

[54] SEA-SURFACE OIL EXTRACTOR

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[22] Filed: **May 13, 1971**

[21] Appl. No.: **142,940**

[52] U.S. Cl. **210/242, 210/DIG. 21**

[51] Int. Cl. **C02b 9/02**

[58] Field of Search **210/83, 242, DIG. 21**

[56] References Cited

UNITED STATES PATENTS

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3,595,392	7/1971	Markel	210/DIG. 21
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[57] ABSTRACT

An apparatus for extracting oil or the like from the surface of the sea. A centrally disposed ballast chamber is surrounded by a sump compartment into which liquids are deposited over the lips of a plurality of independently floating and an articulated weir member. The latter is provided with a substantially universal connection to the ballast chamber. A flexible skirt member forms an external wall portion of the sump compartment and is connected to the lips of the weir member. In this manner a pressure differential across the skirt member is communicated to an individual segment of the weir member in order to vary the elevation of the weir member in a self-compensating manner. Means are provided to pump liquids out of a submerged exit port in the sump compartment and for imparting direction to these pumped liquids in order to provide controlled propulsion for the skimming apparatus.

7 Claims, 6 Drawing Figures

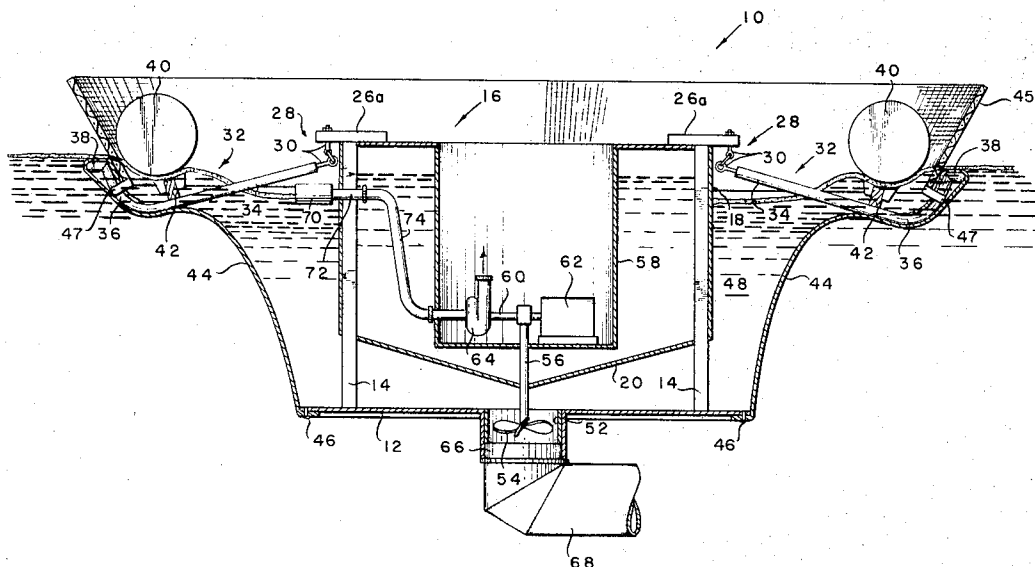


Fig. 1

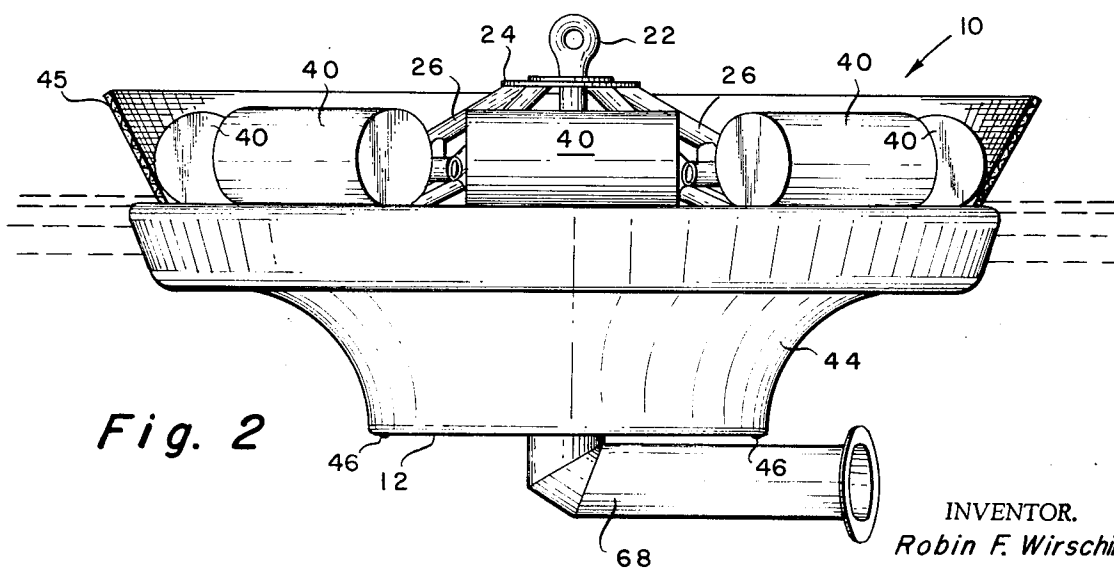
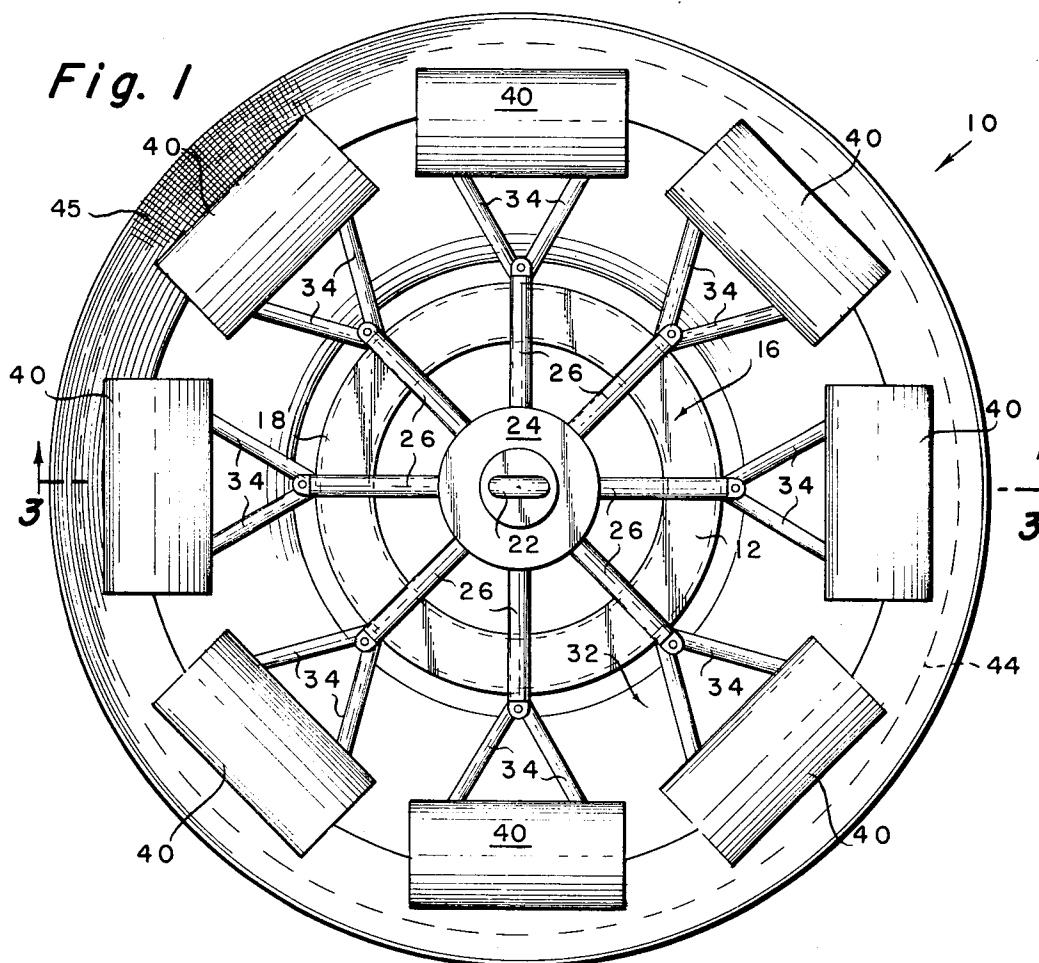


