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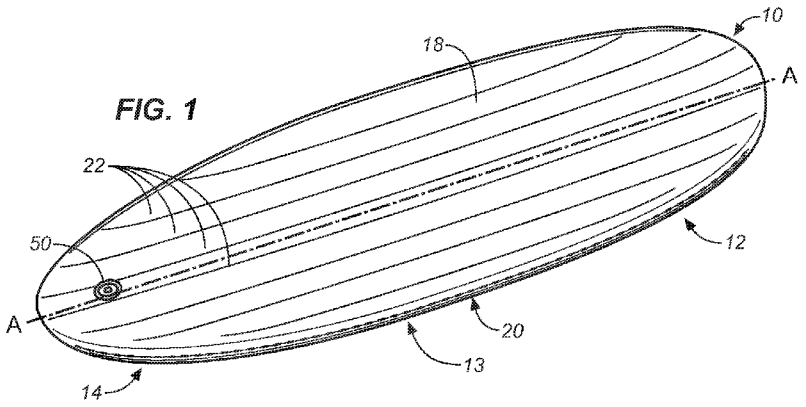
FIG. 1



(57) Abstract: An inflatable structure that includes continuous longitudinal and axial curves, constructed to form a hydrodynamically designed performance platform for use as a performance water sports board, rescue board, or rescue sled, such as a stand-up paddle board, paddleboard, surfboard, PWC rescue sled, bodyboard, or other floating or dynamic platform. Alternatively, it may be adapted for use with additional structure to provide an inflatable hull and floor for a watercraft, such as a boat, raft, life-raft, rescue craft, or other floating or dynamic platform. Longitudinal stringers welded to opposing panels defining the interior volume of the inflatable structure are joined by welding, gluing, or lashing, and the shape of the stringers and the welding/gluing/lashing schedule can be employed to give the inflatable structure a highly customized curved shape.

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INFLATABLE WATERCRAFT STRUCTURES AND METHOD OF MAKING THE SAME

BACKGROUND OF THE INVENTION

Technical Field

[0001] The invention relates most generally to watercraft, and more particularly to floatation structures for watercraft or comprising a sports board, and still more particularly to inflatable watercraft and/or watercraft parts, and methods of manufacturing the same.

Background Art

[0001] All of the known state of the art inflatable high pressure watersports boards are constructed with a drop-stitched PVC fabric. The manufactures number over 20. The drop stitch fabric includes two walls, and is therefore termed a "double wall fabric." It typically includes opposing and parallel PVC panels connected with thin and dense columns of tens of thousands of interwoven nylon stitches holding the panels in their opposing relationship. The stitching pattern can be varied so as to provide differing degrees of rigidity, but any degree of rigidity using any known pattern requires the introduction of high pressure into the closed volume defined by the panels. Pressures over 30 psi are possible, and pressures of 15-25 psi are common, but more importantly, they are needed to provide the board with any meaningful degree of rigidity, particularly when the article is embodiment as a watercraft such as a stand-up paddle board.

[0002] To call these boards "high performance" boards, however, would be hyperbole; in truth, their very modest performance characteristics warrant classifying them in a dramatically subordinate, stepped down position from the solid boards. This is due both to the lack of shear strength in the boards, making them prone to collapse unless inflated to very high pressures, and to the fact that no meaningful rocker or other performance design characteristics (including various types of rail configurations) can be introduced using the drop stitch construction techniques. Performance design characteristics can only be

minimally provided in a drop stitch board, because by the very nature of the fabric employed, the drop stitch resists rocker, and manufacturers must force minimal dimensional gains through side panels, resulting in "boxy" rails very unlike those in performance "hard boards" and the boards made possible by the present invention.

[0003] Accordingly, the very essence of good waterboard performance – namely, bottom rocker – cannot be included in a drop stich board, let alone complex bottom rocker, such as nose rocker, tail rocker, and mid rocker. Likewise, there cannot be any upper curvature suitable for rider comfort and performance features. Disappointingly, drop stitch boards are flat and tend toward square. The flatness of the board is reflected in the flatness of the performance characteristics.

[0002] The foregoing discussion reflects the current state of the art of which the present inventors are aware. Reference to, and discussion of, the known products and manufacturing methods is intended to aid in discharging Applicants' acknowledged duty of candor in disclosing information that may be relevant to the examination of claims to the present invention. However, it is respectfully submitted that none of the known prior art products disclose, teach, suggest, show, or otherwise render obvious, either singly or when considered in combination, the invention described and claimed herein.

Disclosure of Invention

[0004] The present invention represents a radical departure from the above-described commonly accepted materials and means of manufacturing inflatable watercraft, such as stand up paddle boards (SUP boards). Using the inventive materials and inventive fabrication techniques, high performance inflatable boards can be produced that possess the desirable performance characteristics of solid boards, including remarkable rigidity for an inflatable design, plus bottom rocker of all kinds – nose, tail, staged, continuous, and variations thereof, and performance rail designs such as pinched and ballooned rails, as well as others, and even changes in the rail type and thickness along the length of the board or watercraft. Upper deck shape and curvature is also achieved, including domed or dished shapes (i.e., convex or concave about several axes). This is achieved using a novel internal stringer system, constructed using a new inflatable board construction process. The internal stringers provide internal longitudinal sheer resistance that significantly increases rigidity and simultaneously

reduces the necessary internal air pressure required for characteristics comparable to the rigid boards on the market. Several other advantages are realized by the present invention:

[0005] Internal (or recessed) fin boxes may be employed, similar to those found in hard boards, which are vastly superior to externally mounted fin bases on currently marketed inflatable boards, which increase drag by obstructing water flow across the bottom of the inflatable board. In an embodiment, the fin boxes are recessed, and in this configuration the fin boxes can be anchored to the opposing side of the board, thereby decreasing fin flex due to hydrodynamic pressures encountered in high performance conditions.

[0006] The use of chemically bonded urethane coatings provides a permanent extra layer of puncture, tear and abrasion resistance that also seals out water from wicking into the scrim at all of the exterior exposed edges of the assembled fabric panels.

[0007] Further, permanent, customized designs (both board shape and applied artwork) can be achieved for every individual board (just like custom shaped surfboard art).

[0008] The most salient improvements are attributable to a customizable internal longitudinal stringer system. Each internal stringer in the stringer system is longitudinally cut down its length and welded or glued to either the upper or lower board panel. It is then coupled to a complementary opposing stringer on the opposing panel, effectively creating a plurality of upper and lower stringers that are joined together. The upper and lower stringers may overlap a predetermined amount and the overlapping portions can be welded or glued together. Alternatively, the opposing upper and lower stringers can be zig-zag lashed together by parachute cord, from a single anchoring point in the nose or bow, and to a permanent anchor, or alternatively, to an individual winch mechanism in the tail or stern that allows a user to expand or decrease the thickness of the board based on user or environmental conditions. A lower profile board can be achieved for use in doing yoga, for instance, or a higher profile can be achieved for use in rough water conditions.

[0009] In an embodiment, the inventive inflatable panels of the present invention may be employed to make an inflatable boat hull, floor, or even an entire boat. The internal stringer system of the present invention is adaptable and suitable for use in producing innovative inflatable hulls and/or floors and/or sides for and of inflatable boats. This can yield a complete inflatable boat or, when fixed to a conventional inflatable boat solid transom, a complete performance inflatable boat. They may be shaped with complex curvature, as described above.

[0010] The foregoing summary broadly sets out the more important features of the present invention so that the detailed description that follows may be better understood, and so that the present contributions to the art may be better appreciated. There are additional features of the invention described in the detailed description of the preferred embodiments of the invention, which follows, below, and which form the subject matter of the claims appended hereto.

[0003] Accordingly, before explaining the preferred embodiment of the disclosure in detail, it is to be understood that the disclosure is not limited in its application to the details of the construction and the arrangements set forth in the following description or illustrated in the drawings. The inventive apparatus described herein is capable of other embodiments and of being practiced and carried out in various ways.

Brief Description of the Drawings

[0011] The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

[0012] FIG. 1 is an upper right rear perspective view of a high performance water sport board constructed using the materials and inventive fabrication techniques of the present invention;

[0013] FIG. 2A is a highly schematic cross-sectional end view in elevation showing an embodiment of the longitudinal internal stringers used to provide shear strength in the present invention, the embodiment comprising a planar base stringers, and this view showing the upper and lower portions of the stringers in their pre-fabrication configuration;

[0014] FIG. 2B is the same view showing the base portion of each of the upper and lower stringer portions welded to together to form overlapping upper and lower medial flaps;

[0015] FIG. 3A is the same view showing upper and lower flexible material panels disposed above and below the stringers;

[0016] FIG. 3B shows the flexible material panels being folded at their sides to form overlapping edge portions;

[0017] FIG. 3C shows the overlapping edge portions of the fabric panels welded to form a sealed side;

[0018] FIG. 4A is a highly schematic cross-sectional side view in elevation corresponding to FIG. 3A;

[0019] FIG. 4B is a schematic side view in elevation corresponding to FIG. 3C, showing the end portions of the flexible fabric panels being folded to form an overlapping portion;

[0020] FIG. 4C, is a schematic side view in elevation showing the overlapping end portions joined in a welded seam;

[0021] FIG. 5 is a top plan view of the board as formed and shown in FIG. 4C;

[0022] FIG. 6A is a highly schematic end view in elevation of upper and lower portions of a split base stringer with the medial flap portions in their pre-fabrication configuration;

[0023] FIG. 6B is the same view showing the upper and lower medial portions each welded into upper and lower medial flaps, respectively;

[0024] FIG. 6C is the same view showing the upper and lower medial flaps welded together to form a unitary stringer;

[0025] FIG. 7A is a highly schematic end view in elevation of upper and lower portions of a planar base stringer with the medial flap portions in their pre-fabrication configuration;

[0026] FIG. 7B is the same view showing the upper and lower medial portions each welded into upper and lower medial flaps, respectively;

[0027] FIG. 7C is the same view showing grommets installed in each of the upper and lower medial flaps and the flaps being lashed together with a lashing so as to form a unitary stringer;

[0028] FIG. 7D is a side view in elevation showing a portion of the stringer of FIG. 7C;

[0029] FIG. 8A is a highly schematic end view in elevation of upper and lower portions of a split base stringer with the medial flap portions in their pre-fabrication configuration;

[0030] FIG. 8B is the same view showing the upper and lower medial portions each welded into upper and lower medial flaps, respectively;

[0031] FIG. 8C is the same view showing grommets installed in each of the upper and lower medial flaps and the flaps being lashed together with a lashing so as to form a unitary stringer;

[0032] FIG. 9A is a highly schematic end view in elevation of upper and lower portions of a split base stringer with the medial flap portions in their pre-fabrication configuration and cordage disposed in the crotch of each of the upper and lower medial portions;

[0033] FIG. 9B is the same view showing the upper and lower medial portions each welded into upper and lower medial flaps, respectively, with the cordage secured within the weld at the edges of the upper and lower medial flaps;

[0034] FIG. 9C is the same view showing the flaps being lashed together with a lashing so as to form a unitary stringer;

[0035] FIG. 9D is a side view in elevation showing a portion of the stringer of FIG. 9C;

[0036] FIG. 10A is a flow chart showing the method steps employed in the pre-assembly portion of fabricating the inflatable structure of the present invention;

[0037] FIG. 10B is a flow chart showing the steps involved in the assembly method;

[0038] FIG. 11A is a top plan view of the inventive apparatus embodiment in a performance surfboard with a planing hull;

[0039] FIG. 11B is a side view in elevation thereof;

[0040] FIG. 11C is an end view in elevation thereof;

[0041] FIG. 12A is a top plan view of the inventive apparatus embodied in a beginner's surfboard (alternatively, a yoga board) having buoyancy rails;

[0042] FIG. 12B is a side view in elevation thereof;

[0043] FIG. 12C is an end view in elevation thereof;

[0044] FIG. 13A is a top plan view of the inventive apparatus embodied in a performance racing paddleboard or distance ocean board with a displacement hull;

[0045] FIG. 13B is a side view in elevation thereof;

[0046] FIG. 13C is an end view in elevation thereof;

[0047] FIG. 14A is a bottom plan view of performance sports board of the present invention, the view showing a fin and stringer configuration made possible by the fin assembly employed in the present invention;

[0048] FIG. 14B is a side view in elevation thereof;

[0049] FIG. 15A is a schematic exploded side view in elevation showing the fin assembly of the present invention disposed between deck and bottom panels;

[0050] FIG. 15B is a cross-sectional end view in elevation thereof, taken along section lines 15B-15B of FIG. 15A;

[0051] FIG. 16A is a side view in elevation showing the fin assembly installed and secured between the deck and bottom panels; and

FIG. 16B is a cross-sectional end view in elevation thereof, taken along section lines 16B-

16B of FIG. 16A.

