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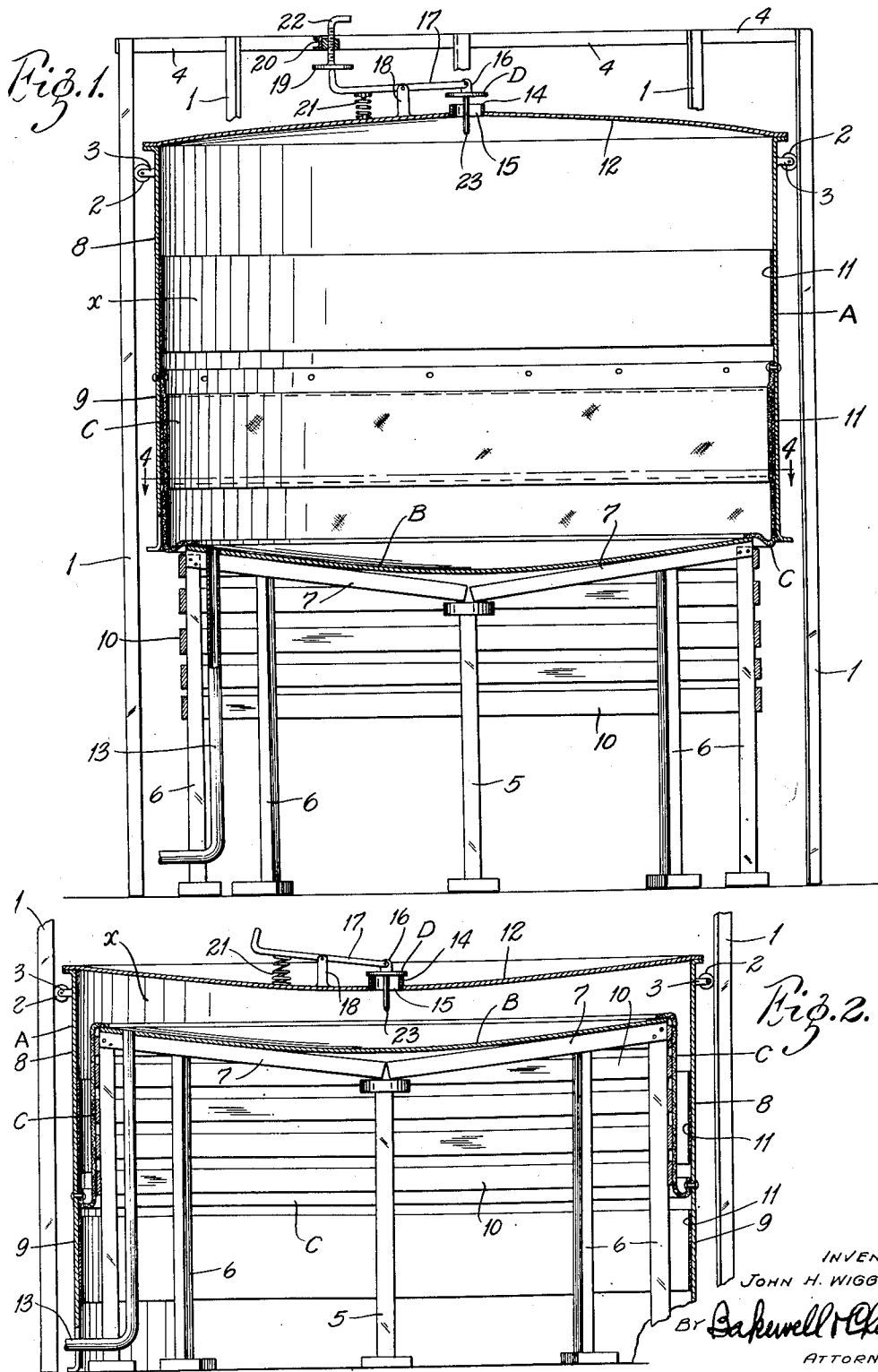
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GAS AND LIQUID STORAGE DEVICE

Filed April 18, 1935

3 Sheets-Sheet 1



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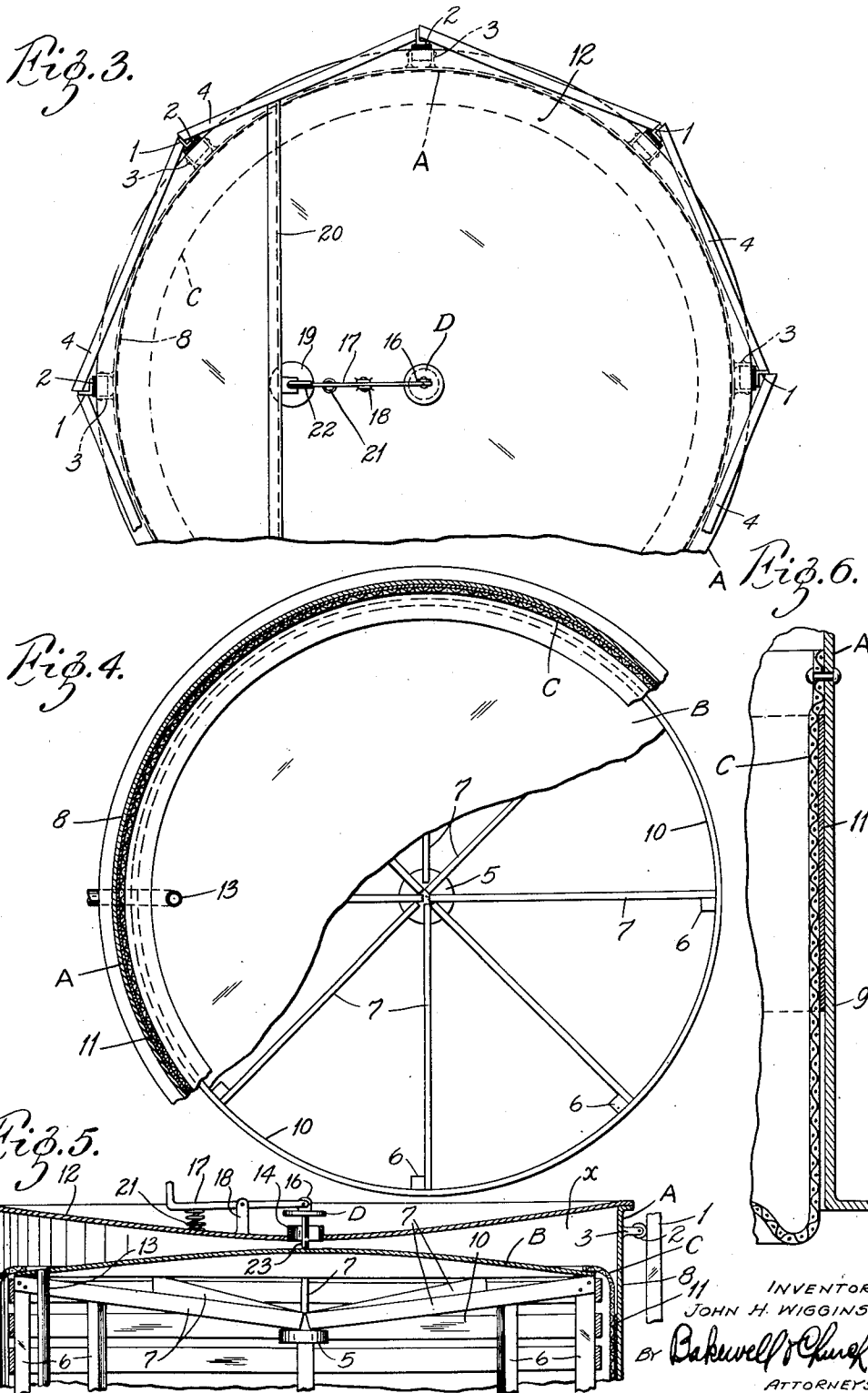
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