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
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...
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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 1/8 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 drapes 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 sorbitive 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 theretap. 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 arrangement. 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 therapeutically 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 therapeutically comprising:

   providing spaced apart buoyant float means defining therebetween a capture area;
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7 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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