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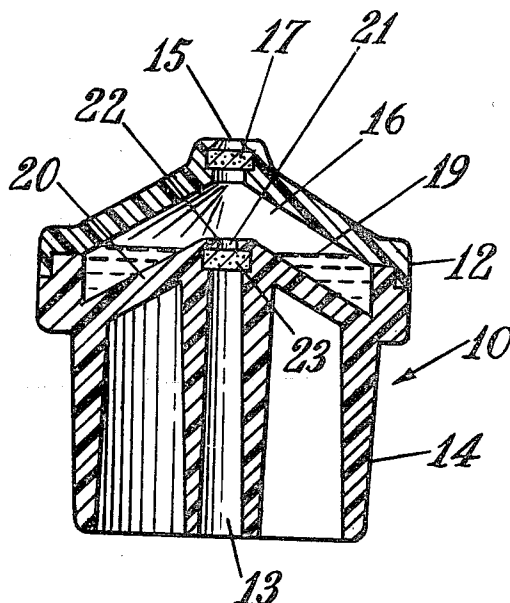
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[54] **VENTING CLOSURE FOR LIQUID CONTAINERS**
7 Claims, 4 Drawing Figs.

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 44, 44A; 136/177+, 178+; 215/56; 251/21

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ABSTRACT: A venting closure for a liquid container, e.g. a battery vent plug, which is sensitive to tilting of the container such that the vent closes off whenever the container tilts and opens when the same resumes its original position. The closure consists of a chamber containing a partial filling of mercury. The chamber has an upwardly sloping bottom surface having a small opening in the upper portion thereof communicating with a vent passage. The top of the chamber also has a vent opening for permitting gases to escape from the chamber. Each opening is small enough to prevent the liquid mercury from flowing through it but large enough to vent gases therethrough. In operation, when the container tilts, the mercury flows over and closes off the openings thereby preventing fluid from leaking from the container. When the container resumes its original position the mercury flows away from the openings thereby permitting the vents to again open.



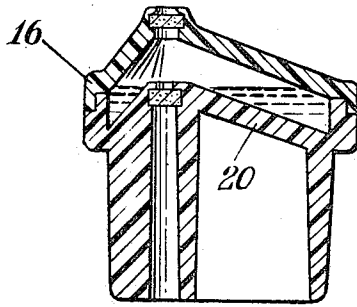


Fig. 4

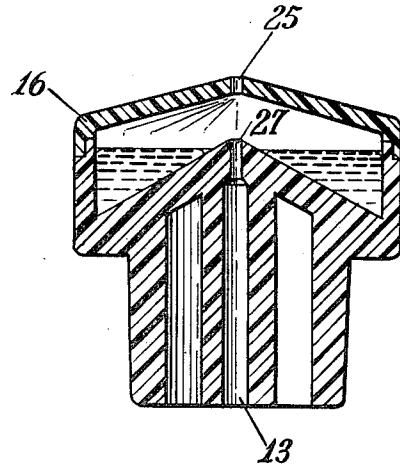


Fig. 3

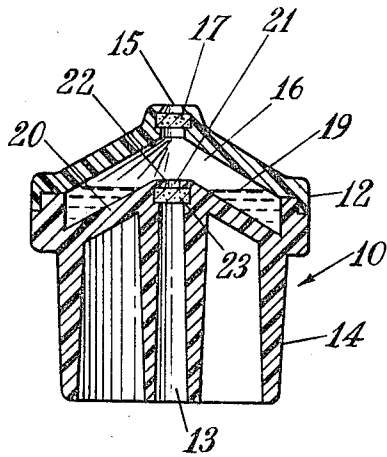


Fig. 1

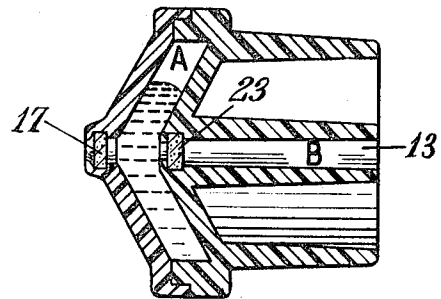


Fig. 2

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VENTING CLOSURE FOR LIQUID CONTAINERS

This invention relates to a venting closure for a liquid container and more particularly to a venting closure of the non-spill type. Closures of this type are employed to prevent the spilling of liquids whenever the container is abnormally tilted from its upright position. A particularly valuable application of the invention is as a battery vent plug. When used in battery cells, the apparatus permits venting of battery gases under normal operation when the cell is in a substantially upright position, while operating automatically to prevent spilling of electrolyte therefrom when the cell is tilted abnormally, such as in aircraft or shipboard use.

