Nov. 29, 1966 T. D. PRICE ET AL 3,287,754

COLLAPSIBLE SURFBOARD

Filed Oct. 9, 1964 4 Sheets-Sheet 1

Fig. 1.

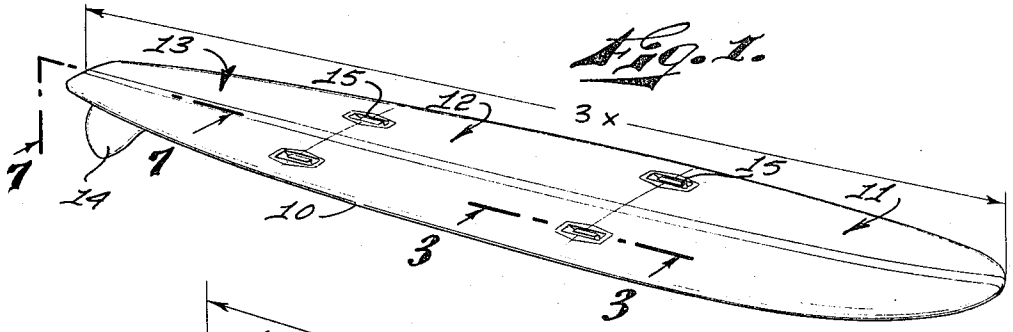


Fig. 2.

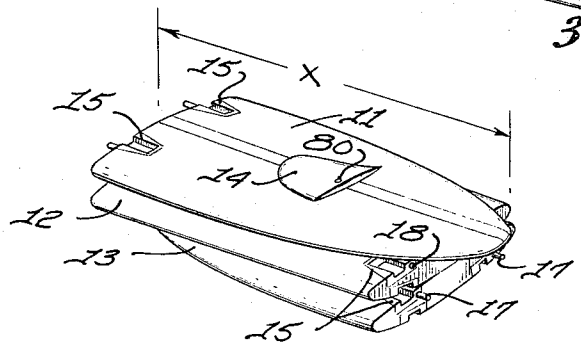


Fig. 3.

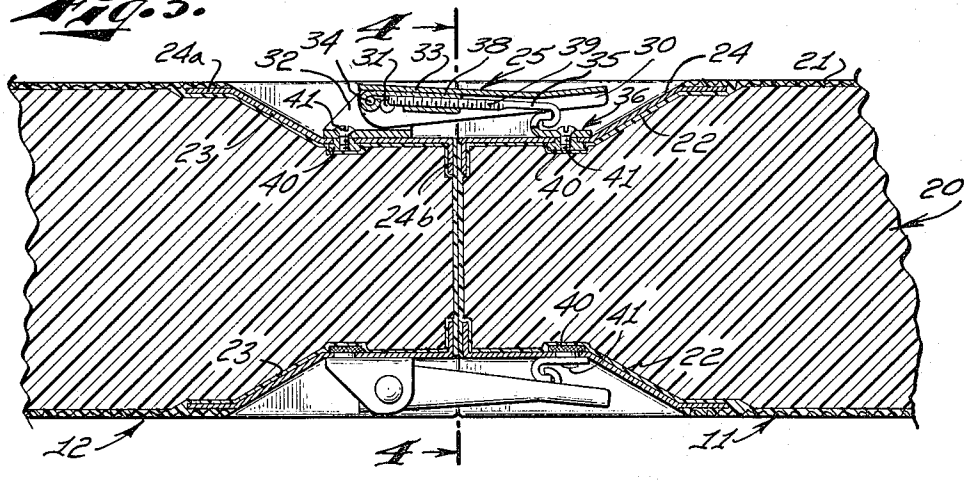
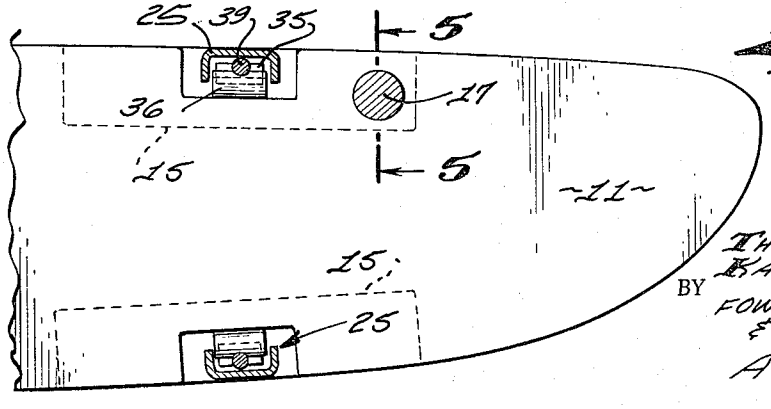


Fig. 4.



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Nov. 29, 1966 T. D. PRICE ET AL 3,287,754

COLLAPSIBLE SURFBOARD

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Fig. 5.