Best Mode for Carrying Out the Invention

[0052] Referring initially to FIG. 1, we see that in an embodiment, the inflatable structure of the present invention can take the form of a water sport board **10**. The board is shown with evident nose rocker **12** mid-rocker **13**, and tail rocker **14**. Also shown is nose and tail taper as the board thins closer to the ends (refer here to FIG. 4A), and rail shape **16**, e.g., a tapered performance rail (referring to FIG. 3C). While the rail shape **16** is more subtle, it is clearly seen in FIG. 3C, and it will be appreciated that there are numerous rail shapes and bottom contours possible, including vee or concave.

[0053] The board is generally symmetrical right and left of its longitudinal axis **A**, and includes a top (first) flexible material panel ("upper panel" or "deck panel") **18** and a bottom (second) flexible material panel ("lower panel" or "bottom panel") **20**. The panels are preferably made from very high quality coated fabric, for instance, a plastic-based polymer, such as the XR MARINER® fabric or other material from Seaman Corporation of Wooster, Ohio or comparably strong, waterproof, bondable polymeric material or composite material. [XR MARINER® is a registered trademark of Seaman Corporation.] A plurality of internal longitudinally oriented stringers **22** made of the same fabric are disposed between and affixed to the interior sides **24**, **26** of the upper and lower panels, respectively.

[0054] In an embodiment, the stringers are paired inboard stringers **28** and outboard stringers **30** and symmetrically spaced about the longitudinal axis, thus entailing the use of an even number of stringers. Full scale water sports boards preferably have a total of eight (8) stringers disposed alongside the board centerline. The interior stringers (those closest to the centerline) each include an upper portion, **28a**, **30a**, for the upper portions of the inboard and outboard stringers, respectively, and **28b**, **30b** for the lower portions of the inboard and outboard stringers, respectively.

[0055] In an embodiment, shown in FIGS. 2A-2B, wherein the stringers have planar bases and the upper and lower stringers are manufactured from a single panel of flexible material, the panels may be folded into a cross-sectional shape of a "V" or inverted "V". Using the outboard stringer as an example, it is seen that the stringer thus includes the two stems **30c** (comparable to stem and arm), a crotch **30d**, and the flanges or base portions **30e** (comparable to outwardly extending serifs). In manufacture, the stems (FIG. 2A) are first

welded together to form a single generally planar panel (FIG. 2B); then the base portions of the upper stringers are welded to the upper panel and the base portions of the lower stringers are welded to the lower panel. The stringers are oriented generally parallel to the longitudinal axis of the panels. Once affixed, the upper stringers present a medial flap extending downwardly from the interior side of the upper panel, and the lower stringers present a medial flap extending upwardly from the interior side of the lower panel. The medial flaps may overlap in a side-by-side arrangement or have edges slightly spaced apart, depending on whether the flaps are to be joined with a lashing (when the edges are separated) or a weld (when the flaps overlap).

[0056] As can be seen in FIGS 3A-3C, once the upper and lower portions of the stringers are coupled, the outboard stringers have a height less than that of the inboard stringers. Further, and referring now to FIGS. 3A through 3C and FIGS. 4A through 4C, it is seen that the stringers can, and preferably do, have upper and lower contours from the front end **32** to the rear end **34** of the inflatable board **10**. These contours may include a continuous or staged concave upper curvature **36** and a continuous or staged lower curvature **38**. The upper and lower contours can be, and preferably are, different from one another. When the upper and lower panels **18**, **20** are welded to the flanges (base portions) **28a/28b**, **30a/30b** of the upper and lower stringers, because the paired inboard and outboard stringers are identical in their pairings, the panel surfaces are configured allochirally in their conformation to the shape dictated by the upper and lower stringers. Thus, in the exemplary views, the upper panel **18** is configured with a concave surface **40**, and the lower panel **20** is configured with a convex surface **42**.

[0057] Closure of the inflatable structure to form an airtight interior volume involves bending the sides and ends of the upper and lower fabric panels to create a continuous, surrounding seam **44** sealed with a high frequency, solvent, hot air, or ultrasonic weld, or glued with a suitable plastic adhesive. The entire floatation platform may be coated with chemically bonded urethane to increase its durability and provide artistic customization.

[0058] An air inlet/outlet (inflation /deflation) boat valve **50**, such as a Boston or thwart valve, or preferably a C7 valve as manufactured by Leafield Marine, Ltd. of Wiltshire, UK, is inserted in the deck fabric along the longitudinal centerline **A** proximate the stringer terminations on each side of the centerline, or other locations. Thus, air under pressure can be pumped or fed into the inflatable board (or selectively released, as desired) to achieve high

overall rigidity, and access can be provided for adjusting stringer tensions in a lashing embodiment. Working models of watersport boards have been demonstrated to provide high performance characteristics inflated with only low pressures, e.g., not exceeding 5psi. The internal longitudinal stringers provide such superior shear strength that the board will have an overall rigidity and resistance to collapse around any axis, thus rivalling the structural characteristics of solid boards, and with a shear strength vastly exceeding that of drop stitch inflatable designs.

[0059] FIGS. 6A through 9D show alternative stringer configurations, each capable of achieving the above-described advantageous characteristics. Referring now to FIGS. 6A-6C there is shown in an end view in elevation, a highly schematic split base stringer **60** having upper and lower portions **62a/62b** with medial flaps **64a/64b** in their pre-fabrication configuration, and showing how two unattached fabric sections **66a/66b** form the arms of a "Y" configuration viewed on end, while the bonded medial flap portions (see FIG. 6B) for the stem. The base portions **68a/68b** of the upper and lower portions **62a/62b** are welded or otherwise affixed to the upper and lower panel interior sides, as described above. In assembly they are then welded together to form the unitary longitudinal internal stringer (see FIG. 6C).

[0060] FIGS. 7A through 7D show yet another stringer configuration **70**, this having the structural features of the planar base stringer described above, but having upper and lower portions **72a/72b** with medial flap portions **74a/74b** with troughs or crotches **76a/76b** spaced apart when installed on the fabric panels. Grommets 78a/78b are installed in rows in the upper and lower medial flaps **74a/74b** and a lashing **75** connects the upper and lower stringer portions by being threaded in a continuous serpentine pattern through the grommets extending from the front end of the stringer to the rear end (see FIG. 7D). The lashing is anchored at the front end of the stringer and secured for adjustment at the rear end.

[0061] FIGS. 8A-8C show yet another stringer configuration **80**, this synthesizing the split base design shown in FIGS. 6A-6C with the lashing method of coupling the upper and lower stringer portions, as described in connection with FIGS. 7A-7D.

[0062] FIGS. 9A-9C show still another embodiment **90** of the longitudinal stringer of the present invention, this design also constituting a slight variation on the lashing design shown in FIGS. 7A-7D. Rather than using grommets, a durable cord **92a/92b** (such as parachute cord) is placed in the troughs or crotches **94a/94b** of the upper and lower medial flaps **96a/96b**, and the medial portions are then welded or bonded so as to capture the cordage in a

strong terminal line defining the edge of the medial flap. Apertures **98a/98b** are then cut in rows immediately above the cordage so that a lashing **95** can be threaded in a continuous serpertine pattern through the apertures, in the manner described with respect to the use of grommets.

[0063] The method of manufacturing and assembling the inflatable structure of the present invention is also novel, making possible the inventive floatation structures. Referring to FIGS. 10A-10B, there is shown in flow chart form the essential method steps for preparing the structural elements for assembling and then of assembling the inventive inflatable structures. Referring now to FIG. 10A, pre-assembly **100** involves preparing the structural elements and begins by laying out the first and second flexible material panels (upper/top and lower/bottom, respectively) and using templates to mark the panels for cuts and bonding surfaces **102**. The templates define whether the panels will be employed for a board, hull, boat bottom, or some other inflatable structure.

[0064] The panels are then cut to shape and further cut with accessory installation patterns **104**, as called for by the final design. The panels are also marked for the bonding steps. If the inflatable structure is a sports board, fin base holes are cut in the bottom panel **106**. A valve reinforcement patch is bonded, either by welding or gluing, to the underside (interior side) of the top panel **108**, and a valve hole is cut into the top panel **110**.

[0065] Again, if the inflatable structure is a sports board, injection molded fin base anchors are bonded to the interior side of the top panel **112**, and injection molded fin bases are bonded in the fin base holes in the bottom panel **114**. If a lashing arrangement is contemplated, D-ring attachments/anchors are then glued or welded to the bottom panel **114** at the front, nose, or bow, as well as the rear, tail, or stern.

[0066] Referring next to FIG. 10B, assembly **120** then begins by assembling the top and bottom stringers **122** by folding each stringer panel in half along its longitudinal axis, and then bonding the halves together. If the cordage/lashing approach is to be employed for connecting upper and lower stringer portions, the cordage is placed in the crotch of each portion before the medial flap portions are bonded together. The stringer flanges remain untouched to this point. This is repeated for all deck and bottom panel stringers until the stringers are assembled.

[0067] If grommets will be used for lashing, then grommet holes are punched and grommets installed. If cordage and lashing is to be employed, then apertures are punched above the cordage.

[0068] Next, the upper portions of the stringers are bonded to the bottom side of the deck/top panel **124**. This imparts the deck contour to the top panel. The lower portions of the stringers are bonded to the top side of the bottom panel **126**, and this imparts bottom rocker or bow/stern profile.

[0069] Next, if the upper and lower stringer portions are to be coupled using lashings, at step **127** lashing anchors are attached to the top of the bottom panel adjacent to the ends of the stringers at the tail or stern of the watercraft.

[0070] Then, depending on the method employed to connect the upper and lower stringer portions – lashing or welding – the upper/top stringer portions are either welded or lashed to the bottom stringer portions **128**.

[0071] If the inflatable structure is to be a board, then fin bases are installed in fin base anchors at this point (not shown in the view).

