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J. W. ALLEN

2,540,773

BALANCING MECHANISM FOR FLUID STORAGE APPARATUS OF THE VERTICALLY MOVABLE TYPE

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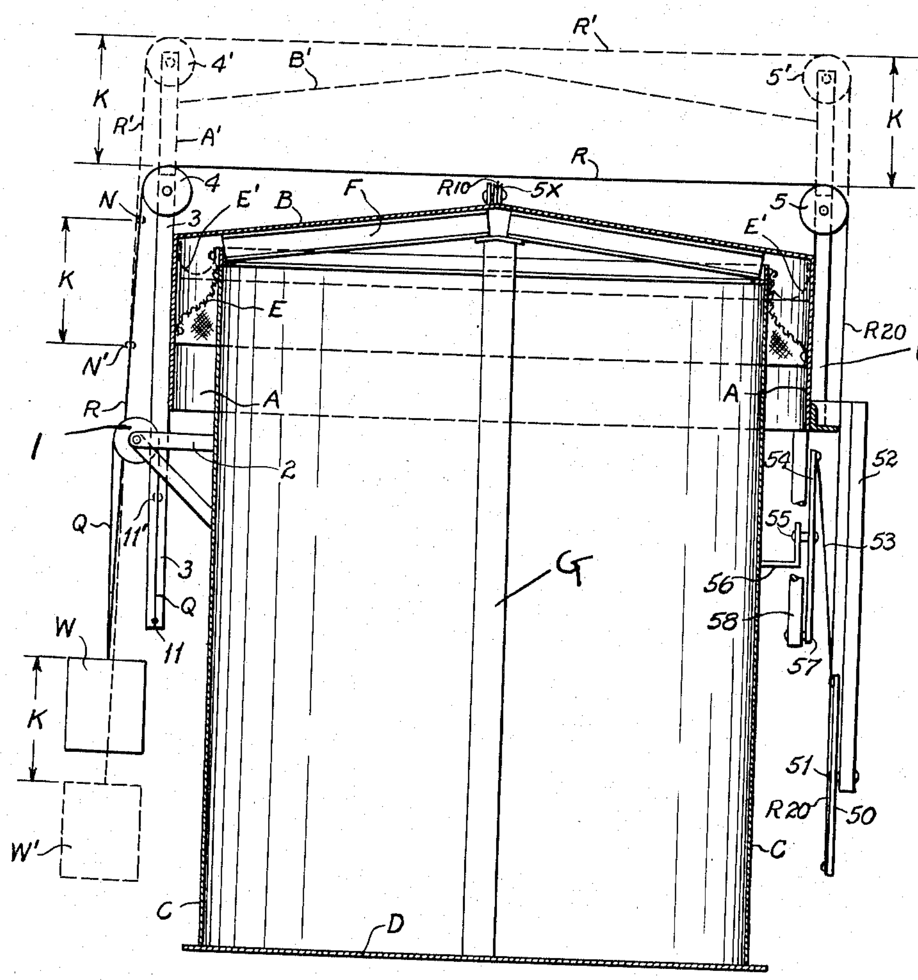
2 Sheets-Sheet 1

FIG. 1.



INVENTOR:
JOHN W. ALLEN
BY Wells L. Church
ATTORNEY.

FIG. 2.

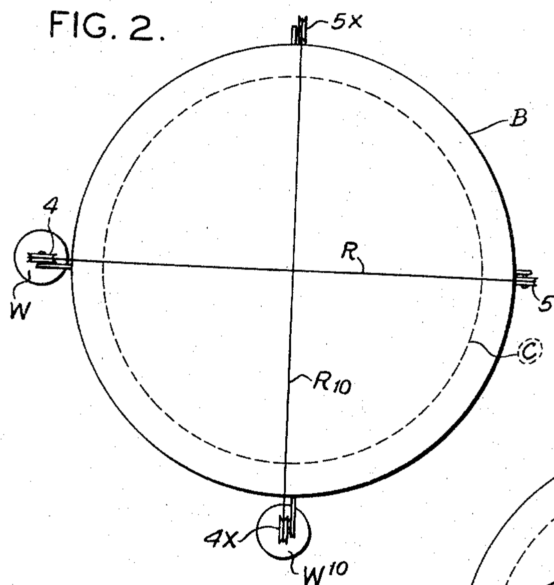


FIG. 3.