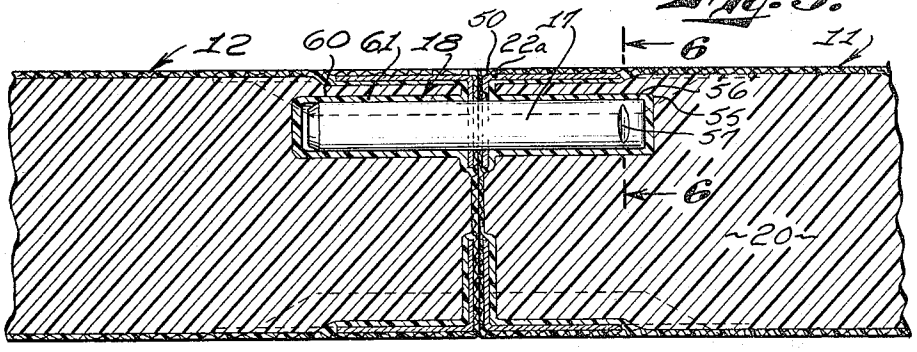


Fig. 6.

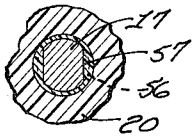


Fig. 7.

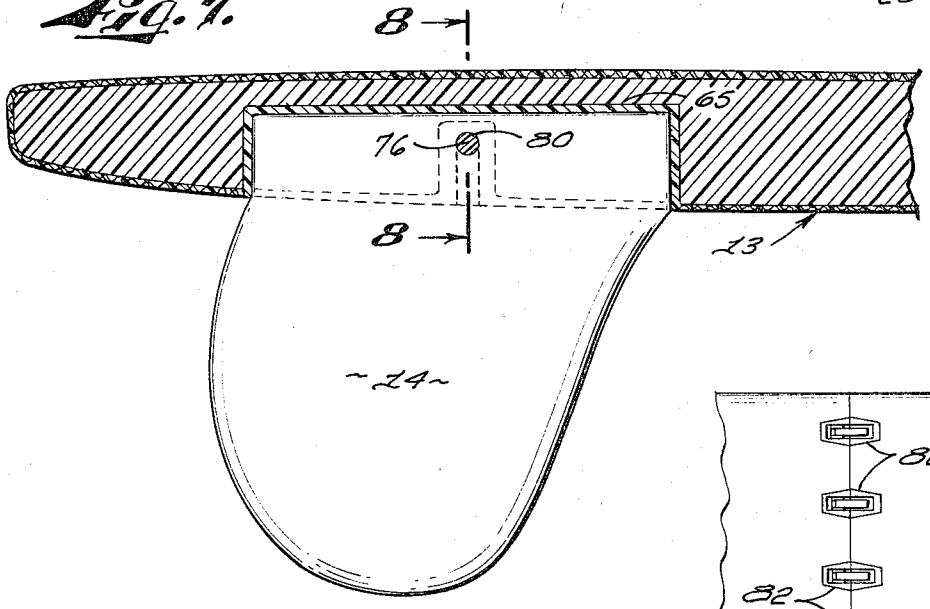
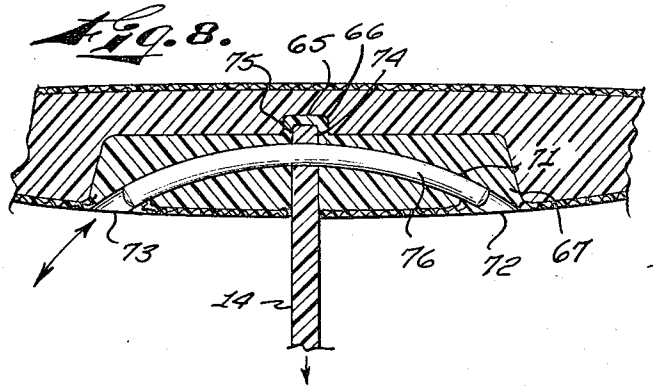


Fig. 9.

Fig. 8.



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Nov. 29, 1966 T. D. PRICE ET AL 3,287,754

COLLAPSIBLE SURFBOARD

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Fig. 10.

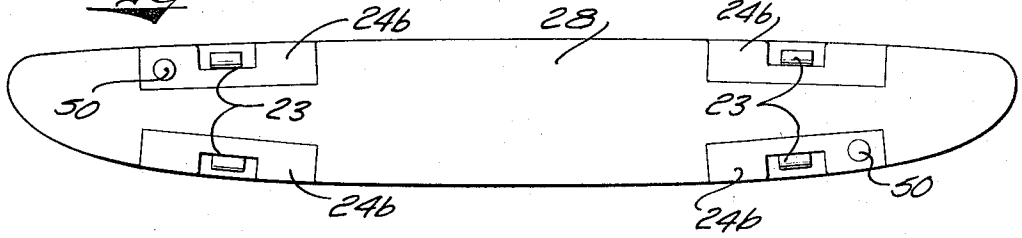


Fig. 11.

