected on both sides of the centering mounting 9 and are mutually supported.

Since the recess 9 has only a small longitudinal expansion in the fore and aft direction as shown in FIG. 3, and since possible elastic transverse widening of the centering recess 9 is prevented under the influence of bending moments which occur due to the support of the boat body which follows the center mounting longitudinally, the fore and aft longitudinal centering mounting surfaces may have a different conical angle B than the angle A as shown in FIG. 3. It should be also understood that the center mounting recess 9 can be stepped while converging to provide a number of parallel connected support surfaces.

Since even a very small longitudinal displacement of the keel will direct the boat to one side, care must be taken to maintain a fixed center line for the keel.

In fixedly mounting the keel to the hull, a hardenable attachment layer C of adhesive can be provided, or spacers can be used.

In the embodiment of FIG. 10, the removable keel 46 is illustrated as extending through a mounting 9'''' opening upwardly in a wedge-like shape and receiving the removable keel or center board 46. The bottom tray 5 adjacent the keel 46 is provided with a recess 5' with edges turned downwardly and fitting into the upper end of the recess 9'''' so that a wedge seat is provided when the two parts are assembled. This can be sealed by means of plastic cement.

The removable keel 46 is guided approximately linear at its upper and lower body mounting range 46' and is secured against dropping out of the hull by a head plate 47.

The floor tray 5 has a recess 48 dammed off by calking ledges 49 and the floor is inclined toward the outside of the hull to flow water to the drain channels 5'''. The recess 48 can be drained through suitable drain valves.

The keel 2 is molded from two half-shells united together to provide a smooth surface form and the strengthening reinforcements 10 and 11 are inserted between the shell halves. They can be formed of glass fiber.

The load distributing plate 18 may be of laminated construction embedded in the plastic in the strengthening layers.

The ballast weight 16 can have spacing humps 16a distributed on its surfaces so that it can be centered in the half-shells of the keel. In addition, of course, the weight can be formed in two half-parts composed of lead or cast iron and positioned as desired during the foaming process. The half-sections have center surfaces 16*b* as shown in FIG. 5, providing a space 16*c* therebetween maintained by spacer humps 16*a*. Plastic spacing bundles or bales 16*d* are inserted to provide a space surrounding the ballast weights. The entire assembly is then held in place by the foam.

As also shown in FIG. 5, the keel attachment bolt 12 is threaded in lugs 12' anchored in the plastic foam.

The lugs 12' are additionally reinforced by fibers passed therethrough as shown. Since the keel is hollow before it is filled with the foam, electric conductors, tubes and the like can be inserted for attachment to pressure head indicators, current meters or the like so that the speed of the boat can be measured.

As shown in FIG. 5, filling channels 28 can be provided in the keel for injection of the foam plastic.

The filled-in foam 3 can be formulated as desired to provide different densities and can be heavier in the lower portion of the keel. Strengthening fibers such as glass, metal and the like can be mixed with the foam to increase the keel strength.

The keels can be very thin in profile with the entire center of mass at the bottom thereof and with as little weight as possible above this bottom. Heavy fillers such as metal powder and the like can be used to obtain sufficient weight concentration in the lower end of the keel.

The floor 5 is easily inserted into the outer boat hull 1 with a jig, preferably after the flanges 5'' and 20' are coated with plastic to form the seal and create the stringer reinforcement described above. The shell is pressed against the foam replacement bodies 43 to obtain a desired loading and snug connection with the plastic.

The stern of the boat is sufficiently rigid without requiring frames and stringers, and is capable of supporting the rudder shank 24 and rudder blade 23 in the bearing 24' extending high above the water line WL, preferably up to the deck 31, thereby avoiding the necessity of a seal packing. The bearing 24' is formed during the production of the hull 1 and is sufficiently attached thereto and reinforced by strengthening inserts.

