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Andrew

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[54] **SAFETY SYSTEM FOR EXPLOSIVE POWDER STORAGE BIN**

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[52] **U.S. Cl.** .....**86/1,** 102/24 R

[51] **Int. Cl.** **F42b 33/00,** F42b 37/00

[58] **Field of Search** .....86/1, 20, 20 C; 102/24 R, 97, 102/100; 60/252, 253

[56] **References Cited**

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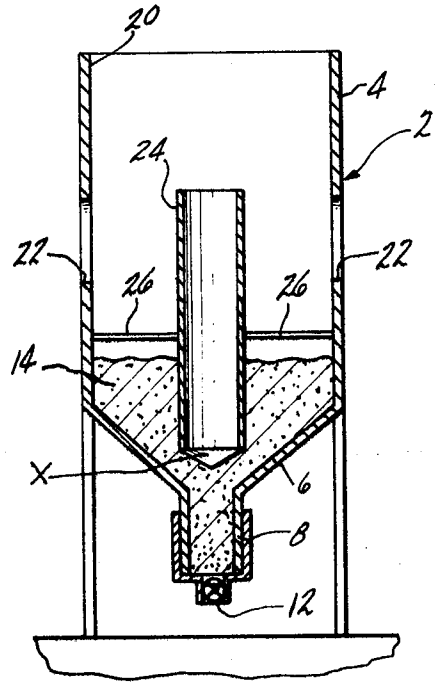
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[57] **ABSTRACT**

Prevention of deflagration of explosive powder from developing into a detonation within a storage chamber is accomplished by venting pressure from within the storage chamber so that the critical mass detonation rate of burning of the powder can never be reached.

4 Claims, 2 Drawing Figures



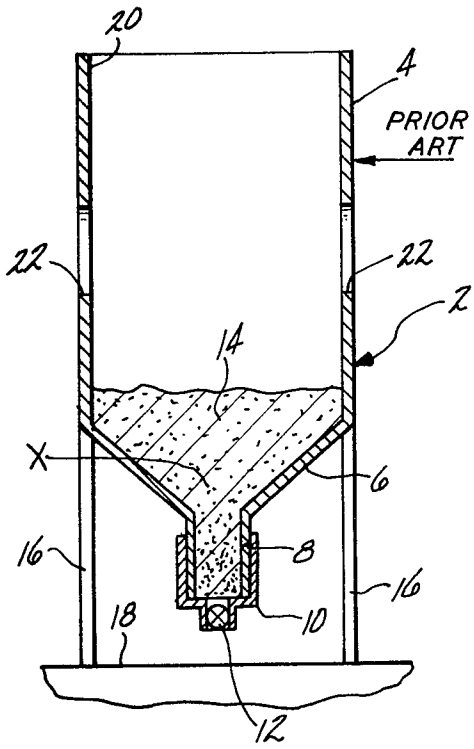


FIG - 1

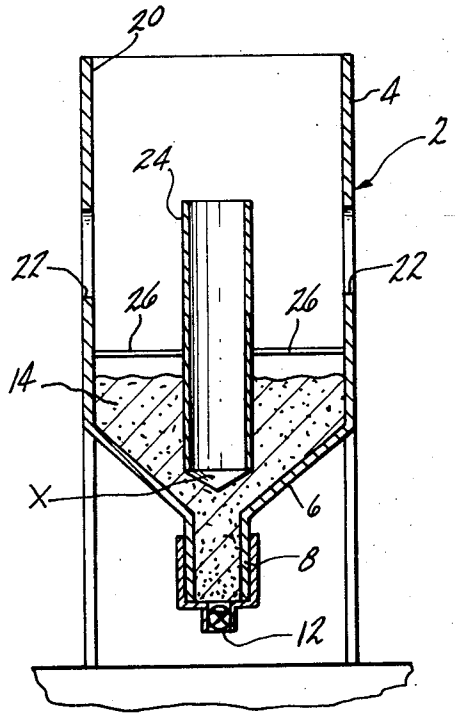


FIG - 2

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SAFETY SYSTEM FOR EXPLOSIVE POWDER STORAGE BIN

This invention concerns the prevention of detonation of a charge of explosive powder within a storage container which would otherwise result from deflagration of the powder within the storage container.

In the manufacture of explosive or incindiary devices such as certain types of ammunition, and the like, large quantities of explosive material, such as smokeless powder and the like, must be stored. Such storage occurs in large containers, hoppers, or bins which can take the form of containers on assembly lines from which the explosive material is metered into the explosive devices being produced. Large quantities of explosive powder are also stored in other types of containers during various stages of production.

