Feb. 13, 1973 R. A. BIANCHI 3,716,142

LIQUID SURFACE SWEEPING APPARATUS

Filed June 14, 1971 3 Sheets-Sheet 1

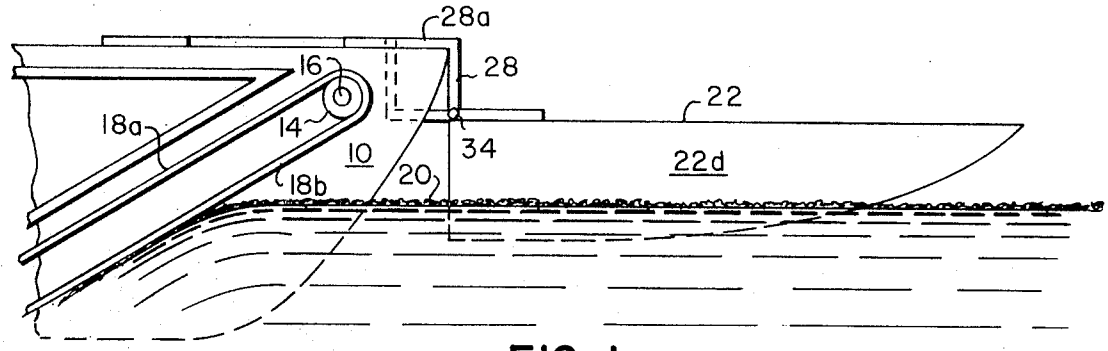



FIG. 1

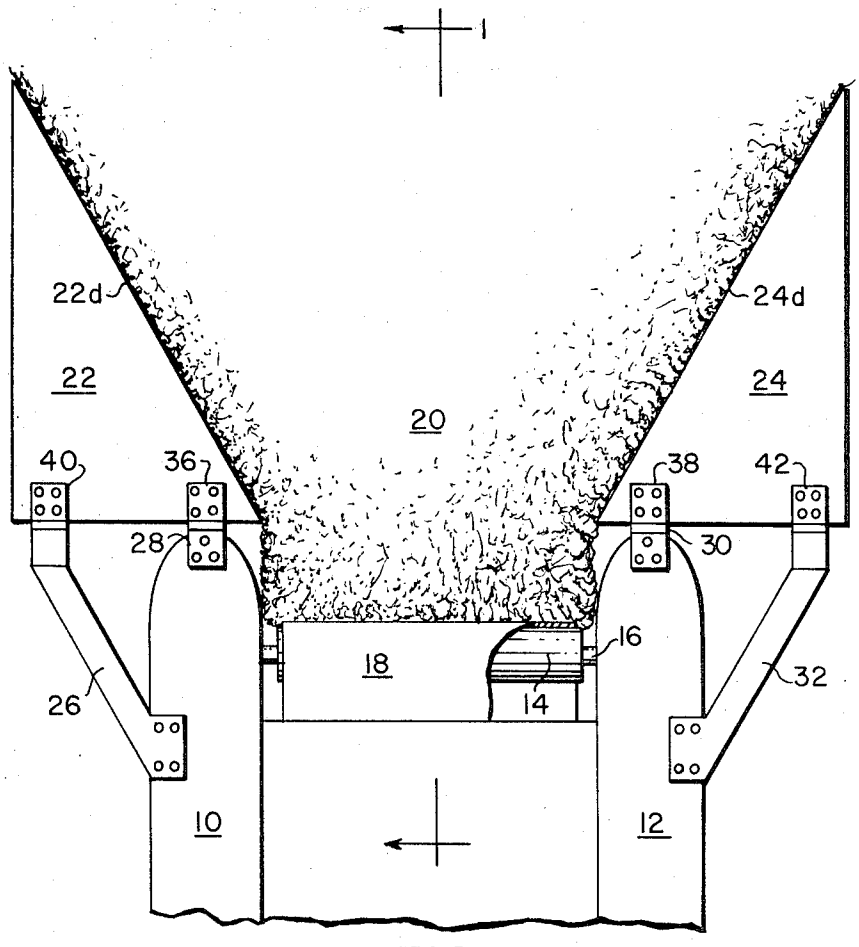



FIG. 2

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LIQUID SURFACE SWEEPING APPARATUS