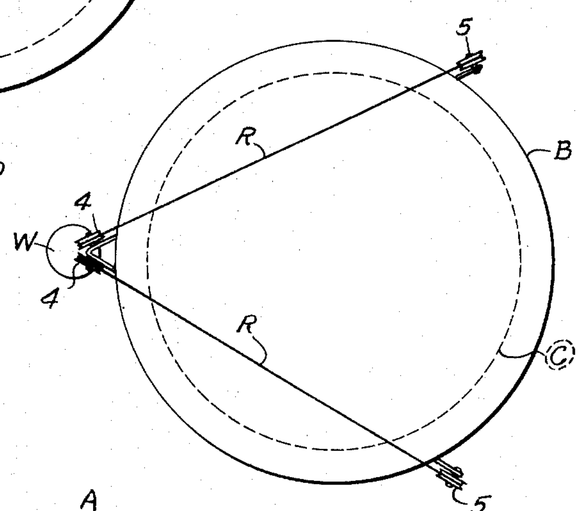
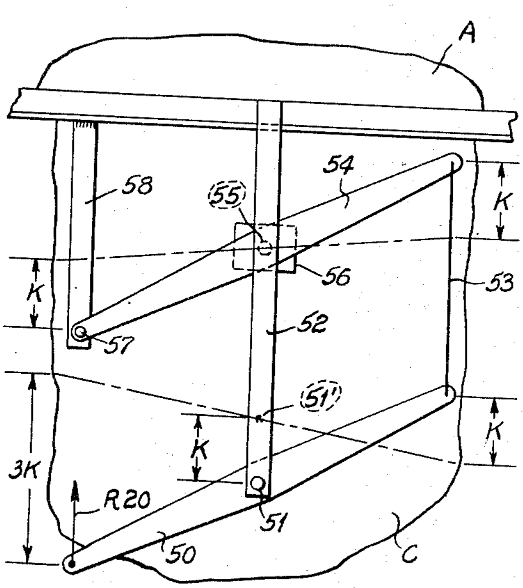


FIG. 4.



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BALANCING MECHANISM FOR FLUID STORAGE APPARATUS OF THE VERTICALLY MOVABLE TYPE

John W. Allen, Chicago, Ill., assignor to John H. Wiggins, Chicago, Ill.

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4 Claims. (Cl. 48—176)

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This application is a division of my pending application Serial No. 720,405, filed January 6, 1947.

The object of my present invention is to provide a balancing, leveling, or stabilizing mechanism for gas holders and other fluid storage apparatus of the vertically-movable roof type, that comprises the desirable characteristics and features of the balancing mechanism forming the subject-matter of my above mentioned pending application for patent, but which is equipped with a system of levers for maintaining in a taut condition the cable that leads upwardly from the counterweight, and thence extends across the top side of the vertically-movable roof of the apparatus.

I have herein illustrated my present invention embodied in a balancing, leveling, or stabilizing mechanism, which is of such construction that if the vertically-movable roof or equivalent part of the apparatus moves, or tends to move, out of a level or horizontal position, said roof is brought back to its normal, level position by an upward pull exerted by one of the cables on the low side of the peripheral portion of the roof, but I wish it to be understood that my invention contemplates arranging the cables and weight in such a way that if the roof moves, or tends to move, out of a level or horizontal position, such movement or incipient movement, is counteracted by downward pull exerted by one of the cables on the high side of the roof, i. e., on that part of the peripheral portion of the roof which has moved, or tended to move, upwardly relatively to the other parts of the peripheral portion of the roof. As herein used, the term "cables" is intended to include chains or any other kind of flexible elements employed to transmit, or assist in transmitting, movement from the weight to the roof, the term "sheaves" is intended to include pulleys, wheels, and other kinds of devices used to guide the cables that cause the load of the weight to resist movement of the roof tending to throw the roof out of balance, and the term "roof" is intended to mean and include any kind of vertically-movable structure which has a tendency to tip or tilt out of a level position, my improved stabilizing, leveling, or balancing mechanism being capable of use with any kind of fluid storage apparatus equipped with a vertically-movable bell or equivalent part that rises and falls during the normal use of the apparatus.

