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Ayers et al.

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[54] **OIL CONTAINMENT APPARATUS**

[75] Inventors: **Ray R. Ayers; Errol V. Seymour,** both of Houston, Tex.

[73] Assignee: **Shell Oil Company,** Houston, Tex.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 81,305, Oct. 16, 1970, abandoned.

[52] **U.S. Cl.** ..... **61/1 F**

[51] **Int. Cl.** **E02b 15/04**

[58] **Field of Search** ..... 61/1 F, 5; 210/242, DIG. 21

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Primary Examiner—Peter M. Caun

Attorney, Agent, or Firm—Fredrik Marlowe

[57] **ABSTRACT**

Oil containment apparatus for use in water experiencing high current velocity which includes a barrier and means upstream of the barrier defining therewith a capture area where the flow velocity is locally reduced. Oil or other floating pollutant liquid enters the capture area and accumulates therein because of the inability of the low current velocity to remove the oil. Oil thus collected may be skimmed or otherwise removed from the capture area.

15 Claims, 4 Drawing Figures

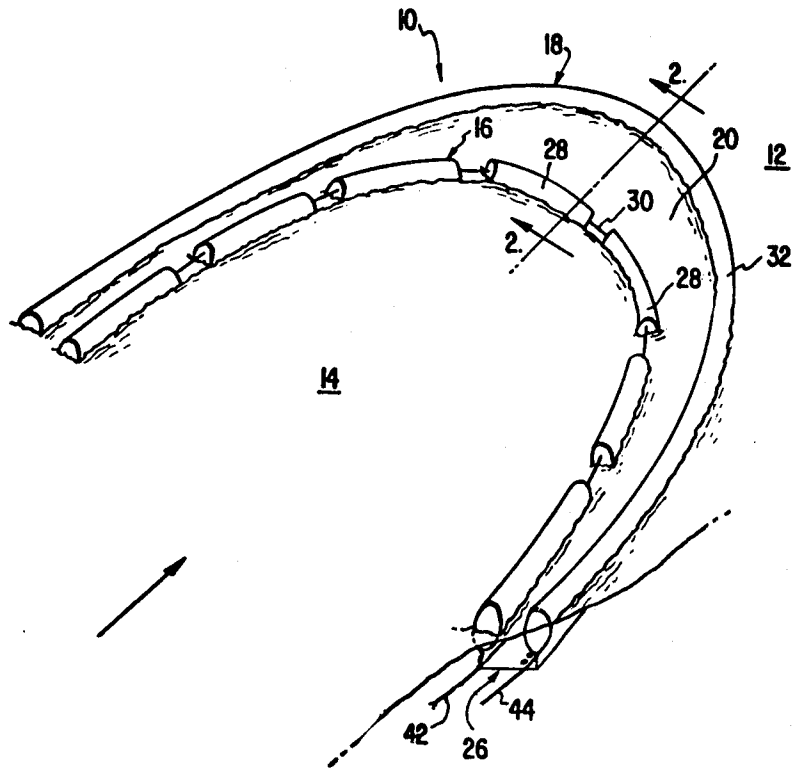


FIG. 1

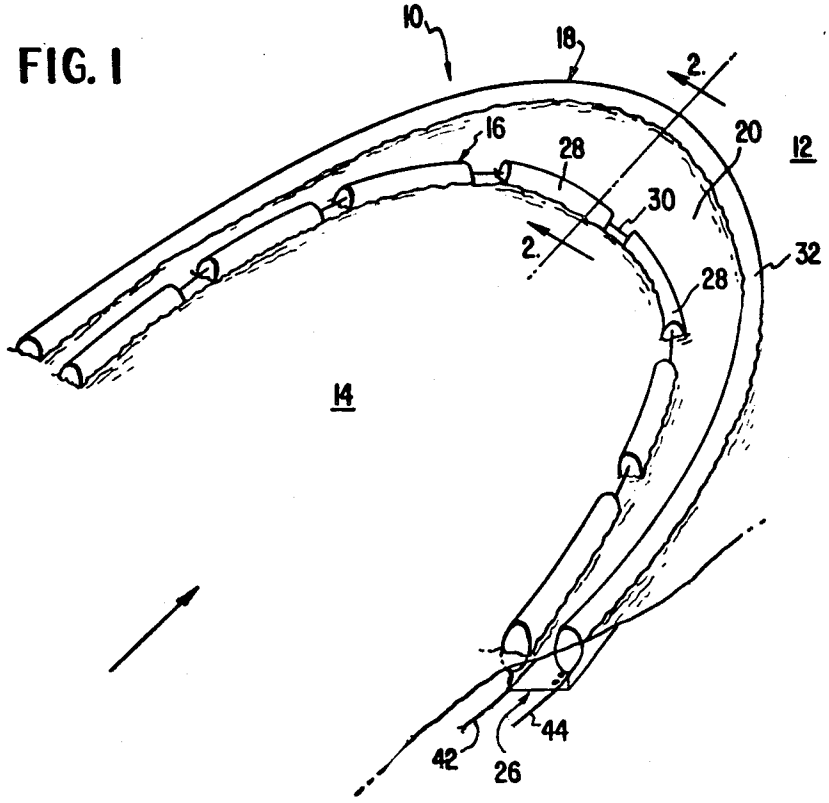

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FIG. 2

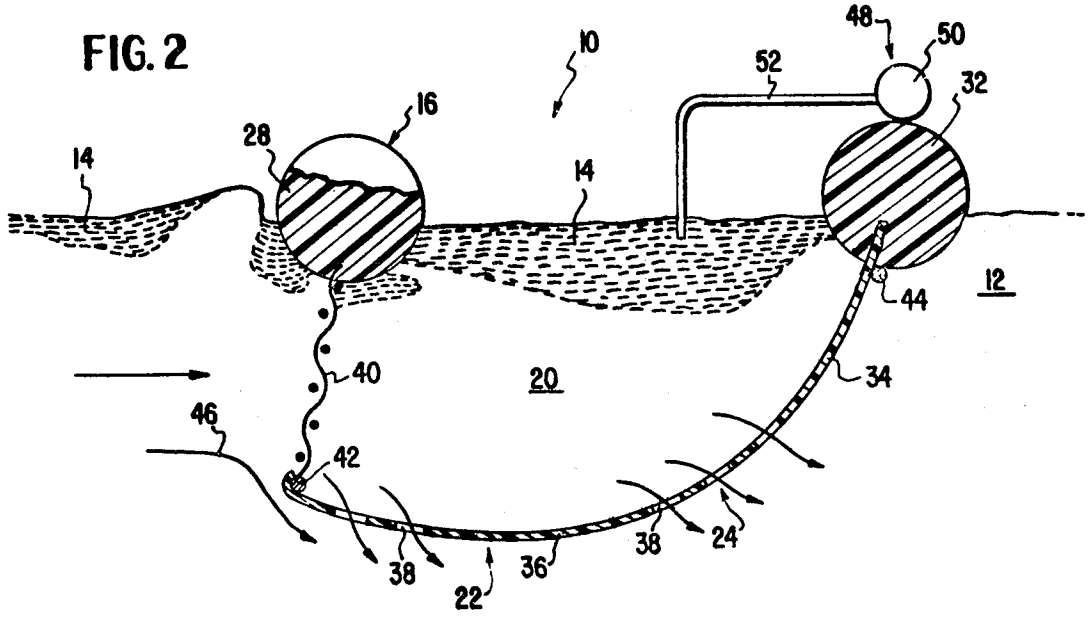

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FIG. 3

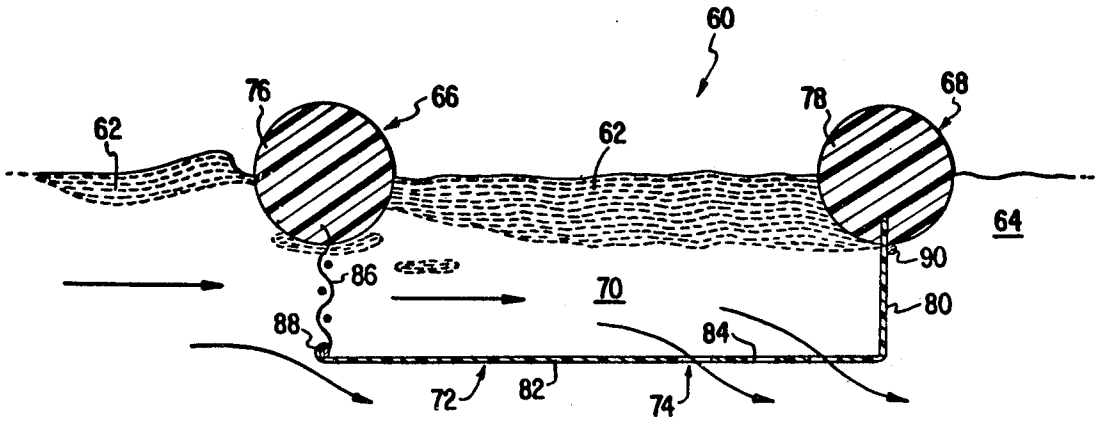
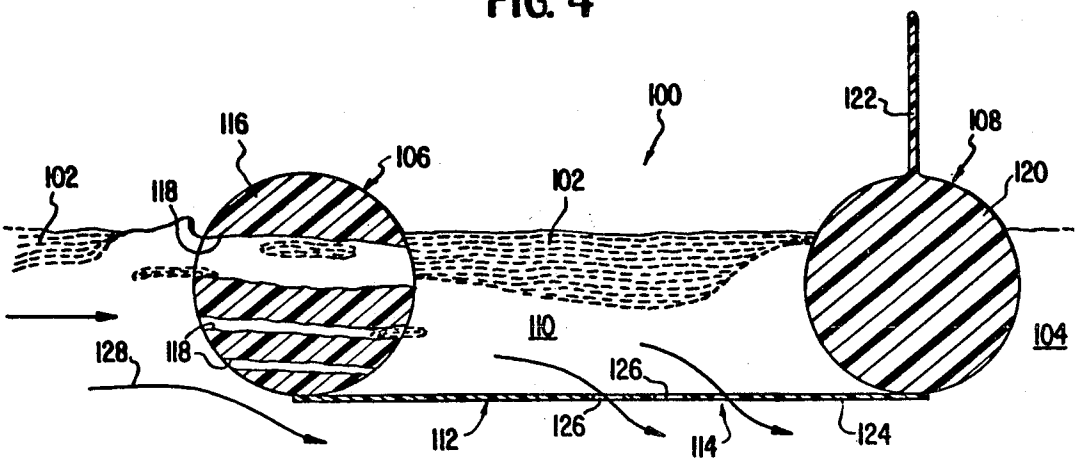

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FIG. 4


100
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112
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114
124

OIL CONTAINMENT APPARATUS

RELATED APPLICATION

This is a continuation-in-part of application Ser. No. 81,305, filed Oct. 16, 1970 now abandoned.

BACKGROUND OF THE INVENTION

Oil containment apparatus such as booms are well known in the prior art and are available commercially, for example, from Neirad Industries under the trade-name "Slickbar." Conventional oil containment booms have a maximum containment velocity of approximately one knot, i.e. oil is lost past the boom at current velocities in excess of one knot or at towing speeds in excess of one knot. At greater relative current velocities, oil bubbles break off from the head wave at the oil-water interface and escape below conventional booms. Thus conventional booms are not particularly effective in waters experiencing high current velocities. Equally important, prior art booms cannot be towed through the water in excess of one knot thereby causing containment operations to be prolonged unduly. To an extent, these problems are also experienced with certain skimmer designs which, like booms, may be towed or placed stationary in a current.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an oil containment boom or skimmer apparatus which is successful in containing oil at current velocities substantially in excess of prior art apparatus.

Another object of the invention is to provide a barrier arrangement which may be towed through the water as a skimmer or boom at speeds substantially in excess of prior art towing limits without loss of substantial quantities of liquid pollutant.

