United States Patent [19]

Smith et al.

[11] **3,756,031**

[45] **Sept. 4, 1973**

[54] **SELF-RIGHTING FLOATING BOOMS**

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[73] Assignee: **said Smith, by said Anusauckas**

[22] Filed: **July 21, 1971**

[21] Appl. No.: **164,606**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 815,663, April 14, 1969.

[52] **U.S. Cl.** ..... **61/1 F,** 24/201, 114/.5 F, 161/84

[51] **Int. Cl. . E02b 15/04,** A44b 17/00, B32b 17/10

[58] **Field of Search** ..... 61/1 F, 5; 210/242; 114/1 F

[56] **References Cited**

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[57] **ABSTRACT**

A unique self-righting and quickly deployable floating boom capable of enduring strong winds and waves comprises a series of polymer floats each incorporating a horizontally extending shelf securely attached at spaced intervals to an integral composite fin of vinyl sheet reinforced by woven polyester fibers incorporating an interwoven core of two characteristically different fibers that provide the vinyl sheet with different vertical and horizontal flexing capabilities. An extension shelf formed on each of the polymer floats provides the boom with additional buoyancy while also serving as a barrier effectively containing oil and other floating materials despite wind, choppy water and strong waves. Furthermore, the extension shelves incorporate fore and aft lifting surfaces which tend to induce "planing" and counteract the forces which tend to draw the floating boom beneath the water surface during fast end-wise deployment. The dual fiber core of the vinyl sheet is manufactured with relatively thin horizontal fibers interwoven with relatively stiff, thick vertical fibers to allow the vinyl sheet to flex easily about vertical flexing axes while strongly resisting horizontal flexing about horizontal flexing axes.

