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[50] Field of Search..... 98/54, 55;
99/235 (S)

[56] **References Cited**
UNITED STATES PATENTS
2,643,602 6/1953 Martin..... 98/54X
Primary Examiner—Meyer Perlin
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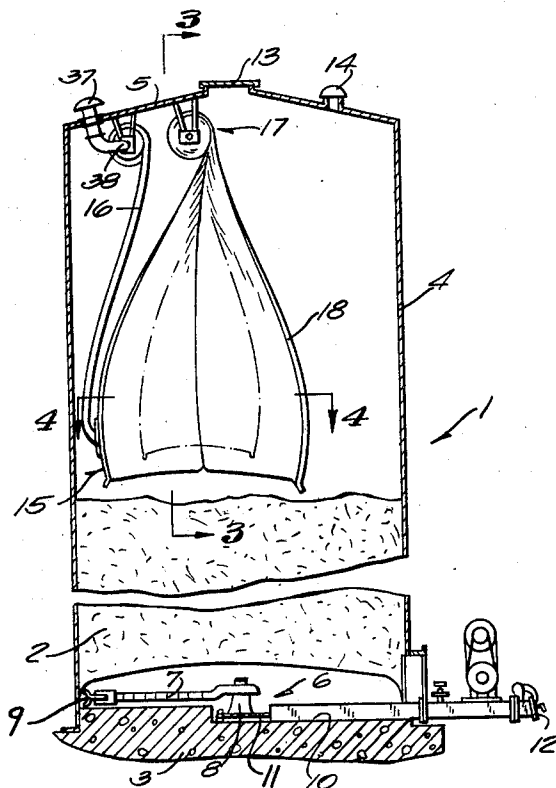
[54] **RETRACTABLE VARIABLE CAPACITY
BREATHER SYSTEM**
12 Claims, 5 Drawing Figs.

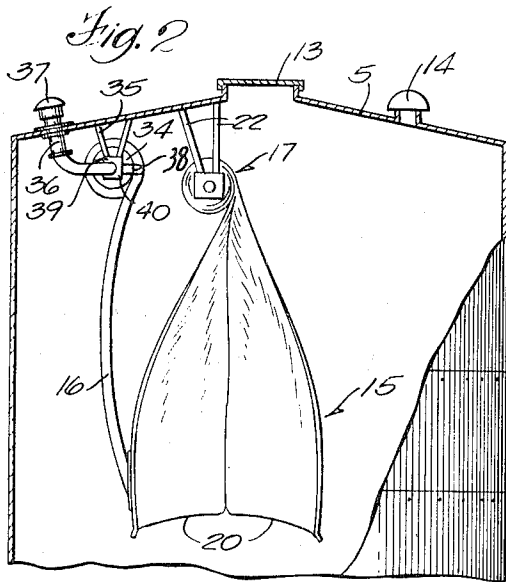
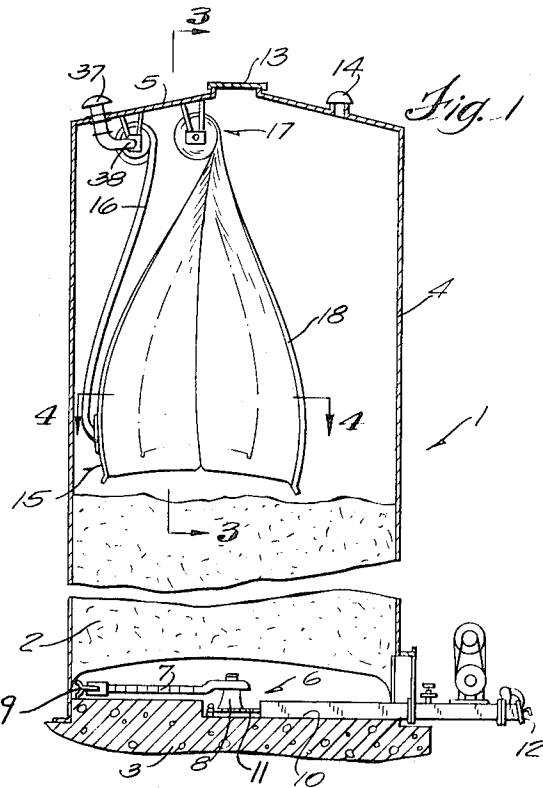
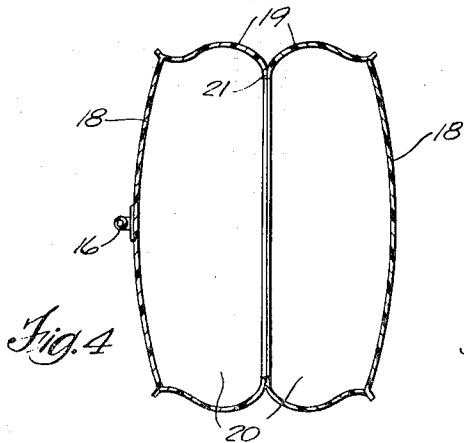
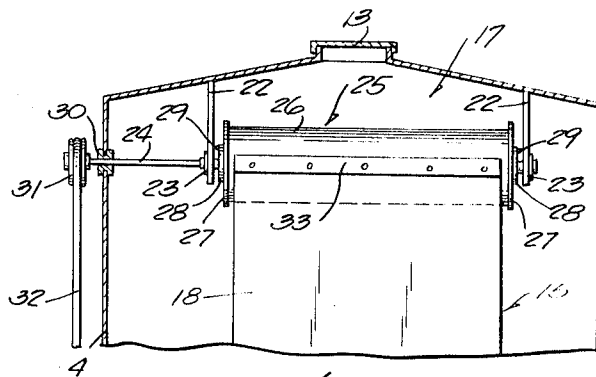
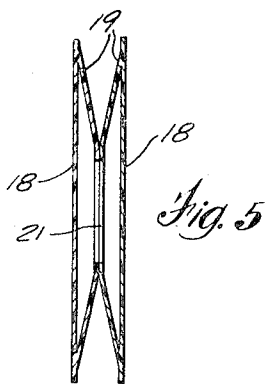
[52] U.S. Cl..... **99/235,**

98/54, 98/55

[51] Int. Cl..... **A01f 25/08**

ABSTRACT: An upright sealed storage structure has within it a breather system including an expandible-contractible, bag which is internally exposed to the ambient pressure. The system also includes a reel upon which the bag can be coiled. The bag folds to a flattened shape when contracted and can then be raised to the top of the structure by winding over the reel.





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RETRACTABLE VARIABLE CAPACITY BREATH- ER SYSTEM

This invention relates to a storage structure and more particularly to an airtight storage structure having a flexible bag to balance the internal pressure with the atmospheric pressure.

BACKGROUND OF THE INVENTION

An airtight storage structure, such as a sealed silo, is subjected to widely varying temperature changes which, among other causes, substantially affect the pressure differentials across the walls of the structure. This results in undesirable stresses on the structure and causes gas leakage through any openings.

The silage, or other perishable material stored within a silo, respire and usually gives off an appreciable amount of gas, including carbon dioxide. These gasses will replace oxygen in the sealed structure and, if air from the atmosphere can be excluded from within the silo, spoilage of the stored materials can be substantially reduced.

To equalize pressure differentials across the silo walls, breather bags have come into use. Generally, the breather bag is located in the upper part of the silo and the interior of the bag is in communication with the outside atmosphere, while the exterior surface of the bag is exposed to pressure within the silo. By expanding and contracting in response to the differences in external and internal pressures, the bag will tend to equalize the pressures acting on the silo walls.

