June 10, 1958 J. H. WIGGINS 2,838,199

FLOATING ROOF FOR RESISTING AIR OR GAS SHOCK WAVES

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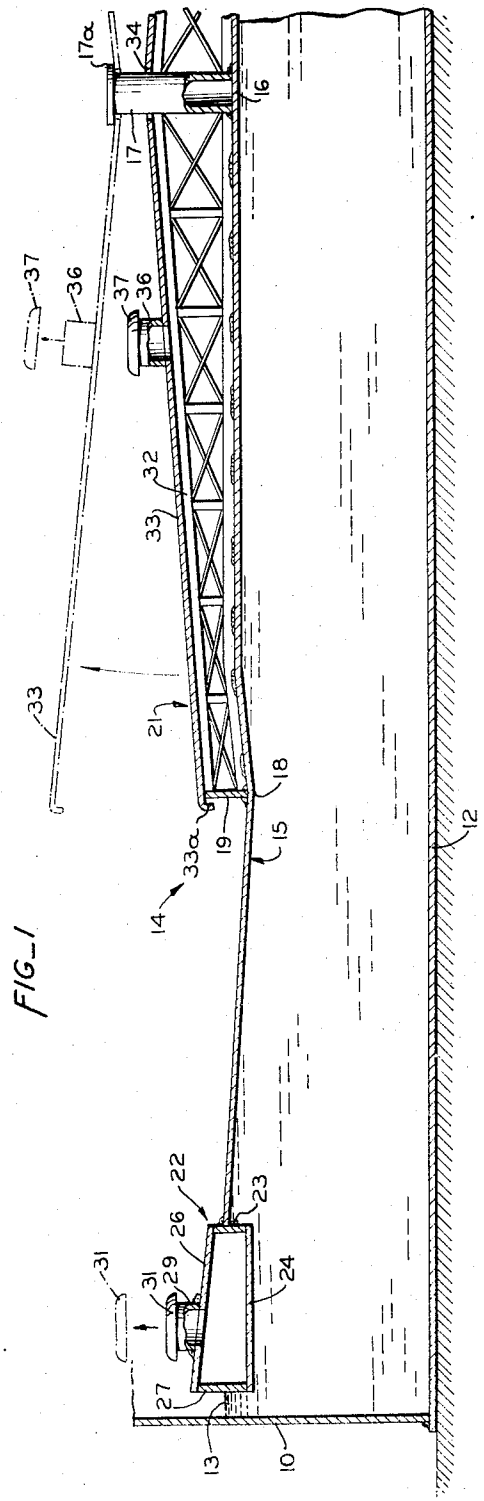


