United States Patent

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[54] SELF-CLOSING VENT ASSEMBLY FOR A SEALED CONTAINER
14 Claims, 6 Drawing Figs.

[52] U.S. Cl. .... 220/44 R, 136/162, 136/178
[51] Int. Cl. B65d 51/16
[50] Field of Search 136/178, 162; 222/479; 220/44; 215/56

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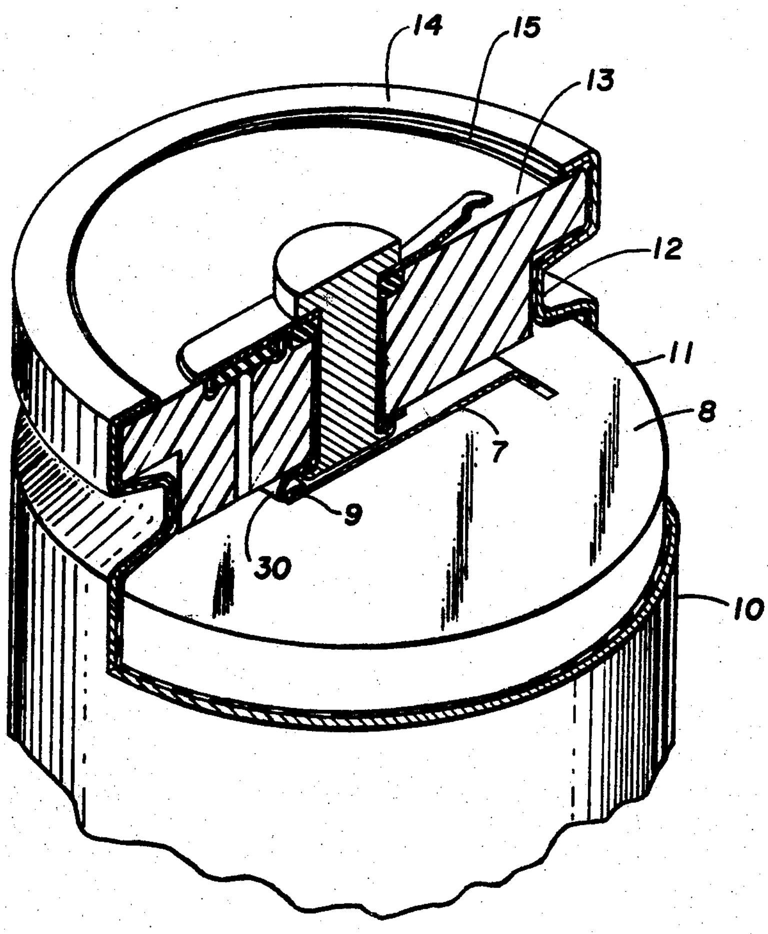
ABSTRACT: A battery casing fitted at its top with a central terminal has a cantilever spring traversed by that terminal and clamped between the head thereof and an underlying O-ring to exert pressure upon a resilient plug member projecting from a recess alongside the terminal, this plug member overlying the exit end of a vent hole passing through the casing top. Rotation of the spring from its normal position allows removal of the plug member for the introduction of fresh electrolyte into the battery via the vent hole.



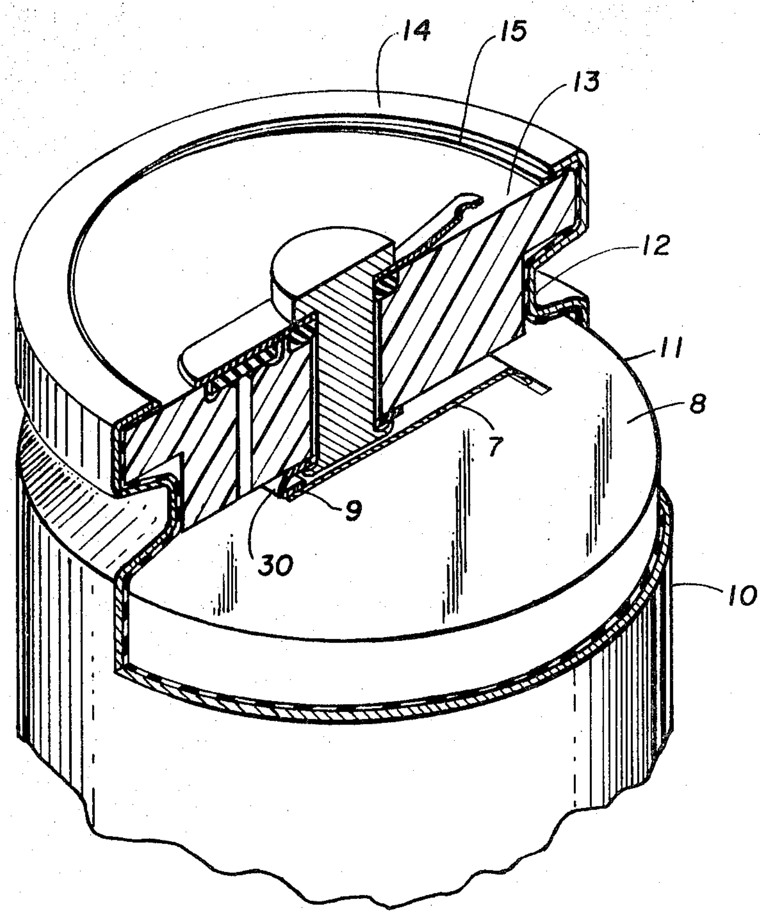


FIG. 1

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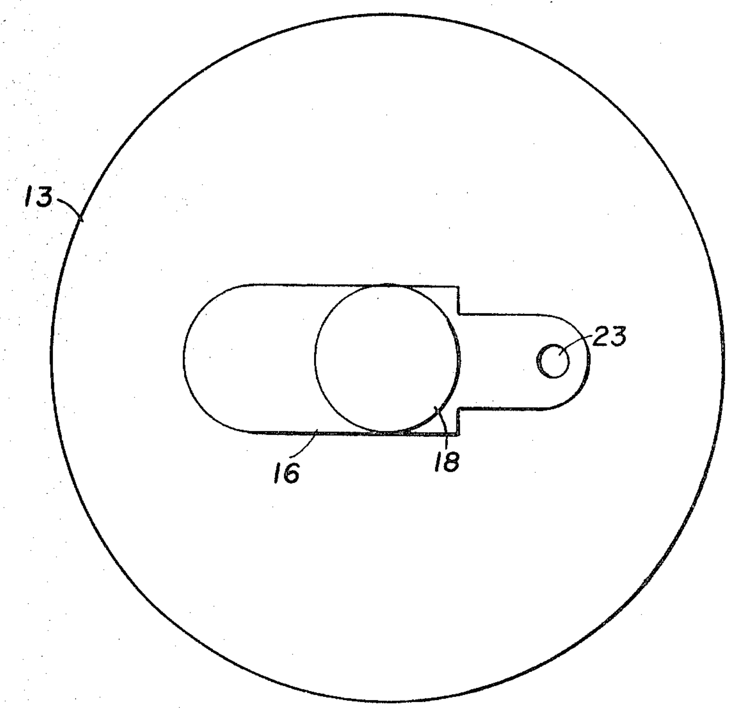

FIG. 2a

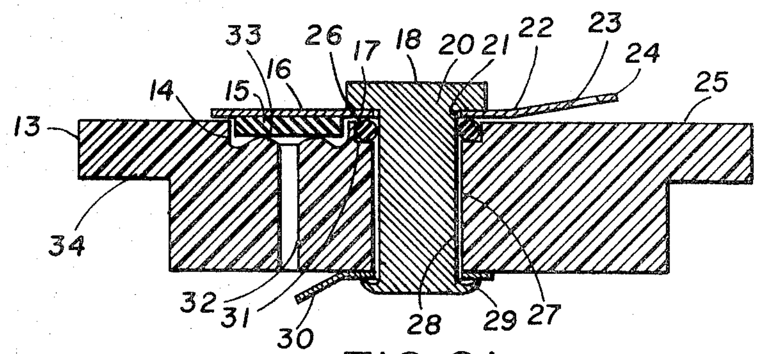

FIG. 2b

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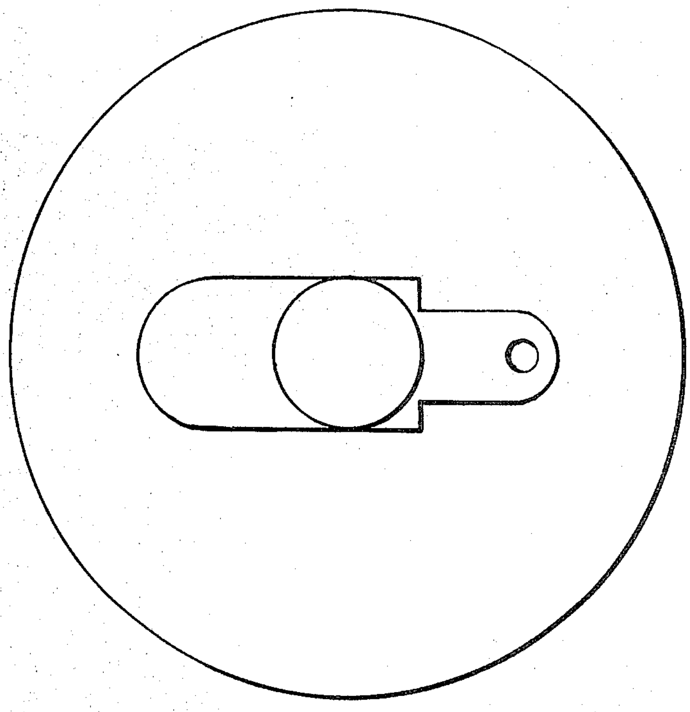

FIG. 3a

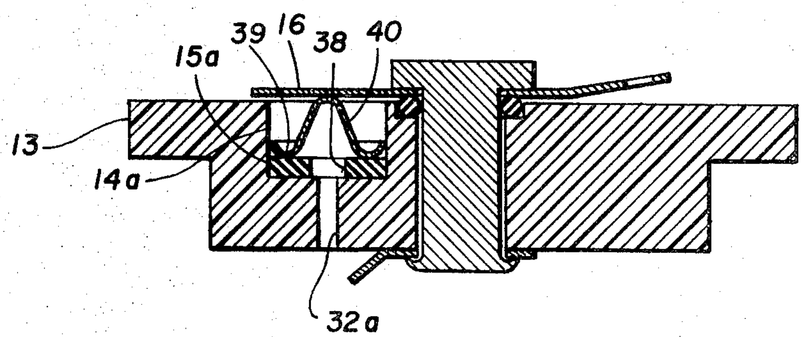

FIG. 3b

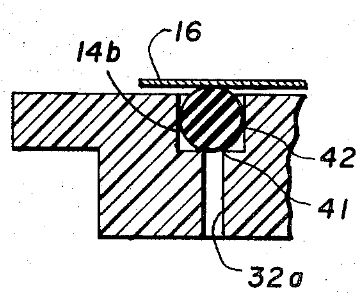

FIG. 4

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SELF-CLOSING VENT ASSEMBLY FOR A SEALED CONTAINER

This invention relates to devices for releasing high-pressure gases generated in hermetically sealed enclosures without destroying the pressuretight integrity of the container. More specifically, it relates to a self-closing pressure-vent assembly for a sealed battery.

Rechargeable batteries, e.g. those of the silver-zinc, nickel-cadmium or silver-cadmium types, may generate gases during the charging and discharging process. At times the gas pressure may rise to objectionably high values capable of exploding the can or harming the contents in the absence of a safety valve. However, the various applications in which these devices are used require that the cells be hermetically sealed. This prevents electrolyte leakage and keeps the carbon dioxide of the atmosphere from combining with the alkaline electrolyte to produce deleterious effects on cell life.