[0072] The perimeter of the top panel is folded over and welded to the perimeter of the bottom panel from one side of the structure (or stern) to the other, leaving the center or end open **130**. The end (e.g., the tail/stern) is then closed by hand gluing or welding **132**.

[0073] If the stringer type involves lashing, then lashing adjustments can be made by accessing the interior of the board through the 2 inch valve hole and resetting the stringer D-ring anchor **134**.

[0074] An air fill valve is then installed in the top panel hole **136**. The structure (e.g., the board) is then inflated **138**, at which point all of the shape, curvature, conformations, and design characteristics are fully expressed.

[0075] The structure may then be coated (though it need not be) with a protective and artistic liquid polyurethane **140**. Fins are then installed **142**. If the structure is a sports board, non-slip traction pads are installed on the deck **144**. The structure is then ready for high performance use. It will be appreciated that fins can be swapped out at any time over the life of the board so as to take advantage of various fin shapes for different applications, and number of fins.

[0076] FIGS. 11A-11C show the inflatable watercraft structure of the present invention embodiment in a performance surfboard with a planing hull **200**. In this embodiment, the

eight stringers **202** on each side of the centerline are spaced generally equidistantly on each side of the board. The upper panel (top deck) **204** is provided with a gentle convex curvature (inverted V) induced by the stringer installation as described above. Rails **206** are soft or pinched for hydrodynamic performance. The bottom panel (bottom deck) contains a predetermined rocker profile for surfing performance of various wave applications and rider skill levels. The tail **208** and nose **210** give this particular board a conventional egg design. Different tail and nose shapes are possible for different surfing applications.

[0077] FIGS. 12A-12C show the inventive apparatus embodied in a beginner's surfboard (or yoga board) **300** having buoyancy rails. The additional stability provided by the buoyancy rails **302** enables a user to engage in yoga on the water. The stringer shapes employed in this board enable not only the cylindrical buoyancy rails but a gradual tail rocker **304** and a gradual nose rocker **306** for some maneuverability but high stability. The top panel **308** has a slight concavity to cradle the user on the top. The bottom side **310** may include continuous rocker and/or center rocker, or only nose and tail rocker, as shown.

[0078] FIGS. 13A-13C show the inventive apparatus embodied in a performance racing paddleboard or distance ocean board **500** with a displacement hull having a V-shape bottom **502** and a generally flat top **504**. In this embodiment, the lowest point of the board in the water **506** is along the longitudinal axis. In an alternative embodiment, longitudinal channels can also be included in the bottom contour to promote speed.

[0079] FIGS. 14A-14B show a board **600** incorporating the fin assembly of the present invention, which assembly is made possible by the stringer system employed in the present invention. The fins (or skegs) **602** are placed between stringers **604** and can include any of a number of suitable depths, base lengths, rakes (sweeps), and orientations according to user preference and intended use. FIG. 14A shows a center fin and two side fins, the alignment dictated by longitudinal lines running through the length of the fin and converging at a point in the nose **606** of the board in a manner known in the art.

[0080] FIGS. 15A-16B show the components and placement of the fin assembly **700** employed in the present invention. It is a radical departure from any fin system known for inflatable boards and makes possible a rigid, high-performance fin system for inflatables. As will be appreciated from the views, the fin assembly includes a fin base anchor **702** and fin base **704**, the former affixed/welded to the underside **706** of the deck panel **708**, the latter affixed/welded to the upper side **710** of the bottom panel **712**.

[0081] The fin base anchor includes a generally planar top side **714** and an integral anchor box **716**. The anchor box is fabricated from a slightly resilient polymeric material that readily welds to the deck panel, and it may include a channel into which is disposed an interior anchor box **718** with surface features, such as barbs **720**, which prevent the interior anchor box from being removed from the anchor box **716**. The anchor box alone or interior anchor box includes a fin base channel or socket **722**.

[0082] The fin base **704** includes a flexible foot **724** having a generally planar bottom side **726** which may be affixed/welded to the upper side **710** of bottom panel **712**. Integral with the foot is a block portion **728** which tapers upwardly and then narrows into an elongate bar or male element **730** that fits tightly into the base anchor socket **722**. Similarly to the base anchor, the base may include an interior fin box **732** also captured and retained in the block portion using surface features **734** and is formed to include a channel **736** for insertion of a fin base **738** of a fin **740**. The male element is secured in the fin base anchor by passing bolts **742** through aligned fin base anchor holes **744** and fin base holes **746**. The fin itself is secured in the fin box using grub screws **748**.

[0083] From the foregoing, it will be appreciated that in an embodiment, and in a most essential aspect, the inventive inflatable structure is a hydrodynamically designed performance platform that includes: a first flexible material panel having an interior side, an exterior side, and a longitudinal axis; a second flexible material panel having an interior side, and exterior side, and a longitudinal axis; a plurality of internal stringers disposed between the first flexible material panel and the second flexible material panel, the internal stringers having an upper portion affixed to the interior side of the first flexible material panel, a lower portion affixed to the interior side of the second flexible material panel, and a medial portion defining a plane generally normal to the interior sides of the first and second flexible material panel, the internal stringers oriented generally parallel to the longitudinal axes of the first and second flexible material panels; wherein the internal stringers have a profile as seen in side view in elevation that defines the shape of the first flexible material panel and the second flexible material panel when the inflatable structure is assembled; the first and second flexible material panels joined at their edges to form a sealed interior volume; and a valve for selectively introducing pressurized air into and releasing air from the sealed interior volume.

[0084] It will be further appreciated that the essential inventive method for manufacturing and assembling an inflatable structure includes the following steps: laying out first and

second flexible material panels; cutting the first and second flexible material panels to a shape suitable for the particular kind of inflatable structure under construction; marking the first and second flexible material panels for bonding; installing a valve reinforcement patch in the interior side of one of the first and second flexible material panels; cutting a valve hole in the flexible material panel at the valve reinforcement patch; installing a first set of stringer panels on the first flexible material panel; installing an opposing second set of stringer panels on the second flexible material panel such that when the first and second material panels are approximated in assembly, the first set of stinger panels overlap and engage stringer panels in the opposing second set of stringer panels; connecting the stringers on the first flexible material panel to their respective opposing stringers on the second flexible material panel; folding over a portion of the perimeter of the first flexible material panel and welding the folded portion to a perimeter of the second flexible material panel, leaving an end of the inflatable structure open; closing the open end by hand gluing or welding; installing an air fill valve in the valve hole; and inflating the inflatable structure by introducing air into the structure through the air valve.

[0085] Numerous sub-steps and variations on the essential steps may be undertaken either due to the particular kind of inflatable structure under construction or to customize or tailor the apparatus according to user preferences or use requirements.

[0086] The above disclosure is sufficient to enable one of ordinary skill in the art to practice the invention, and provides the best mode of practicing the invention presently contemplated by the inventor. While there is provided herein a full and complete disclosure of the preferred embodiments of this invention, it is not desired to limit the invention to the exact construction, dimensional relationships, and operation shown and described. Various modifications, alternative constructions, changes and equivalents will readily occur to those skilled in the art and may be employed, as suitable, without departing from the true spirit and scope of the invention. Such changes might involve alternative materials, components, structural arrangements, sizes, shapes, the number of stringers employed, forms, functions, operational features or the like.

[0087] Therefore, the above description and illustrations should not be construed as limiting the scope of the invention.

CLAIMS

What is claimed as invention is:

1. An airtight inflatable structure for use as a hydrodynamically designed performance platform, comprising:

a first flexible material panel having an interior side, an exterior side, and a longitudinal axis;

a second flexible material panel having an interior side, and exterior side, and a longitudinal axis;

a plurality of internal stringers disposed between said first flexible material panel and said second flexible material panel, said internal stringers having an upper portion affixed to said interior side of said first flexible material panel, a lower portion affixed to said interior side of said second flexible material panel, and a medial portion defining a plane generally normal to the interior sides of said first and second flexible material panel, said internal stringers oriented generally parallel to said longitudinal axes of said first and second flexible material panels;

wherein said internal stringers have a profile as seen in side view in elevation that defines the shape of said first flexible material panel and said second flexible material panel when said inflatable structure is assembled;

said first and second flexible material panels joined at their edges to form a sealed interior volume; and

a valve for selectively introducing pressurized air into and releasing air from said sealed interior volume.

2. The inflatable structure of claim **1**, wherein the design and construction of said inflatable structure provides hydrodynamic performance characteristic of high performance non-inflatable watercraft.

3. The inflatable structure of claim **2**, wherein said inflatable structure is selected from the group consisting of a stand up paddle board, paddleboard, surfboard, PWC rescue sled, bodyboard, or other performance watersport board.

4. The inflatable structure of claim **2**, wherein said inflatable structure is an inflatable hull and/or floor for a watercraft selected from the group consisting of a boat, inflatable boat, raft, life-raft, rescue craft, or dynamic floating platform.

5. The inflatable structure of claim **4**, wherein said structure includes longitudinal and axial curvature optimal for and intended use as a watersports board, said longitudinal and axial curvature including one or more of longitudinal rocker; tail and nose kick; domed, dished (recessed) and flat decks; ballooned, pinched and 50/50 (round) rails; and bottom contours, including vee, channels, concaves and spoons (dished noses); and nose and tail thickness tapering from the axial mid-section toward longitudinal extremes.

6. The inflatable structure of claim **4**, wherein said structure includes longitudinal and axial curvature related to and integrated hull and/or floor for boats, inflatable boats, rafts, crafts and vessels, and provides one or more of a rigid and stable floor, bow rise, stern rise, hull chines, and hull vees.

7. The inflatable structure of claim **1**, wherein each of said internal stringers define differing non-planar top and bottom longitudinal curves which, when affixed to said interior sides of said first and second flexible material panels, imparts longitudinal curves, wherein when air is pumped through said valve into said interior volume, said first and second flexible material panels form surfaces conforming to and contiguous with the curved surfaces defined by said top and bottom longitudinal curves, respectively.

8. The inflatable structure of claim **7**, wherein said curved surfaces include deck curvature and bottom rocker.

9. The inflatable structure of claim **7**, wherein said curved surfaces include stern and bow rise.

10. The inflatable structure of claim **1**, wherein each of said internal stringers comprise an upper stringer portion having a bonded portion bonded to said interior side of said first flexible material panel and having an upper medial flap, and a lower stringer portion

having a bonded portion bonded to said interior side of said second flexible material panel and having a lower medial flap, said upper medial flaps joined to said lower medial flaps.

11. The inflatable structure of claim **10**, wherein said upper medial flaps are joined to said lower medial flaps by fabric welding.

12. The inflatable structure of claim **10**, wherein said upper medial flaps are joined to said lower medial flaps with one or more lashings.

13. The inflatable structure of claim **10**, wherein said upper medial flaps are joined to said lower medial flaps with glue.

14. The inflatable structure of claim **2**, wherein said inflatable structure is a complete boat having a hull, floor, sides, and a solid transom.

15. A method of manufacturing an inflatable structure for use as a watercraft, comprising the method steps set out in paragraphs of the written description and as shown in FIGS. 10A-10B of the drawings.