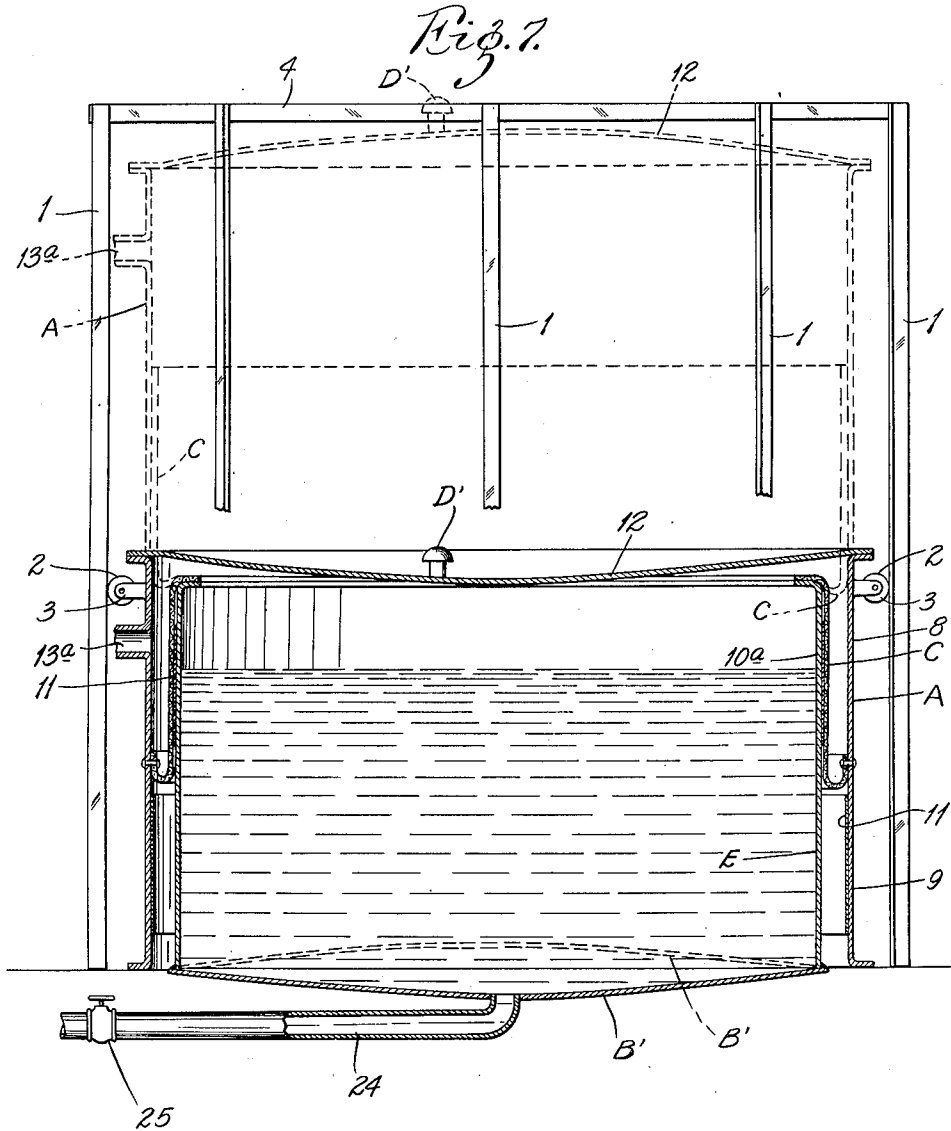
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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GAS AND LIQUID STORAGE DEVICE

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7 Claims. (Cl. 220—1)

This invention relates to storage devices for gases and volatile liquids, and particularly storage devices of the type in which gas-tight fabric or some other suitable flexible or pliable, non-metallic material is used to seal a vertically-movable member or structure that forms the roof or upper portion of the gas receiving space or chamber of the device.

The main object of my present invention is to provide a gas and/or liquid storage device of the general type mentioned, which is of such construction that the gas-tight fabric or other flexible, non-metallic material that constitutes the sealing element of the device, is effectively protected against strains or pressures which tend to tear or disrupt said element, thereby making it commercially practicable or feasible to build the device in the form of a large unit of relatively great storage capacity.

Another object is to provide a storage device of the type mentioned, that is equipped with means for preventing the gas-tight coating of the sealing element from being impaired or destroyed, by reason of said sealing element sticking to or freezing against a part of the device contacted by said element.

Another object is to provide a storage device of the type mentioned, in which the gas-tight sealing element is protected from the elements and arranged so that ice and snow cannot collect on said element.

Another object is to provide a "breather type" metal gas chamber or storage space that is equipped with a collapsible or extensible side wall which is sealed by gas-tight fabric or other suitable flexible or pliable material, arranged so that a relatively great positive pressure or minus pressure in said chamber has no injurious effect on said sealing material.

And still another object of my invention is to provide a novel means for venting a breather type gas chamber or storage space. Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a vertical transverse sectional view of a gas holder constructed in accordance with my present invention, the vertically-movable member that constitutes the upper portion of the gas chamber being shown in its fully raised position, with the vent valve open to relieve an abnormal pressure in said chamber.

Figure 2 is a similar view of said device, showing the vertically-movable member in its extreme lower position.

Figure 3 is a top plan view of the device.

Figure 4 is a horizontal sectional view, taken on the line 4—4 of Figure 1, partly broken away to illustrate the supporting structure on which the bottom diaphragm of the gas chamber normally rests.

Figure 5 is a view similar to Figure 2, illustrating the bottom diaphragm of the gas chamber in its upwardly flexed position and with the vent valve open so as to admit air to said chamber to relieve an abnormal minus pressure therein.

Figure 6 is an enlarged fragmentary vertical sectional view, taken through the lower portion of the side wall of the vertically-movable member of the device, illustrating the insulating material that is used to prevent the sealing element from sticking to or freezing against said side wall; and

Figure 7 is a vertical transverse sectional view of a device constructed in accordance with my invention and designed to be used for storing gases and volatile liquids.

In the form of my invention illustrated in Figures 1 to 6, inclusive, the gas storage space or chamber *x* of the device is formed by a vertically-movable, inverted cup-shaped member A of cylindrical form, and a stationarily supported, horizontally-disposed, disk-shaped member B, over which the member A telescopes, the bottom member B being arranged in an elevated position on a stationary supporting structure, so that when the member A is in its extreme lower position, with its bottom edge resting on the ground, as shown in Figure 2, the top wall of said member A will be in close proximity to the bottom member B, thus forming a gas chamber *x* of relatively small volume, and when said member A is in its extreme upper position, as shown in Figure 1, the gas chamber *x* will be of relatively great volume. The annular space between the bottom B of the gas chamber and the collapsible or extensible side wall of said chamber, is sealed by a sealing element C of fabric or other suitable flexible or pliable, non-metallic material, that is combined with said members in a novel manner, as hereinafter described, the material of which said sealing element is constructed being treated or coated with a substance that will make said material gas-tight. The vertically-movable upper member A is guided and held centered with relation to the bottom member B by a guideway formed by vertically-disposed tracks or guides 1 that are engaged by rollers 2 carried by brackets 3 which project laterally from the side wall of the member A adjacent the

upper end of same, the upper ends of said guides 1 being joined together by horizontally-disposed braces or frame members 4. The supporting structure which sustains the bottom member B of the gas chamber may be of any preferred construction, and is herein illustrated as comprising a center post 5, an annular row of wood up-rights or posts 6, and radially-disposed beams 7 attached to said center post and uprights, so as to form a skeleton-like support for the member B.