Pressure-relief valves for sealed containers in which gases are generated are known. The containers should be automatically resealed once the objectionably high gas pressures have been reduced to acceptable values, otherwise the problem of leakage and short cell life will remain once the valve has popped. However, the existing so-called resealable vents are not completely satisfactory. In conventional safety valves gases are allowed to escape through the space in the closure between the center terminal and the closure aperture through which the terminal stem passes to make contact with the cell electrode. A resilient strip or an O-ring compressed between two surfaces provides a normally closed seal which stops the high-pressure gas exiting through the previously mentioned space. As the pressure increases, the gas ultimately escapes between the strip or the O-ring, as the case may be, and the top surface. But the top surface is the terminal point to which external connections are made, and any such connections destroy the delicate spring balance which is designed to release the gas pressure when it reaches a predetermined level.

A second major disadvantage of existing types is that the escape of high-pressure gases will ultimately reduce the amount of electrolyte and consequently the cell life. Since the closure is assembled into the container as a one-time installation and the terminal through the vent aperture is a permanent-type connection, it is not possible to refill the container after the closure is installed in hermetically sealed casings with the present resealable vent designs.

It is accordingly an object of this invention to provide an improved self-resealing pressure-vent assembly for a sealed container.

It is another object of this invention to provide a self-resealable pressure vent assembly for a sealed battery in which an external connection can be made to a terminal without affecting the level at which high-pressure gas is released to the atmosphere.

It is a further object to provide a self-resealable pressure-vent assembly for a sealed container which can be filled or refilled after the closure is permanently installed in the container.

These and additional objects and features are realized in accordance with my present invention by providing a vent hole through an otherwise conventional closure or casing top to give passage to high-pressure gases for releasing them to the atmosphere. A resilient disc or other deformable plug member is positioned in a recess over the exit atmosphere end of the vent to seal it under pressure from a cantilever spring overlying it under stress. The spring is swingably clamped between the head of a boldlike stud or fastening member and an underlying resilient support such as an O-ring. If the encased device is a battery, the fastening member and the spring are conductors, the closure is an insulator and the fastener or spring will serve as one terminal. The entire assembly is secured to the closure by flaring the free end of the stem over a rigid washer forming part of a connector lug placed around this stem and against the undersurface of the closure. The compression of the O-ring seals off any leakage path through the aperture in which the fastener stem passes through the closure. The compression of the resilient plug against the vent exit determines the sealing force which must be overcome by the gas pressure inside the container. When objectionably high gas pressure is generated, its action on the underside of the disc overcomes the sealing force and breaks the seal, releasing the high pressure gas to the atmosphere. The continuing spring pressure then reseals the vent until the container pressure builds up again to the objectionable level for which the spring tension is designed. The pivoted spring fastening allows the spring to be rotated away from the vent and the disc to be removed and permits filling or refilling the container after the closure has been permanently installed in the container.

In the accompanying drawing:

FIG. 1 is a perspective view of a sealed container with a portion removed to revel an embodiment of the self-resealing pressure-vent assembly embodying the present invention;

FIG. 2*a* is a plan view of the self-resealing pressure-vent assembly of FIG. 1;

FIG. 2*b* is an elevational section of the self-resealing pressure-vent assembly of FIG. 1;

FIG. 3*a* is an elevational section of a second embodiment of a self-resealing pressure-vent assembly for a sealed container embodying the present invention;

FIG. 3*b* is a plan view of the second embodiment shown in FIG. 3*a*; and

FIG. 4 is an elevational view of a ball seal for the vent exit port in an alternative embodiment.

FIG. 1 shows a galvanic cell **11** assembled into and enclosed in a hermetically sealed container **10**. A connector **7** passes through a top cover **8** to make contact with the internal electrode of cell **11**. The internal structure of the cell is not shown, as it is not necessary to an understanding of the invention. A conductive lug **30** traversing a sealing member or closure **13** is joined by a suitable weld **9** to connector **7**. Before assembly, connector **7** which is a flexible copper strip stands up from container **10** to provide room for the welding operation. When closure **13** is assembled into container **10**, connector **7** bends over as shown. Cylindrically shouldered closure **13** made from a suitable insulating material and having a resilient gasket of sheet material **15** around its periphery, is seated over the crimped portion **12** of the container over the cell **11**, and the top **14** of the container is spun over gasket **15** and the top of closure **13** to form a hermetic seal between container and closure.

FIGS. 2*a* and 2*b* illustrate the principle of a preferred embodiment of the self-resealing pressure-vent assembly according to the present invention in more detail. The closure **13** is cylindrical and has a shoulder **34** which rests on the crimped-in portion **12** of container **10**. For battery applications, the closure will be fabricated from a suitable electrically insulating material such as Teflon.

A vent hole **32** passes eccentrically through the closure **13** to discharge objectionably high-pressure gas from the interior of the container **10** to the atmosphere through the exit end **33** of this vent, the end **33** opening into a cylindrical recess **14** in the relatively smooth outer surface **25** of closure **13**. Exit **33** of vent **32** is in the form of an annular or semitoroidal rim which is raised above the bottom of recess **14** to provide a sealing surface for a resilient disc **15**.

Resilient disc **15**, preferably made of neoprene, is shown in FIG.2*b* resting on vent exit end **33**. The inner circumference of recess **14** prevents the cylindrical resilient disc **15** from moving laterally off vent exit end **33**. A leaf spring **16** exerts a downward force on resilient disc **15** to prevent it from escaping out of recess **14**.

An aperture or bore **27** passes centrally through the closure **13**. A second cylindrical recess depression **31** concentric with aperture **27** is provided in the outer surface **25** to accommodate resilient O-ring **26** also preferably of neoprene.

Leaf spring 16 has a hole 21 near its center which fits around the stem 28 and under the shoulder 17 a terminal stud or fastener 20. For battery applications, spring 16 is made from a suitably conductive elastic material such as beryllium copper. To facilitate the attachment of terminal leads or tabs, a lug portion 24 of spring 16 has a bend 22 upwards and away from the closure surface 25, a connecting hole 23 being provided in the lug 24.

Fastener 20 has a head portion 18 on its stem 28. For battery applications where fastener 20 makes a connection with an internal electrode through the closure, the fastener will be made from a suitable conductive material such as copper.

The depth of recesses 14 and 31 and the thickness of resilient disc 15 and O-ring 26 are such that when disc 15 and O-ring 26 lie in their normal uncompressed condition on vent exit end 33 and the bottom of recess 31 respectively, the top surfaces of disc 15 and O-ring 26 extend above the top of closure surface 25. This is the condition illustrated in FIG. 2*b* for clarity of understanding. The stem of fastener 20 passes through the hole 21 in leaf spring 16, then through O-ring 26, then through aperture 27 in closure 13. Rigid washer 30 is placed around the free end of stem 27.

Fastener terminal 20 clamps the leaf spring 16 against O-ring 26 so that the bottom surface of spring 16 rests on the top surface 25 of closure 13. To obtain uniform compression, the head portion 18 of fastener 20 and the leaf spring 16 are made wide enough to cover the compressed O-ring 31 and resilient disc 15. When spring 16 bottoms on surface 25, the entire assembly is secured together in the operating position by flaring the stem end 29 over washer 30. The hitherto loose parts are then clamped to closure 13 between the shoulder 17 and flared end portion 29 of fastener 20. Excessive tightness is avoided to permit rotation of the elongate spring 16.

When the assembly is completed as described, O-ring 26 is compressed between the bottom surface of spring 16 and the bottom surface of recess 31 and confined by the sides of recess 31 to form a permanent seal against the passage of any high-pressure fluid attempting to escape from the container through the space between bore 27 and stem 28. In a similar manner the force exerted on resilient disc 15 by the end of spring 16 compresses the disc 15 which obstructs the vent exhaust end 32 to form a seal against the passage of high-pressure fluids at pressure levels below the critical threshold.

When the assembly is installed in the battery container as shown in FIG. 1, washer lug 30 makes electrical contact with cell connector 7 and the system is a completely self-contained hermetically sealed operating unit. In operation with successive discharging and recharging cycles objectionably high gas pressure may eventually build up. The spring constant of spring 16 and the dimensions and characteristics of resilient disc 15 and the other components of the system are such that the compression of the disc 15 around vent exit 33 establishes a tight seal for all allowable internal gas pressures in the battery. As the gas pressure continues to rise, it reaches a level which constitutes the critical threshold for which the spring force of resilient disc 15 has been designed. Any pressure in excess of this threshold lifts the underside of disc 15 away from the exit 33 whereby fluid is immediately released into recess 14 and the atmosphere, until the force created by the internal pressure becomes less than the spring force, at which time spring 16 and disc 15 come down again on vent exit 33 and reestablish the seal. This process continues over the life of the battery.

An important feature of my present improvement is its capability for filling or refilling after the closure has been permanently installed in container 10. With a sufficient number of gas escapements as described, the electrolyte volume may drop to an undesirable level. The spring 16 may be rotated away from resilient disc 15 and in the presence of a suitably inert atmosphere, disc 15 can be removed for introduction of additional electrolyte though vent hole 32 and disc 15 whereupon spring 16 are returned to their operating positions as described.

A second embodiment of the present invention is illustrated in FIGS. 3*a* and 3*b*. Cylindrical recess 14*a* of FIG. 3*b* is deeper than the corresponding recess 14 of FIG. 2*b*, and vent hole 32*a* is correspondingly shorter for the same thickness of closure 13. Resilient annular washer 15*a*, preferably of neoprene, which is so received in recess 14*a* that the central aperture 38 is concentric with vent 32*a*. A hat-shaped plug 40, which may be of stainless steel, compresses washer 15*a* against the bottom of recess 14*a* under the restraining force of spring 16, bearing upon the upwardly projecting peak of the "hat", to maintain a fluid seal between the upper surface of washer 15*a* and the lower surface of the crimped base or brim 39 of plug member 40 for all allowable gas pressures. When the gas pressure becomes abnormally high in the container and therefore on the concave underside of plug member 40, the restraining force of spring 16 is exceeded and the seal between the crimped base 39 and washer 15*a* is broken whereupon high-pressure gas escapes through recess 14 past spring 16, which has been lifted by the pressure, and into the atmosphere. As in the previous embodiment, when the force of the internal pressure becomes less than the spring tension, the seal between washer 15*a* and crimped base 39 is reestablished.

In FIG. 4, a spherical resilient ball 42 which may be of neoprene replaces annular washer 15*a* and plug member 40. The walls of recess 14*b* which is concentric with vent hole 32*b* constrain ball 42 to be concentric with vent hole 32*b*. The self-resealable seal in this embodiment is between the periphery of the vent exit 41 and ball 42. The operation is the same as described for FIGS. 2*b* and 3*b*.

I claim:

1. A vent assembly for a container subject to internal gas pressure, comprising:
   - a closure member forming a seal across the top of the container, said closure member being provided with a through-going venthole terminating in a recess at the upper surface thereof;
   - resilient plug means in said recess obstructing said vent hole;
   - fastening means on said upper surface offset from said recess; and
   - an elongate spring separate and independent of said plug means pivotally engaged by said fastening means for rotation about the latter, said spring normally overlying said recess in cantilever fashion and exerting downward pressure upon said plug means for resisting the escape of gases through said vent hole, rotation of said spring into an off-normal position enabling withdrawal of said plug means and filling of the container through said vent hole.

2. A vent assembly as defined in claim 1 wherein said fastening means comprises a stem with a head rising from said closure member and resilient support means surrounding said stem, said spring being traversed by said stem and being clamped between said head and said support means.

3. A vent assembly as defined in claim 2 wherein said plug means projects above said recess in its uncompressed state, said spring bearing upon said plug means with sufficient pressure to come to rest against said upper surface outside said recess.

4. A vent assembly as defined in claim 1 wherein said plug means has the shape of a disc substantially filling said recess.

5. A vent assembly as defined in claim 1 wherein said plug means has the shape of a sphere substantially filling said recess.

6. A vent assembly for a battery casing subject to internal gas pressure, comprising:
   - a closure member forming a seal across the top of the casing, said closure member being provided with a throughgoing vent hole terminating in a recess at the upper surface thereof and with a bore offset from said vent hole;
   - resilient plug means in said recess obstructing said vent hole;

a terminal stud passing through said aperture in conductive contact with a battery component in said casing, said stud having a head above said upper surface;

an elastic ring surrounding said stud below said head; and

an elongate spring separate and independent of said plug means traversed by said stud and clamped between said ring and said head while being rotatable about said stud, with elastic deformation of said ring to seal said bore, said spring normally overlying said recess in cantilever fashion and exerting downward pressure upon said plug means for resisting the escape of gases through said vent hole, rotation of said spring into an off-normal position enabling withdrawal of said plug means and filling of the casing through said vent hole.

7. A vent assembly as defined in claim **6** wherein said bore terminates at its upper end in an annular depression receiving said ring.

8. A vent assembly as defined in claim **7** wherein said plug means projects above said recess in its uncompressed state, said spring bearing upon said plug means with sufficient pressure to come to rest against said upper surface outside said recess while deforming said ring against the periphery of said depression.

9. A vent assembly for a container subject to internal gas pressure, comprising:

a closure member forming a seal across the top of the container, said closure member being provided with a throughgoing vent hole terminating in a recess at the upper surface thereof;

a resilient plug in said recess obstructing said vent hole, said plug having a concave underside overlying said vent hole and a peak rising above said vent hole slightly beyond the level of said upper surface;

fastening means on said upper surface offset from said recess; and

an elongate spring engaged by said fastening means, said spring overlying said recess in cantilever fashion and exerting downward pressure upon said peak for resisting the escape of gases rising from said vent hole and accumulating in said concave underside.

10. A vent assembly as defined in claim **9**, further comprising a resilient annular washer on the bottom of said recess, said plug being substantially hat shaped and provided with a crimped brim surrounding said vent hole and resting against the top of said washer.

11. A vent assembly for a battery casing subject to internal gas pressure, comprising:

a closure member forming a seal across the top of the casing, said closure member being provided with a throughgoing vent hole terminating in a recess at the upper surface thereof and with a bore offset from said vent hole;

a resilient plug in said recess obstructing said vent hole, said plug having a concave underside overlying said vent hole and a peak rising above said vent hole substantially to the level of said upper surface;

a terminal stud passing through said aperture in conductive contact with a battery component in said casing, said stud having a head above said upper surface;

an elastic ring surrounding said stud below said head; and

an elongate spring traversed by said stud and clamped between said head and said ring with elastic deformation of the latter to seal said bore, said spring overlying said recess in cantilever fashion and exerting downward pressure upon said peak for resisting the escape of gases rising from said vent hole and accumulating in said concave underside.

12. A vent assembly as defined in claim **11** wherein said bore terminates at its upper end in an annular depression receiving said ring, the latter being elastically deformed against the periphery of said depression.

13. A vent assembly for a container subject to internal gas pressure, comprising:

a closure member forming a seal across the top of the container, said closure member being provided with a throughgoing vent hole terminating in a recess at the upper surface thereof;

a resilient plug in said recess obstructing said vent hole, said plug having a concave underside overlying said vent hole and a peak rising in line with said vent hole above said surface;

fastening means on said upper surface offset from said recess; and

an elongate spring pivotally engaged by said fastening means for rotation about the latter, said spring normally overlying said recess in cantilever fashion and exerting downward pressure upon said peak for resisting the escape of gases rising from said vent hole and accumulating in said concave underside.

14. A vent assembly for a battery casing subject to internal gas pressure, comprising:

a closure member forming a seal across the top of the casing, said closure member being provided with a throughgoing vent hole terminating in a recess at the upper surface thereof and with a bore offset from said vent hole terminating in an annular depression at said upper surface;

a resilient plug in said recess obstructing said vent hole, said plug having a concave underside bounded by a crimped base surrounding said vent hole and a peak rising in line with said vent hole above said upper surface;

a terminal stud passing through said aperture in conductive contact with a battery component in said casing, said stud having a head above said upper surface;

an elastic ring around said stud received in said depression; and

an elongate spring traversed by said stud and clamped between said ring and said head while being rotatable about said stud, with elastic deformation of said ring against the periphery of said depression to seal said bore, said spring normally overlying said recess in cantilever fashion and exerting downward pressure upon said peak for resisting the escape of gases rising from said vent hole and accumulating in said concave underside.