In the FIG. 2 embodiment, and as also illustrated on the left side of FIG. 12, the bottom floor 5 is inclined toward the outside starting from the center line to better discharge spray water and to provide a bottom on the wind-side, which is less inclined to provide better standing safety for the crew. The drain channel 5''' embodied in the bottom shell 5 is deeper than the level of the bottom shell or floor for better drainage without flowing back during a change of listing of the boat. The

drain valve 7 is arranged at suitable places on one or both sides of the boat which is lowest during the listing or heeling of the boat. At rest, the drain flaps 7 remain open, and rain and spray water are run off. Therefore, it is not necessary to cover boats of this design with a tarpaulin since they are always fully drained. The center recess 48 in the embodiment on the right side of FIG. 11 can be drained by a stern drain flap.

As is also shown in FIG. 2, the bottom shell 5 is designed with a center support piece 5'''' extending over the entire length of the shell and designed in a trapezoid shape. The center support piece 5'''' stiffens the bottom shell or floor 5 and also the boat body. The center support piece 5'''' also serves as the keel load carrier and eliminates the necessity for a keel beam extending over the length of the boat which increases the weight of the boat.

As shown in FIGS. 3 and 7, the mast base or pedestal 25 is reinforced by a brace 25' laminated on the inner side of the center support 5'''' of the floor tray or shell 5. The front mast stay 32 is preferably pivoted to its base 32' which is also laminated on the center support 5'''' of the floor tray 5.

As shown in FIGS. 9 and 9*a*, the floor 5 with its center support section 5'''' is formed with a bulge or pyramid-like hump at the front stay pivot 32', which is designed triangularly and is secured to a strengthening laminate layer 32''. Bending stresses are reduced and redirected into push-and-pull forces in the laminate. Strengthening layers are provided for impact protection at 33, as shown in FIG. 9*a*. The impact protection 33 can be molded into the boat hull 1 on both sides and take the form of a metal layer or additional laminate layer.

The center support piece 5'''' can have longitudinal profiling open toward the top or toward the bottom with a U- or H-shape, thereby providing a good reinforcement for attaching the keel as illustrated in FIG. 7, since cross-bars 34 of the support piece will rest directly against the corresponding walls of the center mounting 9 of the hull 1 and can be connected during assembly by means of plastic adhesive. In the same manner the mast 26 and the front stay 32, mounting belts for the crew, and similar things may be attached in a simple manner to the upwardly extending cross-bars 35 without having to bore holes in the shell 5.

The center support piece 5'''' can take the form of a closed longitudinal tube as shown in FIGS. 8 and 12, and can be made of metal or plastic. The tube can have passage openings 50 at its outside, as shown in FIG. 8, and can have a filling opening 54 as shown in FIG. 12 for foam. The tube thus serves as a foam distributor to insure filling of the space between the hull and the floor tray, especially when the floor rises to the levels as shown in FIGS. 11 and 12. The tube feed for the foam prevents air bubble formation, and after the space is filled with foam, the opening 54 can be closed.

As shown in FIG. 2, one or several centering mounting strengthening members 10 and 11 may be laminated in the area of the connection of the centering mounting 9 with the keel 2, and in the boat body shell 1, and these may extend to the center support piece 5'''' and connected therewith by flanges, adhesive layers and the like so that a mounting of increased strength is obtained. Spacing tubes 13 may be mounted around the attachment bolts 12 to support axial stresses.

FIGS. 8, 10 and 11 show additional contours for the floor tray 5 with FIG. 8 showing protrusions 36 supporting the track 37 for the main sheet. Additional longitudinal stringers 38 are provided and can be shaped to provide storage compartments 40 under the deck 31. Drain passages 41 in the humps or protrusions 36 drain toward the channel 5''' and toward the drain valve 7 as shown in the left side of FIG. 8. The circumferential stringer flange 5'' may be extended and attached to the longitudinal wall 38 as shown at FIG. 8 on the right side to form a further longitudinal strengthening arrangement. Ad edge connector 42 is provided to unite the deck 31 to the hull.

