United States Patent

[11] **3,617,556**

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[21] Appl. No. **785,566**
[22] Filed **Dec. 20, 1968**
[45] Patented **Nov. 2, 1971**

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[54] **ERADICATING OIL SLICKS**
3 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **210/30,** 210/40, 210/242, 210/402, 210/523, 210/DIG. 21
[51] **Int. Cl.** **E02b 15/04,** B01d 33/12
[50] **Field of Search** ..... 210/40, 242, 400, 402, 505, DIG. 21

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ABSTRACT: Separation and recovery of oil from oil slicks on the surface of water by continuously and selectively picking up the surface oil in a relatively thick blanket of a bulk fabric composed of highly oleophilic fibers expressing the oil from the blanket and leaving the fibers in an open condition highly receptive to additional oil.

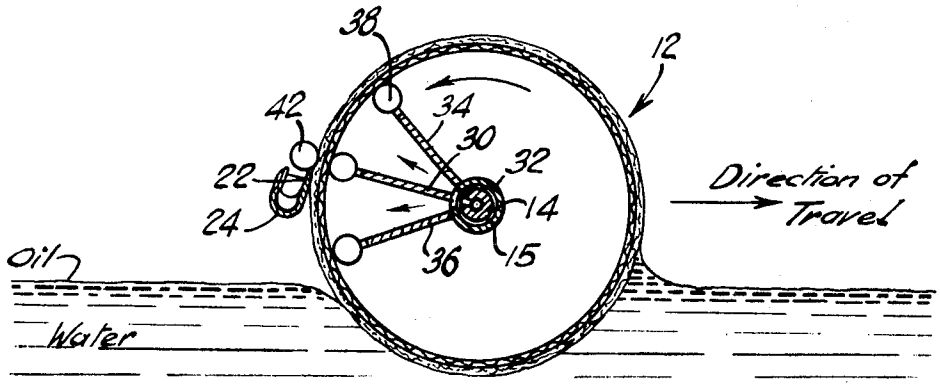


Fig. 1.

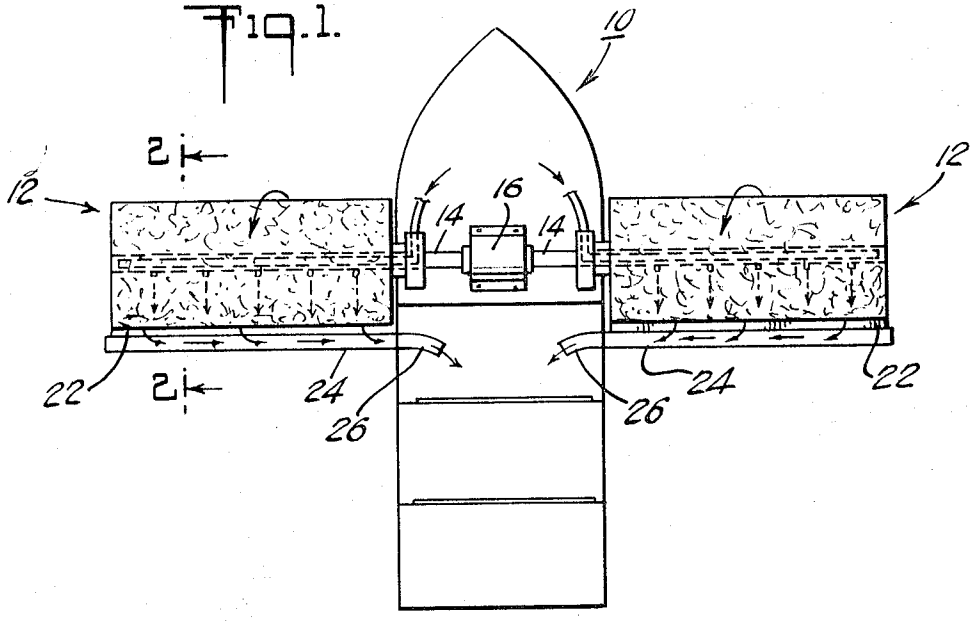


Fig. 2.