FIG_1

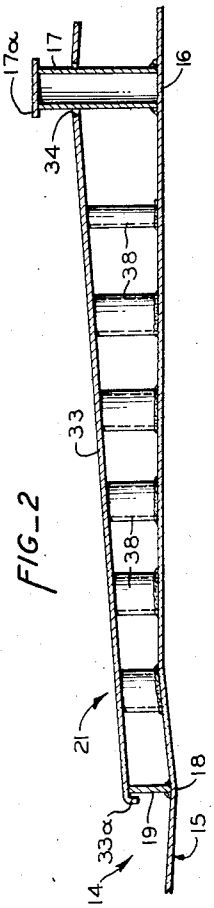


FIG_2

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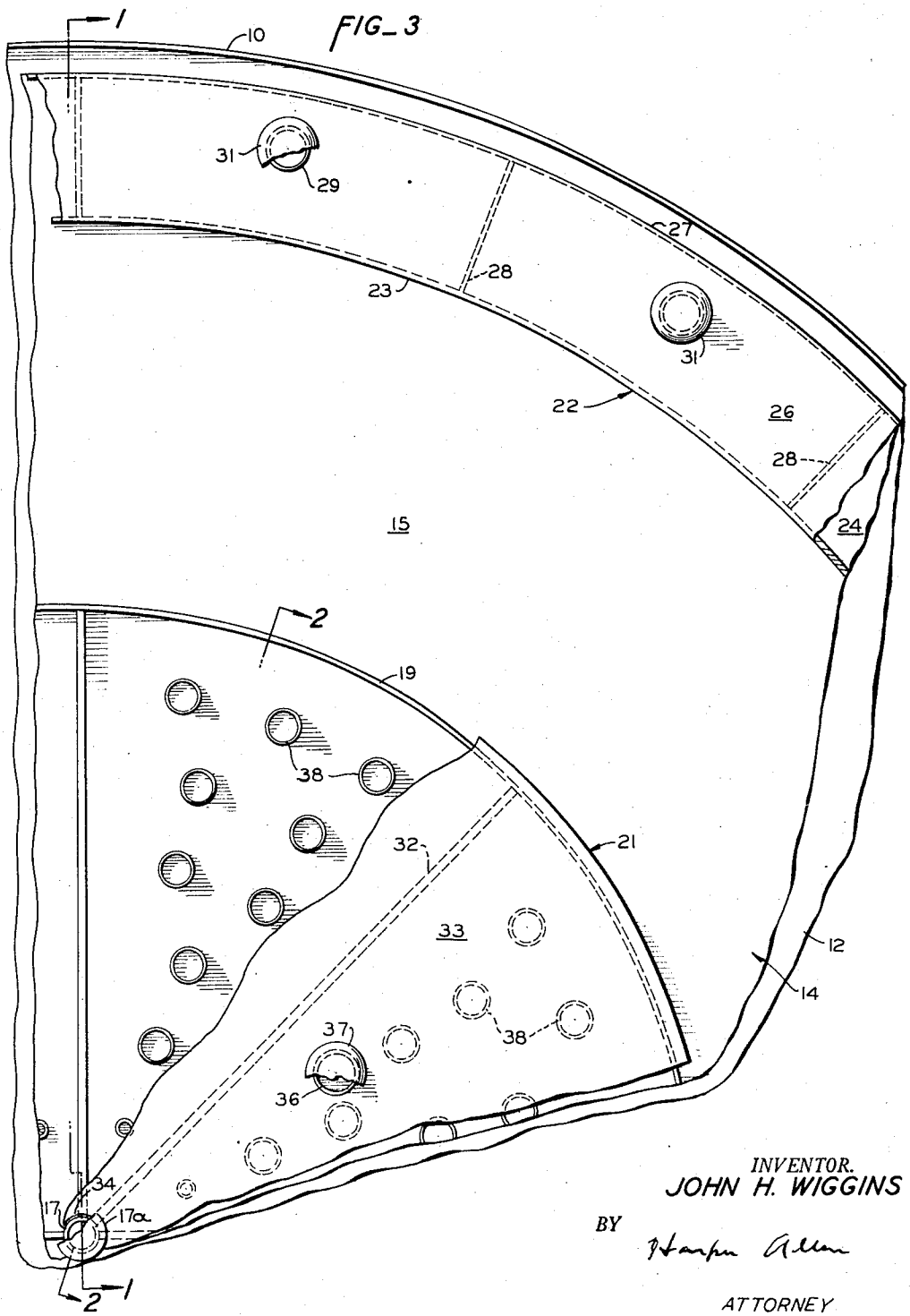
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FIG_3



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FLOATING ROOF FOR RESISTING AIR OR GAS SHOCK WAVES

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Application August 29, 1955, Serial No. 531,082

8 Claims. (Cl. 220—26)

The present invention relates to floating roofs for liquid storage tanks of the type commonly employed in the oil industry for storing various types of petroleum products, and is concerned more particularly with a pontoon type floating roof which is constructed to resist air or gas shock waves of the type caused by internal explosions within one of the pontoons, or of the type caused by a nearby atomic explosion.

Pontoon type floating roofs are subject to internal explosions whenever a leak occurs in the bottom deck, and an explosive mixture is gathered within the pontoon, and subjected to a spark or flame. An explosion within a pontoon can generate internal pressures as high as 45 lbs. to the square inch. Also it is known that an atomic explosion is followed by a positive pressure wave with pressures in the neighborhood of 12 lbs per square inch, and a subsequent negative or reduced pressure wave with negative pressures of approximately 5 lbs. per square inch.

The building of a pontoon roof of a strength to withstand internal explosions is such an expensive project as to be entirely impractical, and I have solved this problem by providing a roof structure which serves to relieve internal explosions by venting and to withstand external pressures structurally.

Accordingly it is a general object of the invention to design a practical, relatively inexpensive roof which is adapted to relieve pressure within the roof in case of an explosion in a closed pontoon, and to withstand external air shock waves.

Another object of the invention is to provide a floating roof of the pontoon type of an automatic self-venting nature as to pass through an explosive or an atomic shock wave in undamaged condition.

Another object of the invention is to provide a floating roof structure in accordance with the foregoing objects, and one which can also be easily adapted to the reconstruction of existing floating roofs.

The above and other objects of the invention are attained as described in connection with a preferred embodiment of the invention, as illustrated in the attached drawings, in which:

Fig. 1 is a transverse sectional view through one half of a storage tank incorporating a pontoon type floating roof constructed in accordance with the instant invention, the plane of the view being indicated by the line 1—1 in Fig. 3.

Fig. 2 is a fragmentary sectional view taken in a plane indicated by the line 2—2 in Fig. 3.

Fig. 3 is a fragmentary plan view with certain parts broken away to illustrate certain details of construction.

The roof structure of the instant invention is incorporated in a floating roof of the type described in my U. S. Letters Patent 2,430,592, dated November 11, 1947, to which reference is made for features not shown or described in detail herein. Referring to the drawings, there is shown an oil storage tank including a side wall 10 and a bottom wall 12, the sidewall 10 being shown

as a conventional metal section, which may be reinforced and protected by an earthen embankment not shown. The liquid 13 in the tank has a floating roof 14 thereon.

The floating roof 14 includes a bottom deck 15 of suitable sheet metal plate structure, which slants outwardly and downwardly from a central portion 16, where a center post 17 is secured thereon in upright position, to a low point 18 which is immediately adjacent the outer rim or wall 19 of the center pontoon 21. The low region 18 forms an annular drainage area. From the low point 18 deck 15 slopes upwardly to its outer edge which is joined to the annular outer pontoon 22 approximately midway of the height of an inner wall 23 thereof. The pontoon 22 also includes a bottom wall 24, a top wall 26, and an outer wall 27.

The outer pontoon 22 is preferably a compartmented construction, and is separated into compartments by series of bulkheads 28, each compartment having an upwardly directed manhole or vent openings formed by a pipe 29 which is closed by a vent cap or manhole cover 31. Each cover 31 is secured frictionally in place, so as to be easily displaced when a low internal pressure is generated to vent this pressure to atmosphere. The size of the compartments, and the construction of the walls of the outer pontoon 22 are such that the compartments will withstand external pressures within the ranges noted, and will stand internal pressure until the rise in pressure removes the cover 31 and the pressure is thereby vented to atmosphere.

The center pontoon 21, in addition to the outer rim 19 includes a series of radially extending truss structures 32 which extend between the center post 17, and the outer rim or wall 19 and are generally conventional construction including in general conventional structural elements. If desired the truss structures 32 may be replaced by suitable bulkheads.

The roof 33 of the center pontoon is of flexible construction, and is connected to the pontoon in a novel manner whereby it is floatingly supported, or rests freely on the outer rim 19 and the various truss structures 32. This roof 33 is composed of flexible sheet metal plate structure and the center of the roof 33 is apertured at 34 to engage about the center post 17, this center post 17 is provided with a top flange 17*a* which operates as a stop upon upward movement of the roof. At various points around the roof, it is supplied with upwardly directed vent openings, each including an upstanding pipe 36, having a manhole cover 37 frictionally secured therein, so as to be displaced easily therefrom.

The top deck or roof 33 of the pontoon structure is constructed just steep enough so that the roof will drain properly and shallow enough so that the peripheral edge of the roof may flex up several feet, the amount depending on the diameter of the pontoon, and this roof is provided with a depending flange 33*a* which overlaps the outer rim 19 of the pontoon, to insure proper shedding of the water.

Intermediate the truss structures 32, the center pontoon 21 is provided with a plurality of spaced upright posts or shock resisting members 38, which are shown in the drawing as cylinders, although any suitable structural member may be employed. These cylinders 38 are secured to the bottom deck 15, and have their tops disposed to form a continuation of the surface defined by the truss structures 32 and the outer rim 19. When a shock wave is encountered such as caused by an internal explosion, the entire roof or top deck of the center pontoon rises until its center engages and is stopped by the flange 17*a* of the center post 17. Then if the pressure is sufficient the roof will continue to flex upwardly with a reverse slope until it reaches approximately the phantom line position shown in Fig. 1. During this

upward flexing the depending flange **33***a* acts as a compression member to resist collapse of the edge. Due to the fact that the roof moving as a whole engages the flange **17***a* as a stop, and thereafter flexes, the flexing of the roof acts as a shock absorber which prevents the roof from being damaged.

With a pitch of the roof of from about 3/8" in 12" of radius to about 1" in 12" of radius, the roof can flex up and wrinkle and flex down and wrinkle again without any damage thereto. On a 120' diameter tank, the center pontoon would be approximately 30' in radius, and the desirable rise of the roof to the flange **17***a* would be about 18". The periphery of the roof could rise about 30" to a horizontal plane, and about 25" more to its maximum reversed slope before the peripheral flange **33***a* would be put into compression by the tension in the roof plates. This would give a total peripheral rise of about 73", and the venting area would be about 1140 square feet to vent a volume of about 20,000 cubic feet of gases. With this relation of parts the velocity required to vent the pontoon in one second is less than 20 ft. per second which would require a very low pressure to effect complete venting.

From the above description it will be seen that I have provided a floating roof structure of the pontoon type, which is automatically vented in the case of severe internal rises in pressure, and which operates automatically to relieve such pressure and to return to its normal condition. This roof can be constructed at a cost substantially equal to the conventional type pontoon roof.

While I have shown and described a preferred embodiment of the invention, it is apparent that the invention is capable of variation and modification from the form shown, so that the scope thereof should be limited only by the proper scope of the claims appended hereto.

I claim:

1. An explosion and shockproof floating roof for tanks of the oil storage type comprising a deck for floating engagement throughout substantially its entire area with the liquid in the tank, and a center pontoon structure including an upstanding center guide post secured to said deck, an upstanding outer wall secured to said deck, a plurality of upwardly extending frame and support elements secured to said deck and disposed between said post and said wall, a flexible, sheet-metal roof for said center pontoon structure having sliding engagement with said post and normally resting freely upon the tops of said wall and said support elements, said wall and said support elements having relative heights such that said flexible roof is supported thereby in a water-shedding configuration and is supported thereby so as to withstand external pressures that may be applied to the upper surface of said flexible roof, said roof being adapted to be lifted bodily about said guide post and upwardly out of contact with said wall and said support elements upon occurrence of an explosion within said center pontoon, thereby venting the interior of said center pontoon, and a stop on said post for limiting upward movement of said roof, said roof having by virtue of its flexibility a freely liftable outer periphery which flexes upwardly with respect to the center portion of said roof in response to the internal pressure created by said explosion within said center pontoon, thereby increasing the speed with which said internal pressure is relieved from the interior of said center pontoon.

2. An explosion and shockproof floating roof for tanks of the oil storage type comprising a deck for floating engagement throughout substantially its entire area with the liquid in the tank, an outer pontoon structure secured to the outer edge of said deck including a series of compartments each having an upwardly directed opening, each opening being provided with a cover that is readily removed by pressure from within the compartment, and a center pontoon structure including an upstanding center guide post secured to said deck, an upstanding outer wall

secured to said deck, a plurality of upwardly extending frame and support elements secured to said deck and disposed between said post and said wall, a flexible, sheet-metal roof for said center pontoon structure having sliding engagement with said post and normally resting freely upon the tops of said wall and said support elements, said wall and said support elements having relative heights such that said flexible roof is supported thereby in a water-shedding configuration and is supported thereby so as to withstand external pressures that may be applied to the upper surface of said flexible roof, said roof being adapted to be lifted bodily about said guide post and upwardly out of contact with said wall and said support elements upon occurrence of an explosion within said center pontoon, thereby venting the interior of said center pontoon, and a stop on said post for limiting upward movement of said roof, said roof having by virtue of its flexibility a freely liftable outer periphery which flexes upwardly with respect to the center portion of said roof in response to the internal pressure created by said explosion within said center pontoon, thereby increasing the speed with which said internal pressure is relieved from the interior of said center pontoon.

3. In an explosion and shock-proof floating roof for oil storage tanks and the like, a deck for floating engagement with liquid contained in such tank, and a center pontoon structure including an upstanding center guide post secured to said deck, an upstanding outer wall also secured to said deck in spaced relation with said guide post, support elements secured to said deck and disposed intermediate said guide post and said wall, a flexible roof for said pontoon structure normally resting upon the tops of said wall and said support elements, said roof having a central opening therein passing said guide post therethrough and being longitudinally movable with respect thereto, said roof being adapted to be lifted bodily along said guide post and upwardly from said wall and said support elements upon occurrence of an explosion within said center pontoon, thereby venting the interior thereof, and a stop carried by said guide post for limiting upward movement of said roof, said roof having by virtue of its flexibility a freely liftable outer portion which flexes upwardly with respect to the center portion thereof in response to internal pressure increases created by an explosion within said center pontoon, thereby increasing the speed with which such internal pressure is relieved from the interior of said center pontoon.

4. The structure of claim 3 in which said roof is equipped with a depending perimetric rim adjacent the outer edge thereof adapted to function as a compression member upon upward flexing of said roof.

5. In an explosion and shock-proof floating roof adapted for use in oil storage tanks, a deck for floating engagement with liquid contained in such tank, and a center pontoon structure disposed well inwardly of the outer boundary of said deck and comprising a perimetric wall secured to said deck and extending upwardly therefrom, a flexible roof having an outer edge portion carried by said wall and extending inwardly therefrom, support means provided by said deck inwardly of said wall for receiving said roof to support the same in spaced, covering relation with respect to said deck, guide means carried by said deck and cooperating with said roof for mounting said roof for bodily upward movement relative to said deck, and means for limiting such upward movement of said roof with respect to said deck, said roof being adapted to be lifted bodily upwardly and out of contact with said wall upon occurrence of an explosion within said center pontoon and, by virtue of its flexibility, having an upwardly deflectible outer portion which flexes upwardly with respect to the center portion thereof in response to an increase in pressure within said center pontoon created by an explosion therein, thereby increasing the speed with which such pressure

increase is relieved from the interior of said center pontoon.

6. The structure of claim 5 in which said roof is equipped with a depending perimetric rim adjacent the outer edge thereof adapted to function as a compression member upon upward flexing of said roof.

7. The structure of claim 5 in which said center pontoon is compartmented, in which said roof is provided with a plurality of openings therein respectively communicating with at least certain of said compartments, and in which each of said openings is equipped with a cover removable therefrom by explosion-created pressure increases occurring within said center pontoon.

8. An explosion and shock-proof floating roof adapted for use with oil storage tanks, comprising a deck for floating engagement throughout substantially its entire area with liquid contained within such tank, an outer pontoon structure secured to said deck and including a plurality of compartments each having an upwardly directed opening therein, each of said openings being provided with a cover removable therefrom by explosion-created pressure increases occurring within said outer pontoon, and a center pontoon structure including an upstanding center guide post secured to said deck, an upstanding outer wall also secured to said deck in spaced relation with said guide post, support elements secured to said deck and disposed intermediate said guide post and said wall, a flexible roof for said pontoon structure

normally resting upon the tops of said wall and said support elements, said roof having a central opening therein passing said guide post therethrough and being longitudinally movable with respect thereto, said roof being adapted to be lifted bodily along said guide post and upwardly from said wall and said support elements upon occurrence of an explosion within said center pontoon, thereby venting the interior thereof, and a stop carried by said guide post for limiting upward movement of said roof, said roof having by virtue of its flexibility a freely liftable outer portion which flexes upwardly with respect to the center portion thereof in response to internal pressure increases created by an explosion within said center pontoon, thereby increasing the speed with which such internal pressure is relieved from the interior of said center pontoon.

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