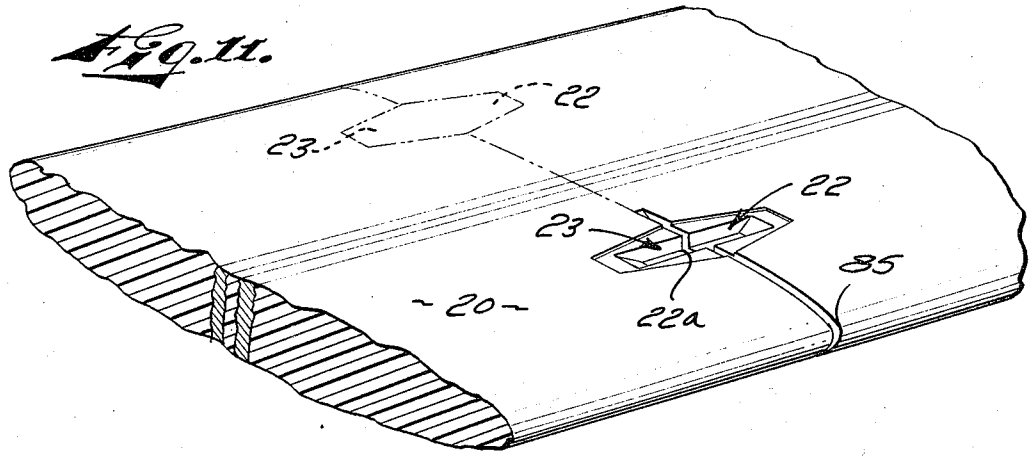
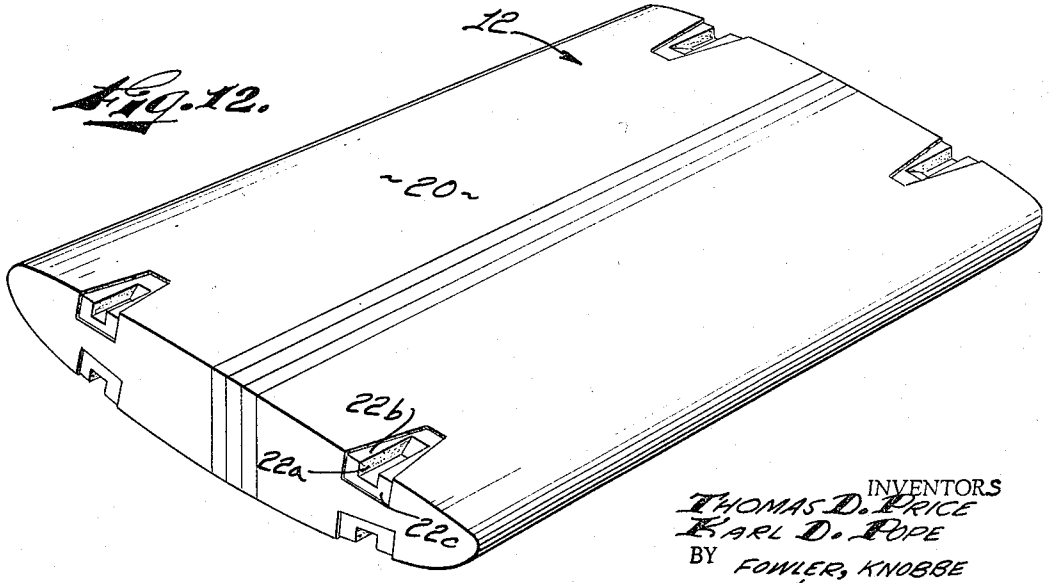


Fig. 12.



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Nov. 29, 1966 T. D. PRICE ET AL 3,287,754

COLLAPSIBLE SURFBOARD

Filed Oct. 9, 1964 4 Sheets-Sheet 4

Fig. 14.

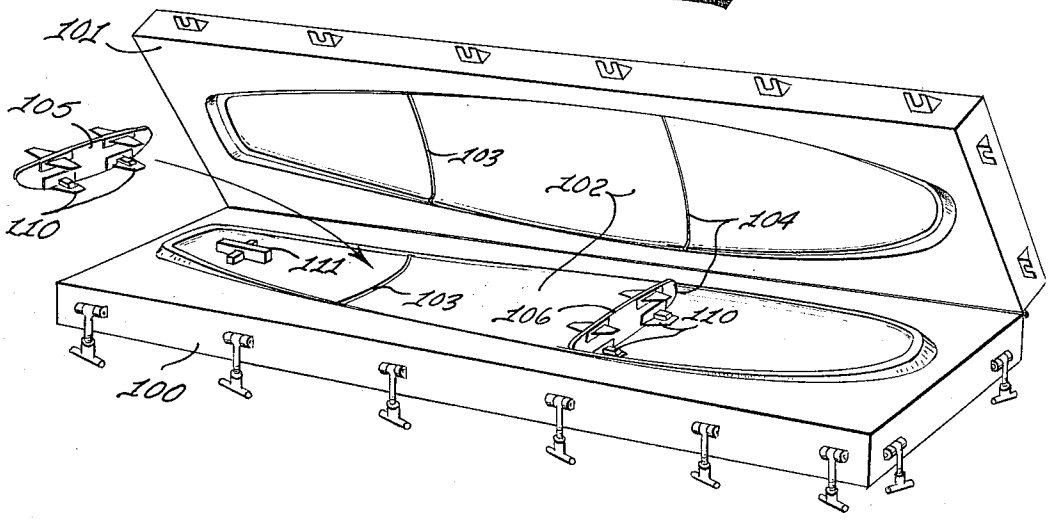


Fig. 15.

