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STORAGE SYSTEM

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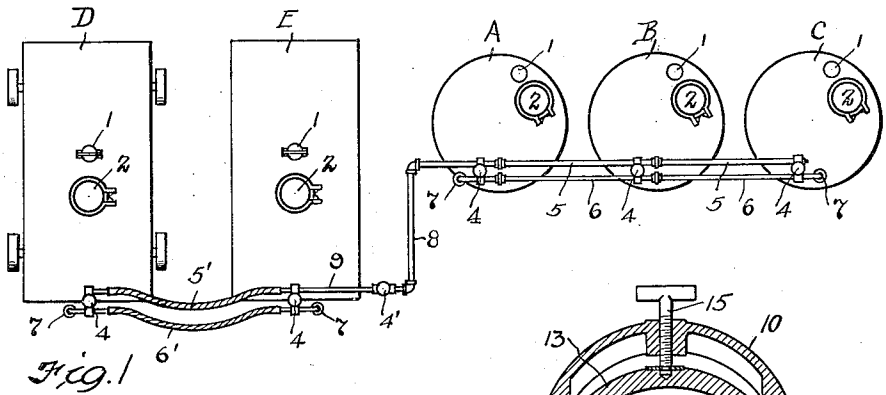


Fig. 1

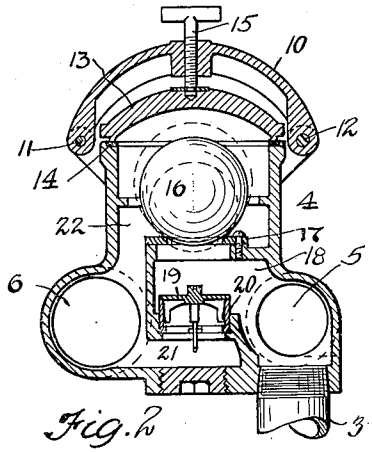


Fig. 2

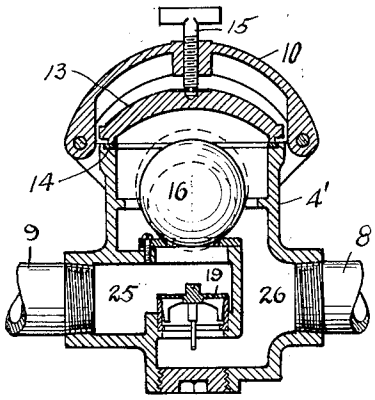


Fig. 4

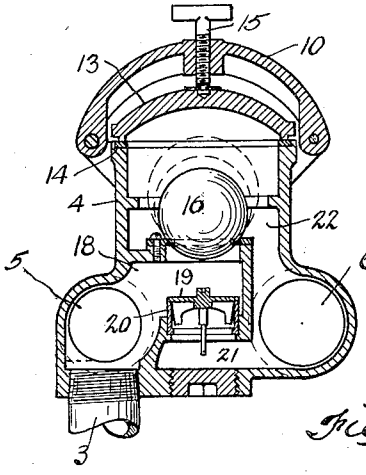


Fig. 3

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STORAGE SYSTEM

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9 Claims. (Cl. 220—85)

The present invention relates to a system for the storing and handling of volatile or vaporizable liquids, and to apparatus designed for use in such system. For a particular example, I have contemplated the application of my invention to the storage, handling and shipment of liquid hydrocarbon fuels, such as gasoline.

It is the general object and nature of my invention to provide means and process for conserving the vapor of a liquid such as gasoline when it is stored, handled, or transported in large quantities. When a quantity of such volatile liquid is placed in a container, it is well known that owing to changes in temperature and other conditions the vapor pressure continually varies, or in other words, that the container undergoes a "breathing" action during which alternately the vapor from the liquid is passed off to the atmosphere and a certain amount of air is drawn or inhaled into the container.

Also whenever such liquid is withdrawn from a container, the vacuum that would otherwise be created, is relieved by admitting air, which mingles with the vapor from the liquid, and this mixture is then passed off when the container is again filled, either in whole or in part, with the liquid.

It is an object of my invention to distribute and equalize the aforesaid breathing action of a plurality of volatile liquid containers as well as confine the vapors displaced incidental to the filling and refilling of such containers, so that the vapor which has been heretofore exhausted and lost in the atmosphere will be properly conserved and retained within the system.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a top plan view of a series of storage tanks illustrating the general application of my vapor control system; Fig. 2 is a greatly enlarged sectional elevation of one of the vapor control valves installed in the high pressure series of tanks; Fig. 3 is an elevational view similar to Fig. 2 illustrating the construction of one of the low pressure tank vapor control valves; Fig. 4 is a sectional elevational view of the equalizer valve positioned between the high and low pressure tanks.

The variation in vapor pressure of a volatile liquid or gasoline tank is due to substantially three factors, viz: (1) temperature variation, (2) barometric pressure variation, and, (3) variation in the liquid volume.

