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FLOATING SCREENS FOR USE IN LIQUID STORAGE TANKS

Filed Sept. 23, 1959

3 Sheets-Sheet 1

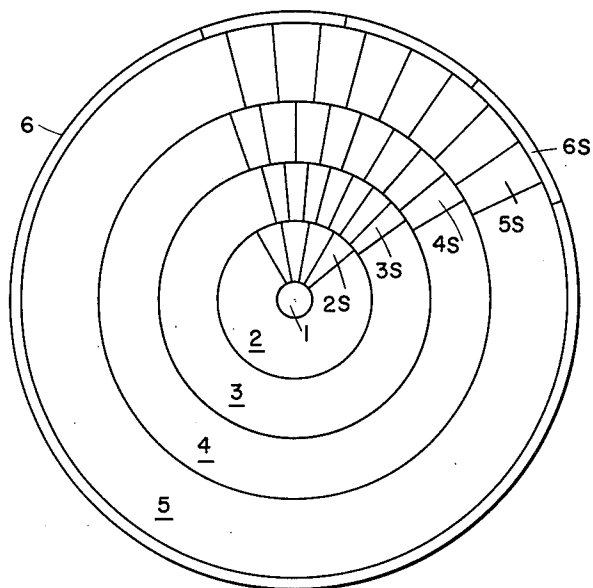


FIG. 1

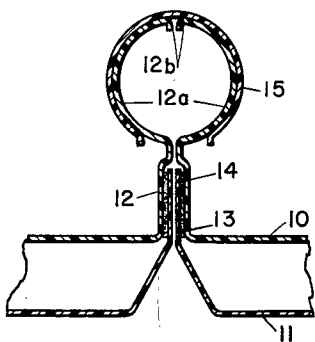


FIG. 2

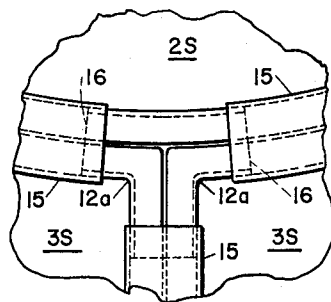


FIG. 3

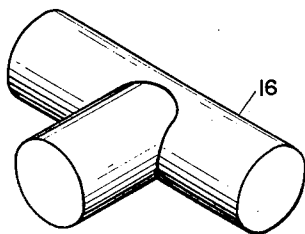


FIG. 4

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FIG. 5

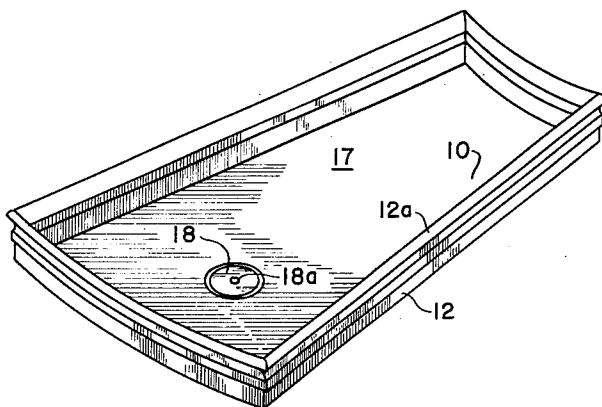


FIG. 6

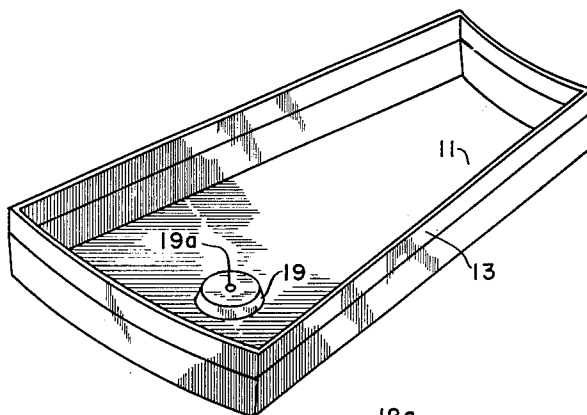
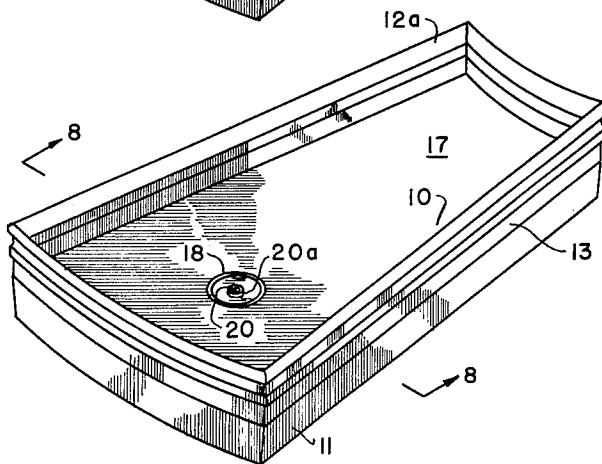


