United States Patent [19]

Hand

[11] **3,744,419**

[45] **July 10, 1973**

[54] **PYROTECHNIC DEVICE**

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[22] Filed: **June 17, 1970**

[21] Appl. No.: **46,992**

[30] **Foreign Application Priority Data**

Apr. 9, 1970 Canada 079,654

[52] **U.S. Cl.** **102/37.7,** 102/37.8

[51] **Int. Cl.** **C06d 1/04,** C06d 1/10

[58] **Field of Search** 102/32, 35.4, 37.6, 102/37.7, 37.8, 60, 66, 87, 90, 34.5

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Assistant Examiner—James M. Hanley
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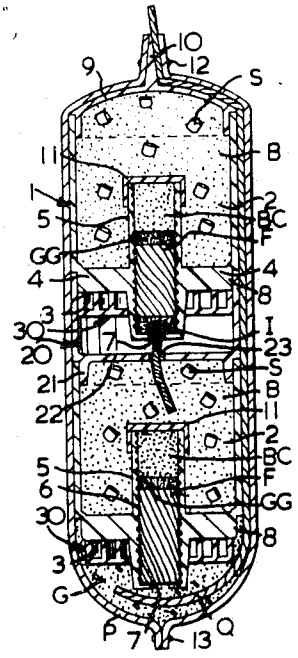
[57] **ABSTRACT**

Air-burst pyrotechnic shells and an improved unitary casing for containing the pyrotechnic composition, the casing having a fuze-holder provided with an irregular internal surface capable of holding the fuze firmly in position. If desired, the casing can be provided with a shock-absorber to withstand the force imposed by a heavy propellent charge.

7 Claims, 12 Drawing Figures



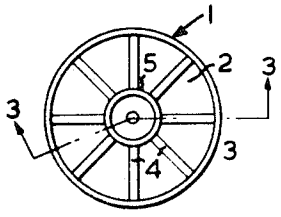


FIG. 1

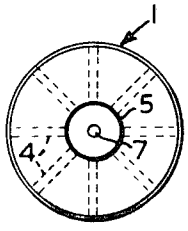


FIG. 2

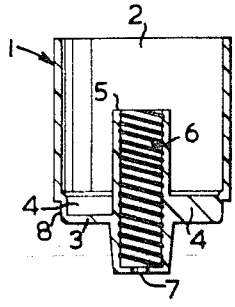


FIG. 3

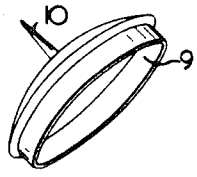


FIG. 4

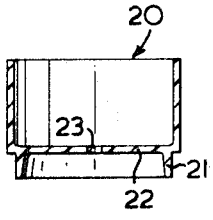


FIG. 6

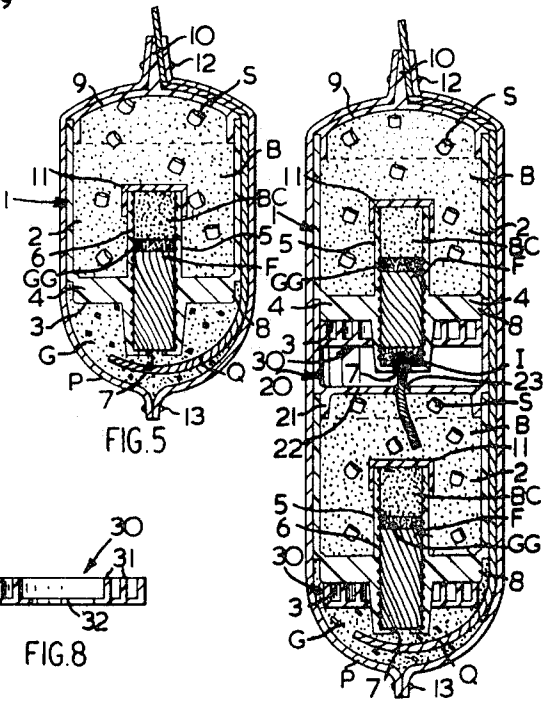


FIG. 5

FIG. 7

FIG. 8

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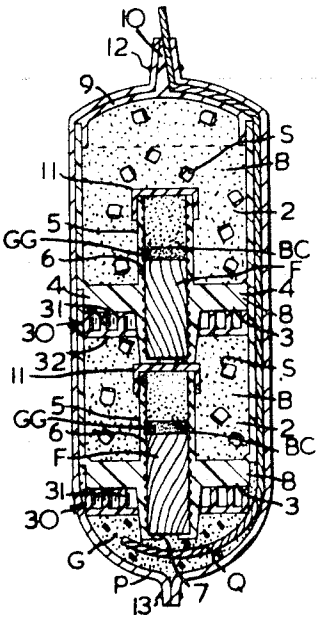