Storage of large volumes of detonatable explosive material, such as smokeless powder, and the like, is, of course, dangerous since ignition of the stored volumes of such material can result in detonation thereof with catastrophic results. This danger requires utmost precautions being taken in the storage areas, such precautions including the abolition of smoking, matches, lighters, and other devices which could cause ignition of the stored powder charges.

Notwithstanding such safety precautions, accidental explosions may still occur as a result of sparks caused by metal parts being dropped, defective electrical wiring, heat generated by friction in working mechanisms, and other causes which the most stringent safety precautions can minimize, but not eliminate.

This invention concerns the prevention of detonation of a stored volume of explosive material even if deflagration by combustion within the stored volume has occurred. It is known that detonation of a confined mass of explosive powder will occur once heat and gas pressure (caused by combustion gases produced by the burning powder) become sufficiently high to cause the burning rate of the powder to reach a mass detonation rate, at which time all of the powder is substantially instantaneously consumed, causing an explosion. If the stored powder burns at a rate which is less than the mass detonation rate, no explosion will occur, and the powder will merely burn itself up. The mass detonation rate of a particular powder varies with the composition and physical shape of the powder, certain powders being fast burning, and other powders being slow burning. This invention provides for the venting of the burning area of the powder mass so that, if combustion of the stored powder mass occurs, the burning area is vented to the atmosphere so as to reduce combustion gas pressure and head buildup before the mass detonation rate of combustion is reached. Thus the burning powder will merely burn itself up without detonating.

The venting can be accomplished by providing a void volume within the powder mass, which void volume is adjacent to the critical portion of the powder mass which will be able to support combustion sufficient to reach the mass detonation rate. Preferably the void can be formed by providing a hollow vent, in the form of a tube or the like, which extends from the critical area of the powder mass, through the power mass to the atmosphere. If a tubular vent or void volume is used, care must be taken to prevent the tubular vent or void volume from becoming filled with powder.

It is, therefore, an object of this invention to provide a system to prevent detonation of a volume of explosive material after commencement of deflagration of the explosive material.

It is a further object of this invention to provide a system of the character described which reduces pressure in the burning portion of the volume of explosive material before the mass detonation rate of the explosive is reached.

It is yet another object of this invention to provide a system of the character described which vents the burning portion of the volume of explosive material before the mass detonation rate of the explosive is reached.

These and other objects and advantages of the invention will become more readily apparent from the following detailed description of a preferred embodiment of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side sectional view of a powder hopper formed in accordance with the prior art and used for storing and dispensing of large volumes of explosive powder; and

FIG. 2 is a side sectional view of a powder hopper similar to that shown in FIG. 1, but including a preferred embodiment of the system of this invention in the form of a tubular vent.

Referring now to FIG. 1, there is shown a sectional view of a conventional Kingsmill powder hopper used for storing and dispensing comparatively large volumes of explosive powder. The hopper 2 includes a cylindrical side wall 4 and a frustoconical bottom wall 6 opening into an exit tube 8. A cap member 10 is fitted onto the exit chute 8 and includes a valve 12 (shown schematically) through which powder 14 is fed. A plurality of supports 16 hold the hopper 2 above a surface 18 such as the ground or a floor. The top of the hopper 2 is open to the atmosphere, as at 20. Additional powder is fed into the hopper 2 through openings 22 in the side wall 4. It has been found that if burning of the powder occurs in the area marked X, generally near the apex of the bottom wall 6, detonation will occur due to the insulating of pressure and heat by the surrounding powder mass.

Referring now to FIG. 2, a preferred embodiment of the invention is illustrated in conjunction with a Kingsmill hopper of the type shown in FIG. 1. An open ended tubular member 24 is mounted in the hopper 2 by means of struts 26 secured to the side wall 4 of the hopper and to the tubular member 24. The tubular member 24 extends into the powder mass 14 and terminates generally in the critical area X. Also the tubular member 24 extends above the top surface 15 of the powder mass 14 sufficiently to prevent powder which is being poured into the hopper through the openings 22 from entering the member 24 through the top thereof. Thus the interior of the member 24 is always devoid of powder and serves as a vent between the critical area X of the powder mass 14 and the atmosphere, by means of the open end 20 of the hopper. The member 24 also causes a void to form in the critical area X of the powder mass 14. The side wall of the vent member 24 is spaced apart from the frustoconical bottom wall 6 of the hopper sufficiently to permit powder to readily flow between the member 24 and the bottom wall 6 and into

the chute 8. Combustion which occurs within the hopper in the general area of criticality will quickly be vented through the member 24 to insure that combustion gas pressure will never rise sufficiently to permit attainment of the mass detonation rate of burning. Thus, detonation of the powder mass 14 is prevented.

