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(54) **Fluid displacement body for emergency floatation of marine craft**

(57) A portable inflatable water displacing body (10) for preventing complete submersion of watercraft in immanent danger of sinking due to a sudden influx of water is comprised generally of at least one bladder (12), normally mounted within the hull of the vessel in a collapsed and deflated condition, each bladder having: 1) internal volumetric expansion means (14) including an inlet (26) connected to an external gas source (24) for charging the expansion means and a relief valve (30) for controlling the amount of pressure in the expansion means, and 2) a check valve (16) for allowing one-way passage of ambient air into the bladder. The expansion means (14) is comprised of an extremely light-weight, highly flexible tubular framework which when charged with the gas expands into a pre-defined three-dimensional geometric shape causing the volume within the surrounding bladder to increase. The increase in volume reduces the pressure and creates a partial vacuum, which is filled by air pushed in through the check valve by the higher atmospheric pressure. The expanded water displacing body competes for and successfully occupies space within the vessel's hull, and preferably but not essentially below the waterline, which would otherwise be filled by incoming water. Because both the volume of the vessel and its average density are substantially maintained, so is the buoyancy needed to keep the vessel afloat.

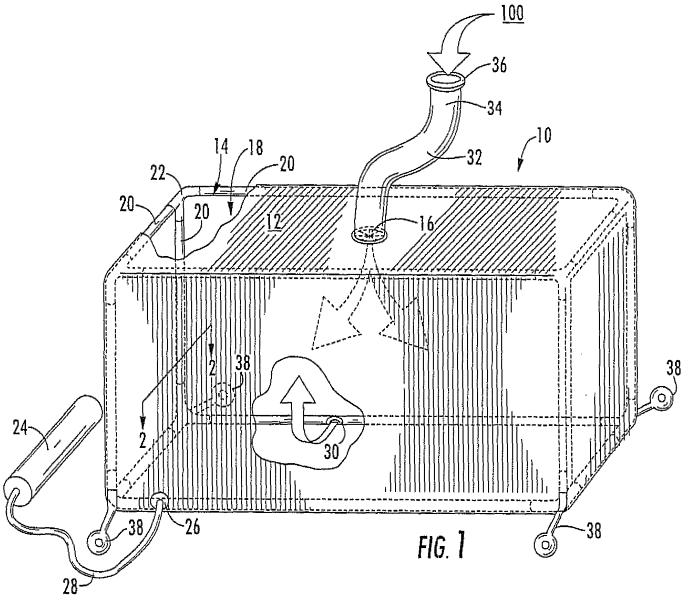

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] The subject invention relates generally to a floatation devices for waterborne vessels, and to an inflatable water displacing body for preventing the complete submersion of water craft in danger of sinking, in particular.

BACKGROUND OF THE INVENTION

[0002] A common cause of sinking vessels is a rupture in the hull with subsequent sudden influx of water. Often this is caused by collisions with objects in blue water conditions or on large lakes such as floating containers, trees, other vehicles and reefs. As a result of the rupture, water rapidly enters the hull, or the space between a double-walled hull, replacing the air. A similar effect is present when excessive influx of water is caused by large waves or capsizing of the watercraft in stormy conditions, or when the vessel's drain or bilge pumps are not able to effectively evacuate the water entering into the vessel. In each of these events, the added weight of the water within the open spaces of the vessel eventually overcomes the vessel's buoyancy, and sinking is the result.

[0003] According to Archimedes' principal, a body immersed in a fluid experiences a buoyant force equal to the weight of the fluid which it displaces. Buoyancy is the upward force on an object produced by the surrounding fluid (in this case water) in which it is fully or partially immersed, due to the pressure difference of the fluid between the top and bottom of the object. The net upward buoyancy force is equal to the magnitude of the weight of fluid displaced by the body. *Displacement* is the term used for the weight of the displaced fluid and, thus, is an equivalent term to buoyancy. The buoyancy of an object depends, therefore, only upon two factors: the object's submerged volume (which equals the volume of fluid displaced or "displaced volume"), and the density of the surrounding fluid. The buoyant force may be expressed using the following equation:

$$F_{\text{bouyant}} = -\rho_{\text{fl}} V_{\text{s}} g$$

where

ρ_{fl} is the density of the fluid;
V_{s} is the volume of the object submerged; and
g is the standard gravity (≈9.81 N/kg on Earth). A negative sign must be used because the buoyancy acts in the opposite direction to the acceleration due to gravity.

[0004] In the context of a waterborne vessel, it may be appreciated from the above equation that the greater the vessel's volume, the more buoyant force it experiences. If the vessel's weight exceeds its buoyancy, it will sink. Another way to look at Archimedes' Principle in this context is that when the density of the vessel is greater then the density of the surrounding fluid (water) it will sink. A watercraft consists of various components, some of which have a significantly higher density than water such as the engine, lead keel and batteries, for instance. Based on these objects alone, the vessel would have a tendency to sink. However, the density of the vessel is a function of not only its mass, but of its volume. Specifically, the density of a vessel may be expressed using the equation:

$$\rho_{\text{v}} = m/V$$

where

ρ_{v} is the density of the vessel;
m is its mass; and
V is its volume.

[0005] As can be appreciated from this equation, the density of the vessel may be reduced to less than that of water by increasing the vessel's volume. By far the greatest effect on the vessel's volume come from "air-filled" spaces, for example the space of the cockpit, cabin, double-walls and similar areas 'confined' within the hull of the watercraft. These open spaces increase the volume of the vessel thereby reducing its overall density (hereinafter, "average density").

[0006] Unfortunately, water entering into the vessel through a breach or by swamping seeks out these open spaces and replaces them with its mass. The effect is an increase in the vessel's mass and a decrease of its volume resulting in a net increase of the vessel's average density. The accidental influx of water is actually the same as a loading process. The watercraft will settle deeper and deeper into the water until the density outscores the density of the water.

[0007] But if we supply displacement bodies within the vessel that cannot be filled or flooded with water, these bodies prevent the average density of the vessel from increasing. Moreover, because water cannot flow uphill - meaning, that the inside water level can never exceed the outside water level- it is sufficient to provide air-filled bodies within the submerged volume of the vessel (i.e., in those open spaces that exist below the waterline) rather than in the freeboard region (i.e., in those open spaces that exist above the waterline). Competing for these areas and wining is critical. By providing displacement bodies of sufficient size and quantity to fill (to the extent possible) the open spaces within the submerged volume of the vessel it is possible to limit the amount of water mass entering the vessel thereby limiting the degree of sinking. The less water that can enter these areas, the less sinking

will occur. This is true even if the breach occurs below the waterline which is typically the case. Even though the hull may be ruptured, no additional water will enter into the vessel if it has no volume to fill below the waterline.

[0008] Heretofore, a variety of devices have been developed which inflate automatically or manually to provide additional buoyancy in the event of sudden influx of water into the vessel. These floatation devices fall into two classes; those which are located outside of the vessel and those which are located within.

[0009] A first example of the exterior variety of floatation devices is U.S. Patent No. 3,121,888 issued to Morgan et al which teaches a protected inflatable component located along the top of the outside surface of the hull. When needed, this inflatable body is filled with gas from a pressurized air cylinder in order to provide a buoyant bag along the top of the boat keeping the boat afloat. U.S. Patent. No. 4,817,555 issued to Meinen discloses a boat holding a canister of compressed air which is automatically triggered by the rising of a float inside of the boat. Upon opening of the canister, longitudinal bags along the top of the hull outside the boat are inflated to keep the boat afloat. U.S. Patent No. 4,864,961 issued to Slonski discloses an auxiliary flotation apparatus for vessels which encompasses canisters connected to a source of compressed air, an inclinometer, and an independent power source. When needed, the compressed air is released into the canisters. When pressurized air enters the canisters, a projectile is propelled away from each canister. The projectile ruptures a frangible membrane located flush with the hull of the vessel. The projectile goes beyond the vessel and carries with it an attached inflatable tubular sheath. One end of the tubular sheath is attached to the hull of the vessel. The sheath becomes filled with air from the source of compressed air, providing a buoyant bag on the outside of the vessel to maintain the vessel afloat. U.S. Patent. No. 5,357,888 issued to Insinna discloses a boat having an elongated inflatable buoyancy tube located on the outside of the hull. The tube is connected to a source of compressed air which, when automatically or manually activated, provides air to the buoyancy tube to keep the vessel afloat. Other examples are U.S. Patent No. 1,283,345 issued to Sova in 1918 as well as U.S. Patent Number 6,435,125 issued to Meras in 2002.

