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FLOATING ROOF FOR OIL TANKS

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FLOATING ROOF FOR OIL TANKS

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This invention relates to floating roofs for oil tanks and proposes the construction of a flat member of the class indicated, floatable upon the surface of the oil and rising and falling with changes in the oil level within said tank so as to avoid the formation or existence of gas filled spaces.

It is well known that where the structure is of such character as to permit the accumulation of gas and air between itself and the surface of the oil, the fire hazard is great owing to the inflammable or explosive character of said gas mixture.

Moreover, the evaporative losses from such a construction are excessive from the fact that a tank having a stationary canopy roof must be vented in order to be operative, and such a tank breathes continually, drawing in fresh atmospheric air at night when the temperature is low, and expelling it in the day time when it expands due to the relative warmth. The air thus expelled is the vehicle to ignite the oil in the tank and the constituents of the oil, which are thus wasted.

By the improved floating roof construction disclosed and claimed in the following specification, not a particle of gas may accumulate between the under surface of the roof and the oil level. Therefore the fire risk is eliminated for it is a matter of common knowledge that oil cannot be burned or exploded without access to air.

The evaporative losses are also reduced to a minimum since there is no interchange of air between the surface of the oil and the atmosphere, nor does the roof suffer from the corrosive action of the oil gases which destroys a roof of the canopy type within a few years.

One of the objects of the present invention is to construct a flat roof of the floating type which shall be as light as may be consistent with structural stability. As the roof is to be normally supported at all points by the oil upon which it floats, no great factor of safety need be allowed to ensure horizontal rigidity. There may be, however, certain mechanical devices in the bottom of the tank which prevent the roof from descending quite to the bottom when all the oil is run off, thus depriving it of the support of the oil, and there are occasions when the oil must be drained from under the roof when the latter is at a comparatively high level, for the purpose of cleaning or repairing the tank.

In order to compensate at these times for the withdrawal of the support afforded by the oil, another object of the invention is the provision of permanent means for supporting the roof above the level of such mechanical devices as may be permanently positioned in the bottom of the tank, and the furnishing of detachable supporting means arranged to be selectively used as auxiliary to the permanent supporting means, or independently of the latter, to support the roof at a comparatively high elevation for cleaning out the tank.

Another object of the invention is the provision of means for guiding the floating roof in its vertical movements within the tank, said means cooperating with the peripheral wall of the tank to preserve the normal shape of the same against distortion, whereby to improve the efficiency of the seal between the edge of the roof and the wall of the tank.

A further object of the invention is the construction of novel flexible sealing baskets arranged in close adjacency and between the edge of the roof and the wall of the tank, and floating partially submerged in the oil, said baskets being filled with pieces of cork or other material such as gravel, or a mixture of such substances, to a depth sufficient both to reduce the evaporative surface of the oil in said baskets and to enable said pieces of material to function according to the principle of a miners safety lamp, should a flame be applied to the inflammable or combustible gases arising through the interstices in said sealing baskets. It has been found impossible to ignite the oil in a tank equipped with my improved floating roof even by kindling fire around and over said tank even when the oil in it was made to boil.

Still another object of the invention is the provision of drainage means for the
floating roof, including a flexible deck for turning water away from the sealing baskets.

A further object of the invention resides in the combination with the tank and the floating roof, therefore, of a collapsible ladder giving access to the roof over the upper rim of the tank automatically changing in length with the changes in position assumed by the roof as the oil level within the tank varies.

With the above and other objects in view, my invention consists in the improved floating roof for oil tanks illustrated in the accompanying drawings, described in the following specification, and particularly claimed, and in such variations and modifications thereof as will be obvious to those skilled in the art to which my invention relates.

In the drawings accompanying and forming a part of this specification, and wherein the preferred embodiment of my invention is illustrated:

Figure 1 is a plan view of the floating roof, parts being broken away to show parts beneath.

Figure 2 is a side sectional view through a tank equipped with my improved floating roof.

Figure 3 is a detail view in elevation, partly in section showing one of the permanent legs, one of the detachable legs and a sealing basket.

Figure 4 is a perspective view with parts broken away showing a pair of adjacent sealing baskets.

Figure 5 is a plan view showing a detail of the framing construction surrounding one of the detachable legs.

Figure 6 is a sectional view showing in detail the construction of the thimble through which passes one of the detachable legs this being also the construction of the thimble surrounding the central guide posts.

Figure 9 is a view in cross section taken in a plane transversely to that of Figure 8.

Figure 10 is a front elevation of the collapsible ladder.

