April 16, 1957 J. W. ALLEN 2,788,913

CENTERING DEVICE FOR FLOATING ROOF

Filed Oct. 5, 1953

Fig. 1

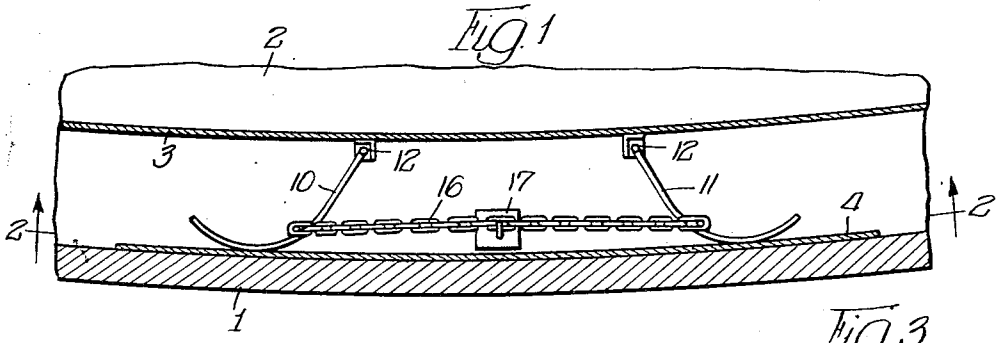


Fig. 3

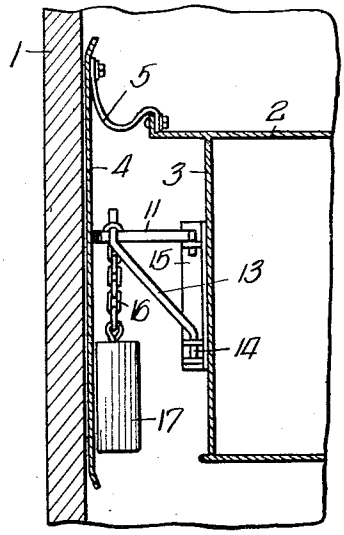


Fig. 2

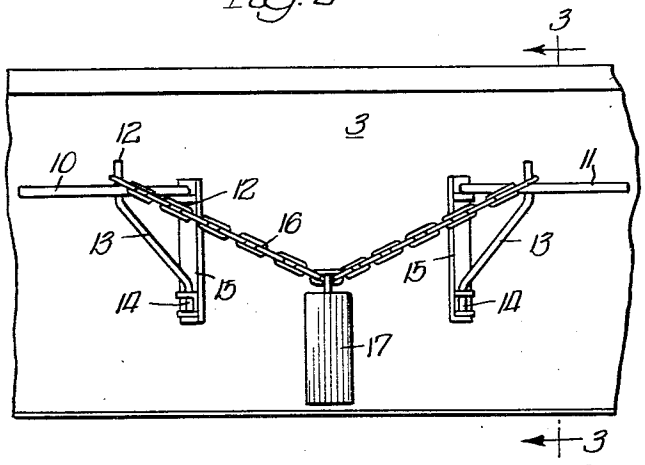
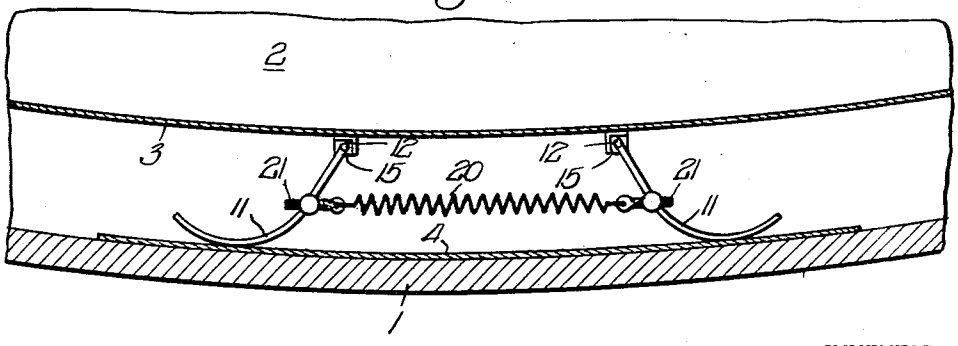


Fig. 4



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CENTERING DEVICE FOR FLOATING ROOF

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4 Claims. (Cl. 220—26)

This invention relates to storage tanks and has for its principal object the provision of a new and improved device of this kind.

It is a main object of the invention to provide an improved mechanism for maintaining a floating roof centered in a tank.

Another object of the invention is to provide a floating roof centering device which can be manufactured, installed and maintained in proper working condition at low cost.

Still another object of the invention is to provide a centering device for a floating roof located solely between the edge of the roof and the tank wall and therefore protected from the weather by the vapor seal forming devices of the tank.

Still another object of the invention is to provide a device for centering a floating roof in a tank which is of rugged construction and is not deteriorated by corrosion and the like.

Further objects of the invention not specifically mentioned here will be apparent from the detailed description and claims which follow, reference being had to the accompanying drawings in which a preferred embodiment of the invention is shown by way of example and in which:

Fig. 1 is a fragmentary plan view of a tank and roof showing the pusher device installed therebetween;

Fig. 2 is an elevational view, partly in section, along the line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a cross sectional view taken substantially along the line 3—3 of Fig. 1, looking in the direction of the arrows; and

Fig. 4 is a view similar to Fig. 1, showing a modified form of the structure.

Cylindrical tanks disposed with their axes vertical and equipped with roofs which float upon the surface of liquid stored in the tank are commonly used for the storage of petroleum products and the like. Such roof structures are equipped with shoes supported on the roof and disposed on the inside surface of the tank shell to form a seal therebetween. Vaporproof membranes are connected to the upper ends of the seal and to the roof adjacent its periphery to form a vaportight seal between the roof and the tank, so that even if the liquid stored in the tank is highly volatile, losses due to evaporation will be minimized.

In such structures the roof is supported upon the surface of the liquid by pontoons, including an outer pontoon extending around the periphery of the roof. Obviously, for the proper functioning of a device of this kind, the roof must be maintained centered, or very nearly centered, on the axis of the tank. Numerous devices have been provided heretofore to maintain such centering of the roof and the present invention relates specifically to such centering devices and provides a new and improved device which is inexpensive to install and maintain and is of such simple construction as to remain in proper operative condition over a long period of time with a minimum of maintenance.

In its preferred form, the centering device of the present invention consists of arcuate brackets pivotally mounted upon the roof in pairs and tensioned to be drawn together, thereby to exert forces extending radially outwardly from the roof and against the shoe to maintain that shoe tightly engaging the inner surface of the tank wall. In the event that forces such as prolonged winds in a given direction tend to move the roof towards one side of the tank, the brackets will be spread apart against the tension tending to pull them together, and the force exerted by the brackets on the shoe and through it on the wall of the tank will be increased on the side of the roof towards which it has a tendency to move. On the side of the tank away from which the roof moves, the brackets will move towards each other and the force exerted thereby on the shoe and tank will be decreased to facilitate maintaining the roof centered.

The centering device of the present invention is located solely between the outer periphery of the roof and the tank wall engaging shoe and beneath the vapor tight seal therebetween, in which position it is completely shielded from the weather and not adversely affected by the elements. The centering device is located completely between the roof and the shoe and does not extend below the roof or the shoe, and therefore does not in any way interfere with the travel of the roof up and down in the tank throughout the entire range of movement that the roof is designed to make.

The invention will be best understood by reference to the drawings wherein the outer wall or shell of the tank is shown at 1, the deck of the roof at 2, and the outer periphery or rim of the roof at 3. As will be understood by those skilled in the art, floating roofs of this type are equipped with a boxlike pontoon that extends completely around the periphery of the roof and provides the necessary buoyancy to the roof. Fitted against the inside surface of the shell 1 is a shoe 4 that likewise extends completely around the shell and forms a seal thereagainst. The shoes of this type are usually made in sections and equipped with vaportight seals between the sections, thereby enabling the shoe to maintain a tight contact with the tank even though the walls or shell thereof be slightly out of round.

The shoe 4 is supported upon the roof of the tank by a plurality of hangers forming no part of the instant invention and therefore omitted from the drawing to avoid an unnecessary complication thereof.

Fixed to the upper part of the shoe 4 and extending therefrom to the outer periphery of the roof 2 is a flexible vaporproof membrane 5 which cooperates with the shoe to form a vaportight seal between the roof and tank shell. The details of this seal likewise form no part of the present invention.

The centering device of the present invention consists of a pair of brackets 10 and 11 pivotally mounted upon the vertical outer wall 3 of the roof, as indicated at 12. Each of the brackets 10 and 11 is generally J-shaped having an arcuate end remote from the pivot 12 which engages the shoe 4 and exerts pressure thereagainst, as will presently appear. The brackets 10 and 11 are maintained in a horizontal position by suitable braces 13 fixed to the brackets and pivotally connected to the wall 3, as indicated at 14. To facilitate ease of installation, the assemblies thus formed are mounted upon bases 15 which can be readily attached to the wall 3 of the tank by welding, riveting or bolting.

Extending between the brackets 10 and 11 is a flexible tension member 16, preferably a chain, at the center of which a weight 17 is hung. Gravity acting upon the weight tends to pull it downwardly, thereby exerting force

transmitted by the chain **16** to the brackets **10** and **11** and tending to rotate them about their pivots toward each other. Thus the brackets **10** and **11** are made to exert outwardly extending force on the shoe **4** to maintain it tightly against the shell **1** and to maintain the roof centered in the tank. When the roof is centered, the brackets **10** and **11** are in a normal position, such as is shown in the drawing. It will be noted that as a result of the arcuate shape of the brackets **10** and **11**, the distance between the pivots **12** and the point of engagement of the bracket with the shoe **4** increases as the brackets move towards each other and decreases as they move apart.

Should forces such as wind acting upon the roof force it off-center, thus decreasing the distance between the outer wall **3** of the roof and the tank wall **1**, brackets **10** and **11** will thus be rotated away from each other, chain **16** will be moved upwardly so that the point of attachment of weight **17** thereto is more nearly in line with the ends of the chain, and as a consequence the force tending to rotate brackets **10** and **11** towards each other will thereby be increased, with the result that the pressure exerted on the tank wall by the brackets will be increased to oppose the forces tending to move the roof off-center.

On the side of the tank away from which the forces acting on the roof tend to move the roof, the distance between the outer wall **3** and the tank shell **1** will be increased. Weight **17** will draw the brackets **10** and **11** towards each other thereby increasing the angularity of the chain **16**, with the result that the component of force placed on the chain by the weight **17** and acting in a horizontal direction will be lessened thereby making it easier for the diametrically opposed brackets to push the roof back into the center of the tank.

Thus it will be seen that with the centering device of the present invention installed on a floating roof, movement of the roof off-center will increase the tension in the device that opposes such movement and will decrease the tension in the device that aids the movement. As a result, movements of the roof off-center are limited to small amounts and the roof is thereby maintained centered with sufficient accuracy to permit its proper functioning.

As will be seen, particularly in Fig. 3, the centering device of the present invention is located entirely in the space between the outer wall **3** and the shell and beneath the vapor seal **5** where it is protected from the weather and consequently is not deteriorated thereby. The centering device does not project below the roof and shoe, and consequently in no way interferes with travel of the roof up and down in the tank throughout the entire range of such travel that the roof is adapted to make.

The tensioning arrangement, consisting of the weight **17** and flexible member **16**, is advantageous in that it is rugged and forces generated in it are dead weight forces which will exist with a minimum interference from corrosion and the like. In certain instances it may be advantageous to tension the brackets **10** and **11** by means of a spring such as **20**, Fig. 4. The spring is connected to the brackets by threaded rods **21** and **22** which provide for a certain amount of adjustment of the tension of the spring. Obviously, as the brackets are moved away from each other, the spring **20** is elongated and the tension in it thereby increased. As the brackets move towards each other, the spring is shortened and its tension decreased.

Thus it will be seen that the principle of operation of the modification shown in Fig. 4 is identical with that hereinbefore described and need not be described in further detail.

The centering device of the present invention being composed of simple parts can be made rugged economically and when installed upon the tank roof will remain in proper operative condition upon the tank roof will remain in proper operative condition with a minimum of maintenance. Since the centering devices are located beneath the vapor seal, they are not affected by weather and are subject only to the effects of the vapor rising between the roof and shoe, which vapors ordinarily have little or no effect upon the brackets which preferably are composed of iron or steel.

While I have chosen to show my invention by illustrating and describing a preferred embodiment of it, I have done so by way of example only, as there are many modifications and adaptations which can be made by one skilled in the art within the teachings of the invention.

Having thus complied with the statutes and shown and described a preferred embodiment of my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

What is claimed is:

1. The combination with a vertically disposed cylindrical tank having a roof structure floating upon the surface of liquid therein and containing an outer vertically disposed cylindrical wall, and means including a shoe supported on and spaced from said roof and engaging the inner surface of the tank and a flexible membrane extending between the shoe and roof for forming a vaportight seal between the tank and roof in all positions of the roof; of means for maintaining the roof centered in the tank disposed entirely below the seal and between the roof and the shoe and comprising: a plurality of pairs of rigid lever arms slidably engaging the shoe and pivotally mounted upon the roof for rotation around vertical axes, the pivotal connections of each pair of arms being closer together than the points of contact of said arms with the shoe; and means extending between the arms of each pair tensioned to rotate the arms toward each other thereby to exert a force outwardly on the shoe tending to maintain the roof centered in the tank.

2. Centering means as claimed in claim 1, in which the lever arms are arcuate and are pivotally mounted upon the outer vertical wall of the roof.

3. Centering means as claimed in claim 1, in which the lever arms are connected together by a flexible member that is tensioned by a weight hung thereon at the middle thereof.

4. Centering means as claimed in claim 1, in which the tensioning means urging the lever arms together are springs adjustably connected to the lever arms.

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