16. A method of manufacturing and assembling an inflatable structure, comprising:

laying out first and second flexible material panels;

cutting the first and second flexible material panels to a shape suitable for the particular kind of inflatable structure under construction;

marking the first and second flexible material panels for bonding;

installing a valve reinforcement patch in the interior side of one of the first and second flexible material panels;

cutting a valve hole in the flexible material panel at the valve reinforcement patch;

installing a first set of stringer panels on the first flexible material panel;

installing an opposing second set of stringer panels on the second flexible material panel such that when the first and second material panels are approximated in assembly, the first set of stinger panels overlap and engage stringer panels in the opposing second set of stringer panels;

connecting the first set of stringers to their respective opposing stringers in the second set of stringer;

wherein each of the stringers have an upper portion affixed to the interior side of the first flexible material panel, a lower portion affixed to the interior side of the second flexible material panel, and a medial portion defining a plane generally normal to the interior sides of the first and second flexible material panel, the internal stringers oriented generally parallel to the longitudinal axes of the first and second flexible material panels, and further wherein the stringers have a profile as seen in side view in elevation that defines the shape of the first flexible material panel and the second flexible material panel when the inflatable structure is assembled;

folding over a portion of the perimeter of the first flexible material panel and welding the folded portion to a perimeter of the second flexible material panel, leaving an end of the inflatable structure open;

closing the open end by hand gluing or welding;

installing an air fill valve in the valve hole; and

inflating the inflatable structure by introducing air into the structure through the air valve.

17. The method of claim **16**, wherein the first and second material panels are upper/top and lower/bottom panels, respectively.

18. The method of claim **17**, wherein said step of laying out the flexible material panels involves using templates to mark the panels for cuts and bonding surfaces.

19. The method of claim **18**, wherein the templates define whether the panels will be employed for a board, hull, boat bottom, or another kind of inflatable structure.

20. The method of claim **19**, further including cutting the material panels with accessory installation patterns according to the final inflatable structure design.

21. The method of claim **16**, further including cutting the material panels with accessory installation patterns, as called for by the final design.

22. The method of claim **16**, wherein the inflatable structure is a sports board, and further including the step of cutting fin base holes in the second flexible material panel.

23. The method of claim **22**, further including bonding fin base anchors to the interior side of the first flexible material panel.

24. The method of claim **23**, further including bonding fin bases in the fin base holes.

25. The method of claim **16**, wherein the valve reinforcement patch is bonded to the first flexible material panel by welding or gluing.

26. The method of claim **25**, wherein the first flexible material panel is a top side panel, and the valve reinforcement patch is installed on the underside of the top side panel.

27. The method of claim **16**, wherein the opposing stringer panels are connecting using a lashing arrangement, and further including attaching D-ring anchors to the interior side of the second flexible material panel at a front end and a rear end of the inflatable structure.

28. The method of claim **16**, wherein assembling each of the first and second set of stringers proceeds by folding each stringer panel in half along a longitudinal axis, and then bonding the halves together.

29. The method of claim **16**, wherein the opposing stringers in the first and second sets of stringers are joined using a lashing technique in which cordage is disposed between bonded layers of stringer panel material in each of the stringers.

30. The method of claim **29**, further including installing grommets for use in threading the lashing to connect the stringers.

31. The method of claim **16**, wherein the stringers in the first set of stringers are bonded to the interior side of the first flexible material panel and imparting deck contour to

the first flexible material panel, and bonding lower portions of the second set of stringers to the interior side of the second flexible material panel to impart bottom rocker or bow/stern profile.

32. The method of claim **31**, further including attaching lashing anchors to the interior side of the second flexible material panel adjacent the ends of the stringers at an end of the inflatable structure.

33. The method of claim **32**, wherein the first and second sets of stringers are joined using lashings.

34. The method of claim **32**, wherein the first and second sets of stringers are joined using welding or bonding.

35. The method of claim **16**, wherein the end left open in the inflatable structure is a center or tail portion of a sports board.

36. The method of claim **16**, wherein the inflatable structure is a sports board and further including installing fins.

37. The method of claim **36**, further including installing non-slip traction pads are installed on an outer surface of the first flexible material panel.

38. The method of claim **36**, further including attaching D-rings to an exterior side of the first flexible material panel.

39. The method of claim **36**, further including coating the inflatable structure with a protective coating.

40. An inflatable vessel, comprising:

a first flexible panel having an interior side and an exterior side;

a second flexible panel having an interior side and an exterior side, said second flexible panel joined to said first flexible panel to form a sealed interior volume;

an air valve;

a first plurality of stringer panels having a top portion attached to said interior side of said first flexible so as to impart deck contour to said first flexible panel; and

a second plurality of stringer panels having a bottom portion attached to said interior side of said second flexible material panel and positioned in relation to said first plurality of stringer panels so as to form pairs of opposing stringers panels and so as to impart bottom rocker to said second flexible panel, wherein each stringer panel of said second plurality of stringer panels includes a top portion connected to a bottom portion of an opposing stringer panel in said first plurality of stringer panels, wherein the shape of said stringers and the connection between opposing stringers imparts contour to each of said first flexible panel and said second flexible panel when said inflatable vessel is inflated.

41. The inflatable vessel of claim **40** configured as a sports board.

42. The inflatable vessel of claim **41**, further including fins.

43. The inflatable vessel of claim **42**, wherein said fins are installed in fin base holes in said second flexible material panel.

44. The inflatable vessel of claim **43**, further including fin base anchors disposed on said interior side of said first flexible material panel.

45. The inflatable vessel of claim **40**, wherein said air valve is positioned in a rear portion of said first flexible material panel.

46. The inflatable vessel of claim **40**, wherein said stringers have a profile that defines a shape of both of said first flexible material panel and said second flexible material panel when the inflatable structure is assembled.

47. The inflatable vessel of claim **46**, wherein said first and second flexible material panels are joined at their edges.

48. The inflatable vessel of claim **47**, wherein said opposing stringer panels are overlapped and bonded to one another.

49. The inflatable vessel of claim **47**, wherein said opposing stringer panels are joined to one another using cordage lashings.

50. The inflatable vessel of claim **49**, wherein said air valve is configured to provide access to said interior volume so as to permit adjustment of lashing tension.

FIG. 1

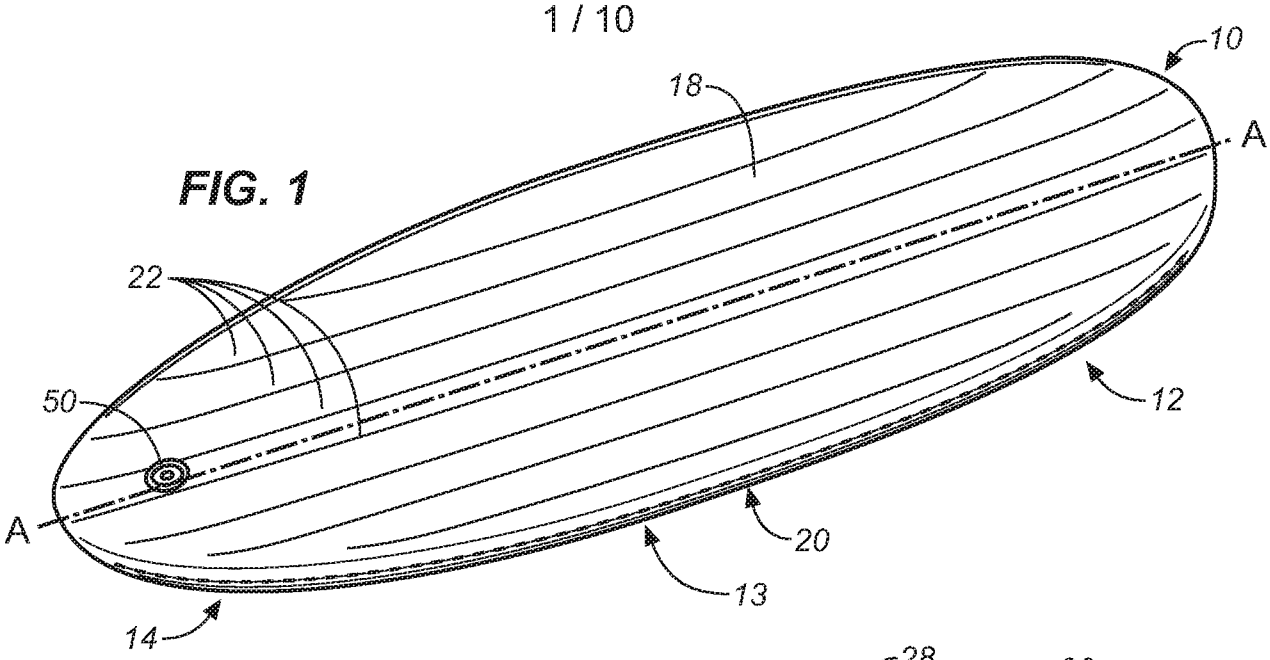


FIG. 2A

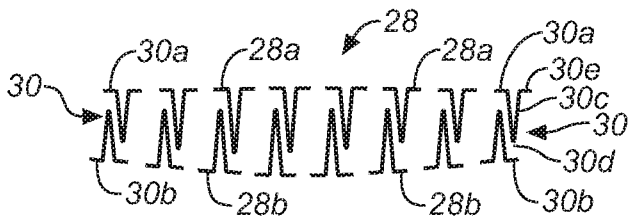


FIG. 2B

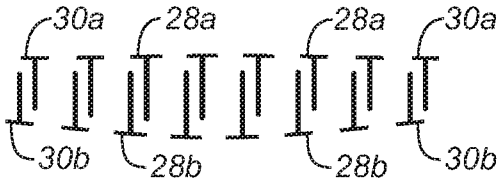


FIG. 3A

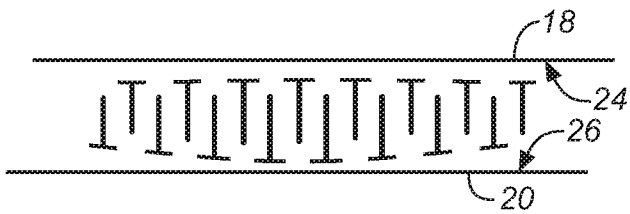


FIG. 3B

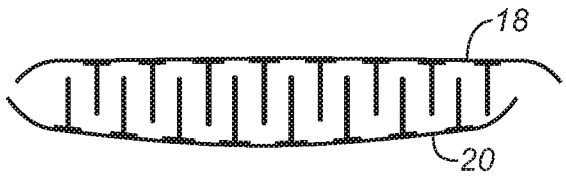
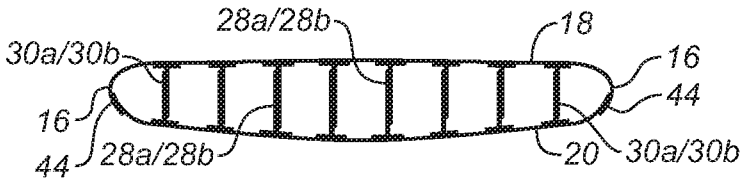