Fig. 2

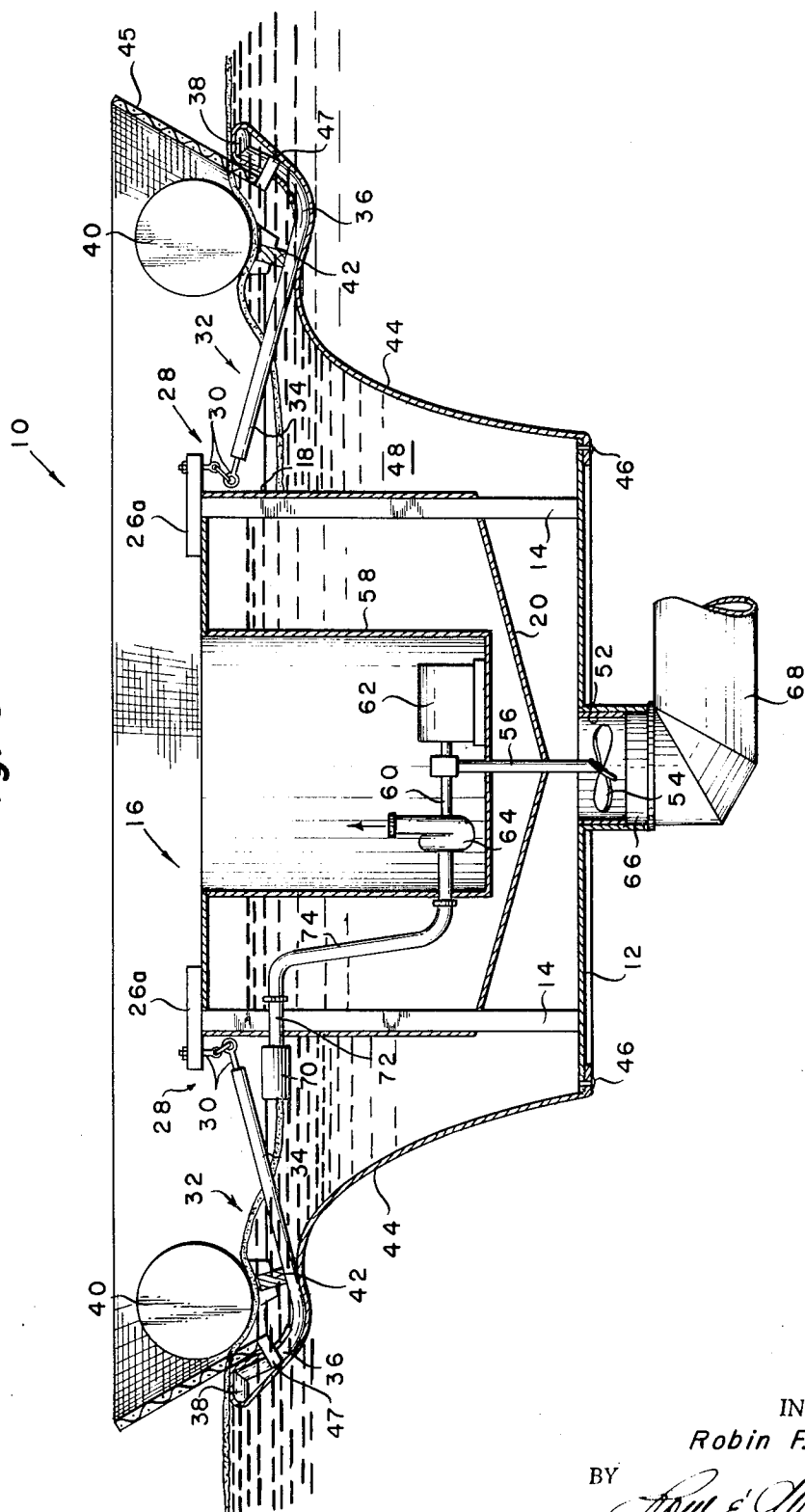
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