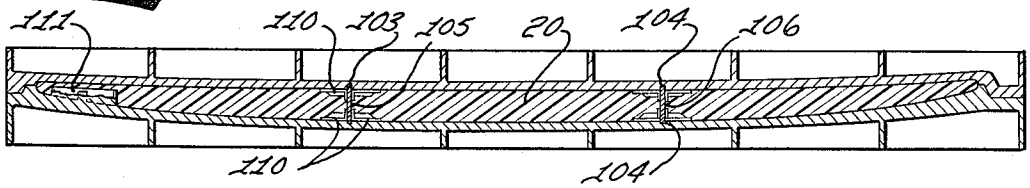


Fig. 13.

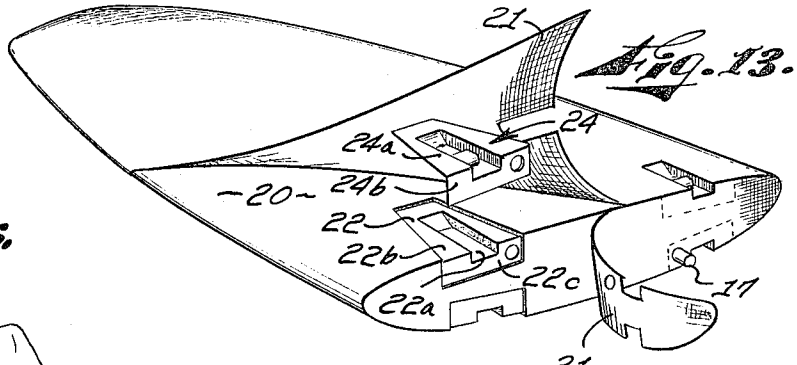


Fig. 16.

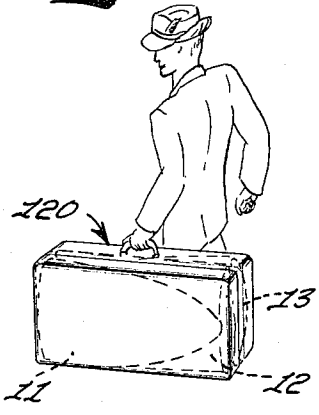


Fig. 17a.

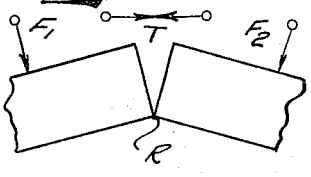
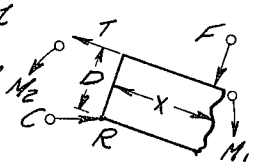


Fig. 17b.



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3,287,754

COLLAPSIBLE SURFBOARD

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Filed Oct. 9, 1964, Ser. No. 402,856
9 Claims. (Cl. 9—310)

This invention relates to an improved surfboard of the type adapted to be arranged in a collapsed and disassembled condition for compact storage and ease in handling without losing any desirable feature of the non-collapsible type of board.

Although the sport of surfing or surf boarding is one of an increasing popularity, the storage and transportation problems associated with surfboards due to their considerable length inhibit the practice of this sport. Thus, the board is ordinarily carried on the exterior of an automobile where it is highly susceptible to loss by theft when the automobile is left unattended or to damage because of failure of the auto carrier. Further, it is difficult and expensive to carry a surfboard on public modes of transportation. By way of specific example, a surfing enthusiast is charged an extra fee of $40 by a major airline to transport his surfboard roundtrip between Los Angeles and Hawaii.

The plastic foam and fiber glass construction of a surfboard gives it an inherent lightness of weight so that a multi-section board can be easily carried by one person. However, the soft foam interior and thin sheet fiber glass exterior, while providing a light-weight construction, makes it very difficult to removably secure together the individual sections of a multi-section board since any fastener extending through or into the foam material will tend to enlarge the opening formed in the foam when the board is subjected to the stresses and strains caused by the surfing activity. Prior to this invention, means have not been known in the art for constructing a collapsible board which will satisfactorily withstand the substantial loading forces applied thereto during the surfing activity while maintaining full maneuverability in the water with respect to paddling and surfing.

Accordingly, one of the important features of the invention resides in the provision of means for securely locking the disconnectable surfboard sections together in such a manner as to withstanding the stresses and strains to which the sections are subjected when connected together and placed in use, and yet at the same time, permits the surfboard sections to be readily and conveniently separated when so desired.