Filed June 14, 1971 3 Sheets-Sheet 2

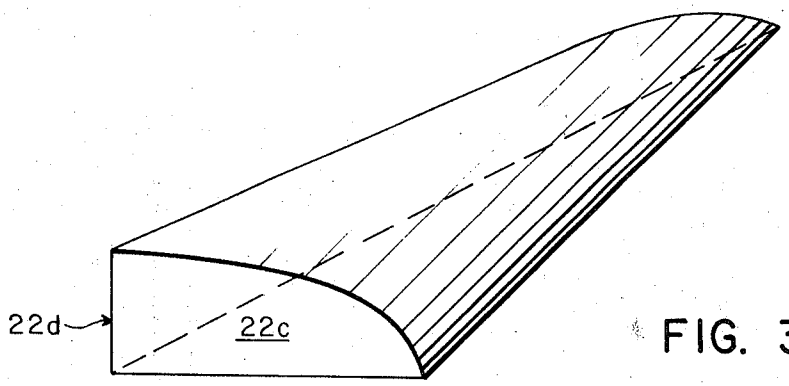



FIG. 3

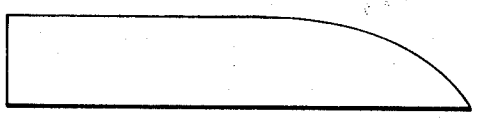


FIG. 4B

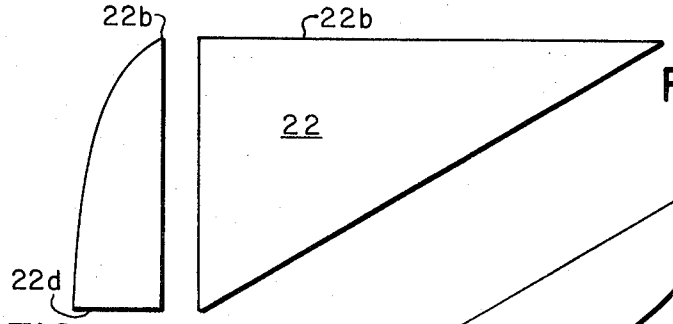



FIG. 4A

FIG. 4C

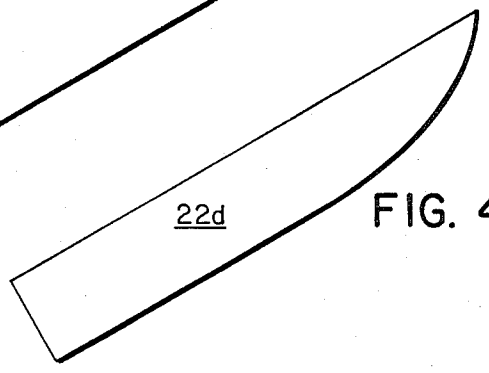



FIG. 4D

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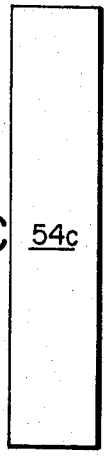
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Feb. 13, 1973 R. A. BIANCHI 3,716,142