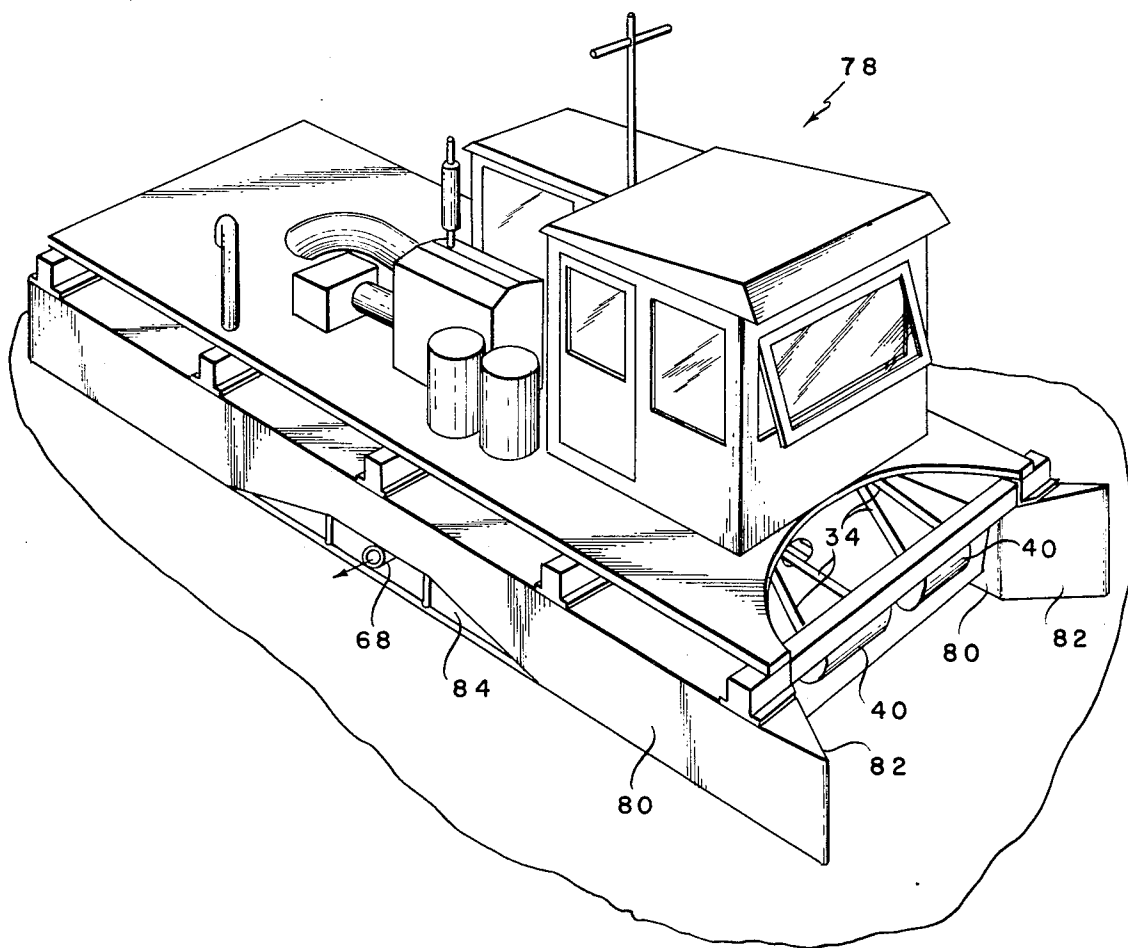
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Fig. 3