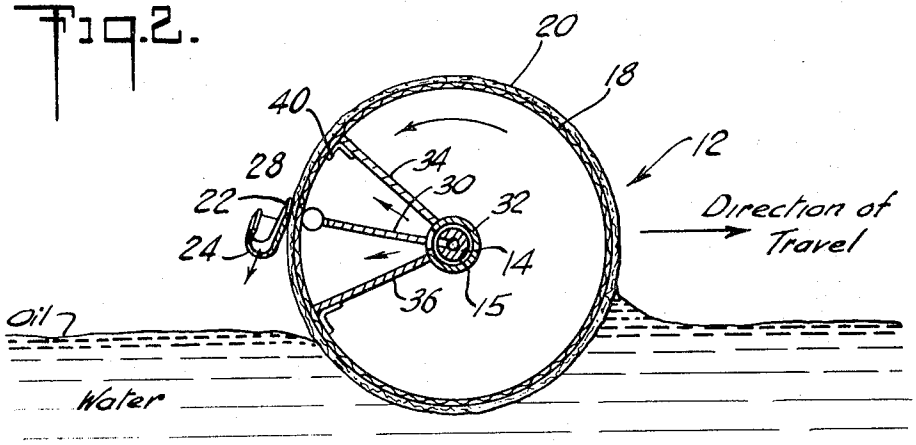
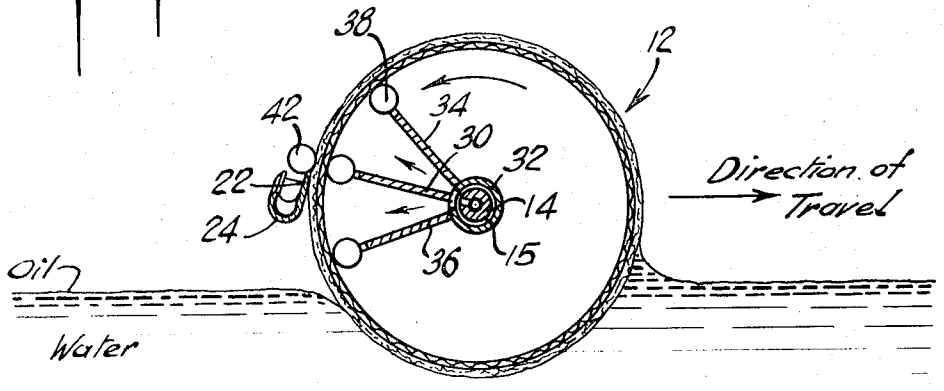


Fig. 3.



ERADICATING OIL SLICKS

The present invention is concerned with the problem of water pollution and more specifically with eradicating oil slicks which occur on the surface of water as a result of handling petroleum and similar products.

Even though the highest degree of care is used in transferring liquid hydrocarbons, spillage appears to be inevitable at times through accident, failure of equipment or leakage of conduits, for which reason it becomes necessary and advisable to provide means for promptly containing and disposing of such spills as do occur.

Hitherto recovery of petroleum fractions floating on the surface of a body of water has been variously proposed, as for example by equipment which selectively skims the surface of the body of water. According to another proposed scheme of operations an oleophilic material dips into the body of oil-bearing water and picks up a film of oil which is then carried to a point of disposal.

The first of these methods, of course, operates effectively only in areas of essential quiescence but meets with serious problems in the typical waterways or channels in a normal state of agitation or turbulence.

The latter proposal is limited in regard to the rate at which the oily fraction can be caused to adhere to an ordinary surface even if it has been roughened. To overcome this, it has been proposed to use screens or to employ rollers which are vastly expanded in area as by providing them with fins, protruberances and similar extensions.

In accordance with the present invention it has been found that the rate of oil removal from the surface of a body of water is sharply improved by using a blanket of bulk fabric composed of a solid synthetic polymeric plastic material having a critical surface tension[1] greater than about 30 dynes cm.[11] and by continuously immersing this in a spill area, withdrawing it, removing the oil and then cycling the bulk fabric back into the slick area, after first expanding the texture of the fabric to make it highly receptive for the preferential acceptance of a large proportion of oil.

[1] Defined by E. G. Shafrin, U.S. Naval Research Laboratory under title "Critical Surface Tension of Polymers"—Polymer handbook-Brandrup & Immergent—Interscience 1966.

The polymeric plastics which are used herein have a high degree of selectivity for the absorption of oil and as a result they are preferentially wet by oil floating on a layer of water and therefore, when the material is immersed in the water upon which an oil slick is floating, the surface absorbs a substantial layer of the oil to the substantial exclusion of water, as a consequence of which the oil is preferentially separated from the water as the fabric is removed.

The term "bulk fabric" as used herein is specifically defined as a fabric or blanket having a minimum thickness greater than at least about one-eighth inch, composed of fibers of polymeric plastic material as described, either in matted or felted condition or in the form of a pile fabric, all sufficiently loosely arranged so that a stream of air is capable of readily passing therethrough. The bulk fabric may, and advantageously does have a thickness substantially greater than about one-eighth inch inasmuch as receiving and carrying capacity for the oil is correspondingly increased.

The result is however a mass of closely associated highly oleophilic fibers exposing a relatively vast internal surface area for the absorption of oil in the interstices thereof.