LIQUID SURFACE SWEEPING APPARATUS

Filed June 14, 1971 3 Sheets-Sheet 3

FIG. 5C



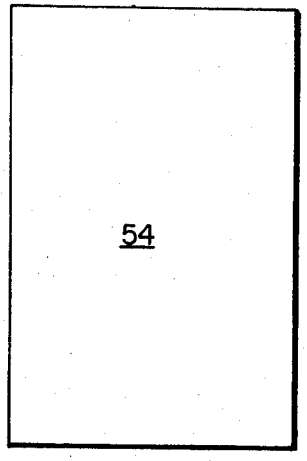




FIG. 5A

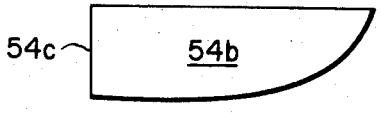



FIG. 5B

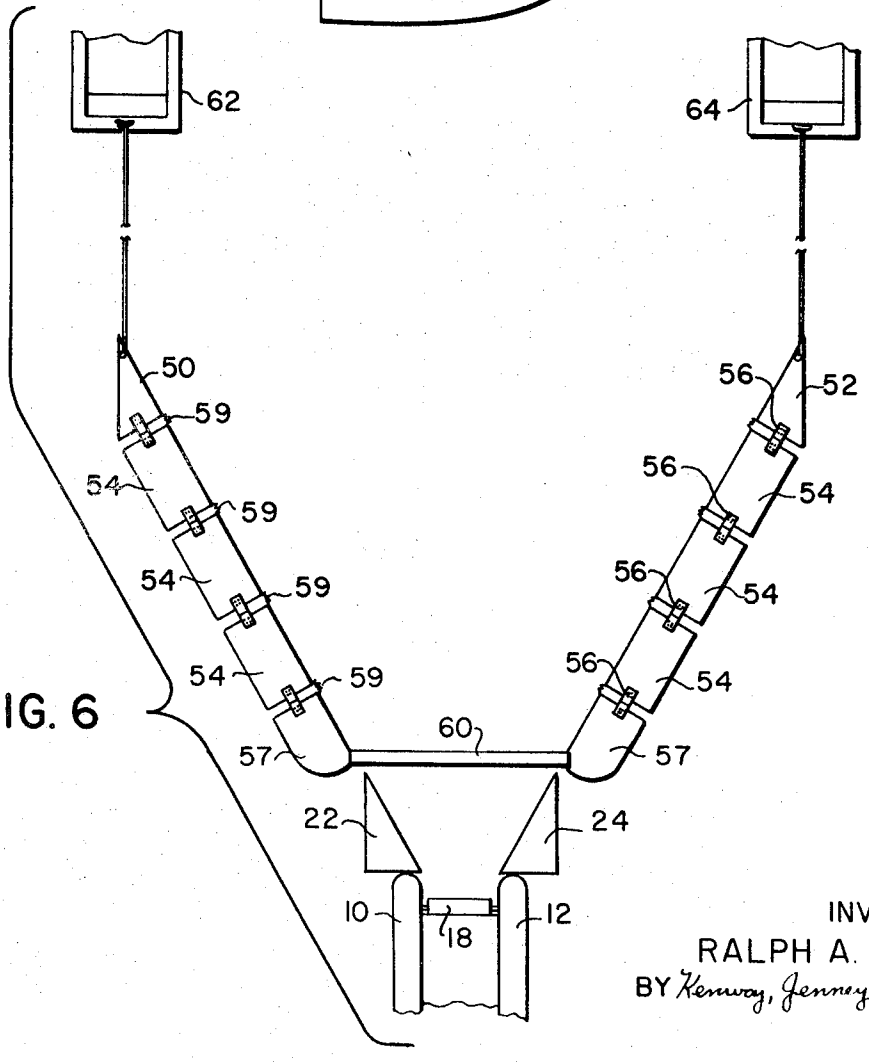



FIG. 6

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3,716,142

# LIQUID SURFACE SWEEPING APPARATUS

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Int. Cl. C02b 9/02
U.S. Cl. 210—242 11 Claims

## ABSTRACT OF THE DISCLOSURE

Buoyant sweeping members for use with a craft designed to skim floating materials, such as oil or oil-soaked sorbents from the surface of a body of water are described. These members are of two general types. The first is roughly triangular in shape when floating in the water and viewed from above. It has one planar edge surface and the underbody is curved both laterally away from this planar edge and also longitudinally. To form a sweep, two of these members are located with their planar surfaces opposing each other and converging in the direction of water flow. The points of the triangular shape point upstream and the members are articulated about a generally horizontal axis. A second member, used in conjunction with the first is generally rectangular in shape with a single planar edge surface. This member is laterally curved from the lower edge of the planar surface upwardly to the outer edge of the member. It is joined with members of the type described to form elongated booms for concentrating floating materials to then be skimmed from the water surface.

