March 15, 1966 M. F. SMITH 3,240,381

SURFACE COVER FOR STORED LIQUIDS

Original Filed Jan. 9, 1959 2 Sheets-Sheet 1

FIG. 1

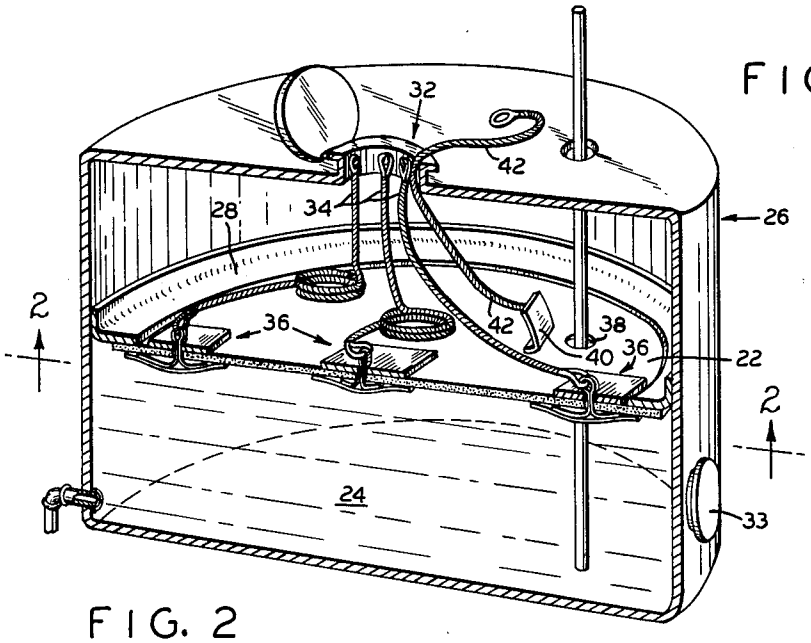


FIG. 2

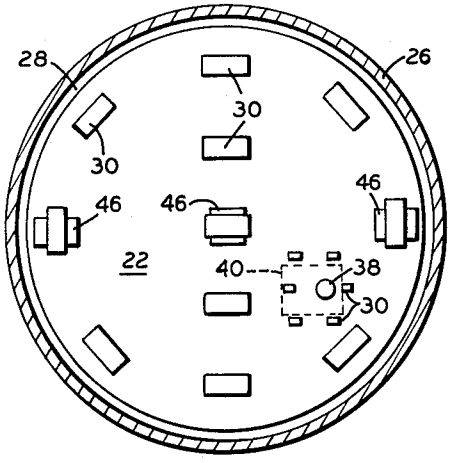


FIG. 3

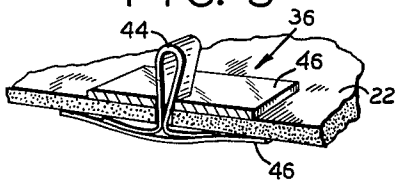


FIG. 4

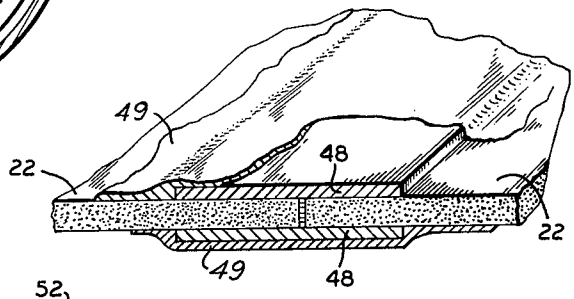
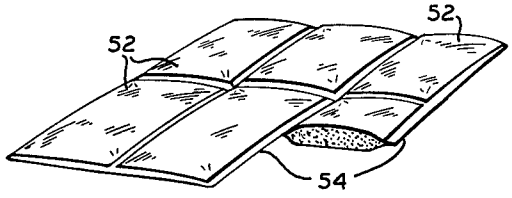