[0010] A first example of an interiorly mounted floatation device for watercraft is U.S. Patent No. 4,458,618 issued to Tufflier which teaches a vessel having enclosed areas such as cabins and cockpits and equipped with three inflatable 'envelopes'. A compressed air container is attached to the three envelopes so that, when needed, the envelopes may be automatically or manually inflated to render the boat buoyant. Other examples are U.S. Patent Number 3,340, 842 issued to Winslow in 1967, U.S. Patent Number 3,324,816 issued to Vogalsang in 1967, U.S. Patent Number 3,092,853 issued to Owen in 1963, U.S. Patent Number 1,320,012 issued to Lee and Cochran in 1919, U.S. Patent Number 1,170,095 issued to Neumann in 1916 and U.S. Patent Number 644,480.

[0011] While it is clear that the prior art is replete with emergency floatation devices for watercraft, all suffer from a common shortcoming, namely they all require onboard stowage of air compressors or large tanks of compressed gas to fill the displacement bodies. Such devices sacrifice valuable space within the vessel as well as add to the vessel's weight, together resulting in an increase in average watercraft density. One of the most important benchmarks in boat construction is an efficient ratio of the usable interior space related to its overall size. Accordingly, it is not desirable to stow large tanks or equipment.

[0012] Certainly there exists a longstanding need for an inflatable emergency floatation device for marine craft which does not rely on heavy equipment or large tanks of compressed air for its operation.

SUMMARY OF THE INVENTION

[0013] The subject invention is directed to a portable inflatable water displacing body for preventing complete submersion of watercraft in immanent danger of sinking due to a sudden influx of water. All embodiments of the invention are comprised generally of at least one bladder, normally mounted within the hull of the vessel in a collapsed and deflated condition, each bladder having: 1) internal volumetric expansion means including an inlet connected to an external gas source for charging the expansion means and a relief valve for controlling the amount of pressure in the expansion means, and 2) a check valve for allowing one-way passage of ambient air into the bladder. The expansion means is comprised of an extremely light-weight, highly flexible tubular framework which when charged with the gas expands into a pre-defined three-dimensional geometric shape causing the volume within the surrounding bladder to increase. The increase in volume reduces the pressure and creates a partial vacuum, which is filled by air pushed in through the check valve by the higher atmospheric pressure. The expanded water displacing body competes for and successfully occupies space within the vessel's hull, and preferably but not essentially below the waterline, which would otherwise be filled by incoming water. Because both the volume of the vessel and its average density are substantially maintained, so is the buoyancy needed to keep the vessel afloat.

[0014] The subject water displacing body can be actuated automatically upon triggering of a float valve or, in the alternative, manually with minimal effort by one person. Volumetric expansion of the device can be accomplished within a short period of time (under 2 minutes) to prevent the watercraft from dangerously submerging into the water or sinking.

[0015] There has thus been outlined, rather broadly, the more important components and features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the

present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject matter of the claims appended hereto. In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting. As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based, may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

[0016] Further, the purpose of the foregoing abstract is to enable the U.S. Patent and Trademark Office and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The abstract is neither intended to define the invention of the application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

[0017] It is, therefore, a primary object of the subject invention to provide a portable inflatable water displacing body for preventing complete submersion of watercraft in immanent danger of sinking due to a sudden influx of water. The subject invention has several advantages over devices of the prior art not the least of which is that the filling of the displacement body may be accomplished using only a small amount of compressed air complimented by large amounts of atmospheric air. Accordingly, only a small cylinder of pressurized air is needed to inflate the framing structure of the subject invention versus large and heavy tanks needed by like devices of the prior art. Moreover, inflation of the structural frame component of the subject invention can be accomplished manually without the need for compressed air tanks at all; thus the device does not necessarily rely on any 'technical' equipment such as gas or compressed air in containers. Because no large tanks or air compressors are required the subject apparatus has substantially less mass per unit volume over similar prior art devices and, therefore, has a lesser impact on the vessel's average density. Also, due to the small size of device when folded, it can be easily carried between crafts and for service purposes and it does not entail a substantial reduction of usable space within the watercraft during its ordinary usage. Still another advantage of the subject invention over the prior art is that set off, installation and initialization of the device are significantly easier. Finally, the subject apparatus is relatively simple in design and therefore capable of rapid construction, installation and use, and is relatively inexpensive to manufacture.

[0018] These together with other objects and advantages of the invention, along with the various features of novelty which characterize the invention, are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its advantages and the specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] 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:

FIG. 1 is an a perspective view of the inflatable fluid displacement body according to the present invention shown in its fully inflated configuration and having portions thereof depicted in phantom and cutaway view to better illustrate the primary components and operation thereof;

FIG. 2 is a plan view of a corner of the subject apparatus taken along 2-2 of Figure 1;

FIG. 3 is a perspective view of the invention of Figure 1 with the outer covering removed to better reveal the inflatable framing component of the subject apparatus;

FIG. 4 is a perspective view of the device in a collapsed configuration;

FIG. 5A is a side view of a small-size Sail Yacht partially submerged in a fluid;

FIG. 5B is a plan view of the Sail Yacht of Figure 5A with sails, mast and cabin roof removed to better illustrate the interior layout of the vessel;

FIG. 5C is a cross-sectional view of the Sailing Yacht of Figure 5A with interior components removed;

FIG. 6A is a side view of the Sail Yacht of Figure 5A equipped with the subject inflatable displacement body and showing the vessel taking on water through a breach at the bow;

FIG. 6B is a plan view of the Sail Yacht of Figure 6A

with sails, mast and cabin roof removed to better illustrate the placement of the displacement body within the interior of the vessel;

FIG. 7 is a plan view of the interior of a Sail Yacht illustrating an alternative arrangement of displacement bodies therein;

FIG. 8 is a plan view of the interior of a Sail Yacht illustrating still another alternative arrangement of displacement bodies therein; and

FIGS. 9A - 9I are simplified illustrations of the subject apparatus depicting sequential stages of its deployment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Reference is now made to Figure 1 in which there is illustrated a perspective view of the subject fluid displacement body for emergency floatation of a marine vessel (hereinafter sometimes also referred to simply as "displacement body"), designated generally by reference numeral **10** and shown in its fully operational (inflated) configuration. The subject apparatus is comprised of three primary components, namely: 1) a bladder **12** normally mounted within the hull of a vessel in a collapsed and deflated condition, 2) volumetric expansion means **14** within the bladder and generally comprised of an inflatable framing assembly, and 3) a check valve **16** for allowing one-way passage of ambient air into the bladder upon inflation of the framing assembly.

[0021] As its name suggests, bladder **12** is a flexible enclosure with waterproof and gas-proof walls, and is preferably but not essentially fabricated from a light-weight material that is flexible, tolerant of high pressure and capable of being folded and unfolded (or rolled and unrolled) with ease. A woven polyester or other polymeric fabric may be employed, or textiles used in the manufacture of rubber boats and other flexible floatation devices. One example of such a material is produced by a German company and sold under the brand name, *Siloflex K50/S.* The interior surface of bladder **12,** and especially seems and corners, may be re-enforced with integrated mesh netting for added strength and durability, and both interior and exterior surfaces may be treated with various coatings well known in the industry to impart additional weather resistant and protective properties.

[0022] A novel aspect of the subject invention relates to the manner in which the volume of bladder **12** is caused to increase for operational use as a displacement body. Rather than necessitating the delivery of a large volume of gas to fill the interior chamber **18** of bladder **12,** such as with an air compressor, air pump or large container of compressed gas which must be stowed on board the vessel, volumetric expansion is accomplished via expansion of volumetric expansion means **14** located within bladder **12.** Specifically, volumetric expansion means **14** is comprised of an extremely light-weight, highly flexible tubular framework, closed to the atmosphere and which when charged with only a small amount of gas expands into a pre-defined three-dimensional geometric shape causing the volume within the surrounding bladder **12** to increase. The increase in volume of bladder **12** reduces the pressure therein and creates a partial vacuum which is filled by air pushed in through check valve **16** by the higher ambient atmospheric pressure. The expanded fluid displacement body **10** competes for and successfully occupies space within the vessel's hull as described in greater detail herein.

[0023] Referring now to Figures 2 and 3, volumetric expansion means **14** may be fabricated of a flat-woven 100% polyester, high tenacity, low friction loss hose material such as that used for air pressure tools and air compressors. The inner lining of each tube member **20** is preferably fabricated from either polyurethane or Hytrel® (made by DuPont) to impart a smooth surface and high flexibility for storage purposes. Other advantages of these materials are that they are extremely light-weight, rot-resistant and capable of withstanding pressures up to 30 Bar. Tube members **20** have an exterior diameter ranging from approximately two (2") inches to four (4) inches with three (3") inches being preferred. Employment of the subject apparatus in other applications may necessitate larger or smaller diameters. Corner members **22**, having an interior diameter substantially equal to the outer diameter of tube members **20** such that the latter may be brought into slidable engagement with the former, are prefabricated from an injection molded plastic or other suitable material that is not subject to cracking in extreme temperatures. Bonding agents well known to those skilled in the art are used to create a permanent leak-proof union.