Testing of the prior art containers without and with the specific venting system was performed under the following conditions resulting in the observations set forth below. In order to determine what would happen to a conventional Kingsmill hopper in the event of an internal hopper fire, a test hopper was constructed substantially as appears in FIG. 1. The hopper was loaded with 150 lbs. of Class 7 smokeless powder, which is a detonatable powder used in the manufacture of shotshells and rimfire ammunition. A black powder squib was placed in the general area marked X in FIG. 1 in the powder mass, and was electrically ignited. After a time lapse of 0.030 second measured from ignition of the squib, high order detonation occurred with total destruction and complete disappearance of all pieces of the hopper. The explosion was accompanied by a violent ground and air shock wave.

A series of five hoppers were then constructed in accordance with the embodiment of the invention shown in FIG. 2. Each of the hoppers was loaded with 150 lbs. of Class 7 smokeless powder and a black powder squib was placed at the point marked X on FIG. 2 in each of the five hoppers. Each squib was electrically ignited. An average of 0.160 second after ignition of the squib, a tube of flame was observed arising through the vent tube proper. Shortly thereafter, the vent tube was itself ejected from the hopper on the expanding flame column. The flame column continued to burn for an average time of 1.90 seconds after ignition of the squibs, and kept approximately the same diameter as the hopper side wall. The maximum flame height observed was about 30 to 35 feet. No detonation occurred. Since the hoppers are ordinarily constructed in a building with the top of the hopper side wall extending through the roof of the building the provision of the vent tube enables the hopper to act much like a chimney, directionalizing the flame out of harm's way, and preventing detonation of the stored powder mass.

It will be readily appreciated that venting of the combustion gas pressure and combustion heat away from the critical area of a mass of detonatable explosive powder, if done quickly enough, will prevent occurence of the mass detonation rate of burning of a mass of ignited powder, and the ignited powder mass will merely burn itself up. Furthermore, by properly venting the powder mass, flames of combustion can be directionalized and carried out of harm's way so as to minimize or prevent the danger of a fire accidentally started in one powder mass spreading to adjacent powder masses.

Since many changes and variations of the disclosed embodiments of the invention may be made without departing from the inventive concept, it is not intended to limit the invention otherwise than as required by the appended claims.

What is claimed is:

1. A container for holding a predetermined volume of readily flowable detonatable explosive material, said container comprising; an interior for receiving and holding a quantity of the flowable explosive material sufficient to have a critical area of predetermined location, in which critical area combustion of the material will result in attainment of the mass detonation rate of burning of the material; and open ended vent means mounted in said container interior to form a volumetric void proximate to said critical area, said vent means extending from said void to a point in communication with the ambient atmosphere to provide a path through which combustion heat and pressure can be vented from said critical area to the atmosphere.

2. A system for storing detonatable explosive material, said system comprising:

a. container means;

b. a volume of readily flowable detonatable material in said container means, said volume of detonatable material being sufficiently large to have a critical area in which combustion of the material can result in attainment of the mass detonation rate of burning of the material; and

c. elongated, hollow, open-ended means secured to said container means, said open-ended means having one end portion disposed within said volume of detonatable material proximate to said critical area, and said open-ended means having another end portion disposed beyond the limits of said volume of detonatable material and communicating with the ambient atmosphere.

3. A system for storing detonatable explosive material, said system comprising:

a. container means having a cylindrical side wall and a frustoconical bottom wall, said container means having a top end open to the ambient atmosphere, and said container means including chute means at the apex of said bottom wall means for dispensing material from the interior of said container means;

b. support means fixing the spacial position of said container means;

c. a volume of readily flowable detonatable material in said container means, said volume of detonatable material having a critical area in which combustion of the material can result in attainment of the mass detonation rate of burning of the material, said critical area being located near the apex of said bottom wall means; and

d. tubular means mounted in said container means, said tubular means having one open-ended portion disposed within said volume of detonatable material proximate to said critical area, and said tubular means having another open-ended portion disposed outside of said volume of detonatable material, said tubular means being devoid of said detonatable material to act as a vent for combustion gas and heat from said critical area to the ambient atmosphere.

4. The system of claim 3, wherein said one end portion of said tubular means is spaced apart from said container bottom wall to permit passage of said material past said tubular means to said chute means.

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