The accompanying drawings illustrate my invention applied to a gas holder provided with a "lifter" roof and with a dry seal that maintains

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a gas-tight joint between the lifter roof and the side wall of the tank which constitutes the lower portion of the gas holder.

Figure 1 of the drawings is a vertical transverse sectional view of a fluid storage apparatus equipped with a balancing mechanism constructed in accordance with my present invention.

Figure 2 is a top plan view of the structure illustrated in Figure 1 and shows how the vertically-movable roof of the storage space is balanced in four directions by two pairs of cables attached at four different points on the peripheral portion of the roof, separated from each other by angles of 90°, each pair of cables cooperating with a separate weight.

Figure 3 is a top plan view, showing how the roof can be balanced in three different directions by a weight and three cables attached at three symmetrically-arranged points on the peripheral portion of the roof; and

Figure 4 is a view in side elevation of the system of levers which holds in a taut condition, the cable that leads upwardly from the counterweight and then extends across the top side of the vertically-movable roof of the apparatus.

In the accompanying drawings C designates the side wall of the tank or stationary lower portion of a fluid storage apparatus, D designates the bottom of said tank, B designates a "lifter" roof or vertically-movable roof that forms the top wall of the storage space of the apparatus, A designates a depending skirt portion on the roof arranged in telescopic relation with the side wall of the tank, E designates a conventional "dry seal" attached to the tank side wall C and to the skirt portion A of the roof, so as to maintain a gas-tight joint between said parts and still permit the roof to rise and fall, and thus vary the volume of the storage space, and F designates rafters attached to the tank side wall and to a center post G, so as to support the roof when it is in its lowermost position.

My improved balancing, leveling, or stabilizing mechanism comprises a vertically-movable weight W arranged on the exterior of the tank side wall at the left hand side of same (looking at Figure 1), and a pair of cables Q and R attached to said weight and to remotely spaced peripheral portions of the roof in such a manner that any forces tending to raise or lower one side of the roof relatively to the other side of the roof, for example, the right hand side relatively to the left hand side, or vice versa, are counteracted by the load of the weight W, applied to a peripheral portion of the roof by one or the other of the cables Q or R. The cable Q, which is attached at its lower end to the weight W, leads upwardly from the weight over a sheave 1 carried by a laterally-projecting bracket 2 on the side wall of the tank, and thence downwardly from said sheave 1 to a point 11 on the peripheral portion of the roof to which the other end of said cable Q is attached. The particular level of the sheave 1 relatively to the top edge of the tank side wall, and the particular level of the cable attaching point 11 relatively to the top portion of the roof, is immaterial, so long as the vertical height or distance between said sheave 1 and cable-attaching point 11 is approximately equal to the designed rise of the roof. If the sheave 1 is located at a level considerably lower than the top edge of the tank side wall, as in the apparatus herein illustrated, it is necessary that the cable Q be attached to the peripheral portion of the roof at a distance below the sheave 1, equal to the designed rise of the roof, this effect being obtained by providing the skirt A of the roof with a vertically-disposed post 3 that forms a rigid extension at the lower end of the skirt to which the cable Q can be attached at a point 11, which is the required distance below the sheave 1 on the tank side wall. The cable R is attached to the weight W at the same point as the cable Q and leads upwardly from said weight over a sheave 4 mounted on the left hand side of the roof B preferably on the upper end portion of the post 3. Said cable R thence passes transversely across the top side of the roof to a sheave 5 located at the right hand side of the roof and mounted preferably on the upper end portion of a vertically-disposed post 6 which is attached to the exterior of the right hand side of the roof skirt A. After passing over the top side of the sheave 5, a run or portion of the cable R, designated, for convenience, by the reference character R^{20}, leads downwardly from the sheave 5 and is connected by means of a system of levers to a point on the roof skirt A, designated by the reference character 51 and located in remote relationship with the point 11 at which the cable Q is attached to said skirt. During the rise and fall of the roof, said system of levers holds the cable R in a taut condition.