[0024] Inflation of volumetric expansion means **14** may be accomplished either manually, such as with a bicycle pump or using an external pressure source such as a pressurized air tank **24** such as those used by firefighters as an oxygen supply. Such units are typically lightweight and robust and have a capacity of approximately 6 liters. In instances where a greater volume of air is required to fully inflate volumetric expansion means **14**, such as when large fluid displacement bodies are involved, two tanks may be joined together using conventional coupling means. Tank **24** is connected to framing inlet **26** either directly or via hose **28.** Each component may be reciprocally threaded for this purpose. Framing inlet **26** may be fixedly attached to any tube member **20** and at any location although a location within one of the bottom members of the framed assembly is preferred. Referring once again to Figure 1, it should be appreciate that inlet **26** passes through bladder **12** in sealing engagement therewith.

[0025] An optional relief valve **30** releases excess amounts of pressurized air into chamber **18** of bladder **12,** or alternatively into the ambient air, when the maxi-

mum desired pressure within framing assembly **14** is reached. Relief valve **30** is therefore used to control or limit the pressure in the framing assembly by allowing the pressure source fluid (air) to flow from an auxiliary passage, away from the main flow path. Relief valve **30** is designed or set to open at a predetermined pressure to protect framing assembly **14**, as well as other components of the subject apparatus, from being subjected to pressures that exceed their design limits. When the pressure setting is exceeded, the relief valve becomes the "path of least resistance" as the valve is forced open and a portion of the fluid is diverted through the auxiliary route, typically into chamber **18**. This action further aids in the volumetric expansion of bladder **12** and increases the pressure therein to better resist outside pressure which may increase with the influx of water into the vessel, but this is not essential for the proper operation of the subject device.

[0026] Check valve **16** is a mechanical device, a valve, that allows ambient air **100** to flow through it in only one direction, namely from outside fluid displacement body **10** into chamber **18** of bladder **12.** Check valve **16** is a two-port valve, meaning it has two openings in its body, one for fluid to enter and the other for fluid to leave. Check valve **16** works automatically and is not controlled by a person or any external control; accordingly, it does not require a valve handle or stem. Its body (external shell) is made of plastic or metal. Its cracking pressure, or minimum pressure outside the subject apparatus at which the valve will operate, is set to freely allow entry of ambient air upon volumetric expansion of bladder **12** caused by inflation of framing assembly **14**. Check valve **16** may be connected to a hose **32** having the same diameter (approximately four (4") inches to five (5") inches in length and a length of approximately three (3') feet. Because water entering the vessel will naturally begin to rise, it is desirable to locate check valve **16** on the uppermost surface of displacement body 10 as shown (Figure 1). The free end **34** of hose **32** includes a floatation ring **36** made of, for instance, polystyrene and coated for high abrasion resistance. Thus, free end **34** of hose **32** will float above the surface of any water entering the vessel.

[0027] A plurality of mounting fixtures **38** are fixedly attached to structurally re-enforced sections of bladder **12** for mounting of the apparatus to surfaces within the watercraft, preferably as low in the hull as possible, such as floor surfaces within the cabin compartment if present.

[0028] As may be appreciated from the above described components of the subject fluid displacement body **10**, inflation of bladder **12** is accomplished by increasing the volume of its interior chamber **18** through erection of the tubular framing assembly **14** housed therein using a relatively small amount of gas. This increase in volume reduces the pressure within the bladder creating a partial vacuum. Because air flows from an area of greater concentration to an area of lower concentration, the higher atmospheric pressure pushes ambient air through check valve **16** filling the chamber without any need for onboard gas. In short, the bladder is filled by ambient air rather than pressurized air stored onboard the vessel. Accordingly, rather than having to fill the entire displacement body with air using heavy compressors or large containers of compressed air, a much smaller volume of stowed air is used to erect an internal inflatable framing assembly causing ambient air to fill inflate the bladder. Stated more succinctly, filling of the subject displacement body may be accomplished using only a small amount of compressed air complimented by relatively large amounts of atmospheric air.

[0029] The subject water displacement body **10** may be actuated automatically upon triggering of a float valve or, in the alternative, manually with minimal effort by one person. As may be observed in the example below, volumetric expansion of the device can be accomplished within a short period of time (under 2 minutes) to prevent the watercraft from dangerously submerging into the water or sinking.

Example Deployment

[0030] Reference now being made to Figure 5A and 5B, a small Sail Yacht **102** (hereinafter "vessel **102"** or "watercraft") is illustrated diagrammatically in side and plan views, respectively. Vessel **102** is of typical size for recreational use, but is also capable of crossing the oceans. Vessel **102** is illustrated in full load departure or "full displacement" condition where it is submerged to a point that the waterline **104** (dotted line) substantially equals its load line **106** (solid line). The purpose of the load line is to endure that a vessel has sufficient freeboard (meaning distance between the uppermost deck and the waterline) and thus sufficient reserve buoyancy. Waterline **104** refers to an imaginary line marking the level at which a vessel floats in the water **108**. Figure 5B illustrates the arrangement of fixtures within the cabin compartment such as shower/toilet **110**, isle way **112,** sleeping compartments **114**, and galley **116**.

[0031] In a distress situation the subject apparatus will be preferably mounted via mounting means **38** to the cabin floor or cockpit floor in its collapsed or storage configuration (Figure 4). The vessel begins to take on water as a result of either swamping or, as is illustrated in this instance, a breach **110** in the vessel's hull **112**. Then the small tank of compressed air **24** is turned open either manually or automatically, inflating framing assembly **14** within chamber **18** of bladder **12.** Chamber 18 will be caused to simultaneously fill with atmospheric air **100** and by this achieve volumetric expansion necessary to substantially maintain the vessel's interior space that would otherwise be flooded by incoming water. This action could be considered the equivalent of a "bailing effect". The total volume of the fluid displacement body or bodies needed to maintain vessel buoyancy will depend on the specifications of the watercraft (i.e., specific weight and volume or average density). Because both the volume of the vessel and its average density are substan-

tially maintained, so is the buoyancy needed to keep the vessel afloat. Note that displacement body **10** has displaced a sufficient volume of water to reduce the average density of the craft relative to the surrounding water. While the craft has experienced some sinking as a result of the increase in mass and decrease in volume associated with the water it has taken on (as evidenced by the waterline **104** being lower than the load line **106**), there is sufficient buoyancy to keep the vessel afloat and there remains substantial freeboard to keep passengers and equipment dry. Again, the degree to which the vessel will submerge in the water will depend on the amount of open space below the waterline (before taking on any water) can be filled with the subject displacement bodies. Figures 7 and 8 depict alternative locations of a plurality of fluid displacement bodies within the watercraft **102.**

[0032] Figures 9A through 9I are simplified illustrations of the subject apparatus depicting sequential stages of its deployment including elapsed time in the process. Figure 9A shows the subject apparatus at zero minutes in its collapsed or stowage configuration. Figure 9B shows the apparatus at 0:02 minutes having been laid flat on the cockpit or cabin floor. Figure 9C shows the apparatus at 0:15 minutes attached to the floor using four pre-installed floor anchors. Figure 9D shows the apparatus at 0:20 minutes completely unfolded (note that multiple folding arrangements are conceivable). Figure 9E shows the apparatus at 0:45 minutes fully unfolded and completely locked to the floor anchors. Figure 9F shows the apparatus at 1:00 minute after filling of the frame structure with compressed air has commenced. Ambient air begins entering the interior chamber of the bladder. Figure 9G shows the apparatus at 1:30 minutes with maximum volumetric expansion achieved. Figure 9H shows the apparatus relieving excess gas from the compressed air cylinder into the interior of the bladder to avoid over pressurization of the framing assembly. Finally, Figure 9I shows the apparatus at 2:00 minutes in its fully operable configuration as a fluid displacement body. Total set up time may be achieved in under 2:00 minutes, however, it is important to note that of this time only approximately 45 seconds require actual attention of the user (and none if inflation is triggered automatically upon entry of water).

[0033] If the device for any reason cannot be locked to the floor anchors, the device may be activated and will eventually float to the cabin's ceiling. In this case it will not provide a dry space for shelter within the craft but by its sheer volume will still prevent complete submerging or sinking. Because the device after initial actuation does not need any further attention by the crew, time for repair attempts, and/or initiating rescue requests from third parties, and/or maneuvering the vessel to a safe location is gained. The subject apparatus is suitable for use in a wide variety of small watercraft and vessels, either of recreational, commercial or military use, which are designed with an (partially) enclosed space such as a cockpit or a cabin. The device may also be employed by open boats in which case although there is no secure shelter the device will still prevent the vessel from sinking.

[0034] The present invention makes an evacuation obsolete because the watercraft will be prevented from submerging. The vessel will maintain an almost similar displacement in the water as an undamaged watercraft, in particular maintaining sufficient freeboard to keep passengers and essential equipment (i.e., auxiliary battery, radio and electronic equipment) dry.