Many nonspill vent plugs have been suggested by the prior art. Most of them however employ mechanical valves of various types which are actuated by pendulums or other movable weights as the container tilts. In addition to their relative complexity, these units are not entirely satisfactory because they do not respond quickly when the container resumes a normal upright position. One reason for this is that gas pressure frequently builds up whenever the container remains tilted for a considerable time period. Usually this pressure prevents or retards the valve from opening quickly. Moreover, dirt and battery acids acting over the service life of the battery frequently produce wear upon valve surfaces causing premature leakage.

A primary object of the invention is to provide a venting closure for a liquid container which is quick acting and positive in action and which will automatically close off the vent passage when the container is tilted, but will quickly open such passage when the same resumes its original position;

Another object is to provide a venting closure which operates without mechanical valves;

Yet another object is to provide a novel vent plug characterized by simplicity of construction and reliability of performance.

These and other objects are achieved by the apparatus of the invention which generally comprises a plug adapted to be secured in an opening in the top of a container. The plug has a chamber therein having an opening to the atmosphere. The chamber has an upwardly extending bottom wall forming a raised surface therein. Preferably, the chamber bottom surface is frustoconical. The plug has a passage which normally vents the space-above the liquid in the container to the chamber through an opening in such raised surface when the container is in an upright position. The chamber has a partial filling of liquid mercury. In operation, when the container is tilted, the mercury flows over the opening in the raised surface, thereby closing off the vent passage. When the container resumes its original position, the mercury flows away from the opening in the raised surface, thereby opening the vent passage.

In the drawings:

FIG. 1 is a vertical cross-sectional view of a preferred embodiment of the venting closure of the invention, the same shown in a normal upright position;

FIG. 2 is a view similar to FIG. 1 but showing the closure tilted 90° from its upright position;

FIG. 3 is a vertical cross-sectional view of another embodiment of the invention; and

FIG. 4 is a vertical sectional view of still another embodiment of the invention.

Referring now to FIG. 1, the preferred venting closure according to the invention is shown. The closure has a body 10 having an upper portion 12 and a lower portion 14. The body preferably is formed of nonamalgamating material such as stainless steel or plastic. The lower portion 14 has a slightly tapered wall making it adaptable for easily securing the same in an opening in the top of a container (not shown) such as, for example, a battery cell cover. The upper portion 12 terminates in an enclosed chamber 16 having at least one opening 15 to the atmosphere. Preferably, a porous body 17 is positioned in the upper wall of the chamber thus providing a venting path from the chamber to the atmosphere. The closure in-

cludes a vent passage 13 extending through the body thereof. This vent passage normally vents the space-above the liquid level in the container to the chamber 16.

The chamber 16 has an upwardly sloping bottom wall 20, terminating in a generally raised surface 22 having at least one opening 21 therein in communication with the vent passage 13. This permits the passage 13 to vent into the chamber 16. Preferably, a porous body 23 in the shape of a disc is positioned in the bottom wall 20 at the generally flat portion thereof. The porous disc provides a large number of very small openings which form a path for venting gases to the chamber 16. The chamber 16 also contains a partial filling of liquid mercury 19 which is operable to close off the vent passage 13 upon tilting of the container. Preferably, the porous bodies 17 and 23 are formed of a material which does not amalgamate in the presence of mercury. Examples of materials found suitable are stainless steel, nickel, plastics, e.g., polyethylene, carbon and various ceramics. For most purposes it is preferred that the bottom wall of chamber 16 be frustoconical as shown in FIG. 1 since this configuration is most responsive to tilting in any direction. In operation, upon tilting of the container, the liquid mercury flows over the exposed surface of porous body 23 (see FIG. 2) thereby closing off the vent passage 13. Concurrently, the mercury also flows over the lower surface of porous body 17. The openings in the porous bodies 17 and 23, while large enough to vent gases, are small enough to prevent passage of the mercury which has a high surface tension. It has been found that nonamalgamating porous material having a porosity of 50 percent and a pore size of 20 microns is admirably suited for use in the vent closure of the invention. As the mercury covers the exposed surfaces of porous bodies 17 and 23 it creates air locks A and B in the chamber 16 and vent passage 13 respectively (see FIG. 2).

Air lock A is formed whenever the closure assumes a position which causes the mercury in chamber 16 to cover porous bodies 17 and 23. As the porous bodies are covered a gas pocket is formed. This gas pocket is compressed by the head of container liquid acting upon it as the container is tilted until a condition of equilibrium is established, i.e., the gas pocket is compressed until it supports the head of liquid which is thereby prevented from entering chamber 16.

Air lock B is formed in vent passage 13 concurrently with the formation of air lock A in chamber 16, and thus the escape of liquid from the container, e.g. electrolyte, is prevented from reaching the underside of porous disc 23. The purpose of air lock B is to prevent liquid in the container from entering the chamber 16 and reacting with the mercury therein.

While porous bodies 17 and 23 are preferably employed in the invention, one or more small openings 25 and 27 can be utilized in the upper and lower walls of the chamber 16 in lieu of the porous bodies, as shown in FIG. 3. The openings should be small enough that the surface tension of the mercury will prevent flow therethrough. If a single opening is used in place of each porous body, as contrasted with a plurality of smaller openings, it has been found that the same should have a diameter not exceeding about 0.01 inch. Still another alternative is to employ an annular vent opening. This configuration is advantageous in that it provides a large venting area while retaining a small gap which can be closed off effectively by the mercury.

According to the embodiment shown in FIG. 3, the vent passage 13 is restricted in diameter adjacent its upper end, i.e. the diameter of opening 27 is substantially smaller than the diameter of the passage 13. This is an advantageous feature in that it more rapidly forms an air lock upon tilting on the container. This enables the mercury to seal off the vent passage before the liquid in the container can flow to the underside of chamber 16.

Referring now to FIG. 4, a venting closure similar to FIG. 1 is shown, the major distinction between the two being in the nonsymmetrical shape of the bottom surface 20 of chamber 16. A venting closure having nonsymmetrical sloping walls as shown will be more responsive to tilting in one direction than

in another. Thus tilting in one direction causes the mercury to close off the vent passage while the same degree of tilt in the opposite direction permits the vent passage to remain open.

While the invention has been described in connection with several venting closure embodiments, it should be understood that many changes may be made and that some parts may be used without others while still keeping within the spirit and scope of the invention. For example, while mercury is the preferred liquid metal for use in the closure of the invention it is recognized that under certain conditions of elevated temperature that mercury will vaporize. In such instances a substitute liquid metal having a higher melting point and lower vapor pressure may be used. It is suggested that gallium, woodsmetal, tin and lead would be feasible substitutes for mercury in high temperature systems wherein mercury would normally vaporize. These substitutes are set forth in the order of higher temperature, i.e. gallium vaporizes at a temperature higher than mercury, woodsmetal vaporizes at a temperature higher than gallium, etc.

It should also be understood that in certain applications wherein splashing of container liquid is prevalent, the entrance portion of vent passage 13 may be baffled to prevent the splashing liquid from entering the passageway.

We claim:

1. A venting closure for a liquid container comprising a plug adapted to be secured in an opening in the top of the container; upper and bottom walls defining a chamber in said plug, said chamber having at least one opening to the atmosphere; said bottom wall extending upwardly and terminating in a raised surface which has at least one passage opening for normally venting the space-above the liquid level in the container to said chamber, and a partial filling of liquid mercury within said chamber having its level normally below said passage opening when said plug is substantially upright and being operable to close off said passage upon tilting of the container to cause the mercury to cover the opening.

2. A venting closure as claimed in claim 1 wherein said bottom wall is frustroconical and said opening is at the top thereof.

3. A venting closure as claimed in claim 1 wherein a porous

body is positioned in the upper wall of said chamber and comprises said opening to the atmosphere.

4. A venting closure as claimed in claim 1 wherein a porous body is positioned in said raised surface in communication with said passage.

5. A venting closure as claimed in claim 4 wherein a porous body is positioned in the upper wall of said chamber and comprises said opening to the atmosphere.

6. A nonspill vent plug comprising:

a. a body having an upper portion and lower portion and having a vent passage extending therethrough, said lower portion adapted to be fitted into the opening of a battery cell cover, said upper portion terminating in an enclosed chamber;

b. a frustroconical surface within said chamber providing a top horizontal portion thereof having an opening therein communicating with said vent passage;

c. a vent opening in the upper part of said chamber and being spaced from the frustroconical surface; and

d. a partial filling of liquid mercury within said chamber having a normal level below said opening in the frustroconical surface and of sufficient volume whereby tilting of the vent plug causes the mercury to flow over and close off the opening in said frustroconical surface and thereby close off said vent passage.

7. A venting closure for a liquid container comprising a plug adapted to be secured in an opening in the top of the container; upper and bottom walls defining a chamber in said plug, said chamber having at least one opening to the atmosphere; said bottom wall extending upwardly and terminating in a raised surface which has at least one passage opening for normally venting the space above the liquid level in the container to said chamber, and a partial filling of liquid metal within said chamber having its level normally below said passage opening when said plug is substantially upright and being operable to close off said passage upon tilting of the container to cause the metal to cover the opening, said metal being selected from the group consisting of mercury, gallium, woodsmetal, tin and lead.

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