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Fig. 4



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Fig. 5

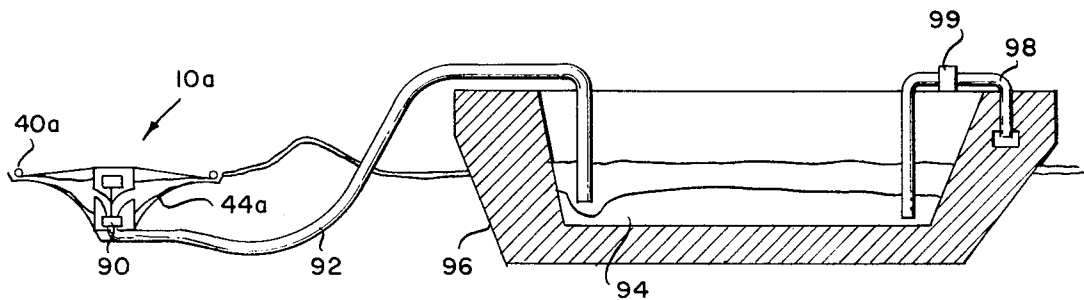


Fig. 6

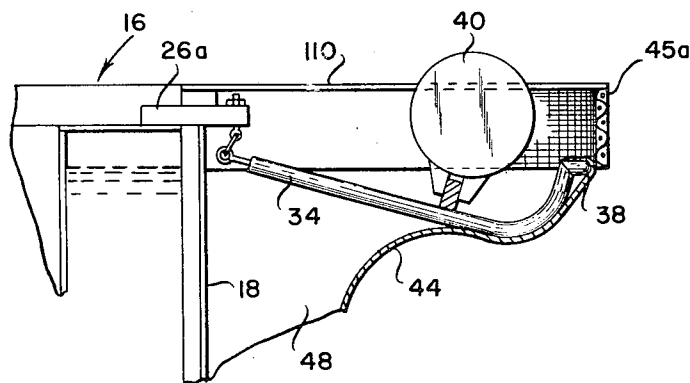
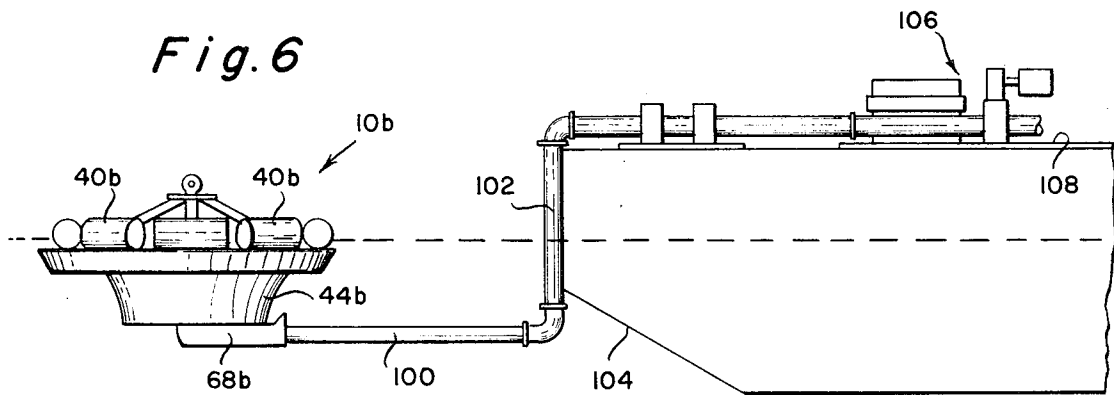


Fig. 7

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SEA-SURFACE OIL EXTRACTOR

This invention relates to an apparatus for extracting oil or the like from the surface of the sea and, more particularly, to a self-compensating weir arrangement by means of which the apparatus skims the contents of the surface of the sea.

It has been known heretofore to employ skimming apparatus in order to extract from the surface of a body of water concentrations of oil or the like. Such devices have in general been deficient in that the skimming apparatus has been unstable or lacking in means for automatically adjusting the elevation of the weir or in providing means for regulating the intake over the weir in wave conditions.

The aforementioned difficulties and shortcomings have been overcome in accordance with the present invention wherein a surface layer extractor or skimming apparatus carries its own ballast substantially centrally of the apparatus itself. A flexible skirt is employed to form a wall portion of a sump compartment which substantially surrounds the ballast chamber. Thus there is provided means for communicating a pressure differential to the lips or upper edges of the segments of the floating weir member in order to vary the elevation thereof. The apparatus is provided with means for pumping liquids out of the sump compartment through a submerged exit port therein. In this manner, the pressure on the skirt member is varied from within the sump compartment and this establishes a pressure differential across the skirt member which serves to raise or lower the segments of the weir member whereby the skimming apparatus is made self-compensating.

The apparatus of the present invention may be used in at least two different types of environments. In one of these the apparatus of the present invention functions as a skimmer-collector. In this form, the flow of liquids in the sump compartment is turbulent and the sump compartment itself is relatively small. Oil and water are ultimately pumped into a suitable collecting tank or tanks. If desired, collecting tanks may be located on a separate vessel with the aid of a pump on the separate vessel and/or a pump located at the bottom of the skimmer apparatus.