In order that the sealing element C will not be strained or ruptured by any pressure, tension or force that may be exerted on same when the gas chamber x is under a positive pressure or minus pressure, said element is so constructed and arranged that it is always backed up by a substantially rigid or inflexible surface that will absorb any force or pressure which tends to strain or disrupt the sealing element or subject it to undue tension. Preferably, the top edge of the sealing element C is attached in a gas-tight manner to the inner face of the side wall of the movable member A at a point some distance above the lower edge of said side wall, and the bottom edge of said sealing element C is arranged in overlapping relationship with the peripheral edge of the bottom member B and attached to same in a gas-tight manner. The upper portion 8 of the side wall of the member A that is located above the point at which the sealing element C is attached to said wall, must be gas-tight, but it is not essential that the lower portion 9 of said side wall be gas-tight, due to the fact that the function of said lower portion 9 is to back up the sealing element C and protect said element from injurious strains produced by the outward pressure which the gases in the chamber x exert on the sealing element when the member A is moving upwardly, and after said member A has reached its extreme upper position. A similar backing or abutment surface 10 is provided for protecting the sealing element C from injurious strains when the movable member A is in its extreme lower position, and a positive pressure is created in the chamber x , as, for example, during the first part of the operation of admitting gases to said chamber. The backing or abutment surface 10 is mounted on the stationary supporting structure that carries the bottom B of the gas chamber, and is herein illustrated as being formed by horizontally-disposed wooden boards or slats attached to the upright 6 in such a way as to form in effect a circular shell that surrounds the uprights 6. Obviously, a cylindrical metal shell could be substituted for the wooden backing 10 without departing from the spirit of my invention.

When the member A is in its extreme upper position, as shown in Figure 1, the lower portion 9 of the side wall of said member constitutes a substantially rigid or inflexible abutment surface on the outside of the sealing element C that backs up said element and effectively absorbs the outward force or pressure which the gases in the chamber x exert on the element C, thereby preventing said element from being strained or ruptured, as would be liable to occur if no means were provided for resisting or preventing the outward movement or flexing of the sealing element. When the member A is in its extreme lower position, as shown in Figure 2, the sealing element C is disposed in such relationship with the stationary backing or abutment surface 10 on the supporting structure that carries

the bottom B of the gas chamber, that if a positive pressure exists in or is created in the gas chamber x , the sealing element C will be forced against the backing or abutment surface 10, said backing or abutment surface absorbing the force or pressure exerted on the sealing element and preventing said element from being placed under sufficient tension to strain or disrupt it. If a minus pressure or vacuum is created in the chamber x , when the member A is in its lower position, as, for example, when gases are being exhausted or withdrawn from said chamber, the sealing element C will be flexed in the opposite direction, i. e., away from the backing 10, and drawn tightly against the upper portion 8 of the side wall of the member A, as indicated in Figure 5, said side wall portion 8 functioning at this time as a backing for the sealing element which restricts movement or flexing of said element, sufficiently to subject it to undue tension or to strain or disrupt it. During the vertical movement of the member A, either upwardly or downwardly, the internal pressure of the chamber x is exerted on the sealing element C in such a manner as to force said sealing element either against the stationary backing member 10 associated with the lower portion B of the device, or against the movable backing member 9 associated with the movable upper portion A of the device, said sealing element and backing members being so constructed and arranged that the sealing element C will, in effect, be progressively peeled off of or stripped from one backing member and applied to the other backing member as the member A rises and falls. It will thus be seen that in any and all positions of the member A, when the chamber x is under a positive pressure, the sealing element C will be backed up or supported by substantially rigid or inflexible surfaces that take up any strains, pressure or forces tending to disrupt or tear said sealing element. Similarly, when the gas chamber x is under a minus pressure, the sealing element C is incapable of moving or flexing in such a way as to cause it to be strained, because at such times the upper portion 8 of the side wall of the member A acts as a backing or abutment surface against which the sealing element is held tightly by the vacuum in the gas chamber.

In addition to protecting the sealing element C against excessive tension or strains or pressures which tend to tear or disrupt said element, I provide means for preventing said element from sticking to or freezing against the backing members or abutment surfaces previously described, and I house said sealing element in such a way that snow and ice cannot collect thereon. In this way I prevent the sealing element from interfering with the rise and fall of the vertically-movable member A, as would be liable to occur if said element adhered to or froze to the backing surfaces that co-act with same, and I also prevent the gas-tight qualities of the sealing element C from being impaired or destroyed, as would be apt to result if said element were subjected to frequent or repeated sticking or freezing to a surface, followed by a sudden stripping or pulling away of said element from said surface. The means that I employ to prevent sticking or freezing of the element C to the backing members or abutment surfaces consists of insulating material 11 mounted either on the sealing element C or on metal parts of the device contacted by said sealing element. In a device of the particular construction herein illustrated it will be

sufficient if the inner surface of the backing 9 on the movable member A is covered for more or less of its area, as shown in Figure 6, by insulating material 11 that will prevent dew from accumulating thereon, it being unnecessary to apply insulating material to the backing member 10 if said backing member is constructed of wood. However, if the backing member 10 were formed by a cylindrical metal shell, it would be necessary to cover more or less of the outer surface of said shell with insulating material, as above described. The housing of the sealing element C is effected or obtained by arranging said element so that it is surrounded or protected by a portion of the member A when said member is in its extreme upper and lower positions and in any of its various intermediate positions. Thus, when the member A is fully raised, as shown in Figure 1, the sealing element C is arranged on the inside of same with the side wall of said member completely covering the sealing element, and when said member A is in its fully lowered position, as shown in Figure 2, the sealing element is completely surrounded by the side wall of said member. By protecting the sealing element from snow and ice, eliminating the possibility of said element sticking to or freezing on a surface from which it subsequently is stripped off, and protecting said sealing element against strains or pressures which tend to strain or disrupt the same, I have produced a safe gas holder of long life, that can be kept in operative condition with minimum trouble and expense.

In conventional bell type gas storage devices of the kind that are equipped with a sealing element made of gas-tight fabric or equivalent material for joining the bell to the stationary lower portion of the device, the bell or vertically-movable member of the device is provided with a rigid or inflexible top wall, and the lower portion of the device is provided with a rigid or inflexible bottom. In my improved device the vertically-movable top member A of the device is provided with a roof or top wall 12 that is capable of flexing upwardly and downwardly, and thus producing a gas storage space or chamber of the "breather type". Preferably, said top wall 12 is formed by a limber metal diaphragm that has a natural tendency to assume a downwardly flexed condition, as shown in Figure 2, when the gas chamber x is empty, but which is capable of flexing upwardly, as shown in Figure 1, thus increasing the volume of the gas chamber, when the internal pressure of said chamber becomes great enough to overcome the weight of said top wall 12. The member B which constitutes the bottom of the gas chamber x is also preferably formed from a limber metal diaphragm that has a natural tendency to assume a downwardly flexed condition, as shown in Figures 1 and 2, but which is capable of flexing upwardly, as shown in Figure 5, thus reducing the volume of the gas chamber in the event a vacuum or minus pressure of a certain approximate degree is created in the chamber x from any cause, as for example, during the operation of withdrawing gases from said chamber through the combined gas inlet and outlet pipe 13 attached to the bottom B of said chamber. A gas storage space or chamber of the construction above described is novel, in that in addition to having a collapsible or extensible side wall, it is equipped with a top wall, or a top and bottom wall, constructed so as to be capable of flexing sufficiently to prevent the parts of said chamber

from being subjected to injurious strains produced by an abnormal positive pressure or minus pressure in said chamber.

Any suitable type or kind of means may be used to automatically vent the gas chamber x, in the event a dangerous pressure, either positive or minus, is created in said chamber, but I prefer to equip the device with a combined pressure relief and vacuum relief valve D, so constructed and arranged that it will open automatically and vent the chamber x, when the member A reaches a certain point in its upward travel, and will also open automatically and admit air to the chamber x when the member A is in its extreme lower position, in the event an abnormal or dangerous vacuum is created in said chamber. As shown in Figure 1, the valve D consists of a horizontally-disposed disk arranged so as to seat upon an annular valve seat 14 on the top side of the diaphragm 12 that surrounds a vent opening 15 in said diaphragm. Said valve D is provided on its top side with an upwardly-projecting lug 16 that is pivotally attached to one end of a lever 17 which is pivotally mounted on a bracket 18 on the top side of the diaphragm 12, the other end of said lever being arranged so that it will co-act with a tripping device 19 carried by a stationary horizontally-disposed beam 20 supported by the guideway structure for the vertically-movable member A. The valve D is normally held seated by a spring 21, and the tripping device 19 is preferably adjustably mounted, so that it can be raised or lowered to accurately control the time of opening of the valve D to relieve the pressure of the gas chamber. In the form of my invention herein illustrated the tripping device 19 is carried by a manually-adjustable, screw-threaded member 22 sustained by the beam 20. Projecting downwardly from the underside of the valve D is a rigid stem 23 that co-acts with the bottom diaphragm B to open said valve and admit air to the chamber x, if the diaphragm B flexes upwardly, as shown in Figure 5, due to an abnormal or dangerous vacuum being created in said chamber.

When the gas chamber x is empty, the co-acting parts of the device occupy the position shown in Figure 2, wherein it will be noted that the valve D is seated and the top and bottom diaphragms 12 and B, respectively, are flexed downwardly. When gases are admitted to the chamber x through the pipe 13, an internal pressure is set up, forcing the sealing element C against the abutment surface or backing 10, and as the gases continue to flow into said chamber, the roof or top wall 12 of said chamber flexes upwardly and assumes a substantially frusto-conical form. Thereafter, as the gases continue to flow into the chamber x, the member A rises, and in so doing, causes the sealing element C to be progressively stripped off of the stationary backing surface 10 and applied to the movable backing surface 9 formed by the lower portion of the side wall of the member A. Accordingly, the sealing element C will never be subjected to sufficient tension or strain to disrupt said element, because said element is always backed up or supported by a substantially rigid or inflexible surface that absorbs the force or pressure exerted on said element, and prevents said element from moving or flexing sufficiently to set up a destructive tension in same. If a dangerous pressure is created in the gas chamber x, the member A rises high enough to cause the free end of the lever 17 to strike against the

tripping device 19, thus causing the valve D to unseat and automatically relieve the pressure in the chamber x. Thereafter, when the member A moves downwardly slightly, due to venting of the gas chamber, the valve D will seat. During the operation of withdrawing gases from the chamber x the member A moves downwardly to its former position, shown in Figure 2, thereby causing the sealing element C to be progressively removed from the backing surface 9 on the side wall of the member A and applied to the stationary backing 10. If a vacuum is set up in the chamber x, no injurious strain or pressure will be exerted on the sealing element C, due to the fact that even a slight vacuum in the gas chamber causes the sealing element C to be drawn tightly against the upper portion 8 of the side wall of the member A, as illustrated in Figure 5. If an abnormal vacuum or dangerous minus pressure is created in the gas chamber, the bottom diaphragm B will flex upwardly, and in so doing, will engage the stem 23 of the valve D and move said valve into its open position, thereby causing air to be admitted to the chamber x before any parts of said chamber will be subjected to a force sufficient to collapse said chamber. As soon as the vacuum or minus pressure in the chamber x is relieved, the bottom diaphragm B flexes downwardly into its normal position on the beams 7 of the supporting structure that sustains said diaphragm.

In Figure 7 of the drawings I have illustrated my invention embodied in a device that is adapted to be used for holding gases and also volatile liquids. Said device is similar in general design and principle of operation to the device illustrated in Figures 1 to 6, but the stationary lower portion of the device, instead of consisting of an elevated diaphragm carried by a supporting structure, is composed of a stationary cylindrical tank E mounted on the ground and made of such diameter that the inverted cup-shaped member A will telescope over the same and rest on the ground, as shown in Figure 7, when the internal pressure of the storage chamber of the device is not sufficient to sustain the weight of the member A. The top edge of the sealing element C is attached to the side wall of the member A at a point considerably above the lower edge of said side wall, and the bottom edge of said sealing element is attached to the upper end of the side wall of the tank E, thereby causing the upper half of the side wall of the tank E to act as a backing or abutment surface 10^a for the sealing element C when the member A is in its extreme lower position. Due to the fact that the tank E is constructed of metal, the outer side of the upper half 10^a of the side wall of same is faced with insulating material 11, and the inner side of the lower half 9 of the side wall of the member A is also faced with insulating material 11, so as to prevent the sealing element from sticking to or freezing on the backing members or supporting surfaces with which it co-acts. The tank E is provided with a pipe 24 equipped with a control valve 25, through which the liquid is admitted to and withdrawn from said tank, and a combined gas inlet and exhaust pipe 13^a is attached to the side wall of the member A above the point where the sealing element C is attached to said side wall. If the device is intended to be used solely for storing volatile liquids and gases, the bottom of the tank E is preferably rigid or inflexible, but if the device is intended to be used for storing either gases or gases

and volatile liquids, the bottom of the tank E is formed from a flexible metal diaphragm B' that is capable of flexing upwardly into the position shown in broken lines in Figure 7, thus preventing parts of the gas chamber from being strained, if a vacuum is set up in the gas chamber during the operation of withdrawing gases. Any suitable means may be used to vent the gas chamber of the device, the means illustrated for this purpose in Figure 7 consisting of a conventional vent valve D' of the differential pressure type.

When the device is used for storing volatile liquids and gases, liquid is admitted through the pipe 24 so as to fill the tank E to a height below the gas pipe 13^a, as shown in Figure 7. Thereafter, gases are admitted to the device through the pipe 13^a, the pressure of the gases causing the top wall 12 of the member A to flex upwardly, after which said member will rise or move upwardly into the position shown in broken lines in Figure 7, the sealing element C being effectively protected against strains in any and all of the various positions of the member A by the backing or supporting surfaces previously described.

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

1. A storage device provided with a storage chamber that comprises a stationarily mounted lower portion, a vertically-movable upper portion that is adapted to rise and fall and move into a position in which the top part of same is disposed in a considerably higher horizontal plane than said lower portion, a gas-tight sealing element of fabric or the like attached to said upper and lower portions, and stationary and movable abutment surfaces for said sealing element associated with said upper and lower portions and disposed so as to back up said sealing element in any and all positions of said vertically-movable portion and prevent said sealing element from being strained or ruptured by the forces exerted on same by the medium confined in the storage chamber.

2. A storage device provided with a storage chamber that comprises a stationarily mounted lower portion, a vertically-movable upper portion that is adapted to rise and fall relatively to said lower portion, and a gas-tight sealing element of fabric or the like attached to said upper and lower portions, said movable upper portion having surfaces disposed in such relationship with said sealing element as to back up the same and prevent said element from being subjected to strains tending to tear or disrupt same in any and all positions of said upper portion when the storage chamber is under a positive pressure, and also when the storage chamber is under a minus pressure.

3. A storage device provided with a storage chamber that comprises a stationarily mounted member and a vertically-movable, inverted, cup-shaped top member arranged in telescopic relation with said stationary member, and a gas-tight, non-metallic, flexible sealing element for said members attached to the inner face of the side wall of said top member at a point above the bottom edge of said side wall, whereby the lower portion of said side wall will act as a backing for said sealing element when said top member is in its elevated position or is moving vertically.

4. A storage device provided with a storage chamber that comprises a stationarily mounted lower portion, a vertically-movable upper portion

that is adapted to telescope over said lower portion, a sealing element of gas-tight fabric or the like for producing a gas-tight joint or connection between said upper and lower portions, said movable upper portion having one part disposed so as to act as a backing for said sealing element when the storage chamber is under a positive pressure and a different part disposed so as to act as a backing for said sealing element when the storage chamber is under a minus pressure, and an independent backing surface for said sealing element associated with the stationarily mounted lower portion of the device.

5. A storage device provided with a storage chamber that comprises a bottom portion and a vertically-movable upper portion arranged in telescopic relation with said bottom portion, abutment surfaces associated with said portions, and a sealing element of fabric or the like for producing a gas-tight joint or connection between said upper portion and bottom portion, said sealing

element and abutment surfaces being so constructed and arranged that when said upper portion moves vertically, said sealing element will be stripped progressively from one of said abutment surfaces and applied progressively to the other abutment surface.

6. In a storage device, the combination of a sealing element of fabric or the like treated to render it gas-tight, a metal part disposed so as to back up said sealing element and protect it from strain or pressure tending to disrupt the same, and insulating material on one of said devices for preventing said sealing element from sticking to or freezing on said metal part.

7. A storage device of the kind described in claim 3, in which the sealing element is housed inside of said vertically-movable upper portion, and insulating material arranged so as to prevent said sealing element from sticking to or freezing on said abutment surfaces.

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