[0035] Although the present invention has been described with reference to the particular embodiments herein set forth, it is understood that the present disclosure has been made only by way of example and that numerous changes in details of construction may be resorted to without departing from the spirit and scope of the invention. Thus, the scope of the invention should not be limited by the foregoing specifications, but rather only by the scope of the claims appended hereto.

Claims

1. An inflatable fluid displacement body, comprising:

a. at least one bladder;
b. inflatable volumetric expansion means within said at least one bladder;
c. a gas inlet attached to said inflatable volumetric expansion means; and
d. a check valve attached to said at least one bladder for allowing the one-way passage of ambient air into said at least one bladder when said inflatable volumetric expansion means is charged with a gas through said gas inlet.

2. An inflatable fluid displacement body, comprising:

a. at least one bladder;
b. an inflatable framing assembly within said at least one bladder;
c. a gas inlet attached to said inflatable framing assembly; and
d. a check valve attached to said at least one bladder for allowing the one-way passage of ambient air into said at least one bladder when said inflatable framing assembly is charged with a gas through said gas inlet.

3. An inflatable fluid displacement body, comprising:

a. at least one bladder normally in a collapsed and deflated condition;
b. an inflatable framing assembly within said at least one bladder which when inflated causes an increase in volume of said at least one bladder;
c. a gas inlet attached to said inflatable framing assembly;
d. means for charging said inflatable framing as-

sembly with a gas; said means being detachably connected to said gas inlet; and

e. a check valve attached to said at least one bladder for allowing the one-way passage of ambient air into said at least one bladder when said inflatable framing assembly is charged with a gas through said gas inlet.

4. The inflatable fluid displacement body of claim 1 wherein said inflatable volumetric expansion means is comprised of a light-weight, flexible tubular framework normally in a collapsed and deflated condition and which when charged with a gas expands into a pre-defined three-dimensional geometric shape thereby causing an increase in volume of the surrounding at least one bladder.

5. The inflatable fluid displacement body of claim 2 wherein said inflatable framing assembly is comprised of a light-weight, flexible tubular framework normally in a collapsed and deflated condition and which when charged with a gas expands into a pre-defined three-dimensional geometric shape thereby causing an increase in volume of the surrounding at least one bladder.

6. The inflatable fluid displacement body of claim 1 wherein said inflatable volumetric expansion means further includes a relief valve for limiting the amount of pressure within said inflatable volumetric expansion means.

7. The inflatable fluid displacement body of claim 2 wherein said inflatable framing assembly further includes a relief valve for limiting the amount of pressure within said inflatable framing assembly.

8. The inflatable fluid displacement body of claim 3 wherein said inflatable framing assembly further includes a relief valve for limiting the amount of pressure within said inflatable framing assembly.

9. The inflatable fluid displacement body of claim 4 wherein said inflatable framing assembly further includes a relief valve for limiting the amount of pressure within said inflatable framing assembly.

10. The inflatable fluid displacement body of claim 5 wherein said inflatable framing assembly further includes a relief valve for limiting the amount of pressure within said inflatable framing assembly.

11. The inflatable fluid displacement body of claim 1-10 wherein said at least one bladder is not permeable to gas or liquid.

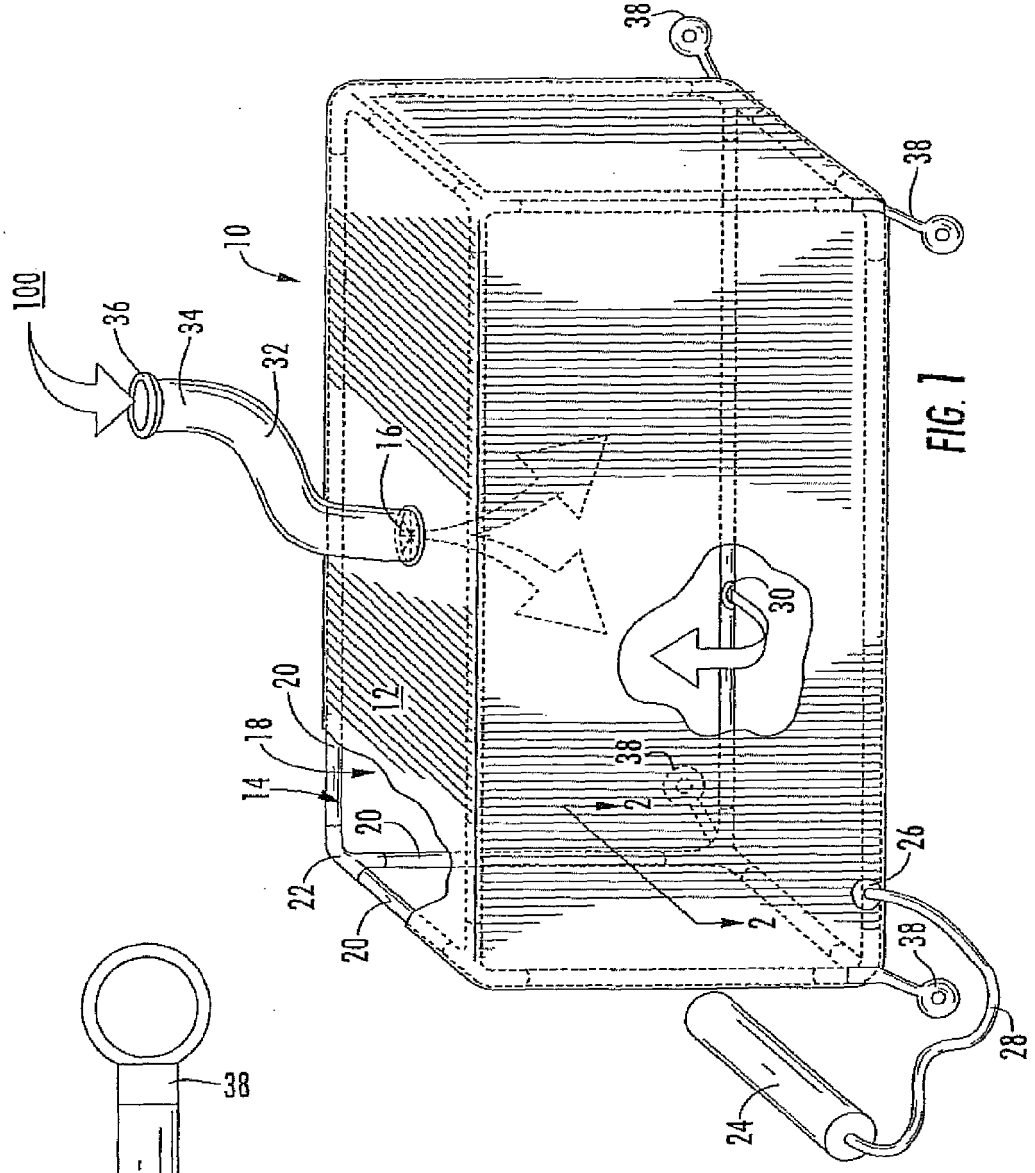
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FIG. 1

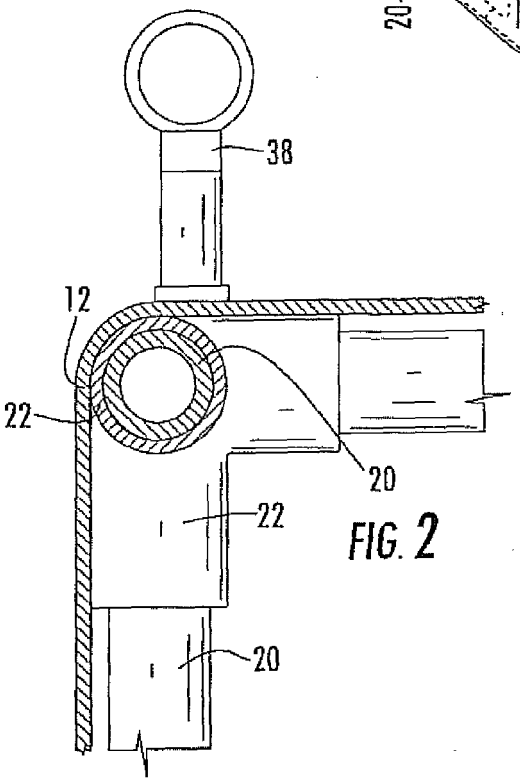
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FIG. 2

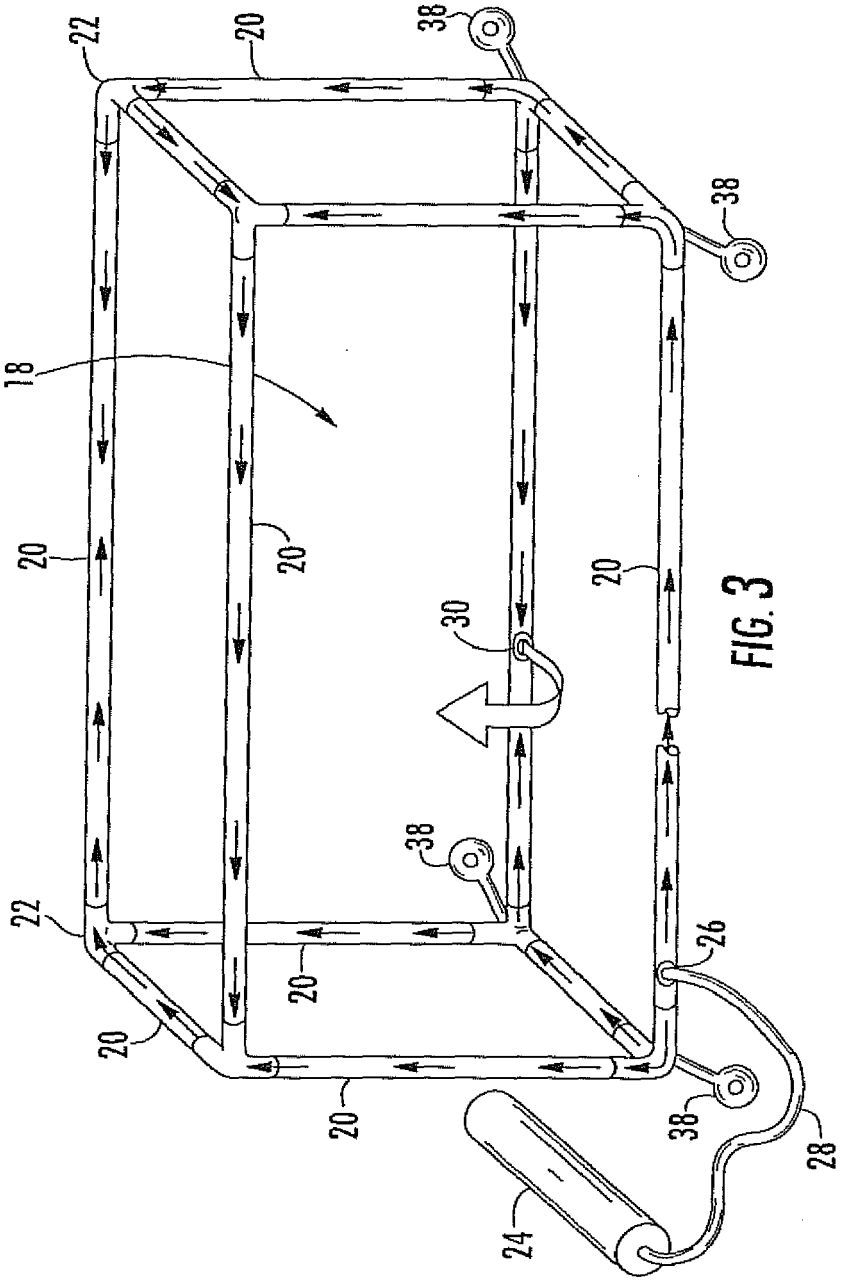

FIG. 3

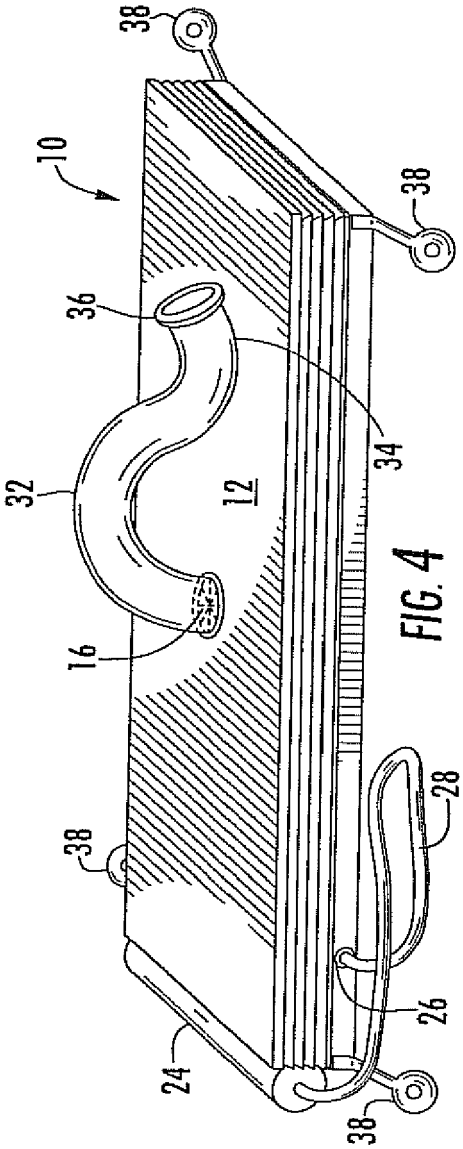

FIG. 4

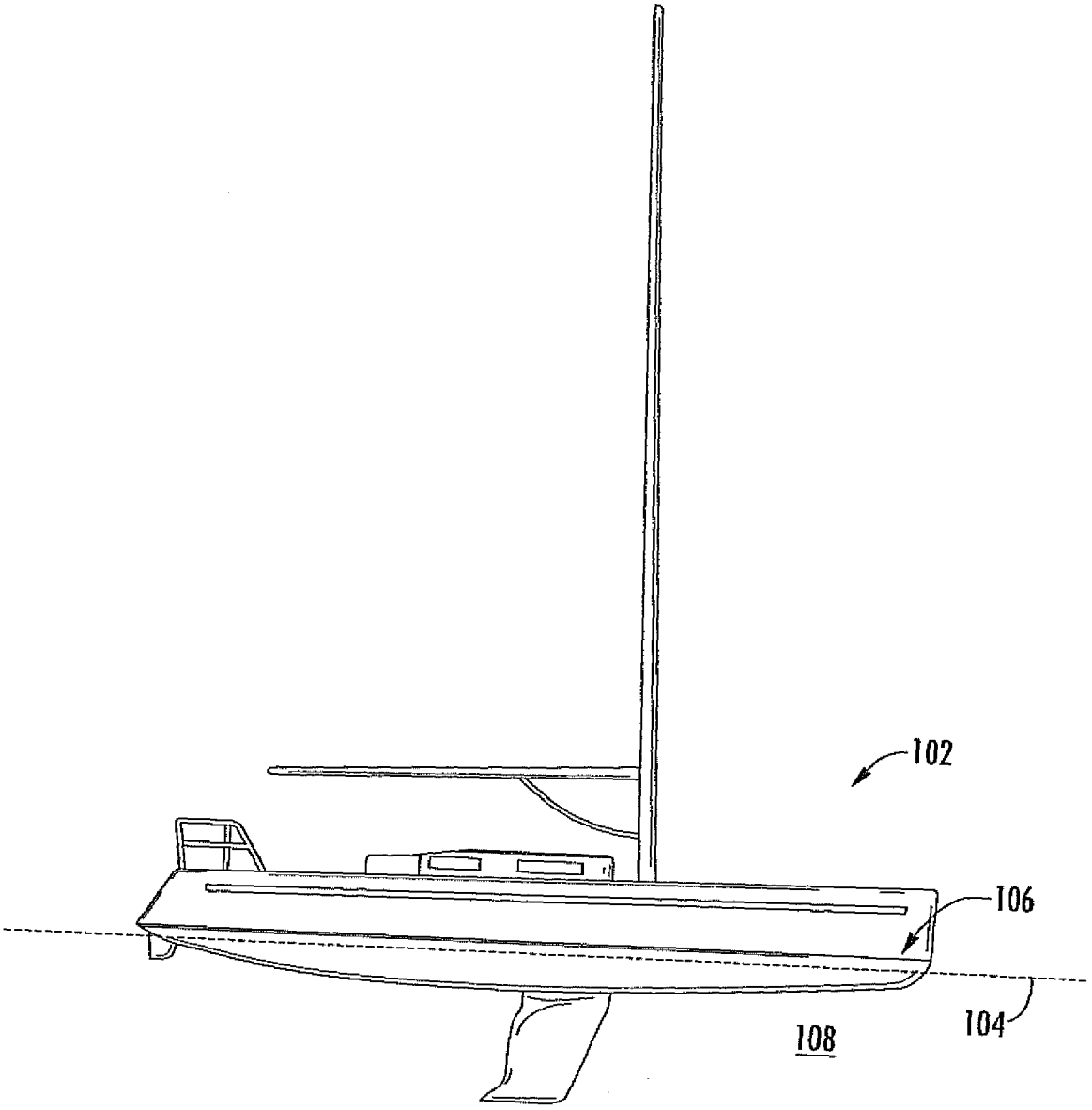

FIG. 5A

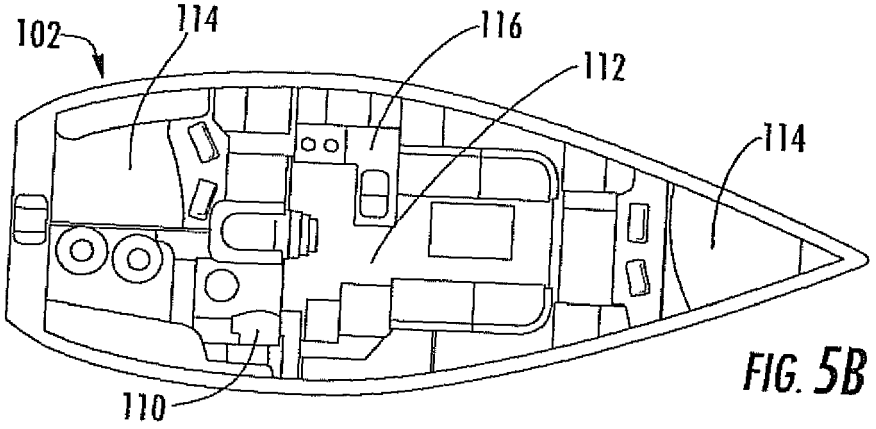

FIG. 5B

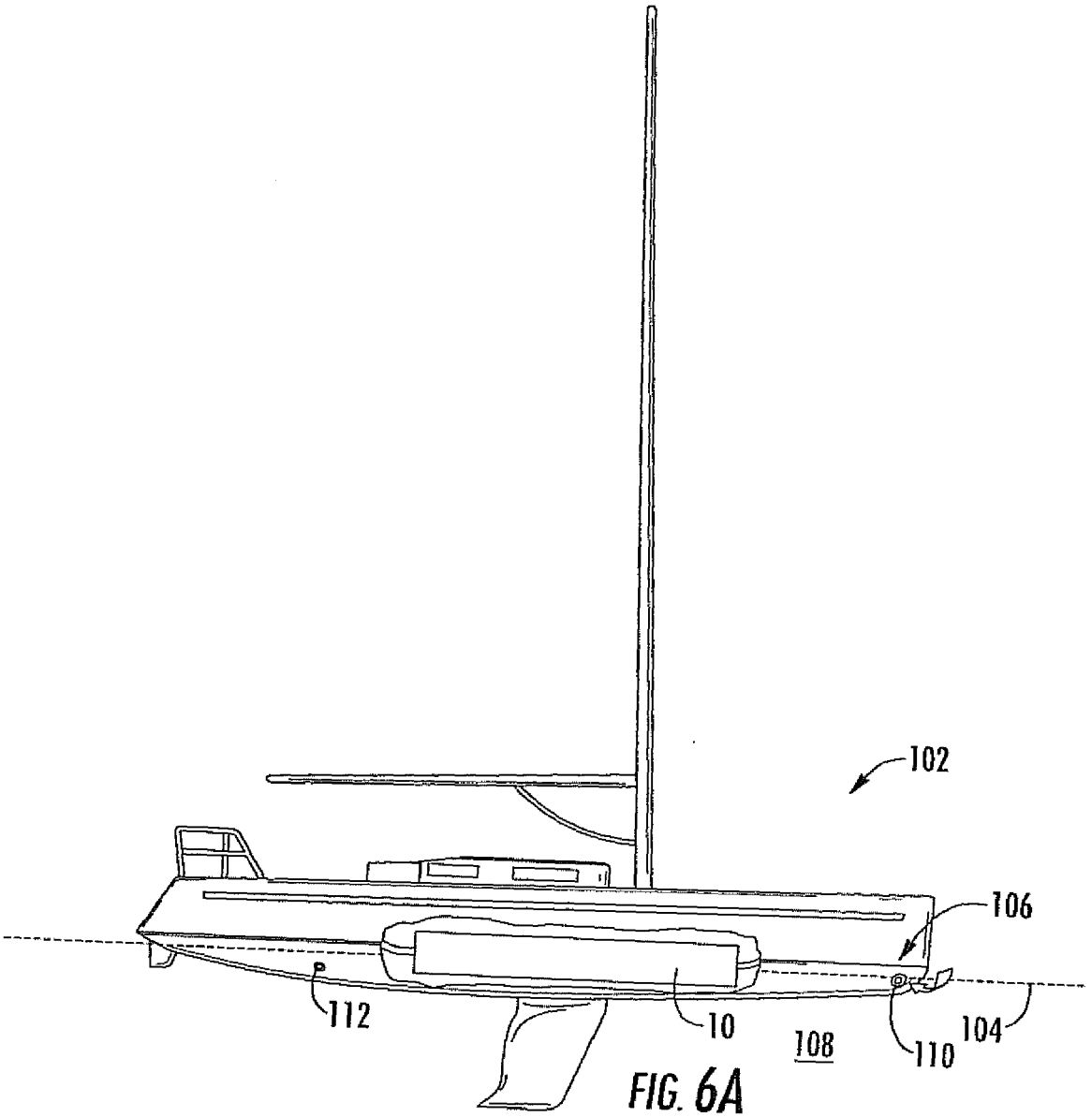

FIG. 6A

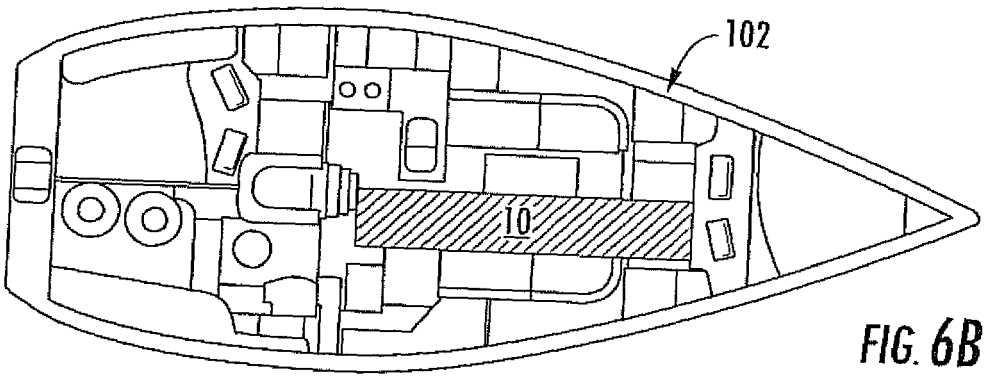

FIG. 6B

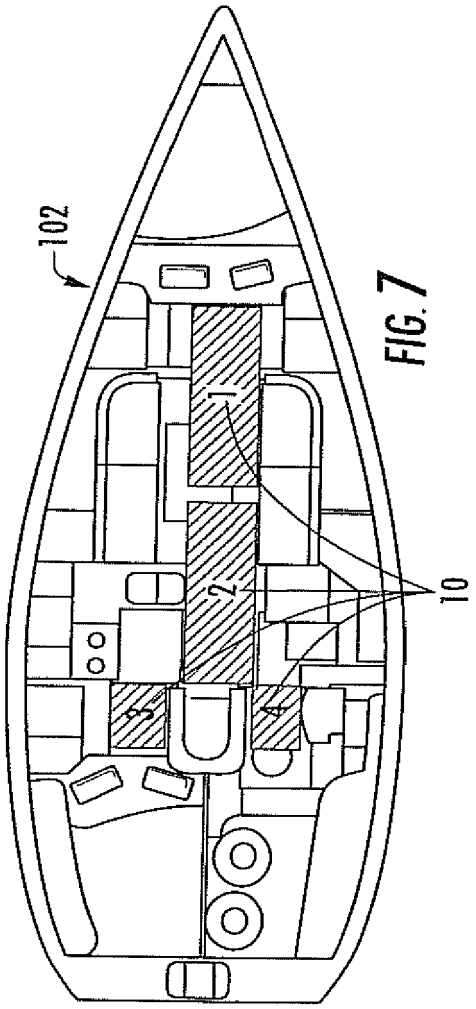

FIG. 7

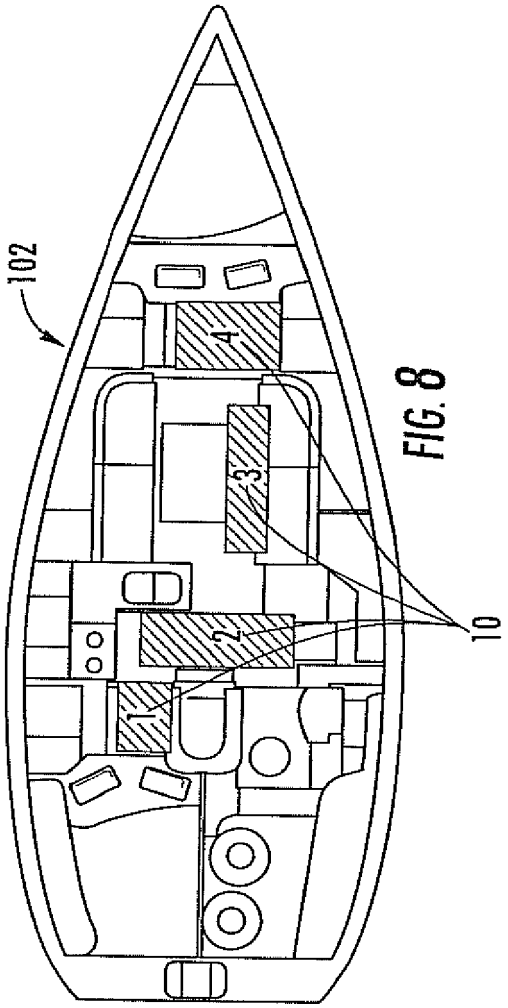

FIG. 8

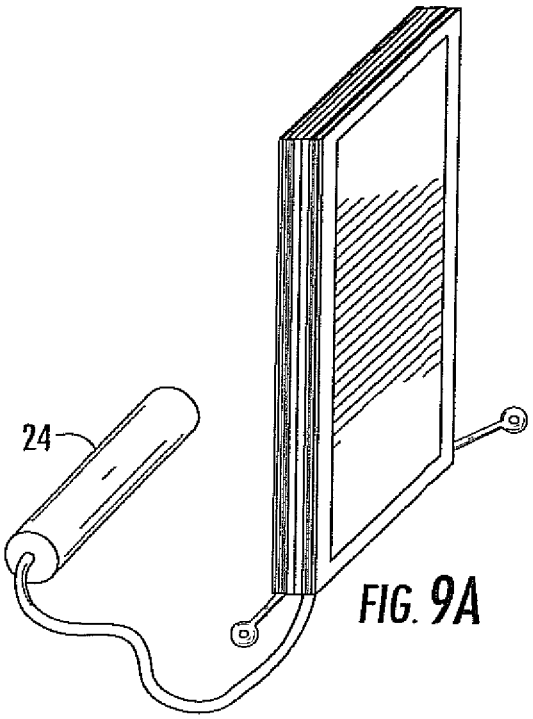

FIG. 9A

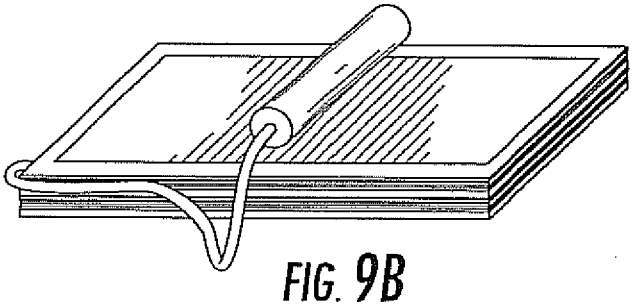