Referring now in detail to the several figures, the numeral 1 represents the peripheral wall of an oil tank which in the present example is cylindrical in shape having a bottom wall 2. The walls of said tank are of usual construction being made of a heavy grade of sheet metal, in the form of plates riveted together. As the tanks are usually of large size the side walls thereof are readily deformable from their true shape by any considerable unequally distributed stress. This has an important bearing upon the operation of the floating roof for while the latter is furnished, as will be seen, with means for adapting it to inequalities on the inner surface of the side wall of the tank, it is essential that means be provided for holding said side walls of the tank against excessive deformation from its normal shape.

This roof consists of a floating member adapted to rest upon the surface of the oil within the tank and to rise or fall with the changes of level therein. The roof proper which is designated by the reference numeral 3 terminates preferably about six inches from the side wall of the tank on each side, and is constructed of a plurality of radially extending wooden rafters 4, the spaces between the adjacent rafters being bridged by framing arranged in any desired way, for instance as shown at 5, 6, 7, 8 and 9 in Figure 1. The tubular joints between the members of said framing may be reinforced if desired by suitable metallic fittings 10. The spaces between said framing members are further bridged by lighter timbers 11 set on edge and preferably extending radially of the roof. Upon these timbers and the framing is arranged the sheathing panels 12, the latter being covered with the metallic plates 13, suitably riveted together or otherwise secured at the seams. At the central portion of the roof is erected a vertical sleeve 14 the top of which is flanged as at 15, said flange being peripherally apertured for the attachment of one end of the cables 16, the other ends 17 of said cables being secured by means of the clevis 18 to the anchor blocks 19 as clearly shown in Figure 8. Said cables act as tensioning members supporting the edges of the roof and maintaining the latter in its flat shape. Turn buckles 20 are installed in these cables and perform the usual function of adjusting the tensioning of the latter. The lower end of the sleeve 14 is thereto precisely similar to the lower end of the sleeve 21 associated with the detachable legs and shown in Figure 6. Said threaded end fits into a flanged member 22, the latter being bolted to the framing of the roof, a suitable packing gasket intervening. Below the sheathing is another flanged member 23 having a tubular extension 24 of the same size as and aligned with the sleeve 14. The bore of said sleeve and tubular extension affords a sliding bearing for the roof upon the vertical guide pole 25. Said guide pole is secured in any suitable manner as shown at 26 in Figure 2, to the bottom of the tank and extends some distance above the level of the upper edge thereof, having a flange 27 at its upper end apertured in a manner similar to that of the flange 15 and supporting cables 28 the outer ends of which are connected to off-set brackets 29 secured at intervals around the upper edge of the tank. Turn buckles 30
are intercalated in these cables and serve as a means not only for adjusting the verticality of the guiding pole 25 but also for sustaining the side of the tank in its original shape or for correcting any material deformation which may have taken place in the shape of said side. The offset brackets 29 extend a short distance above the upper edge of the tank to allow room for the floating roof when supported by the maximum oil level of the tank, so that the cables 28 will not be shorn off by the tendency of the roof to rise, or the latter be submerged by having its upward movement prematurely arrested by contacting with said cables.

The outer end of those radial frame members which terminate in the peripheral edge of the roof are shod with a U-shaped strap 31 the cross member 32 of which is provided with a threaded aperture. This affords a means for securing to said framing a vertical rim 33, extending all the way there around and held in place by bolts 34 threaded into the cross members 32. The rim 33 is in the form of a shallow channel having upper and lower flanges 35 and 36 respectively, the latter being perforated as best shown at 37 in Figure 4 providing a hinged joint for the sealing baskets. The upper flange 35 is bolted to an overhanging edge of the plates 13 which form the metallic cover of the roof and to the flange of an inclined coping 38 which extends around the periphery of the roof proper at a slight elevation above said roof, said coping affords a seat which the sealing baskets slidably engage in the movements which they may make in accommodating themselves to inequalities or projections on the inner surface of the side wall of the tank.

The sealing baskets each comprises a sheet metal receptacle 39 having turned up sides or flanges 40, adjacent baskets lying with their adjoining sides in contact but freely relatively movable. The lower end of the basket is provided with a lug or lugs 41 fitting into apertures 37 and bent outwardly beneath the flange 36 constituting a hinged connection between said basket and said flange. The sheet metal container is bent angularly upward at its back as shown at 42 in figure 4 to lie substantially parallel with the inner surface of the side wall of the tank and to make contact therewith.

When said back portion 42 encounters a dent in the side wall of the tank or a rivet head it rises over the obstruction causing the sealing basket to rock slightly relatively to the flange 36. Since the baskets while lying laterally closely adjacent are freely relatively movable one basket may rock without disturbing in the slightest degree the close contact made by the other baskets with the tank wall.