In the past, breather systems have been constant capacity units, and therefore had to be large enough for the maximum conditions experienced. However, the capacity requirements can vary due in part to the fact that the silo is gradually unloaded, as by a bottom unloader. Greater capacity is needed for pressure differentials across the walls of an unloaded, or partially unloaded, silo than for differentials experienced by loaded structures, since more breather bag expansion is required to equalize the pressures. Thus, the constant capacity breather bags had to be large enough to fulfill the requirements of an empty or partially empty silo and thereby occupied extra space until the maximum capacity was needed. This was true even though the bags would be partially deflated most of the time.

Further, the silos are generally loaded through an opening in the top. The bags tended to interfere in this operation and could not be completely moved out of the way without removal from the silo. Additionally, apparatus which has been devised to partially retract the bags during loading involved relatively difficult maneuvering of several cables or the like attached at several places to the bag.

SUMMARY OF THE INVENTION

The present invention is directed to the solution of the above problems and has other advantages which will be apparent from the description.

To save space while allowing for a maximum capacity breather system in a sealed storage structure, the invention provides a variable capacity system which is easily manipulated to the capacity desired, occupying no more space than necessary while the storage structure is being unloaded over a period of time. The bag is fully retractable when desired, as when the silo is being loaded from its top.

In a particularly advantageous structure of the invention, a flexible bag having a degree of resiliency is employed. The bag is generally flat in its natural state and when deflated, will tend to fold in toward a pleat extending around the lengthwise periphery of the bag. In this folded condition, the bag may be partially retracted by reeling the folded portion over a rotatable drum attached at the top of the silo, thus storing a deflated portion of the bag.

An extendible hose connects the inside of the bag to the ambient and the bag will expand and contract in response to pressure differentials between the silo and the outside atmosphere.

The capacity of the bag is varied by reeling it in or out, thus providing variable proportions of the bag for breather operation. When fully deflated, the bag is in a folded condition and can be fully wound over the drum to be entirely retracted and out of the way for loading operations.

The drawings illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIG. 1 is a plan view of the invention as incorporated with a silo having parts broken away in section for viewing the structure within;

FIG. 2 is an enlarged fragmentary view of parts shown in FIG. 1; with the bag shown partially deflated and retracted;

FIG. 3 is a section taken on line 3-3 of FIG. 1;

FIG. 4 is a cross section of the inflated bag taken at line 4-4 of FIG. 1; and

FIG. 5 is a second cross section as shown in FIG. 4 with the bag in deflated condition.

The drawings illustrate a substantially airtight storage structure 1, such as a silo, which is adapted to hold silage 2, or other perishable material. Silo 1 is supported on a concrete foundation 3 and includes a generally cylindrical, enclosed shell comprised of a wall 4 and a roof 5. The shell and roof may consist of a series of glass coated steel plates.

For unloading the silage, a bottom unloader 6, similar in structure and function to that described in Tiedemann Pat. No. 2,635,770, is included. The essential parts of unloader 6 are a cutter arm 7 rotatably mounted on center post 8 for cutting a swath of silage as it rotates about foundation 3. Cutter arm 7 has an endless chain 9 with cutter teeth which dislodge the silage for conveyance to the center by chain 9. A radially extending trough 10 in foundation 3 receives the dislodged silage and a conveyor mechanism 11 moves the silage to the exterior via door 12, which is normally closed except during unloading.

To load the silo 1, a filler hole on roof 5, normally enclosed by cover 13, is opened and silage is blown into the structure.

Excessive pressures produced by unexpected situations are relieved by a dual relief breather valve 14 on roof 5 which is set to permit gas entrance or exit in response to high pressure differentials in the order of $-1\frac{1}{2}$ inches of water to $+3\frac{1}{2}$ inches of water. Valve 14 can be similar to that described in the Pat. to Martin No. 2,520,771.

To otherwise balance the internal and external pressures creating pressure differentials across the walls of silo 1, a flexible bag 15 is located in the head space above the silage 2 and provides a breather chamber. An outlet tube 16 provides communication between the inside of the bag and the atmosphere, and a reel 17 supports the bag from roof 5.