Another object of the present invention is to provide an improved collapsible surfboard characterized by its simplicity of construction and in its adaptability to economical manufacture.

Other and further objects, features and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of a preferred embodiment of a collapsible surfboard constructed in connection with this invention;

FIG. 2 is a perspective view of the collapsible surfboard of FIG. 1 shown in a collapsed or folded state;

FIG. 3 is an enlarged cross-sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a view taken along the line 4—4 of FIG. 3;

FIG. 5 is an enlarged cross-sectional view taken along the line 5—5 of FIG. 4, particularly illustrating the indexing means;

FIG. 6 is a cross-sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a cross-sectional view taken along the line 7—7 of FIG. 1, particularly illustrating the detachable skeg inserted into a mating recession provided in the rear section of the surfboard;

FIG. 8 is a cross-sectional view taken along the line 8—8 of FIG. 7, illustrating the means for fastening the detachable skeg to the surfboard;

FIG. 9 is a partial plan view of an alternative embodiment of the present invention;

FIG. 10 is an elevation view of the end of one of the surfboard sections;

FIGS. 11, 12 and 13 illustrate successive stages of manufacture of the collapsible surfboard of the present invention;

FIGS. 14 and 15 illustrate perspective and cross-sectional views, respectively, of a mold adapted to form the plastic foam bodies for the collapsible surfboard;

FIG. 16 illustrates the convenient manner in which the surfboard may be transported by a person on either public or private modes of transportation; and

FIG. 17*a* illustrates the loading forces applied at the joints of the collapsible surfboard and FIG. 17*b* is a free body diagram to facilitate understanding of the improved structural rigidity of collapsible surfboards constructed according to the present invention.

Referring now to FIGS. 1 and 2, a preferred embodiment of the collapsible surfboard constructed in accordance with the teachings of this invention comprises a surfboard **10** comprised of three separate sections, i.e., a front section **11**, a center section **12**, and a rear section **13**. The latter section includes a skeg **14** which may be detached therefrom. These three sections are advantageously of substantially equal length and are adapted to be rigidly connected in longitudinal alignment with each other as shown in FIG. 1. FIG 2 illustrates the surfboard in a collapsed or folded condition wherein the three sections **11**, **12** and **13** are detached one from another and the skeg **14** is detached from the rear section **13**.

The surfboard sections **11**, **12** and **13** are retained together by pairs of laterally spaced clamp assemblies **15** disposed on the upper and lower sides of the respective sections. Each clamp assembly advantageously comprises a cam action type clamp whereby the sections may be quickly assembled and disassembled. As shown in FIG. 2 and described below, the assembly is facilitated by respective mating index pins **17** and sockets **18** formed in the adjacent board sections for facilitating longitudinally aligning the sections during assembly.

An enlarged sectional view illustrating the details of the clamp assemblies is shown in FIGS. 3 and 4. The board sections are seen to comprise an inner plastic core **20**, usually formed of a polyurethane foam, and a covering of resin impregnated fiber glass **21**. A metal bracket **24** having extending horizontal and vertical flanges **24***a*, **24***b* is disposed in each of the mating recesses **22**, **23** formed in the cores of the respective sections **11**, **12** and permanently affixed therein providing a support for the cam action clamp assembly **25**. Sheet aluminum alloy 0.060 inch thick has been found to be quite satisfactory for constructing the brackets **24**. As shown, the depth of each recess **22**, **23** is small compared to the thickness of the board at the joint assembly. By way of specific example, the recesses **22**, **23** advantageously have a depth of the order of $\frac{3}{16}$ inch for a board having a thickness of 3½ inches at each joint.

Each cam assembly advantageously comprises a lever **30** pivoted at **31** to respective trunnions of yoke **32** affixed to one of the clamp brackets **24** by bolts **41** and latch arm **33** pivotable about axis **34** defined by respec-

tive trunnions of lever **30**. Latch arm **33** includes an adjustable lock piece **35** adapted to engage a permanent lock piece **36** affixed to the adjacent clamp bracket **24**. Each of these clamp parts should be of stainless steel or like rust-resistant alloy. Preferably, each of the clamp brackets **24** includes threaded stainless steel inserts **40** secured to their underside faces which are threadedly engaged by mounting bolts **41**. In this manner, any of the latch assemblies may be easily replaced if they should become damaged or worn.

The operation of the clamp assembly will be seen to be such that the pivot axis **34** is translated away from the permanent lock piece **35** when the lever **30** is rotated on axis **31** in a clockwise direction (as seen in FIG. 3) to a position parallel the surfboard surface. The cam action provided by the pivotal movement of axis **34** with respect to axis **31** enables a substantial tension to be exerted by a relatively small clamp member, which tension has been found to be completely satisfactory for rigidly securing together respective sections of the surfboard.

The tension supplied by the clamp assemblies may be varied by providing the latch arm **33** with a threaded portion **38** receiving an engaging threaded end portion **39** of the lock piece **35**. The tension provided by the clamp may then be increased or decreased by rotating the lock piece **35** relative the threaded portion **33** in the appropriate direction to either decrease or increase the distance between the end of the lock piece and the pivot axis **34**.