At the base of the angularly bent portion 42 each basket is provided with a hook or hooks 43 to which is loosely connected the concave plate 44 the free end of which bears slidably against the coping 38. In its normal position the sealing basket is submerged until the oil occupies a level above the surface of the plate 44. The sealing basket above said plate is filled with small pieces 45 of cork or other suitable comminuted material to a depth which extends considerably above the oil level in said sealing basket. The object of the cork is two-fold namely, to reduce the area of the oil surface in said sealing basket in order to minimize loss by evaporation and, by providing minute interstices between said oil and the atmosphere to act according to the principle of a miner’s safety lamp so that should a flame be brought into contact with such gases of evaporation as may find their way through the cork seal the flame of the resulting explosion will not be communicated to the surface of the oil. Cork is chosen rather than gravel or heavier-than-oil substances to carry out the scheme of the invention which is to produce a floating roof in which simplicity of construction is made possible by its extreme buoyancy. The cork being itself combustible is protected by an asbestos sheet 46, laid over the top.

Water is excluded from the sealing basket by a shed formed of plates 47 which are bolted to the upper edge of the back portion 42 of the sealing basket and overly at their free ends the upper edge of the coping 38 making a sliding joint at that point. The plates 47 are preferably overlapped in order to obtain a high degree of water tightness.

Water that drains from the shed 47 upon the roof, as well as water that falls upon the latter is carried away by means of jointed conduits 48 which open at one end upon the upper surface of the roof as shown at 49 in figure 2 and discharge through the side wall of the tank as at 50.

In operation the floating roof rises and falls with change of level of oil in the tank being guided by the guide pole 25. The sealing baskets closely engage the side wall of the tank, and being individually movable only such baskets as encounter inequalities in the surface of said walls such as rivet heads or indented portions are rocked away therefrom the remaining baskets maintaining their sealing relationship. As the floating roof rises the jointed conduits 48 unfold, and they assume a folded position at the bottom of the tank when the oil is drained therefrom.

On account of the presence of said jointed conduit it is impossible for the floating roof to descend completely to the bottom of the tank. Thus a situation may arise in which all the oil is drained from the tank, the roof
being maintained in an elevated position resting upon said jointed conduits. This might endanger the stability of the construction of the roof by robbing it of its means of support at peripheral and intermediate points. To meet this situation and to ensure that the roof be adequately supported at such times, means have been provided consisting of legs 51 secured peripherally of the roof to the under side thereof, preferably beneath the radial framing members. These legs are of sufficient length to make contact with the bottom of the tank when the roof is resting upon the jointed conduits. A series of detachable legs 52 are also arranged at intervals around the roof and extending through the latter. In the examples shown in the drawings two series of such legs are provided but it is clearly within the scope of the invention to arrange said legs in any number of series and in any manner that may be expedied for by the structural requirements of the roof, to which they are applied. These legs are slidable arranged in bores formed in metallic fittings which may be similar in every respect except size to those which constitute the central bearing surrounding the guide pole 25. As shown in Figure 6 each of these fittings comprises a sleeve 21 extending sufficiently high to be above the level of submergence of the roof, having the lower end thereof threadedly engaging a flanged member 53 the latter bearing against the upper face of the roof with a washer 54 intervening and being bolted to a similar flanged member 55 on the under side of the roof into which is threaded a thimble 56 having a bore continuous with the bore of the sleeve 21. Said thimble is arranged at a joint in the framing the latter being broken away for the accommodation thereof, as shown in Figures 6 and 7, and the lower end of said thimble being preferably flanged as at 57 to clampably engage the ends of said framing when the thimble is screwed into position. The detachable leg which passes through the sleeve 21 and thimble 56 may be in the form of a bar or hollow pipe and the sleeve 21 and said leg are formed with transverse apertures 98 and 99 respectively which may be brought into alignment, a pin 58 being passed there through to hold said leg in position. Said leg is of such length below said pin that it terminates in the same plane as the permanent legs 51.

For cleaning or repairing the tank it is sometimes necessary to support the roof at a sufficiently high elevation to permit the entrance of a man therebeneath after the oil has been drawn therefrom. To this end a leg 52 is provided with another transverse pin hole 100 at a higher level than the aperture hereinbefore mentioned so that when the pin 58 is passed through said upper aperture said leg will project below the surface of the roof sufficiently to give head room underneath for a man. When supported in this position the roof will of course be deprived of the peripheral support afforded by the permanent legs 51, to compensate for which cables 59 are provided which are attached at the lower ends to clevises 60 pivotedly secured to the anchor block 10, being furnished at their upper ends with hooks 61 for engaging over the upper edge of the side wall of the tank. These cables are of such length as to become tensioned, at the point at which the legs 52, when adjusted to their greater length make contact with the bottom of the tank. The roof is provided with a manhole 64 near the edge thereof at one side to give entrance to the tank.

The anchor blocks 19 are secured to the rafters 4 by means of U-bolts 62 passing beneath said rafters and engageable with horizontal flanges 63 formed on said anchor blocks.

Access to the floating roof is had by means of a stairway 65 leading to the top edge of the tank and a collapsible ladder adjoining said stairway 66 a portion of which rests upon the roof. This ladder is constructed with fixed standards 67 secured to the bottom of the tank and passing through the roof, having slidably arranged thereupon the collapsible rungs 68. As the roof rises the lower rungs come together leaving only those rungs expanded which bridge the distance from the top of the ladder to the roof. Specific construction of said ladder is made the subject matter of a separate application.

While I have above described what I have found to be a very practical embodiment of my invention, it is nevertheless to be understood that the floating roof also be exemplified in numerous other alternative constructions and I accordingly reserve the right of adopting all such legitimate changes as may be fairly embodied within the spirit and scope of the invention as claimed.

Having described my invention what I claim as new and desire to secure by Letters Patent, is—

1. In combination, a tank, a guide pole rising vertically from said tank and extending above the level of the upper end thereof, a floating roof reciprocable within said tank and rising appreciably above the edge of the latter when sustained by the maximum liquid level therein, said roof being slidable along said guide pole and provided with an expansible peripheral edge, brackets secured to the side of said tank, guy cables connected to said brackets, said brackets extending above the side of said tank to keep said guy cables out of contact with said roof when at its maximum level, said brackets being outwardly off-set to permit expansion...
of said edge slightly beyond the upper end of the side of said tank.

2. In combination, a tank, a floating roof reciprocable within said tank comprising a flat member, a plurality of tensioning members secured at intervals peripherally of said flat member and a strut separating said flat member and tensioning members at a point remote from the periphery of said flat member.

3. In combination, a tank, a guide pole secured within said tank and rising above the level of the top thereof, a flat roof reciprocable within said tank comprising a flat member, a plurality of tensioning members secured at intervals adjacent the peripheral edge of said flat member and a hollow strut surrounding said guide pole and secured at spaced points to said flat member and tensioning members.

4. In combination, a tank, a guide pole secured within said tank and rising above the plane of the top thereof, a floating roof for said tank comprising a flat member, anchoring means arranged at intervals peripherally of said flat member, a hollow bearing secured adjacent its lower end to said flat member and slidably engaging said guide pole and tensioning members secured at their offset ends to said anchoring means and the upper portion of said bearing.

5. A floating roof for tanks comprising a rigid member, a coping surrounding said rigid member and inclined inwardly thereof, a flexible sealing edge secured peripherally of said rigid member comprising a plurality of sealing baskets yieldingly engageable with the side wall of a tank and slidably upon said coping, and a waterproof cover for said sealing baskets supported by the edge of said coping and making sliding contact therewith.

6. A floating roof for tanks comprising a rigid member, a coping surrounding said rigid member and inclined inwardly thereof, a flexible sealing edge secured peripherally of said rigid member, comprising a plurality of sealing baskets yieldingly engageable with the side wall of a tank and slidable upon said coping and a waterproof cover for said sealing baskets comprising relative movable plates secured to said sealing baskets and supported by the edge of said coping, making slight contact therewith.

7. In combination, a tank, a flat roof reciprocably mounted in said tank and a collapsible ladder having one end fixed relatively to said tank and the other end engaging said roof and adapted to rise and fall with the movements thereof.

8. The combination with a tank, of a floating deck therefor and a ladder adjustable in accordance with the position of said deck in said tank, said ladder comprising means for holding said deck from rotation in said tank.

9. The combination with a tank, of a floating deck therefor and means for guiding the movements of said deck within said tank, comprising a central fixed guide member and a sleeve-like member on said deck slidably mounted on said guide member, said guide member extending above the top of the tank a distance sufficient to permit said deck to move to the top edge of said tank.

10. The combination with a tank, of a floating deck therefor, drainage means for said deck comprising a drain line adjustable in accordance with the position of said deck, leading to a point outside said tank, and a ladder leading to said deck comprising means for holding said deck from rotation within said tank.

11. The combination with a tank, of a floating deck therefor, drainage means for said deck comprising a drain line adjustable in accordance with the position of said deck, leading to a point outside said tank, and a ladder adjustable with the position of said deck leading thereto and comprising means for holding said deck from rotation within said tank.

12. The combination with a tank, of a deck smaller than said tank movable therein, and means for closing the space between the wall of said tank and said deck, comprising a layer of loose material and fibrous sheet material superposed on said layer of loose material and cooperating with said loose material to provide a seal between said deck and tank.

13. The combination with a tank, of a deck smaller than said tank movable therein, means for closing the space between the wall of said tank and said deck comprising loose material means on said deck for supporting said loose material, and fibrous sheet material co-operating with said loose material to provide a seal between the deck and tank, and means for preventing rotation of said deck relative to said tank.

14. The combination with a tank, of a deck smaller than said tank movable therein, an upwardly extending inwardly inclined flange on said deck, a downwardly extending circumferential member on said deck, a plurality of shoes hinged on said circumferential member and engaging said tank, and water deflectors mounted on said shoes and engaging said inclined flange.

15. The combination with a tank, of a deck smaller than said tank movable therein, an upwardly extending inwardly inclined flange on said deck, a downwardly extending circumferential member on said deck, a plurality of shoes hinged at their lower ends on said circumferential member and engaging said tank by the action of gravity, and
water deflectors mounted on said shoes and engaging said inclined flange.

16. The combination with a tank, of a deck smaller than said tank movable therein, an upwardly extending inwardly inclined flange on said deck, a downwardly extending circumferential member on said deck, a plurality of shoes hinged on said circumferential member and engaging said tank, and water deflectors secured to the upper ends of said shoes and engaging said inclined flange.

17. The combination with a tank, of a deck smaller than said tank movable therein, an upwardly extending flange on said deck, a plurality of shoes, means for loosely hinging said shoes to said deck below the top thereof, said shoes engaging said tank, and water deflectors secured to the upper ends of said shoes and engaging said flange.

18. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members secured to said tank and extending through said deck.

19. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members secured to said tank and extending through said deck, and means on said deck having a sliding connection with said ladder side members.

20. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members and tread members movable on said side members.

21. The combination with a tank, of a floating deck and ladder leading to said deck comprising vertically extending means fixed relative to said tank and tread members movable vertically on said means.

22. The combination with a tank, of a floating deck and a ladder leading to said deck comprising vertically extending means fixed relative to said tank, tread members movable vertically on said means and means for moving said tread members controlled by the movement of said deck.

23. The combination with a tank, of a deck movable therein and a ladder leading to said deck, said ladder being adjustable by the action of gravity and the movement of said deck in accordance with the position of said deck in said tank and comprising means for holding said deck against rotation in said tank.

24. The combination with a tank, of a deck smaller than said tank movable therein, shoes carried by said deck and engaging said tank, receptacles mounted on said shoes, and sealing material in said receptacles.

25. The combination with a tank, of a deck smaller than said tank movable therein, shoes pivotally mounted on said deck and engaging with said tank, receptacles mounted on said shoes and loose, finely divided, sealing material in said receptacles.

26. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members, tread members movable on said side members, and links connecting said tread members together.

27. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members, tread members mounted on said side members above said deck, the uppermost tread member being fixed in position on said side members and the other tread members being slidably mounted thereon, and means connecting said tread members together whereby a plurality thereof is suspended below said uppermost tread member in spaced relation.

28. The combination with a tank, of a floating deck and a ladder leading to said deck comprising side members, tread members mounted on said side members above said deck, the uppermost tread member being fixed in position on said side members and the other tread members being slidably mounted thereon, and toggle links connecting said tread members together whereby a plurality thereof is suspended below said uppermost tread member in spaced relation.

29. In a floating deck for tanks, a main body portion of smaller diameter than said tank having an upwardly and inwardly inclined peripheral flange thereon and sealing means engaging said upwardly and inwardly inclined flange and the tank to seal the space between said deck and tank.

30. In a floating deck for tanks, a pan-like body portion of smaller diameter than the tank having an upwardly and inwardly disposed circumferential flange and sealing means resting on said inwardly disposed flange, said sealing means being urged toward the tank wall by the inclination of said flange.

31. In a floating deck for tanks, a panlike body portion of smaller diameter than the tank having an upwardly and inwardly disposed circumferential flange and sealing means engaging said flange and said tank, said sealing means comprising a plurality of sealing members resting on said flange.

32. The combination with a tank of a floating deck therein, a tubular member in said tank secured to the bottom thereof and extending upwardly over the side wall thereof, said tubular member being mounted closely adjacent the side wall of the tank, and extending slidably through an opening in said deck to prevent said deck from turning.

In testimony whereof I have hereunto set my hand.

FREDERICH W. KUEFFER.