The system of levers just referred to is herein illustrated as comprising a lever 50 that is rockably mounted on the skirt A of the roof, and a lever 54 that is rockably mounted on the side wall of the tank. As shown in Figure 4, the pivot 51 of the lever 50 constitutes, in effect, the point at which the cable R is connected with the right hand side of the roof. Said pivot or cable-attaching point is carried by a post 52 fastened to the skirt of the roof and projecting downwardly below the bottom edge of said skirt, and the pivot or axis 55 of the lever 54 is carried by a laterally-projecting bracket 56 on the side wall of the tank. The vertical run R^{20} of the cable R is attached to the left hand end of the lever 50, and the right hand end of said lever is connected with the right hand end of the lever 54 by a cable or equivalent flexible element 53. The opposite end or left hand end of lever 54 is joined by a pivot 57 to a post 58 carried by and projecting downwardly from the bottom edge of the skirt A of the roof.

When the internal pressure of the storage space of the apparatus increases, the roof B and the co-acting parts of the stabilizing mechanism assume the positions indicated by broken lines and by prime marks on the previously mentioned reference characters, as shown in Figure 1. During such movement of the roof the cable R moves bodily upwardly with the roof, because the horizontal run of said cable extends over the top side of the roof and is supported by sheaves 4 and 5 mounted on the roof.

In a stabilizing or balancing mechanism of the construction above described the tables R and Q exert an upward pull on the roof skirt A at opposite ends of the diameter of the roof. In order that the upward lift will be equal on the two points 11 and 51, at which said cables are attached to the peripheral portion of the roof, the net uplift on the cable-attaching points must be the same, and therefore, equal W/2.

Assuming that the roof moves upwardly a distance K, as shown in Figure 1, the weight W moves downwardly a distance K and the two cable-attaching points 11 and 51 at the left hand and right hand sides, respectively, of the roof move upwardly a corresponding distance K. During such movement of the roof, a point N on the vertical run of the cable R at the left hand side of the roof moves downwardly relatively to the ground or relatively to the tank side wall a distance K, as shown in Figure 1. However, the vertical run or portion R^{20} of the cable R at the right hand side of the roof moves upwardly a considerably greater distance, due to the fact that the right hand end of the cable R is connected with the roof by the previously described system of levers which comprises one lever 50 rockably mounted on the skirt A of the roof, a second lever 54 rockably mounted on the tank side wall, a flexible connection 53 between the right hand ends of said lever, and a pivotal connection 57 between the left hand end of lever 54 and the depending post 58 on the roof skirt. Thus, when the roof moves upwardly a distance K, the pivot 51 of lever 50 will move upwardly a distance K, as indicated in Figure 4, with the result that the upward movement of the roof, plus the pull the weight W exerts on the cable R, will cause the vertical run R^{20} of said cable at the right hand side of the roof to move upwardly a distance 3K, as shown in Figure 4. The flexible element 53, which joins the right hand ends of the levers 50 and 54 together, will move downwardly only one-third of the upward movement of the left hand end of lever 50 to which the vertical run R^{20} of cable R is attached. Similarly, the pivotal connection 57 between the left hand end of lever 54 and the depending post 58 on the roof skirt will also move upwardly only one-third of the upward movement of the left hand end of lever 50. From the foregoing, it will be seen that the entire roof, has moved upwardly a distance K, the weight W has moved downwardly a distance K, and both ends of the diameter of the roof to which the weight cables are attached, have moved upwardly an equal distance K. The net uplift on the roof is then equal the load of the weight W, one-half of it being applied at the left hand cable-attaching point, and the other half being applied at the right hand cable-attaching point 51. Consequently, the weight W not only balances the roof against external loads, but said weight also acts as a counterweight to lift the roof, which is very desirable in order to reduce the operating pressure of the roof as it rises and falls.

Preferably, an additional pair of cables, a weight, and co-acting guiding and supporting sheaves are used in conjunction with the weight W and cables Q and R shown in Figure 1, to balance the roof in all directions, said additional pair of cables being arranged at right angles to the cables Q and R, shown in Figure 1. In Figure 2, the reference character W/10 designates the weight that co-acts with said additional pair of cables, the reference character R^{10} designates the cable that extends transversely across the top side of the roof, the reference character 4X designates the sheave on the roof in vertical alignment with the weight W/10, and the reference character 5X designates the sheave at the far side or opposite side of the roof.

Instead of using two systems arranged at right angles to each other, as described in the preceding paragraph, three or more systems may be used at substantially equal spaces around the tank. Figure 3 illustrates a mechanism comprising a single weight W connected to the left hand side of the roof by a single cable corresponding to the cable Q, shown in Figure 1, and connected by two cables R with symmetrically spaced points on the peripheral portion of the roof, each of said cables R comprising a horizontal run that travels over sheaves 4 and 5 of the roof, and a plurality of vertical runs each of which is connected with the roof skirt by a system of levers of the construction and arrangement previously described and shown in Figure 4.

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

The particular level of the sheave 1 relatively to the top edge of the tank side wall, and the particular level of the cable attaching point 11 relatively to the top portion of the roof, is immaterial, so long as the vertical height or distance between said sheave 1 and cable-attaching point 11 is approximately equal to the designed rise of the roof. If the sheave 1 is located at a level considerably lower than the top edge of the tank side wall, as in the apparatus herein illustrated, it is necessary that the cable Q be attached to the peripheral portion of the roof at a distance below the sheave 1, equal to the designed rise of the roof, this effect being obtained by providing the skirt A of the roof with a vertically-disposed post 3 that forms a rigid extension at the lower end of the skirt to which the cable Q can be attached at a point 11, which is the required distance below the sheave 1 on the tank side wall.

1. A balancing mechanism for a vertically-movable roof provided with a depending skirt arranged in telescoped relationship, with the side wall of a stationary tank, comprising a vertically-movable weight arranged at one side of the tank, a cable leading from said weight over a guide on the tank side wall and attached to the skirt at a distance below said guide equal to the designed rise of the roof, a second cable leading upwardly from said weight, thence over supporting guides mounted on the top side of the roof and thereafter downwardly from the roof to a point of attachment in remote relationship with the point of attachment of the first mentioned cable to the skirt and a plurality of rock levers that co-act with said second cable to normally hold the same in a taut condition during the rise and fall of the roof, one of said rock levers being carried by the roof skirt and one of said levers being carried by the tank side wall.

2. A mechanism of the kind described in claim 1, in which said rock levers are joined together at one end by a means that causes said levers to rock simultaneously.

3. A mechanism of the kind described in claim 1, in which the rock lever carried by the skirt has one of its ends attached to said second cable and has its opposite end connected by a flexible element to one end of the rock lever carried by the tank side wall.

4. A mechanism of the kind described in claim 1, in which said second cable and rock levers are combined and arranged as follows, to wit: (*a*) the lever carried by the skirt has one of its ends attached to said second cable and has its opposite end connected by a flexible element to one end of the lever carried by the tank side wall; and (*b*) the lever carried by the tank side wall has its other end pivotally attached with the skirt.

JOHN W. ALLEN.

REFERENCES CITED

The following references are of record in the file of this patent:

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