FIG. 3C



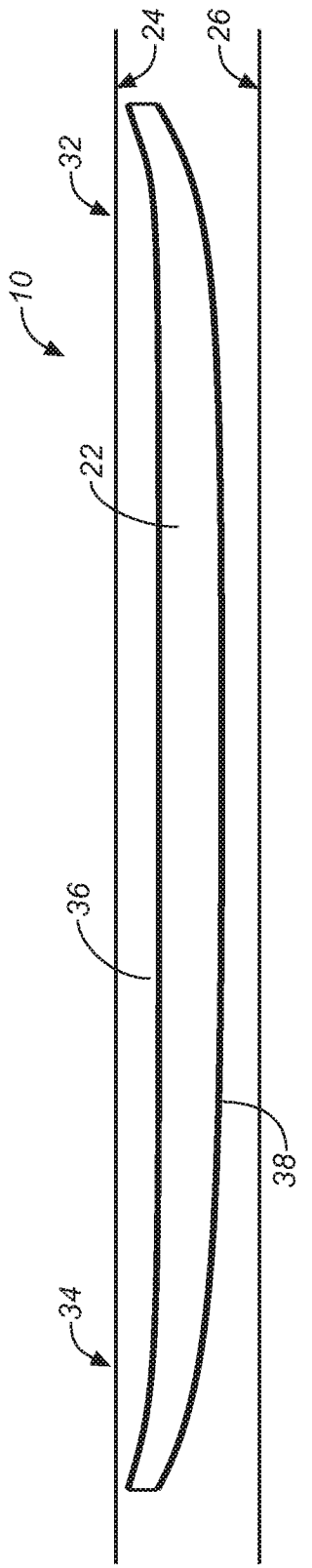


FIG. 4A

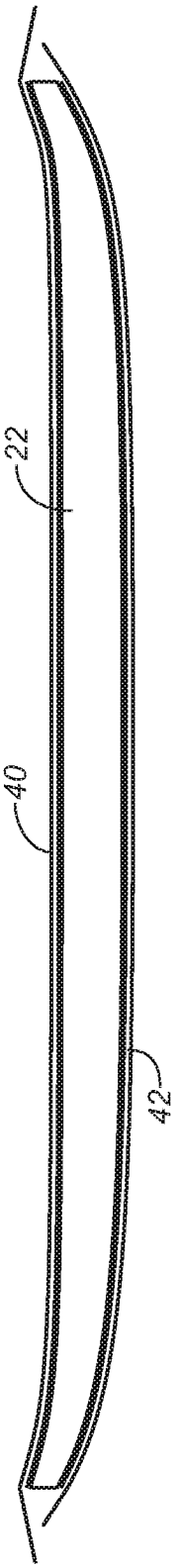


FIG. 4B

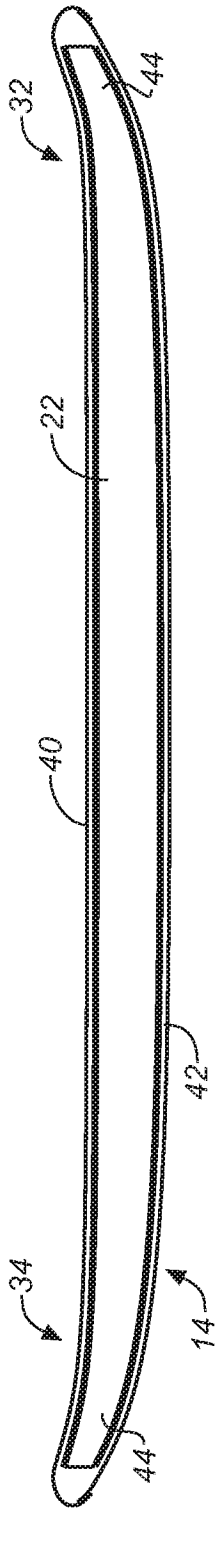


FIG. 4C

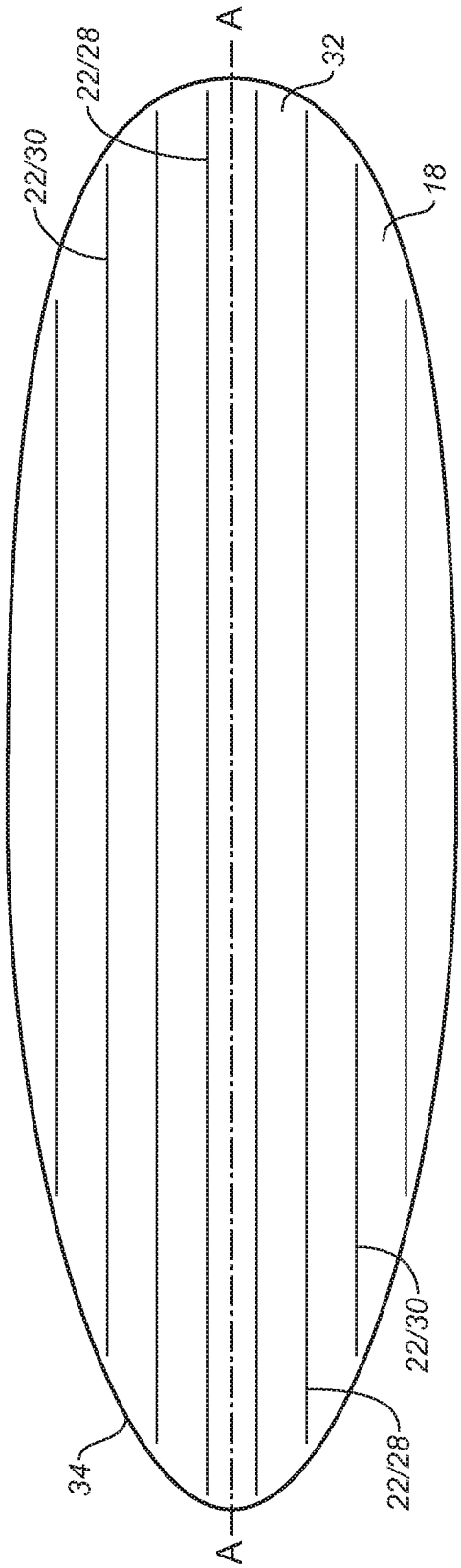


FIG. 5

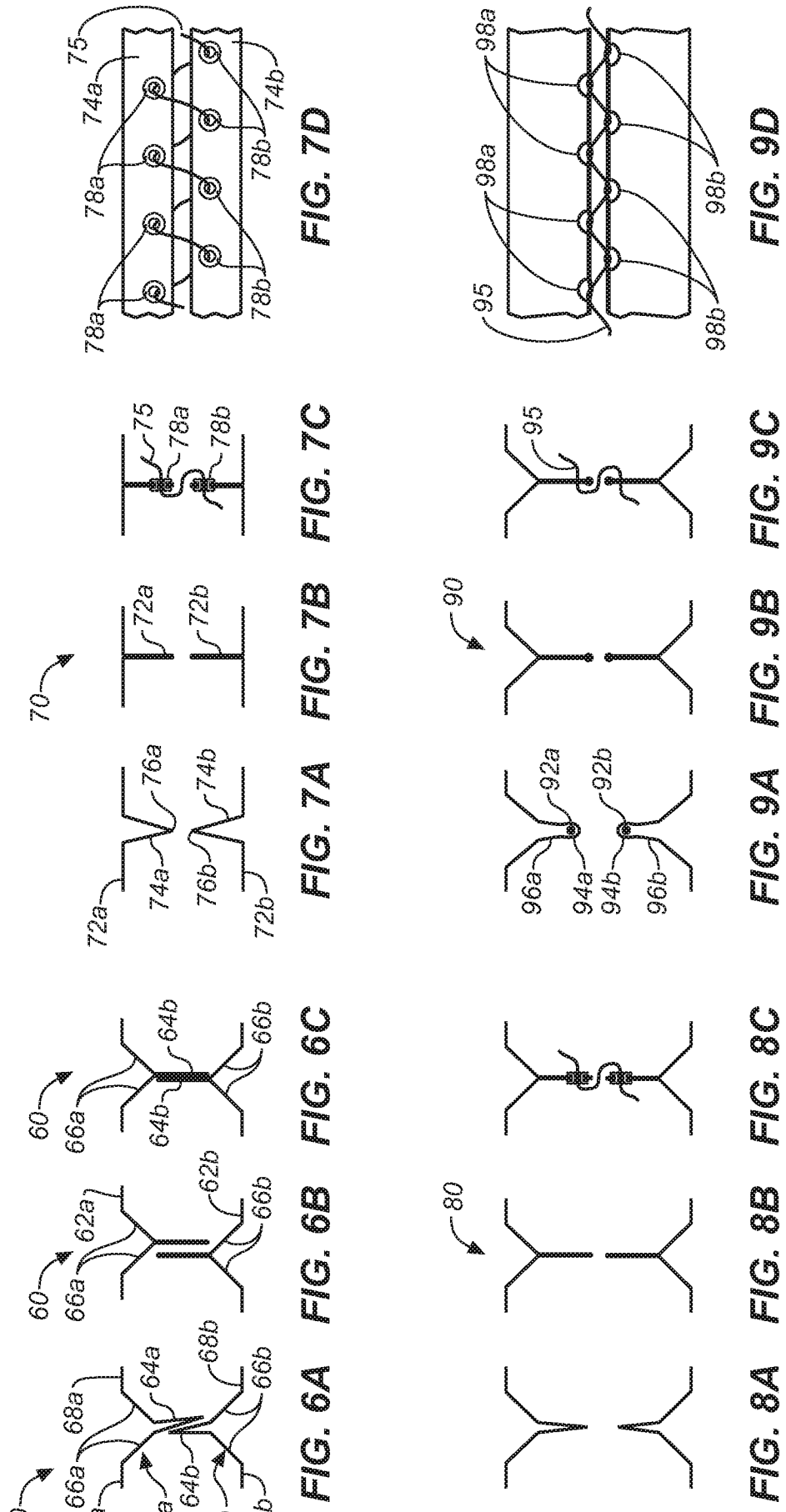


FIG. 6A FIG. 6B FIG. 6C FIG. 7A FIG. 7B FIG. 7C FIG. 7D

FIG. 8A FIG. 8B FIG. 8C FIG. 9A FIG. 9B FIG. 9C FIG. 9D

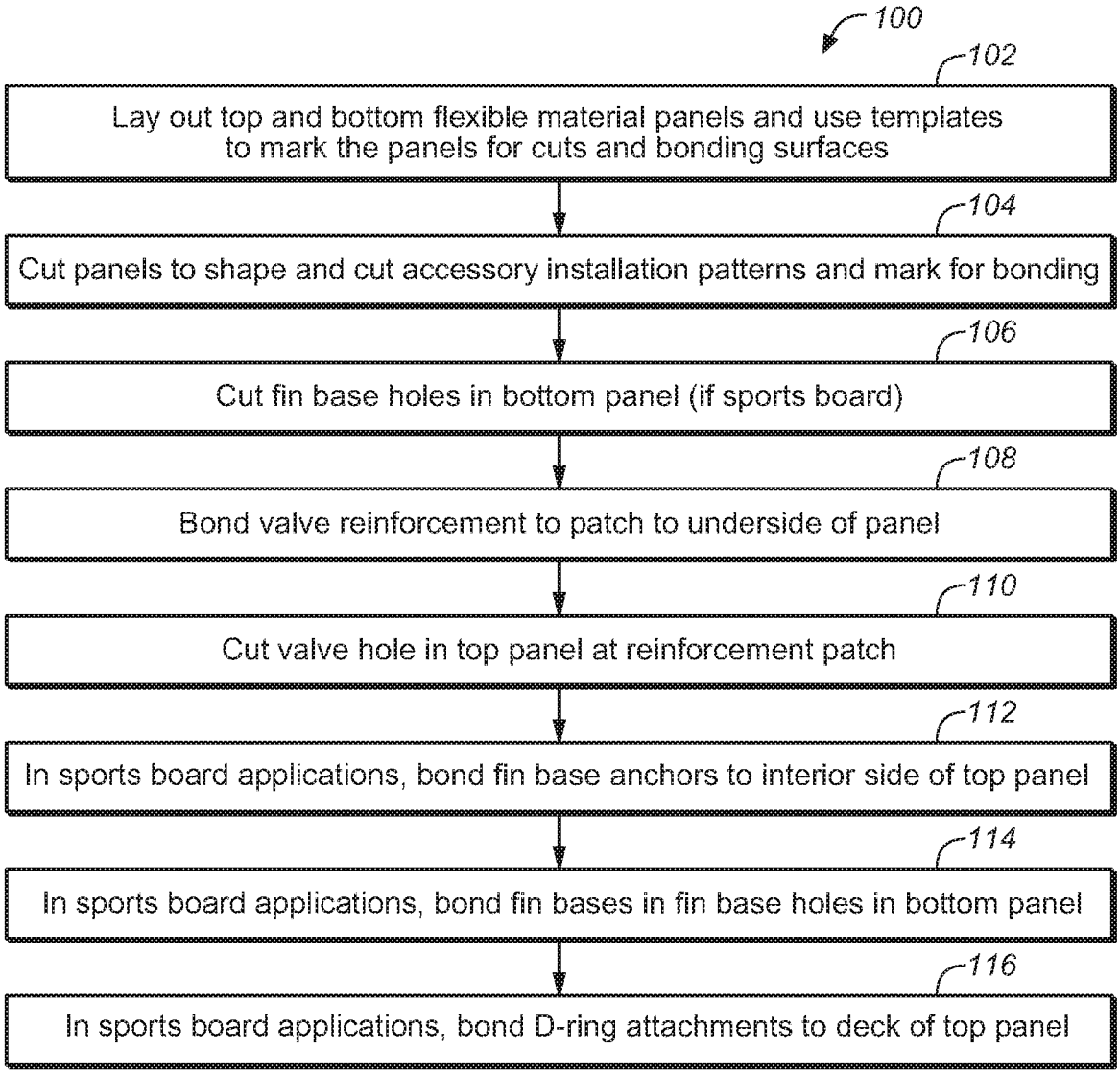

100
102
Lay out top and bottom flexible material panels and use templates to mark the panels for cuts and bonding surfaces
104
Cut panels to shape and cut accessory installation patterns and mark for bonding
106
Cut fin base holes in bottom panel (if sports board)
108
Bond valve reinforcement to patch to underside of panel
110
Cut valve hole in top panel at reinforcement patch
112
In sports board applications, bond fin base anchors to interior side of top panel
114
In sports board applications, bond fin bases in fin base holes in bottom panel
116
In sports board applications, bond D-ring attachments to deck of top panel

FIG. 10A

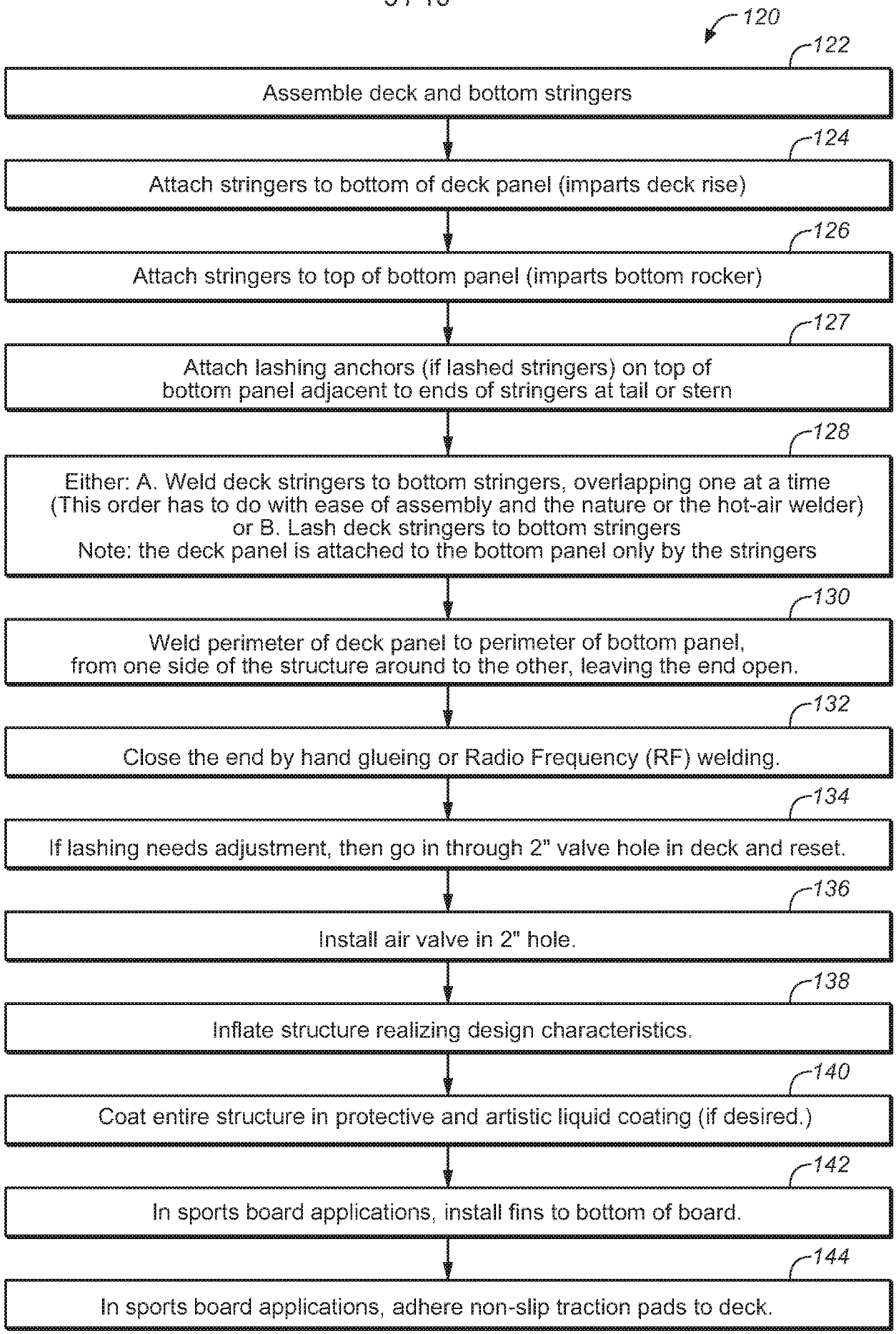

120
122
Assemble deck and bottom stringers
124
Attach stringers to bottom of deck panel (imparts deck rise)
126
Attach stringers to top of bottom panel (imparts bottom rocker)
127
Attach lashing anchors (if lashed stringers) on top of bottom panel adjacent to ends of stringers at tail or stern
128
Either: A. Weld deck stringers to bottom stringers, overlapping one at a time (This order has to do with ease of assembly and the nature or the hot-air welder) or B. Lash deck stringers to bottom stringers
Note: the deck panel is attached to the bottom panel only by the stringers
130
Weld perimeter of deck panel to perimeter of bottom panel, from one side of the structure around to the other, leaving the end open.
132
Close the end by hand glueing or Radio Frequency (RF) welding.
134
If lashing needs adjustment, then go in through 2" valve hole in deck and reset.
136
Install air valve in 2" hole.
138
Inflate structure realizing design characteristics.
140
Coat entire structure in protective and artistic liquid coating (if desired.)
142
In sports board applications, install fins to bottom of board.
144
In sports board applications, adhere non-slip traction pads to deck.

