Jan. 22, 1952 J. M. RIBOUD 2,583,062
VAPOR SELECTIVE BREATHER
Filed March 13, 1947

Fig. 1

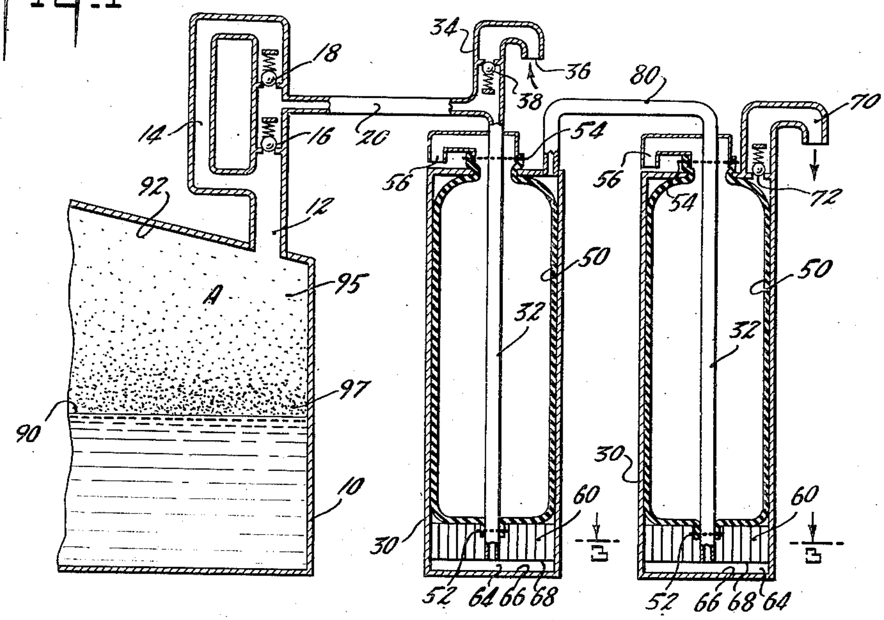


Fig. 2

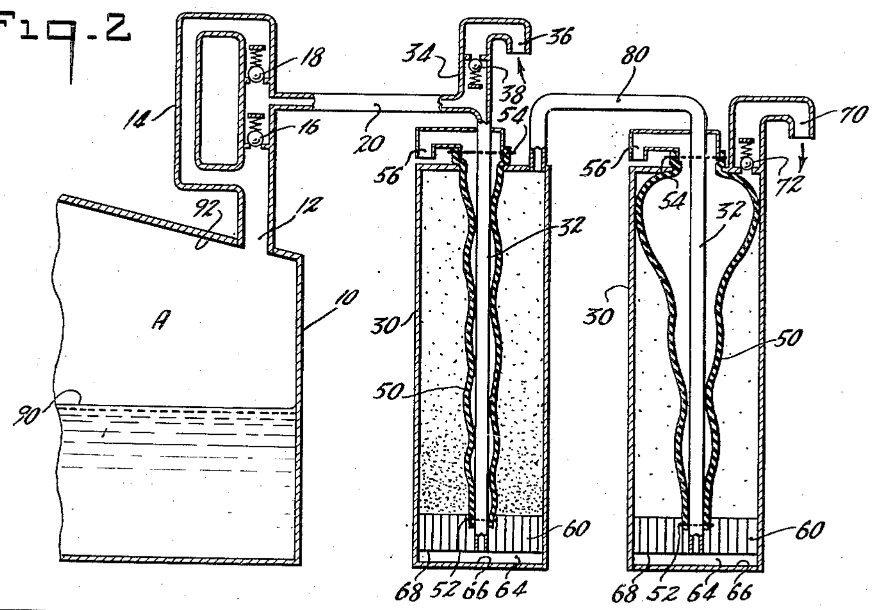
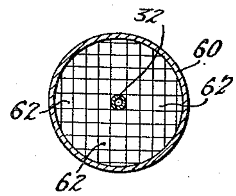


Fig. 3



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VAPOR SELECTIVE BREATHER

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1 Claim. (Cl. 220—85)

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My invention relates generally to the storage of volatile liquids, as gasoline and the like. In particular, my invention relates to a method of and apparatus for handling such material as to retain during storage the richest portion thereof.

When stored in sealed containers, as tanks and the like, the space between the liquid level and the roof of the tank becomes saturated with gasoline vapor, a mixture of gasoline and air. The liquid gasoline material evaporates until the relative proportion of gasoline vapor to air within the—so to speak—vapor space reaches a maximum, dependent on such factors as temperature, volatility of the liquid, etc. When the contents of the vapor space expand, a certain amount thereof will be expelled from the tank through a safety valve outlet conventionally supplied in all volatile liquid storage tanks. These tanks are not normally or usually built to withstand substantial internal pressures, and so provision is made for relief from pressures developed by expanding vapor within the tank. The outlet valves, therefore, permit the escape of vapor therethrough when expansion within the tank builds up pressure above the valve setting. When the contents of the vapor space contract, fresh air is drawn into the tank through a suitable inlet to equalize the internal pressure, which fresh air then mixes with the evaporated gas material until that fresh air is saturated and itself becomes part of the gasoline vapor.

These phases of expansion and contraction are caused by several factors, among them being temperature variations in the vapor space or at the liquid level within the tank, etc., and the cycle of contraction and expansion is commonly known as "breathing." This breathing action also occurs when fresh volatile liquid is pumped into the tank and air is driven out therefrom, and also occurs when fuel is taken from the tank and air admitted and mixed with the evaporated liquid and vapor already present in the tank.

In my invention, I am primarily concerned with the handling of the gasoline vapor during the breathing process. I have found that gasoline vapor is not at all homogeneous; that the vapor close to the liquid level is rich in gasoline content; and that the vapor remote from the liquid level is much leaner in gasoline content. In short, I have found that within storage tanks, the richness of the vapor in gas content with respect to air content varies directly with its proximity to the liquid level. In my invention, I have utilized this circumstance so that I am enabled, with my apparatus, to control the vapor breathing as to lose on expansion the leanest vapor and to retain the richest vapor.

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Numerous processes and apparatus are conventionally known to reduce losses by evaporation in large capacity storage tanks, one such process consisting of connecting the tank with a gas holder, also called a balloon or breather. During the expansion phase, the gasoline vapor is caused to flow into the holder and stored therein, and during contraction it is permitted to flow back into the tank. Since this expelled and retracted vapor is already quite rich in gasoline content, there is no new evaporation. The amount of vapor which may be expelled will, of course, vary with the size of the storage tank and the relative volume of liquid with respect to the vapor space, and it will also vary dependent upon the volatility of the particular gas stored and the amplitude of the temperature variations. It has been found, in practice, that the volume of vapor expelled may be very large in relation to the volume storage tank, and since the gas holders, balloons or breathers (as these devices are called) are seldom of sufficiently large size so as to meet all the variations of permissible conditions would be very uneconomical, and this arrangement is thus more theoretical than practical.

I have been able to reduce the size of the gas holders without decreasing the efficiency thereof, or rather, to increase the efficiency thereof by using the device of my invention as hereinafter described.

The main object of my invention, therefore, is the provision of a method and apparatus to control the movement of the vapor during the breathing cycle so as to retain the richer portions and permit escape only of the leaner portions thereof.

Another object of my invention is the provision of a method of and apparatus for selectively breathing vapor from volatile liquid storage tanks, so as to prevent intermingling of the vapor from different regions of the vapor space.

Still another object of my invention is the provision of an apparatus for permitting storage tanks for volatile liquids to breathe in response to condition variations, so as to expel the vapor in more or less strata condition, and prevent intermingling of the vapor from different space levels.

Still another object of my invention is the provision of a breather unit which is several times longer than it is wide; which has vapor channelling means therewithin to reduce or minimize gas vapor swirling or agitation; which has hollow bags therewithin which will be inflated to occupy unit space during the contraction phase, and which will be deflated during the expansion phase.

Other and further objects, of which the above are merely indicative, will in part be pointed out specifically, and still others will be apparent from the following description of an illustrative embodiment thereof.

In the drawings annexed hereto and forming a part hereof,

Figure 1 is a vertical cross section through one form of apparatus constructed according to and embodying my invention, the portion of the parts being shown as during the contraction phase;

Fig. 2 is a similar section during the expansion phase; and

Fig. 3 is a section on the line 3—3 of Fig. 1.

The gas storage tank is indicated generally by reference numeral 10, and may be of conventional size, shape and material, and having an inlet opening 12 connected to a two-way conduit 14 having a pair of oppositely acting valves 16, 18 therein; relief valve 16 being so arranged as to permit the exit of gas and/or vapor from the interior of tank 10, and valve 18 being so arranged as to permit the entrance of gas, air, vapor, etc., into tank 10, through suitably disposed conduit 20.

I provide either one or more holder units 30, 30 of elongated cylindrical hollow shape, the relationship between diameter and height being such that the units 30, 30 are several times higher than they are wide. The reasons for this particular dimensioning, and the importance thereof will be detailed below.

Conduit 20 is connected to a pipe 32 which is of such length as to extend down into the interior of unit 30, short of the bottom thereof, having a branch 34 extending upwardly from conduit 20 which is vented to the atmosphere as at 36. A relief valve 38 is mounted in branch 34, valve 38 being so biased to permit only the entrance of air through opening 36, so that any vapor moving from tank 10 through conduit 20 will pass directly into pipe 32 down towards the bottom of unit 30. An air bag 50 is provided and disposed within the interior of unit 30, the material of which bag is of such character as to be resistant to the action of the liquids stored in the tank 10. The bottom of each bag 50 is tied off as at 52 around pipe 32, and the top of each bag 50 is tied about a tube 54 which is vented to the atmosphere as at 56, so that bags 50, 50 will always be in communication with the atmosphere.

In the bottom of each holder unit 30 I provide a honeycomb device 60, composed of a plurality of vertical, independent conduits 62, 62 in each thereof, through the center of which honeycomb pipe 32 passes. As shown in Figs. 1 and 2, the honeycombs 60, 60 are mounted slightly above the floor or bottom of unit 30, and vapor material passing down through pipe 32 will pass into and through the space 64 between the holder unit floor 66 and the underside 68 of the honeycomb 60, and then up through the vertically extending conduits or channels 62, 62.

If more than one holder unit 30 is provided, the endmost thereof will have, in addition to the elements above-described, an air vent 70, having a valve 72 therewithin so biased as to prevent the entrance of air or other material therethrough into the units.

In operation, and during the period of contraction, the air bag 50 in the first holder unit 30 is expanded by the suction created by the emptying of units 30, 30 so as to bell out and occupy the interior of the units. This condition is illustrated in Fig. 1. When the expanding phase begins, the gasoline vapor driven from tank 10 through valve 16, passes through conduit 20, into and down pipe 32 into the space 64 of the first unit 30. The vapor then moves up through the vertically extending channels 62, 62 of honeycomb 60 to fill the interior of unit 30 and cause a shrinkage of bag 50, as illustrated in Fig. 2. This operation continues until bag 50 is entirely collapsed and the first unit 30 is filled with vapor, and if more vapor is expelled from tank 10 after the first of units 30 is full, the pressure within holder unit 30 will rise and the vapor within will be forced out of the first unit 30 through conduit 80 and into the second unit 30 through pipe 32, up through honeycomb channels 62, 62 in that unit until the bag in the said second of units 30 is collapsed. If the expansion phase still continues, and the pressure keeps rising, relief valve 72 in vent 70 will open and permit the spilling of vapor therethrough into the atmosphere. During the contraction phase of the breathing process, the vapors will move in the reverse path, entering tank 10 through and past valve 18, and the units 30 will be emptied. Upon further contraction, relief valve 38 will open to permit the passage therethrough of air to equalize the internal pressure within tank 10.

I have found, as above recited, that within the vapor space of tank 10, that is, within the space A between the top of the liquid level as 90, and the underside of the tank cover 92, there is no equal distribution of vapor; that is, the vapor is not a homogeneous mixture at all. In fact, I have found that the vapor is substantially layered, and in the upper strata or layer 95, nearest the tank top 92, the gasoline content is very small and the vapor is mainly composed of air. There is more gasoline and less air content in the successive lower layers, with the maximum gasoline content and minimum air content in the layer 97 immediately adjacent the liquid level 90. Thus, in the expansion phase of the breathing, vapor from the upper portion of space A, as at 95 is first driven from tank 10 into the first of units 30, 30, which vapor is very poor of gasoline content. The vapor, of course, gets richer and richer in gasoline content as the expansion is continued until vapor from level at 97 is forced out of tank 10. It is of course highly desirable that only the vapor which comes out of tank 10 at the end of the expansion phase be stored in the holder units 30, 30, since it is this vapor which is richer in gasoline content, and with my device this aim is accomplished, since the vapor initially expelled during the expansion phase is driven off through outlet 70 and the vapor subsequently expelled from tank 10 is retained in the holder units 30, 30. The lean mixture which first fills the holder units 30, 30 is driven out by the richer mixtures which are subsequently expelled from within the storage tank 10.

In conventional storage tanks and breather devices, the vapor which is first driven off during the expansion phase is blended and mixed with the richer vapor subsequently expelled, so that at the end of the expansion phase, there is a mixture of lean and rich gasoline vapor, rather than only the rich mixture desirable. Due to the particular elongated shape of the holder units 30, 30, and due also to the provision of the honeycomb devices 60, 60, blending and mixing of the lean and rich vapors is minimized. When the horizontal section of the flow of vapor is small, as in my device, and the direction of flow is kept in more or less a straight line, with swirling eliminated, also as in my device, there will be no intermingling of the layers of rich and lean mixtures. In my device, the relative narrowness of the units 30, 30, and the straight line channeling of the vapor through honeycombs 60, 60, reduces the intermixing action, and keeps the gas vapor in its layered relation as driven off by tank 10 internal pressures. Thus, at the end of the expansion phase, the units 30, 30 are filled with the richest vapors, and when these return to tank 10 during the contraction phase of the breathing process, the vapors already rich in gasoline content will reduce evaporation to the minimum, and it is obvious that my method and apparatus result in a higher efficiency for reducing evaporation than conventional devices having the same overall capacity.

Having now described by invention, what I claim and desire to secure by Letters Patent is:

An apparatus of the character described, comprising a gas storage tank, a plurality of holder units adjacent thereto, the first of which is in

direct communication with the tank, and the last of which is in communication with an adjacent holder at one side thereof and open to the atmosphere at the other side, a normally expanded hollow bag within each of the holders to fill the space therewithin upon contraction of the gas within the tank, said bags offering slight resistance to contraction and to the movement of vapor under pressure into and through the holder upon expansion of the gas within the tank the bags being in direct communication with the atmosphere, and means within the holder units to direct movement of vapor therethrough in straight line paths.

JACQUES MARCEL RIBOUD.

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