The term "felted" and "matted" as previously used, must be interpreted in a broad sense, so as not necessarily to require the surface interlocking effect met with in felted woolen fibers the fabric structure being maintained by other techniques presently known in the formation of plastic bulk fabrics of this kind.

It has been moreover discovered that the adsorbent fabric arranged on a drum or endless belt may be carried by a moving vessel so that the lower surface of the carpet or belt continuously moves in the direction of motion of the vessel, tending thereby to pile up and thus to promote the adsorption of oil, whereby substantial quantities are readily removable from the water surface.

By way of specifically describing the present invention, reference is made to the attached drawing wherein

FIG. 1 is a plan view of a small work boat carrying outboard two drums adapted to practice the present invention,

FIG. 2 is detailed elevation through one of the oil pickup drums, taken on the line 2—2 of FIG. 1, and

FIG. 3 is a sectional elevation as in FIG. 2 of a modified drum construction.

As shown therein more or less diagrammatically, a vessel **10** supports two laterally extending drums **12** rotated on axle **14** by driving means **16**. The drum is, as indicated, so located that the lower extremity dips into the water a substantial distance as shown more clearly in FIGS. 2 and 3.

The drum has the form of a cylinder which may comprise a screen **18** or a perforated sheet at least sufficiently rigid to maintain its cylindrical shape and support an outer layer of bulk fabric **20**, which completely envelops the cylindrical periphery of the drum.

A doctor blade **22**, preferably of Teflon or similar flexible material (FIG. 2) or roller **42** (FIG. 3) are provided on the after side of the drum as shown, to remove the adsorbed oil which falls into trough **24**, from which it is recovered via outlet pipe **26**.

To support the gentle pressure of the doctor blade **22** against the drum, an internal fixed roller **28** is mounted within the interior of the drum, bearing lightly against its inner surface. Roller **28** is, in turn, rotationally mounted, by means not shown on spider or arm **30** which are mounted upon central sleeve **32**. It must be particularly observed that sleeve **32** is fixedly mounted against rotation, by means not shown in detail, on the main frame of the vessel, also sleeve **32** is spaced substantially from rotating axle **14** by annular space **15** to provide an internal duct for reasons which will hereinafter appear.

Thus while the drums rotate with the axle, the internal structures mounted on sleeve **32** remain angularly fixed.

Moreover, as is known in the art of lubricating oil dewaxing filters, the internal section of the drum in the region of the doctor blade is compartmentalized by fixed walls **34** and **36**, also mounted on sleeve **32** and which are impermeable and terminate preferably in rollers (FIG. 3) or wipers (FIG. 2) designated as the numerals **38** and **40** respectively, which also bear lightly against the interior internal walls of the drum. Thus the parts **30–36** are fixed as shown relative to the drum, which rotates about it.

The resultant compartmentalized segment of the drum is continuously provided with a supply of air under a pressure slightly above atmospheric, which performs the functions of supporting the bulk fabric in the area of the doctor blade while at the same time greatly facilitating the expulsion of oil from the spaces between the polymeric fibers to assist the wiping action of the doctor blade.

It is particularly important to note that the air blow is continued for a substantial angular distance after the point of contact by the doctor blade. This has the important function of counteracting the compressive effect of the doctor blade upon the relatively compressible fibrous fabric and expanding it again to a condition of substantial permeability so that the maximum volume of oil can thereafter be readily adsorbed.

As will be apparent from the foregoing, mechanical means is provided to continuously rotate the drum, preferably in the direction of the arrow, as shown in FIG. 2, namely in a direction such that the lower surface of the drum moves continuously in the same direction as the direction of movement of the vessel itself. Therefore, as the vessel heads into an oil slick the surface of the drum tends to, at least momentarily, pile up the equivalent of a "bow wave," which, since it is composed largely of oil, facilitates the absorption of oil into the previously prepared, highly receptive fibrous interior of the bulk fabric.

Referring again to the bulk fabric, the fibrous materials, as previously indicated, are those having a critical surface tension of over about 30 dynes cm[1].

Typical materials coming within this category are listed in the following table opposite their respective surface tension:

Polypropylene	31–32
Poly (vinyl chloride)	39
Poly (vinyl alcohol)	37
Poly acrylamide	35–40
Poly (hexamethylene adipamine)	46
Polystyrene	33–35
Poly (ethylene terephthalate)	42.5–43

As previously stated, the present invention depends upon use of polymeric oleophilic material in the form of a blanket of bulk fabric, which is readily permeable to air. This calls for, in bulk fabrics as defined, either a matted or felted structure or a pile fabric, both of which provide reasonably loosely associated fibers with a bulk of interstices sufficient to accommodate a relatively large proportion of oil.

