June 2, 1970 J. A. HAYES ET AL 3,515,308

SAFETY-VALVE FOR A PRESSURE VESSEL

Filed Nov. 28, 1967

FIG. 1

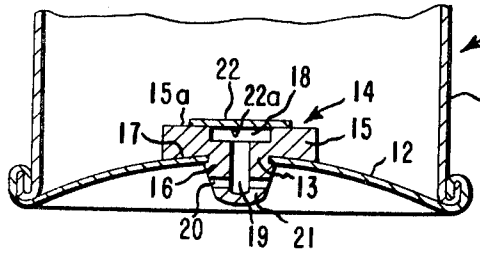


FIG. 2

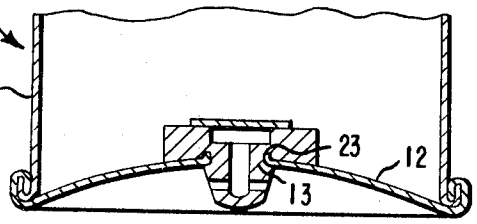


FIG. 3

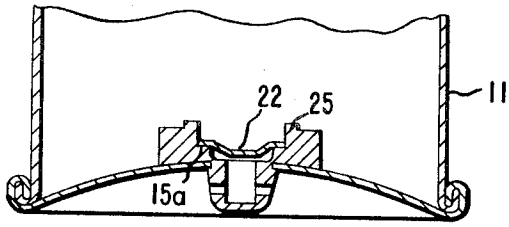


FIG. 4

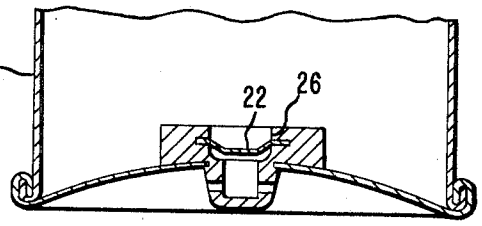


FIG. 5

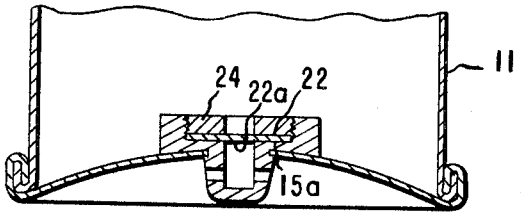


FIG. 6

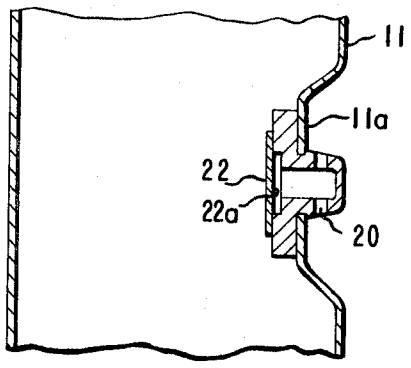
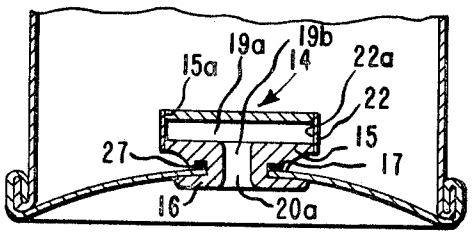


FIG. 7



INVENTORS

JOHN A. HAYES

EDWARD S. PREISENDANZ

BY Melville J. Hayes

AGENT

United States Patent Office 3,515,308 Patented June 2, 1970

3,515,308

SAFETY-VALVE FOR A PRESSURE VESSEL

John A. Hayes, Philadelphia, Pa., and Edward S. Preisendanz, Wilmington, Del., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Nov. 28, 1967, Ser. No. 686,185
Int. Cl. B65d 25/00
U.S. Cl. 220—89 2 Claims

ABSTRACT OF THE DISCLOSURE

The invention provides a pressure vessel (e.g., an aerosol dispenser) equipped with a safety-valve which opens when the pressure in the vessel reaches a certain excessive level below that which would burst the vessel; the safety-valve has an outer plug portion fitted in an orifice of a wall of the vessel, an inner washer-like portion to which is attached a rupturable wall member, and a duct providing communication between the rupturable wall and an exit port in said plug portion. Thus, when the rupturable wall ruptures, the interior of the vessel is in communication with said exit port. Also provided is a safety-valve which is useful in pressure vessels and vacuum vessels.

Background of the invention

This invention relates to a pressure vessel equipped with a safety-valve device which opens when the pressure in the vessel reaches a certain excessive level. An aerosol dispenser is a preferred embodiment of the vessel. The invention also concerns a safety-valve device capable of providing a vent in any kind of fluid-tight vessel (e.g., a pressure vessel or a vacuum vessel) at a predetermined pressure difference with reference to the pressure inside and outside the vessel.

The hazards associated with the storage and disposal of conventional aerosol dispensers which are not provided with a suitable safety-valve are well-known. For example, when such a dispenser (whether full or "empty") is exposed to an open flame or other source of excessive heat, it usually explodes with great force, sending sharp metal fragments in all directions somewhat in the manner of a bomb or hand grenade. Such an explosion can also occur as the result of a pressure-generating chemical reaction within the container, for example, when separately-stored reactive materials within the container inadvertently become mixed prior to being discharged through the dispensing valve as a result of failure of a storage compartment. It is known in the art that there is increasing interest in the use of aerosol dispensers containing separately-stored reactive materials; for example, such dispensers, useful for the preparation of warm shaving lather and the like, are described in the U.S. Pats. Nissen 3,241,722, Lewis 3,325,056, and Hayes 3,326,416. Although such dispensers are very useful, they are not entirely satisfactory from the standpoint of safety in the absence of an effective safety-valve. A harmful explosion can also occur during the manufacture of the dispensers; for example, when an operator introduces too much of the propellent component.

The aerosol dispenser industry is therefore in need of a safety-valve device which is effective in providing a dispenser vent at a predetermined excessive level of pressure below that which would burst the dispenser, and preferably a device which is not unduly difficult or costly to manufacture and install. In other words, the industry needs a dispenser which is practical to manufacture and substantially free of explosion hazards.

Summary of the invention

The present invention provides a pressure vessel in the form of a can, tank, pipe or the like, adapted to hold a fluid under super-atmospheric pressure, at least one wall of the vessel having a safety-valve adapted to open when the pressure in the vessel reaches a predetermined excessive level below that which would burst the vessel, said safety-valve comprising:

(A) an orifice in said wall,
(B) a valve body having
  (1) an outer plug portion sealingly fitted in said orifice and having at least one exit port located outside said wall,
  (2) an inner washer-like portion integrally united to said plug portion and having an outer face which forms a fluid-tight seal with the inner surface of said wall in an area surrounding said orifice, and an inner face adapted for attachment thereto of a rupturable wall member, and
  (3) a duct therein providing communication between (a) the outer surface of a rupturable wall attached to said inner face of component (2) and (b) the exit port of component (1),
(C) a rupturable wall of fluid-impervious material sealingly attached to said inner face of component (2) so as to form a fluid-tight closure of the inner end of said duct, said rupturable wall being adapted to rupture at said predetermined excessive level of pressure and thereby provide sufficient communication between the interior of the vessel and said exit port to prevent bursting of the vessel.

The invention also provides a safety-valve device, adapted to provide a vent in a fluid-tight vessel when the difference between the exterior pressure and the interior pressure of the vessel reaches a predetermined level, comprising:

A valve body having
  (1) a lower plug portion adapted to be sealingly fitted in an orifice in a wall of said vessel, and having at least one exit port located so that it will be outside said wall,
  (2) an upper washer-like portion integrally united to said plug portion and having a first face adapted to form a fluid-tight seal with the inner surface of said wall in an area surrounding said orifice, and a second face adapted for attachment thereto of a rupturable wall member, and
  (3) a duct therein providing communication between (a) the outer surface of a rupturable wall attached to said second face of component (2) and (b) the exit port of component (1), and
a rupturable wall of fluid-impervious material sealingly attached to said second face of component (2) so as to form a fluid-tight closure of the inner end of said duct, said rupturable wall being adapted to rupture at said predetermined pressure difference and thereby provide sufficient communication between the interior of the vessel and said exit port to prevent bursting of the vessel.