In summary, the apparatus of this invention comprises spaced apart buoyant float means defining therebetween a capture area for a floating liquid pollutant, means defining a path of water movement having a generally horizontal inlet into the capture area and an outlet generally downwardly out of the capture area and means for reducing the flow velocity in the capture area below the relative current velocity experienced by the apparatus. The buoyant float means may be arranged upstream and downstream as part of a boom arrangement or side-by-side as sides of a skimmer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of one embodiment of this invention positioned in a body of water experiencing relative current movement in the direction indicated by the arrow;

FIG. 2 is an enlarged cross-sectional view of the embodiment of FIG. 1 taken substantially along line 2—2 thereof as viewed in the direction indicated by the arrows;

FIG. 3 is an enlarged cross-sectional view, similar to FIG. 2, of another embodiment of the invention; and

FIG. 4 is an enlarged cross-sectional view, similar to FIGS. 2 and 3, of a second embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Attention is directed to FIGS. 1 and 2 where a boom-type apparatus 10 of this invention is illustrated as positioned in a body of water 12 on which there is floating

a layer of liquid pollutant 14. Although the liquid pollutant 14 typically comprises liquid hydrocarbons, it will be apparent that the apparatus 10 may be used to control floating liquid pollutants of any type. The apparatus 10 comprises as major components upstream and downstream spaced apart buoyant float means 16, 18 defining therebetween a capture area 20 for the liquid pollutant 14, means 22 defining a path of water movement generally horizontally into the capture area and generally downwardly out of the capture area and means 24 for reducing the flow velocity in the capture area 20 below the relative current velocity to which the apparatus 10 is subjected. Means 26 are provided for positioning the apparatus 10 in an area of high current velocity or for towing the apparatus 10 through the water 12.

The float means 16, 18 may comprise oil containment booms of the type commercially available. The float means 16 is illustrated in FIGS. 1 and 2 as comprising a plurality of discrete spaced apart floats 28 connected together by suitable flexible lines or cables 30. It will be apparent that the upstream float means 16 acts to retard wave movement in the capture area 20. Waves breaking over the upstream float means 16 act to deposit some liquid pollutant in the capture area 20. The float means 18 may comprise a single elongate float 32 or a plurality of discrete floats forming a barrier.

The flow path defining means 22 comprises a flexible impervious skirt 34 depending from adjacent the float 32 and may conveniently be attached thereto in a conventional manner. The lower end of the impervious skirt 34 merges with a flexible foraminous member 36 having a plurality of apertures 38 which function as the velocity releasing means 24 as will be more fully explained hereinafter. The upstream end of the foraminous member 36 is conveniently connected to the upstream float means 16 in any suitable manner, as by the use of a foraminous member 40 which is illustrated as a screen or net. Suitable weights (not shown) or other means may be provided at the upstream end of the foraminous member 36 to tension the member 40 and thereby maintain the member 36 at a desired location. It will be apparent that the means 22 defines a path of water movement generally horizontally into the capture area 20 and generally downwardly out of the capture area 20.

The positioning or towing means 26 is provided to position the apparatus 10 in an area of high current velocity or to tow the apparatus 10 through the water 12. The term relative velocity or relative current velocity is used to define the situation where water moves past the apparatus 10 regardless of whether the apparatus 10 is placed in an area of high current velocity, the apparatus 10 is towed through the water or combinations thereof. The positioning or towing means 26 may be of any suitable type but is illustrated as comprising a first flexible line or cable 42 connected to the upstream end of the foraminous member 36 and a second flexible line or cable 44 connected to the float means 18 in a conventional manner. Of course, where the apparatus of this invention is specifically arranged to define a skimmer, as hereinafter more particularly described, the towing means may be unnecessary since the skimmer may be self-propelled.