FIG. 5



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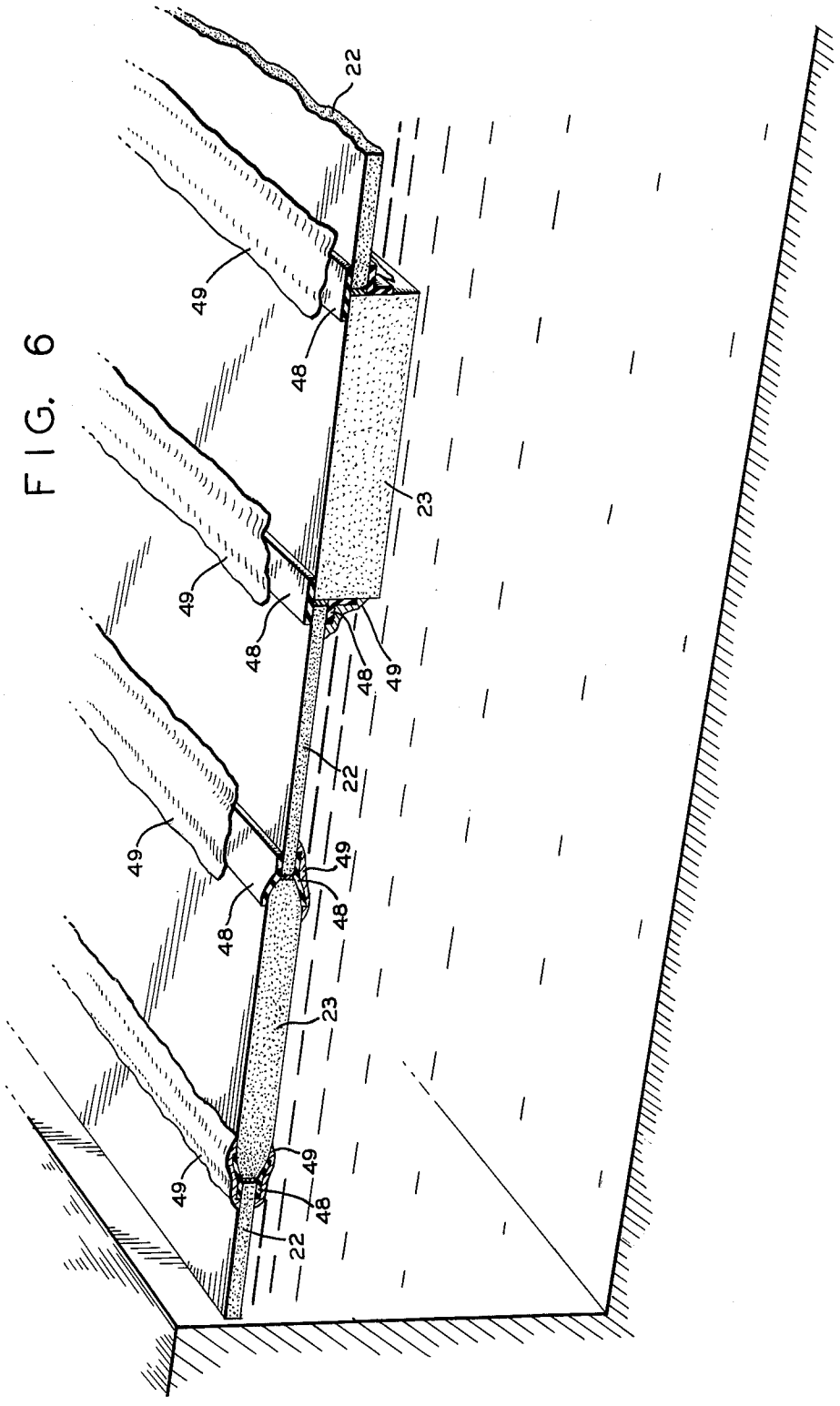
ATTORNEYS.

March 15, 1966 M. F. SMITH 3,240,381

SURFACE COVER FOR STORED LIQUIDS

Original Filed Jan. 9, 1959 2 Sheets-Sheet 2

FIG. 6



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3,240,381

SURFACE COVER FOR STORED LIQUIDS

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Continuation of application Ser. No. 785,966, Jan. 9, 1959. This application Jan. 2, 1962, Ser. No. 163,428
6 Claims. (Cl. 220—26)

This application is a continuation of my earlier application of the same title, filed January 9, 1959, Serial No. 785,966, now abandoned.