The "outer" surface of the rupturable wall is the surface which communicates with the exit port of the valve body while the valve is closed.

Brief description of the drawing

The invention will be more readily understood by referring to the attached drawing wherein:

FIG. 1 shows an embodiment of the novel pressure vessel as it appears when the pressure therein is normal; this is a view in central vertical section of the lower portion of an aerosol dispenser wherein the safety-valve

feature of the invention is in the bottom wall of the dispenser container.

FIG. 2 shows a modification of the dispenser of FIG. 1 wherein the central portion of the bottom wall of the container which surrounds the orifice into which the valve body is fastened has been bent upwardly so as to fit sealingly into a matching groove in the lower part of the washer-like portion of the valve body.

FIGS. 3 and 4 illustrate one method of attaching the rupturable wall member to the valve body. In FIG. 3 it can be seen that there is a ridge of thermoplastic material surrounding the rupturable wall of the valve. FIG. 4 shows this valve after the top of the valve body has been subjected to sufficient heat and pressure to mold said ridge into a retainer ring which locks the rupturable wall in position.

FIG. 5 differs from FIG. 1 mainly in that the rupturable wall is attached to a recessed face of the valve body by means of a threaded retainer ring.

In FIG. 6, a safety-valve similar to the one shown in FIG. 1 is present in an indented portion of a vertical side wall of a pressure vessel, the pressure vessel being any suitable container, tank, pipe or the like; the valve and a portion of the vessel (which excludeds the top and bottom portions) are shown in central vertical section.

FIG. 7 is a view in central vertical section of the lower portion of an aerosol dispenser wherein the safety-valve in the bottom wall of the container has a rupturable wall member attached to both ends of a tubular upper portion of the valve body.

Description of preferred embodiments

In a particularly preferred embodiment of the invention, the novel pressure vessel is an aerosol dispenser wherein the wall containing the safety-valve is a wall of the dispenser container, for example, the bottom wall or side wall of the can portion of any one of numerous known types of aerosol dispensers. Such a wall of course is normally made of metal; however, other suitable construction materials can be used without departing from the spirit of the invention. Some very useful embodiments are illustrated in the drawings, which will now be discussed in further detail.

In FIG. 1, container **10**, which is adapted to hold a fluid under super-atmospheric pressure, is a can of the type commonly used in aerosal dispensers. The roller bottom edge of can side wall **11** tightly engages the rolled edge of can bottom wall **12**, and is crimpled therewith to form a pressure-proof seal. Bottom wall **12** is convex when viewed from its top surface.

The upper portion of the container (not shown in the drawing) and the dispensing valve therein can have any suitable structure known in the aerosol dispenser art. Among the useful kinds of dispenser upper portions are those shown in these U.S. patents: Giangualano 3,045,925; Miles 3,117,404; Soffer 3,132,774; Nissen 3,241,722; Lewis 3,325,056 and Hayes 3,326,416; the disclosures of these patents are incorporated herein by reference.

The central portion of dome-shaped wall **12** has a safety-valve which consists of circular orifice **13** in the center of wall **12**, valve body **14** and rupturable wall member (rupture disc) **22**. The valve body and rupture disc are made of a thermoplastic material having sufficient strength and resistance to the contents of the dispenser, and capable of being strongly bonded by heat-sealing (e.g., polyethylene or polypropylene). Polyester film or aluminum foil can be laminated to the top surface of the rupture disc if desired. The valve body is made up of an outer (lower) plug portion **16**, which is sealingly fitted in orifice **13**, and an inner (upper) disc-shaped washer-like portion **15**. A horizontal hole has been drilled diametrically through plug portion **16** a short distance above its lower end to provide exit port **20** in the form of a horizontal duct which communicates with vertical duct **19** inside the valve body. The portion of wall **12** immediately surrounding orifice **13** sealingly fits into a shallow annular groove in the uppermost part of plug portion **16**. Plug portion **16** has an imperforate outer (lower) end portion **21** which prevents rupture disc **22** from being damaged by needles, knives and the like which might otherwise find their way into duct **19** (e.g., with the help of curious children).

Washer-like portion **15** of the valve body is integrally united to plug portion **16**; and it has an outer or lower face **17** which has the same curvature as wall **12**, thereby forming a fluid-tight seal with the inner surface of wall **12** in an area surrounding orifice **13**. Washer-like portion **15** also has an inner (upper) face **15***a* suitable for the fluid-tight attachment thereto of rupture disc **22**.

Vertical duct **19** of the valve body, which is enlarged at its upper end to form cavity **18**, provides communication between the outer (lower) surface **22***a* of rupture disc **22** and exit port **20**. Surface **22***a* is the "outer" surface of the rupture disc since it is the surface which communicates with the exit port **20** of the valve body. The edge area of surface **22***a*, which is in heat-sealed contact with face **15***a*, of course is not in communication with the exit port.

Rupture disc **22** is made of a fluid-impervious material adapted to rupture at a predetermined excessive level of pressure (e.g., 195 p.s.i.g.) below that which would burst can **10** (e.g., 240 p.s.i.g.); and it is sealingly attached to inner face **15***a* of washer-like portion **16** so as to form a fluid-tight closure of the inner (upper) end of duct **19** as long as the pressure in can **11** remains below said excessive level.

In FIG. 2, the safety-valve has the same structure as in FIG. 1 except the portion of bottom wall **12** which surrounds orifice **13** has been bent upwardly so as to fit sealingly into a matching annular groove **23** in the lower face of washer-like portion **15**.

The safety-valve shown in FIG. 4 has a bowl-shaped rupture disc **22**, and a retainer ring **26** which forms an integral part of the valve body; the valve body is made of any suitable thermoplastic material. After rupture disc **22** is placed in position on face **15***a* of the valve body as shown in FIG. 3, the top portion of the valve body is subjected to pressure while it is at an elevated temperature above its softening point whereby the material in ridge **25** is caused to flow downward and inward to form retainer ring **26**.

In FIG. 5, rupture disc **22** rests in sealing contact with face **15***a* which forms the bottom of a threaded recess in the washer-like portion of the valve body. Threaded retainer ring **24** is screwed into the threaded recess so that the rupture disc is sealingly locked in position between the bottom of ring **24** and face **15***a*. If desired, the rupture disc can be bonded to face **15***a* by a heat-sealing operation prior to the installation of ring **24**. As in FIG. 1, central lower face **22***a* of the rupture disc is in communication with the exit port of the valve body. One embodiment of the dispenser shown in FIG. 5 is prepared by (1) using a can which will burst (in the absence of the safety-valve) when the pressure inside the dispenser reaches 240 p.s.i.g.; (2) using a valve body whose vertical duct has a diameter of ¼ inch, and (3) using a laminated rupture disc made by bonding a top layer of 0.5 inch thick polyethylene terephthalate film to a 1.5 inch thick film of medium density polyethylene, the rupture disc being adapted to rupture at ordinary room temperature (e.g., 22° C.) when the pressure inside the dispenser reaches 195 p.s.i.g.

Another embodiment is prepared in the same manner except a can is used which will burst at 390 p.s.i.g., and the rupture disc is thick enough so that it will rupture at 270 p.s.i.g. Another embodiment is prepared in the same manner except a can is used which will burst at 300 p.s.i.g., the vertical duct has a diameter of 5/16 inch; and the rupture disc, which is made of a 4.5 mil thick film of high density polyethylene, will rupture at 225 p.s.i.g. Another embodiment is prepared in the same manner as the

last one except the rupture disc is made of 1.2 mil thick aluminum foil, and it will rupture at 250 p.s.i.g.

In FIG. 6 the same type of safety-valve as shown in FIG. 1 is mounted in an indented portion **11***a* of vertical side wall **11** of a pressure vessel which may be container **10** of FIG. 1 or any suitable tank, pipe or other vessel adapted to hold a fluid under super-atmospheric pressure. The central portion of the outer face **22***a* of rupture disc **22** is in communication with exit port **20**. Face **22***a* is the "outer" face of the rupture disc because of its communication with the exit port.

In FIG. 7 the central portion of the dome-shaped bottom wall of the container of the type shown in FIG. 1 has a safety-valve which consists of a circular orifice in the center of said bottom wall, a valve body **14** sealingly fastened in said orifice, and a rupture disc **22** sealingly attached to both ends **15***a* of a horizontal duct or tubular member **19***a*. The valve body is made up of outer plug portion **16** sealingly fitted in said orifice, and an inner disc-shaped washer-like portion **15** integrally united to portion **16** and having an integrally united upper portion consisting of horizontal tubular member **19***a*. Plug portion **16** contains exit port **20***a* which communicates with vertical duct **19***b* and horizontal duct **19***a* of the valve body. The lower part of plug portion **16** can be formed by outwardly bending the sidewall at the lower end of a tube of metal, thermoplastic material or the like to form a disc-shaped member whose upper surface is in sealing contact with the bottom wall of the container. Needles, knives and other sharp or potentially harmful objects which might find their way into exit port **20***a* and duct **19***b* will not be likely to reach the rupture discs **22** at the ends of duct **19***a*. However, additional protection of the rupture discs can be obtained if desired in any suitable manner, for example, by providing exit port **20***a* with a cap or plug (not shown) that contains numerous small holes, or an imperfortae cap or plug that is readily removable under the pressure conditions which will cause the rupture disc to rupture.

Washer-like portion **15** of the valve body has a first face **17** adapted to form a fluid-tight seal with the inner surface of the can bottom wall in an area surrounding the bottom wall orifice. One portion of said face, in the form of an annular ridge, is in sealing contact with said bottom wall; and another portion, in the form of an annular groove, is in sealing contact with a rubber O-ring **27**, which in turn is in sealing contact with the can bottom wall in an area immediately surrounding the bottom wall orifice. The groove has a depth slightly less than the thickness of the uncompressed O-ring. Washer-like portion **15** also has a second face **15***a* which forms one end of duct **19***a*, and an identical face which forms the other end of duct **19***a*. Each face **15***a* is adapted for sealing attachment thereto of a rupture disc **22** whose outer face **22***a* is in communication with exit port **20***a*.

The two ruptured discs **22** form fluid-tight closures of the two ends of duct **19***a* as long as the pressure in the can remains below a certain excessive level. If the pressure in the can reaches a certain excessive level below that which would burst the can, the rupture discs rupture and allow the pressurized fluid in the can to be discharged through ducts **19***a* and **19***b* and exit port **28**; a dangerous explosion is thereby prevented.

It will be apparent that one skilled in the art, after reading the present disclosure, will be able to make various changes in the design of the safety-valves described above without departing from the spirit of the present invention. For example, bottom wall **12** of FIG. 1 can be flat or any other suitable shape which still permits the safety-valve to be placed therein. The safety-valve can be considerably smaller in relation to the size of the container than illustrated in the drawings and still prevent explosive bursting of the container. When the pressure vessel is in the form of a large storage tank or the like, it may be desirable to install a plurality of safety-valves in accordance with the present invention at spaced-apart locations in one or more walls of the vessel. If the tank contains a substance which cannot safely be vented through the safety-valve into the area surrounding the tank, a duct can be sealingly attached to the exit port of the safety-valve for carrying the substance flowing from the exit port to a container or area to which it can safely be transferred.

In a modification of an installation of the type shown in FIG. 6, when it is desired to maintain a constant inside diameter of the vessel, the portion of the vessel sidewall containing the safety-valve can be an outward bent area instead of an inward bent area.

The valve body and the rupture disc can be made of any suitable construction material, for example a rigid plastic, a semi-rigid plastic, metal or composite structures made from two or more such materials. In some embodiments of the invention at least the upper portion of the valve body is made of a thermoplastic material to which a thermoplastic rupture disc can be attached by a heat-sealing operation wherein the parts are assembled under pressure while at an elevated temperature above the softening point of the thermoplastic materials. Any other suitable known fastening means, for example, adhesives and mechanical fasteners, can be employed for sealingly attaching the rupture disc to the valve body. It is also possible to mold the rupture disc as an integral part of the valve body. A preferred type of rupture disc is prepared by laminating a film of polyethylene to a film of a polyester such as polyethylene terephthalate.

The valve body can be molded, cast, machined or otherwise manufactured from a single piece of material, or two or more portions thereof can be made separately and then assembled with the aid of adhesives, heat-sealing procedures, mechanical fasteners or the like. A polymer composition such as a suitable known adhesive or sealer composition can be applied to one or more surfaces of valve body **14** and/or the portion of wall **12** in contact therewith if it is desired to provide additional means of holding the valve body in place with a fluid-tight seal during the manufacture, filling and normal use of the vessel.