## BACKGROUND OF THE INVENTION

The invention relates to apparatus for use with so-called "skimmers" which remove materials floating on the surface of lakes, rivers, or from the surface of the ocean. In particular, skimmers have been developed for removing oil spills from the surface of the ocean to prevent pollution of harbors, beaches, etc. They may skim off the oil directly or alternatively, they may collect floating sorbents which have been placed in the oil spill to adsorb the oil. The skimming vehicles may be of various types. One recently developed skimmer of the type with which this invention is concerned is described in the copending application of James H. Farrell, myself and Edward E. Johanson, entitled "Floatage Collecting Apparatus," Ser. No. 151,838, filed June 10, 1971, now abandoned, and assigned to the assignee of this invention.

The skimmers operate by propelling themselves or being towed over the water surface and collecting the spilled oil, sorbents or other material on the water surface.

It is obviously desirable to concentrate the material floating on the liquid surface in front of the skimmer to thereby collect and remove from the water surface as much material as possible. To this end various boom arrangements have been developed which extend in a forward direction from the bow of the skimmer and which diverge outwardly from the craft as they extend farther forward. Such booms are sometimes termed "sweeps." As the sweep-equipped skimmer propels itself or is towed through the water, the booms cause the material on the water surface to concentrate in front of the skimmer craft. The booms, in effect, form a two dimensional funnel. The sweep-equipped skimmer thus operates more efficiently than one without sweeps since it can clear larger areas of the water surface in a given time.

Sweeps such as those described are not wholly satisfactory however. The inside surface of the booms, which may be termed the "sweeping surface" is desirably planar



in nature. However, if the rear surface is also planar, as is common with most booms, there is severe turbulence behind the boom. Thus turbulence has several undesirable effects. The energy required to move the boom through the water is being used to generate the turbulence behind the boom, thus requiring a more powerful propulsion system than would be required if the turbulence were not present. The turbulence also causes "boiling" in the area between the sweep faces, with the result that some of the material on the water surface escapes under the boom. Further, since the booms must transfer a significant amount of energy to the water they must be extremely strong so as not to bend or break under the forces to which they are subjected.

The result of this has been that sweeping booms heretofore developed have been of heavy construction. Because of this, they have not been particularly buoyant and when waves were encountered, much of the material on the surface of the water which was to be concentrated in front of the skimmer would escape over the top of the boom when carried by breaking waves.

My invention attempts to solve these and other problems of prior sweeping apparatus by providing sweeping apparatus which consists of a pair of triangular shaped floats or pontoons which are secured to the bow of the skimmer. Typically, although not necessarily, these floats or pontoons, when viewed from above have the shape of a right triangle; the face of the pontoon whose edge forms the hypotenuse of the triangle is the sweeping face and is substantially planar. While the top surface of the pontoon or float is flat, the underbody curves upwardly from the lower edge of the sweeping face to the outer upper edge of the outside of the pontoon in the lateral direction. The underbody also curves upwardly to the point of the triangle in the forward portion.

Two triangular pontoons or floats, as described are secured to the bow of a skimming craft by hinges or the like which permit the floats to rotate about a horizontal axis at the bow. They are spaced so that the two sweep faces are opposed and so that they diverge outwardly from the bow of the skimmer.

With this construction, efficient sweeping is obtained since the curved underbody of the pontoons causes water flowing under them to be substantially free of turbulence, thereby reducing power requirements, reducing the force on the sweep face and contributing to more efficient sweeping. Further, since the floats are buoyant, and articulated as described, they will follow wave action, lifting with the waves, and thus will contain any material floating on the wave surface.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1 and 2 are respectively a side elevation and a top plan view of a skimmer equipped with the sweeping device of my invention;

FIG. 3 is a perspective view of one of the sweeping members of my invention, the member being inverted to show the underbody configuration;

FIGS. 4*a*, *b*, *c* and *d* are respectively a top plan view, a side elevation of the outside face, an end elevation and a side elevation of the inside face of the sweeping member of my invention;

FIGS. 5*a*, *b*, and *c* are a top plan view, a side elevation and an end elevation of an alternative form of sweeping member useful in combination with the sweeping members described above to form an elongated boom; and

FIG. 6 illustrates the manner in which the sweeping elements of FIGS. 4 and 5 may be combined to form an elongated boom.

## DESCRIPTION OF ILLUSTRATED EMBODIMENTS

The skimming apparatus of my invention is shown in FIGS. 1 and 2 secured to the flotation pontons of a skimmer such as that disclosed in the above-identified co-pending application.