FIG. 10B

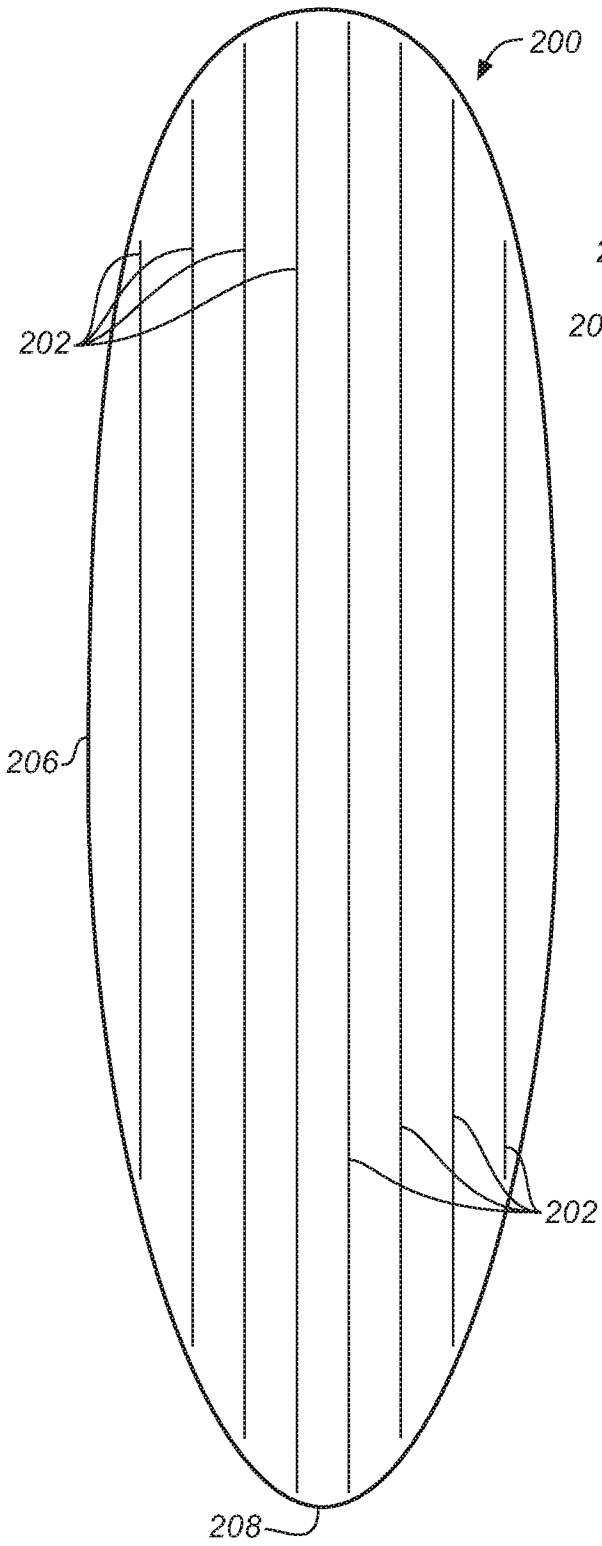


FIG. 11A

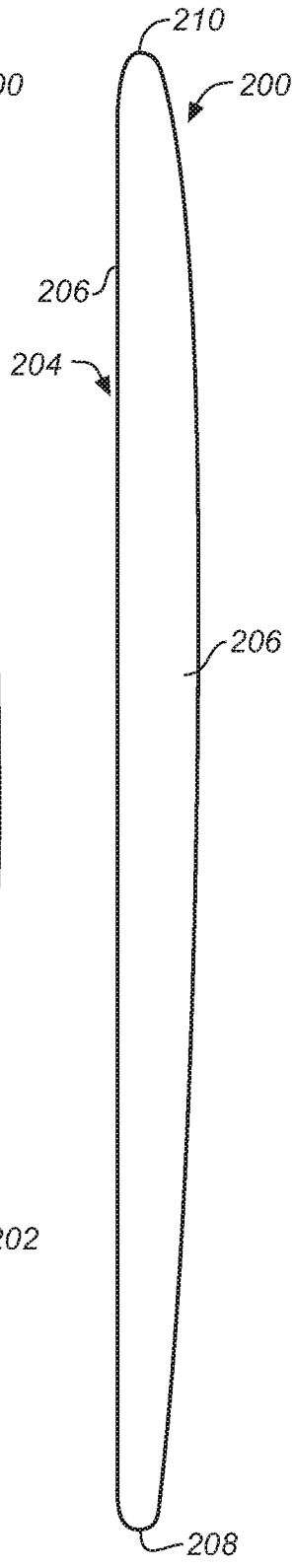


FIG. 11B

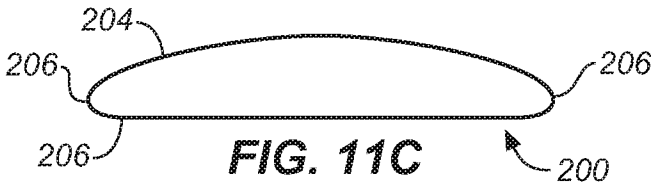


FIG. 11C

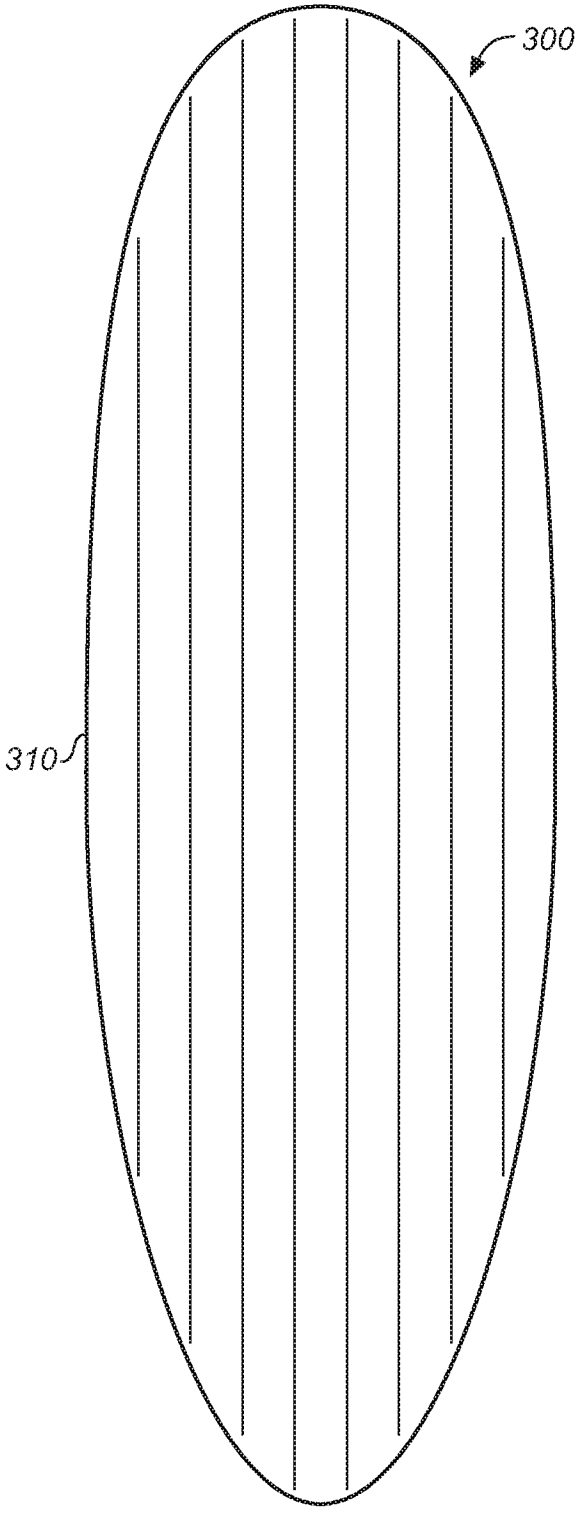


FIG. 12A

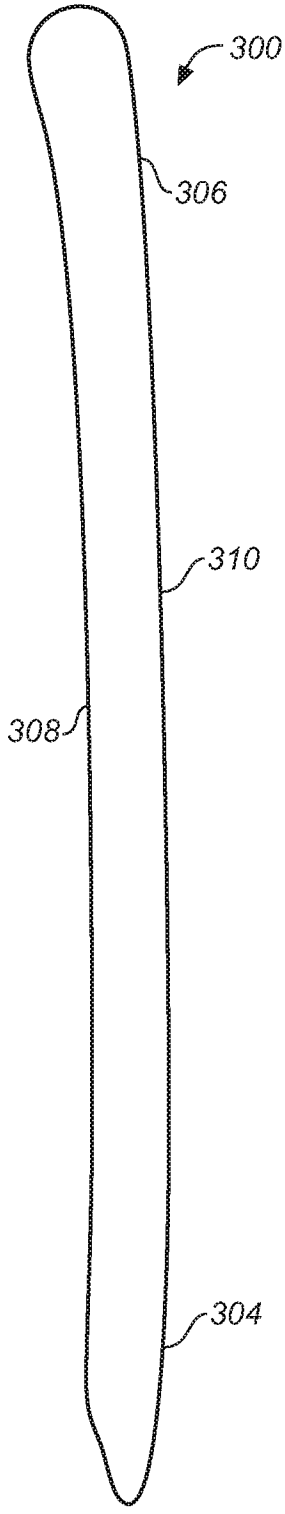


FIG. 12B

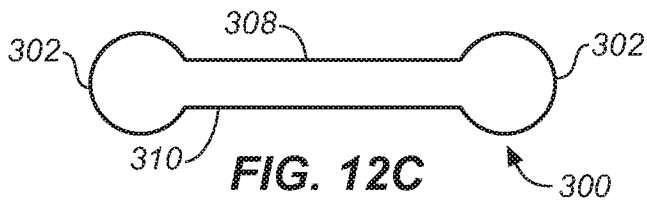


FIG. 12C

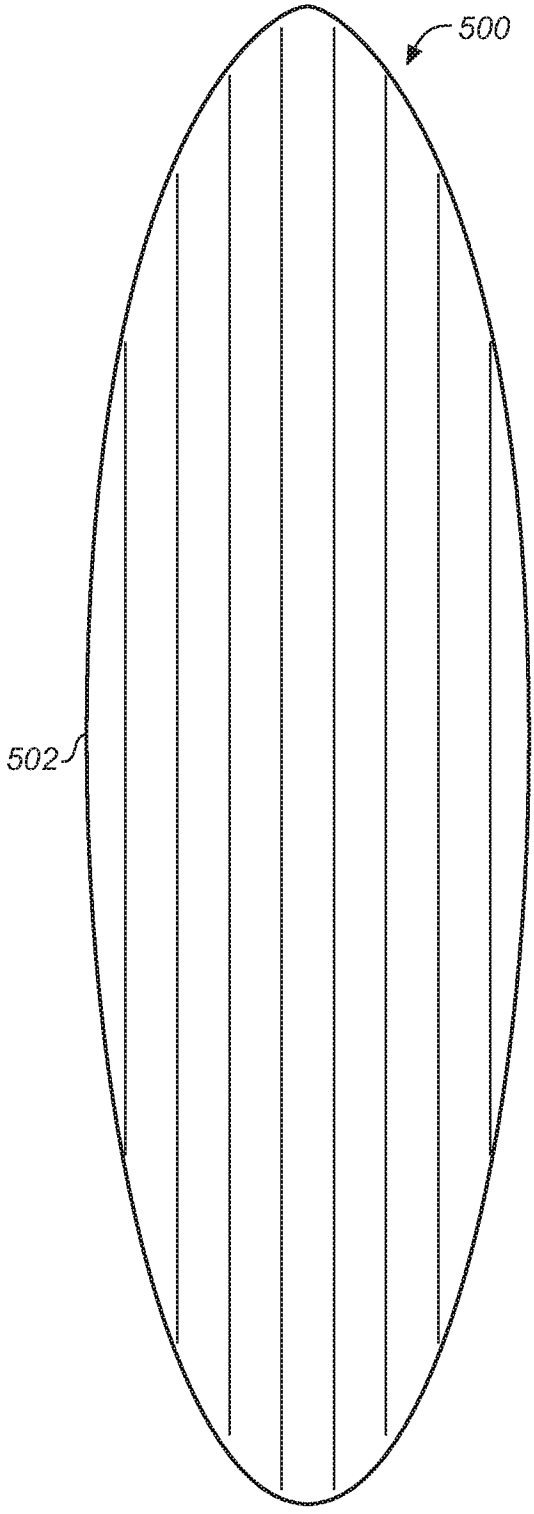


FIG. 13A

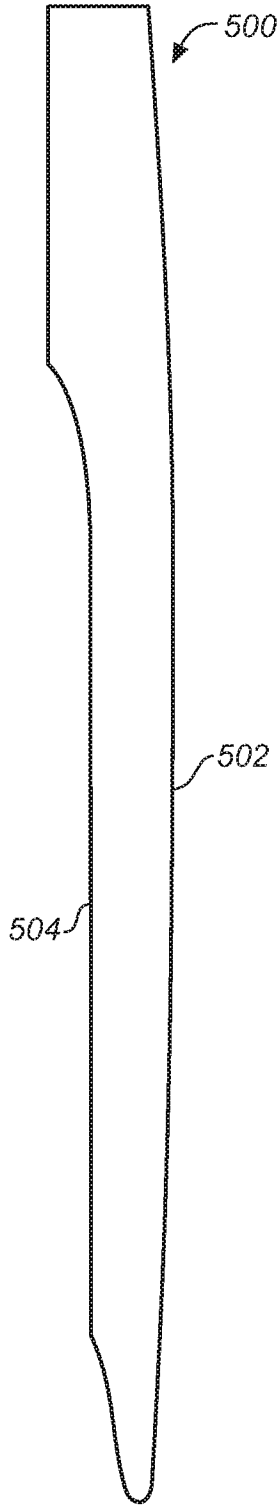


FIG. 13B

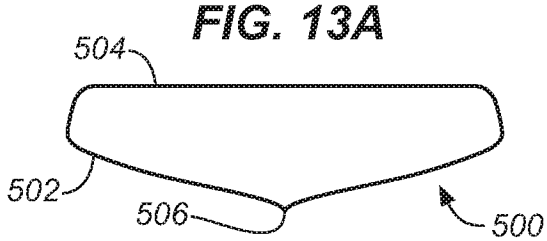


FIG. 13C

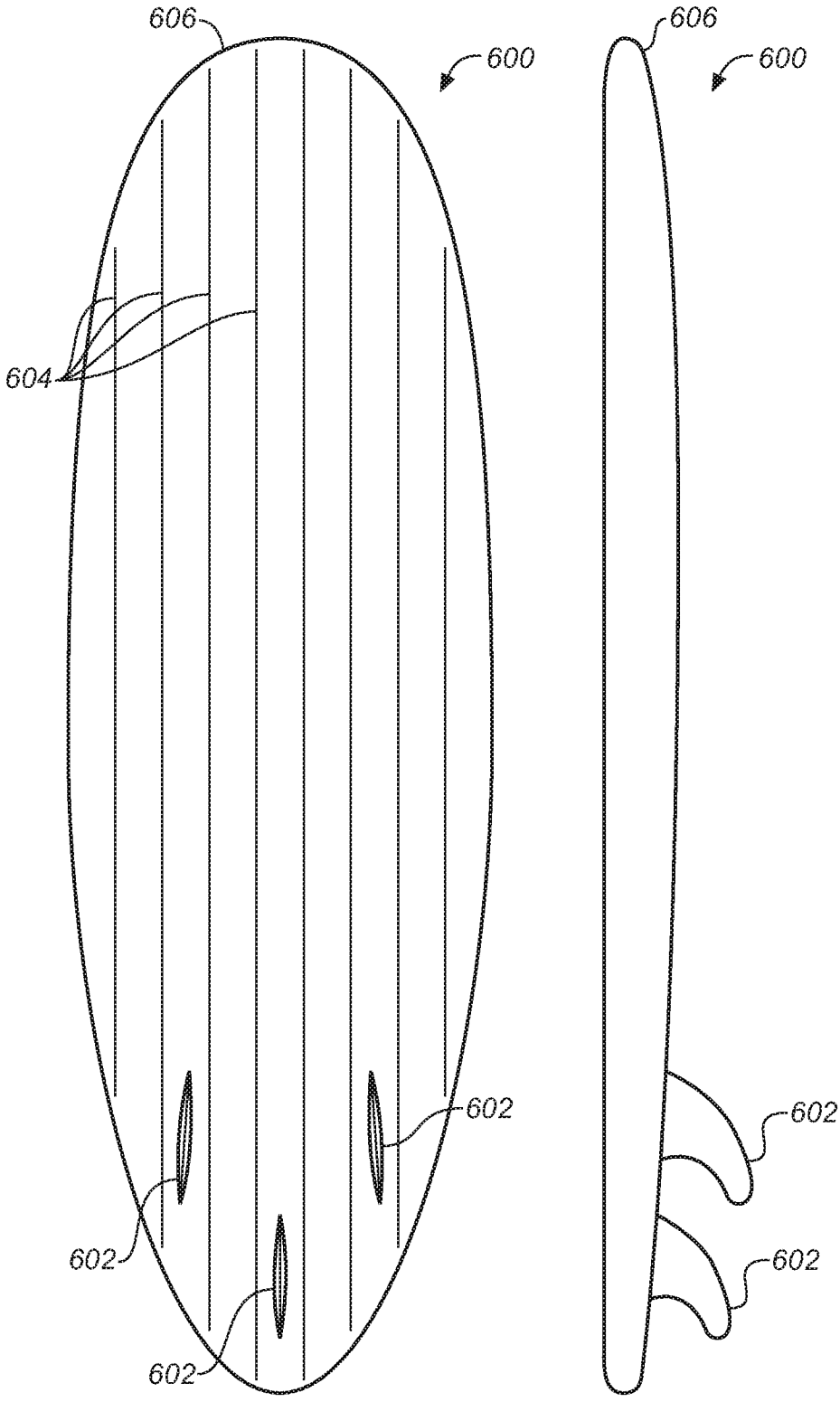


FIG. 14A FIG. 14B

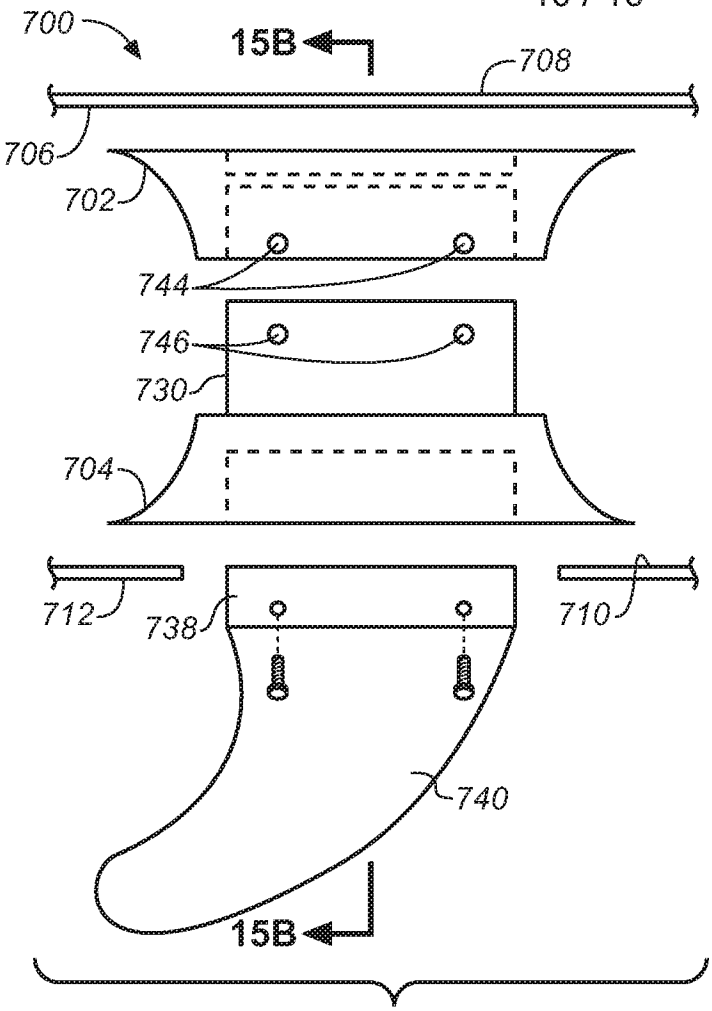


FIG. 15A

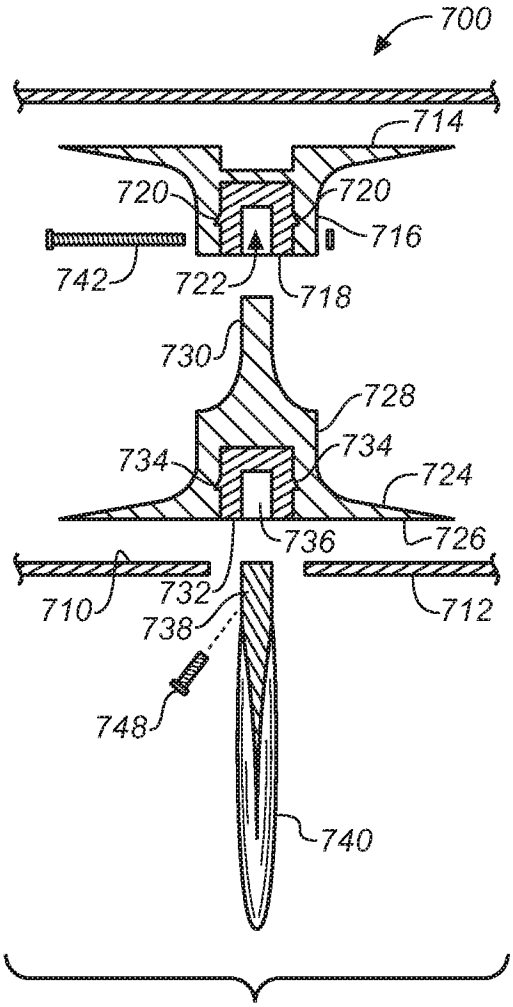


FIG. 15B

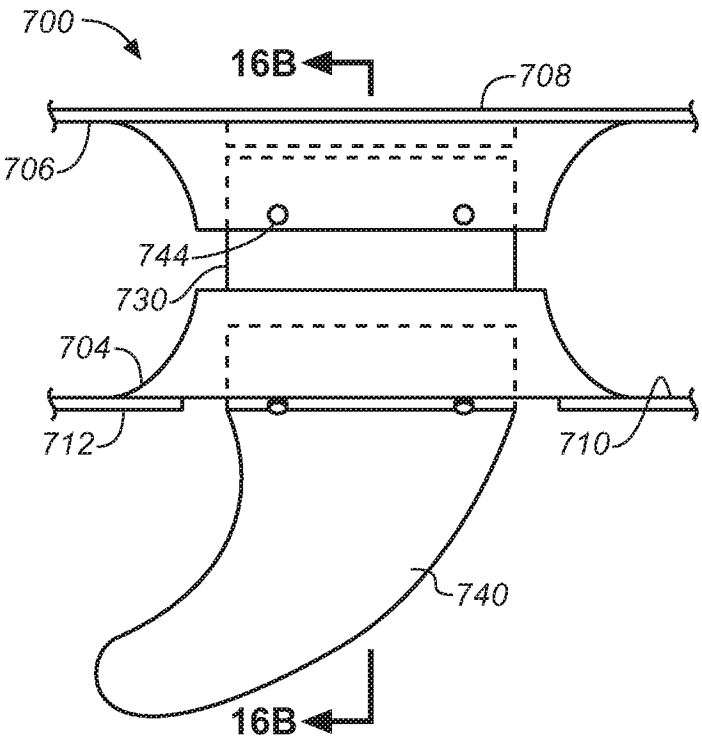


FIG. 16A

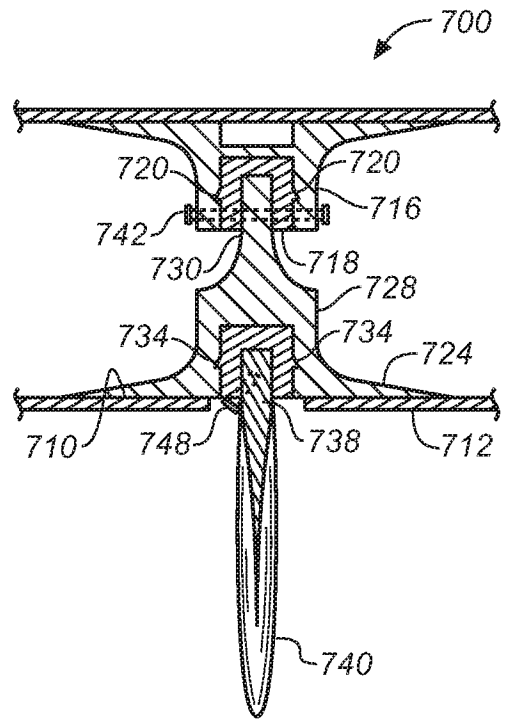


FIG. 16B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/013232

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 15
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 15 is held to be an omnibus claim because claim 15 fails to point out what is included or excluded by the claim language.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/013232

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B63B 35/73; B63B 7/06; B63B 7/08; B63B 9/00; B63B 35/58; B63B 35/79; B63B 43/10 (2017.01)
CPC - B63B 35/73; B63B 7/06; B63B 7/08; B63B 9/00; B63B 35/58; B63B 35/79; B63B 43/10; B63B 43/12 (2017.02)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 114/264; 114/266; 114/345; 441/35; 441/40; 441/41 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,561,873 A (WEEDLING) 08 October 1996 (08.10.1996) entire document	1-4
A	US 2004/0031207 A1 (FLEMING) 19 February 2004 (19.02.2004) entire document	1-14, 16-50
A	US 6,044,789 A (KURZMAN) 04 April 2000 (04.04.2000) entire document	1-14, 16-50
A	US 3,716,953 A (MOORE) 20 February 1973 (20.02.1973) entire document	1-14, 16-50

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 March 2017	23 MAR 2017
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774