An alternative embodiment of the present invention is shown in FIG. 9 wherein four clamp assemblies **82** are utilized on both sides of the board for retaining together the respective board sections. The additional number of clamps would be particularly useful when the width of the board is wider than average. Also, for a given size of board, each of the clamps **82** could be physically smaller than when only two clamps are employed and still obtain the same tension between the respective board sections. In this manner, the depth of each of the recesses **22, 23** may be decreased to lengthen the moment arm D of equation **3**.

It will be apparent that the surfboard will be subjected to numerous bending moments during the surfing activity which will produce maximum tension on one horizontal surface of the board and maximum compression on the other horizontal surface. An important feature of the present invention is that a substantial tension can be applied near the surface of the board for retaining the respective sections in longitudinal alignment while locating the entire clamping structure flush or beneath the board surface so as to obviate any interference with the user of the board.

The mechanical advantage derived from this structure will be apparent from a simple stress analysis. As shown in FIG. 17*a*, forces F_1 and F_2 are applied to respective board sections, tending to rotate the boards around point R and separate the boards at the upper edge of the joint. In order to prevent this separation, a tension force T must be applied by the clamping means. For the exaggerated case shown in FIG. 17*a*, the free body diagram of FIG. 17*b* may be drawn, where T is equal to the tension force resisting separation, F is some force applied at a distance X from the center of rotation R, resulting in a moment $M_1=FX$ acting about R; C is a compression force acting through the center of rotation R and producing no moment; and D is the distance the tension force acts through to produce the moment $M_2=TD$.

When the body shown in FIG. 17*b* is in equilibrium, the summation of moments about any point in that body is equal to zero, i.e.

$$M_1-M_2=0$$

Substituting the moment values gives

$$TD=FX$$

or

$$T=FX/D$$

From the Equation 3, it may be seen that the distance D between the tension producing means and the axis about which the board sections tend to pivot must be maximized in order to minimize the tension force T required to maintain equilibrium. Conversely, as the distance D is reduced, the tension force required to maintain equilibrium follows a hyperbolic relationship. Therefore, the tension should be applied as close as possible to the upper and lower surface of the board as provided by the present invention.

Consider, for example, an extreme loading condition wherein a 250 lb. man is standing on a board solely supported at its end points. The tension force which must be exerted along an axis midway between the upper and lower board surfaces to prevent separation is of the order of 5,000 lb., whereas the tension force at the lower board surface required to prevent separation under these conditions is of the order of 2,500 lb., which force may be provided by plural clamps. For example, if four clamps are used, each clamp need only provide some 625 lb. of tension force.

FIGS. 4, 5 and 10 illustrate in greater detail the indexing pin and socket. Referring to FIG. 10, one of the upper brackets **24***a* and a laterally disposed lower bracket **24***b* are respectively provided with a circular aperture **50** concentric with an indexing pin or a socket **18**. As shown in FIG. 5, a relatively flexible indexing pin **17** formed of a material such as polypropylene and having a diameter of the order of ½ inch is inserted through the aperture **50** of bracket **24***a* into a slightly oversized bore **55** filled with a resin **56** such as isothalic polyester resin. Oppositely disposed grooves **57** are formed at the circumference of pin **17** whereby the resin produces a mating shoulder for assuring that the pin is permanently secured to the core section. A mating socket **18** is provided and comprises a bore **60** long enough to accommodate the extending end of pin **17**. As shown, the bore is made slightly oversize and the exposed surface of the foam coated with isothalic polyester resin **61** after which the polypropylene pin **17** is inserted until the resin sets. The polypropylene material is self-lubricating so that the resin does not bond itself to its smooth exterior surface so that the pin may be withdrawn after the resin sets, thereby forming a close tolerance socket **18**.

A particular feature of the present invention is that the indexing pins and the sockets are utilized solely for properly positioning the sections in longitudinal alignment during assembly of the multi-section board. All shear, torsion, and longitudinal tension and compressive loading forces are opposed solely by the tension provided by the clamping means; accordingly, no stresses are placed either upon the index pin **17** or socket openings **18** when the board is assembled. This obviates any wearing of the soft inner core **20** of the surfboard which inevitably occurs if a member such as pin **17** is relied upon for opposing of the bending moments which tend to separate the board sections. For example, if the pin and socket are used as strength members, the pin will have to be a rigid member adapted for resisting bending moments instead of the relatively flexible pin preferably employed in this invention. Since the rigid pin and socket must be located within the interior portion of the core **20**, the moment arm D is reduced, thereby increasing the tension forces which must be provided by the pin structure. As a practical matter, a rigid pin will inherently tend to enlarge both the socket opening **18** and also the bore **55** within which it is retained, eventually compressing the foam material in these areas and thereby undermining the structural integrity of the board and nullifying the usefulness of such a pin and socket as stress members. Contrariwise, a collapsible surfboard may be constructed according to the present invention having incorporated therewith clamping means which accomplishes both longitudinal rigidity of the board and which obviates separation between the board sections. Any separation be-

tween the sections, however small, is highly undersirable, both because it inherently lessens the rigidity of the board and also because of the danger of the surfer that his skin or clothing may become pinched between abutting sections.