FIG.9

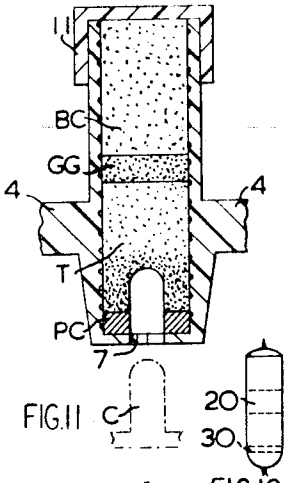

FIG.11 FIG.10

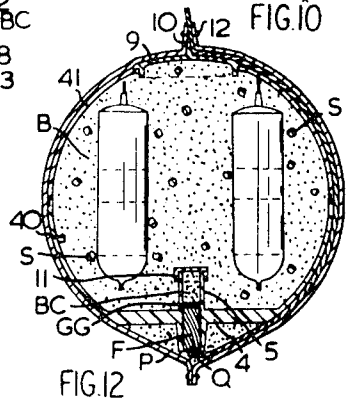

FIG.12

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PYROTECHNIC DEVICE

This invention relates to a pyrotechnic device, and, in particular, to an air-burst pyrotechnic shell.

Air-burst pyrotechnic shells are usually projected from mortars and are either of spherical or cylindrical shape. The casings of spherical air-burst pyrotechnic shells are usually formed of two half-spheres of multi-layered paper with string interposed between the layers and glued thereto. The casings of cylindrical air-burst pyrotechnic shells are usually formed from cardboard covered with paper.

With spherical air-burst pyrotechnic shells, the falling half-spheres constitute a hazard particularly if such shells are detonated in a public area. Moreover, the retention of the fuzes in either the spherical or cylindrical air-burst shells has not, until now, been particularly efficient and it has been relatively easy for the fuzes to become detached from the main body of the shell because, heretofore, the fuzes have been glued in position. Consequently, the glue has either become brittle, causing the fuze to break away from the casing or has lost its efficiency due to wetness or dampness. Moreover, another disadvantage that has existed with both the spherical and cylindrical type air-burst pyrotechnic shells is that either form of device has been affected by wetness or dampness due to the material forming the casing. A still further disadvantage existing with the cylindrical type shells is that the paper casing, upon detonation of the shell, has caught fire and the burning fragments, in descending, have constituted a fire hazard to property, Hence, it is the object of the present invention to provide an air-burst pyrotechnic shell which is of relatively simple construction and inexpensive to manufacture yet which will overcome all of the above-mentioned disadvantages.

Accordingly, the present invention relates to a pyrotechnic device comprising a unitary holder the major portion of which defines a chamber for the reception of pyrotechnic composition, a fuze-holder located within said chamber and extending beyond the lower end thereof, fuze-retaining means within said fuze-holder, closure means on one end of said fuze-holder, and closure means for the upper end of said chamber.

The invention is illustrated by way of example in the accompanying drawings in which:

FIG. 1 is a plan view of a unit capable of forming the major part of a cylindrical air-burst pyrotechnic shell or capable of forming one state of a multi-stage cylindrical air-burst pyrotechnic shell;

FIG. 2 is an underside view of FIG. 1;

FIG. 3 is a vertical section taken on the line 3—3 of FIG. 1;

FIG. 4 is a perspective view of the end cap suitable for use with the unit shown in FIGS. 1 to 3;

FIG. 5 is a vertical section through the unit shown in FIGS. 1 to 3 and the cap shown in FIG. 5, but showing the contents of the shell in situ;