FIG. 7



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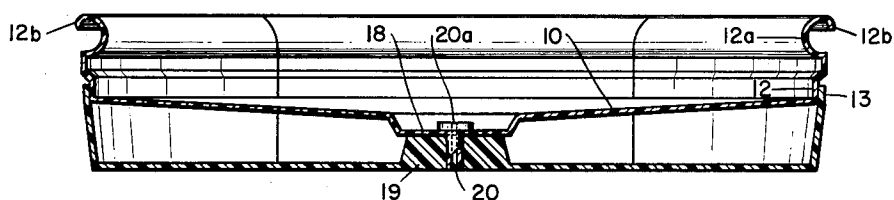


FIG. 8

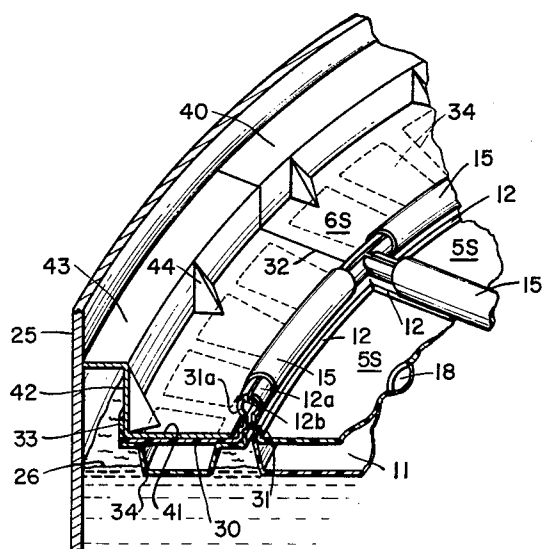


FIG. 9

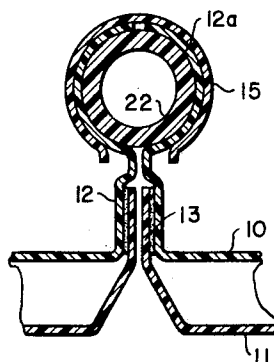


FIG. 10

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FLOATING SCREENS FOR USE IN LIQUID STORAGE TANKS

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1 Claim. (Cl. 220-26)

The present invention relates to floating screens or partitions for use in liquid storage tanks. When storing either volatile liquids (e.g. gasoline) or liquids having volatile components (e.g. crude oil), in exposed storage tanks such as those employed in the tank farms of oil refineries and other oil-handling installations, considerable losses occur due to the expulsion of vapor through the tanks' venting valves which are arranged to prevent the build-up of dangerously high vapor pressures within the tanks. These losses may occur for example on heating of a tank during the day, or an expulsion of vapor due to filling of the tank with liquid. Naturally they are greatest in a hot climate.

It has been proposed to reduce these losses by providing liquid storage tanks with floating screens which lie in or on the surface of the liquid and cover the majority of the liquid surface, limiting the surface area from which evaporation can occur. Particular proposals include the provision of floating screens of metal foil or flexible sheets of synthetic resin material.

It is an object of the present invention to provide an improved construction for such screens, important factors being ease of assembly of a screen in situ within a tank and simplicity and hence reduced cost of manufacture.

According to the present invention a floating screen for use in a liquid storage tank comprises a plurality of sections assembled to form a screen shaped to cover the majority of the surface of liquid stored in the tank, each section being formed from two flexible sheets joined at or near their edges to form an airtight pocket or chamber so as to render the section buoyant, adjoining sections each having at least one of its sheets formed at the adjoining edge into a flange projecting upwards and inwards over the section, whereby the inward projection of the flanges of adjoining sections provide a broadening around or on which one or more sleeve fastening means are placed to secure the sections together. The flange comprises a lower substantially vertical portion adapted to abut against the corresponding portion on an adjacent section, and an upper portion which projects or has a part projecting inwards over the surface of the section but does not project outwards beyond said lower portion.

Usually the screen will be shaped to fit within the tank for which it is intended with a small clearance between its edge and the walls of the tank, a flexible sealing collar or the like which makes rubbing contact with the walls of the tank being provided around the edge of the screen to seal the gap. It is usually convenient also to have a separate central sheet which may be supported by the remainder of the screen.

In one arrangement of a screen according to the present invention for use in tanks of circular horizontal cross-section, the sections of the screen, apart from a central circular section, are arranged to form one or more concentric annuli, each annulus being made up of a number of sections formed by dividing the complete annulus into a number of equal sectors. In particular the annuli, except for an outer edge annulus of comparatively narrow radial width, may be subdivided so that the length of of the outer arcuate ends of all the sections is approximately the same regardless of which annulus they form part, this length being determined so that the sections can

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pass through the manholes provided on a tank. The radii of the outer edges of the annuli may be determined to correspond to various standard tank diameters so that standard sections may be manufactured for use in tanks of several diameters. The sections in the different annuli are arranged so that the radial joins in one annulus do not, as far as possible, lie opposite those in the neighboring annuli. The sections of the outermost annulus will usually be provided with means for mounting on it a flexible collar for sealing the gap between the edge of the screen and the tank wall.

In another form of screen according to the present invention there may be a plurality of sections of identical shape and size, the shape being that of an equilateral triangle, a square, a rhombus or a regular polygon having an even number (preferably six or eight) of sides, these sections being assembled in a honeycomb pattern and constituting the whole or only a major part of the screen. In the majority of cases which includes all tanks of arcular cross-section, the honeycomb pattern cannot fit the shape of the tank and additional sections of different shapes have to be included to form the outer edge part and in some cases also the center part of the screen. Some of these additional sections may conveniently have a shape which is a part of the shape of the sections forming the honeycomb pattern and is formed by omitting the part to one side of a line joining two non-adjacent corners.

An example of a floating screen according to the present invention for use in a liquid storage tank will now be described with reference to the accompanying drawing in which:

FIG. 1 shows a plan view of a screen illustrating an arrangement of the sections in a circular screen;

FIG. 2 shows a cross-section through the adjoining edges of two sections of the screen shown in FIG. 1;

FIGS. 3 and 4 show respectively a plan view of a part of the screen where three sections meet and a perspective view of an element incorporated at that point;

FIGS. 5 and 6 show separate perspective views of two trays which together form a section;

FIG. 7 shows a similar perspective of the trays of FIGS. 5 and 6 when assembled;

FIG. 8 shows a section at 8-8 in FIG. 7;

FIG. 9 shows a perspective view of a part of the edge of the screen in position in a tank; and

FIG. 10 is a similar view to FIG. 2 showing a modification.

Referring to FIG. 1 it will be seen that the screen which in this specific example is designed for a tank of 48 ft. diameter, includes a central section 1 which is surrounded by four successive concentric annuli 2-5 and an outer edge annulus 6. The diameters of the successive perimeters of the section 1 and annuli 2-6 are, in order, 3, 13, 23, 33, 46 and 48 ft. These diameters are chosen, apart from the first and the last one, as being in each case 2 ft. less than a standard tank diameter, so that by adding an edge annulus, 1 ft. wide and of appropriate diameters to only the appropriate part of the screen shown in FIG. 1, a screen for tanks of 15, 25 and 35 ft. diameter can be formed. By providing additional annuli with inner and outer diameters of 46, 54 and 62 ft., tanks of 48, 56 and 64 ft. diameter can be covered and the annuli for this whole range of tanks is standardized. A different series of annuli of inner and outer diameters of 14, 18, 28 and 38 ft. can be used to cover the range of tanks of 15, 20, 30 and 40 ft. diameter.

Each of the annuli 2-5 (it is to be understood that where less or more annuli are provided in a screen the intermediate ones are all similar to the annuli 2-5 in this particular case) is made up of a number of screen sections 2s-5s respectively, each annulus being divided into a number of equal sectors. The number is determined in

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each case so that the length of the chord extending across the wider arcuate end of the sections is in all cases less than the diameter of the manholes provided on the tanks for which the screens are intended, so that the sections of a screen can be passed into the tanks and assembled in situ. Often these manholes are 2 ft. 6 ins. in diameter so that the chord width may conveniently be about 2 ft. or 2 ft. 3 ins. In addition, when assembling the screen, it is arranged as far as possible that radial joints in the annuli do not lie opposite those in adjoining annuli.

FIG. 2 shows a vertical section through the adjacent edges of two sections of the screen, the arrangement being as shown whether the edges are circumferential or radial edges. Each section is formed by two trays 10 and 11 each constructed of a flexible plastic sheet material, such for example as polyvinyl chloride or polyethylene, only parts of the trays 10 and 11 of the two sections appearing in FIG. 2 being shown. The edges of the upper trays 10 are turned upwards to form flanges 12 having an upper portion 12a which in section is semicircular apart from a small downwardly projecting lip 12b on the upper edge of the portion 12a. The lower trays 11, slope upwards towards their edges and then terminate in vertical flanges 13 the inner surfaces of which are cemented to the outer surfaces of the flanges 12 on the upper trays 10, the cement being indicated by the shaded areas 14. The two trays 10 and 11 of each section are joined in this manner right round their edges so that the space between them forms an air-tight pocket rendering the section buoyant when placed on liquid. When two sections are placed side by side, the upper flange portions 12a of the upper trays 10 together form a tubular broadening of the upper edges of the flanges 12, around which is sprung a sleeve fastener 15. The fasteners 15 extend along the whole length of the edges of the sections apart from short breaks at the junctions where three sections of the screen are contiguous. A small clearance space of for example $\frac{1}{8}$ " is left between the outer faces of the flanges 13 of neighboring sections.

FIG. 3 shows a plan view of a point where three sections are contiguous, two of them being section 3s of the second annulus and one a section 2s of the first annulus. The ends of three fasteners 15 are shown each terminating short of the junction. A solid or tubular plastic T-piece 16 (see FIG. 4) is inserted inside the upper flange portions 12a to seal the gap that would otherwise occur. The lips 12b may be removed for the distance that piece 16 projects into the flange portions 12a or piece 16 may be provided with grooves to accommodate the lips 12b. A molded press-on cover could be provided as an alternative to piece 16.

A preferred form of construction of the trays 10 and 11 is shown in FIGS. 5-8. FIG. 5 shows a perspective view of the upper tray 10, including the flange 12, the main surface 17 of the tray 10 sloping downwards from all points to a circular flat or level portion 18 of small area. FIG. 6 shows the corresponding view of the lower tray 11 with its flange 13, a central boss 19 being mounted (for example it may be molded integrally with the tray 11) on the upper surface of tray 6 in a position such that it lies directly under the flat 18 on the tray 10 when the two trays 10 and 11 are assembled together. The upper surface of the boss 19 is the same area as the flat 18 and lies in contact with or close to the flat 18 when the trays 10 and 11 are loosely fitted together. A metal drainage unit comprising a tube 20 with a flange 20a (see FIG. 7 which shows the trays 10 and 11 together) at one end is passed through the corresponding holes 18a and 19a in the flat 18 and the boss 19 respectively. FIG. 8 is a section at 8-8 in FIG. 7 and shows the juxtaposition of the flat 18 and the top of the boss 19, together with the drainage unit, the tube 20 of which provides a passage enabling liquid collected on the upper surface of the tray 10 to run through to the underside of the screen.

If required two or more bosses 19 and flats 18 may

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be provided on the same section of the screen, each having a draining unit. Besides allowing provision for drainage, the bosses 19 add to the rigidity of the sections, and without them it will usually be necessary to provide some other strengthening such as lattice of struts which fits within the space between the trays 10 and 11.

FIG. 9 shows a part of the edge of the screen assembled in a tank, part of the wall 25 of which is shown together with the liquid surface 26. Parts of two sections 5s are shown assembled and joined along their adjacent radial edges by a sleeve fastener 15. Also shown are parts of two sections 6s of the outer edge annulus which are about 1 ft. in width (radially) and 3 ft. in length. These sections 6s are constructed of the same material as the remainder of the screen and each includes a sheet 30 provided on its inner circumferential edge with a flange 31 identical with the flanges 12 on the sections 2s-5s. As shown in FIG. 9, the flanges 31 are joined to the flanges 12 on the adjoining edges of the sections 5s in the usual manner with sleeve fasteners 15. The radial edges 32 of the sections 6s simply overlap, and the outer circumferential edge is provided with a short upstanding flange 33 about 1 inch high. To render the sections 6s buoyant, air pockets are formed by attaching (by cementing or by welding) pocket pieces 34 to the underside of the sheet 30.

The sections 6s each carry a part of a sealing collar 40 of known form which makes rubbing contact with the wall 25 of the tank to seal the gap between the edge of the screen and the wall 25. The sections of the collar 40 are constructed of corrugated sheet material, each section having a base 41 which is some 10" wide and is bolted to the upper surface of the sheet 30 of the section 6s on which it is mounted, a vertical wall 42 some 8" high and an upper horizontal flange 43 about 3" wide which projects radially beyond the periphery of the section 6s and rubs against the tank wall 25. The wall 42 is formed with gussets 44 for stiffening purposes. Corrugations on the sheet material used for constructing the collar may be provided for stiffening purposes and could run circumferentially being about $\frac{1}{8}$ " deep and spaced about $\frac{1}{2}$ " apart. The material used will usually be the same as that employed for the rest of the screen. The ends of the sections of the collar 40 overlap in the same way as the screen sections 6s on which they are mounted.

FIG. 10 is a similar view to that of FIG. 2 and shows a stiffener 22 mounted between the upper flange portions 12a to support them against the clamping pressure of the fastener 15. The stiffener 22 may be a plastic tube and may extend the same length of the flange portions as the fastener 15.

In an alternative arrangement, in order to standardize as far as possible the shape of the sections to be employed in screens of different sizes, use is made of sections having some regular shape for example square, rhombus or the shape of a regular hexagon. Apart from their shape, these can be constructed and joined in exactly the same way as the sections of the screen described with reference to the drawing. They are fastened together in a honeycomb pattern to form the majority of the screen for tanks of a variety of shapes and sizes. Apart from the case of square sections in a square or rectangular cross-section tank, the screen will usually have to be completed around its edge by an outer edge part the shape of which is somewhat irregular, but which is constructed in a similar manner to the edge annulus 6 of the screen shown in the accompanying drawing. To reduce the irregularity of the edge part, use may be made of sections the shape of which is a convenient part of the shape of the sections forming the honeycomb. Thus where the honeycomb is formed of sections in the shape of a regular hexagon, sections having a shape formed by dividing the hexagon across a diagonal or across a line joining two corners spaced apart by one corner only can conveniently be incorporated in

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the screen to make the edge of the honeycomb more regular in shape.

It is particularly envisaged that this last construction may be employed for screens for use in new tanks under construction so that no limit is placed on the size of the sections by the need to pass them through existing man-holes, the screen being assembled before the tank roof is applied. For example, hexagonal sections measuring 4 feet across a diagonal may be used. The use of such large sections will be particularly convenient in large tanks.

In the screens described above, use has been made of sections of certain convenient shapes and constructed in particular ways of various materials. It will be appreciated, however, that construction of screens according to the present invention is not limited to these examples. In particular, sections of other shapes may be found convenient in tanks of some particular shape, while the construction of the trays may be varied in detail while retaining the basic principles that they include two flexible sheets joined at or near the edges to form an airtight pocket and have a suitable flange. Any sheet material may be used provided it is impermeable to liquid and chemically resistant to the liquid to be stored in the tank, and amenable to being formed to the desired shape. For example, other synthetic plastics or resins with or without fibrous or other reinforcement may be employed, or metallic sheets which may have a thin plastic or resinous coating may be used.

While the provision of one or a small number of bosses 19 (FIGS. 6 and 8) is preferred for strengthening each section, other strengthening structures may be incorporated if desired. For example, a lattice of strips with their major surfaces vertical and of width equal to the vertical spacing of the trays 10 and 11 may be placed between the trays 10 and 11 to provide additional rigidity. These strips may be of the same material as the remainder of the section or may be, for example, of aluminum foil held together with synthetic resin. If desired a synthetic resin foam may be used as a filling for the sections.

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In the screen shown in FIGS. 1-10, a particular semi-circular form has been shown for the upper flange portion 12a on the upper trays 10. This is a convenient form, but other forms may be used, as long as the upper flange portions 12a of two sections, together form a suitable broadening on the upper part of the flange around which sleeve fasteners can be retained.

I claim as my invention:

The combination with a storage vessel for volatile liquids, the vessel having an upright wall of: a flexible blanket comprising multiple plastic cellular float units, each float unit comprising an upper dished plastic section and a lower dished plastic section, said plastic sections being so formed that upon assembly said sections fit together along their peripheral edges to form a unitary hollow structure, each said float unit being provided with an integral flange at its upper edge, said flange projecting upward from said edge to form a substantially vertical wall portion, and continuing from the top of said vertical wall portion in the form of an inwardly extending bead of substantially semicircular cross-section, whereby the beads of two adjacent float units define a hollow tubular top rim; a cylindrical reinforcing member fitting snugly in the hollow of said top rim between two adjacent float units, and a split tubular clamping sleeve fitting snugly over said tubular top rim and resiliently pressing said beads against said cylindrical member to firmly retain two adjacent float units joined together while permitting a limited amount of angular play between said joined units.

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