The structure of the removable skeg **14** is shown in detail in FIGS. 7 and 8. Skeg **14** is located in a longitudinal groove **65** formed in a resin-filled cavity **66** on the underside surface of the board core (FIG. 8). A second cavity **67** generally orthogonal to the cavity **66** is also filled with resin and has formed therein an arcuate bore **68** generally orthogonal to the groove **65** and terminating at opposite apertures **72, 73** in the underside section **13** and at oppositely disposed surfaces **74, 75** of the groove **70**. An aperture **80** is formed through the skeg **14** and so located that when the skeg is positioned in groove **70**, the aperture **80** is in alignment with bore **71**. The skeg may then be secured to the board by pushing a flexible plastic pin **76** through one end of the bore **71** and aperture **80**, thereby locking the skeg **14** into position. Removal of the skeg is quickly accomplished by applying a force to either end of the pin **76** until a portion of it extends above the surface of the board, which end may then be grasped and withdrawn from the bore **71**. Both groove **65** and bore **68** are advantageously formed by pouring isothalic polyester resin into the cavities **66, 67** after the skeg **14** and a flexible rod (both formed of a self-lubricating plastic) until the resin sets. The skeg and rod may then be withdrawn, leaving a groove and bore whose dimensions very accurately conform to skeg **14** and pin **76**, respectively. Accordingly, the skeg can be very rigidly retained to the board, while being very easily removed therefrom. Besides affording a very compact package, a further advantage of a removable skeg adapted to be rigidly retained to the board is that a damaged skeg can be very easily replaced.

FIGS. 11, 12 and 13 illustrate the method of constructing the individual board sections described hereinabove. As shown in FIG. 11, the recesses **22, 23** for the clamp means are advantageously formed simultaneously in opposing board sections. One method for constructing these recesses is to initially form the core **20** of the surfboard in the customary manner, then form the recesses **22, 23** in a single routing operation, and subsequently cut through the core **20** as shown at **85**. After cutting the board into the three sections shown in FIGS. 1 and 2, the edge portions proximate the recesses **22, 23** are routed. Each recess **22** (and **23**) therefore comprises a longitudinal groove **22*a***, a shallow mortise **22*b*** formed in the exterior surface of the core, and another shallow mortise **22*c*** in the edge surface of the core proximate groove **22*a***. Each of the other recesses is formed in the same manner to produce the multi-section core, one section of which is shown in FIG. 12.

Another method for producing the respective sections of the board is by forming the recesses and each core section when the core is molded. A mold for producing the sections in this manner is described hereinafter. It will be apparent that the core section shown in FIG. 12 illustrates the core formed by either of these two methods.

The finishing stages of a representative section are accomplished in the manner shown in FIG. 13. Initially, each recess **22** is coated with a suitable resin such as the isothalic polyester resin and the metal bracket **24** positioned in place. The depth of longitudinal groove **22*a*** and shallow mortises **22*b*** and **22*c*** match the dimensions of the bracket **24** whereby the exterior surface of the bracket **24**, including flange surrfaces **24*a*, 24*b***, is essentially flush with the surface of the core as shown in FIG. 3.

Each board section is then covered by laminating fiber glass over both the core and flanges **24*a*, 24*b*** of the bracket, a very firm bond being obtained between the fiber glass laminate and metal brackets of sheet aluminum by anodizing or iriditing the surface of the aluminum. It has been found that this structure distributes the tension forces applied to the clamp means and their associated brackets and prevents excessive stress upon the core material immediately adjacent the bracket **24**. Without such a force distribution, the stresses and strain applied to the core material will be sufficient to quickly cause the deleterious wear at each joint, thereby destroying the utility of the board even though its remaining structure is unblemished.

After the brackets have been secured into position, the respective bores **55, 60** (FIG. 5) are drilled, using the preformed apertures **50** for defining their respective locations. These apertures are accurately located when the brackets **24** are stamped or otherwise formed from sheet metal stock. Thus, by accurately forming the recesses **22, 23** in the core for each pair of brackets, either in the manner shown in FIG. 11 or by the mold described below, the apertures **50** serve to self-align the respective indexing pins **17** and sockets **18**.

A preferred embodiment of a mold **100** for preparing the respective sections of the surfboard is illustrated in FIGS. 14 and 15. As shown, the mold comprises upper and lower halves **100, 101** forming an elongated cavity **102** having the shape of the desired finished surfboard core. Spaced lateral grooves **103, 104** are formed at one-third intervals in the bottom surface of each cavity half, which grooves are adapted to accommodate respective partitions **105, 106**. These partitions are thus placed at one-third intervals along the mold cavity to produce a foam body **20** cast into three separate sections. Each partition is provided with plural extending mold cores **110** shaped according to the interior surface of a juxtaposed pair of brackets **24**. Consequently, both recesses **22** and **23** are formed simultaneously with the formation of the core sections. Further, mutually orthogonal longitudinal rectangular cores **111, 112** are provided at the bottom and rear of mold cavity **102** to form respective cavities **66, 67** used for forming the removable skeg retaining structure.