FIG. 6 is a vertical section taken through a unit forming an intermediate connector of a multi-stage cylindrical air-burst pyrotechnic shell;

FIG. 7 is a view similar to FIG. 5 but showing a multi-stage cylindrical air-burst pyrotechnic shell formed by a pair of units of the type shown in FIGS. 1 to 3 and the type of connector shown in FIG. 6;

FIG. 8 is a vertical section taken through the unit forming a shock absorber disc used with a cylindrical air-burst pyrotechnic shell of a larger size;

FIG. 9 is a vertical section rather on the lines of FIG. 7, but showing a pair of shock absorbing discs in situ;

FIG. 10 is a diagrammatic view of a multi-stage unit similar to that shown in FIG. 7 but showing an alternative embodiment of the invention;

FIG. 11 is a vertical section taken through the lower end of a cylindrical air-burst pyrotecynic shell suitable for use with tracer compound; and

FIG. 12 is a vertical section taken through a spherical air-burst pyrotechnic shell incorporating the elements of the present invention.

Referring to the drawings, and in particular to FIGS. 1 to 3, a relatively thin walled cylindrical holder, indicated generally at 1, is provided, the major portion of which defines a chamber 2 for the reception of pyrotechnic composition. The bottom 3 of the chamber 2 is provided with a plurality of upstanding radially extending ribs 4 disposed about an upstanding centrally bored fuze-holder 5 located within the chamber and extending beyond the bottom 3. The inner surface of the fuze-holder 5 is grooved as at 6 in FIG. 3, said grooves 6 constituting fuze-retaining means within the holder 5. The lower end of the fuze-holder is provided with a bore 7 of smaller diameter than the remaining length of the fuze-holder 5. As will also be seen from FIG. 3, the lower end of the holder 1 is of reduced diameter, as at 8, when compared with the remaining length of the holder.

A domed cap 9, shown in FIG. 4 and constituting closure means for the upper end of the chamber 2 is also provided for use in conjunction with the holder when the chamber 2 has been filled with the required pyrotechnic composition, the cap having a projecting central spike 10.

Referring now to FIG. 5, it will be seen that the chamber 2 contains a mixture of "stars" S and burster-composition B, the upper end of the chamber being closed by the cap 9. The holder 5 contains a fuze F which is forced radially into the grooves 6, the lower end of said fuze F terminating adjacent the small bore 7 at the lower end of the fuze-holder 5 and the upper end of the latter being closed by a second cap 11 constituting closure means for the fuze-holder. The length of the fuze F is approximately half the depth of the holder 5 and the upper end of said fuze is covered by a quantity of grain gunpowder GG. The remaining upper portion of the holder 5 is filled with a burster-composition BC. A quick-match Q extends down the outside of the holder 1 so that its lower end is located adjacent the lower end of the fuze-holder 5 and the entire unit is covered in a paper-wrapper P with the space between the lower end of the holder 1 and the wrapper and surrounding the lower end of the quick-match Q being filled with a propellent charge of gunpowder G. The paper-wrapper P, with the quick-match Q, is secured at 12, to the spike 10 of cap 9, the upper end of the quick-match Q thereafter extending from the paper-wrapping P for any desired length. The lower end of the wrapper P is secured in any convenient manner such as, for example, by staple 13.

In operation, the device shown in FIG. 5 is dropped into the usual mortar and the free end of the quick-match Q ignited. This will, in turn, ignite the gunpowder G which will propel the unit from the mortar and,

simultaneously, ignite the fuze F. This will ignite the grain gunpowder GG and, in turn, the burster-composition BC. In due course, the burster-composition BC will shatter the fuze-holder 5 thereby igniting the burster-composition BC. This will cause the entire unit to fragment and the stars S to ignite and burst. In addition, the radial fins 4 serve to strengthen the bottom 3 of the chamber 2 to counteract stress imposed by the explosion of the propellent charge of gunpowder G located beneath said bottom. It will be appreciated that cap 11 is provided so that the force of the explosion from the mortar will not drive the fuze F through the top of the holder 5. In addition, although the provision of the small bore 7 at the bottom of the holder 5 ensures that the lower end of the fuze F will readily ignite, it also ensures that the force of the explosion will not blow the fuze F through the bottom of said holder.

Referring now to FIG. 6, which is a vertical section taken through a unit forming an intermediate connector of a multistage cylindrical air-burst pyrotechnic shell, it will be seen that the inner diameter of the major portion of the length of the connector indicated generally at 20 is substantially the same as the outer diameter of the reduced lower end 9 of the cylindrical holder 1 shown in FIGS. 3 and 5. In addition, the outer diameter of the lower end 21 of connector 20 is reduced and is substantially the same as the inner diameter of the upper end of the holder 1. The connector 20 is provided with a bottom 22 recessed slightly from the terminal edge of the lower end of the connector, the bottom 22 being provided with a small central bore 23.

FIG. 7 shows such a connector 20 is used with a pair of cylindrical holders 1 the upper or second stage of which is provided with an end cap 10. As will be seen from FIG. 7, the lower end of the fuze-holder 5 of the upper or second stage unit 1 is slightly spaced from the bottom 22 of the intermediate connector 20, and a predetermined length of igniter cord I extends from the chamber of the lower or first stage unit 1 through the bore 23 of the intermediate connector and the bore 7 of the fuze-holder of the second stage where it is tied in a knot adjacent the lower end of the fuze F of the upper or second stage unit 1.

Also located within the intermediate connector 20 and around the lower end of the fuze-holder 5 of the second stage unit 1 is a shockabsorber 30 which will be described in detail hereinafter. A similar shock absorbing unit 30 is disposed about the lower end of the first stage unit 1. The remaining integer of both the first and second stages, together with their contents, are similar to the unit shown in FIG. 5 and like reference numerals have been employed.

The intermediate connector 20 and igniter cord I is utilized when a time delay is required between the bursting of the first stage and the bursting of the second stage. The shock-absorbing units 30 are utilized when it is desired for the air-burst pyrotechnic shell to explode at higher altitudes when, as will be appreciated, larger propellent charges must be employed with the attendent risks of fracture of the various units due to the force of such a larger propellent charge acting against the underside of the associated unit. Hence, and as will be seen from FIG. 8, the shock-absorbing unit 30 is constituted by a disc provided with a plurality of upstanding concentric ribs 30 and a central bore 32 adapted to receive the lower projecting end of a fuze-holder 5 of an associated unit.

In operation, the mortar ejects the combined assembly shown in FIG. 7 in the same manner as that described above in connection with the unit shown in FIG. 5. However, when the assembly has reached the desired height say, for example, three to four hundred feet, the lower unit or first stage will explode and, in so doing, will ignite the igniter cord I of the intermediate connector which will, in turn, ignite the delay fuze of the upper or second stage unit 1 of the multi-stage air-burst pyrotechnic shell. When the fuze F of the second stage has burned to its limit, it will then cause said stage to explode. Hence, the intermediate unit 20 will prevent the premature shattering of the base of the second stage of the shell and will ensure that the fuze of the said second stage will ignite in the timed sequence of the shell.

FIG. 9 shows a two-stage assembly which is essentially the same as the two-stage assembly shown in FIG. 7 but which omits the connector unit 20 and has a shock-absorbing disc 30 located adjacent the lower end of each cylindrical star holder 1 so that the bottom 3 of each unit will be reinforced by such a disc 30 and will be able to withstand the force imposed on it by the increased propellant charge.

FIG. 10 is a diagrammatic view of a multi-stage shell constituted by two holders 1 separated by an intermediate connector 20, the first stage or lower holder of which is provided with a shock absorbing disc 30.

Although in all examples of fuzes shown in FIGS. 5, 7 and 9 are of the woven type which are pressed radially into the grooves 6 of the fuze-holders 5, other forms of fuze can be employed with equal success. For instance, what is known in the art as "filled fuze" can be employed. One form of filled fuze is gunpowder wrapped in paper but this, too, is radially forced into the groves 6 where it is satisfactorily anchored.

Alternatively, the filled fuze can take the form of tracer-composition T shown in FIG. 11, providing that such a composition is rammed into the grooves 6. When this composition is used, a core C is introduced into the aperture 7 at the bottom of holder 5 and then, from the open top of the latter, the following materials are sequentially introduced into said holder and compacted radially into the grooves 6, pressed-clay PC, pressed tracer composition T or any other similar substances, grain gunpowder GG and burster-composition BC. The cap 11 is then cemented on to the top of the holder 5. The clay PC is utilized for the purpose of preventing melting of the holder adjacent the aperture 7 and the consequent enlargement of the latter.

Inasmuch as both the holders 1, intermediate connectors 20 and caps 9, 11 are moulded from any suitable polymeric material such as polyfines, e.g. polyethylene, polypropylene, P.V.C. or P.V.A. or polyamides such as, for example, nylons or polyesters such as polyethylene terephthalate or high-impact strength polystyrene, these resins being of the type which will readily fragment with the force of an explosion. However, and until such an explosion occurs, the star-shell holder will retain its shape and, due to the choice of material, will render the contents of the holder impervious to dampness.

It is within the scope of the invention to form the shockabsorbers 30 from similar resins although they can be formed from felt or cardboard.

Moreover, although the inner periphery of the fuze-holder **5** has been illustrated as being provided with fuze-retaining grooves **6**, any irregular surface, such as a knurled surface, will suffice providing, of course, that it is capable of receiving and retaining a fuze when the latter is pressed radially outwardly by any suitable means such as, for example, by means of an air-press.

Finally, FIG. **12** shows the invention applied to a spherical type air-burst pyrotechnic shell having a diameter in the order of 5 inches – 10 inches. A hemi-spherical holder **40** is closed by a hemi-spherical cap **41** provided with a secondary cap **9**, said holder **40** being provided with an integral fuze-holder **5**. The shell shown in FIG. **12** may contain stars S or it may contain, as illustrated, a mixture of stars S and a plurality of filled cylindrical units such as those shown in FIGS. **5, 7** and **9** to give what is termed in the art as a "shell of shells". In other words, when the spherical or main shell bursts, the stars S will ignite and fan out. Simultaneously, the fuzes of the cylindrical units will ignite and such units will eventually fragment discharging their contents in a delayed visual display. If desired, the body of the spherical shells may incorporate intermediate connectors and shock absorbing-discs rather on the lines of those discribed above in connection with FIGS. **5 – 9.**

It will be appreciated that whereas the contents of both the cylindrical and spherical shells are shown in the drawings as being only stars S, the latter may be mixed with whistles, buzzers and similar audio-pyrotechnic effects.

I claim:

1. A container for use in a pyrotechnic device comprising a first unitary holder which includes a chamber for the reception of pyrotechnic composition; a cylindrical fuze-holder located within said chamber adjacent one end thereof and having its lower end extending outwardly beyond said one end; closure means on the upper end of said fuze-holder; closure means for the end of said chamber remote; from the fuze-holder; said cylindrical fuze-holder having an irregular surface therein to provide retaining means for said fuze; the lower end of the fuze-holder having an aperture of a diameter smaller than that of a fuze to be retained in the fuze-holder.

2. A device according to claim **1** including a second unitary holder adjacent said first unitary holder, the lower end of said first holder is of reduced diameter for reception, as a friction fit, in the upper end of the second holder, and strengthening ribs on the lower surface of the first and second unitary holders.

3. A device according to claim **2** wherein said first and second unitary holders when fitted together constitute a multi-stage holder; a quick-match extending down the side of the latter and having its lower end terminating adjacent the lower end of the fuze-holder of the first unitary holder; a paper wrapper enclosing the multi-stage holder and from the top of which the upper end of the quick-match extends; and gunpowder surrounding the lower end of the first unitary holder and the lower end of said quick-match, the gunpowder being retained in position by said wrapper.

4. A device according to claim **3** including at least one ribbed shock-absorbing disc mounted on the lower end of a selected one of said unitary holders.

5. A device according to claim **3** including an intermediate connector the lower end of which is received, as a friction fit, within the upper end of the first unitary holder; the lower end of the second unitary holder being received, as a friction fit, within the upper end of the intermediate connector.

6. A device according to claim **5** including an igniter cord extending from adjacent the lower end of the fuze-holder of the second unitary holder, through the intermediate connector and into the chamber of the first unitary holder.

7. A device according to claim **6** including at lease one ribbed shock-absorbing disc mounted on the lower end of a selected one of said unitary holders.

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