FIG. 9B

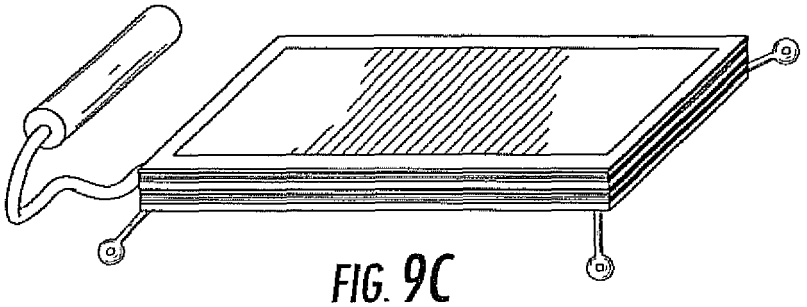

FIG. 9C

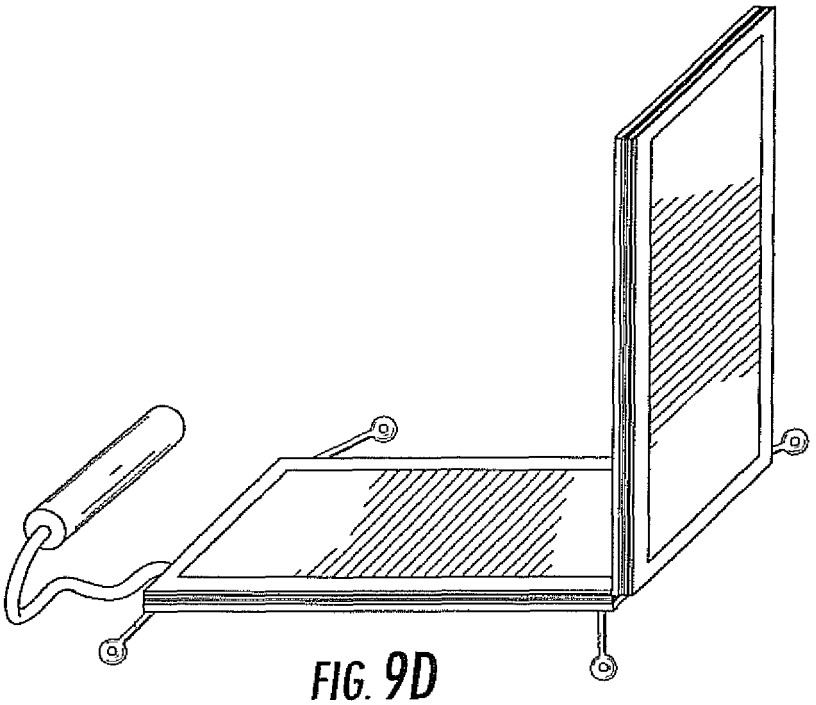

FIG. 9D

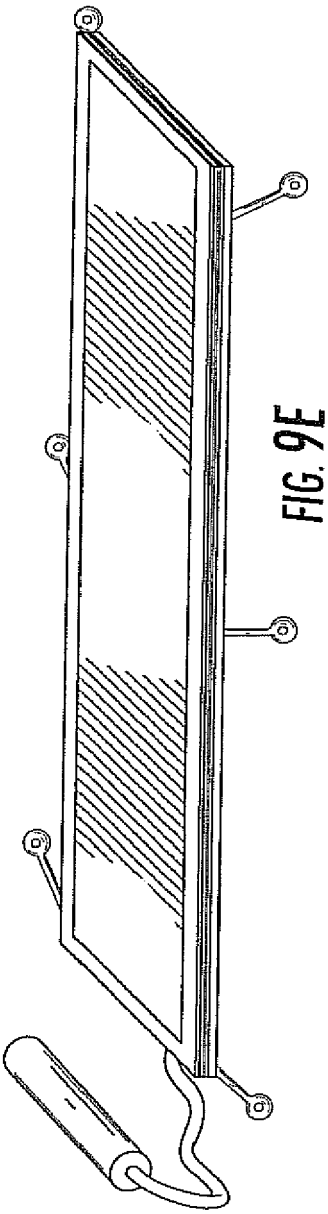

FIG. 9E

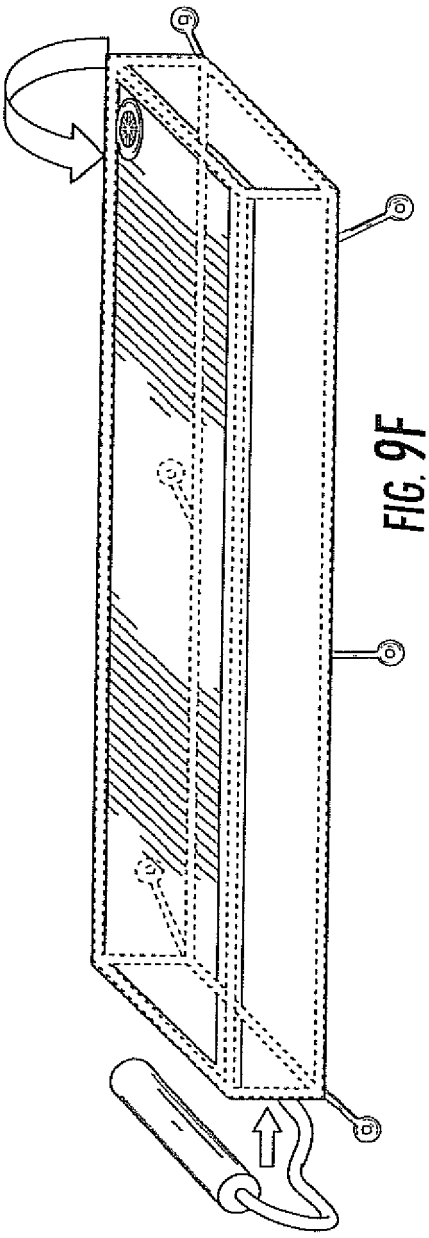

FIG. 9F

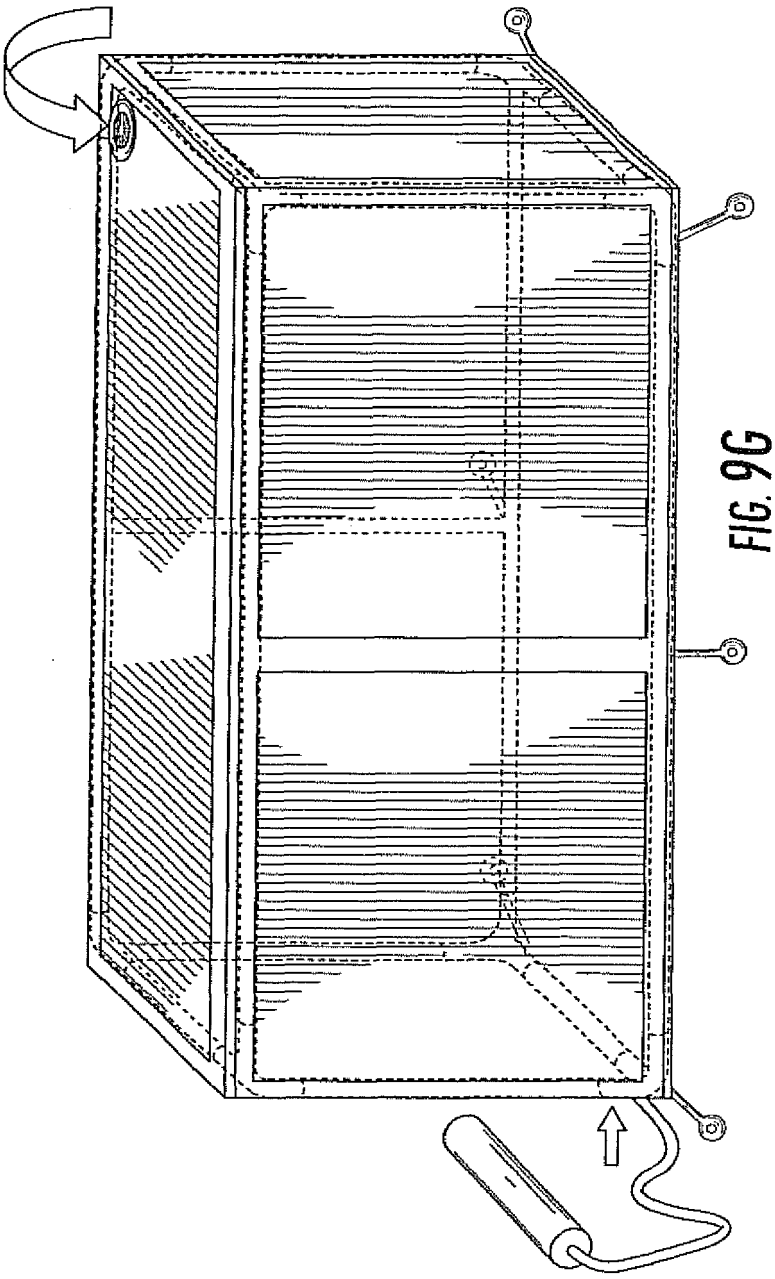

FIG. 9G

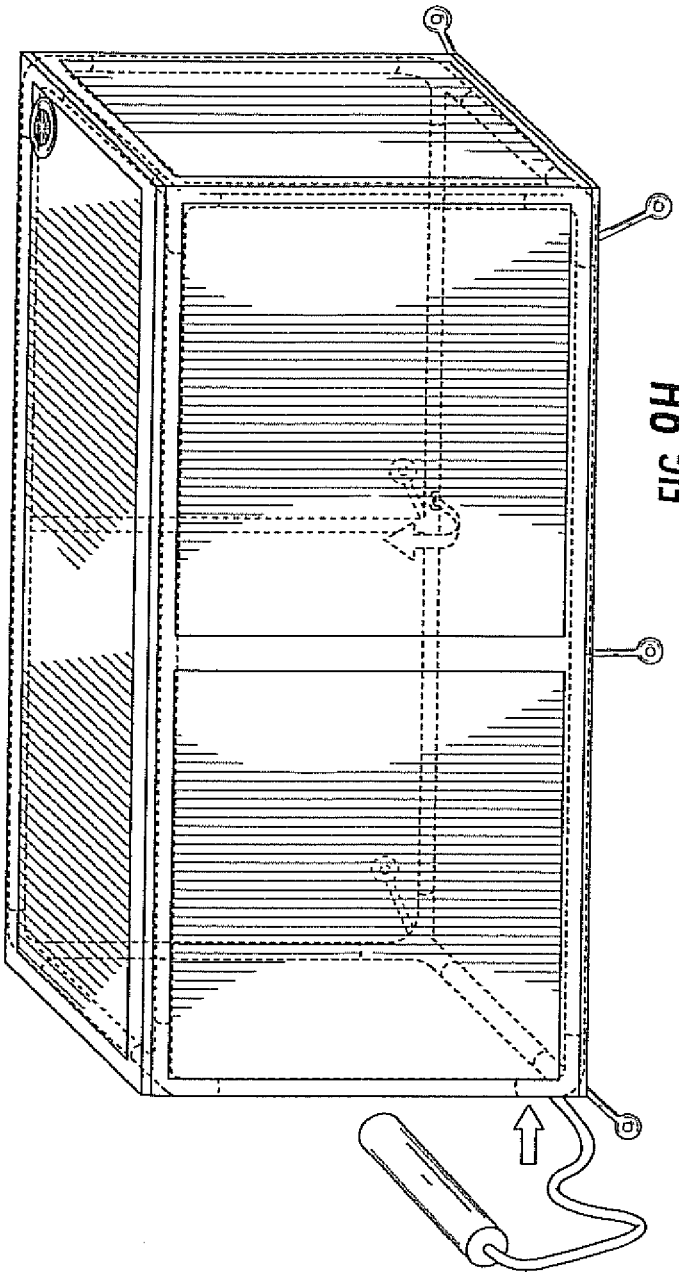

FIG. 9H

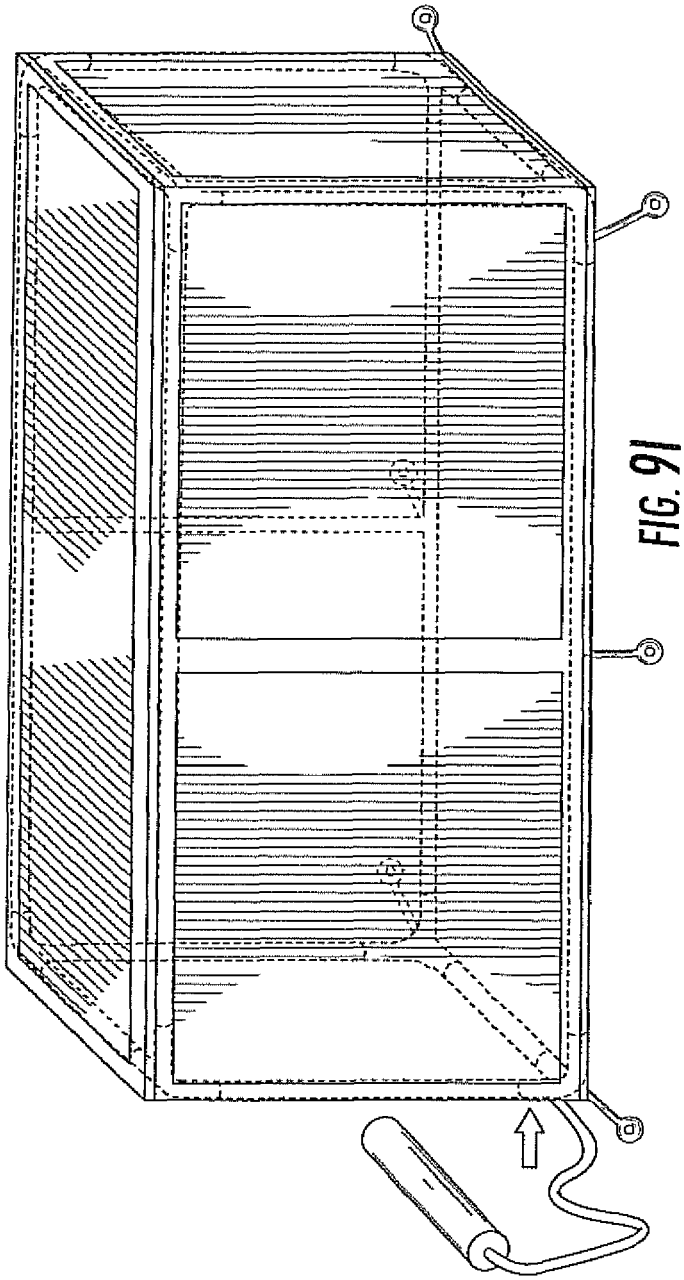

FIG. 9I

REFERENCES CITED IN THE DESCRIPTION

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