FIG. 16 illustrates the manner in which the surfboard of this invention can be carried as a piece of luggage **120**. As a result, the surfing enthusiast can carry his surfboard in the trunk of an automobile and on any form of public transportation.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

We claim:

1. A surfboard adapted to be arranged in a collapsed and disassembled condition for compact storage and ease of handling comprising

front, center and rear molded plastic foam sections of approximately equivalent length, with one end of said center section being adapted to abut one end of said front section in longitudinal alignment and the other end of said center section being adapted to abut one end of said rear section in longitudinal alignment, and

means for detachably securing said sections including at least two laterally spaced tension clamps located in the upper surface and at least two laterally spaced tension clamps located in the bottom surface of said sections at their respective abutting ends, said clamps being disposed in recesses formed in the surface of said plastic foam and

means for distributing the forces applied to said tension clamps for preventing the application of excessive stress upon the plastic foam material immediately adjacent thereto so that substantial tension can be applied near the upper and lower surfaces of the board for opposing

the loading forces produced by the surfing activity which tend to separate said board sections while locating the entire clamping structure flush or beneath the board surface, thereby obviating any interference with the user of the board and maintaining full maneuverability in the water with respect to paddling and surfing.

2. The surfboard defined in claim 1 wherein

said means for detachably securing said sections includes a thin metal clamp support bracket having integral flange portions substantially flush with the surface of the plastic foam and

said means for distributing the forces applied to said tension clamps comprises a sheet of fiber glass laminated both to the surface of said plastic foam and to the exposed surfaces of the flange portions of said metal brackets.

3. The surfboard defined in claim 2 wherein

said thin metal brackets are constructed of sheet aluminum whose surface is anodized or iridited to effect a firm bond between the fiber glass laminate and the metal bracket.

4. The surfboard defined in claim 1 comprising

means for positioning said front, center and rear sections in longitudinal alignment including an indexing pin in one section and a mating socket in the abutting section.

5. The surfboard defined in claim 4 wherein

said indexing pin has a grooved portion located within a bore formed in the plastic foam material, said bore being filled with a resin which produces a mating shoulder for permanently securing the pin to said surfboard section.

6. The surfboard defined in claim 4 wherein

said socket comprises a bore in said core material covered with a protective and sealing resin coating.

7. A collapsible surfboard comprising, in combination,

a front section, a center section and a rear section adapted to be connected in an assembled condition in end abutment and longitudinal alignment with one another, said sections being made of foam and having bracket recessions formed therein laterally spaced on the top and bottom side of adjacent sections,

means for connecting said sections together including tension clamps affixed to thin metal clamp mounting brackets secured in said bracket recessions, said bracket recessions having substantially the same configuration as said clamp mounting brackets,

means for indexing the longitudinal alignment of said sections comprising mating pin and socket connections between said abutting ends, and,

a glass fiber material laminated over said separable sections and said mounting brackets bonded thereto.

8. A surfboard adapted to be arranged in a collapsed and disassembled condition for compact storage and ease of handling comprising

a plurality of molded plastic foam sections of approxmately equivalent length, adapted to be connected in an assembled condition in end abutment and longitudinal alignment with one another, and

means for detachably securing said sections including at least two laterally spaced tension clamps located in the upper surface and at least two laterally spaced tension clamps located in the bottom surface of said sections at their respective abutting ends, said clamps being disposed in recesses formed in the surface of said plastic foam and

means for distributing the forces applied to said tension clamps for preventing the application of excessive stress upon the plastic foam material immediately adjacent thereto so that substantial tension can be applied near the upper and lower surfaces of the board for opposing the loading forces produced by the surfing activity which tend to separate said board sections while locating the entire clamping structure flush or beneath the board surface, thereby obviating any interference with the user of the board and maintaining full maneuverability in the water with respect to paddling and surfing.

9. A surfboard adapted to be arranged in a collapsed and disassembled condition for compact storage and ease of handling including

first and second molded plastic foam sections of approximately equivalent length, adapted to be connected in an assembled condition in end abutment and longitudinal alignment with each other, and

means for detachably securing said sections including at least two laterally spaced tension clamps located in the upper surface and at least two laterally spaced tension clamps located in the bottom surface of said sections at their respective abutting ends, said clamps being disposed in recesses formed in the surface of said plastic foam and

means for distributing the forces applied to said tension clamps for preventing the application of excessive stress upon the plastic foam material immediately adjacent thereto so that substantial tension can be applied near the upper and lower surfaces of the board for opposing the loading forces produced by the surfing activity which tend to separate said board sections while locating the entire clamping structure flush or beneath the board surface, thereby obviating any interference with the user of the board and maintaining full maneuverability in the water with respect to paddling and surfing.

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