11 Claims, 13 Drawing Figures

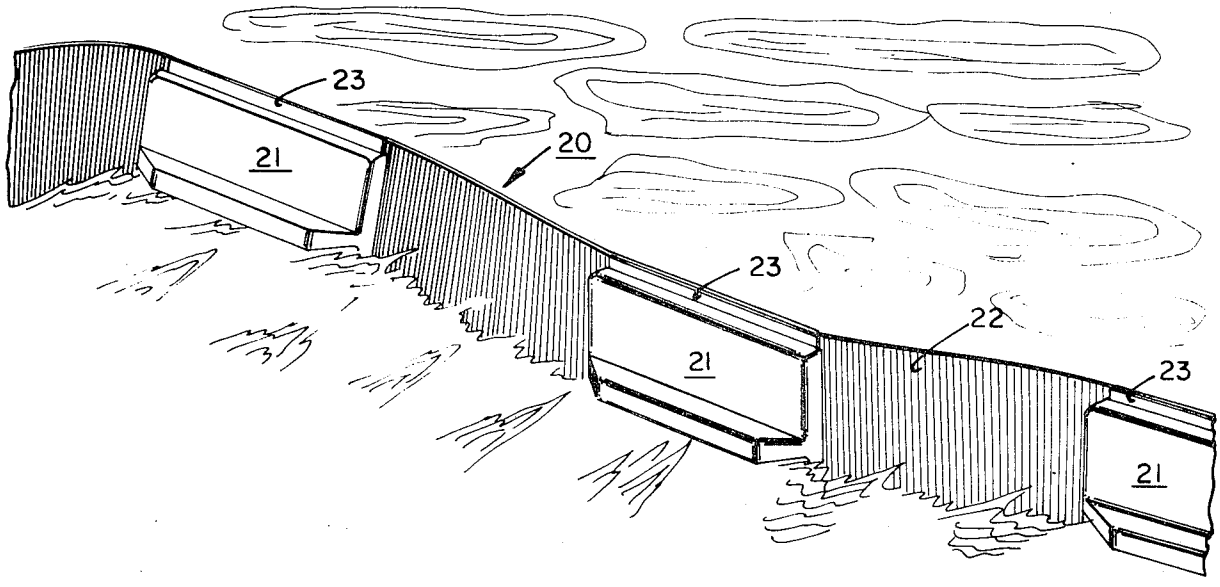


FIG. 1

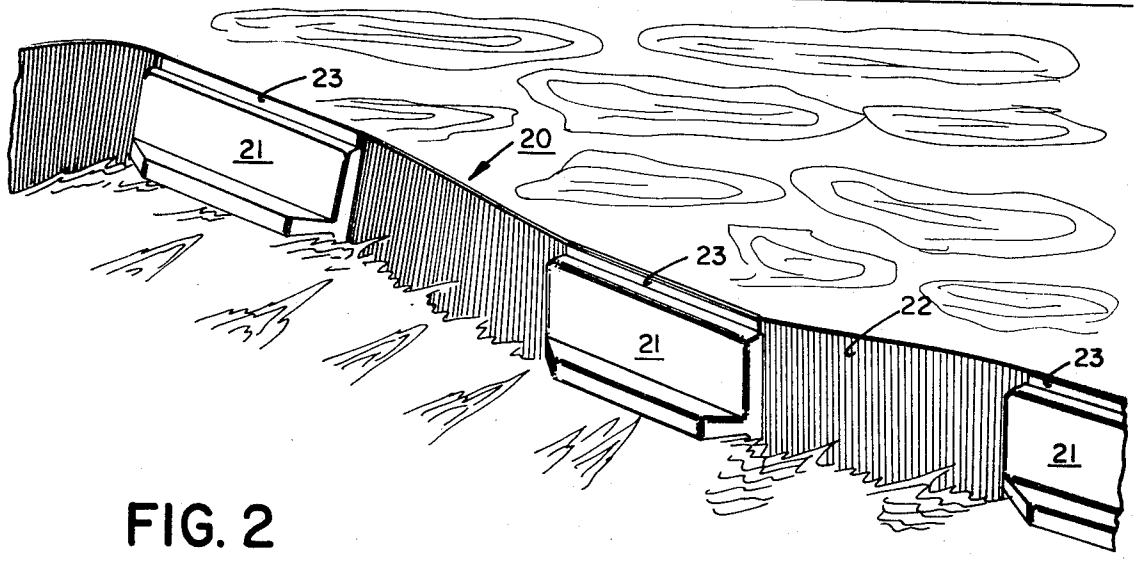


FIG. 2

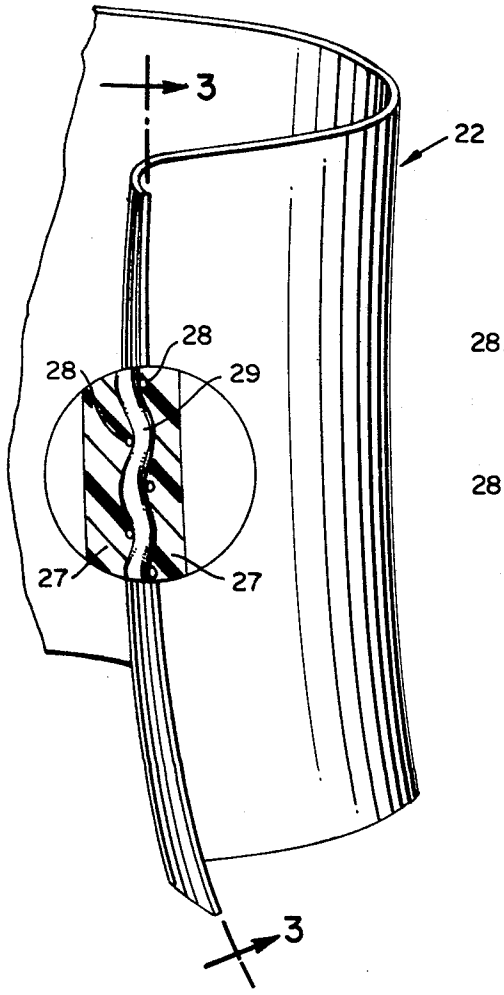
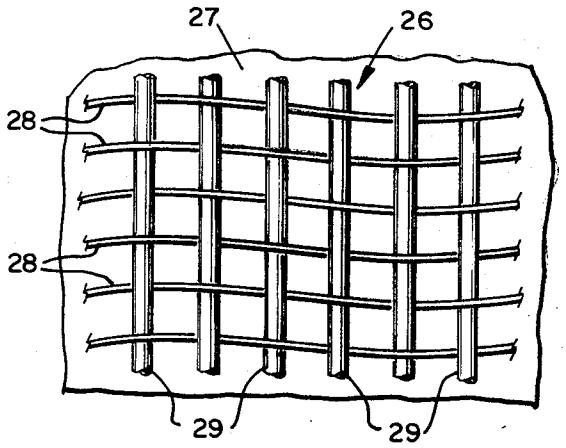


FIG. 3



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FIG. 4

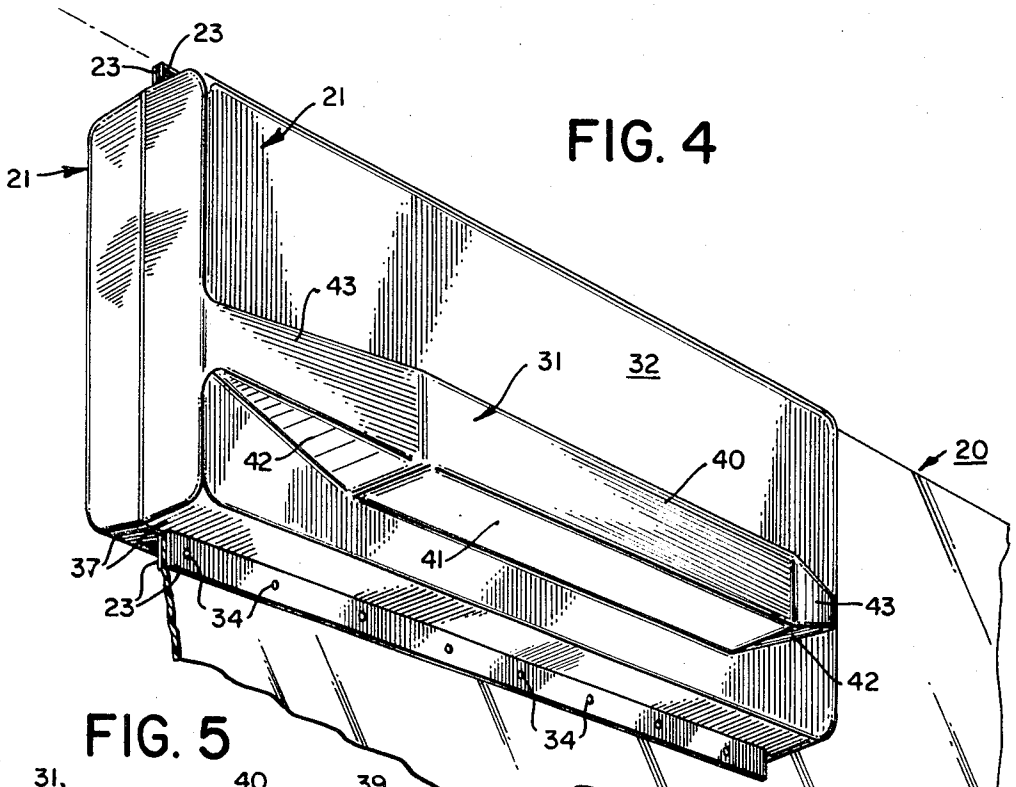
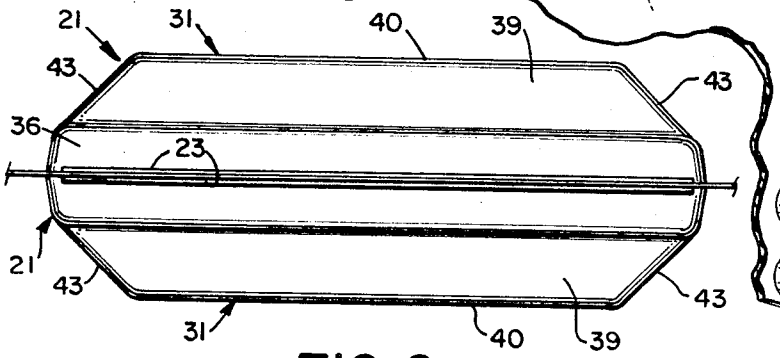


FIG. 5



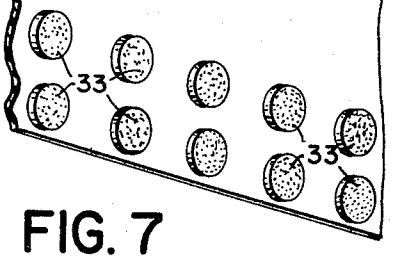


FIG. 6

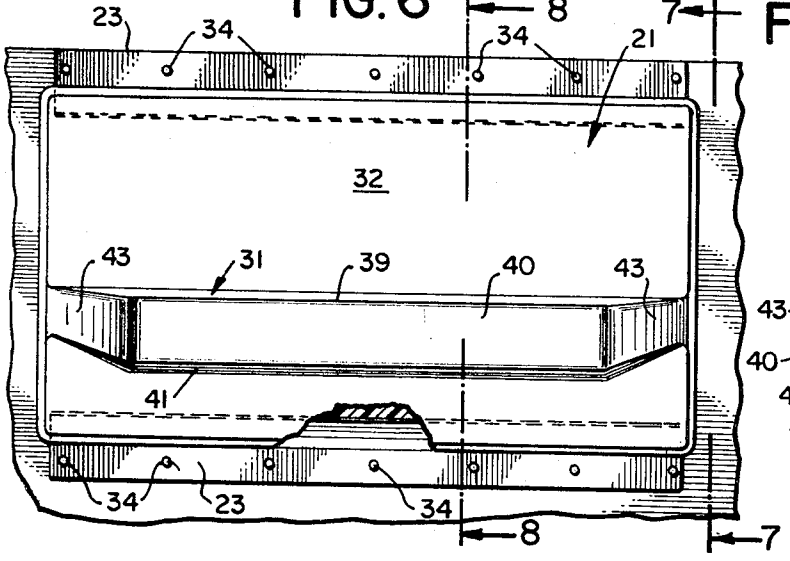


FIG. 7

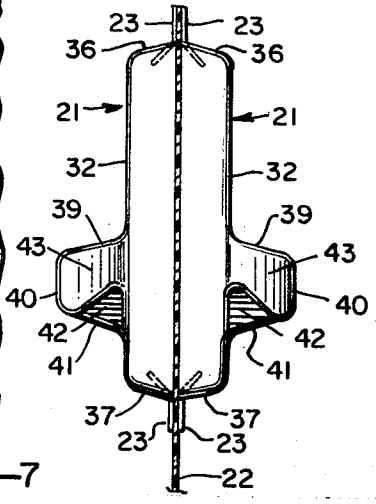


FIG. 8

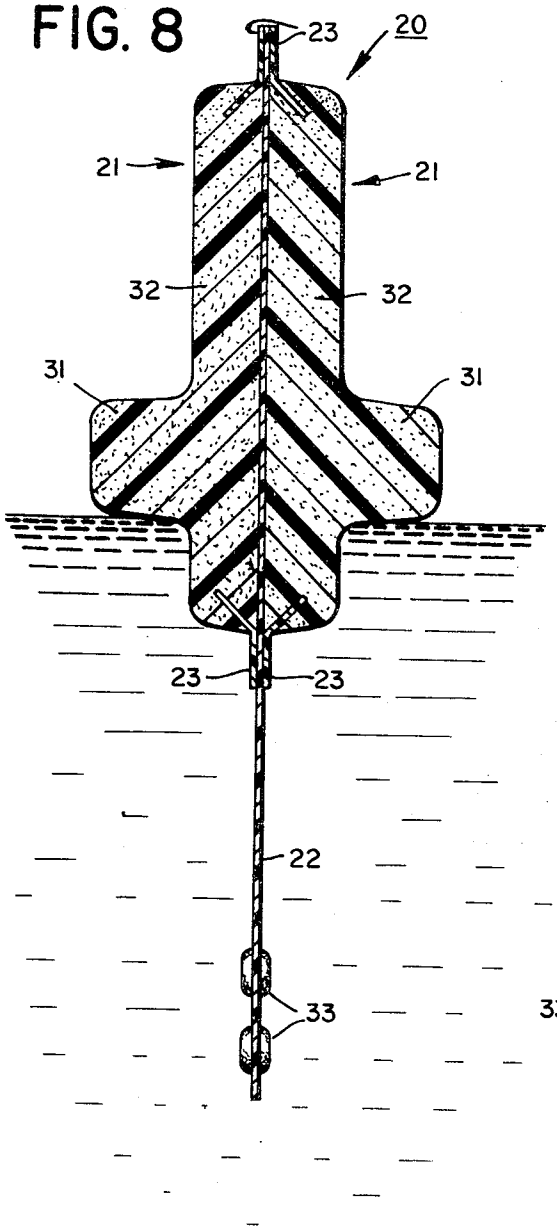


FIG. 9

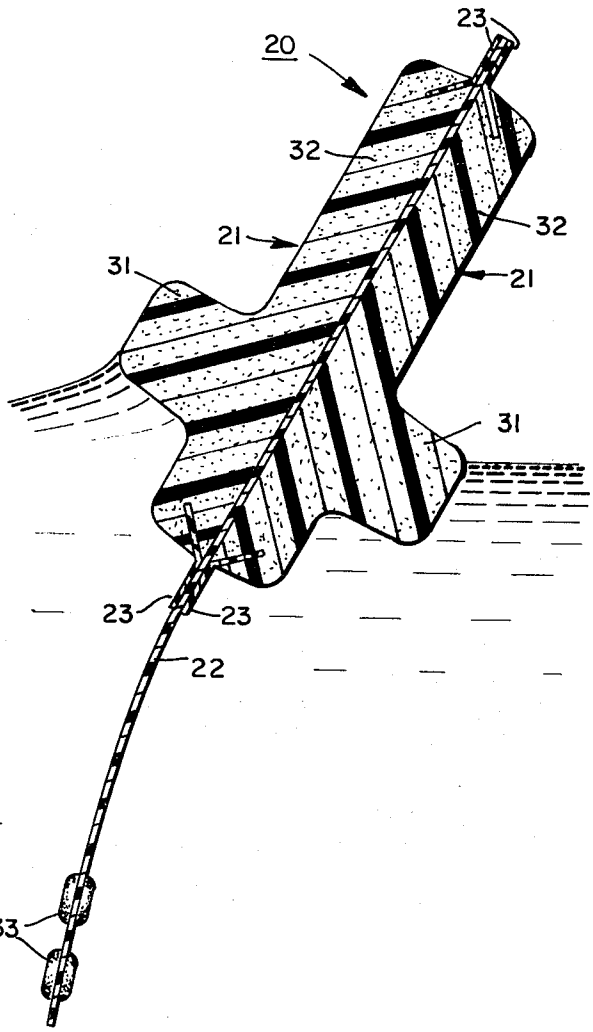


FIG. 10

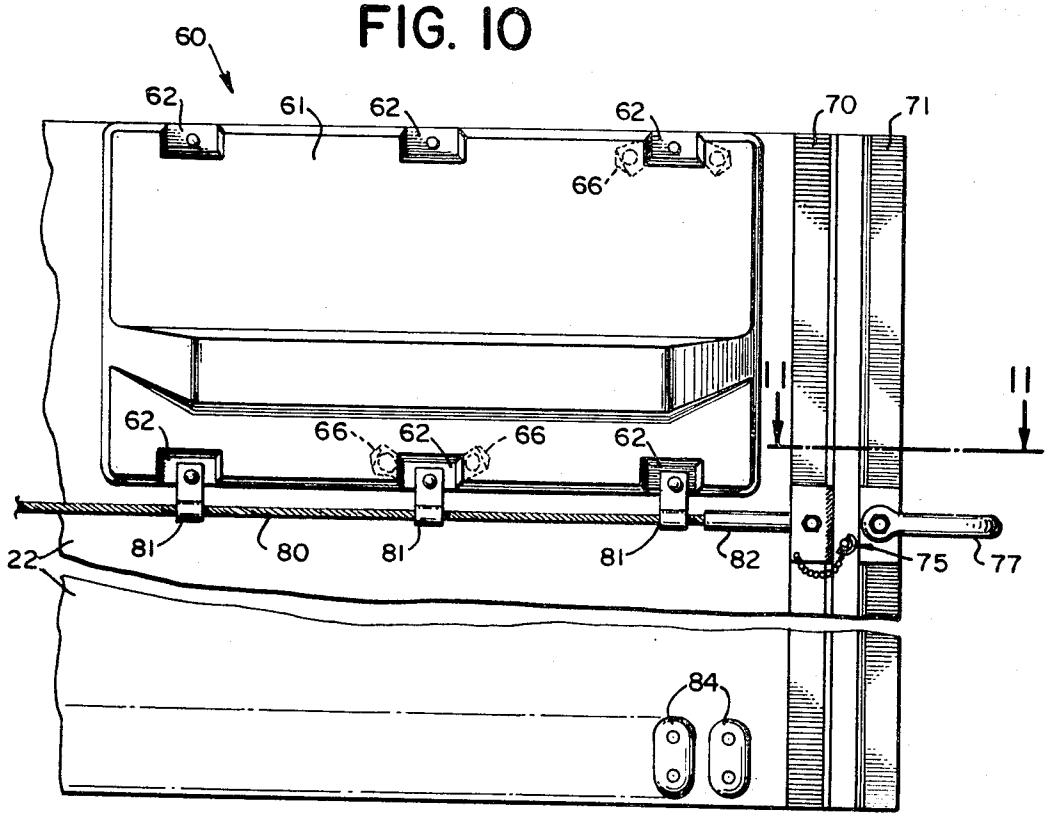


FIG. 11

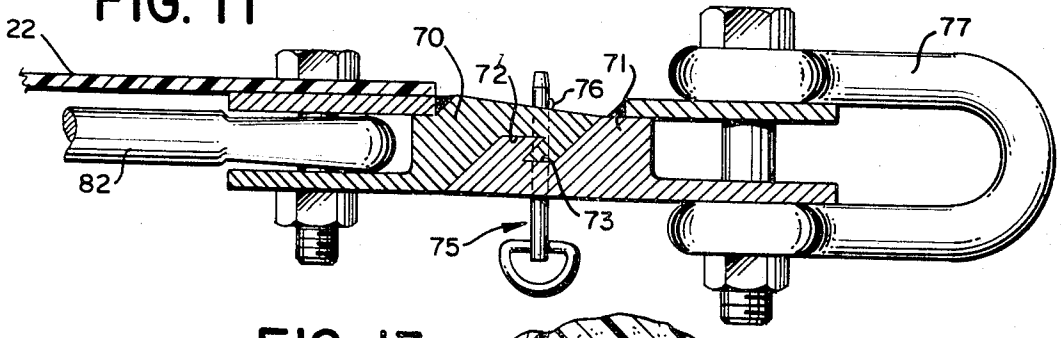
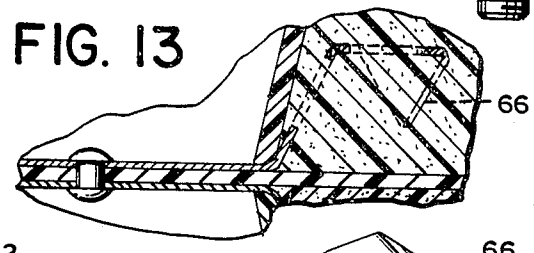


FIG. 13



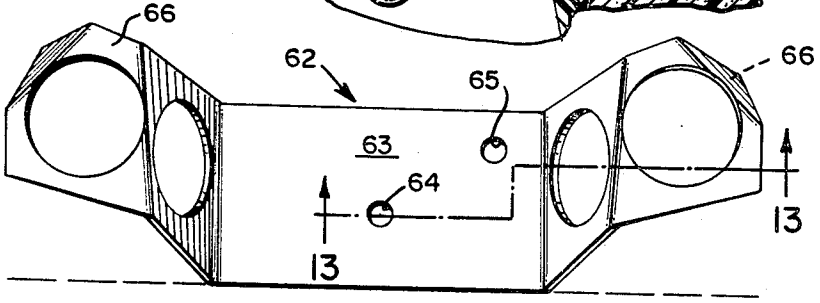


FIG. 12

SELF-RIGHTING FLOATING BOOMS

CROSS-REFERENCE

This application is a continuation-in-part application of Millard F. Smith's patent application relating to High-Strength Fire-Resistant Spill Control Booms filed Apr. 14, 1969 and bearing Ser. No. 815,633.

BACKGROUND OF THE INVENTION

With the ever-increasing awareness of our environmental pollution, the problem of oil spills has received much attention. Because of the severe ecological damage which may result from oil spills, many states have adopted laws or are in the process of adopting laws which will require oil containment booms to be available at all oil transfer installations. The oil boom of Millard F. Smith's U.S. Pat. No. 3,146,598 and the oil boom of Millard F. Smith's U.S. Pat. No. 3,299,490 have gone into wide use in many such installations and have provided effective oil containment under a wide variety of water, wind and sea conditions.

Many floating booms, however, are not capable of successfully containing oil during weather ocnditions which produce strong winds and relatively short choppy waves, having high ratios of wave amplitude to wave length. Under these conditions, the wind and waves often drive the oil over the polymer floats and the oil retaining fin. This oil loss is also compounded by the horizontal flexing of the fin, and thin, limp boom-fins have been known to "roll up" around their floats like a window shade on its roller, thereby eliminating any containment capability and allowing the oil to escape. As a result, any oil spills resulting from mid-ocean collisions between tankers during severe weather conditions pose oil containment problems that cannot be handled by conventional floating booms.

Another problem with most existing oil containment booms is their inability to remain afloat when there are strong tidal currents. This inability is generally due to the common rectangular or cylindrical shape employed in most of the booms for the buoyant floats. As a result, the strong tidal currents pulling against the longitudinal tension of the anchored boom may draw the submerged portion of the fin downwardly, causing the floats and the oil containment portion of the fin to be pulled toward or even below the water surface. Consequently, the oil is free to escape at wave crests where there is nothing remaining above the water level to contain the oil.

OBJECTS OF THE INVENTION

Therefore, it is a principal object of the invention to provide a floating boom that is self-righting, even under adverse weather conditions, short steep choppy waves and the like.

Another object of this invention is to provide a self-righting boom of the above character possessing supplemental buoyancy characteristics, that is capable of remaining afloat in strong tidal currents.

Another object of this invention is to provide a self-righting boom of the above character that is capable of containing oil even while exposed to strong winds and waves, with lateral shelf means, which achieves excess "reserve" buoyancy providing a large righting moment whenever heeling occurs, and also presents additional barrier surfaces to prevent the escape of contained oil during such weather conditions.

A further object of this invention is to provide a floating boom of the above character that allows longitudinal flexing and resists "horizontal" bending about horizontal bending axes.

Other and more specific objects will be apparent from the features, elements, combinations and operating procedures disclosed in the following detailed description and shown in the drawings.

SUMMARY OF THE INVENTION

By mounting on a vinyl fin a plurality of polymer floats which incorporate laterally protruding shelves extending the length of the polymer floats and incorporating planing or lifting surfaces, a unique self-righting floating boom is constructed. The polymer float of this invention is substantially rectangular in shape with a shelf-like portion extending laterally from the otherwise substantially flat side surface of the float and running the length of the float, with its ends being "raked", to reduce drag during rapid endwise deployment. The shelf-like portion extends from the body of the float a distance at least equal to the float thickness and is positioned along the lower half of the float height. The bottom surface of the shelf-like extension of the float of this invention incorporates sloped surfaces along its terminating ends. This provides a lifting surface causing each float to skim or "plane" on its shelf during endwise deployment, and substantially eliminates any submerging tendency during endwise towing.

U.S. Pat. No. 3,184,923 issued to L. Galvaing on May 25, 1965 discloses separate, independent wood floats mounted in a horizontal plane, perpendicular to a vertical plate or board housed in an enveloping sheath. Such wood floats secured to the vertical plate only by means of screws produce a structure very prone to failure. A boom assembly incorporating floats merely screwed to a vertical fin is not capable of sustaining the tremendous forces which are generated during use.

Galvaing's principal buoyant floatation is produced by his separate indepenent wood floats, as contrasted to uniformly buoyant integral cruciform cross section of the float of the present invention. The normal static buoyancy of the present boom is produced primarily by the lower end of the central portion of the buoyant floats **21** extending downward beneath the lower surfaces **41** of the laterally protruding shelves **31**. Thus, applicant's shelves **31** provide a unique source of excess or "reserve" buoyancy producing enormous and laterally spaced buoyant force strongly resisting overturning whenever lateral upsetting forces of waves or wind tilt or heal the float portion **21** to immerse one of the shelves **31**, as shown in FIG. **9**.

In the boom of the present invention, a unitary float structure incorporating both a float body and an extension shelf is provided. Since the extension shelf is an integral part of the float, the buoyant float is capable of enduring the tremendous forces generated during use. Also, the use of two identical floats interconnected in juxtaposed facing relationship with the barrier fin sandwiched therebetween provides a floating boom having superior inherent strength and, consequently, superior oil retentive capabilities. Also, the floats of this invention incorporate lifting and planing ramp surfaces and raked or beveled ends on the extension shelf to enhance the stability and deployability of the boom of the present invention.

Also, the float incorporates integral mounting strips or inserts which are molded in place during the formation of the float, providing easily accessible, readily attachable flange or insert surfaces by which the polymer floats can be secured to the vinyl fin. The attachment strip may extend the entire length of the float and be located at both the top and bottom of the float, or a plurality of separate integrally mounted inserts may be molded within the polymer float with a portion thereof exposed for attachment to the fin. The polymer floats of this invention are used in pairs and are secured to both sides of the vinyl fin. This results in floating booms having a float which provides not only the usual float height but also provides buoyant extension shelves on both sides of the vinyl fin, providing added buoyancy and self-righting capability to the boom.

The unusual stability and ready towability of the booms of this invention are further enhanced by a novel connector transmitting tension loads between adjacent boom segments and terminal towing attachments while preserving the containment integrity of the booms at all joints between boom segments.

Also, the vinyl fin of the floating boom of this invention is manufactured with a central woven core which incorporates two different types of fibers. The horizontally extending fibers are relatively thin strands and are interwoven with substantially thicker vertically extending fibers. This dual fiber core is then sandwiched and coated with vinyl to form the finished integral fin. Due to the construction of the woven core, the vinyl fin has two different bending characteristics. The horizontally extending fibers are substantially smaller than the vertically extending fibers. Consequently, the fin can be easily flexed along lines running parallel with the heavier fibers or, in other words, along vertically extending flexing axes. However, in order to bend the vinyl fin parallel to the smaller, more pliable fibers, the stronger, thicker fibers must be bent. Since these fibers are stronger and heavier, they resist bending and, as a result, impart greater stiffness to the vinyl fin to overcome forces tending to bend the fin along any horizontal axis. As a result, winds and waves which tend to bend the polymer fin horizontally are resisted by the fin of the floating boom of this invention and, thereby, impart greater stability and effectiveness to the floating booms.

The invention accordingly comprises the features, elements, combinations and operating procedures hereinafter disclosed, and the scope of the invention will be indicated in the claims.

THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a portion of the self-righting floating boom of this invention deployed in rough waters;

FIG. 2 is a perspective view of a portion of the two-fiber core of the vinyl fin of the floating boom of this invention with a magnified fin portion shown;

FIG. 3 is a cross-sectional front view of the vinyl fin of this invention taken along line 3—3 of FIG. 2;

FIG. 4 is a greatly enlarged underside perspective view of the polymer floats assembled with the fin in the floating boom of FIG. 1;

FIG. 5 is a top plan view of the assembled floats and fin of FIG. 4;

FIG. 6 is a front elevation view of the floats and fin of FIG. 4;

FIG. 7 is a cross sectional end elevation view of the boom of FIG. 4, taken along plane 7—7 of FIG. 6;

FIG. 8 is an enlarged cross sectional end elevation view of the floating boom of FIG. 4, taken along plane 8—8 shown in FIG. 6, and shown deployed in calm water;

FIG. 9 is a corresponding enlarged cross sectional end elevation view similar to that of FIG. 8 showing the same boom deployed in rough water.

FIG. 10 is a front elevation view partially broken away of a second embodiment of the floating boom of this invention;

FIG. 11 is a greatly enlarged cross sectional top plan view taken along line 11—11 of FIG. 10;

FIG. 12 is a greatly enlarged front elevation view of a fin mounting insert shown embedded in the polymer float of FIG. 10; and

FIG. 13 is a top plan view partially in cross-section taken along line 13—13 of FIG. 12.

DETAILED DESCRIPTION

The self-righting floating boom 20 of this invention is shown in operation in FIG. 1. Floating boom 20 incorporates a plurality of floats 21 securely mounted to fin 22. Each float 21 incorporates attachment strips 23 molded in position during the formation of float 21, ready for rapid and simple mounting to fin 22.

SELECTIVE BENDING FIN

As can best be seen in FIGS. 2 and 3, fin 22 incorporates a woven, dual-fiber web core 26 which is surroundingly enclosed by vinyl 27. Web core 26 comprises relatively thin stranded horizontal fibers 28 interwoven with substantially thicker vertical fibers 29. Preferably, fibers 28 comprise fine denier spun polyester yarn, such as "Dacron" or "Terylene", and fibers 29 comprise higher denier monofalament polyester fibers. The thin fibers 28 will horizontally traverse fin 22, substantially parallel along the length of the fin, while comparatively thick fibers 29 will traverse fin 22 vertically and substantially parallel over the height of the fin.

Preferably vinyl 27 comprises buna-polyvinylchloride and is approved "international orange" in color to improve the visibility of boom 20. In manufacturing fin 22, dual fiber core 26 is "oriented" by being simultaneously heated and stretched out on a frame. Then it is laminated or coated with vinyl 27. This fabrication technique improves the bending characteristics of fin 22 by substantially reducing or eliminating any tendency of fiber core 26 to stretch or elongate.

The incorporation of dual fiber web core 26 in fin 22 arranged in the manner discussed above provides fin 22 with unique, selective bending characteristics. Since the only resistance to the longitudinal flexing of fin 22 about vertical axes is provided by vinyl 27 and the relatively thin horizontal fibers 28, fin 22 can be easily flexed about vertically oriented lines.

Fin 22, however, has a vastly different flexing characteristic about horizontally extending lines. When fin 22 is flexed or "bent over" about a horizontal line, thick fibers 29 must be bent along with vinyl 27. Since the

monofilament fibers 29 are substantially heavier than fibers 28, fibers 29 strongly resist forces tending to bend them and, consequently, they rigidify fin 22 against bending about horizontal lines.

This unique dual-flex characteristic of fin 22 is extremely important in the stability and overall performance of floating boom 20. Since fin 22 can be easily flexed about vertical lines, the fin will respond to normal water currents and waves as presently existing booms do now perform, and, also, the boom can be easily folded accordion-fashion for storage. However, when strong winds and driving waves impact against fin 22, attempting to bend the fin about horizontal lines, semi-rigidified fin 22 resists these forces with great effectiveness. As indicated in FIG. 9, the high buoyancy of floats 21 coupled with the relative stiffness of fin 22 against bending about horizontal lines maintains the float portion of the boom well above the sea surface, refusing to be horizontally flexed and driven into the water or to allow the contained oil to escape. Furthermore, the controlled rigidity of fin 22 allows the floats 21 to be spaced 28 to 34 inches apart without the necessity of having the floats linked together in a continuous "chain". Also, dual-fiber core 26 of fin 22 substantially increases the tensile strength of fin 22, thereby essentially eliminating the need for incorporating tension carrying means on boom 20, if desired.

The relative stiffness of the fin 22 against bending about horizontal axes assures the depending downward deployment of the fin 22 projecting well beneath the surface to guarantee effective containment of oil or other floating material. The ballast weights 33 help to maintain this substantially vertical downward depolyment of fin 22, even against lateral current, wind or wave loads tending to bend over slightly the upper portion of fin 22.

This semi-rigid downwardly depending barrier fin, coupled with the skimming "planing" floats of this invention, together assure that these booms will "track" readily behind a towboat, and their extremely low drag avoids sweeping or "corner-cutting" as the towboat changes course; thus, during deployment the boom readily moves endwise "in trace" behind the towboat along each leg of its course, while depending fin 22 remains downwardly deployed at all times to serve as a guiding keel, as shown in FIGS. 8 and 9. This assures that boom 20 will follow or "track" behind the towboat, substantially following the identical deployment path of the towboat.

SELF-RIGHTING FLOAT

Float 21 can best be seen in FIGS. 4, 5, 6 and 7. Float 21 comprises an overall shape substantially similar to a right angled parallelepiped with a shelf 31 perpendicularly extending from the front face 32 of float 21 and longitudinally transversing the entire length of face 32, protruding substantially parallel to the top surface 36 and bottom surface 37 of float 21 in the direction of the sea surface, as shown in FIG. 8. Mounting strips 23 also extend substantially the entire length of float 21 and are molded in place protruding vertically at the rear of top surface 36 and the rear of bottom surface 36 of float 21. Two floats 21 are preferably positioned, juxtaposed to each other, on both sides of fin 22 with their back surfaces facing each other. Floats 21 are then secured to each other and fin 22 by fastening means, such as rivets 34, ultrasonic spot welding, or the like. The construction of boom 20 is completed by mounting ballast weights 33 along the bottom edge of fin 22 to aid in maintaining the lower portion of fin 22 below the water surface.

The inclusion of shelf 31 as an integral part of each paired float 21 provides the buoyant float assembly with an entirely new "buoyant cruciform" configuration not employed with prior art floats, and this imparts distinct advantages to floating boom 20. Shelf 31 preferably extends from the front face 32 of float 21 by a distance that is greater than the thickness of float 21 (the distance between front face 32 and securing strip 23). Consequently, the shelves 31 of the paired floats provide a wide buoyant platform, thereby greatly increasing the buoyancy of floats 21 and the entire boom 20.

As shown in FIGS. 4, 5, and 6, shelf 31 incorporates a top surface 39, a front side surface comprising a middle portion 40 and beveled or "raked" end portions 43, and a bottom surface comprising a middle portion 41 and tapering and ramp portions 42. Preferably, front side portion 40 is substantially flat, and substantially parallel to front face 32 of float 21, and the raked end portions 43 are substantially flat and extend angularly from middle portion 40 to the end edges of front face 32, blending therewith at their terminating ends. Top surface 39 of shelf 31 is substantially flat and, as best seen in FIG. 7, extends from the side surface 40 of shelf 31 to front face 32 of float 21. The slight angle with which top surface 39 approaches and joins front face 32 of float 21 provides shelf 31 with integral, sturdy support from the central body of float 21.

In the preferred embodiment, the length of each float 21 is about 28 inches and the floats are spaced about 30 to 32 inches apart on fin 22 to form boom 20. This arrangement along with beveled end portions 43 allows boom 20 to be stored accordion-folded in a nested position ready for immediate deployment. Although the nested storage configuration can take many forms, generally, the boom configuration provides sufficient fin length betweem floats to allow the boom to be folded in accordion fashion in any desired length, with juxtaposed floats easily nested between adjacent floats in juxtaposed relationship with the intermediate fin surfaces therebetween.

Preferably, middle portion 41 of the underside of shelf 31 is substantially flat and extends angularly from front face 32 of float 21 to front side portion 40 of shelf 31. Ramped tapering end portions 42 slope upwardly from bottom portion 41 until reaching the sides of front portion 32 of float 21, blending therewith at their terminating ends. Generally, all of the interfacing surfaces between front face 32 and shelf 31 are tapered and incorporate fillet radii at their interblending points. The tapering surfaces and radii are preferred, since their inclusion increases the strength of the float while also providing a more easily molded product.

The slope of ramped end portions 42 away from bottom portion 41 towards top portion 39 of shelf 31 provide float 21 with unique "hydroplane" lifting surfaces which allows boom 20 to be towed rapidly without fear of float submersion, since surfaces 42 tend to lift floats 21 out of the water, resulting in a line of floats freely bobbing on the water surface. The inclusion of raked end portions 43 and ramped end portions 42 are preferred since both surfaces cooperate to impart streamlining and additional buoyancy to boom 20, thereby al-

lowing boom 20 to be rapidly deployed in position around an oil slick even during rough seas and adverse weather conditions.

The construction of shelf 31 and its configuration on float 21 provide boom 20 with a highly useful self-righting capability. When boom 20 is employed in poor weather conditions with high winds and choppy waves, these adverse forces will impinge upon front face 32 of one of the floats 21 in an attempt to drive shelf 31 into the water. The buoyant displacement of the widespread buoyant floation platform defined by shelf surfaces 41 and 42 resists these forces, and instead counteracts heeling and tends to right the boom 20 itself to its normal position.

In FIGS. 8 and 9, various advantages of the widespread buoyant float configuration and stiff fin of this invention can best be seen. When the waters in which the floating boom is employed are relatively calm, as represented in FIG. 8, boom 20 floats in the water with vinyl fin 22 substantially perpendicular to the water surface. Floats 21 with extension shelves 31 float on the surface of the water, maintaining a substantial portion of fin 22 above the surface of the water to provide boom 20 with the necessary upstanding oil containment surface area, blocking splashing or slopping of oil past the boom 20.

The position of extension shelves 31 along the lower half of the front surface 32 of float 21 provides assurance that floating boom 20 will possess the required amount of buoyancy while also providing a substantially greater oil retaining surface area above the water surface. In the preferred embodiment, fin 22 is about 36 inches wide and about 12 inches of fin 22 is maintained above the water surface. Maintenance of the substantially vertical orientation of fin 22 in the water is assured by ballast weights 33 which are mounted along the lower edge of fin 22, imparting added weight thereto.

By analogy, the booms of the present invention exhibit the high lateral stability against "initial" heeling, produced by flat-bottomed and multi-hull vessels, with the highly effective self-righting action of a deep keel sailboat, whose increasing angle of heel correspondingly increases the righting arm and righting moment of the vessel's heavy keel. Thus, a slight angle of heel immersing the right shelf 31 in FIG. 9 immediately moves the boom's center of buoyancy to the right, tending to re-erect the heeling boom; simultaneously, the relative stiffness of the fin 22 against bending about horizontal axes serves to produce an increasing "deep-keel" righting moment of ballast 33, further tending to re-erect the boom 20 with highly efficient self-righting action.

In FIG. 9, the unique advantages of extension shelves 31 of float 21 when exposed to rough waters and/or severe weather conditions can best be seen. When strong winds and waves impinge upon front surface 32 of floats 21, the heeling forces thereby generated tend to drive extension shelf 31 of the opposite float 21 below the water surface. As previously described, the widespread buoyancy achieved by extension shelf 31 resists these heeling forces by attempting to remain above the water surface and right boom 20 into its normal position of FIG. 8.

As shown in FIG. 8, the boom 20 normally rides in the water with the shelves 31 at or above the water surface. Sudden heeling plunges shelf 31 below the surface, as shown in FIG. 9, and the buoyant force B thereon, acting at a laterally displaced moment arm a from the center of gravity of the boom provides enormous "reserve" buoyancy, increasing geometrically with the angle of heel to the ratio of 2:1 or 2.5:1 or more. The booms of this invention thus combine the high initial stability of flat bottomed vessels with the high ultimate stability of deep keel sailing vessels contributed by the ballasted semi-rigid fin 22.

If the winds and waves are capable of overcoming the self-righting capabilities of floats 21, a portion of extension shelf 31 may be driven below the water surface, as shown in FIG. 9. However, when extension shelf 31 of one of the floats 21 is driven below the water surface, the other extension shelf 31 of the other float 21 is raised above the water surface. Consequently, the waves which heel the boom and tend to submerge it or to carry oil over the boom meet a new obstacle head-on—the newly exposed underside of the raised shelf 31—which not only reduces the force of the waves but also prevents the waves from driving oil over floating boom 20. As previously described, the dual fiber web at the core of fin 22 also resists the forces which attempt to submerge floats 21 and impart greater rigidity to fin 22.

In the preferred embodiment, floats 21 are manufactured from foamed polyurethane, although any other substantially oil-resistant material can be used with equal efficacy. Also, the floats can be manufactured from high temperature-resistant materials such as modified polyvinyl chloride cellular foam, foamed aluminum blocks having a closed cell foam structure, and polymer foam with a neoprene-supported fabric sheath.

In the prior art floating booms, severe weather conditions and rough waters sometimes cause entire floats to be submerged, releasing previously retained oil from containment and permitting it to be driven by wind and waves far beyond the previously confined area.

With the boom of this invention, complete submersion is minimized or eliminated by the unique stability and self-righting characteristics produced by the float shape and ballast-fin-float configuration described above, and substantial oil confinement continues regardless of severe weather conditions and/or rough waters. The boom of this invention is capable of achieving previously unattainable stability due to the selective bendability of the fin and the unique widespread buoyancy and oil splash-resistance of the buoyant cruciform floats cooperating with the selectively bendable ballast-carrying fin. Under normal weather conditions, the preferred construction and arrangement of the floats and the fin provide an oil barrier standing about 12 inches above the water surface. Experiments have shown that under the relatively high wind loading of 38 miles an hour, the boom of this invention with its minimum angle of heel provided an effective oil barrier standing 11 inches above the water surface.

The unique selective bendability of the fin produced by the woven dual fiber web core provides the boom with the desirable advantage of eliminating the need for the closely spaced "continuous" chain of buoyant floats required in many prior art booms. The need for a continuous chain of floats is eliminated because of the inherent capability of the fin to withstand and remain relatively rigid under wind, current and wave forces tending to bend the fin about horizontal lines. This rigidified fin accomplishes the task previously

achieved by close spacing of the floats, thereby allowing the floats to be merely mounted to the fin at substantially any desired spacing without costly and complicated additional stiffening or load carrying equipment. Increased float spacing also enhances the boom's capability for interfloat nesting and accordion folding in compactly stored condition, ready for instant deployment. The float shelf ramp surfaces permit rapid skimming, planing, endwise deployment of the boom by a high speed towing vessel, without risk of "pitch-poling", "cartwheeling" or excessive drag.

A second embodiment of the floating boom of this invention is presented in FIG. **10**, incorporating various alternative structural features. Floating boom **60** incorporates polymer float **61** secured to composite polyester vinyl sheet fin **22**. Polymer float **61** incorporates a plurality of mounting inserts **62** disposed along the top and bottom edge of the float with a portion of each insert embedded and surroundingly held by the foamed polymer float.

As best seen in FIG. **12**, insert **62**, preferably, comprises a single piece of metal with a substantially flat central portion **63** and two arms **66**, which are formed by symmetrically bending the arm portion in several different planes. Large diameter holes are punched in arms **66** and insert **62** is positioned for foamed entrapment in float **61** during forming. Substantially flat central portion **63** of insert **61** remains exposed and incorporates a small attachment hole **64**, and if desired a molding alignment hole **65**. The holding arms **66** of insert **62**, which incorporate the large holes, become part of the polymer float, securely retained therein by the foam structure. In FIG. **13**, the secure entrapment of arm **66** in the polymer foam of float **61** is best seen.

Float **61** is attached to fin **22** by fastening means, such as rivets, which pass through holes **64** of inserts **62**, thereby securing float **61** to fin **22**. As described above, in the preferred embodiment, floats **61** are mounted to fin **22** in pairs which are symmetrically aligned; this allows a single rivet to secure each pair of juxtaposed inserts of the opposed floats to each other and fin **22**, forming a substantially unitary buoyant float body having a cruciform cross section, as shown in FIGS. **7**, **8** and **9**.

In order to provide a floating boom of any desired length, it is important that standardized floating boom sections are readily interconnectible and readily attachable to a towing rig for easy deployment. As shown in FIG. **10**, connector bracket **70** is longitudinally disposed along one edge of fin **22** and secured thereto. Although bracket **70** is shown disposed along the entire height of fin **22**, it should be evident to one skilled in the art that bracket **70** may be successfully employed over any desired portion of the fin height. Interconnected with bracket **70** is a cooperating towing bracket **71**.

This connector assembly can best be seen in FIG. **11**. Connector bracket **70** incorporates a longitudinally extending recess **72** and jaw **73**. Bracket **71** incorporates a mating recess and jaw to provide firm positive interlocking of bracket **71** with bracket **70**.

Recess **72** is angularly constructed to require unloading of tension and longitudinal shifting of bracket **70** and **71** before disconnection occurs. Pin **75** is positioned in a perpendicularly arranged cooperating hole through both brackets **70** and **71** in order to prevent any unwanted longitudinal shifting of brackets **70** and **71**. Undesired slippage of pin **75** is prevented by ball detent **76**.

Towing bracket **71** incorporates a shackle **77**, which is securely bolted to bracket **71**, thereby providing efficient means for secured attachment of a towing line to allow rapid deployment of the floating boom.

In the preferred embodiment, the connector assembly is manufactured by extruding aluminum in the desired configurations. It is preferred, however, that the extrusions be constructed so that the center line of the connectors passes directly through the cooperating, interlocking jaws thereof.

By referring to FIGS. **10** and **11**, it can best be seen that optional non-slack tension-carrying reinforcing cable **80** is disposed along the lower edge of float **61**. Cable **80** is preferably maintained in position by means of metallic clips **81**, which are secured to each metal insert **62** by the fastening means discussed above. Cable **80** is swaged or otherwise securely mounted within eye connector **82**, which is bolted to bracket **70**. The use of reinforcing cable **80**, which extends along the entire boom length and is securely mounted to a bracket at both ends of the floating boom section, provides assurance that all forces tending to stretch fin **22** longitudinally will be substantially absorbed by cable **80**, thereby preventing degradation or tearing of fin **22**.

Disposed along the lower edge of fin **22** are a plurality of substantially elliptical weights **84** to provide the desired ballast weight to the lower edge of fin **22**. Elliptical ballast weights which can be easily secured together are desired, since a single weight can be used, where previously two or more independent weight were required.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative so as to obtain the benefits of all equivalents to which the invention is fairly entitled.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and that all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what we claim as new and desire to secure by Letters Patent is:

1. A flexible, high strength floating boom suitable for deployment and oil containment in rough waters comprising:

A. a continuous elongated flexible barrier fin having upper and lower edges extending over the length of the boom; and

B. a plurality of unitary buoyant floats mounted at spaced intervals along said fin,

a. each having a cross-section comprising a vertically elongated substantially rectangular portion having a substantially uniform width and

b. an integral laterally extending wide outrigger shelf portion

1. protruding from at least one side of the vertically elongated portion,

2. having a width and depth equal to at least the width of the vertically elongated portion, and

3. positioned above a lower end of the vertically elongated portion,

with the major part of the displacement required for buoyant flotation of the boom being provided by the lower end of said vertically elongated portion below said shelf.

2. The barrier boom defined in claim **1**, wherein the outrigger shelf of each buoyant float is further defined as protruding from the lower half of the vertically elongated portion substantially perpendicular thereto, laterally extending substantially parallel to the waterline.

3. The barrier boom defined in claim **1**, wherein the extension shelf of each buoyant float further comprises raked side end portions, and slanting bottom end ramp planing surfaces.

4. The barrier boom defined in claim **1**, wherein each buoyant float further comprises a substantially flat fin-engaging surface for mounting to a first side of the fin in juxtaposed facing relationship with the fin-engaging surface of a second buoyant float positioned on the opposite side of the fin, forming an integral buoyant flotation body having a cruciform cross-section.

5. The barrier boom defined in claim **4**, wherein the float further includes fin-securing inserts having an embedded anchoring portion molded within the float and a fin-securing portion along an edge portion of the float, substantially aligned with the fin-engaging surface.

6. The barrier boom defined in claim **1**, wherein the floats are mounted to the fin at spaced substantially equal intervals ranging between about 28 and 34 inches.

7. The barrier boom defined in claim **1**, wherein the floats comprise an overall height of about 16 inches, thereby providing an oil containing fin barrier extending between about 10 inches and 12 inches above the water surface.

8. The barrier boom defined in claim **1**, further comprising a plurality of ballast weights mounted along the lower edge of the fin imparting additional weight thereto, and lowering the center of gravity of the barrier boom.

9. The barrier boom as defined in claim **1**, wherein said fin further comprises a central core incorporating a woven dual fiber network wherein the fibers disposed along one direction of the network are substantially thicker and less pliable than the fibers disposed along the other direction of the network.

10. The barrier boom defined in claim **9**, wherein the network core is surroundingly enveloped by heat sealed vinyl layers, thereby forming a unitary fin structure.

11. The barrier boom defined in claim **9**, wherein the thicker, less pliable fibers of the fual fiber network are positioned substantially perpendicular to the upper and lower edges of the fin, and the thinner, more pliable fibers are disposed substantially parallel to the upper and lower edges of the fin, thereby providing easy bending about vertical axes and substantial resistance to bending about horizontal axes.

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