It will thus be seen that where a plurality of such storage tanks is provided that a continual intake and exhaust of vapor and air occurs in each of the several tanks. Heretofore, efforts towards the conservation or partial limitation of this breathing action have been limited to the provision of a double acting check valve positioned upon each individual tank. The principle of my invention, however, is based upon the theory of preventing the exhaust of the vapor to the atmosphere and distributing the pressure incident thereto throughout the system, and coincidentally, when the vapor pressure of an individual tank attains such a limit as to actuate the check valve which is positioned upon the particular tank, the excess pressure and vapor will then be conducted to any lower pressure area throughout the system and absorbed by whatever tank or tanks might at that time possess a lower vapor pressure. Accordingly, there will be loss due to the exhaust of vapors to the atmosphere only in the exceptional case where all of the tanks are simultaneously full or under maximum pressure.

Now referring more particularly to Fig. 1, I have shown a series of low pressure tanks, A, B, and C and a series of high pressure tanks D and E. The low pressure tanks A, B and C which are usually of the vertical large capacity type have a certain maximum pressure limit due to their necessarily large proportions. The high pressure tanks D and E which are of the horizontal type can necessarily by virtue of their construction accommodate a larger vapor pressure. To employ more specific terminology, the low pressure tanks A, B and C represent bulk storage tanks the tank D represents a tank wagon or railroad tank car, and the tank E is a loading tank positioned adjacent a railroad line or highway. Each one of the tanks customarily has positioned upon the upper walls or "vapor side" a thief hole and cover 1, and a manhole and cover 2. These openings are normally sealed to the outside atmosphere. Another opening in the upper wall or vapor side of the several tanks is provided through the pipe or conduit 3 which leads to the vapor control valve housing indicated generally by the numeral 4.

A connecting pipe or manifold 5 places each one of the vapor openings 3 in communication with the remainder of such openings in the respective series of tanks. Another conduit pipe or manifold 6 connects the pressure side of the vapor control valves with each and every other valve of the series. In the case of the loading tank E and the tank wagon D, flexible, readily disconnectible conduits 5' and 6' are provided which serve the same function as the manifolds 5 and 6, but permit the necessary relative movements between the two tanks. Air intake or outlet ports 7 are provided at suitable positions upon each end of the pressure manifold 6. The ports 7 are merely screened openings and hence have not been illustrated in greater detail. A conduit 8 connects the low pressure or vacuum manifold 5 to the conduit 9 which leads to the analogous manifold 5' in the high pressure series of tanks. An equalizer valve 4' is connected between the conduits 8 and 9.

The vapor control valves illustrated in Figs. 2, 3 and 4 possess substantially identical modes of operation and are merely different in structural arrangement, and therefore, they will be described simultaneously. These valves consist of the main casing or housing 4 upon the top of which is attached a yoke 10 hinged at the point 11 and locked in position by means of a cotter pin or padlock at the point 12. A valve housing cover 13 which seats upon a gasket 14 is held in position by means of a threaded T-bolt 15. A spherical ball 16 is seated upon a removable gasket 17 which is in turn held in position by suitable fastening screws. A passage 18 places the above described ball valve in communication with the conduits 3 and 5. A second valve 19 of the poppet or disc type is positioned upon a seat 20 and in turn communicates with the passage 21 leading to the conduit or manifold 6. The valve 19 is preferably constructed of a light metal such as aluminum in order that its actuating pressure may be relatively low, which in the instantly contemplated embodiment is 1 ounce per square inch.

The lower portion of the valve housing, it will be noted from Figs. 2 and 3 flares out in order to accommodate the manifold passages 5 and 6. These manifold passages, as incorporated in the valve housing 4 are placed in parallel relationship in order to facilitate the installation of the vapor conservation system upon a series of tanks. In installing the vapor control system, it is merely necessary to connect the valve housing 4 to the pipe 3 and then the manifold openings in the valve housing may be turned into position in order to be in alignment with the manifold conduits 5 and 6.

The construction of the equalizer valve shown in Fig. 4 is substantially the same as that just described with the exception that the ball valve 16 and poppet valve 19 are positioned in the passages 25 and 26 respectively. The passage 26 communicates with the conduit 8 and the passage 25 communicates with the conduit 9.

It will be noted that the ball 16 can be made of various diameters as indicated by the dotted lines in Figs. 2, 3 and 4. Likewise, the ball seat gaskets 17 are made removable and interchangeable to accommodate various sizes of balls and to give a variation in the diameter of the opening. In this manner, it is possible to predeterminately regulate the actuating pressure of each and every one of the vapor control and equalizer valves. By way of specific example, it is contemplated that the vapor control valves 4 are positioned in the low pressure series of tanks A, B, and C and shall be set at a pressure of 13 ounces per square inch; that the vapor control valves in the high pressure series of tanks D and E be set at a pressure of 48 ounces per square inch; and that the equalizer valve be set at a pressure of 40 ounces per square inch.