As shown in FIG. 4, the floor tray 5 can have two layers including the top floor layer 5 and a bottom layer 51 with a foam filler 52 therebetween. The filler may be hard foam or may be a soft fleece layer. The layers 5 and 51 are pulled together around their peripheries as illustrated at 5'' and may be bowed to form the drain channel 5'''. A stringer strip 6 may cover the upper ends of the joined together shells 5 and 51, and a drain valve 7 can be provided for the channel 5'''.

From the above descriptions, it therefore will be understood that this invention provides an integrated, lightweight molded plastic boat body stiffened by plastic foam and free from heretofore necessary ribs. The body consists only of two essential components and affords a novel keel mounting.

I claim as my invention:

1. A plastic boat body comprising a molded hull portion with a keel receiving recess in the bottom thereof, a molded plastic floor tray in said hull and sealed around the periphery thereof to the hull, a molded plastic keel having a head portion fitting said recess in the bottom of the hull and suspension means attaching the keel to the hull.

2. The boat body of claim 1 wherein the hull recess has a frustro-pyramid shape.

3. The boat body of claim 1 wherein the space between the hull and the floor is filled with plastic foam.

4. The boat body of claim 1 wherein the floor tray is flanged upwardly in the hull and has the flange thereof bonded to the hull for forming a reinforcing stringer.

5. The boat body of claim 4 wherein the stringer is covered with a reinforcing plastic strip.

6. The boat body of claim 1 wherein the molded plastic hull has a deck and the periphery of the floor tray extends upwardly toward the deck and the space between the hull and floor tray is filled with plastic foam extending upwardly toward the deck level.

7. The boat body of claim 1 wherein the space between the hull and floor tray has bags therein adapted to be filled with air, foam or other lightweight material.

8. The boat body of claim 1 wherein the floor tray is inclined from a longitudinal center line to the boat hull.

9. The boat body of claim 1 including two floor trays with a foam layer therebetween.

10. The boat body of claim 1 wherein the floor tray is at the water level of the hull.

11. The boat body of claim 1 wherein the floor tray has a peripheral drain channel and a drain valve is provided in the hull to drain water from the channel.

12. The boat body of claim 1 including reinforcing braces between the floor and hull for supporting a mast.

13. The boat body of claim 1 including reinforcing members between the floor tray and surrounding the recess defining portion of the hull.

14. The boat body of claim 1 wherein the floor tray has a longitudinally extending supporting piece thereunder.

15. The boat body of claim 1 wherein additional strengthening laminate layers are provided under the floor tray for a mast pedestal and a front stay.

16. The boat body according to claim 1 including a distributor tube in the floor tray for filling the space between the tray and hull with plastic foam.

17. The boat body of claim 1 including a separate layer of material between the head of the keel and the recess.

18. The boat body of claim 1 including a spacer tube surrounding the suspension mounting for the keel between the hull and floor tray.

19. The boat body of claim 1 wherein the keel is hollow, has a ballast weight at the bottom thereof and is filled with plastic foam.

20. The boat body of claim 1 wherein the keel is formed from two molded plastic halves.

21. The boat body of claim 1 wherein the keel is hollow and filled with material having a low specific weight in the upper end thereof and a high specific weight in the lower end thereof.

22. The boat body of claim 1 wherein the keel is hollow and contains conduits and the like for recorders and measuring devices.

23. The boat body of claim 1 where the stern of the hull has a molded-in tubular bearing for the rudder shank.

24. The boat body of claim 1 wherein the deck tray terminates short of the stern of the hull in an upstanding bulkhead.

25. The boat body of claim 1 wherein the recess of the hull is slotted for receiving a removable center board.

26. A fiber reinforced plastic sailboat construction comprising a one-piece molded plastic hull with an elongated tapered recess in the bottom thereof along the longitudinal center line, a molded plastic keel having a head fitting said recess and suspension bolts securing the head in said recess.

27. A fiber reinforced plastic sailboat construction comprising a one-piece molded plastic hull with an elongated tapered recess in the bottom thereof along the longitudinal center line, said recess having a flat top wall, a molded plastic keel having a head fitting said recess, suspension bolts securing the head in said recess, and a molded plastic floor secured around its periphery in the hull resting on said top wall of the recess.

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