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Venable et al.

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[54] **METHOD FOR MITIGATING BLAST AND SHOCK TRANSMISSION WITHIN A CONFINED VOLUME**

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[73] Assignee: **The United States of America as represented by the United States Atomic Energy Commission,** Washington, D.C.

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[52] **U.S. Cl.** **102/23**
[51] **Int. Cl.** **F42d 5/00**
[58] **Field of Search** .... 102/22-24, 102/89, 36 A

[56] **References Cited**

UNITED STATES PATENTS

2,797,892	7/1957	Ryan	102/24 HC
2,984,307	5/1961	Barnes	102/24 HC
1,237,883	8/1917	Elia	89/36 A

OTHER PUBLICATIONS

Nature, Attenuating Blast Waves Produced by an Instantaneous Release of Thermal Energy, Wadsworth, p. 673 relied on, Nov. 14, 1964.

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[57] **ABSTRACT**

The blast and shock wave emanating from an explosive event within a confined volume is substantially reducėd when the volume is filled with a low-density, particulate, energy absorbing medium having poor shock transmission characteristics such as vermiculite or expanded ("popped") perlite. If a vacuum can be drawn in the volume containing the particulate medium, even greater shock and blast mitigation is achieved.

2 Claims, No Drawings

METHOD FOR MITIGATING BLAST AND SHOCK TRANSMISSION WITHIN A CONFINED VOLUME

CROSS REFERENCE TO RELATED APPLICATION

Ser. No. 252,171 entitled "Confinement System for High Explosive Events" by Benjamin T. Rogers, Roger W. Taylor, and Douglas Venable filed May 11, 1972.

BACKGROUND OF THE INVENTION

The invention disclosed herein was made in the course of, or under, a contract with the U.S. ATOMIC ENERGY COMMISSION. It relates to a method of mitigating the blast and shock transmission from an explosive event within a confined volume.

In the course of research directed at the high pressure hydrodynamic properties of materials, it is necessary to resort to explosive driven systems to attain the required pressures. From time to time it may also be necessary to examine toxic, noxious, or radioactive materials to complete the study of a given class of materials. Increasingly, considerations of safety, environmental protection, and long term economics preclude experimental procedures that would allow such materials to be dispersed into the air, onto the earth, or into water.

Apart from the concurrently filed application entitled "Confinement System for High Explosive Events" by the same inventors, the art discloses no system for completely containing both the energy and the products of an explosive event within a reasonably small volume when the size of the explosive charge detonated exceeds about one pound. The concurrently filed application, however, reveals that the energy and products of the detonation of an explosive charge weighing in excess of 30 pounds can be completely contained in a 6 ft diameter spherical confinement vessel having a 1 inch thick mild steel wall and in which a vacuum of about 500 microns has been drawn.

In U.S. Pat. No. 3,268,107, issued Aug. 23, 1966, Sperling discloses a vented container in which small quantities of powerful explosive compositions may be detonated with the container substantially absorbing the energy of the detonation. An important feature of the container is an inner liner which is preferably a light-weight energy absorbent barrier of fairly high mechanical strength but of material particularly suitable for absorbing a large portion of the explosive force. The liner may be frangible or it may be made of some material exhibiting resilience. A limitation on the use of energy absorbing liners is that they must be so configured when manufactured as to enable them to be inserted into the containment vessel.

In U.S. Pat. No. 3,165,916, issued Jan. 19, 1965, Loving indicates that the load limit for a confinement vessel having explosive charges detonated therein may be increased by the presence of a substantial mass of loose granular material within the vessel. According to the invention, the granular material may occupy a segment of the vessel having a height about one twenty-fourth to one-half the height of the vessel. Sand is the preferred material, but any loose granular material having a bulk density of 40–280 lb/ft^3 may be used.

SUMMARY OF THE INVENTION

We have now found that the total explosive loading capacity of a confinement vessel may be substantially increased by filling it with a low-density, particulate, energy-absorbing medium with very poor shock transmission characteristics. Examples of a medium of this type are expanded vermiculite mica and expanded ("popped") perlite; however, the medium is in no way limited to these two materials. The manner in which the low-density particulate material is loaded into the vessel or other enclosure is not critical insolong as the material encompasses the explosive event and substantially fills the vessel or enclosure.

The method of this invention is particularly suitable for use with confinement vessels of the type disclosed in the concurrently filed application. The vessel may be either at atmospheric pressure or have a partial vacuum drawn in it. For example, the detonation of an 8 lb charge of composition C-4 in a 6 ft diameter spherical confinement vessel filled with vermiculite and at atmospheric pressure results in a pressure rise at the wall of the vessel a factor of about 15 less than if the charge had been detonated in the same vessel with no filler added. With the use of a filler material such as vermiculite, it is difficult to draw a substantial vacuum within a confinement vessel within a reasonable time due to outgassing from the filler material. However, with a partial vacuum, i.e., a pressure of several thousand microns, which can be readily achieved, the pressure rise from the detonation of the same charge is a factor of about 27 less than that produced in the same type of vessel with no filling and at atmospheric pressure.

Our method is also quite useful in mitigating the blast and shock transmission from an explosive event in any confined volume. That is to say, it is not limited to use with vessels intended to completely contain the energy and other products of an explosive event, but may be used wherever there is some confining volume available for encompassing the event with a suitable filler material.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Two 1 lb charges of the high explosive composition C-4 were detonated in 3 ft diameter spherical confinement vessels of the type disclosed in the concurrently filed application. Both vessels were at atmospheric pressure, but one was filled with vermiculite and the other—which acted as a control—had no filler material in it. The control vessel registered at its walls a sharp rise to a peak pressure of 750 psi whereas the filled vessel showed only a slow rise to a peak of 50 psi. A similar pair of shots were fired in 6 ft diameter vessels with 8 lb charges of composition C-4. On a volume basis, 8 pounds of explosive in a 6 ft diameter vessel scales with a 1 lb shot in a 3 ft diameter vessel. In the 6 ft diameter vessels the control gave a sharp rise to 800 psi and the filled shot gave a slow rise to 45 psi. These data indicate that the blast mitigation effect of vermiculite scales to larger confinements. In the 6 ft diameter vessel the detonation of an 8 lb charge of composition C-4 at atmospheric pressure with the vessel filled with vermiculite showed a pressure rise at the wall of the vessel that was a factor of ~ 15 less than that of an 8 lb charge fired in the same vessel at atmospheric pressure with no filling.

Similar shots were then fired in vessels containing vermiculite and also partially evacuated. Because of the large surface area of the vermiculite, it was not feasible to pump down the vessels to pressures of 500 microns or less in any reasonable time. However, firing the charges at a pressure of several thousand microns in a vermiculite filled vessel produced a pressure rise at the wall of the vessel which was a factor of ~ 27 less than that produced by the same charge fired in the same type of vessel at atmospheric pressure with no filling.

Sandia Corporation performed the following experiment in a magazine about 40 feet long by 15 feet wide, having 8 foot high walls and a curved ceiling with a maximum height of 15 feet. Three 20 lb high explosive charges were placed at 8 foot intervals in the magazine, beginning 8 feet from the rear of the magazine. The magazine was then filled with sacks of vermiculite and the three charges detonated serially. There was no evidence of blast damage on the walls or ceiling of the magazine and the bags of vermiculite at the entrance remained undisturbed.

What we claim is:

1. A method of mitigating blast and shock transmission from an explosive event within a confined volume which comprises substantially filling said volume and encompassing said event with a low-density, particulate, energy absorbing medium and drawing a partial vacuum within said volume.

2. The method of claim 1 wherein said medium is vermiculite.

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