The mode of operation of the above described system is as follows: The initial vapor pressure generated by each of the tanks, whether in the high or low pressure series, is conducted through the individual connections 3 and distributed throughout the remainder of the tanks of the respective series through the manifold 5. This distribution will continue until the vapor pressure limit at which the ball valves have been predeterminately set is reached. When such limit is exceeded, the ball valve 16 will be opened and the excess pressure permitted to flow into the manifold 6 where it will, in turn, be distributed to the series of tanks and taken in through the passage 21 and valve 19 into whatever tank might at that time possess a lower vapor pressure.

The equalizer valve 4' which is set at a pressure intermediate the individual limits of the vapor valves of the high and low pressure series functions to permit the high pressure tanks to vent into the series of low pressure tanks. The air intake port 7 on each end of the pressure manifolds 6 and 6' permits air to be inhaled into the system in the event that the pressure within any one of the tanks or the resultant pressure in the series of tanks should drop below atmospheric and a consequent replacement of such a gaseous volume becomes necessary. The port 7 further serves the purpose, that if necessity demands, when the pressure in all of the tanks becomes greater than that at which the vapor control valves are set, then such excess vapor pressure will be passed to the atmosphere through these ports. However, such a contingency is relatively exceptional due to the fact that in a series of tanks there will always be one or more individual tanks which are being emptied or subjected to a relatively lower temperature and hence are below the predetermined pressure and consequently inhaling a volume of air or vapor or both.

In brief conclusion, it will be seen that the principle of my system provides in effect two parallel distribution manifolds. The first of these manifolds is adapted to operate within a certain pressure limit prescribed by the predetermined pressure at which the ball valves have been set. The secondary manifold system operates at the pressure in excess of such predetermined limit.

In actual practice, it has been ascertained that the elimination of vapor loss made possible by the principle of my invention amounts to 1½% of the total volume of liquid stored and transported; or in other words, the application of the principle of my invention has permitted the saving of 2,000 to 10,000 gallons per 400,000 gallons turnover.

The interests of safety are also promoted by the application of the principle of my invention. Due to the conservation of the vapor within the system of tanks, the presence of such vapor in the vicinity of a storage system greatly reduces fire hazards as well as being conducive to health and sanitation in that the liberation of noxious gases is practically eliminated. By way of recommendation for efficient operation of the system, it should be pointed out that in practice the tanks are preferably filled with liquid to about ⅔ ca-

pacity. This leaves ⅓ of the volume of the tanks as a vapor and vapor pressure reservoir. Hence when additional quantities of liquid are pumped into the system, it has been found that the volume of liquid receivable into the system without vapor loss is directly proportionate to the pressure at which the vapor control valves are set. For example, if a space of 200,000 gallons is available, assuming that there is no pressure in the tanks, 6,000 gallons may be pumped into the system without incurring any vapor loss when the vapor control valves are set at 10 ounces per square inch. Similarly 12,000 gallons may be added to the system without vapor loss when the vapor control valves are set at 20 ounces per square inch.

In the appended claims, the vapor manifold which is connected directly to the vapor side of the series of tanks is referred to as "the primary manifold". The vapor manifold which is connected in parallel with this primary manifold and to the opposite sides of the vapor control valves and placed in communication with the atmosphere is referred to as "the secondary manifold". This explanation of terminology is inserted for the purpose of more readily comprehending the subject matter defined by the appended claims.

It will be understood, of course, that while three storage tanks are shown in the drawing (Fig. 1), the number of these may be less and, usually, will be considerably greater, similarly, while only one loading tank E is illustrated, there will ordinarily be a number of these suitably interconnected for vapor pressure relief and transfer, such connections being the same as those shown between said tank E and truck tank D, except they need not be flexible nor readily disconnectible.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold normally closed to the atmosphere and connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, and means for venting said primary manifold into said secondary manifold at a predetermined vapor pressure.

2. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, and double acting valve means positioned between said secondary and said primary manifolds.

3. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold normally closed to the atmosphere and connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, and atmospheric ports connected to said secondary manifold.

4. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, double acting valve means positioned between said secondary and said primary manifolds, and atmospheric ports connected to said secondary manifold.

5. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, double acting valve means positioned between said secondary and said primary manifolds, and means for predeterminately regulating the actuating pressure of said valve means.

6. In a volatile liquid storage system, the combination of a series of atmospherically sealed chambers, a primary manifold connecting the vapor side of each of said chambers, a secondary manifold connected in parallel with said primary manifold, double acting valve means positioned between said secondary and said primary manifolds, and means for predeterminately regulating the actuating pressure of said valve means, and atmospheric intake ports connected to said secondary manifold.

7. The method of storing a volatile liquid comprising the steps of proportioning such liquid into separate bodies, venting the vapor pressure generated by each of said liquid bodies one into the other, and then venting the vapor pressure generated in all bodies in excess of a predetermined pressure to the atmosphere.

8. The method of storing a volatile liquid comprising the steps of proportioning such liquid into separate bodies, equalizing the vapor pressure generated by each body throughout the several bodies, and then venting the vapor pressure generated in all bodies in excess of a predetermined pressure to the atmosphere.

9. The method of storing a volatile liquid comprising the steps of proportioning such liquid into separate bodies, limiting the vapor pressure attained in such several bodies, and then redistributing the excess pressure throughout the system.

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