This invention relates to surface covers for stored liquids which reduce evaporation and, more particularly, to such surface covers made of foam material which float on top of the surface of the liquid stored.

Large losses through evaporation are suffered each year by industries which store liquids in large vessels, such as the petroleum industry. Large storage tanks must of necessity be open to the atmosphere so that they will not collapse under atmospheric pressure when they are being emptied and so that dangerous pressures will not build up inside them during filling. As such a tank warms during the day, the vapor phase above the stored liquid is expelled and, as the tank cools at night, air is sucked into the tank from the outside. The vapor thus lost is called the breathing loss. As the tank empties, the volume above the stored liquid increases and is saturated with vapor. When the tank is filled, this vapor phase is expelled. This is called the filling loss. Such breathing and filling losses in a 527,000 gallon capacity, 50 foot gasoline storage tank may amount to as much as 15,000 gallons per year for four annual turnovers, and to as much as 32,000 gallons per year for twenty-five annual turnovers.

The vapor phase above the stored liquid often contains a layer or region of explosive composition which can be ignited by static electricity, and the escaping vapors cause air pollution. When a liquid mixture is stored having constituents of different volatilities, such as jet fuel, the more highly volatile liquids are lost at a higher rate than the rest of the mixture. The stored liquid is thus degraded in composition. Liquids stored in open tanks are subject to continuous evaporation losses, which losses pollute the atmosphere. Open tanks often have an explosion zone above their free liquid surfaces, and the stored liquid, being exposed to direct sunlight, is subject to photochemical decomposition.

Prior to the present invention, many attempts were made to design apparatus which would reduce the volume of the vapor phase above stored liquid and seal this phase from the atmosphere. These have often involved complex rigid floating covers having expensive seals between their peripheries and the walls of the tank. Such rigid covers cannot easily be installed in existing tanks. Such non-rigid floating covers have been designed, but these have either required complex associated apparatus or a combination of floats and a flexible sheet which, due to the bulk of the floats, was difficult to install. None of these solutions have the additional advantage of contact with substantially the entire surface of the liquid, which contact inhibits the initial transfer of molecules from the liquid to the vapor phase.

The present invention contemplates the use of a sheet of foam material as a floating surface cover for stored liquids. The foam sheet should be of material unaffected by the liquid stored. Oil refineries salvage all available hydrocarbons by passing waste from their operations through settling and recovery tanks. The present invention provides an easy and cheap method of covering these tanks, reducing evaporation and photochemical decomposition.

Because of the seasonal demand for many petroleum products, such as fuel oil, producers are often forced to store such products in open pits. At Lake Maricaibo, there is an open storage pit 100 feet deep with a surface area of 12½ acres. Evaporation losses from this pit are enormous. Such pits and other open storage vessels may be covered with the foam blanket of the present invention by joining prefabricated sections of foam material at the site.

Accordingly, the principal object of this invention is to provide apparatus for reducing evaporation from liquids being stored. Another object of this invention is to provide apparatus of the above character to safeguard the storage of liquids having explosive volatiles. A further object of this invention is to provide apparatus of the above character for reducing air pollution by stored volatile liquids. A still further object of this invention is to provide apparatus of the above character for maintaining the compositions of stored liquids having volatile components, and avoiding degradation thereof. A further object of this invention is to provide apparatus of the above character fabricated from foam material. Another object of this invention is to provide a foam blanket of the above character capable of floating on the surface of the liquid being stored. Still another object of this invention is to provide a foam blanket of the above character which is capable of installation in existing liquid reservatories while they are in use. A further object of this invention is to provide a foam blanket of the above character which may be removed easily from a reservatory when desired without removing the stored liquid therefrom. A still further object of this invention is to provide a foam blanket of the above character for shielding the liquid stored in open tanks and pits from sunlight so as to prevent photochemical decomposition. A final object of the invention is to provide a foam blanket of the above character for open tanks and pits, which will afford access for men and equipment to substantially all areas of the surface of the foam blanket. Other objects of the invention will in part be obvious and in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view, partially in section, of an embodiment of the present invention installed in a liquid storage tank;

FIGURE 2 is a bottom plan sectional view, taken along line 2—2 of FIGURE 1 and showing the underside of the floating foam blanket seen in perspective in FIGURE 1;

FIGURE 3 is an enlarged sectional perspective view, partially cut away, of the rope tie construction of the embodiment of FIGURE 1;

FIGURE 4 is an enlarged sectional perspective view, partially cut away, of another part of the embodiment of FIGURE 1;

FIGURE 5 is a partial sectional perspective view, partially cut away, of another embodiment of the invention; and

FIGURE 6 is a partial sectional perspective view of still another embodiment of the invention.