Bag 15 is elongated and is suspended from reel 17 but is otherwise free from any restricting connections. The bag material is flexible and has a degree of resiliency so as to be able to return to its original shape when deflated. However, the material need not be fully resilient, since gas pressure within the silo will provide some force to return the deflated bag to its original shape.

The bag 15 has a unique structure for cooperation with reel 17 in the manner of the invention. Flexible panels 18 constitute the front and back portions of bag 15, and are generally flat when gas pressure is not being applied to them. Panels 18 are joined at the top, and a pair of uniform side panels 19 is joined along the sides of each front and back panel 18. Side panels 19 may be tapered to a point at the top, so as to permit easy joining of front and back panels 18 and thus provide a sealed top.

To complete the bag, a pair of bottom panels 20 are similarly joined along the bottom edges of front and back panels 18. The two bottom panels 20 and the two pairs of side panels 19 are in turn joined in their respective pairs of a pleat 21, which extends centrally from the top of bag 15 down one side, across the bottom and fully up the opposite side. Pleat 21, although expandable, does not expand to the same extent as do panels 19. Generally, the contracted dimensions of pleat

21 should be such as to permit panels 19 to fold fully inward against the pleat when the bag is deflated.

This structure of bag 15 makes it appear as a teardrop when viewed from the sides in an expanded state and in that state as having a bowed-out, rectangular cross section with an indentation centrally on its sides as in FIG. 4. In the unexpanded state, the bag folds to an accordion cross section, as shown in FIG. 5, and hangs limply from reel 17. In this contracted state, bag 15 tends to return to its original shape by operation of its own resiliency and the gas pressure in silo 1. Pleat 21 thus contracts more fully and the bag folds crosswise like an accordion. The pinched top of bag 15, at reel 17, will cause the upper portion of the bag to fold first, providing a flat portion as partial deflation occurs, as shown in FIG. 2. Bag 15, in this folded condition, or as much of it which assumes that state, may be wound over reel 17 for raising or lowering, and thus varying the portion of the bag available for pressure equalization. In the fully deflated condition, the bag may be entirely wound over reel 17 to be well compressed and then occupies only an insubstantial space, considering the size of the silo.

For these purposes, reel 17 is supported by suitable hangers 22 depending from and attached to roof 5. Hangers 22 are spaced apart a little more than the width of bag front and back panels 18 and each support a bushing 23. To provide a rotatable reel 17, a shaft 24 is journaled within the bushings.

For purposes of providing a winding and storage surface, a metallic drum 25 is mounted on shaft 24 between spaced hangers 22. Drum 25 has a cylindrical wall 26 and two end walls 27, thus providing a cylinder of length generally corresponding to the width of bag panels 18. Shaft 24 extends through central holes in end walls 27, and for connecting means, two collars 28 having lock pins 29 are disposed on the end walls and around the shaft. Drum 25 will rotate with shaft 24. Shaft 24 is excluded from sliding out of one bushing 23 by suitable means, such as a lock pin or nut and bolt. At the opposite end, shaft 24 extends through silo wall 4 and is journaled within a sealed bushing 30 in wall 4, the bushing keeping gas from escaping or entering the silo. As an example of means for providing torque, a pulley 31 is secured to the exterior end of shaft 24 and an endless rope 32, which may extend to the bottom of silo 1, is placed about the pulley. By manipulating rope 32, reel 17 is caused to wind in either direction desired. Alternately, an electric motor could be attached to shaft 24 internally of the silo to provide the torque. Also, when bag 15 inflates, it will contribute to the torque and reel itself out. It would be permissible to have no power means and let the bag wind itself out as needed. In that case a brake could be included.

At the top of bag 15, an unflexible lip 33, such as a corrosive resistant plastic strip, is bonded along the top edge of one panel 18 and is secured to drum 25 by rivets or other attaching means. Secured in this manner, bag 15 will wind or unwind in accordance with the rotation of reel 17.

Since the bag can hang to various levels in the silo, outlet tube 16 is made extendable. For this reason, the tube is flexible and is wound over a tube reel 34 supported for rotation on roof 5 by a suitable hanger 35. Breather tube 36, having the conventional vent cap 37, extends through the roof 5 and is open to the atmosphere. On the inside of silo 1, tube 36 extends to a hollow swivel joint 38 having a stationary chamber 39 to which tube 36 opens, and a rotating, hollow connector 40 connected to and opening to the end of outlet tube 16 which is on reel 34. Tube 36, swivel joint 38 and outlet tube 16, define a passageway between the atmosphere and the inside of bag 15. Reel 34 may be biased by means, such as a conventional circular strip spring, not shown, to assist the raising or lowering of outlet tube 16 in accordance with the length of extension of bag 15 down, and to wind-in tube 16 as the bag is raised. The weight of the bag should be sufficient to overcome the spring. Another assembly which would provide these advantages would be to merely secure reel 34 on shaft 24 so that it can rotate in accordance with the same apparatus which determines the extension of bag 15.

OPERATION

The operation of the invention begins with the loading of silo 1 through filler hole 12, at which time it is desired to retract bag 15 and outlet tube 16. Assuming that bag 15 is at least partially extended and partially inflated, various openings of the silo are uncovered, and any pressure differential with the atmosphere is erased by an inrush or escape of gas or air. Bag 15 will then have equal pressures acting on its panels 18, 19 and 20 and the natural resiliency of the material will cause it to fold inward to pleat 21, like an accordion. Air in the bag will escape through outlet tube 16 to outlet 37 and thus to the atmosphere. Any extra impetus, if needed, to fold bag 15, will be provided by winding it up over reel 17, which will force extra gas out through tube 16.

Before the silage is loaded, endless rope 32 is reeled to rotate pulley 31, thus rotating shaft 34 and drum 35. The folded bag is thereby fully retracted by reeling it up over drum 25. Outlet tube 16 follows the bag and is wound around reel 34. Silage is then loaded as high in the silo as desired, up to near the reels 17 and 34.

The silo is then resealed and the endless rope 32 is maneuvered to partially extend bag 15 down to the level of the loaded silage 2. The extended portion of bag 15 is then available for expansion and contraction to equalize the internal and external pressures.

At times, it will be desired to withdraw some of the silage and this is done by using bottom unloader 6. The level of silage 2 will thus drop over a period of time, creating more headspace above the silage level. Greater breather capacity is then needed, so endless rope 32 is again reeled to let out more bag 15 and tube 16. This is repeated until the silage is low enough to permit full extension of the bag. All the while, the extended portion of the bag will expand and contract to equalize pressures, as shown by the phantom lines in FIG. 1.

By this means, the invention provides a variable capacity breather system which may at times be fully retracted and taken out of the way of other operations.

It is contemplated that the system could provide a plurality of such bags and reels and thereby make the system all the more variable.

The embodiment described is the best example presently contemplated of the various modes of the invention. The following claims particularly point out and claim the subject matter of the invention.

I claim:

1. In an upright normally sealed storage structure for storing perishable materials, the structure being adapted for loading and unloading of the stored material resulting in a varying amount of headspace at the top of the structure, the breather system comprising:

A support assembly attached to the storage structure;

A breather member operably connected to the support assembly, the breather member defining a closed chamber located in the headspace and having an expansible surface exposed internally to ambient pressure and exposed externally to pressure in the headspace and the breather member being retractable and extensible to and from the support assembly, the breather member having a larger volume in the extended condition; and

A retractor assembly connected with said breather member and having a storage member with which portions of said breather member are stored as said retractor assembly selectively retracts and extends said breather member.

2. The invention defined by claim 1, wherein the structure is adapted for loading at its upper end, the support structure is disposed at the top and the breather member and storage member occupy only insubstantial space in the top of the structure when the breather member is fully retracted and stored.

3. The invention defined by claim 2, wherein the breather member comprises a flexible bag exposed internally to the ambient pressures, the bag being expandable and contractable in response to pressure differentials between the ambient and the

headspace, and the bag when contracted being foldable into a flattened condition.

4. The structure of claim 3, and including an extendible outlet tube attached to the extended portion of the bag and extending to an opening in the storage structure, said tube defining a passageway between the ambient and the inside of the bag, and the tube being extendible in accordance with the retraction and extension of the bag.

5. In an upright generally sealed storage structure for storing perishable materials, the structure being adapted for loading and unloading of the stored material resulting in a varying amount of headspace at the top of the structure; the breather system comprising:

A flexible bag disposed in the headspace, the bag being exposed internally to the ambient pressures and being expandable and contractable in response to pressure differentials between the ambient and the headspace, the bag further being retractable and extensible within the headspace and having a larger volume in the extended condition, and the bag portions when contracted being foldable into a flattened condition; and

A retractor assembly including a rotatable reel having a drum, the reel being supported at the top of the storage structure, the drum providing a winding and support surface to which one end of the bag is attached an over which the portion of the bag which is in the flattened condition is wound by rotation of the reel, and a reel operating member connected to the reel and operable to exert torque on the reel.

6. The structure defined by claim 5, wherein the bag is elongated and has at least one longitudinally extending pleat, the bag being foldable against said pleat to partially assume said flattened condition.

7. The structure defined by claim 6 wherein the bag has a series of second longitudinally extending pleats extending a substantial distance from the portion of the bag which is attached to the drum, the bag being foldable against said pleats.

8. The structure defined by claim 5, wherein the bag has front and back elongated sections, portions of said sections being attached to the drum and extending laterally away from the winding surface, the front and back sections having corresponding side edges, the bag also having intermediate sections connecting said corresponding side edges, and the intermediate portions are each pleated and foldable when the bag is contracted.

9. The structure defined by claim 5, wherein the bag depends lengthwise freely from the reel drum a predetermined distance in accordance with the degree of winding of the flattened portion of the bag over the drum;

said bag is comprised of a set of front and back panels the width of which extend longitudinally of the drum winding surface, said panels having longitudinal side edges and bottom edges, and a second series of panels connected to corresponding pairs of said longitudinal edges and extending between the bottom edges;

a pleat disposed in said second set of panels and extending around the periphery of the bag; and the front and back panels being foldable against the pleat during contraction of the bag and in such condition provide said flattened condition of the bag.

10. The structure of claim 9, wherein the pleat is formed in a portion of the bag which is less expandable than the second set of panels and the pleat when contracted is disposed inward of the longitudinal and bottom edges in accordance with the desired degree of flattening of the bag when contracted.

11. The structure defined by claim 5, and including an outlet assembly comprising:

a flexible outlet tube attached to the bag;

reel means attached to the storage structure and carrying the outlet tube for winding the tube in and out in accordance with the winding of the bag over the drum; and

a hollow outlet joint connected to the tube at the location of the reel means and communicating with an opening in the storage structure, said joint having swivel means for following the tube during winding in and out by the reel means and providing a moveable gas connection to the joint, said tube and joint defining a gas passageway between the inside of the bag and the ambient.

12. In a normally sealed storage structure for storing perishable materials, the combination comprising:

a support structure connected to the storage structure;

A flexible breather bag operably attached to the support structure, the bag having an extended condition and a retracted condition relative to the support structure, and the bag being expandable to a predetermined maximum volume in each condition, with the maximum volume in the extended condition being substantially larger than the maximum volume in the retracted condition;

bag retractor means attached to the bag for retracting and extending the bag and for maintaining the bag in a predetermined extended or retracted condition; and

outlet means having a flexible tube connected to the extended portion of the bag and extending to an opening in the storage structure for providing communication between the bag and the ambient pressure, the outlet means being constructed to allow the tube to follow the retraction and extension of the bag.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,568,588 Dated March 9, 1971

Inventor(s) ALLEN A. KUDECK

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 17,

Cancel "35" and substitute
therefor ---25---

Column 4, line 72,

Cancel "2" and substitute
therefor ---1---

Signed and sealed this 6th day of July 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents