United States Patent [19]

Hurst et al.

[11] **3,926,119**

[45] **Dec. 16, 1975**

[54] **EXPLOSIVE DEVICE**

[75] Inventors: **Gerald L. Hurst; Oldrich Machacek,** both of Dallas, Tex.

[73] Assignee: **Tyler Holding Company,** Dallas, Tex.

[22] Filed: **Jan. 28, 1974**

[21] Appl. No.: **436,591**

[52] **U.S. Cl.** ..... **102/24 R;** 102/DIG. 9

[51] **Int. Cl.²** **F42B 3/00**

[58] **Field of Search** 102/22–24, 102/28; 149/14–17

[56] **References Cited**

UNITED STATES PATENTS

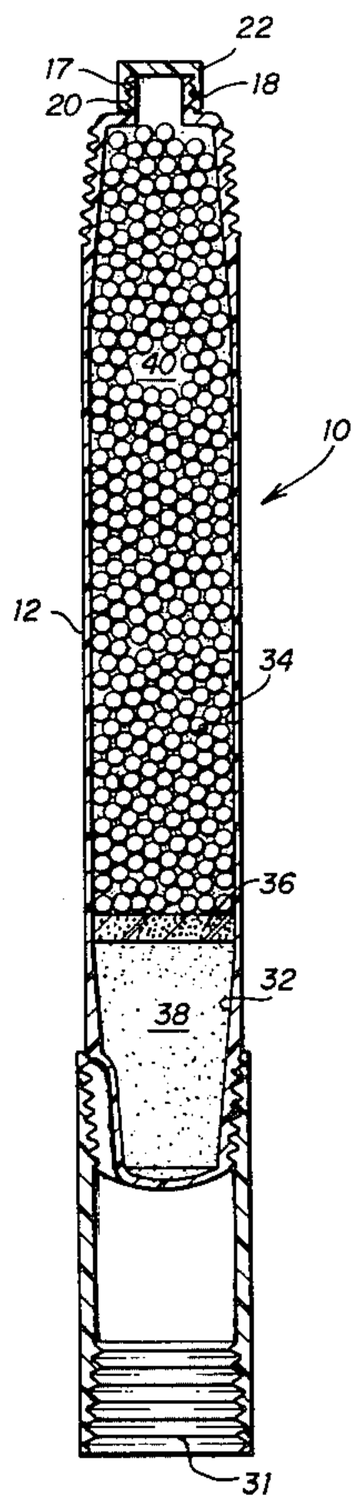
3,580,171	5/1971	Maes	102/28 R
3,718,512	2/1973	Hurst	149/15
3,797,392	3/1974	Eckels	102/23

Primary Examiner—Verlin R. Pendegrass
Attorney, Agent, or Firm—Richards, Harris & Medlock

[57] **ABSTRACT**

A device is provided which carries a solid particulate primary component for a liquid-solid explosive which includes a container having an opening for receiving the liquid component and which carries a sensitized particulate material such as an oxidizing material as the solid primary component adjacent a cap well on the container, and a chamber for carrying a secondary charge or liquid-solid explosive charge component such as a particulate oxidizing material as a solid particulate secondary component, the primary component and the chamber being separated in the container by a porous member which will pass the liquid component but neither of the solid components. A cap sensitive explosive composition is formed, for example, by pouring a liquid component through the opening of the container and into the chamber and allowing it to admix with both the solid primary component and the solid secondary component.

53 Claims, 4 Drawing Figures



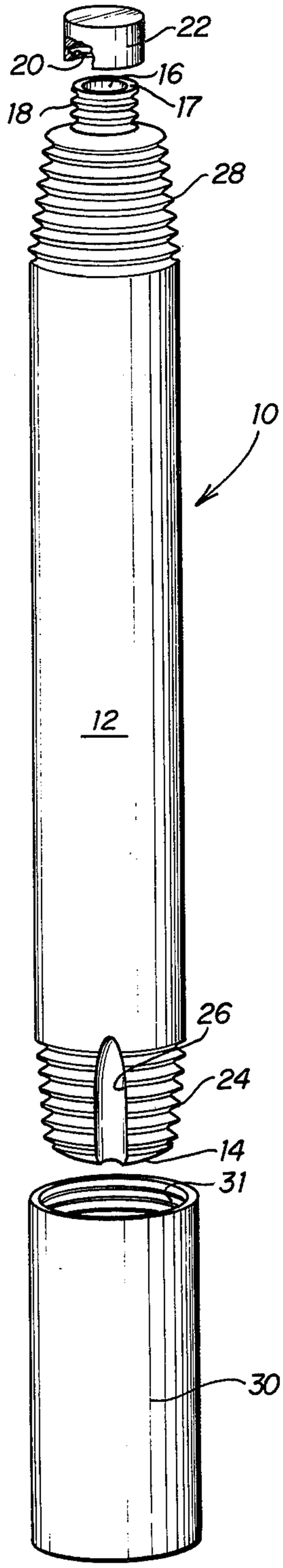


FIG. 1

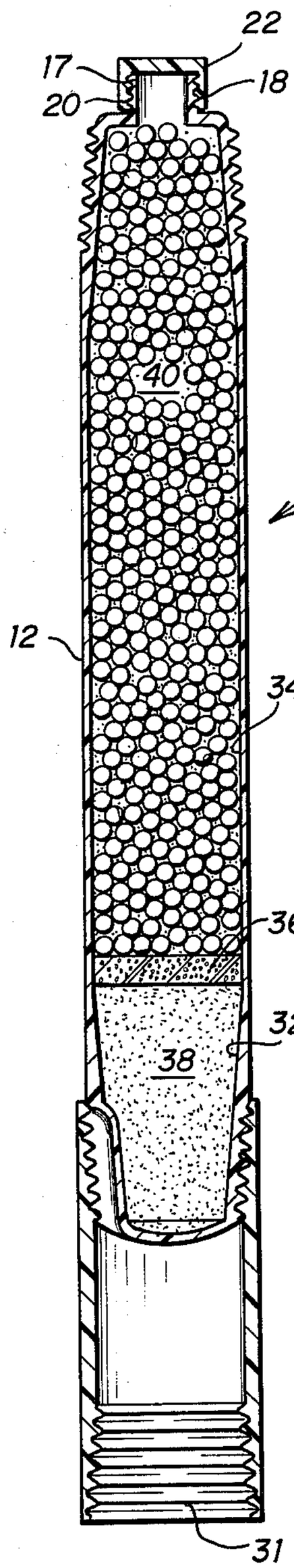


FIG. 2

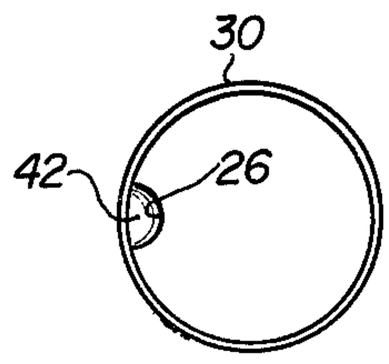


FIG. 3

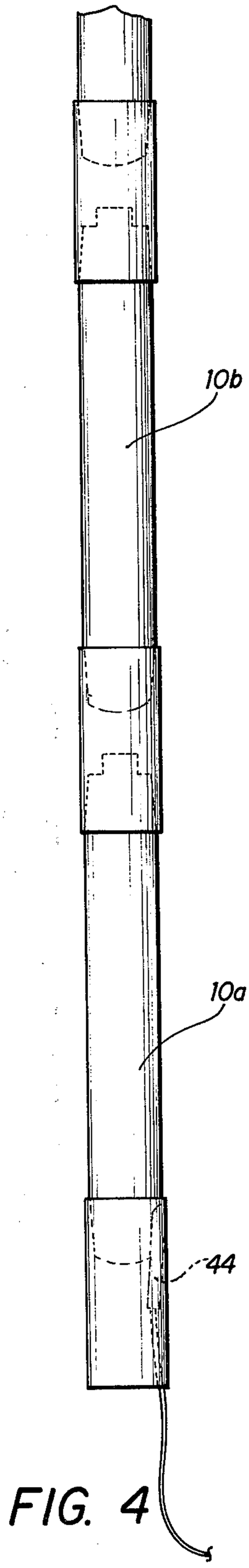


FIG. 4

EXPLOSIVE DEVICE

This invention relates to explosives. In another aspect, this invention relates to two-component liquid-solid based explosive compositions. In still another aspect, this invention relates to a novel device which includes solid primary and secondary components for liquid-solid explosive compositions.

Explosive compositions such as used in seismic work, blasting in bore holes, and ditching, such as underwater ditching, commonly comprise a Class A explosive composition such as nitroglycerin, dynamite, and the like. These compositions are easily detonated by a low power blasting cap, but of course, require extreme caution when being shipped, stored and utilized.

Many times, the Class A explosives are used as a primer or booster charge for a main or secondary explosive charge such as a relatively nonsensitive liquid-solid two-component explosive, e.g., ammonium nitrate-dinitrotoluene or ammonium nitrate-fuel oil compositions. Thus, the typical two-component explosive composition comprises a solid oxidizing material such as ammonium nitrate and a liquid fuel such as fuel oil and/or a nitrogen containing hydrocarbon material neither of which is classified as a Class A explosive. Therefore, both components can be shipped separately in ordinary commerce. The two components are generally admixed at the site of use to create the explosive mixture. Examples of other typical two-component explosive compoositions are set forth in U.S. Pat. No. 2,892,377. Each of these two-component explosive compositions is generally not very sensitive and cannot be detonated by a No. 6 blasting cap and therefore, they generally require a booster charge comprising a Class A explosive to detonate the same.

Recently two improved liquid-solid two-component explosive compositions have been devoloped. One such composition is set forth in U.S. Pat. No. 3,718,512. This material comprises a first component which includes a porous particulate solid component which can comprise particles of either an oxidizing substance, such as ammonium nitrate, or a non-oxidizing substance such as diatomaceous earth, or mixtures thereof; and a liquid component such as nitromethane which is sensitized when it is admixed with a solid component. When the liquid component is admixed with a porous bed of solid particles it is dispersed by capillary action, which action inherently leaves void spaces throughout the mixture which serves to sensitize the liquid component and make it detonable by a No. 6 blasting cap. Another such improved two-component explosive composition is set forth in U.S. Pat. No. 3,722,410 and comprises ammonium nitrate prills which have been sensitized in such a manner to make them uniquely porous and to have a density of less than about 0.80 grams per cubic centimeter; and a liquid such as a nitroalkane. This two-component explosive can also be detonated by a No. 6 blasting cap. The solid and liquid components of the above-described improved two-component explosive compositions can be shipped separately in ordinary commerce because they are not classified as Class A explosives.

Furthermore, the above-described improved two-component explosive compositions have been utilized as boosters as primary charges for ammonium nitrate-fuel oil secondary charges and the like. However, in each instance, the two-component primary charge and the two-component secondary charge must be individually mixed.

One object of this invention is to provide a novel explosive device for a two-component liquid-solid explosive.

Another object of this invention is to provide a novel demolition device which is detonable by a Number 6 blasting cap.

A further object of this invention is to provide a novel explosive comprising a liquid-solid secondary explosive charge and an improved liquid-solid booster charge.

A further object of this invention is to provide an explosive device comprising an enclosure containing dissimilar primary and secondary particulate solid components for a liquid solid explosive which can be rapidly activated by a liquid which is added into the enclosure.

According to the invention a novel explosive device is provided which comprises an enclosure which contains an activated particulate solid component for a liquid-solid primer explosive separated by a porous member from a chamber for carrying a secondary charge or charge component such as a particulate oxidizing solid component for a secondary liquid-solid explosive charge. Primer and secondary explosive charges are formed by pouring an arming liquid such as a nitroalkane into the enclosure.

According to a preferred embodiment of the subject invention a demolition device is provided which comprises an elongated cylindrical container having an enclosed first end and a sealable opeining at its second end and a solid primary component positioned within the first end comprising particles of an oxidizing material, e.g., particles of ammonium nitrate having a size of less than about 3000 microns, and having distributed therein from about 0.1–50% by weight of hollow balloons made of thin wall nonoxidizing material, a porous member separating the primary solid component from the portion of the container adjacent the second end thereof, and with a secondary component positioned within said portion which comprises particulate oxidizing solids such as prilled ammonium nitrate. Preferably, a cap well means is positioned adjacent the first end of the container and tubular sleeve means is provided for engaging both the first and the second end of the container so that several such containers can be connected in series.

This invention can be more easily understood from a study of the drawings in which:

FIG. **1** is an exploded view of a preferred explosive device of the subject invention:

FIG. **2** is a sectional view of the assembled explosive device shown in FIG. **1**;

FIG. **3** is a bottom plan view of the device of FIG. **2**; and

FIG. **4** is a view of several explosive devices coupled together in accordance with one embodiment of the subject invention.

Now referring to the drawings and specifically to FIG. **1**, an exploded view of explosive device **10** of the subject invention is schematically shown. As shown, explosive device **10** comprises an elongated tubular cylindrically shaped container **12** having an enclosed first end **14** and an opening **16** through a narrowed neck **17** on the second end thereof. Screw threads **18** are carried on the outer periphery of neck **17** and cooperate with the internal screw threads **20** carried on the inner peripheral portion of cap **22**. Furthermore, the

outside periphery of container 12 adjacent end 14 carries screw threads 24 as shown in the drawing. Also, longitudinal cap slot 26 is positioned through screw threads 24 (to form an indentation therein) adjacent end 14 in the manner shown in the drawing. Furthermore, screw threads 28 are carried around the periphery of the upper end of container 12. Sleeve 30 contains screw threads 31 around the internal periphery thereof for engaging screw threads 24 and/or 28. Explosive device 10 carries a solid particulate booster or primary component for a liquid-solid booster explosive composition within its interior adjacent longitudinal cap slot 26. In addition, container 12 carries a solid particulate component for a secondary or main liquid-solid explosive composition in the upper portion thereof.

As shown in FIG. 2, the interior of container 12 is divided into a lower primary charge chamber 32 and an upper secondary charge chamber 34 by porous partition member 36. The primary charge chamber 32 carries an activated particulate solid component 38 for a liquid-solid explosive composition which functions as a booster charge for explosive device 10. As shown, secondary charge chamber 34 carries a particulate solid component 40 for a liquid-solid secondary or main charge for explosive device.

The particulate primary solid component 38 positioned within primary charge chamber 32 is made of two sub-components. The first sub-component comprises a comminuted particulate material, and the second sub-component comprises thin-walled hollow balloons.

The comminuted solid sub-component of primary solid component 38 can comprise a noncap-sensitive inert or oxidizing material, capable of being freely shipped in normal commerce. The primary function of this sub-component is to provide a porous base or substrate which is used to uniformly disperse the hollow balloons and which will uniformly disperse the liquid component by gravity and capillary action, thereby automatically providing an intimate mixture of finely divided liquid component and void space. A second function of providing additional energy through the reaction of an oxidizing group with excess fuel portion in the liquid component can be provided by an oxidizing solid component according to the preferred embodiment of the subject invention. If an oxidizing substrate contains potential gas forming elements in addition to the elements of the oxidizing group a third function of the solid component is to provide expandible gas capable of doing useful work. Solid components usable within the scope of the present invention are alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates and ammonium perchlorate, diatomaceous earth and expanded low density silica. The solid particulate component used in the scope of this invention has a particle size less than about 3000 microns, preferably less than about 500 microns, and most preferably is in the range of from about 5 to about 250 microns. The oxidizing particulate materials used in the scope of the preferred embodiment of the subject invention can be the alkali and alkaline earth metal nitrates, ammonium nitrate, the alkali and alkaline earth metal perchlorates, and ammonium perchlorate and mixtures thereof. The preferred such materials include ammonium nitrate, sodium nitrate, and ammonium perchlorate and mixtures thereof, with the most preferred being ammonium nitrate.

The thin walled hollow balloons which can be used in the scope of this invention generaly include the thin walled balloons or microspheres made of glass, ceramic material, silica or resin. Generally, the thin walled balloons can be made of any material which is inert in the presence of the remaining constituents of the composition. By "inert", such material should not constitute a fuel for the oxidizing partiuclate material (if used therewith) and also, should be stable in the presence of the liquid component used in the scope of the subject invention. Generally, the thin walled hollow balloons should have a particle size within the range of from about 2 to about 400 microns. Any gas can be contained within the hollow balloons.

Generally, from about 0.1 to about 50 percent by weight and more preferably from about 0.5 to about 8 percent by weight of primary solid component 38 made in accordance with the subject invention will comprise the thin walled hollow balloons. Generally, the thin-walled hollow balloons will provide a void volume of from about 0.3 to 75 percent by volume of the total solids, preferably about 0.8 to about 25 percent by volume of the total solids of the explosive composition of the subject invention.

The thin-walled hollow balloons can be admixed with the comminuted particulate material in any suitable way to obtain a random but generally uniform distribution of the balloons therein. Suitable methods include the mixing of two sub-components with a mixing auger, or a ribbon blender, for example.

The hollow ballons which can be used only as a sub-component with the comminuted particulate material of non-oxidizing material in primary solid component 38 can include the hollow oxidizable microspheres made of resin. Suitable such resin balloons which can be used in the scope of the present invention are water insoluble and nitromethane insoluble, thin-walled, hollow, spherical balloons of a polymerized thermosetting resin selected from the group consisting of urea-formaldehyde and phenolformaldehyde. The resin balloons are of low density and small particle size. Typical resin balloons have a bulk density of less than 0.5 gr./cc. and a diameter of from about 2 to about 360 microns. Resin balloons are more fully described in U.S. Pat. No. 3,010,288 to Coursen et al issued Aug. 20, 1963, which patent is hereby incorporated by reference into this application.

Suitable hollow balloons made of thin-walled non-oxidizable material which can be used in the preferred embodiment of the subject invention within primary solid component 38 include hollow balloons sold under the trademarks of "ECCOSPHERES" and "MICRO-BALLOONS" by Emerson and Cuming, Inc., Canton, Massachusetts, or 3M brand glass bubbles sold by 3M Company, St. Paul, Minnesota and can include the microspheres which are made of sodium borosilicate glass, silica, insoluble glass, and ceramic material. These thin-walled balloons are basically free flowing, thin-walled, hollow, glass or ceramic spheres which have a particle size of from about 10 to about 300 microns. These spheres have an average wall thickness from about 1.0 microns and generally, from about 1.5 to about 2 microns. Furthermore, the spherical hollow particles are hole-free, nonflammable, and have a low thermal conductivity, a high melting point, are readily wetted, and have a low dielectric constant. Suitable

nonoxidizable thin-walled hollow balloons comprise about 40 weight percent therof having a particle size in the range of from about 60 to about 100 microns with the majority of the remaining balloons having a particle size of 100 microns or greater.

Particulate secondary solid component **40** comprises particles of oxidizing material generally larger in size than those of the primary solid component **38.** Suitable such oxidizing materials include particles selected from alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates, ammonium perchlorate, and mixtures thereof. Again, the preferred oxidizing materials include ammonium nitrate, sodium nitrate, and ammonium perchlorate and mixtures thereof, with the most preferred being ammonium nitrate. The particle size of the particulate materials used within secondary solid component **40** can be selected depending on the arming rate which is desired. For example, the larger particle sizes will result in a faster arming rate for explosive device **10.** Suitable particle sizes can be in the range of from about 0.5mm to about 10mm and preferably about 2mm. The most preferred materials utilized are commercially prilled materials such as prilled ammonium nitrate which is commonly sold as a fertilizer. In addition, if desired, the activated ammonium nitrate prills which are disclosed in said U.S. Pat. No. 3,722,410 can be used in the scope of this invention as a part of all of the particulate solids used within secondary solid component **40** and such patent is herein incorporated by reference into this application. Furthermore, if desired, the particulate secondary solid component **40** can contain up to 2 percent by weight of the hollow balloons made of a thin-walled nonoxidizable material which are described above. In such instance, the hollow ballons are thoroughly admixed within the particulate oxidizing material so that a random but uniform distribution thereof results therein.

The relative quantity of primary solid component **38** to secondary solid component **40** can vary with the particular device. Generally, sufficient primary solid component **38** must be present which, when combined with a liquid component and detonated by a blasting cap will also detonate the secondary liquid-solid charge. Generally, primary solid component **38** comprises from about 1/6 to about ⅓ of the volume of the secondary solid component **40.**

Furthermore, in accordance with a lesser preferred embodiment of the subject invention, solid component **40** is not utilized. In this embodiment, secondary charge chamber **34** can be partially or completely filled with a detonable liquid component, and the primary liquid-solid charge is utilized as a primer charge therefor.

Container **12,** cap **22** and sleeve **30** are preferably made of a plastic material such as a polyolefin, e.g., high density polyethylene, and can be easily molded. Porous partition member **36** is preferably made of a flexible open cell polymeric foam, e.g., an open cell polyurethane foam and preferably takes the form of a thin disc or a short cylinder. It is noted that any other suitable porous means can be utilized to separate primary solid component **38** from the remainder of the enclosure within container **12.** For example a porous bag such as made of woven fibers can be utilized to contain solid component **38.** The porosity of porous partition member **36** should be such that it effectively separates the primary solid component **38** and secondary solid component **40,** but yet will allow the liquid which is used in the scope of the invention to pass therethrough.

In the manufacture of explosive device **10,** container **12,** screw cap **22** and sleeve **30** are molded by conventional molding techniques; thereafter, the particulate primary solid charge component **38** is formed and poured through opening **16.** Thereafter, the porous flexible partition member **36** is compressed and passed through opening **16** and then placed upon the top of particulate primary solid component **38.** Thereafter, if desired, particulate secondary solid component **40** is passed through opening **16** and screw cap **18** is threadably engaged with screw threads **18** on neck **17.** Sleeve **30** is threadably engaged upon screw threads **24** of explosive device **10.** When assembled, the explosive **10** can be shipped in ordinary commerce and is not a Class A explosive. In essence, neither of the solid particulate components **38** or **40** are cap-detonable. An explosive composition is formed by merely pouring a liquid component through opening **16** which serves as the liquid component for primary solid component **38** and secondary solid component **40.**

Suitable detonable, but noncap-sensitive liquids which can be used as the liquid component in the scope of the subject invention include noncap-sensitive liquid hydrocarbon material containing bonded nitrogen in a positive valence state. Typical compounds of this class of materials are the nitro and nitrated hydrocarbonss. Exemplary materials which can be utilized within the scope of the present invention include nitroaliphatic hydrocarbons, nitroaromatic hydrocarbons, aliphatic nitrates, nitramines and mixtures thereof. Preferable liquid components include the nitroalkane compounds containing 3 or less carbon atoms and mixtures of the lower aromatic compounds, e.g., nitromethane and the dinitrotoluene oils.

An example of a non-detonable liquid component which becomes detonable and cap-sensitive when admixed with the solid component comprises hydrazine when admixed with a solid nitrate.

The liquid component which is utilized to arm the primary and secondary solid components **38** and **40** within explosive device **10** within the preferred embodiment of the subject invention comprises a nitroalkane. Preferably, the liquid component comprises from about 60 to about 100 percent by weight of nitromethane. The nitromethane can be admixed with up to 40 weight percent of other noncap-sensitive liquid hydrocarbons having bonded nitorgen in the positive valence state and halogenated lower alkanes having from about 1 to about 3 carbon atoms.

Exemplary materials which can be used with the nitromethane in the liquid component in the preferred embodiment of the subject invention include nitroaliphatic hydrocarbons, nitroaromatic hydrocarbons, aliphatic nitrates, nitramines, trichloroethylene, tetrachloroethylene, carbon tetrachloride, and the like, and mixtures thereof. Preferably, the liquid materials which can be used with the nitromethane include nitroalkane compounds having from 2 to 3 carbon atoms and lower nitoraromatic compounds and mixtures thereof. The presence of halogenated compounds in the liquid mixture can serve to lower the flashpoint of the nitromethane.

Again referring to the preferred embodiment set forth in the drawing, to convert explosive device **10** into an explosive charge, with explosive device **10** in

the upright position, cap 22 is removed from neck 17, and the liquid component is poured through opening 16. The liquid component will pass downwardly through particulate solid secondary component 40, within secondary charge chamber 34, through porous partition member 36 and into primary charge chamber 32 containing primary solid component 38. Generally, sufficient liquid component is utilized in the scope of the subject invention to saturate the primary solid component 38 (i.e., fill the interstitial void spaces therewithin), and to provide at least an oxygen balancing amount of fuel for secondary solid component 40. Generally, the liquid component will comprise from about 6 to 60 percent by weight of the total primary charge and from about 6 to 100 percent by weight of the total secondary charge. It is generally preferred that sufficient liquid component be utilized to fill the interstitial space with both solid components.

After the explosive composition has been formed by admixing the liquid component with the solid components within explosive device 10, a blasting cap at least as powerful as a Number 6 blasting cap can be placed within capwell 42, which is formed by the cooperation of longitudinal cap slot 26 and sleeve 30 as shown in FIG. 3. A Number 6 blasting cap will be sufficient to detonate the explosive device 10. The detonation of the blasting cap will fire the liquid-solid explosive within primary charge chamber 32 which will in turn propagate the explosion and detonate the liquid-solid explosive mixture within secondary charge chamber 34.

When armed with the liquid component, explosive device 10 can be used as a single unit or can be coupled with other explosive device units 10 as shown in FIG. 4. As illustrated, the screw threads 28 of a first explosive device 10*a* can be threadably engaged with the screw threads 31 of a second explosive device 10*b* to form a column of explosives. After a sufficient number of explosive devices 10 have been coupled together in a manner schematically illustrated in FIG. 4, a blasting cap 44 can be positioned within cap well 42 of demolition device 10*a* and the entire column detonated. The detonation of explosive device 10*a* will propagate the explosion to explosive device 10*b* and successive such devices. This arrangement whereby the primer charges are staggered assure complete detonation of the entire explosives column.

In addition, it must be noted that explosive device 10 can be utilized according to the lesser preferred embodiment of the subject invention by omitting secondary solid component 40 from secondary charge chamber 34. In this instance the liquid component is used to fill the interstices of primary solid component 38 within primary charge chamber 32, and also fill all or part of secondary charge chamber 34. When operating in accordance with this embodiment, the liquid component should comprise a detonable liquid. In this instance, the most preferred liquid component comprises at least about 75% by weight or nitromethane, and up to 25% by weight of the liquid component can comprise the other liquids disclosed above.

Explosive device 10 can be conveniently utilized in seismic exploration work, explosive operations within bore holes, or ditching. Furthermore, explosive device 10 can be used in underwater demolition operations such as undersea ditching. Once each explosive device 10 is armed with a liquid it can be placed in a demolition site for an indefinite period of time before it is detonated. Furthermore, the explosive device 10 of the subject invention which has been armed with a liquid component can be subjected to rather severe forces which would tend to compact the particulate solid components 38 and 40 but yet not deleteriously affect the explosive. Furthermore, the explosive device 10 when armed with a liquid can be detonated under relatively high pressure, such as hydrostatic pressure under a body of water.

While this invention has been described in relation to its preferred embodiments, it is to be understood that various modifications thereof will now be apparent to one skilled in the art upon reading this specification and it is intended to cover such modifications as fall within the scope of the appended claims.

We claim:

1. An explosive device which includes a particulate primary solid component and a particulate secondary solid component, which solid components are both actuated by a liquid component, comprising:

a. a container forming an enclosure and at least one sealable opening for adding said liquid component therein;

b. a bed comprising sensitized particulate material selected from oxidizing and non-oxidizing material having a particle size smaller than about 3000 microns and positioned within said enclosure forming said particulate primary solid component;

c. porous retaining means which will pass the said liquid component but not said primary or secondary solid components, said porous retaining means separating said particulate solid primary component from the remainder of the cavity within said enclosure; and

d. a bed comprising solid particulate oxidizing material forming said particulate secondary solid component and positioned within the said remainder of said cavity.

2. The explosive device of claim 1 further comprising capwell means on said container positioned adjacent said primary solid component.

3. The explosive device of claim 1 wherein said particulate primary solid component comprises non-oxidizing particules selected from diatomaceous earth and expanded low density silica; and a minor effective quantity of hollow balloons made of a material selected from thin-walled oxidizable and non-oxidizable material.

4. The explosive device of claim 1 wherein said particulate primary solid component comprises a porous bed of solid particles which includes a major effective quantity of oxidizing particles selected from the alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates, and ammonium perchlorate; and a minor effective quantity of hollow ballons made of a thin-walled non-oxidizable material, randomly distributed through said bed.

5. The explosive device of claim 4 wherein said oxidizing particles have a size smaller tha about 500 microns.

6. The explosive device of claim 5 wherein said hollow balloons provide a void volume within said bed of sensitized paticulate oxidizing particles of from about 0.3 to about 75 percent by volume thereof.

7. The explosive device of claim 6 wherein said particulate primary solid component comprises from about 0.1 to about 50 percent by weight of said hollow balloons.

8. The explosive device of claim 7 wherein said hollow balloons have a particle size within the range of from about 2 to about 400 microns.

9. The explosive device of claim 8 wherein said oxidizing particles within said particulate primary solid component comprise ammonium nitrate.

10. The explosive device of claim 8 wherein said particulate solid secondary charge comprises particles of an oxidizing material selected from alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates, ammonium perchlorate, and mixtures thereof.

11. The explosive device of claim 10 wherein the size of said particles in said particulate secondary solid component is in the range of from about 0.5 to about 10mm.

12. The explosive device of claim 11 wherein said particulate secondary solid component comprises prilled ammonium nitrate.

13. The explosive device of claim 12 further comprising a liquid component within the interstices of said primary and secondary solid components.

14. The explosive device of claim 13 wherein said liquid component comprises at least about 60 percent by weight nitromethane and up to about 40 percent by weight of other liquids selected from noncapsensitive liquid hydrocarbons having bonded nitrogen in the positive valence state, and halogenated lower alkanes having from about 1 to about 3 carbon atoms, and mixtures thereof.

15. The explosive device of claim 13 wherein said liquid component comprises noncapsensitive hydrocarbon material containing nitrogen in the positive valence state.

16. An explosive device which includes a particulate primary solid component and a particulate secondary solid component which are both activated by a liquid component comprising:

a. an elongated tubular having a first end and a second end with a sealable opening for adding said liquid component positioned in the first end thereof;

b. a bed comprising sensitized particulate material selected from oxidizing and non-oxidizing material and having a particle size smaller than about 3000 microns forming said particulate primary solid component and positioned within said tubular container adjacent the second end thereof;

c. a porous retaininng means which will pass said liquid component but not said solid primary or secondary components, and separating said particulate primary solid component from the remainder of the enclosure within said container; and

d. a bed comprising solid particulate oxidizing material forming said particulate secondary solid component and positioned within said remainder of said cavity within said container.

17. The explosive device of claim 16 further comprising a cap well means on said container positioned adjacent the second end thereof.

18. The explosive device of claim 17 further comprisinng a sleeve means for threadably engaging said second end.

19. The explosive device of claim 17 wherein the periphery of said second end of said container carries first external screw threads and said cap well means comprises an elongated longitudinal slot forming an indentation transversely across said first external screw threads.

20. The explosive device of claim 19 further comprising a sleeve means for threadably engaging said first external screw threads.

21. The explosive device of claim 20 further comprising second external screw threads carried by the periphery of said first end of said container.

22. The explosive device of claim 17 wherein said particulate primary solid component comprises a porous bed of solid particles which includes a major effective amount particulate non-oxidizing particles selected from diatomaceous earth and expanded low density silica having a minor effective amount of hollow balloons made of a material selected from thin-walled oxidizable and non-oxidizable materials randomly distributed therein.

23. The explosive device of claim 17 wherein said particulate primary solid component comprises a porous bed of solid particles which includes a major effective quantity of oxidizing particles selected from the alkali and alkaline earth metal nitrates, ammonium nitrate alkali and alkaline earth metal perchlorates, and ammonium perchlorate; and a minor effective quantity of hollow balloons made of a thin-walled non-oxidizable material, randomly distributed through said bed.

24. The explosive device of claim 23 wherein said oxidizing particles have a size smaller than about 500 microns.

25. The explosive device of claim 23 wherein said hollow balloons provide a void wolume within said bed of sensitized particulate oxidizing particles of from about 0.3 to about 75 percent by volume thereof.

26. The explosive device of claim 25 wherein said particulate primary solid component comprises from about 1 to about 50 percent by weight of said hollow balloons.

27. The explosive device of claim 26 wherein said hollow balloons have a particle size within the range of from about 2 to about 400 microns.

28. The explosive device of claim 27 wherein said oxidizing particles within said particulate primary solid component comprise ammonium nitrate.

29. The explosive device of claim 17 wherein said particulate solid secondary charge comprises particles of an oxidizing material selected from alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates, ammonium perchlorate, and mixtures thereof.

30. The explosive device of claim 29 wherein the size of said particles in said particulate secondary solid component is in the range of from about 0.5 to about 10mm.

31. The explosive device of claim 30 wherein said particulate secondary solid component comprises prilled ammonium nitrate.

32. The explosive device of claim 30 further comprising a liquid component within the interstices of said primary and secondary solid components.

33. The explosive device of claim 32 wherein said liquid component comprises at least about 60 percent by weight nitromethane and up to about 40 percent by weight of other liquids selected from noncap-sensitive liquid hydrocarbons having bonded nitrogen in the positive valence state, and halogenated lower alkanes having from about 1 to about 3 carbon atoms, and mixtures thereof.

34. The explosive device of claim 32 wherein said liquid component comprises noncap-sensitive hydrocarbon material containing nitrogen in the positive valence state.

35. An explosive device having a primary charge chamber and a secondary charge chamber both armed by a liquid component comprising:

a. a conatiner forming an enclosure for said primary charge chamber and said secondary charge chamber;

b. a bed comprising sensitized particulate material armable by said liquid component selected from oxidizing and non-oxidizing material having a particle size smaller than about 3000 microns, positioned within said primary charge chamber;

c. a porous retaining means positioned in said enclosure and separating said primary charge chamber from said secondary charge chamber, and which will pass said liquid component but not said sensitized particulate material; and

d. a secondary charge chamber positioned in said enclosure on the opposite side of said porous retaining means from said primary charge chamber, and having at least one sealable opening through said enclosure for adding said liquid component directly into said secondary charge chamber.

36. The explosive device of claim 35 further comprising a capwell means on said container positioned adjacent said primary charge chamber.

37. The explosive device of claim 36 wherein said particulate primary solid component comprises a porous bed of solid particles which includes a major effective quantity of oxidizing particles selected from the alkali and alkaline earth metal nitrates, ammonium nitrate, alkali and alkaline earth metal perchlorates, and ammonium perchlorate; and a minor effective quantity of hollow balloons made of a thin-walled nonoxidizable material, randomly distributed through said bed.

38. The explosive device of claim 37 wherein said oxidizing particles have a size smaller than about 500 microns.

39. The explosive device of claim 37 wherein said hollow ballons provide a void volume within said bed of sensitized particulate oxidizing particles of from about 0.3 to about 75 percent by volume thereof.

40. The explosive device of claim 39 wherein said particulate primary solid component comprises from about 1.0 to about 50 percent by weight of said hollow balloons.

41. The explosive device of claim 41 wherein said hollow balloons have a particle size within the range of from about 2 to about 400 microns.

42. The explosive device of claim 41 wherein said oxidizing particles within said particulate primary solid component comprise ammonium nitrate.

43. The explosive device of claim 41 further comprising a liquid component in said remainder of said cavity and within the interstices of said bed.

44. The explosive device of claim 43 wherein said liquid component comprises at least about 75 percent by weight nitromethane and up to about 25 percent by weight of other liquids selected from noncapsensitive liquid hydrocarbons having bonded nitrogen in the positive valence state, and halogenated lower alkanes having from 1 to about 3 carbon atoms, and mixtures thereof.

45. The explosive device of claim 41 wherein said liquid component comprises a noncapsensitive liquid containing nitrogen in the positive valence state.

46. The explosive device of claim 45 wherein said particulate primary solid component comprises a porous bed of solid particles which includes a major effective quantity of noonoxidizing particles selected from diatomaceous earth and expanded low density silica; and a minor effective quantity of hollow balloons made of a material selected from thin-walled nonoxidizable and oxidizable material, randomly distributed through said bed.

47. The explosive device of claim 46 wherein said oxidizing particles have a size smaller than about 500 microns.

48. The explosive device of claim 46 wherein said hollow balloons provide a void volume within said bed of sensitized particulate nonoxidizing particles of from about 0.3 to about 75 percent by volume thereof.

49. The explosive device of claim 48 wherein said particulate primary solid component comprises from about 0.1 to about 50 percent by weight of said hollow balloons.

50. The explosive device of claim 49 wherein said hollow balloons have a particle size within the range of from about 2 to about 400 microns.

51. The explosive device of claim 50 further comprising a liquid component in said remainder of said cavity and within the interstices of said bed.

52. The explosive device of claim 51 wherein said liquid component comprises at least about 75 percent by weight nitromethane and up to about 25 percent by weight of other liquids selected from noncapsensitive liquid hydrocarbons having bonded nitrogen in the positive valence state, and halogenated lower alkanes having from about 1 to about 3 carbon atoms, and mixtures thereof.

53. The explosive device of claim 51 wherein said liquid component comprises a noncapsensitive liquid containing nitrogen in the positive valence state.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

'atent No. 3,926,119 Dated December 16, 1975

:nventor(s) Gerald L. Hurst, et al.

It is certified that error appears in the above-identified patent ınd that said Letters Patent are hereby corrected as shown below:

)l. 1, line 30, "compoositions" should be --compositions--;
line 37, "devoloped" should be --developed--.

)l. 2, line 31, "opeining" should be --opening--.

)l. 4, line 4, "generaly" should be --generally--;
line 10, "partiuclate" should be --particulate--;
line 64, "1.0 microns and generally" should be --1.0 to about 3.5 microns and generally--.

)l. 6, line 29, "hydrocarbonss" should be -- hydrocarbons --;
line 50, "nitrorgen" should be -- nitrogen -- .

)l. 7, line 58, "or" should be --of--.

)l. 8, line 44 (Clm 3), "particules" should be --particles--;
line 59, "tha" should be --than--;
line 63, "paticulate" should be --particulate--.

)l. 9, line 40, (Clm 16), "tubular having" should be --tubular container having--;
line 50, "retainning" should be --retaining--;
lines 62 and 63, "comprisnng" should be --comprising--.

)l. 10, line 32 (Clm 25), "wolume" should be --volume--.

)l. 11, line 8 (Clm 35), "conatiner" should be --container--.

)l. 12, line 13 (Clm 44), "from 1 to about 3" should be --from about 1 to about 3--;
line 21, "noonoxidizing" should be --nonoxidizing--.

Signed and Sealed this

fourth Day of *May 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks