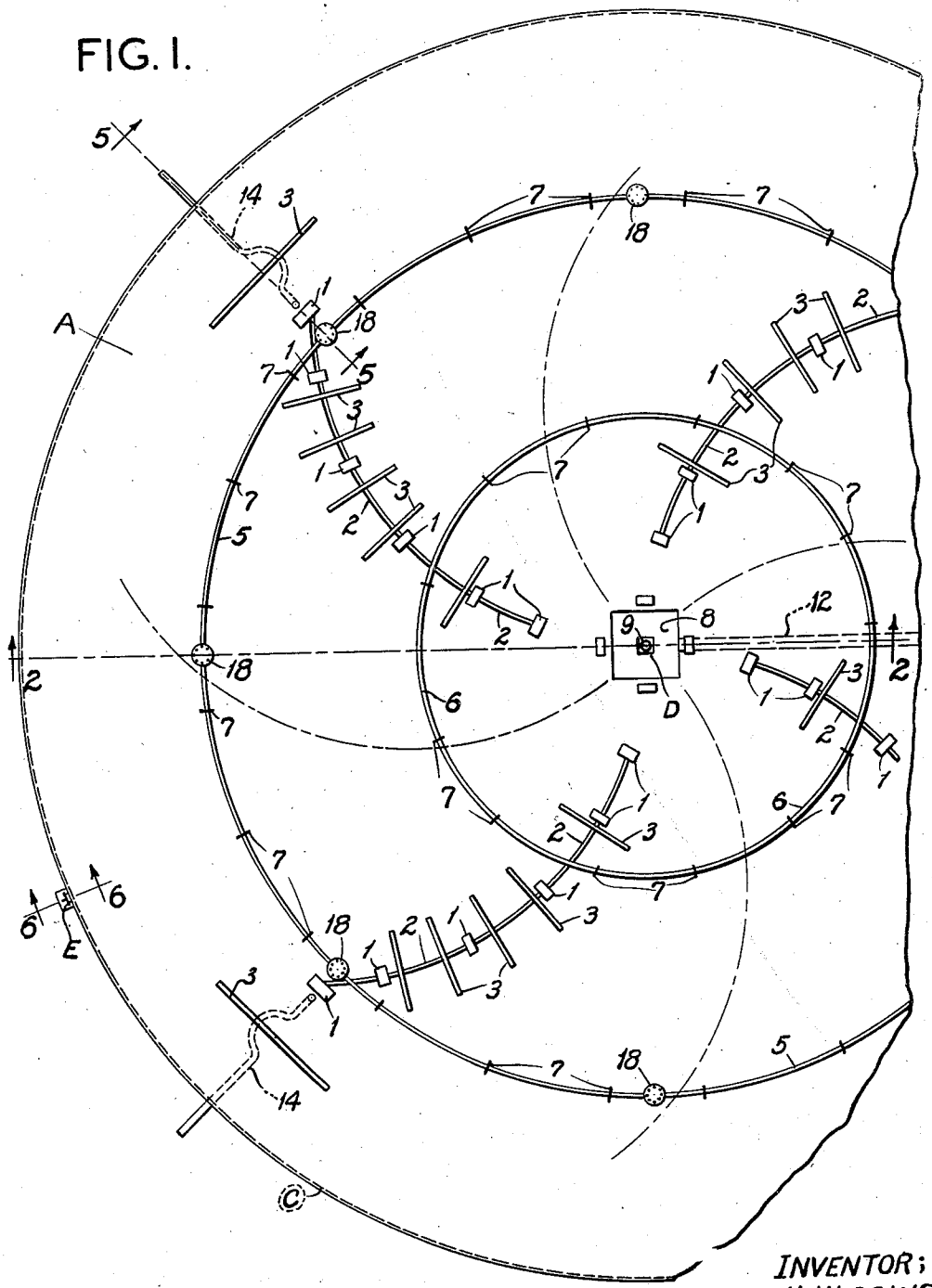
Aug. 11, 1936. J. H. WIGGINS 2,050,684

GAS AND LIQUID STORAGE DEVICE

Filed Feb. 11, 1935 3 Sheets-Sheet 1

FIG. 1.



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GAS AND LIQUID STORAGE DEVICE

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FIG. 2.

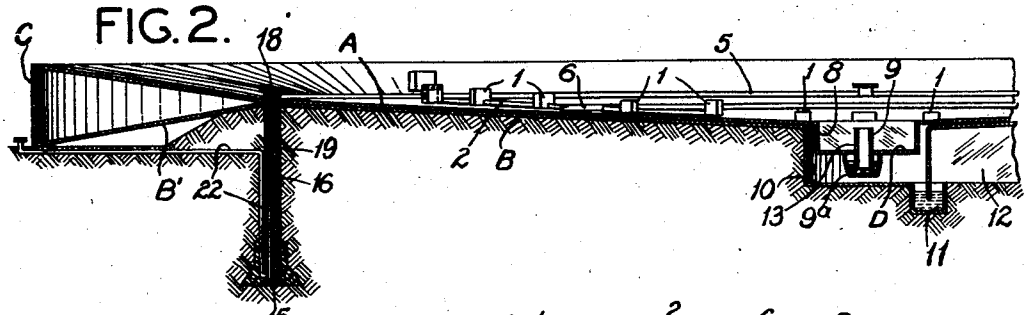


FIG. 3.

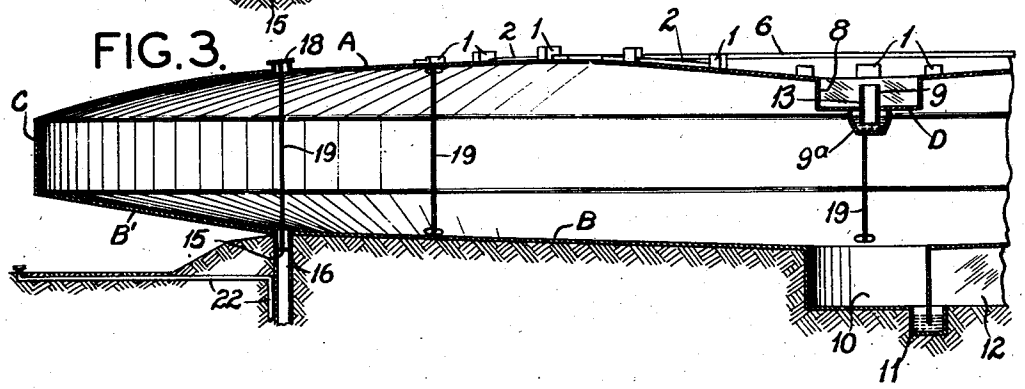
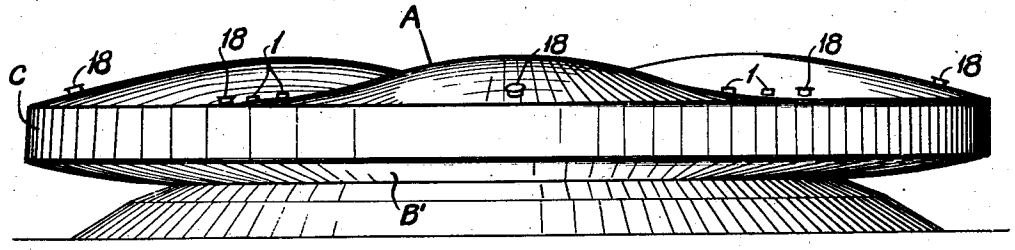


FIG. 4.



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GAS AND LIQUID STORAGE DEVICE

Filed Feb. 11, 1935 3 Sheets-Sheet 3

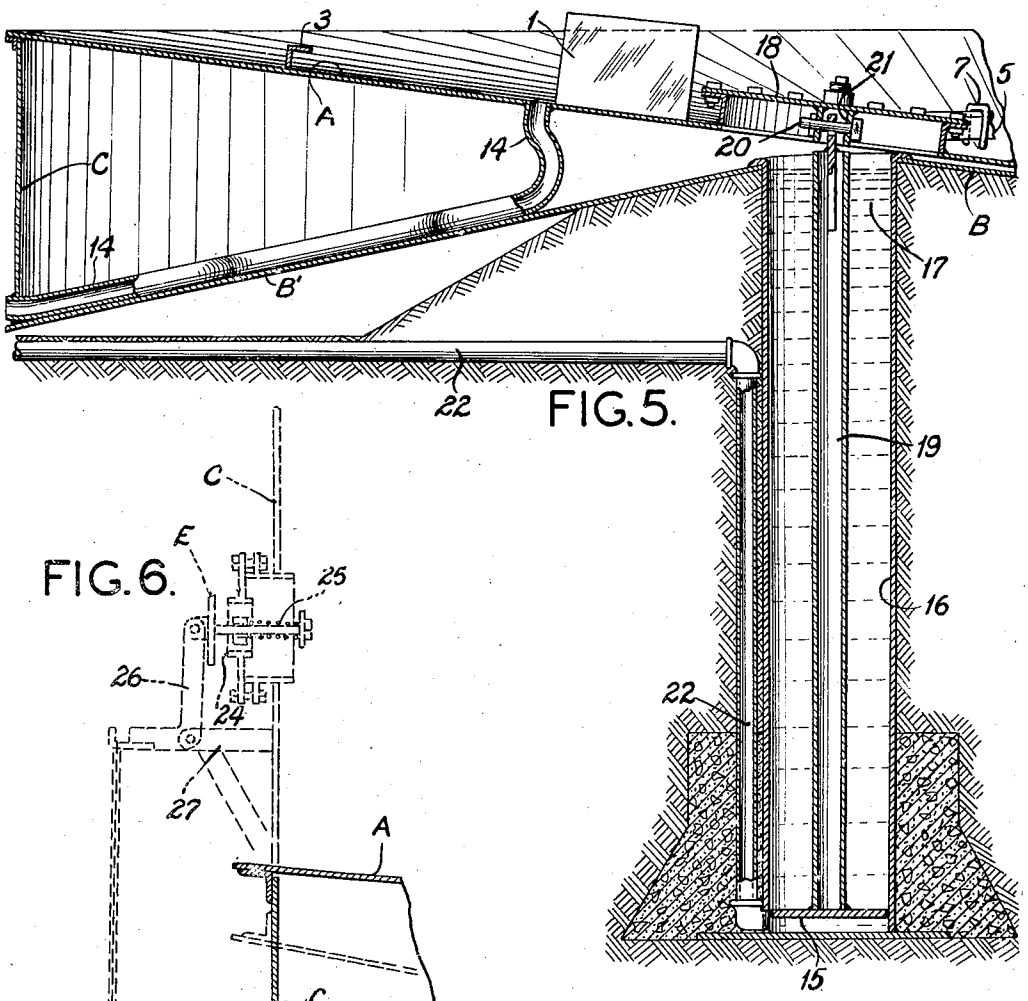


FIG. 5.

FIG. 6.

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Patented Aug. 11, 1936 2,050,684

UNITED STATES PATENT OFFICE

2,050,684

GAS AND LIQUID STORAGE DEVICE

John H. Wiggins, Tulsa, Okla.

Application February 11, 1935, Serial No. 5,961

22 Claims. (Cl. 220—1)

This invention relates to gas and liquid storage devices of the type in which the gas storage space comprises a metal top wall or roof that is capable of flexing or bending in such a manner as to vary the volume of said storage space.

One object of my present invention is to provide a gas or liquid storage device of the general type mentioned, whose metal top wall or roof is of such design or construction, or is equipped with or combined with such a means, that when the device is in normal operation, said top wall or roof will flex or bend in an approximately definite or predetermined manner, thereby eliminating the possibility of the device failing to function properly, due to uncontrolled or haphazard flexing of the top wall of the gas storage space, and also reducing the liability of said top wall rupturing, due to sharp bends forming in same when said wall is passing from one extreme position to the other.

Another object is to provide a gas or liquid storage device of the general type mentioned, whose top wall or roof is constructed in a novel manner, or equipped with a novel means, that insures the accurate control or distribution of rain water on said roof in all of the various positions of same, intermediate its extreme downwardly flexed position, and extreme upwardly flexed position.

Another object of my invention is to provide a gas or liquid storage device of the general type mentioned, that is equipped with a novel means for retarding or checking the wave action of the flexible roof, produced by the action of wind on said roof.

And still another object of my invention is to provide a novel relief valve or volume control valve, for gas and liquid storage devices of the general type mentioned. Other objects and desirable features of my invention will be hereinafter pointed out. I have herein illustrated my invention embodied in a gas holder of the general type described in my prior U. S. Patents Nos. 1,930,493, 1,930,494 and 1,930,495, dated October 17, 1933, but I wish it to be understood that my present invention is applicable to liquid storage tanks of the kind that are equipped with a so-called "breather roof" consisting of or formed by a limber metal diaphragm that is capable of flexing upwardly and downwardly a limited distance relative to an intermediate horizontal plane, so as to vary the volume of the vapor or gas space of the tank.

Figure 1 of the drawings is a top plan view of a gas holder embodying my present invention.

Figure 2 is a fragmentary vertical transverse sectional view of said holder when it is empty.

Figure 3 is a fragmentary vertical transverse sectional view of said holder when it is filled with gases.

Figure 4 is a diagrammatic view, illustrating how the top wall of said gas holder naturally assumes the shape of a plurality of alternating ridges and valleys when said top wall starts to flex upwardly during the operation of admitting gases to the holder.

Figure 5 is an enlarged fragmentary vertical transverse sectional view, taken on the line 5—5 of Figure 1, illustrating the construction of the dampener that is used to prevent or tend to prevent the roof from waving when subjected to the action of a high wind; and

Figure 6 is an enlarged vertical sectional view, taken on the line 6—6 of Figure 1, illustrating the pressure relief or volume control valve.

In the accompanying drawings which illustrate the preferred form of my present invention, A designates the flexible top wall or roof of the gas space of the holder, constructed in the form of a flexible metal diaphragm or substantially imperforate limber sheet. When the holder is empty, or substantially so, said top wall A assumes a downwardly flexed position, as shown in Figure 2, and when the holder is filled with gases or substantially so, said top wall assumes an upwardly flexed condition, as shown in Figure 3. My present invention relates (1st) to a novel means for controlling or governing the flexing of the top wall A, while it is passing from one extreme position to its other extreme position; (2nd) to a novel means for controlling rain water which may fall on or collect on the diaphragm A in any of its various positions; (3rd) to a novel means for retarding or checking the waving action of the diaphragm A, produced by the action of wind thereon; and (4th) to a pressure relief or volume control valve that is arranged in a novel manner. Accordingly, so far as my present invention is concerned, it is immaterial how the bottom portion or lower part of the holder is constructed, and as previously stated, many features of my present invention are applicable to storage tanks equipped with "breather type" metal roofs. In the form of my invention herein illustrated, the bottom portion of the holder comprises a bottom diaphragm B provided with a flexible peripheral portion B' whose outer edge is attached by a gas-tight joint to a vertically-disposed shell C to which the peripheral edge of the top diaphragm A is attached. When the holder is empty, the peripheral portion B' of said bottom diaphragm assumes a downwardly inclined position, as shown in Figure 2, but in the operation of filling the holder with gases, the peripheral portion B' of the bottom diaphragm flexes upwardly into the position shown in Figure 3, thereby moving the shell C bodily in an upward direction, and increasing the distance between the top dia-

phragm A and the central portion of the bottom diaphragm B, as described in my prior Patent No. 1,930,495, previously referred to.

In order to insure proper or successful operation of the gas holder and prevent the top diaphragm A of same from rupturing, due to sharp bends forming in the metal of which it is constructed, I build said diaphragm in such a manner or equip it or combine it with such a means, that the flexing and/or movement of said diaphragm is accurately controlled, and said diaphragm is caused to assume a definite or predetermined shape or shapes while it is passing from its extremely downwardly flexed position to its extreme upwardly flexed position, or vice versa. Preferably, I construct the top diaphragm A so that there are zones or portions of same which are stiffer or less flexible than other portions or zones, and there are also zones or portions of said diaphragm which are more mobile or easier to move, than other portions or zones. The zones above mentioned may be arranged in various ways without departing from the spirit of my invention, and various means may be used to produce said zones. In the gas holder herein illustrated members, which, for convenience, I will refer to as "stiffening members" are attached to the upper side of the diaphragm A at various points throughout the area of same, so as to produce portions or zones which will not flex or bend so easily as other portions or zones of said diaphragm which are not equipped with such stiffening members, and weights are arranged on the upper side of said diaphragm A at various points throughout the area of same, so as to produce portions or zones which are heavier or less mobile than other portions of said diaphragm not equipped with such weights.

It is immaterial how said stiffening members and weights are combined with or attached to the diaphragm A, and while I prefer to arrange them on the top side of said diaphragm, this particular location or arrangement is not essential. The stiffening members above referred to may consist of metal bars, rods, angles or other commercially rolled shapes, and while the function of said members is to retard the flexing of certain portions of the diaphragm A, said stiffening members need not be of such a nature or character as to impart absolute rigidity to the portions of the diaphragm to which they are attached or with which they are combined. On the contrary, it is preferable to use stiffening members which are of such length or cross-sectional area that while they impart some stiffness to certain portions of the diaphragm A, they are nevertheless capable of bending or flexing slightly when said diaphragm is moving from one extreme position to the other. Stiffening members and weights of the kind above referred to are not the only means that can be used to govern or control the flexing and/or movement of the diaphragm A, and therefore, I consider as equivalents, any means that will produce the effect or result herein illustrated and described.

In the commercial use of my present invention in gas holders having a diameter in some instances as great as 200 ft., I have obtained good results by constructing the top diaphragm A in such a way that when it starts to flex upwardly during the operation of admitting gases to the holder, certain spaced portions of said diaphragm will start to flex upwardly sooner than the portions lying between the same, and will thus form in effect a series of ridges radiating from the center of the diaphragm and disposed between valleys or depressions, the continued upward flexing of the diaphragm as an entirety, causing said valleys or depressions to flatten out and merge into the portions constituting the ridges, by the time the diaphragm reaches its extreme upwardly flexed condition. The above described effect or result is attained by attaching weights to the top side of the diaphragm A, so as to form a plurality of rows of weights that radiate from the center of the diaphragm, preferably in a substantially spiral direction, and also attaching stiffening members to the diaphragm, so as to restrict the flexing of the spirally-disposed, weighted portions of the diaphragm, thereby dividing the area of the diaphragm into freely flexible, unweighted portions, and weighted, stiffened portions, arranged in alternating relationship. The diaphragm A, in addition to having stiffening members and weights disposed so as to form a plurality of spiral zones, is also provided with one or more circumferential stiffening members disposed between the center of the diaphragm and the outer edge of same, which circumferential stiffening member or members assist in controlling the flexing or bending of the diaphragm and tend to assure its taking such a shape, when passing from one extreme position to the other, that the metal of the diaphragm cannot crowd and wrinkle so sharply as to cause it to fatigue and rupture.

Usually, the stiffening members and weights above described will be arranged so that the central portion of the diaphragm which comprises the stiffened, weighted zones, will not move so freely as the peripheral portion of the diaphragm. Consequently, in the operation of admitting gases to the holder the peripheral portion of the diaphragm A will start to flex upwardly before the central portion of the diaphragm, and will assume such a position that any rain water that falls on or which may be standing on said peripheral portions, will flow by gravity to the outer edge of the diaphragm or to emergency drains located some distance inwardly from the extreme outer edge of the diaphragm. At such times any rain water which falls on or collects on the central portion of the diaphragm, will flow by gravity to a primary drain D located at the center of the diaphragm. After the peripheral portion of the diaphragm A has reached its upwardly flexed position, the central portion of said diaphragm starts to flex upwardly, but at all points of its upward travel it remains in such shape or form that a large part of any rain water which falls on or collects on same will flow to the primary center drain D, said primary drain having associated with same a sump of relatively great capacity, which tends to hold the center of the diaphragm in a more than normally depressed position, even when said diaphragm is in its extreme upwardly flexed postion or condition. During an exceptionally heavy rain or sudden downpour, the water which falls on the central portion of the diaphragm A will find its way into the sump associated with the primary drain D, and as said sump is of relatively great capacity, the water which is confined therein during an exceptionally heavy rain, will tend to stabilize the diaphragm A. Eventually, the water escapes from said sump through the primary drain that leads from the sump.