Similar reference characters refer to similar parts throughout the several views of the drawing.

The floating surface cover of the present invention consists of a blanket of foam material which is to be

spread upon the surface of the liquid to be covered. This blanket may have a wiper seal around its periphery to further reduce evaporation. Various other facilities are herein described which facilitate the use of foam material for floating surface covers. The foam blanket may be of uniform thickness or of varying thickness. It may be fabricated of plastic, metal, glass, or any material impervious to and unaffected by the liquid to be covered.

Referring to FIGURE 1, the foam blanket **22** floats on top of the liquid **24** in a storage tank generally indicated at **26**. If a high degree of vapor seal is desired, an annular wiper seal **28** may be attached to the periphery of the foam blanket. This seal may be a suitable semi-rigid, abrasive and corrosive resistant material such as neoprene, found to be comparatively unaffected by petroleum products, and which does not generate a dangerous build-up of static electricity on the blanket when the seal rubs against the sides of the tank. A dip sick opening **38**, cover flap **40**, and a rope **42** may provide convenient access to the liquid for measuring depth by conventional dip stick techniques.

The foam blanket of the present invention may be conveniently installed in existing closed tanks, particularly those of 50 foot diameter or smaller, by simply rolling it up so that the ends of the ropes **34** are left outside the rolled-up blanket. The blanket is then inserted through a top manhole **32** to float upon the surface of the liquid. The ropes **34** which are attached near the periphery and at the center of the blanket are then pulled, causing the blanket to unroll upon the surface of the liquid. The blanket may be removed, when desired, simply by pulling the rops **34** to raise the periphery of the blanket up to the manhole **32**, and then drawing the blanket through the manhole.

In larger enclosed tanks, the blanket may be rolled up and introduced into a side manhole **33** when the tank is empty, or it may be fabricated inside the tank out of smaller pieces of foam material. When such a foam blanket surface cover having a wiper seal is installed in an enclosed tank, evaporation is so greatly reduced that ventilation of the volume above the cover may be increased so that no explosive mixture can form there.

The construction may have additional floats **30** (FIGURE 2), which increase the buoyancy of the blanket. Those around the periphery aid in forcing the wiper seal up the sides of the tank, as the tank is filled. Those shown around the dip stick opening **38** raise the blanket around this opening so that scum on the surface of the liquid will collect under the opening and may conveniently be skimmed.

The rope ties **36** (FIGURES 1 and 3) consist of a loop of material **44** inserted through a hole in the blanket **22** and two stiffening and sealing pieces **46**. The arrangement is held together by an appropriate adhesive.

Impervious foam blankets according to the invention may be fabricated in any size, by joining commercially available strips or sheets in the manner shown in FIGURE 4 and in FIGURE 5. The sheets of foam material **22** are butted together, and sealing and stiffening tapes **48** are placed on both sides of the joint. Suitable adhesive material **49** is placed between the foam sheets **22** and the tapes **48** and spread on top of the tapes.

In an alternative embodiment of the invention disclosed in FIGURE 5, a foam blanket may be constructed which has the buoyancy of thick foam material and the flexibility of thin material. Referring to FIGURE 5, foam pillows **52** are joined at their peripheries **54** in a manner similar to that previously described for joining foam sheets.

The foam blanket of the present invention may be constructed of any suitable plastic, metal, or glass foam, the selection of the particular material being dependent upon the corrosive properties of the liquid to be covered and the stability of the material under the ambient conditions expected. For liquid hydrocarbons, a polyester, polyurethane or polyvinyl chloride foam has been found to be satisfactory. Since the main function of the foam blanket is to act as a vapor seal, the material chosen must not allow the vapors of the liquids stored to diffuse through it. For this reason it is most convenient to select a closed cell foam material. If open cell material is used, or if a further reduction in diffusion is desired, the foam material may be covered by a thin continuous film of suitable material on either or both sides of the blanket. For installation in tanks having vertical walls, the foam material is pieced together into a shape slightly smaller than the inner area of the tank. The thickness of the foam blanket depends on the tensile strength of the foam material chosen, the size cover desired, and the expected wear. Thickness of one inch or less of polyurethane foam may be used on petroleum tanks up to 50 feet in diameter.