As described in that application the skimmer itself includes a pair of flotation pontoons **10** and **12**. A roller **14** is mounted on a shaft **16** which extends between the pontoons **10** and **12**. A belt **18** passes over the roller **14** and another driven roller (not shown) so that the upper flight **18***a* of the belt moves upwardly and the lower flight **18***b* moves downwardly and aft.

As explained in the cited patent application, with relative movement of the water toward the bow of the pontoons or floats **10** and **12**, the material **20** on the water surface encounters the lower flight **18***a* of the belt and is carried downwardly and rearwardly to a collection well having a bottom which is open to the water. The material is released at the aft lower end of the belt and floats upwardly to the surface of the collection well.

As previously mentioned, it is desirable to concentrate as much of the material floating on the water surface as possible in front of skimmer and, to this end, the skimmer of FIGS. 1 and 2 is provided with sweep members **22** and **24**.

The shape of these members as viewed from above is generally triangular as seen in FIGS. 2 and 4*a*. FIGS. 3 and 4 illustrate the preferred shape of the sweeping member **22**, the member **24** having a substantially identical shape but being a "mirror image" of the member **22**. As shown in FIGS. 3 and in 4*c*, the underbody of the member **22** is curved laterally from the lower edge of the sweeping face **22***d* upwardly to the upper outboard edge **22***b* of the member **22** and this curve is carried forward as shown in FIG. 3 to the bow of the member **22**. Additionally, the underbody is curved in the fore and aft direction, as shown in FIGS. 3, 4*b* and 4*d*, the curve being most pronounced in the forward portion of the float **22**.

The members **22** and **24** may be formed of any suitable material. For example they may be made of metal or fiberglass in which case they would be hollow, or they may be made of wood in which case they could be either hollow or solid, or they may be formed of flotation material, such as polyurethane foam and suitably covered with water-impervious materials. It is desirable that the members **22** and **24** be highly buoyant and any of the known constructions for manufacturing closed buoyant shapes may be used in their manufacture.

While I have described and illustrated the shape of the deck of the members **22** as being right triangular, such a regular shape is not required. In particular, the outboard edges **22***b* and **24***b* and the stern might be curved, particularly in the larger sizes. Additionally, the underbody might be curved upwardly toward the stern in the longitudinal direction.

It is however desirable that the members **22** and **24** have a generally triangular shape with a generally pointed bow, in the same sense as the deck plan of most small boats is generally triangular. It is of course also desirable that the sweeping faces **22***d* and **24***d* be substantially planar.

The members **22** and **24** are secured to the pontons **10** and **12** respectively by brackets **26**, **28**, **30** and **32**. The brackets **28** and **30** are affixed to the pontoons by plates **28***a* and **30***a* and extend downwardly in front of the pontoon. A pivot pin **34** is carried by bracket **28** and a similar pin is carried by the bracket **30**. A portion of the plates **36** and **38** which are secured to the members **22** and **24** in the position shown also engages the pins carried by the brackets **28** and **30**. Thus the members **22** and **24** are free to pivot about a horizontal axis which is generally transverse to the direction of forward motion of the skimmer. The brackets or struts **26** and **32** may be provided, if required to provide additional bracing of the



members **22** and **24**. These struts also carry pins each of whose axis is the same as that of the pins on brackets **28** and **30**, and plates **40** and **42** engage the pins carried by the struts **26** and **32** respectively. As shown in FIG. 2, the brackets **26**, **28**, **30** and **32** thus maintain the members **22** and **24** upright, and oriented with the sweep faces extending diagonally (or obliquely) between the bow and stern locations and hence converging.

In operation, water flows toward the bow of the skimmer, either because the skimmer is propelled or towed or because it is stationary in a flowing stream. Materials on the water surface are concentrated by the funnel-like action of the opposed sweep faces **22***d* and **24***d* in front of the skimmer and are collected by the skimmer. Because the underbody of members **22** and **24** is streamlined, there is a substantial reduction in turbulence behind the sweep face, thereby increasing sweeping efficiency. Additionally, in the event that wave action is encountered, the buoyant sweep members will rise and fall with the waves by pivoting about the pins in the brackets **26**, **28**, **30** and **32** much as the bow of a boat rises and falls with wave action. The members **22** and **24** will thus prevent the waves from breaking over them with resultant increase in the amount of material collected from the water surface.