In the form of my invention herein illustrated the diaphragm A is provided with four weighted and stiffened portions, produced by weights 1 and

stiffening members 2 and 3, that are attached or held in operative position on the top side of the diaphragm, as shown in Figure 1. The stiffening members 2 are preferably formed by angles or rods that radiate from the center of the diaphragm and extend preferably in a spiral direction, and the stiffening members 3 are formed by angles or rods that are arranged transversely of the radially-disposed or spirally disposed stiffening members 2. As previously intimated, the stiffening members 3 may be of such a character or nature that they are capable of flexing intermediate their ends, as the main function of said members is to spread the load and prevent the metal in the valley portions of the diaphragm A from bending too sharply. The stiffening members 2 may each be made up of a continuous element or a number of short elements welded so as to produce a continuous element, and said members 2 are preferably rigidly connected to the top side of the diaphragm.

By stiffening and weighting the diaphragm A in this manner, said diaphragm will be thrown into a slight tension, during the operation of admitting gases to the holder, due, of course, to the fact that the internal pressure of the gas chamber is slightly greater than the weight of the metal in the diaphragm A. The lighter or unweighted portions of said diaphragm immediately start to rise, but the weighted portions remain stationary, or practically so, until the rising portions create enough extra lift by tension at the low points to start raising said weighted low points. The result is, that the diaphragm A rises and passes through the horizontal plane in smooth curves and without the random or hap-hazard bending and buckling that would certainly occur if all portions of the diaphragm A were of the same degree of flexibility and of the same weight or degree of mobility. Obviously, the diaphragm A may be provided with any desired number of spiral or radially-disposed, weighted and stiffened portions, but I have found, in constructing gas holders having a diameter as greater as 200 ft., that if the flexible top wall of the gas chamber is provided with four weighted, stiffened portions of the kind above described, that said top wall has a natural tendency to flex or bend into the form of a plurality of substantially radially-disposed billows or ridges separated from each other by valleys or depressions which continue to flatten out and merge into said ridges or billows during the continued upward flexing of said top wall. During the downward flexing of said top wall the unweighted and unstiffened portions of same have a natural tendency to assume their former shape, and this is also true of the weighted and stiffened portions lying between the freely flexible and unweighted portions.

It is rather difficult, by means of a drawing, to show the exact shape of the diaphragm A while it is passing from its extreme downwardly flexed position to its extreme upwardly flexed position, but I have endeavored to show diametrically, by Figure 4 of the drawings, and by dotted lines in Figure 1, the action of the diaphragm A during the operation of admitting and withdrawing gases to and from the holder, the dotted lines in Figure 1 which extend substantially spirally from the center of the diaphragm indicating the axis of the ridges that form in the diaphragm. The transverse stiffening members 3, in addition to co-acting with the weights 1 to cause the diaphragm A to naturally assume the shape or form of ridges and valleys, as previously explained, also have a tendency to break up the wave motion in the diaphragm, produced by the action of wind on the top side of the diaphragm, and hence, they reduce reversals of stress in the metal of the diaphragm which tend to cause the diaphragm to fatigue and rupture.

The circumferential stiffening members, previously mentioned, with which the diaphragm is equipped, preferably consist of two substantially annular members 5 and 6 formed from metal rods, bars, angles or other commercially rolled shapes attached to or combined with the top side of the diaphragm A, and arranged between the center and peripheral edge of said diaphragm, as shown in Figure 1. Usually, the members 5 and 6 will be a little stiffer than the stiffening members 3, but they are not so stiff that they are incapable of flexing and following the contour of the diaphragm A when said diaphragm flexes to produce the ridges and valleys previously described, the main function of annular members 5 and 6 being to locally stiffen the diaphragm A. It is not necessary that the members 5 and 6 be welded or permanently attached to the top side of the diaphragm. In practice I prefer to secure said members to the diaphragm by means of stirrups 7 in such a manner that said members cannot rise from the diaphragm, but are capable of sliding circumferentially relatively to the diaphragm. Usually, the stirrups 7 will be welded to the diaphragm A, and the members 5 and 6 will be held slightly spaced away from the top side of the diaphragm, so that water can flow to the drainage points without being impeded by the circumferential stiffening members. The circumferential stiffening members 5 and 6, in addition to aiding in the functions of the stiffening members 2 and 3, attached to the weighted areas or zones of the diaphragm A, also tend to make said diaphragm act as a unit and create partial or slight circumferential stiffening at certain radii. These circumferential stiffening members tend to make the valleys and ridges in the diaphragm about the same size, so that there is no concentration or bending in any one valley or any one ridge. It will be noted that in addition to concentrating the loading of the diaphragm along the valley portions of same, there is a general concentration of load at the center of the diaphragm. This causes the central portion of the diaphragm A to be the last portion to rise, with the consequent effect of creating a downhill slope towards the center in all positions of said diaphragm until the peripheral portion of the diaphragm is sloping downwardly towards the shell C, which constitutes the side wall of the gas chamber. Consequently, in all positions of the diaphragm A there is a hydraulic gradient created, either towards the primary drain at the center of the diaphragm, or towards the periphery of the diaphragm, with the result that no puddles of rain water can be trapped on the diaphragm A in such a way as to create excessive pressure at a point or points on the surface of the diaphragm A which might interfere with the successful or proper operation of same.

As previously explained, there is a sump 8 at the center of the diaphragm, which is of such size and design that during a cloudburst or exceptionally heavy rainfall, said sump will be capable of receiving and holding enough rain water to impose a load on the diaphragm A of sufficient weight to prevent the central portion of said diaphragm from assuming such a position that

water will not drain to the primary drain or center drain D. The size of the sump 8 will, of course, vary with the diameter of the holder, but said sump is made of such capacity that in the event a relatively great volume of rain water is projected onto the diaphragm A, the load on the extreme center of said diaphragm will be of sufficient weight to prevent the center portion of the diaphragm from moving into such a position that water cannot escape from the diaphragm through the primary drain D. Preferably, said primary drain is of the inverted syphon type, consisting of a vertically-disposed, rectangular member 9, positioned in the sump 8 with its upper end terminating above the bottom of the sump, and a cup 9a arranged at the lower end of said tubular member in spaced relationship with same. The bottom diaphragm B of the holder is provided with a depression 10 for receiving water which overflows from the cup 9a of the primary drain. The water which collects in said depression 10 may be removed therefrom in any preferred manner. In the form of my invention herein shown, water is conducted away from the depression 10 by means of an inverted syphon drain formed by a cup 11 at the center of the depression 10, and an outlet 12 leading from said center cup 11. The depression 10 in the bottom diaphragm of the holder is of such depth that when the top diaphragm A is in its extreme downwardly flexed position, as shown in Figure 2, no part of the primary drain will touch the bottom diaphragm B, and hence, cannot freeze to same in cold weather and interfere with the operation of the top diaphragm. The tubular member 9 of the primary drain D is provided at a point below its extreme upper end with an outlet 13 through which water escapes from the sump 8 during an ordinary rainfall. During an exceptionally heavy rain fall, water rises in the sump 8 and overflows the top edge of the tubular member 9 of the primary drain. As previously stated, the peripheral portion of the top diaphragm A is provided with emergency drains formed preferably by flexible tubular members 14 that terminate in the top surface of the peripheral portion of the top diaphragm A and extend downwardly through the gas chamber to the lower edge portion of the shell C, in the outer face of which they terminate, as illustrated in Figure 6. Preferably, one of the weights 1, previously mentioned, is arranged adjacent the inlet of each emergency drain 14, so that the inlet of said drain will always be the low point of a surface of considerable area surrounding said inlet. It is only in rare instances that the said emergency drains come into service, but they are always in readiness to operate, and hence, act, in a way, as safety devices. A drainage means of the kind above described insures proper drainage of the top surface of the diaphragm A in every position of said diaphragm, from empty position to full position, during normal and abnormal conditions. When the gas chamber is full and venting, drainage is either to the primary drain D at the center of the diaphragm, or to the peripheral edge of the diaphragm, or the emergency drains 14 which are located near the peripheral edge of the diaphragm. As shown in Figure 1, the emergency drains 14 are arranged in spaced relationship around the circumference of the diaphragm A.

Another novel feature of my present invention consists in equipping the flexible top wall of a gas chamber of the kind described, with dampeners which prevent or tend to prevent, said top wall from waving when it is subjected to the action of a high wind. The said dampeners are combined with the top diaphragm A in such a manner that they exert a downward force or pull on same in opposition to a quickly moving upward pull exerted on said diaphragm by wind blowing over the top surface of same, and vice versa. In Figure 5 of the drawings I have illustrated such a wave dampener, consisting of a piston 15 reciprocatingly mounted in a vertically-disposed cylinder 16 filled with liquid 17, said piston 15 being attached to the diaphragm A in such a way that if said diaphragm suddenly tries to rise, then a vacuum is set up on the bottom side of said piston, which effectively prevents sudden upward movement of the diaphragm A. Likewise, if the diaphragm A suddenly tries to depress or move downwardly, the pressure that is set up on the underside of the piston 15, checks or retards such sudden or downward movement. The piston 15 rises and falls slowly by slow movement of liquid from one side to the other of the piston 15, as the diaphragm A moves upwardly slowly and downwardly slowly, but said piston effectively checks sudden movement of the diaphragm A either upwardly or downwardly. The holder is equipped with a plurality of such dampeners which are arranged at strategic positions around the circumference of the holder, as shown clearly in Figure 1. Said dampeners, acting in conjunction with the transversely-disposed and circumferential stiffening members on the top side of the diaphragm A, form a very efficient means to eliminate or control the wave motion, which is practically inevitable in a roof or top wall supported by gases and consisting of a limber metal diaphragm or sheet, in many instances having a diameter of 200 ft. The particular details of construction of the dampeners above referred to are immaterial, but in the form of my invention herein illustrated, the cylinder 16 of each dampener is arranged in vertical alignment with a manhole cover 18 attached to the top diaphragm A, and the piston 15 is connected to a piston rod 19, formed preferably from a piece of pipe, whose upper end is pivotally attached in any suitable manner, as, for example, by a pin 20, to lugs 21 on the manhole cover 18. The liquid 17 in the cylinder 16, which preferably consists of glycerine or oil, is admitted to said cylinder by a supply pipe 22 that extends laterally to a point beyond or on the outside of the shell C.