Accordingly, in order to facilitate this function and at the same time provide a sheet material of structural permanence and durability it is preferred that the bulk fabric be provided with sufficient mechanical support either internally or in the form of a suitable backing.

Many techniques, are available for this purpose. For example, a tufted-pile or felted sheet or blanket as it comes from the mill may be dusted on one side, in known ways, with polyethylene powder, thereafter being passed thru a sintering oven maintained at a temperature which melts or softens the powder without scorching the fabric.

As the layer of material cools the sintered polyethylene acts to lock or seal the tufts of fibrous material together where they pass in contact so as to confer a substantial firmness to the structure and provide a material which can be thermoformed.

It is also possible by this means to incorporate a suitable backing material such as high strength fibers or even stainless steel wire mesh or the like so as to confer high strength properties.

Thus, for example, to form an assemblage such as the above, the bulk fabric and backing layers can be run together through the oven after dusting a small amount of polyethylene powder therebetween. At the end of the oven a polished, chilled roller sharply cools the sandwich and hardens the sintered plastic material to join the layers at random points of contact without impairing permeability.

The fibers preferred for forming and the blanketlike or carpet-like bulk fabric of the present invention are those which readily form suitable fibers. To this end polypropylene is preferred. Also suitable are, for example:

1. Linear fiber forming polyeurethanes such as the reaction product of diisocyanates and diols, as for example reaction product of hexamethylene diioscynate and 1,4-butanediol
2. Polyvinyl chloride fibers
3. Polyvinyl alcohols produced by the alcoholysis of polyvinyl acetate.
4. Polyhexamethylene adipamine (nylon 66)
5. Polyacrylonitrile (Orlon)
6. Polyethylene terephthalate (Dacron)

7. Suitable hydropholic copolymers thereof, as for example, vinyl chloride and vinylidene chloride (Saran).

Based on laboratory experiments the following are the estimated capabilities of a power-driven pickup vessel constructed in accordance with the present invention and using two oil pickup drums each four feet in diameter and twenty feet in axial dimension, and arranged so that their axes extend transversely to the direction of the movement of the vessel.

In accordance with the present invention the drums are covered with a continuous layer of bulk fabric composed of polypropylene olefin fiber bearing the trade name Vectra. The thickness of the fibrous blanket is approximately five-thirty-second inch.

The present examples are further based on an oil spill of Arabian crude floating on salt water containing 35,000 p.p.m. salt, the oil layer having a thickness of about 0.232 cm.

The lower surface of the drums is immersed to an average depth of about 10 inch in the water.

On the foregoing basis of design the capabilities of the device are as follows:

Case	A	B
Pickup, grams/pass/in.^{2}	1.47	1.76
Drum speed, r.p.m.	5	5
Boat speed, knots	0.68	0.80
Oil pickup, gallons per minute (90% efficiency)	140	167

The present invention permits of many variations over the embodiment described above. For example, the resilient doctor blades may be substituted by an exterior pressure roller **42** as shown in FIG. 3, which, together with the internal roller 33, expresses the oil from the fabric.

The structures shown herein are merely illustrative of a wide variety of means for carrying out the present invention and which will immediately occur to those skilled in the art, in light of the foregoing disclosure.

We claim:

1. In the recovery of oil from an oil slick floating on the surface of a body of water the improvement which comprises contacting said oil slick with a continuous sheet arranged on a rotating member, said sheet comprising bulk-tufted fabric supported by a high-strength fibrous backing the fabric being composed of fibers of oleophilic plastic fiber-forming material having a Critical Surface Tension of over 30 dynes cm^{11} in sufficient thickness to selectively absorb a substantial proportion of oil within the interstices between the fibers of said fabric to the substantial exclusion of water, removing said oil-saturated bulk fabric from the vicinity of said slick, expressing said oil therefrom and continuously repeating said cycle.

2. The method according to claim 1 wherein said sheet of bulk fabric comprises a felted structure having a thickness substantially greater than one-eighth inch.

3. A method according to claim 1 wherein said sheet of bulk fabric comprises a polypropylene pile.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,617,556 **Dated** November 2, 1971

Inventor(s) EDWARD L. COLE and HOWARD V. HESS

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, Line 34: After the word "dynes", "cm.^{11}" should read --cm.$^{-1}$--

Col. 1, Line 65: After the word "felted", "and" should read --or--

Col. 2, Line 74: After the word "dynes", "cm^{1}1" should read --cm.$^{-1}$--

Col. 4, Line 43: After the word "dynes", "cm^{11}" should read --cm^{-1}--

Signed and sealed this 5th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents