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3,466,444

DIFFERENTIALLY VENTED CARRYING CASK FOR RADIOACTIVE MATERIALS

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Lusk

FIG. 1

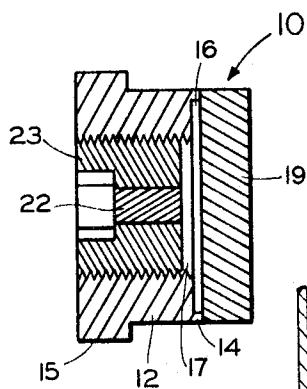


FIG. 2

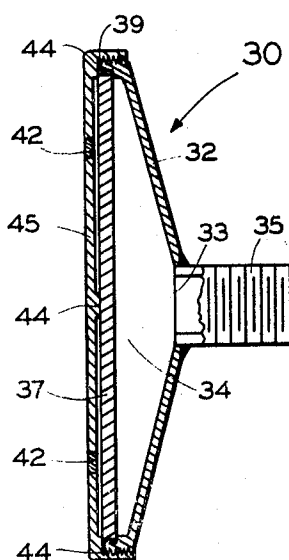
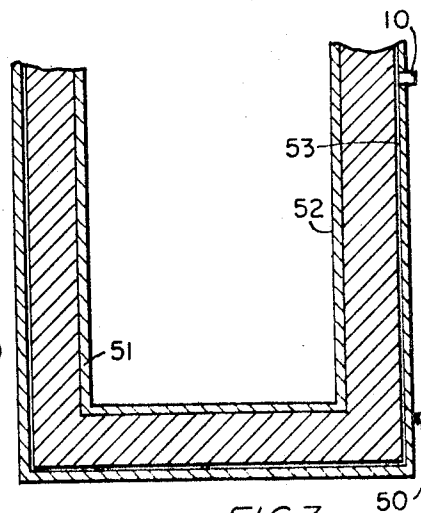


FIG. 3

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DIFFERENTIALLY VENTED CARRYING CASK FOR RADIOACTIVE MATERIALS

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9 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed a carrying cask structure for radioactive materials, and the cask is characterized by having a fusible solid shielding material disposed interiorly thereof in a substantially filled space, there further being in the cask structure a differential material vent, the vent comprising a porous outlet-defining arrangement having pores of a mean pore size in a vent path from the aforementioned space for the pores to vent gas from that space at a pressure at which the pores are substantially impermeable to molten shielding material in the space and to vent molten shielding material at an increased pressure from the space.

This invention relates to differential material venting devices and more particularly, it relates to a differential vent for the removal of gases from a container while retaining molten liquid within the container. The invention further relates to a differential material venting device used in combination with a lead-lined shipping cask for radioactive materials.

In the transportation of radioactive materials, shipping casks are used which generally comprise an inner container and an outer shell with lead shielding material contained in the annular cavity defined therebetween. The area within the container carries radioactive materials being shipped. In the fabrication of these shipping casks, molten lead is poured within the annular space defined by the inner container and outer shell. Because of the high coefficient of thermal expansion of lead as compared to the container and shell materials, the lead shrinks upon solidification and pulls away from the outer shell. This leaves a void between the outer surface of the lead and the inner surface of the outer shell. Safety requirements dictate that the void volume thus formed must remain to provide room for expansion of the lead in the event of fire in the vicinity of the shipping cask. In fact, sufficient void volume must be allowed to take up the expansion of the lead resulting from temperature rise and transformation to the liquid state at temperatures equivalent to those that would be encountered in a fire. Lack of sufficient space for expansion of lead would result in rupture of the outer shell and loss of shielding material with attendant radiation hazards. The presence of the required void volume in the wall of the shipping cask has caused another significant danger. In some cases, cracks in the outer shell have allowed moisture to enter into the void volume. This is a particular hazard where radioactive materials are loaded into the shipping cask under water. The cracks through which water has been admitted may subsequently become sealed by the action of corrosion, dirt, paint, lead packing or shifting, and by yielding of the metal shell. It has been found that when the shipping cask is exposed to high temperature, the moisture entrapped as described above transforms to steam and produces dangerously high pressures within the lead-filled cavity. Even where the crack remains open, considerable pressure is still generated to a dangerously high level because the area of the opening through which steam may escape is insignificant. Catastrophic explosions of shipping

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casks have resulted from transformation of entrapped moisture to vapor as described above. The venting of entrapped steam is made difficult by the likelihood of the presence of molten lead at temperatures of steam formation. Loss of lead must be avoided to minimize the risk of a radiation hazard.

It is therefore an object of this invention to provide a vent for a container which allows gases to escape therefrom but which retains molten liquids therein.

