# United States Patent

**Brill et al.**

[15] **3,640,394**

[45] **Feb. 8, 1972**


## [54] OIL SKIMMER WITH OSCILLATABLE CIRCULAR LOOP


[72] Inventors: **Eugene L. Brill; Beatrice M. Brill,** both of 1803 West Royalton Road, Cleveland, Ohio 44141



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[21] Appl. No.: **40,228**

[52] U.S. Cl. ..... **210/322,** 210/396, 210/526, 210/DIG. 21

[51] **Int. Cl.** ..... **E02b 15/04,** B01d 17/02

[58] **Field of Search** ..... 210/322, 396, 526, 513, DIG. 21



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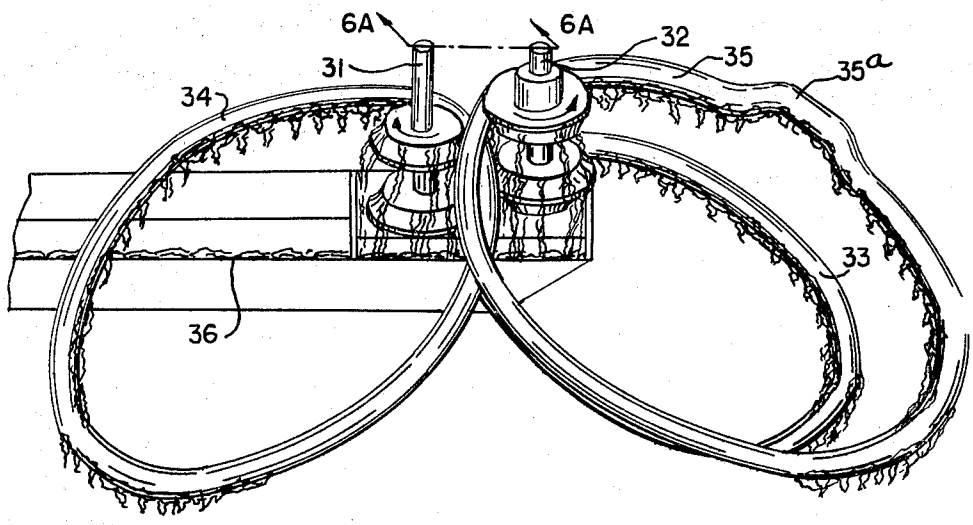
*Primary Examiner*—John Adee
*Attorney*—Baldwin, Egan, Walling & Fetzer



[57] **ABSTRACT**

An apparatus is provided for skimming oil or the like floating on a pool of water including an endless substantially rigid loop of uniform cross section, generally circular. The loop is gripped at its upper edge by a pair of rolls rotating in opposite directions and drivingly engaging said loop at one zone in diagonally opposed quadrants, one above and one below the center of a section of the loop. The rolls rotate the loop in its own plane causing it to pass continuously into and out of the pool of water or hydrophilic liquid and to attract hydrophobic material, such as oil or the like or finely divided or colloidal material, which material is lifted by the coil and squeezed out upon passing through the rolls or separated by a scraper or by a blast of air. The loop may oscillate about an axis substantially tangential the loop at the driving zone. A modification utilizes a brushlike surface on the loop and on the driving rolls.


**15 Claims, 11 Drawing Figures**



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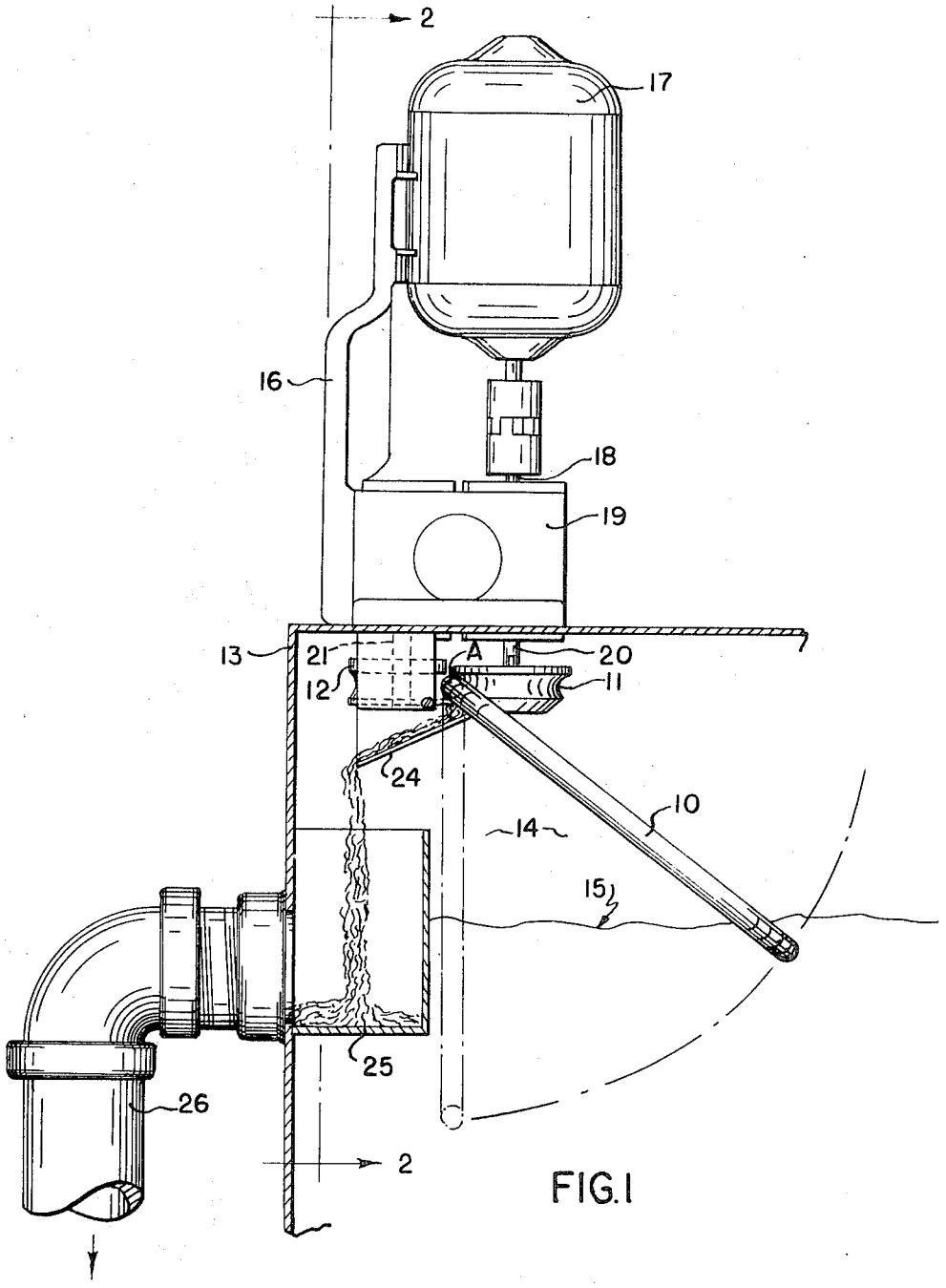


FIG.1

INVENTOR
EUGENE L. BRILL
BEATRICE M. BRILL
BY
Baldwin, Egan, Walling & Fetzer
ATTORNEYS

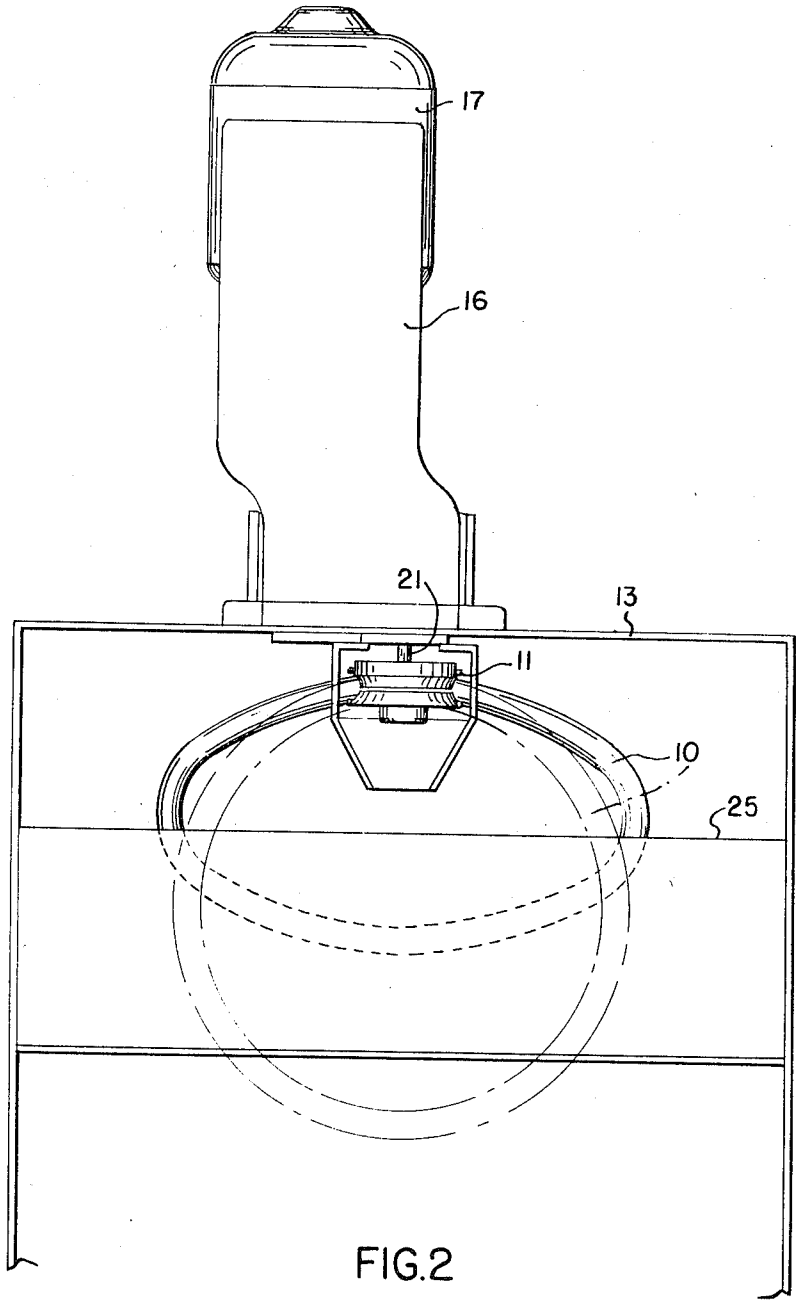


FIG.2

INVENTOR
EUGENE L. BRILL
BY BEATRICE M. BRILL

Baldwin, Egan, Walling & Fetzer
ATTORNEYS

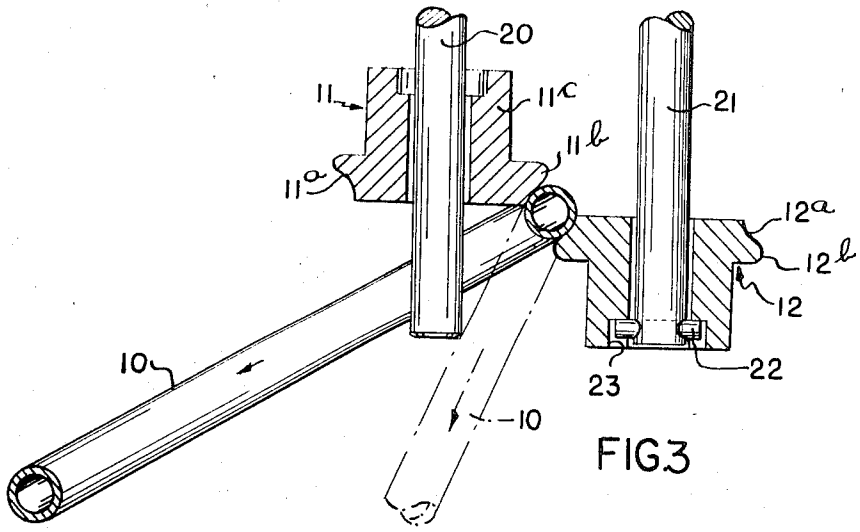


FIG.3

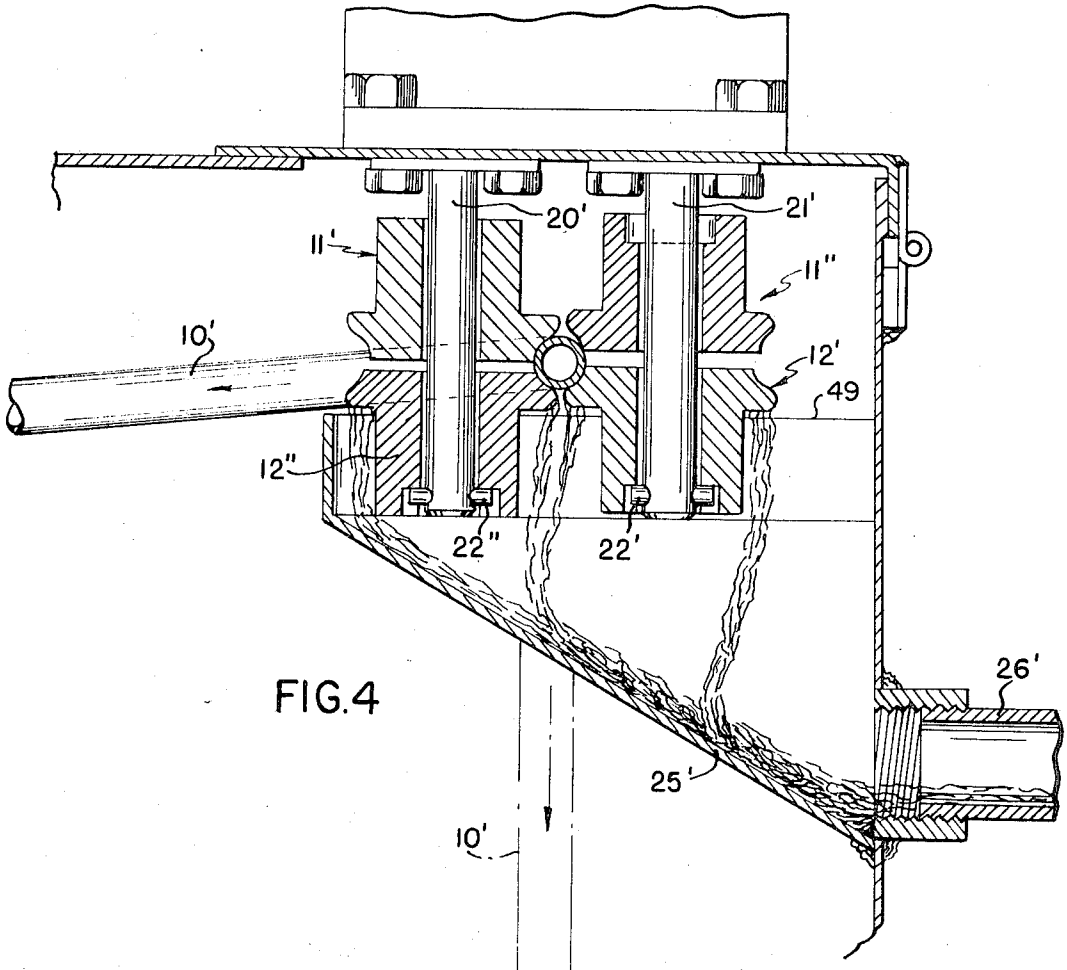


FIG.4

INVENTORS
EUGENE L. BRILL
BEATRICE M. BRILL
BY
Baldwin Egan, Walling & Fetzer
ATTORNEYS

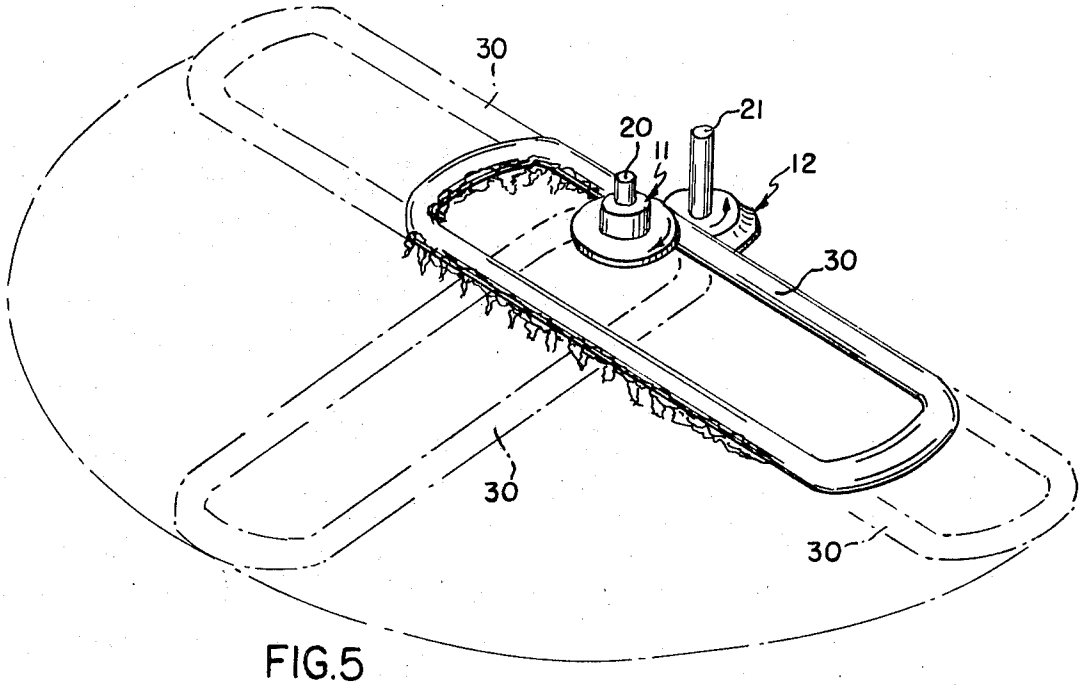


FIG.5

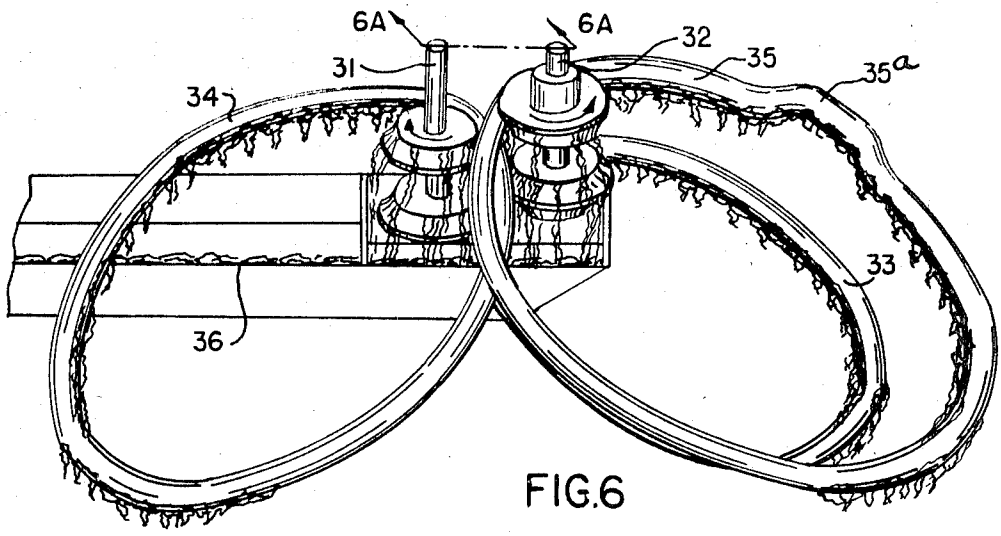


FIG.6

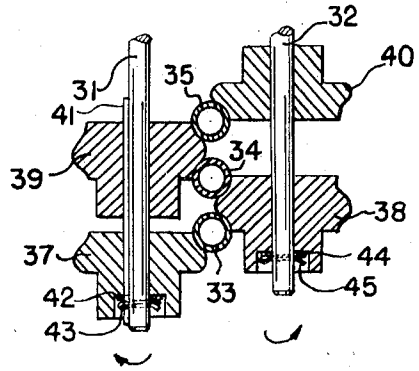


FIG.6A

INVENTORS
EUGENE L. BRILL
BEATRICE M. BRILL
BY
Baldwin, Egan, Walling & Fetzer
ATTORNEYS

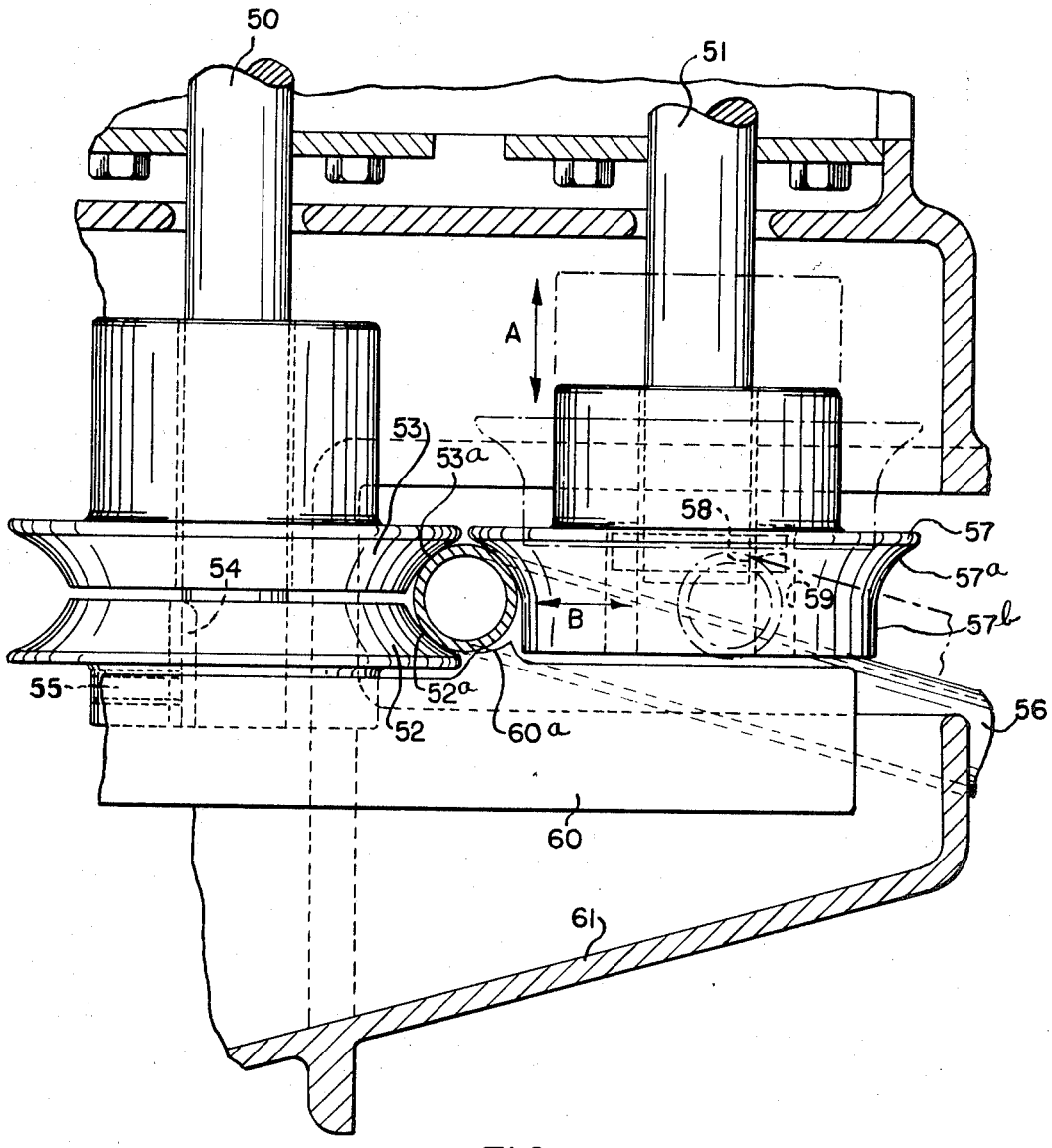


FIG.7

INVENTORS
EUGENE L. BRILL
BEATRICE M. BRILL
BY
Baldwin, Egan, Walling & Fetzer
ATTORNEYS

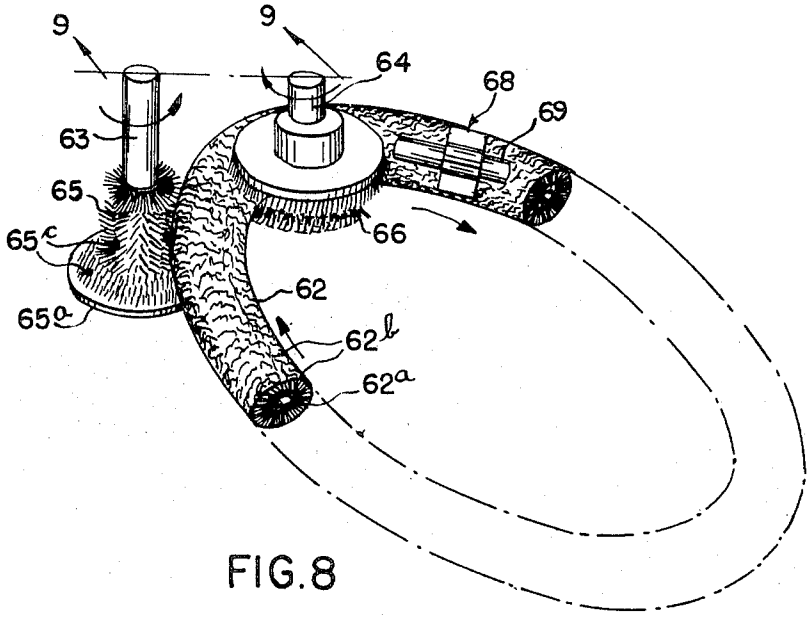


FIG.8

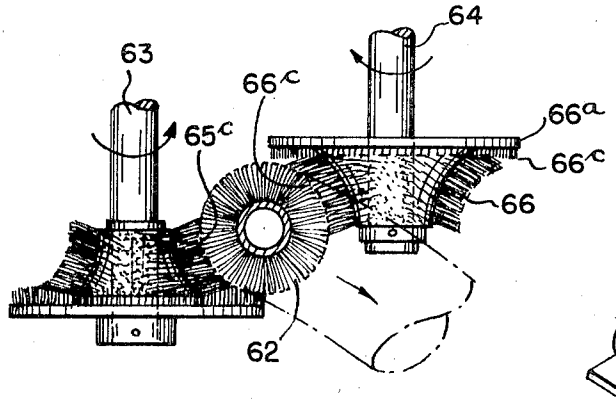


FIG.9

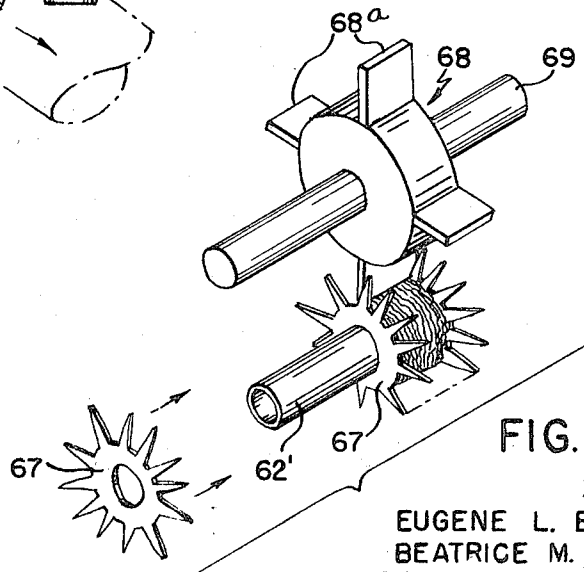


FIG.10

INVENTORS
EUGENE L. BRILL
BEATRICE M. BRILL
BY
Baldwin, Egan, Walling & Fetzer
ATTORNEYS

# OIL SKIMMER WITH OSCILLATABLE CIRCULAR LOOP

An object of the present invention is to provide a skimmer utilizing a substantially rigid endless loop which passes continuously into and out of a pool of water or the like upon which floats hydrophobic material which is attracted to the loop and carried out of the pool and diverted to a different location so as to free the water of pollutants. The use of a substantially rigid material for forming the loop permits the use of a wide range of materials which may be selected to resist extremes of temperature, corrosive agents, and conditions which sometimes prevent the use of flexible hoses or collectors. Also, the substantially rigid endless loop does not become tangled as would a flexible belt or hose.

Other objects and advantages of this invention will be apparent from the accompanying specification and drawings, and the essential features thereof will be set forth in the appended claims.

In the drawings,

FIG. 1 is a side elevational view of one embodiment of this invention utilizing a circular loop and showing the driving mechanism therefor;

FIG. 2 is a front elevational view of the same taken from the left-hand side of FIG. 1;

FIG. 3 is a diagrammatic view, enlarged, illustrating how two rolls cooperate to rotate the loop in its own plane;

FIG. 4 is a central sectional view through the driving rolls of a second embodiment utilizing four driving rolls instead of the two driving rolls of the first embodiment;

FIG. 5 is a diagrammatic view showing the invention using a loop which in plan is longer than it is wide;

FIG. 6 is a diagrammatic view illustrating how the invention may be utilized to drive a plurality of endless loops dipping ping into the same pool of polluted water;

FIG. 6A is a fragmental sectional view taken centrally through the two drive shafts of FIG. 6 as indicated by the line 6A—6A thereof;

FIG. 7 is an embodiment similar to FIG. 4, but using three drive rolls instead of four;

FIG. 8 is a diagrammatic view showing the endless loop and its drive rolls covered by a brushlike structure;

FIG. 9 is a fragmental sectional view of the same, somewhat enlarged, as taken along the line 9—9 of FIG. 8; while

FIG. 10 is a diagrammatic view showing one means of applying the brushlike structure to the endless loop of FIG. 8, and a cleaning appliance therefor.

E. L. Brill U.S. Pat. No. 3,508,663, granted Apr. 28, 1970, describes a flexible elongated generally cylindrical collector for hydrophobic materials. The invention of this patent is not completely satisfactory where the conditions of use are such that the flexible hose will not withstand the rough use or corrosive materials sometimes encountered. Also, flexible hoses may become entangled and the endless substantially rigid loop of the present invention overcomes this difficulty. The present invention, therefore, is desirable in some situations as opposed to the flexible elongated hose or the like of my patent.

It should be understood that the substantially rigid endless loop described and claimed herein may be made of a large class of materials. For instance, it can be made of carbon steel, stainless steel, aluminum, copper, or even platinum or very expensive materials where necessary to withstand the operating conditions. The loop also may be made of glass, synthetic resins, fiberglass or ceramics such as porcelain. It may be made of substantially rigid rubberlike material. The endless loop may be hollow or solid. Where the loop material has a specific gravity lighter than water it may be solid, but otherwise it is hollow to give it buoyancy, as it obviously will be utilized with the lower end of the loop riding upon the surface of the water or reservoir from which the hydrophobic material is being skimmed.

Referring to FIGS. 1, 2 and 3, a substantially rigid endless loop 10, circular in plan, and of uniform cross section, generally circular, is gripped between two rolls 11 and 12. As best seen in FIG. 3, the roll 11 has an annular surface 11*a*, concavely arcuate in section, and arranged to embrace the



upper surface of the loop 10 on one side thereof. The roll 12 has an annular surface 12*a*, concavely arcuate in section and arranged to embrace the lower surface of the loop 10 on the side opposite the surface 11*a*. Each of the rolls has a generally circular periphery and these peripheries approach closely to a mutually tangential position leaving just enough space between the arcuate surfaces 11*a* and 12*a* to firmly grip the loop 10 between them. Note that the rolls have flanges 11*b* and 12*b*, respectively, on the sides of the arcuate surfaces 11*a* and 12*a* farthest removed from the loop 10.

Means is provided for rotating the rolls 11 and 12 in opposite directions so as to cause the loop 10 to rotate in its own plane. A frame 13 surrounds a reservoir 14 or the like in which is a pool of polluted water as indicated at 15. A bracket 16 is rigidly connected to the frame 13 and supports an electrical motor 17, whose drive shaft 18 drives gears in the gearbox 19 so as to drive output shaft 20 in one direction and to drive shaft 21 in the opposite direction. Each of the output shafts could be keyed to its respective roll, but I prefer to provide a driving key 22 in shaft 21 captured in a recess 23 in roll 12 so as to positively drive this roll, while having roll 11 rotate freely on shaft 20. The hub 11*c* of the roll 11 has sufficient weight to cause the surface 11*a* to press down firmly against the loop 10 and the roll 11 can ride up and down slightly to accommodate itself to the action of the loop 10 during a driving operation. This driving arrangement is such that it permits oscillation of the loop 10 about an axis A in FIG. 1 which is substantially tangential to the loop at the gripping point or zone. Thus, the loop 10 inclines outwardly and downwardly from the driving means 11, 12, swinging between the full line position of FIG. 1 and the dot-dash line position. The flanges 11*b* and 12*b* set up a twist on the loop 10 which tends to hold it horizontal and assists the lower edge of the tube in floating on the surface of the water at 15. If the loop 10 is not hollow but is constructed of material having a specific gravity lighter than water, then the lower end of the loop will ride near the surface of the water as indicated at the level 15 in FIG. 1. In any case, if the loop 10 is an imperforate tube having air trapped in the central cavity, then its gravity may be adjusted so that it will float on the surface or near the surface of the level of the water in the pool or reservoir.

Means is provided for collecting and diverting the hydrophobic material carried from the surface of the water up to the level of the driving means. As shown in FIGS. 1 and 2, a collecting trough 24 is positioned to catch the material squeezed off the surface of loop 10 where it passes between the rolls 11 and 12. This is diverted into a trough 25 which is drained away at 26. It is obvious that the hydrophobic material carried by the loop 10 might be removed by a scraper above the trough 24 or a blast of air could blow such hydrophobic material from the loop 10 into the trough 24.

In FIG. 4, a second embodiment is shown utilizing four drive rolls instead of two. Here the rolls 11′ and 12′, mounted on shafts 20′ and 21′, respectively, perform the same function as that described in connection with FIG. 3. Note that the key 22′ positively drives the roll 12′ while 11′ is not directly driven. Mounted at the lower end of shaft 20′ is a roll 12″ nondrivingly connected to shaft 20′ by pin 22″. This roll 12″ is slightly below the level of roll 12′ and embraces the lower side of the loop 10′ on the undersurface of the loop but on the side opposite that embraced by the surface of roll 12′. At approximately the level of the roll 11′, there is mounted a roll 11″ freely rotatable on the shaft 21′. The upper surface of loop 10′ is engaged by the concavely arcuate surface of the roll″ on the side opposite from that engaged by the same surface on roll 11′. The main pressure is exerted between rolls 11′ and 12′ with rolls 11″ and 12″ assisting in squeezing oil off of loop 10′ and in maintaining the cylindrical shape of the tubular loop. A fixed scraper 49 aids in separating collected material from rolls 12′ and 12″. Trough 25 and drain 26′ collect and divert the hydrophobic material skimmed from the pool of water.

FIG. 5 is intended to represent the same embodiment as in FIGS. 1, 2 and 3 except substituting for the circular loop 10 a loop 30 which in plan is longer than it is wide and driven by rolls 11 and 12 utilizing shafts 20 and 21 in the same manner as the first embodiment. The loop 30 is shown as oblong in plan, but it might be elliptical or it might be some other shape departing from a circle depending upon the course and the speed which it is desired for the loop to traverse over the liquid surface during the skimming action. Sometimes cases are encountered where the oil on the surface of the water would not move into the narrow area skimmed clear using a circular loop like that shown at 10 in the first embodiment. An odd-shaped loop as illustrated at 30 in FIG. 5 can open up a sufficiently wide area to permit the oil to move into the range of the skimmer.

FIGS. 6 and 6A illustrate diagrammatically a pair of spaced-parallel drive shafts 31 and 32, generally vertical, on which are mounted a plurality of rolls to provide pairs of coacting arcuately concave annular surfaces, each pair of such surfaces engaging a different one of the loops 33, 34 and 35, to drive each loop for rotation in its own plane into the polluted water to carry the hydrophobic material upwardly out of the water where the hydrophobic material is squeezed out between the coacting drive roll surfaces to be diverted into the trough 36. The drive of shafts 31 and 32 is like that shown in FIGS. 1, 2 and 3.

The loop 33 is driven by coacting surfaces near the upper end of roll 37 and a surface on the lower portion of coacting roll 38 in an opposed quadrant on opposite sides of loop 33 from the driving surface of roll 37 as clearly seen. Loop 34 is driven between an arcuately concave annular surface near the upper edge of roll 38 and a coacting surface near the lower end of roll 39 in an opposed quadrant relationship. In a similar manner, loop 35 is driven between an annular surface near the upper edge of roll 39 and a coacting surface at the lower edge of roll 40 in an opposite quadrant. Rolls 37 and 39 are shown keyed by key 41 to shaft 31 to be positively driven thereby. Roll 37 is held on shaft 31 by washer 42 and cotter key 43. Roll 38 is shown loosely secured on the shaft 32 by washer 44 and cotter key 45. Rolls 38 and 40 move freely on shaft 32 to pass by gravity against loops 33 and 35, respectively.

Another change is indicated in FIG. 6 where the loop 35 is provided with a bump or curve 35*a* which suddenly diverges radially, first outwardly and then again back inwardly so as to cause the loop 35 to swing sharply at its lower side when the diverging curve 35*a* passes through the driving means. There might be more than one of such diverging curves 35*a* in one or more of the loops shown. Such a curve 35*a* is placed in the loop to break up continuous layers of congealed oil or grease floating on the water reservoir. It has been found that where such continuous layers form, a circular loop 10 will simply punch a hole through such a layer and then fail to gather more oil to be conveyed upwardly. When such a layer is broken up by the pounding caused by the curve portion 35*a*, the congealed layer is broken up and the pieces adhere to the loop and are removed from the surface of the reservoir. FIG. 6 illustrates how this invention may employ a plurality of rigid loops for skimming generally in the same area of the reservoir, thus enabling the use of multiple collectors or skimmers without entanglement with each other as would be the case using flexible tubes or belts.

FIG. 7 shows an embodiment quite similar to FIG. 4 except that it utilizes three drive rolls instead of four. Parallel vertical shafts 50 and 51 are driven like shafts 20 and 21 of FIGS. 1 through 3. Rolls 52 and 53 are mounted on the lower end of shaft 50. A key 54, carried by shaft 50, serves to drive roll 52. Roll 52 is held on shaft 50 by a setscrew at 55. Roll 53 moves with shaft 50 in rotation but is free to move up and down on the shaft. Roll 52 has an annular surface 52*a* concavely arcuate and facing upwardly and arranged to embrace the undersurface of the loop 56 which is a substantially rigid circular loop like 10, 10', 30 and any other of the loops disclosed herein for carrying out this invention. The roll 53 has an annular surface 53*a* concavely arcuate in section and facing downwardly and arranged to embrace the upper surface of the loop 56 at one side thereof. Roll 57 is mounted on the lower end of shaft 51 and is arranged for rotation by the shaft through the medium of a cross pin 58 extending through the shaft and laying within a recess 59 in roll 57. Thus, the roll 57 rotates with shaft 51 but is free to move vertically thereon. Roll 57 has an annular surface thereon, concavely arcuate in section, facing downwardly, and arranged to embrace the upper surface of the loop 56 in a quadrant diametrically opposite from the surface 52*a* previously described. Here, as in previously described embodiments of this invention, the upper rolls 53 and 57 are free to press downwardly by gravity on the upper side of loop 56.

FIG. 7 provides means for easily replacing loop or hoop 56, when necessary. To this end, the roll 57 has a cylindrical portion 57*b* extending downwardly a short distance beneath the arcuate portion 57*a*. This extension is sufficient to prevent loop 56 from moving toward the right in FIG. 7 when the device is in operation. When it is desired to replace the loop 56, the roll 57 is moved to the dot-dash position of FIG. 7, upwardly sufficiently to clear the loop 56 and to allow the same to be moved toward the right as shown in dashlines in FIG. 7. The movement of roll 57 upwardly and downwardly is indicated by the double arrow at A and the movement of the loop 56 left and right horizontally is indicated by the double arrow B. If necessary or desirable, positive rotation of roll 57 may be assured by means of a vertical key securing the same to shaft 51.

A scraper 60 may be secured in fixed position to scrape oil and collected material off at loop 56 where it passes through the driving rolls. The scraper has a projecting portion 60*a* to more efficiently perform this function. It should be understood that the collected material is also squeezed off of loop 56 by the rolling action of the drive rolls. Such removed material drops into a trough 61 below the scraper in all respects similar to the trough 25' of FIG. 4 and may be carried away by a pipe not shown similar to 26' of FIG. 4.

Another modification of the invention is shown in FIGS. 8, 9 and 10. The fundamental difference between this embodiment and those previously described is in the provision of a brushlike surface on the rotating loop which passes into and out of the hydrophilic liquid and brushlike surfaces on the driving rolls. This sort of construction greatly increases the collecting surface of the rotating loop which greatly increases its capacity to collect and remove a wide variety of floating material simply by mechanical entrapment. Here the collecting loop 62 is shown as either circular or elliptical in overall shape. This loop has a hollow tubular core 62*a* in which are embedded a very large number of bristles 62*b*. Drive shafts 63 and 64 are provided driven in the same manner as shafts 20 and 21 of the first described embodiment. On the lower end of shaft 63 is provided a drive roll 65 which includes a lowermost radially outwardly extending flange 65*a* and a brushlike structure 65*c* is provided on the roll parts 65 and 65*a* and so shaped as to arcuately conform to a portion of loop 62, at least conforming to a lower left-hand quadrant of the same as seen in section in FIG. 9 at 65*c*. At the lower end of shaft 64 there is secured a drive roll 66 which has a flange portion 66*a* above the downwardly extending portion 66 and constructed to provide an arcuate brushlike portion 66*c* engaging the loop 62 in a quadrant diametrically opposite the quadrant 65*c* as clearly seen in FIG. 9.

Another manner of forming a brushlike surface on the loop 62 is shown diagrammatically in FIG. 10. Here a tubular core 62' has assembled upon it a series of toothed star-shape washers 67, either made of plastic or metal. The loop 62' is completely covered by these members 67 so as to provide a brushlike surface.

Means is provided for cleaning off the liquid and particulate matter which is collected by the lower end of the loop 62 or 62' when it passes through a reservoir of hydrophilic liquid. liquid. This could be a blast of air or water, but a paddle wheel

is shown at **68** in FIGS. **8** and **10**. This paddle wheel is driven by a shaft **69** which is supported and driven in any suitable manner, not shown. Referring to FIG. **8**, the paddle wheel **68** would be placed as near as possible to that portion of the loop **62** which passes between the drive rolls **65** and **66** as there is the least amount of motion of the loop **62** in a vertical direction at this zone as the loop **62** oscillates about its upper driving point as the lower end of loop **62** floats up and down on the liquid in the reservoir to be cleaned, as previously described with respect to this invention. The paddles **68***a* are placed so as to strike the brushlike surface **62***b* or **67** in a manner to dislodge all of the matter collected thereon. This, of course, would be caught in a trough and led away as previously described in connection with other embodiments.

Referring particularly to FIG. **10**, the paddles **68***a* in striking the star-shape washers **67** might rotate them slightly about the tubular core **62'** during the cleaning action which would aid in the efficiency of such action.

The operation of the embodiments shown in FIGS. **8**, **9** and **10** is like that previously described except with greater efficiency where particulate matter is to be collected and disposed of.

What is claimed is:

**1**. In an apparatus for skimming oil or the like floating on the surface of a liquid, a base, an endless substantially rigid loop of uniform cross section generally circular, said loop lying in a single plane, driving means gripping said loop at one point only, said driving means rotating said loop in its own plane, said loop depending downwardly from said gripping point, and said driving means permitting oscillation of said loop about an axis substantially tangential to said loop at said gripping point.

**2**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said driving means comprises two rolls each having a generally circular periphery, said peripheries approaching closely to a mutually tangential position, a first of said rolls having an annular surface concavely arcuate in section and arranged to embrace the upper surface of said loop on one side, and a second of said rolls having an annular surface concavely arcuate in section and arranged to embrace the lower surface of said loop on the opposite side.

**3**. An apparatus for skimming oil or the like, as defined in claim **2**, including a third roll at the level of said first roll embracing the upper surface of said loop at the opposite side, and a fourth roll at the level of said second roll embracing the lower surface of said loop at said one side.

**4**. An apparatus for skimming oil or the like, as defined in claim **2**, wherein said driving means includes power means drivingly connected directly with said roll embracing the lower side of said loop only.

**5**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said loop is of a specific gravity lighter than water.

**6**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said loop is generally circular in plan.

**7**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said loop has a curve suddenly diverging radially at one or more points, whereby to cause said loop to swing sharply at its lower side when said diverging curve passes through said driving means.

**8**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said loop in plan is longer than it is wide, whereby said loop will oscillate in its own plane as it is rotated by said driving means.

**9**. An apparatus for skimming oil or the like, as defined in claim **1**, including a second endless substantially rigid loop of uniform cross section generally circular, a pair of spaced-parallel drive shafts generally vertical, a plurality of rolls mounted on said shafts and providing pairs of coacting arcuately concave annular surfaces, each pair of surfaces engaging a different one of said loops, each pair engaging its associated loop in diagonally opposed quadrants, one above and one below the center of the section of its associated loop, and said driving means drivingly connected with at least one roll of each pair.

**10**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein means is provided for collecting and diverting skimmed material adhering to said loop and being squeezed away from said loop while passing through said driving means.

**11**. An apparatus for skimming oil or the like, as defined in claim **1**, comprising two parallel vertically extending shafts, means for rotating at least one of said shafts, first and second rolls mounted on one of said shafts, a third roll mounted on the other of said shafts, said first roll having an annular surface concavely arcuate in section and directed upwardly and outwardly and engaging the undersurface of said loop on one side, said second roll having an annular surface concavely arcuate in section and directed downwardly and outwardly and engaging the upper surface of said loop on said one side, said third roll having an annular surface concavely arcuate in section and directed downwardly and outwardly and engaging the upper surface of said loop opposite said one side and at approximately the same level as said arcuate surface of said second roll, said third roll having a cylindrical portion extending, in driving position of said rolls, downwardly below said arcuate portion of said third roll to a point below the center of said loop, said cylindrical portion then lying closely adjacent said loop, and said third roll having a mounting on said other shaft permitting movement of said third roll upwardly on said other shaft sufficiently to permit said loop to be removed generally horizontally beneath said cylindrical portion.

**12**. An apparatus for skimming oil or the like, as defined in claim **1**, wherein said loop has a covering of brushlike material.

**13**. Apparatus as defined in claim **12**, wherein said brushlike material comprises a plurality of star-shape washers assembled on a generally cylindrical core.

**14**. Apparatus as defined in claim **12**, wherein said driving means comprises rolls having a covering of brushlike material drivingly engaging said loop.

**15**. Apparatus as defined in claim **12**, including paddle means engaging said brushlike material at a point above said liquid, and said paddle means rotatable in a direction at right angles to said loop to remove material collected on said loop.

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