Prior to my present invention it was the usual practice to equip gas holders of the general type herein illustrated, with a pressure relief valve or volume control valve located near the center of the top diaphragm, and actuated by a chain, cable, or similar device attached to the bottom diaphragm near the center of same. The adjustment of said valve operating device has been a difficult and dangerous operation, due to its location on the underside of the bottom diaphragm near a point at the center of same, and one object of my present invention is to remedy or overcome this inherent defect of prior pressure relief or volume control valves. To this end I have equipped the holder with a pressure relief or volume control valve E arranged in an accessible position and constructed so that the bodily movement or vertical movement of the shell C is used to actuate said valve. In the form of my invention herein illustrated the valve E is mounted on the exterior of the shell C of the holder, and is actuated by an operating device 23 that is easily

accessible from the exterior of the holder, as shown in Figure 6. However, the particular arrangement of said valve is immaterial, and the particular construction of the operating mechanism for said valve is immaterial, so long as said parts are of such design or arrangement that the bodily movement or vertical movement of the shell C causes said valve to operate. The valve E is normally held in snug engagement with an annular valve seat 24 by means of a spring 25. Said valve is unseated, or moved into its open position by means of a bell crank lever or similar device 26 pivotally mounted on a bracket 27 on the exterior of the shell C and actuated by a chain, cable or similar operating means 23, which is attached at one end to the horizontal arm of the bell crank lever 26, and attached at its opposite end to an anchoring device 28 which is stationary with respect to the shell C, which, it is understood, is capable of vertical bodily movement. When the gas chamber is empty, the peripheral portion B' of the bottom diaphragm B assumes a downwardly inclined position, as shown in Figure 2, but during the operation of admitting gases to the gas chamber, the peripheral portion B' of said bottom diaphragm moves upwardly into the position shown in Figure 3, thereby causing the shell C to move upwardly into the position shown in broken lines in Figure 6, with the result that the operating member 23 exerts a pull on the bell crank lever 26 in a direction to open the valve E at a certain approximate point in the upward travel of the shell C. In order to cause the valve E to open quickly, any ratio of length of the horizontal and vertical arms of the bell crank lever 26 can be used. For example, if the horizontal arm of said lever is one-half the length of the vertical arm of said lever, then the valve E opens two inches for each one inch of rise of the shell C. A pressure relief valve or volume control valve of the construction and arrangement above described is inexpensive to construct; easy to install; it can be adjusted quickly and easily without danger to the person making the adjustment, and it differs from prior valves of a similar nature, in that it is operated by the bodily movement or vertical movement of the side wall of the gas chamber, instead of by a flexible diaphragm constituting the top or bottom wall of said chamber.

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

1. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means combined with said top wall for imparting additional stiffness to certain portions or areas of same and for retarding upward movement of said portions or areas, said means being so arranged that when said wall starts to move upwardly, due to the pressure of the gases on the underside of same, said wall will assume approximately the form of a plurality of substantially radially-disposed ridges separated from each other by valleys.

2. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, said wall having loaded areas and unloaded areas disposed so that when said wall starts to move upwardly, due to the pressure of the gases on the underside of same, the loaded areas of said wall will tend to lag or hold back and the unloaded areas of said wall will assume the form of a plurality of substantially spirally disposed ridges that lie between said loaded areas.

3. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means combined with said top wall for stiffening certain portions or areas of same and for counteracting the tendency of said portions or areas to rise, due to the pressure of the gases in said chamber, said means being so disposed that said w ll, when it moves upwardly and downwardly, due to the variation in pressure which sustains and moves the same, will assume an approximately definite shape or form in which certain portions of the top surface of said wall will constitute radially-disposed drainage surfaces on which water cannot remain, and the remaining portions of said top surface will constitute radially-disposed ridges that shed water onto said drainage surfaces.

4. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means combined with said top wall for reducing the tendency of certain areas or portions of said wall to flex and to move upwardly, said means being so constructed and arranged that an increase in the pressure which sustains and moves said wall will cause said wall to assume an approximately definite shape or form in which the top surface of the peripheral portion of said wall is of substantially convex shape and the portion of said wall bounded by said peripheral portion is in the form of alternating ridges and valleys that radiate from the center of said wall.

5. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means combined with said top wall for converting it into a plurality of freely flexible and mobile zones arranged between less flexible and less mobile zones and disposed so that an increase in pressure of the gases on the underside of said wall causes said wall to assume approximately the form of a plurality of substantially spiral ridges separated from each other by valleys.

6. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and devices combined with said top wall for stiffening and retarding upward movement of certain portions of said wall, said devices being so disposed that said wall during the upward movement of same, will assume approximately the shape or form of alternating valleys and spiral ridges radiating from the center of said wall and bounded by an annular convex zone that drains towards the peripheral edge of said wall.

7. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and one or more substantially radially-disposed rows of weights on the top side of said wall, disposed so that when said wall is subjected to a force tending to cause it to flex upwardly, the portions of said wall on which said weights are positioned will lag substantially, as described.

8. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and weights on the top side of said wall disposed so as to in effect divide said wall into a plurality of substantially spiral zones separated from each other by unweighted zones.

9. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, said top wall having a plurality of spaced, radially-disposed portions

which are stiffer or not so easy to flex as the intermediate portions of said wall lying between said stiffer portions.

10. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, said top wall being provided with weights and stiffening members disposed so as to form a plurality of stiffened, weighted spiral zones, separated from each other by unweighted portions of said wall which are capable of flexing and moving more easily than said weighted zones.

11. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means for controlling the flexing and/or movement of said wall, comprising a circumferential stiffening member on the top side of said wall, approximately radially-disposed rows of weights on the top side of said wall, and devices for stiffening said wall in the zones of said weights.

12. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and means for controlling the flexing and/or movement of said wall, comprising an annular stiffening member on the top side of said wall arranged intermediate the center and peripheral edge of same, at least one spiral row of weights on the top side of said wall, and devices for preventing sharp or abrupt bends from forming in the weighted zone of said wall.

13. A gas chamber or space having a flexible top wall that is adapted to flex or move from a downwardly inclined to an upwardly inclined position so as to vary the volume of said chamber, weights and stiffening members on the top side of said wall arranged so as to form alternating zones of different degrees of flexibility and mobility, a sump at the center of said wall of such capacity that when filled with water it imposes a load on said wall of sufficient weight to hold the central portion of said wall slightly depressed, even when said wall is in its extreme upwardly flexed condition, and a drain leading from said sump.

14. A gas chamber or space having a flexible top wall that is adapted to flex or move from a downwardly inclined to an upwardly inclined position so as to vary the volume of said chamber, weights and stiffening devices on the top side of said wall arranged so as to form a plurality of substantially radially-disposed stiffened and weighted zones arranged in spaced relationship, a primary drainage means arranged at the center of said wall, and emergency drains located intermediate said primary drain and the peripheral edge of said wall.

15. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, and piston devices combined with said wall for retarding or checking quick or sudden movement of said wall, produced by the action of wind on the top side of said wall, and constructed so as to not substantially retard a slow or gradual movement of said wall.

16. A gas chamber or space having a top wall that is adapted to flex or move so as to vary the volume of said chamber, a piston attached to the underside of said wall, a cylinder for receiving said piston, and a liquid in said cylinder which co-acts with said piston to check or retard sudden movement of said wall, produced by the action of wind on the top side of same.

17. A gas holder having a chamber which comprises a bottom portion, a flexible top wall for said chamber that is adapted to rest on said bottom portion when said chamber is empty, a sump carried by said top wall and arranged at the center of same for receiving water that falls on said top wall, an inverted syphon drain carried by said sump and depending therefrom, a depression in the bottom portion of said chamber, adapted to receive water from said inverted syhon drain and being of sufficient depth to form a clearance for said drain when the chamber is empty, and a syphon drain for removing water from said depression.

18. A gas holder, comprising a gas chamber provided with a side wall that is adapted to move bodily in a vertical direction during the operation of admitting and withdrawing gases to and from said chamber, a top wall for said chamber that is adapted to flex to vary the volume of said chamber, a pressure relief or volume control valve mounted on the side wall of said chamber, and an operating mechanism for said valve arranged adjacent said side wall on the exterior of same.

19. A gas holder, comprising a gas chamber provided with a side wall that is adapted to move bodily in a vertical direction during the operation of admitting and withdrawing gases to and from said chamber, a top wall for said chamber that is adapted to flex to vary the volume of said chamber, a pressure relief or volume control valve mounted on the side wall of said chamber, an operating mechanism for said valve comprising a bell crank lever on the exterior of said side wall having one of its arms operatively connected to said valve, and an operating device attached to the other arm of said bell crank lever.

20. A gas holder, having a gas storage chamber that comprises a top wall which is adapted to flex to vary the volume of said chamber, a side wall joined to the peripheral edge of said top wall, means for permitting said side wall to move bodily in a vertical direction during the operation of admitting and withdrawing gases to and from said chamber, and means operated by the vertical movement of said wall for venting said chamber.

21. A gas holder having a gas storage chamber that comprises a top wall which is adapted to flex to vary the volume of said chamber, a side wall joined to the peripheral edge of said top wall, means for permitting said side wall to move bodily in a vertical direction during the operation of admitting and withdrawing gases to and from said chamber, a control valve for said chamber, and means actuated by the vertical movement of said side wall for causing said valve to act.

22. A gas holder having a chamber which comprises a bottom portion, a flexible top wall for said chamber that is adapted to rest on said bottom portion when said chamber is empty, a sump carried by said top wall and arranged at the center of same for receiving water that falls on said top wall, an inverted syphon drain carried by said sump and depending therefrom, and a depression in the bottom portion of said chamber, adapted to receive water from said inverted syphon drain and being of sufficient depth to form a clearance for said drain when the chamber is empty.

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