It is a still further object of the present invention to provide a shipping cask for radioactive material having little likelihood of explosion from the presence of entrapped moisture within the container wall and thus increased utility over conventional containers.

It is another object of this invention to provide a vent for the lead-filled walls of shipping casks for radio-active materials.

It is still another object of this invention to provide a vent for the lead-filled wall of shipping casks characterized by the ability to allow vaporized moisture to escape from the void volumes defined therein without allowing molten lead to flow therefrom.

Various other objects and advantages will appear from the description of the embodiments of the invention in the ensuing specification, which is to be read in conjunction with the attached drawings wherein:

FIG. 1 is a vertical sectional view through a vent constructed in accordance with one embodiment of the invention;

FIG. 2 is a vertical sectional view through a vent constructed in accordance with another embodiment of the invention; and,

FIG. 3 is a fragmentary view of a shipping cask having a wall thereof combined with a venting device.

Briefly described, the invention includes within its scope the preferential venting of materials and a differential material venting device therefor comprising a body fitted with a porous metal plate member adapted to vent steam and other gases under pressure but to restrain the flow of molten liquids therethrough.

Referring to FIG. 1, an assembly of a differential material venting device 10 according to this invention is shown comprising a cylindrical body 12 with a centrally located threaded opening 17 extending therethrough. Circumferential shoulder 14 is outwardly disposed from one extremity of cylindrical body 12 to define a shallow opening 16 therein while flanged portion 15 is provided at the opposing extremity of cylindrical body 12. A porous metal member 19 is suitably affixed to the face of circumferential shoulder 14. The dependent threads in opening 17 of cylindrical member 12 are threaded with plug member 23 having a centrally located opening therethrough filled with a material 22 automatically removable at a predetermined temperature above room temperature.

In operation, the assembly is connected into the wall of a container with flanged portion 15 extending outwardly. Gas pressure that develops within the container is vented through porous plate member 19 and the large area defined by space 16. Material 22 is selected so as to be automatically removable at temperatures just below the temperature at which significant vaporization of the liquid is likely to occur within the container.

Material 22 can be a solder having a melting range within the required temperature limits. Bi-metallic snap out disks are equally suitable. In this way, porous metal plate member 19 is protected from possible contaminating influences from without the container during the time that assembly 10 is not in active operation. It should be understood that material 22 is not absolutely essential for the operation of the differential material venting

assembly but merely is convenient. In some applications, it will be obvious that water entering the container from without the vent is merely vented back out as steam when elevated temperatures arise.

Assembly of the pressure venting device is relatively simple. Porous metal member is merely welded by convenient means to circumferential shoulder 14. Plug member 23 is tapped by convenient means and the opening extending therethrough fitted with material 22. The threaded exterior of plug 23 engages threads on the interior of opening 17 extending through cylindrical member 12.

Referring to FIG. 2, a pressure venting device 30, also according to this invention, comprises a funnel-shaped body 32 terminating respective in openings 33 and 34. A centrally located vent port 35 communicates with smaller diameter opening 33 in funnel-shaped body 32. Vent port 35 is provided with threads for fixed attachment to dependent threads provided within the wall of a container, thus allowing assembly 30 to communicate with the interior. At the larger diameter opening 34 of funnel-shaped body 32, a porous metal plate member 37 is disposed within recess 39 provided on the inside diameter defined by larger opening 34 of funnel-shaped member 32. A cap 45 is provided for engagement with larger diameter opening 34. Projections 44—44 on the inside face of cap 45 force the porous metal plate 37 to fit snugly into recess 39 while maintaining a suitable spacing of cap 45 from the same. Numerous small diameter openings 42—42 filled with a material automatically removable at a preferred temperature range extend through the face of cap 45 at various locations thereon.

In assembly of the pressure venting device described above, porous metal plate 37 is merely disposed within recess 39 provided within the inside diameter of larger diameter opening 34 defined at one extremity of funnel-shaped body 32. Cap 45 is secured tightly so that projections 44—44 on the inside face thereof engage porous member 37 to secure the same in place on recess 39 and to seal the assembly 30.

The porous metal plate member comprises the key member of the material venting device of this invention. The porous metal member is available commercially with a variety of different pore sizes. Where high pressures or high-liquid heads may be developed, a small pore size is selected. Similarly, for a given pore size, a thicker porous metal member is selected where high metal heads may be encountered. Generally it is advisable to select a pore opening size and thickness of porous metal member to restrain the flow of the contained liquid and allow the passage of gases therethrough. The actual size of the differential material vent depends on the active surface area needed for the porous metal plate. This, in turn, depends on the gas flow capacity of the porous metal plate, the strength of the porous metal plate, the volume of gas estimated to be generated in the container, and the length of time during which gas would be formed. When these factors are known, the surface area required to vent gas can be determined by simple calculation. Where the calculated surface area is large it may be convenient to assemble a plurality of differential material vents for use in the container. The sum of the areas presented by each vent being equal to or greater than the required area. The use of a plurality of vents would also provide an additional safety factor in the event of injury to one of the vents during transit.

In FIG. 3 one of the hereinbefore described devices 10 is represented connected for venting the space 53 between an inner container 51 and an outer shell 52 of a shipping cask 50 for radioactive elements and very satisfactorily includes a porous metal plate member fabricated from stainless steel. For example, for a porous plate member of stainless steel having a thickness of 0.187-inch and a mean pore diameter of 0.0002 inch, molten lead will be restrained at pressures over 42 p.s.i.g.

This is equivalent to a metal head of 8 feet. In a cask having a void volume of 1521 in.³, a surface area of 56 in.² in porous stainless steel plate as described above vented the quantity of steam that would be expected to form within the lead-filled wall without achieving pressures in excess of 50 p.s.i.g.

In operation in the lead-filled wall of a shipping cask for radioactive elements, the porous metal plate member can be protected at its outer surface by a material that is automatically removable to open and exit for gases at temperatures slightly below the boiling point of water. Upon encountering conditions such as fire wherein the temperature of the atmosphere surrounding the cask rises rapidly, the material in the exit gas opening is automatically removed thus leaving free openings to communicate with the porous metal plate. As temperature continues to increase, steam begins to form and is vented through the porous metal plate. Further increase of temperature causes the lead to become molten but the molten lead is retained within the wall of the cask by the porous metal plate. Should temperatures in the vicinity of the cask exceed values currently foreseen by safety requirements, it has been found that the differential material vent of this invention will still not cause catastrophic rupture of the outer shell of the container. The higher pressures occasioned by these higher temperatures will merely result in a slow leakage of molten lead through the porous plate member thus relieving the excess pressure caused by expansion of molten lead.

The body of the differential material vent may be made from a variety of materials, though it has been found that components of stainless steel are very satisfactory. In the embodiments of the invention shown, the porous metal member is a disk configuration. It is obvious that any configuration disposed between the contents of the outer shell and an opening entering the atmosphere would be satisfactory.

One advantage of this invention is that a material venting device is provided to exhaust steam or other gases at a safe pressure from a cavity filled with molten liquid.

Still another advantage of this invention is that a material venting device is characterized by a porous metal plate having substantial strength and resistance to breakage in service.

In its application to shipping casks for radioactive elements, the material venting device of this invention provides several significant advantages which make the shipping of radioactive elements less hazardous.

It will be apparent that new and useful means for differential venting of materials have been described. Although several preferred embodiments of the invention have been described, it is apparent that modifications may be made therein by those skilled in the art. Such modifications may be made without departing from the spirit or scope of the invention, as is set forth in the appended claims.

What is claimed is:

1. In a carrying cask for radioactive materials which includes an inner container; an outer shell spaced outwardly from said inner container; and a fusible solid shielding material substantially filling the space between said outer shell and said inner container; the improvement comprising a differential material vent including a porous structure having pores of a mean pore size in a vent passage from said space for said pores to vent gas from said space at a pressure at which said pores are substantially impermeable to molten said shielding material and said pores to vent molten said shielding material at an increased pressure from said space.

2. The carrying cask of claim 1, wherein said fusible solid shielding material is a monolithic casting within said space.

3. The carrying cask of claim 2, wherein said monolithic casting includes lead.

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4. The carrying cask of claim 3, wherein said porous structure comprises porous stainless steel.

5. The carrying cask of claim 1, and including thermally sensitive sealing means arranged in said vent passage to seal said space closed and to be automatically displaced to vent said space through said pores after temperature of said thermally sensitive sealing means exceeds a minimum value.

6. The carrying cask of claim 1, wherein a vent member is connected having an opening therein for communicating with said pores and with said space, and said cask is further characterized by including thermally sensitive sealing means arranged to close said vent member opening and to be automatically displaced to vent said space through said vent member opening and through said pores after temperature of said thermally sensitive sealing means exceeds a minimum value.

7. The carrying cask of claim 6, wherein said thermally

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sensitive sealing means comprises a low-melting range solder which fuses when said minimum temperature is exceeded.

8. The carrying cask of claim 6, wherein said porous structure is arranged having said pores interposed between said space and said vent member opening.

9. The carrying cask of claim 6, wherein said vent member has said opening therein interposed between said space and said pores.

No references cited.

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