In open tanks and pits, even if no peripheral seal is used, the surface cover of the present invention, by reducing the exposed surface area, vastly reduces evaporation, shields the liquid from the sunlight reducing photodecomposition, reduces air pollution, and reduces the possibility of explosion. When used on a recovery tank, the dip stick openings may be surrounded by small floats, as previously described, so that foam and scum may accumulate on the surface of the liquid under the openings where it may be conveniently skimmed off.

For large open pit storage, the present invention may be fabricated from smaller pieces of foam sheet **22** and **23** (FIGURE 6) at the site in the manner previously described, and then may be slid on top of the stored liquid. The thickness of the material may be varied so that relatively thick walkways and roadways **23** are formed on the surface capable of supporting a man or small truck. In this manner, convenient access is given to the whole surface of the cover for repairs, inspection, tests, and the like.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim:

1. A liquid reservatory comprising, in combination, a side walled and bottomed enclosure having a floating surface cover comprising a plurality of sheets of flexible closed cell foam material joined substantially hermetically sealed at their edges to form a unitary flexible floating cover for the surface of the liquid being stored, some of said sheets having a different thickness than others such that roadways of greater thickness than the average thickness of said cover are formed therein to afford a support for the access of personnel and equipment to various areas of the surface of said cover, with the undersurface of the cover floating upon and in intimate contact with the stored liquid over substantially its entire area.

2. A floating surface cover for liquid in a storage tank comprising, in combination, a thin flexible closed cell unitary foam blanket of substantially the same size and shape as the surface of said liquid, and a wiper seal joined to the periphery of said foam blanket in such manner that the outer periphery of said seal is larger in size than the surface of said liquid, the surface of said seal being in intimate contact with the sides of said tank at all levels of said liquid surface, loops attached to said blanket near said periphery and near the center of said blanket, and

ropes attached to said loops, the opposite ends of said ropes extending outside the roof of said tank when said blanket is installed therein, whereby said blanket after being rolled up and inserted into said tank may be spread upon the surface of said contained liquid by external manipulation of said ropes, and a dip stick opening formed in said blanket through which external access to said liquid is afforded.

3. The combination of claim 2 in which said foam material is chosen from the class consisting of polyester, polyurethane, and polyvinyl chloride foam, and said blanket has a flexible wiper seal of neoprene attached to its periphery.

4. A hydrocarbon liquid reservatory comprising, in combination,

(A) a bottom and contiguous side walls confining a body of hydrocarbon liquid,

(B) and a thin unitary flexible blanket of closed cell foam material having a substantially flat undersurface

(1) floating upon and supported in intimate contact over substantially its entire area by the free surface of the body of liquid,

(2) and substantially covered by a thin continuous film of hydrocarbon-impervious coating material.

5. Means for confining and storing liquid in a body having an exposed free surface comprising, in combination, a side-walled and bottomed enclosure for the body of stored liquid, a flexible unitary foam blanket of substantially the same size and shape as the free surface of the liquid being stored, said foam blanket being formed of a closed cell foam material impervious to said liquid and having its undersurface substantially covered by a thin continuous film of coating material impervious to the stored liquid, and a flexible, abrasive-resistant sealing means affixed to the periphery of said foam blanket, with the undersurface of the blanket floating upon and in

intimate contact with the stored liquid over substantially its entire free surface.

6. Means for confining and storing liquid in a body having a free surface comprising, in combination, a storage tank having side walls and a bottom, a liquid- and gas-impervious flexibly coilable foam blanket of closed cell material substantially the same size and shape as the free surface of the liquid being stored with its undersurface substantially covered by a thin continuous film of coating material impervious to the stored liquid, a plurality of flexible cables, and means attaching said flexible cables to the blanket, whereby said blanket after being rolled up and inserted into the tank may be spread upon the surface of said liquid therein contained by manipulation of said cables.

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