As mentioned previously, conventional oil containment booms comprise a single elongate float means and

have a maximum containment relative velocity of 1.2 to 1.3 feet per second. At greater relative velocities, oil bubbles break off of the headwave at the oil water interface and escape under the boom. Since current velocities in excess of 1.2 and 1.3 feet per second are not uncommon, it will be apparent that the use of conventional oil containment booms is somewhat limited. Even more important, oil containment booms are often towed to collect the liquid pollutant **14** and the low maximum containment velocity of containment booms substantially prolongs a collection effort.

A prototype of this invention which could be considered as a finite width skimmer, or alternatively as a length increment of a boom was tested in a current tank and subjected to relative current velocities up to 2.54 feet per second before failure occurred. The typical mode of failure of the prototype is that the buoyancy of the float means is insufficient at maximum velocity and the float means submerges thereby allowing escape of the liquid pollutant **14** over the top of the rearmost float. It is apparent that additional floats may be added to the float means of the prototype to increase the maximum containment relative velocity. Further tests with the prototype without any additional float means were conducted at a relative velocity of 2.20 feet per second without loss of the liquid pollutant **14.**

The velocity reducing means **24** acts to reduce the flow velocity in the capture area **20** sufficient to allow the liquid pollutant **14** to gravitate to the surface. The apertures **38** comprise the velocity reducing means **24** and act as a flow restriction in the outlet of the flow path through the capture area **20.** The size and number of the apertures **38** are selected to provide a flow capacity therethrough substantially less than the volume of water approaching the inlet to the capture area **20.** For all reasonable values of relative velocity, the apertures **38** constitute a flow restriction in the flow path tending to deflect water approaching the inlet to the capture area **20** downwardly under the foraminous member **36** as shown by the arrow **46** in FIG. **2.** As the relative velocity increases, a greater quantity of water is so deflected to provide a greater difference between the existing relative velocity and the flow velocity in the capture area **20.** It will thus be seen that the flow velocity in the capture area **20** is controlled by the flow capacity of the apertures **38.** In the prototype, the apertures **38** comprises 3/4 inch diameter holes staggered on three rows 1¾ inches apart.

The capacity of the capture area **20** to collect the liquid pollutant **14** is necessarily finite. There may accordingly be provided a suitable pollutant removal means **48** which is illustrated in FIG. **2** as comprising a pump **50** having an inlet **52** extending into the liquid pollutant collected in the capture area **20.** When the oil is removed from the oil capture area of the boom-type apparatus, the apparatus could be called a mechanical skimmer or alternatively (since the apparatus as shown draped in the water has the appearance of a boom) a "boom-skimmer". It follows then that if the apparatus is relatively rigid along its length so that it does not appreciably drape as a boom and if it is perhaps relatively short in length, oil removal would then distinguish the apparatus as a "skimmer". A suitable outlet conduit (not shown) may be connected to the pump **50** for delivering the liquid pollutant to a suitable barge or the like. Other suitable means for removing the liquid pollutant **14** in the capture area **20** may be provided as, for example, scattering oil sorbtive particles in the capture area **20** and then collecting the same.

Referring now to FIG. **3,** another embodiment of this invention is illustrated as a boom or skimmer apparatus **60** for controlling a spill of liquid pollutant **62** on a body of water **64.** The apparatus **60** comprises as major components upstream and downstream booms or float means **66, 68** defining therebetween a capture area **70,** means **72** defining a path of water movement generally horizontally into the capture area **70** and generally downwardly out of the capture area **70** and means **74** for reducing the flow velocity in the capture area **70** below the relative current velocity to which the apparatus **60** is subjected.

The upstream and downstream float means **66, 68** as in the case of a boom are illustrated as comprising elongate continuous floats **76, 78** of any suitable type. Such floats are presently commercially available. As previously stated, the buoyant float means may be arranged side-by-side as in the case of a skimmer.

The flow path defining means **72** comprises an impervious barrier or skirt **80** depending from adjacent the downstream float means **68** and may be embedded or otherwise secured to the float **78** in any suitable manner. The flow path defining means **72** further comprises a foraminous member **82** having a plurality of apertures **84** therein which function as the velocity reducing means **74** as previously mentioned. The upstream end of the foraminous member **82** is conveniently held in place by connection to the float **76** as by the use of a tension element **86** which allows flow therepast. The tension element **86** may comprise a cable, netting or the like although it is illustrated as a screen. Suitable weights (not shown) or other means may be provided adjacent the upstream end of the foraminous member **82** to depress the same and tension the element **86** to maintain the upstream end of the foraminous member **82** in a desired position.

Suitable means such as flexible lines **88, 90** are connected to the apparatus **60** for positioning the same in an area of high current velocity or for towing as a boom. The flexible lines **88, 90** extend from each end of the apparatus **60** in much the same manner that the cables **42, 44** are shown in FIG. **1.**

It will be apparent that the apparatus **60** functions in much the same manner as the apparatus **10** where the apertures **84** constitute the velocity reducing means **74** and maintain the flow velocity in the capture area **70** at a lower value than the relative current velocity. The liquid pollutant **62** collecting in the capture area **70** may be removed in any convenient manner as will be apparent to those skilled in the art. If, on the other hand, the apparatus of FIG. **3** is short in its length dimension and is composed of relatively rigid members its function would be, as indicated previously, that of a skimmer apparatus.

It is shown in FIG. **4** an apparatus **100** constituting another embodiment of this invention for controlling a spill of floating liquid pollutant **102** on a body of water **104.** The apparatus **100** comprises an upstream pervious float means or barrier **106** and a downstream impervious float means or barrier **108** defining therebetween a capture area **110** for the liquid pollutant **102.** The apparatus **100** further comprises means **112** defining a path of water movement generally horizontally into the capture area **110** generally downwardly therefrom and means **114** for reducing the flow velocity

from the capture area **110** below the relative current velocity to which the apparatus **100** is subjected.

The upstream pervious float means **106** may be constructed in any suitable manner but is illustrated as in the case of a boom as comprising an elongate continuous float **116** having a plurality of passages **118**, preferably generally horizontal, formed therein in any suitable manner, as by molding during construction of the float **116** or by punching or boring after manufacture. The flow capacity of the passages **118** should be sufficient at substantial relative current velocities to prevent the formation of a substantial oil headwave and/or to prevent the formation of vortices on the upstream side of the float **116**. This allows the liquid pollutant **102** to pass through the float means **106** into the capture area **110** without loss of significant quantities of the liquid pollutant **102** under the float means **106**.

The float means **108** may be of the type presently commercially available and is illustrated as comprising an elongate continuous impervious boom float **120** having a fin **122** thereon preventing loss of liquid pollutant **102** from the capture area **110** by splashing over the float **120**.

The flow path defining means **112** comprises a foraminous member **124** having apertures **126** therein functioning as the velocity reducing means **114**. The downstream end of the foraminous member **124** is connected in any suitable manner to the bottom of the float **120**. The upstream end of the foraminous member **124** is connected in similar fashion to the underside of the float **116**. Suitable means (not shown) are provided for positioning and/or towing the apparatus **100** as a boom through the water **104**.

As in the other embodiments, the velocity reducing means **114** is comprised of the apertures **126** and constitutes a flow restriction in the outlet of the flow path through the capture area **110**. The flow capacity of the apertures **126** is preferably selected to be insufficient to accommodate the volume of water approaching the flow path inlet to the capture area **110**. The flow restriction provided by the velocity reducing means **114** accordingly acts to reject part of the water approaching the flow path inlet as shown by the arrow **128**. In order to decrease the flow through the velocity reducing means **114** one can decrease the size of apertures, decrease the number of apertures or alternatively increase the depth of the apertures. A member with deep apertures might look like a grating.

It will be apparent that the flow passages **118** may operate as a flow restriction and accordingly comprise part of the velocity reducing means **114**. The flow restriction provided by the passages **118** and by the apertures **126** accordingly acts to reject part of the water approaching the flow path inlet to the capture area **110**. It will be equally apparent that the flow restriction in the inlet to the flow path through the capture area **110** may be used to supplement or replace entirely the flow restriction provided by the apertures **126**. The openings in the foraminous members **40, 86** of the embodiments of FIGS. **2** and **3** may likewise be designed to function wholly or partially as the velocity reducing means.

The float means described in the previous embodiments may be alternatively arranged side-by-side to form the sides of a skimmer (not shown). Inside the skimmer is formed a quiescent capture area by reducing the flow velocity in the capture area below the relative current velocity experienced by the skimmer, similar to the boom arrangements. To form the quiescent capture area, the skimmer may otherwise be constructed as the boom arrangements of FIGS. **2–4**, e.g., with a restricted inlet and outlet and a current deflector such as one of elements **34, 80** and **124**. The embodiment of FIG. **4** in particular is well suited to use as a skimmer. The outlet flow restriction of the skimmer or boom is effectively greater than the inlet flow restriction. This is accomplished in whole or in part by arranging the direction of outlet flow at an angle to the direction of inlet flow by use of suitable grating whereby the current diversion leads to an increased residence time within the skimmer which is responsible at least in part for the quiescent capture area which allows the oil to float to the top of the water so that it may be skimmed.

We claim as our invention:

1. Apparatus for controlling a spill of floating liquid pollutant on a water surface experiencing a relative current velocity therepast comprising:

spaced apart buoyant float means defining therebetween a capture area;

means defining a path of water movement generally horizontally into the capture area and generally downwardly out of the capture area; and

flow restriction means in the inlet to the capture area;

flow restriction means in the outlet from the capture area for reducing the flow velocity in the capture area below the relative current velocity, the outlet flow restriction being effectively greater than the inlet flow restriction.

2. The apparatus of claim **1** wherein the path defining means includes a skirt depending from adjacent a downstream portion of the float means toward the bottom of the capture area, that part of the skirt adjacent the float being impervious.

3. The apparatus of claim **2** wherein the path defining means further comprises a foraminous part of the skirt extending from the impervious part of the skirt in an upstream direction, the foraminous part comprising the outlet flow restriction means.

4. The apparatus of claim **3** wherein the spaced apart float means define a boom.

5. The apparatus of claim **3** further comprising a tension element connecting an upstream portion of the float means and the upstream end of the foraminous part for positioning the foraminous part relative to an upstream portion of the float means to form a boom arrangement.

6. The apparatus of claim **1** wherein the path defining means includes a foraminous member extending between upstream and downstream portions of the float means, the foraminous member comprising the outlet flow restriction means.

7. The apparatus of claim **1** wherein the inlet flow restriction means comprises a foraminous member extending from adjacent an upstream portion of the float means toward the bottom of the capture area.

8. The apparatus of claim **1** wherein an upstream portion of the float means comprises a pervious float, the pervious float comprising the inlet flow restriction means.

9. Method for controlling a spill of a floating liquid pollutant on a water surface experiencing a relative current velocity therepast comprising:

providing spaced apart buoyant float means defining therebetween a capture area;

defining a path of water movement generally horizontally into the capture area and generally downwardly out of the capture area; and

restricting the path of water movement at the inlet to the capture area and at the outlet to the capture area, the outlet flow restriction being effectively greater than the inlet flow restriction to reduce the flow velocity in the capture area below the relative current velocity.

10. The method of claim **9** wherein the path is defined by including a skirt depending from adjacent a downstream portion of the float means toward the bottom of the capture area, that part of the skirt adjacent the float being impervious.

11. The method of claim **10** wherein the path is defined by including a foraminous part of the skirt extending from the impervious part of the skirt in an upstream direction, the foraminous part also contributing to the flow restriction.

12. The method of claim **11** further comprising providing a tension element connecting an upstream portion of the float means and an upstream end of the foraminous part and thereby positioning the foraminous part relative to the upstream float means to form a boom arrangement.

13. The method of claim **9** wherein the flow is restricted by a foraminous member extending from adjacent an upstream portion of the float means toward the bottom of the capture area.

14. The method of claim **9** wherein the flow is restricted by a pervious upstream float.

15. The apparatus of claim **2** wherein the impervious part of the skirt defines an angle ranging from horizontally pointing into the direction of current flow to not substantially greater than vertical.

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