In another environment, the apparatus functions as a skimmer-separator, wherein an inward radial or an inward vortex flow is established which requires the use of a relatively large sump compartment. In this form which is described and claimed in the joint application of Robin F. Wirsching and Arthur L. Markel, Ser. No. 143,105, filed May 13, 1971 and assigned to a common assignee, guide vanes and wave dampening means are employed. An axial flow oil-water separation pump such as is disclosed in a patent application of Arthur L. Markel, Ser. No. 833,105, filed June 13, 1969 now U.S. Pat. No. 3,595,392 is preferably used in connection with this form. If desired, the axial flow oil-water separation pump may be positioned at the bottom of the skimmer-separator unit and the water discharge therefrom used to provide propulsion for the skimmer-separator unit.

The inherent advantages and improvements of the present invention will become more readily apparent upon considering the following detailed description of the invention and by reference to the drawings in which:

FIG. 1 is a plan view of the skimming apparatus of the present invention;

FIG. 2 is a front elevational view of the apparatus as shown in FIG. 1;

FIG. 3 is an elevational view taken in vertical cross section along line 3—3 of FIG. 1;

FIG. 4 is a perspective view of another embodiment of the present invention showing a skimming apparatus mounted between the hulls of a catamaran type vessel;

FIG. 5 is an elevational view, schematic in nature, illustrating the use of the apparatus of the present invention as a skimmer-collector of oil and water;

FIG. 6 is an elevational view, schematic in nature, illustrating the use of the apparatus of the present invention as a skimmer-separator of oil and water; and,

FIG. 7 is a fragmentary elevational view illustrating a modified mounting for a debris screen.

Referring now to FIGS. 1-3 of the drawings, there is shown a skimming apparatus, indicated generally at 10. This apparatus is provided with a base plate 12 having upright posts or stanchions 14, FIG. 3, on which is supported a ballast chamber, indicated generally at 16 which in service is filled with water or other suitable ballast liquid. Ballast chamber 16 has a vertically extending circumferential wall 18 and inwardly sloping bottom walls 20. By filling ballast chamber 16 with water or the like, a floating central counterweight is provided.

In order to locate the skimming apparatus 10 in a desired position, a superstructure is provided for the skimming apparatus. This superstructure includes an eyelet 22 that extends through support plate 24, FIGS. 1 and 2, from which a plurality of support bars 26 extend in radial fashion and are suitably secured to the top of the circumferential wall 18.

A modified superstructure is disclosed in FIG. 3 wherein modified support bars 26a are employed that are affixed atop the wall 18. A substantially universal joint connection, indicated generally at 28, is utilized in all embodiments of the invention. While the substantially universal joint construction can take any convenient form, a pair of shackle bolts 30 provide one convenient manner of establishing a universal joint. The shackle bolts 30 are connected to an eyelet which extends from one end of each of a plurality of weir segment members, indicated generally at 32 in FIGS. 1 and 3. Weir segment members 32 comprise weir arm segment members 34 which preferably extend in pairs from the universal joint 28 and lead in an upwardly extending portion 36 to a weir lip 38. Attached to each pair of weir arm members 34 is a plastic lip float 40 secured thereto by bar member 42. Thus it is seen that the floats 40 are spaced from and substantially encircle ballast chamber 16.

A flexible skirt member 44 is suitably attached to the base plate 12 forming a lower edge of sump compartment 48 and extends therefrom to the weir lip or upper edge 38. Flexible skirt member 44 thereby provides one wall of the sump compartment 48 which is exterior to ballast chamber 16 which extends along the side of wall 18 as well as beneath the inwardly sloping bottom walls 20. By way of example, one convenient material for flexible skirt 44 is canvas although other materials may be used therefor.

A debris screen 45 extends annularly around the skimmer 10 and projects upwardly above the weir lip 38. Debris screen 45 may be attached to weir arm members 34 with the aid of suitable clip members 47, FIG. 3. Debris screen 45 serves to keep floating logs and other solid flotsam from entering the sump compartment 48 while permitting liquids to pass over weir lip 38.

Base plate 12 is provided with a submerged exit port at 52 in which a propeller 54 is positioned. Propeller 54 is mounted on shaft 56 which extends through the bottom of ballast chamber 16 and is provided with suitable seals, not shown, in order to permit shaft rotation without leakage from the ballast chamber. A housing 52 within ballast chamber 16 contains a right angle drive shaft 60 which is driven by an engine 62 mounted within housing 58. A pump 64 is used to pump collected oil to a collection vessel through a hose, not shown.

A rotatable joint 66 is provided at the exit port 52 whereby water and other liquids in sump compartment 48 may be pumped out of the sump compartment 48 with the discharge thereof providing controlled propulsion for the skimmer unit 10. Also in this manner, a pressure differential is established across the flexible skirt member 44 which by means of its attachment to the lip 38 of weir segment members 32 results in self-compensation for the elevation of the lip or upper edge 38. In this manner, the input into the open topped sump compartment 48 over the lip or upper edge 38 of weir segment members 32 may be stabilized and matched with the output through port 52.

A secondary skimming device 70 is positioned in the sump compartment 48 in order to skim off oil which floats on the surface of the water in sump compartment 48. A suitable conduit 72 takes this extracted fluid through hose 74 into pump 64 wherein the separated oil may be pumped to a collection vessel through a hose connected to the output of the pump.

Reference to FIG. 4 shows the skimmer apparatus of the present invention applied to a catamaran type vessel 78 between its hulls or pontoons 80. Each hull 80 has a water directing nose portion 82 which combine to create a funnel-like effect for water entering and passing over the weir lip of the skimming apparatus. In this embodiment, a portion of the hulls 80 have been cut away at 84 in order to provide an outlet for the discharge tube 68 in providing thrust for the catamaran vessel.

Referring to FIG. 5, a skimming apparatus schematically shown at 10a which may correspond to the type shown in FIG. 3, and illustrating for purposes of reference floats at 40a and a flexible skirt 44a, is shown to be provided with an open center or axial flow pump 90 of the type illustrated in the aforementioned patent application of Markel Ser. No. 833,105. A flexible hose 92 provides a conduit for the oil and water pumped out of the sump compartment in skimmer 10a to one or more collecting tanks 94 in a separate vessel 96. The water which has settled out at the bottom of the oil-water mixture in tank 94 is then pumped overboard through pipe 98 with the aid of an auxiliary pump 99.

FIG. 6 illustrates another means for processing the output of a skimmer designated 10b having floats 40b and a flexible skirt 44b of the type shown in FIGS. 1

and 2. In this arrangement, the apparatus of the present invention functions as a skimmer-separator. Thus a mixture of oil and water is pumped through discharge tube 68b through a flexible hose 100 and a vertical intake standpipe 102 attached to the hull of a separate vessel 104 by conventional brackets (not shown). A non-return valve (not shown) is installed in the suction outlet of skimmer 10b.

The oil-water mixture is delivered to an axial flow oil-water separation pump designated generally at 106, of the type shown in Markel Ser. No. 833,105, filed June 13, 1969, where the oil and water are separated. The pump is mounted on platform 108 affixed to the deck of vessel 104.

In each of FIGS. 5 and 6, the position of the skimmers 10a and 10b are maintained with reference to vessels 96 and 104, respectively, by means of conventional mooring lines and a boat boom extending from the vessel (not shown).

FIG. 7 illustrates an alternative mounting for a debris screen, designated at 45a. In this embodiment, debris screen 45a is cantilevered from the top of support bars 26a atop the wall 18 of ballast chamber 16 with the aid of suitable radially extending rods 110. As in the embodiments of FIGS. 1-3, the screen 45a extends substantially around the outer periphery of the skimmer apparatus. In both forms, the debris screen 45 of FIGS. 1-3 and 45a of FIG. 7 function to prevent undesirable floating debris from passing over the weir lips 38 into the sump compartment 48 of the skimmer apparatus.

The use of a pressure differential across a flexible skirt is considered to be quite advantageous in maintaining a substantially constant attitude of the skimmer weir lip with respect to the wave motion on the surface. In addition, the skimmer apparatus of the present invention maintains a favorable orientation when operated in a surface current. This is accomplished by having a plurality of weir segment members which individually and automatically increase the flow across the weir lips on the upstream side of the current while decreasing the flow on the downstream side because of the current induced inclination of the central floating counterweight tank or ballast chamber and because of the manner in which the floating weir lip arms are attached individually to the tank.

As will be apparent from the foregoing description, since the flexible skirt is connected to a floating weir lip arm, and the arm has its inboard end pivoted to a floating central counterweight, the combined effects of the skirt tension pulling on the end of the weir lip arm and the vertical ascension of the central floating counterweight produce a motion which forces the depth of flow across the weir lip to be increased. The flow across the weir lip is increased automatically until such time that the input flow matches the output flow thereby developing an equilibrium operating condition.

In actual practice, the skimming apparatus of the present invention has been tested in a river where the current was one knot and wherein boat wakes produced waves which were two to three feet in height. The lip 38 of the weir member 32 conformed to the surface of the water and the flexible skirt 44 functioned to control the input flow into the skimmer across the weir lip 38 in such a manner as to match the output flow on a continuous basis. Moreover, an apparatus made in ac-

cordance with the present invention was tested on a large tank wherein oil was poured on the surface of the water in the tank and the oil was subsequently extracted from the surface by the skimmer apparatus. The extraction process was continuous and a constant sump level within the skimmer apparatus was maintained by the self-controlling action of the flexible skirt 44 despite the fact that a number of waves and a surface current were generated in the tank.

On one occasion, 120 gallons of 30 weight motor oil was added to the test tank. The skimmer apparatus successfully extracted the oil from the surface of the water in the tank. The skimming apparatus was demonstrated to be self-adjusting in that the weir lip 38 of the skimmer apparatus 10 was maintained at a level such that the input over the weir lip 38 matched the output of the skimmer while keeping the skimmer sump level constant. The output flow was varied from zero to five thousand (5,000) gallons per minute. At an output flow of five thousand gallons per minute the depth of the flow of the water over the weir lip 38 was approximately 1½ inches deep for a total weir lip length of 32 feet. This resulted in a very rapid removal of the oil from the surface of the water in the tank. In this connection, it is believed that the skimmer apparatus of the present invention has a capacity of at least tenfold greater than units presently available.

It has been observed that as the flow through the skimmer is increased, the dynamic stability defined as the stability to conform to the surface wave motion also increases. This result is obtained because of the increased tension in the skirt 44 because of a greater pressure differential being developed across the skirt as the flow rate is increased.

The skimmer is insensitive to an impulse force which is applied on the skimmer by sea motion. When a force is applied on the skimmer either through one of the weir lip arms or through the center tank section, the energy is evenly distributed and dissipated throughout the entire structure and this prevents any stress concentrations from developing.

While presently preferred embodiments of the invention have been illustrated and described, it will be recognized that the invention may be otherwise variously embodied and practiced within the scope of the claims which follow.

What is claimed is:

1. An apparatus for skimming the surface layer of a

body of water comprising:

- a. a ballast chamber,
- b. an open-topped sump compartment exterior to and encircling said ballast chamber,
- c. a flexible weir member having an upper edge and a lower edge encircling said sump compartment, said upper edge constructed and arranged so that a plurality of float members connected thereto provide articulation with respect to the surface of said body of water, said lower edge of said flexible weir member being connected to a lower edge of said sump compartment,
- d. means provided in said sump compartment comprising an inlet to a pump means for removing the surface layer of liquid collected in said sump compartment,
- e. and means in fluid communication with the lower region of said sump compartment for removing additional liquid therefrom.

2. An apparatus for skimming the surface of a body of water as defined in claim 1, wherein oil and water pass over said upper edge of said flexible weir member and said apparatus includes a secondary skimmer means located within said sump compartment to separate oil from water in said sump compartment.

3. An apparatus for skimming the surface of a body of water as defined in claim 1 wherein said upper edge of said flexible weir member is interconnected by means of a plurality of arm members to substantially universal joint connections on said ballast chamber, and said float members are connected to respective ones of said arm members.

4. An apparatus for skimming the surface layer of a body of water as defined in claim 1 including means for preventing floating debris from entering said sump compartment.

5. An apparatus for skimming the surface layer of a body of water as defined in claim 4 wherein said means for preventing floating debris from entering said sump compartment is a screen extended around the outer periphery of said skimmer apparatus.

6. An apparatus for skimming the surface layer of a body of water as defined in claim 5 wherein said screen is attached to at least one of said arm members.

7. An apparatus for skimming the surface layer of a body of water as defined in claim 5 wherein said screen is cantilevered from atop said sump compartment to extend outboard of said upper edge of said weir.

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