The safety-valve of the present invention, for example the embodiments shown in the drawings, can be installed in a wall of a vessel to be used under conditions (1) wherein the interior pressure is well below atmospheric pressure and the exterior pressure is at about atmospheric pressure, or (2) wherein the interior pressure is at or below atmospheric pressure and the exterior pressure is far above atmospheric pressure. The latter conditions are encountered in vessels lowered to great depths in the ocean, for example during various studies in oceanography. In such applications, the safety-valve device of this invention can be used to prevent costly collapse of the vessel when the pressure differential becomes too great.

Safety-valve devices are obtainable in accordance with this invention which are not only effective in providing a vent at a predetermined excessive level of pressure, but also are easy and inexpensive to manufacture and install. By using these safety-valve devices, a manufacturer of pressure vessels can reduce his costs by eliminating the need to make the vessels capable of withstanding extremely high pressures as a safety measure.

Aerosol dispensers and other pressure vessels constructed according to the present invention have important advantages from the standpoint of safety since they are substantially free of explosion hazards. These dispensers can be made with great ease and economy. And their safety features are effective regardless of what kind of dispensing valve is employed, and regardless of whether the excessive pressure build-up in the containers is caused by (1) introducing too much of one or more fluid components into the containers, (2) a pressure-generating chemical reaction of the contents, (3) exposing the dispensers

to an open flame or other source of excessive heat or (4) a combination of two or more such factors.

These novel dispensers are useful for dispensing many different kinds of fluid materials including, for example, warm shaving lather, heated de-icer compositions for automobile windshields, adhesive compositions, paint compositions, insecticides, compositions for cleaning, dyeing and bleaching, caulking compositions, heated liniment, whipped cream and other food products, polyurethane foam and multicolored cosmetic creams and toothpaste.

Any dangerous build-up of pressure within the pressure vessel of the present invention is avoided by the opening of the safety-valve with the resultant release of pressure through the vent that is formed before the pressure becomes great enough to cause the vessel to burst.

We claim:

1. A pressure vessel in the form of an aerosol dispenser comprising a container adapted to hold a fluid under superatmospheric pressure, at least the bottom wall of the container having a safety-valve adapted to open even at normal room temperatures when the pressure in the container reaches a predetermined excessive level below that which would burst the container, said safety-valve comprising

(A) an orifice in said bottom wall,

(B) a valve body having

(1) an outer plug portion sealingly fitted in said orifice and having at least one exit port located outside said wall,

(2) an inner washer-like portion integrally united to said plug portion and having an outer face which forms a fluid-tight seal with the inner surface of said wall in an area surrounding said orifice, and an inner face adapted for attachment thereto of a rupturable wall member (C) as described below, and

(3) a duct therein providing communication between (a) the outer surface of a rupturable wall (C) as described below attached to said inner face of component (2), and (b) the exit port of component (1), and

(C) a rupturable wall of preformed fluid-impervious material sealingly attached to said inner face of component (2) so as to form a fluid-tight closure of the inner end of said duct, said rupturable wall being

(x) of substantially uniform thickness,

(y) the product of laminating a polyethylene film to a polyester film, and

(z) adapted to rupture at said predetermined excessive level of pressure even at normal room temperature and thereby provide sufficient communication between the interior of the container and said exit port to prevent bursting of the container.

2. A pressure vessel according to claim 1 wherein said plug portion has a substantially imperforate outer end portion adapted to protect said rupturable wall, and a side portion containing an exit port in the form of a substantially horizontal duct.

References Cited

UNITED STATES PATENTS

586,684	7/1897	Griffiths.
1,022,301	4/1912	Campbell.
2,701,075	2/1955	Coffman.
2,811,573	10/1957	Williams.
3,116,747	1/1964	Cowles et al.
3,184,097	5/1965	Kilmer et al.
3,356,257	12/1967	Eimer.

FOREIGN PATENTS

861,289	2/1961	Great Britain.

RAPHAEL H. SCHWARTZ, Primary Examiner