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SAFETY PLUG FOR PRESSURE VESSELS

Filed Sept. 16, 1965

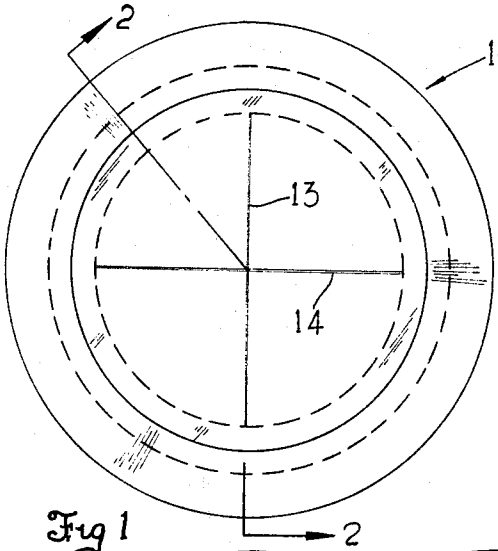


Fig 1

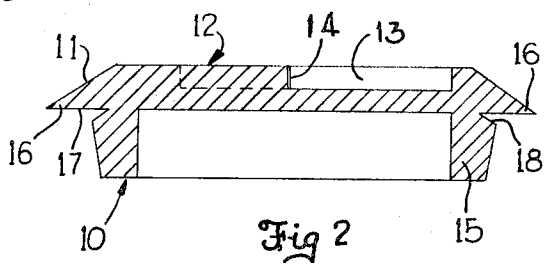


Fig 2

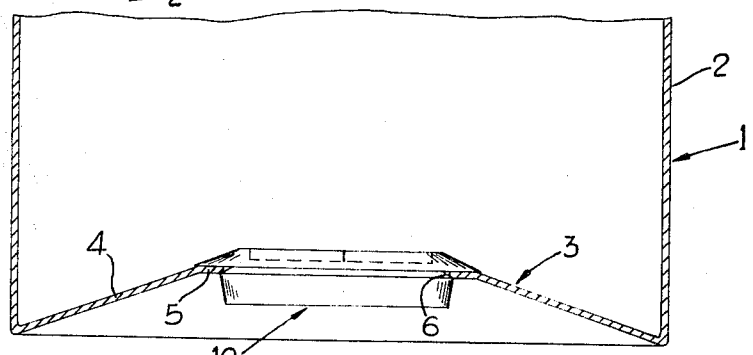


Fig 3

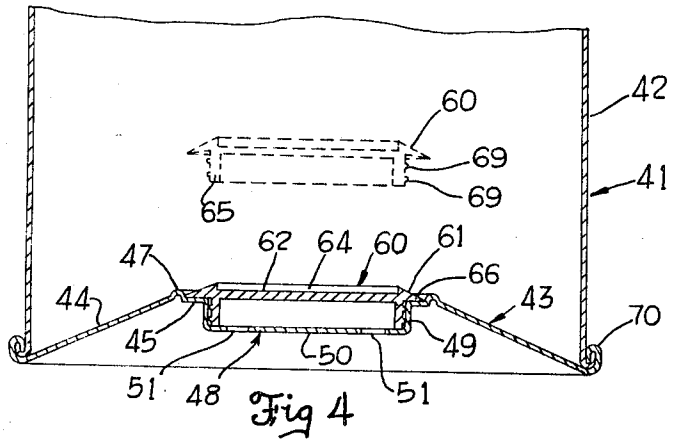


Fig 4

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SAFETY PLUG FOR PRESSURE VESSELS

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ABSTRACT OF THE DISCLOSURE

In an aerosol bomb, a safety plug seated in an opening, the safety plug being made of a thermoplastic material of a character that softens gradually with increasing heat. The plug has a web with an area of predetermined weakness whereby in response to heat and to pressure inside the vessel the web deforms gradually, rupturing slowly at the area of weakness, releasing the contents of the vessel gently. The plug with a radially outwardly projecting flange to engage the opening-defining wall, and a skirt depending toward the outside of the bomb. A cup outboard of the skirt, with the holes in it.

Background of the invention

This invention relates to pressure vessels. It has particular, though not exclusive, application to pressure vessels of the aerosol bomb type, and will be described as applied to aerosol bombs.

The dangers attendant the exposure of aerosol bombs to high temperatures, as in incinerating them, have long been recognized, as is reflected in the notices attached to aerosol containers for household use, and also in a large number of patents upon devices designed to minimize these dangers.

Many of the prior art patents have to do with fusible plugs, constructed in much the same way as fusible plugs for boilers, hot water heaters, and the like. One of the chief difficulties with the fusible plugs suggested heretofore has been that the plugs tend to give way practically instantaneously at some critical temperature. Another difficulty has been that the plugs have been so designed that when they do release, the opening through which the fluid, under high pressure, escapes, acts as if it were a rocket nozzle, propelling the bomb with dangerous force.

One of the objects of this invention is to provide a pressure vessel of the aerosol bomb variety which, when heated above a safe temperature, acts to relieve pressure inside the container slowly and safely.

Another object is to provide such a container which is easy to manufacture, fill and use, using existing machinery for its construction and filling.

Other objects will become apparent to those skilled in the art in the light of the following description and accompanying drawing.

Summary of the invention

In accordance with this invention generally stated, a pressure vessel is provided with a wall having an aperture defined by a substantially planar boundary and a safety plug is provided, seated within the aperture, the plug being made of a thermoplastic material which is resilient, non-frangible at normal temperatures and which gradually softens with increasing temperature. The plug has a flange bearing against the inside surface of the wall, and a thin, continuous web closing the aperture. The web is provided with areas of predetermined weakness, whereby, in response to heat and to pressure inside the vessel, the web deforms gradually, rupturing slowly at the area of weakness, and releasing the contents of the vessel gently.

In the preferred embodiment, the plug is made of

standard low-density polyethylene, and the areas of weakness are defined by incised scorelines intersecting at the center of the web.

Brief description of the drawing

In the drawing, FIGURE 1 is a top plan view of one embodiment of plug of this invention;

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary view, partly in section, showing the plug of FIGURES 1 and 2 seated in an aperture in an aerosol bomb type of pressure vessel; and

FIGURE 4 is a fragmentary sectional view of another embodiment of pressure vessel and plug of this invention, and showing, in dotted lines, an exploded view of the plug.

Description of the prefererd embodiment

Referring now to the drawing, particularly to FIGURES 1–3, for one illustrative embodiment of pressure vessel of this invention, reference numeral **1** indicates an aerosol bomb with a cylindrical side wall **2** and, in this embodiment, a bottom wall **3** integral with the side wall **2**. The bottom wall **3** has an upwardly inwardly extending conical section **4** contiguous the side wall **2** and a planar section **5** at the inner upper part of the conical section **4**. A radially inner edge of the planar section **5** defines a circular aperture **6**, in which a plug **10** is seated.

The plug **10** of this embodiment consists of a radially outwardly projecting flange **11**, a central, continuous web **12**, and an annular, depending skirt **15**. The flange **11** is chamfered on its upper external surface, to form a flexible lip **16**. The lower surface of the lip **16** is planar to form a sealing surface **17** and extends radially outwardly beyond the margin of the skirt **15**. At the upper end of the skirt **15**, at its juncture with the flange **11**, the skirt is provided with an annular groove **18**, the upper margin of which is defined by a part of the sealing surface **17**.

In this embodiment, an area of weakness of the web **12** is defined by two slits or scorelines **13** and **14**, extending diametrically, at right angles to one another entirely across the central web **12**.

The dimensions of the aperture **6** and the plug **10** are such that when the plug **10** is seated in the aperture, the margin of the planar section **5** of the bottom wall **3** projects into the groove **18** in a snap fit, and the sealing surface **17** of the flange **11** fits tightly against the planar top surface of the section **5**. The skirt **15** projects below the lower surface of the section **5**, but above the plane of the bottom edge of the can as defined at the meeting edge of the bottom **3** and side wall **2**.

The outer surface of the skirt **15** is tapered inwardly downwardly, to facilitate the insertion of the plug, as can be seen clearly from FIGURE 3.

The flexibility of the lip **16** permits the sealing surface **17** to accommodate itself, under the pressure of the contents of the can, to any minute irregularity in the upper surface of the planar section, insuring a fluid-(gas and liquid)-tight seal between the sealing surface **17** and the section **5**.

In this preferred embodiment, the slits **13** and **14** extend halfway, axially, through the web **12**.

Merely by way of illustration, and not by way of limitation, a plug of molded standard low-density polyethylene can be provided with a central web .060″ thick with scorelines .03″ deep. The central web can be approximately one-half of an inch in diameter, and the overall diameter to the edge of the lip can be approximately three-fourths of an inch. Under these circumstances, in an aerosol bomb of 3 to 24 ounce capacity and diameters of two to three inches, when Freon 12 is used as the pro-

pellant, the central web will deform and stretch outwardly as the temperature and pressure increase until the elastic limit of the material at the point of scoring is reached, when the plug will open, to release the contents of the can slowly into the atmosphere at a temperature of approximately 138° F. and a pressure of about two hundred pounds per square inch gauge. In numerous tests, no sign of bulging or rupturing of the container has been exhibited, and the contents have been released without any appreciable propellent force.

It is important that the central web of the plug be of sufficient area to permit the contents to be discharged within a short enough time so that pressures do not build up during the discharge process. Within this limitation, the size of the plug can vary widely. Thus, the plug with the web three-fourths of an inch in diameter, of the illustrative example, has been used with equal success in three ounces and twenty ounce aerosol bombs.

Referring now to FIGURE 4 for another illustrative embodiment, a so-called three piece bomb **41** has a cylindrical side wall **42** and a bottom wall **43** joined to the side wall **42** by a rolled or crimped joint **70**.

In this embodiment, the bottom wall **43** has a conical section **44**, sloping upwardly inwardly from the bottom edge of the side wall **42**. It also has a planar section **45**. Between the planar section **45** and the conical section **44**, is an annular rib **47**. In this embodiment, the bottom is drawn, in its central section, to form a cup **48**, of which the planar section **45** is a flat rim. The cup **48** has a cylindrical side wall **49** and a bottom **50**. Holes **51** extend through the bottom **50**. In this embodiment, the cup **48**, along with the holes **51**, constitute the aperture, within which a plug **60** is seated. The bottom **50** forms a tamper-resistant guard.

The plug **60** as a flange **61**, chamfered radially outwardly to define a flexible lip **66**, and a central, continuous web **62**. The plug **60** also has a depending skirt **65**. In this embodiment both the inner and outer faces of the skirt **65** are cylindrical. Upper and lower annular sealing ribs **69** extend around and radially outwardly of the outer surface of the skirt **65**. In this embodiment, the under surface of the lip **66** is slightly coned, so that the radially outer edge is slightly below the radially inner edge of the lip, before the plug is inserted in the cup **48**.

The dimensions of the plug **60** and the cup **48** are such that the sealing ribs **69** engage the inner surface of the side wall **49** of the cup snugly, and the under surface of the lip **66**, when the plug is forced into seated position as shown in FIGURE 4, engages the upper surface of the planar section **54** snugly. The outer edge of the lip is cammed into contact with the annular rib **47**. Again, as in the embodiment shown in FIGURES 1–3, the flexibility of the lip **66**, in response to the pressure within the vessel, permits the lip to adapt itself to any slight irregularities in the upper surface of the section **45**, to insure a tight seal. In addition, in this embodiment, the sealing ribs **69** provide additional protection against leakage. The depth of the cup **48**, and the height of the skirt **65** are such as to permit the opening of the central web in response to an increase in temperature and pressure, just as in the embodiment shown in FIGURES 1–3. Scorelines, of which only one line **64** is shown, are identical to those of the plug shown in FIGURES 1–3.

The operation of the plug and vessel shown in FIGURE 4 is exactly the same as that of the plug and vessel shown in FIGURES 1–3.

Numerous variations in the construction of the plug and vessel of this invention, within the scope of the appended claims, will occur to those skilled in the art in the light of the foregoing disclosure. Other plastics, such as polypropylene, polycarbonate, polystyrene, plasticised acrylic, nylon and other thermoplastics can be used for plugs for particular applications. The depth of the slits defining the areas of weakness can also be varied. For example, in a plug with a central web .06" thick, and

Freon 12 as a propellant, if the scorelines are .02" deep, the plug will release at approximately 240 pounds per square inch gauge, and 155° F., while if the scorelines are .0375" deep, the plug will release at approximately 160 pounds per square inch gauge and 120° F. As has been indicated, while a range of ratios of the diameter of the central web to the diameter of the container of about 1–4 to 1–6 has been found eminently satisfactory, the ratio can vary, provided that the area is sufficient to insure the release of the contents of the vessel without an untoward pressure build up because of a restriction of the aperture through which the contents are to escape. Combinations of elements of the two embodiments shown, e.g., the provision of an annular rib at the radially outer margin of the planar section of the bottom of the embodiment shown in FIGURES 1–3, can be used. The type of propellent gas is relevant only to the conditions of pressure and heat-pressure relationship which the safety plug must meet. Thus, compressed gas, e.g. carbon dioxide and nitrous oxide, hydrocarbons, e.g., isobutane, butane and propane, and halogenated hydrocarbons different from Freon 12 (difluoro dichloro methane) e.g., Freon 11 (trichloro monofluoro methane) and others, may be used. These variations are merely illustrative.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a pressure vessel of the aerosol bomb type the improvement comprising a vessel wall having an aperture defined by a substantially planar boundary and a safety plug seated within said aperture, said plug being made of a thermoplastic material which is resilient, non-frangible at normal temperatures, and gradually softens with increasing temperature, said plug having a flange bearing against the inside surface of said wall and a thin continuous web closing the aperture, said web being provided with areas of predetermined weakness, whereby, in response to heat and pressure inside the vessel, the web deforms gradually, ruptures slowly at the area of weakness, and releases the contents of the vessel gently.

2. The improvement of claim **1** wherein the areas of predetermined weakness are defined by score lines intersecting substantially at the center of the web span.

3. The improvement of claim **1** wherein the plug is provided with a skirt depending from the margin of the web in a direction toward the outside of the vessel, said skirt defining, with the flange, a sealing means.

4. The improvement of claim **1** wherein the flange is chamfered on its inner surface to provide a thin, flexible outer edge portion.

5. The improvement of claim **1** wherein the thermoplastic material is polyethylene.

6. The improvement of claim **5** wherein the plug is adapted to release the contents of the pressure vessel at a pressure of between one hundred and fifty and two hundred and fifty pounds per square inch at a temperature of 118° F. to 155° F., said slug having a web approximately sixty thousandths of an inch thick with incised score lines between twenty and forty thousandths of an inch deep in its inner surface.

7. The improvement of claim **6** wherein the plug is seated in an aperture in the bottom wall of an aerosol bomb of between about ½ and 32-ounce fluid capacity, and the central web is approximately ½ inch wide.

8. In a pressure vessel of the aerosol bomb type the improvement comprising a vessel wall having an aperture therein defined by a substantially planar boundary and a safety plug seated within said aperture, said plug being made of a thermoplastic material which is resilient, non-frangible at normal temperatures and which gradually softens with increasing temperature, said plug having an outwardly projecting flange, chamfered at its upper surface to provide a thin flexible outer edge portion and a flat under surface bearing against the inside surface of said wall, a thin continuous web closing the aperture said web having defined areas of predetermined weakness, and

a skirt depending from the margin of the web in a direction toward the outside of the vessel.

9. In a pressure vessel of the aerosol bomb type the improvement comprising a vessel bottom wall having an aperture therein defined by a substantially planar boundary; a safety plug seated within said aperture, said plug being made of a thermoplastic material which is resilient, non-frangible at normal temperature and which gradually softens with increasing temperature, said plug having an outwardly projecting flange, chamfered at its upper surface to provide a thin flexible outer edge portion and a flat under surface bearing against the inside surface of said wall, a thin continuous web closing the aperture, said web having defined areas of predetermined weakness and a skirt depending from the margin of the web in a direction toward the outside of the vessel, and an upwardly opening cup mounted in the bottom wall of the pressure vessel, said cup having a flat rim which constitutes the planar boundary of the aperture, and a perforate bottom wall.

10. The pressure vessel of claim **9** wherein the cup has a cylindrical side wall, the plug skirt has a cylindrical outer surface and annular sealing ribs, projecting radially outwardly from the said outer surface, engage the inner surface of the cylindrical side wall.

11. In a pressure vessel of the aerosol bomb type the improvement comprising a vessel wall having an aperture defined by a substantially planar boundary and a safety

plug seated within said aperture, said plug being made a thermoplastic material which is resilient, non-frangib at normal temperatures, and gradually softens with i creasing temperatures, said plug having a flange bearir against the inside surface of said wall and a thin contin ous web closing the aperture, said web being provided wi areas of predetermined weakness, whereby, in response t heat and pressure inside the vessel, the web deform gradually, ruptures slowly at the area of weakness, an releases the contents of the vessel gently, said plug beir adapted to release the contents of said vessel at a pressu of between one hundred and three hundred pounds p square inch at a temperature of between 101° F. an 215° F.

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