If the members **22** and **24** are made of materials which are equally dense throughout, the general configuration described may have a tendency to float in still water with the bow or point deeper in the water than the stern. The trim of the buoy can be adjusted so that the buoy floats with desired trim by the addition of ballast to the buoy at appropriate locations.

In some instances, it is desirable to provide much longer booms which are towed for sweeping. Such a longer boom is shown in FIG. 6. The boom includes members **50** and **52** which are similar to the members **22** and **24** described above. Additionally, it includes a plurality of substantially rectangular members **54** whose shape will be described in greater detail below. The final member in each leg of the boom may be a member **54**, or, as shown in FIG. 6, the final member may have a rounded stern as shown on the member **57**. Each member forming the boom is secured to each other member by a hinge-connection **56** so that the members may articulate about generally horizontal axes with respect to each other. The final, aft members in the two legs of the boom are held together by a member **60** so that the boom will assume the desired shape i.e. converging toward the sweep-equipped skimmer which follows the boom. The spaces between individual members forming the legs of the boom in FIG. 6 along the sweep face are preferably closed by expansible skirts **59** which may be made of rubber or plastic sheeting. These skirts prevent the collected material from streaming through the spaces between the members forming the boom. As shown, the boom may be towed by the vessels **62** and **64** or, it may be towed by a suitably equipped single vessel.

The member **54** is similar to the members **22** and **24** previously described except, as shown in FIG. 5*a*, it is rectangular in shape in top plan view. The sweeping face **54***c* is also rectangular as shown in FIG. 5*c*. The underbody is curved only in one direction, from the lower edge of the sweep face **54***c* upwardly to the outer upper edge of the member **54** as shown in FIG. 5*b*. The member **57** is similar in shape to the member **54** except that the stern is rounded as shown in FIG. 6. It may in some instances also be desirable to round the member **57** underbody in the longitudinal direction, the curvature being upwardly toward the stern. The members **50**, **52**, **54** and **57** may be constructed of the same materials and in the same manner as previously discussed for the members **22** and **24**.

It will be apparent that the boom illustrated in FIG. 6 will perform in much the same manner as the sweep members **22** and **24** previously described, except of course, it will concentrate surface materials from a much larger area.

It will thus be seen that the invention provides sweeping apparatus for concentrating material floating on the surface of a body of water so that the concentrated materials may be skimmed from the water surface. This sweeping apparatus provides more efficient concentration since it reduces the turbulence usually associated with conventional booms or arms by providing buoyant sweeping members having streamlined underbodies and permitting the members to articulate about a generally horizontal axis.

Having thus described my invention, I claim:

1. Floatage-sweeping apparatus comprising, in combination,

(A) a buoyant member having

(1) a generally triangular shape when viewed from above with the member floating in normal position on the surface of a liquid, one point of said triangle shape being the bow of said member and the base of said triangle shape opposite the bow being the stern of said member,

(2) a planar sweep surface extending from the bow to the stern,

(3) a bottom surface curved laterally from the lower edge of said sweep surface upwardly to the upper edge of the side of said member opposite said sweep surface, and being curved upwardly in the longitudinal direction toward the bow thereof, and

(B) support means secured to said buoyant member for maintaining it oriented with said sweep surface extending obliquely from said bow-located point to to said stern-located base, and with said bottom surface disposed lowermost.

2. A boom for concentrating material floating on a liquid surface, said boom comprising, in combination,

(A) a pair of converging legs,

(1) each of said legs including a plurality of buoyant sweep members,

(2) the upstream sweep member in each leg being generally triangular in shape when viewed from above and being oriented with a point of said triangular shape directed in the upstream direction, each triangular member having a planar edge surface opposite the corresponding edge surface of the triangular member in the other leg of said boom,

(3) at least one further sweep member in each leg of said boom being of a generally rectangular shape when viewed from above and having an inner planar edge surface opposite the planar edge surface of the corresponding sweep member in the other leg of said boom,

(4) each sweep member in each leg of said boom being secured to each adjacent sweep member by hinge means which permits relative rotation of that sweep member about a generally horizontal axis, and

(B) means maintaining the two downstream sweep members in said boom spaced together by a distance less than the spacing between the two upstream sweep members, so that said planar edge surfaces of said sweep members of one leg converge, along the downstream direction, toward said planar edge surfaces of said sweep members of the other leg.

3. A boom as defined in claim 2 further characterized in that each buoyant sweep member has a curved bottom surface that extends from the bottom of said planar edge surface thereof to a level normally above said surface, the curvature of said bottom surface extending laterally away from the edge surface and upward.

4. A floatage-concentrating sweep comprising, in combination,

(A) a buoyant body having a bow and a stern, said body having



(1) an upper surface of generally triangular shape when viewed from above,

(2) a vertically-extending sweep surface extending from the bow to the stern of said body and having horizontally-extending upper and lower edges and forming with said upper edge the longest side of said triangular shape, and

(3) a bottom surface extending from said lower edge of said sweep surface to said upper surface with a curvature that extends laterally outward relative to said sweep surface and upward from said lower edge, and

(B) mounting means affixed to said body and maintaining said body in an upright orientation relative thereto, and further oriented relative thereto with said sweep surface extending between said bow and said stern in a floatage-converging diagonal direction.

5. A sweep as defined in claim 4 further characterized in that said sweep surface lower edge, and correspondingly said bottom surface, curve upwardly toward said upper surface of said body at the bow.

6. A sweep as defined in claim 4 further characterized in that said sweep surface is planar and vertical.

7. A sweep as defined in claim 4 in which said mounting means includes structure for allowing said body to articulate relative thereto, said articulation being at the stern of said body and about a horizontal axis transverse to the bow-stern spacing.

8. Sweep apparatus for concentrating floatage on a liquid surface, said apparatus comprising, in combination,

(A) a boom having a pair of floatage-concentrating legs, each of which includes

(1) a first buoyant sweep member of generally triangular shape when viewed from above with the member floating in normal position on the surface of said liquid, one corner of said triangular shape being the bow of said member and the base of said triangular shape opposite the bow being the stern of said member, said member having a planar sweep surface extending from the bow to the stern thereof, said member having a bottom surface curved laterally from the lower edge of said sweep surface upwardly to the upper edge of the side of said member opposite said sweep surface, and curved upwardly in a longitudinal direction toward the bow thereof, and

(2) a second buoyant member disposed adjacent the stern of said first buoyant member and of generally rectangular shape when viewed from above floating in normal position, one longitudinal side of said member being a planar sweep surface in line with the sweep surface of said first member, said second member having a bottom surface curved laterally from the lower edge of said sweep surface thereof upwardly to the upper edge of the side of said second member opposite said sweep surface, and

(B) means for moving said boom relative to said liquid and for positioning said buoyant members of one leg with said sweep surfaces thereof converging, in the bow to stern direction, with said sweep surfaces of the other leg.

9. Sweeping means for concentrating material floating on a liquid, said means comprising, in combination,

(A) a pair of buoyant sweep members each of generally triangular shape when viewed from above and being disposed in horizontally-spaced relationship to the other said member with one point of each triangular shape being directed in an upstream direction of relative movement of said sweep members with respect to said liquid, the interior opposed surfaces of said sweep members being substantially planar and vertical and converging in the downstream direction, and

the underbody of each sweep member being curved laterally outward and upward from the lower edge of said planar surface to a level that is normally above the surface of said liquid, and

(B) a support structure affixed to said pair of buoyant sweep members and maintaining them, relative to one another, in said horizontally-spaced relationship and upright with said underbodies lowermost.

**10.** Sweeping means as defined in claim **9** further characterized in that the underbody of each sweep member is curved longitudinally upward toward the point thereof which is directed in the upstream direction.

**11.** Sweeping means as defined in claim **9**

(A) in which each sweep member has the base of said triangular shape thereof located opposite said one point, and

(B) further comprising, in combination, a surface vessel

(1) located downstream of said sweep members adjacent said bases thereof,

(2) having means for removing from the liquid floatage which is between said opposed surfaces of said sweep members, and

(3) having said support structure mounted thereto.




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U.S. Cl. X.R.

210—DIG 21