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R. M. ANDERSON ET AL

3,046,769

FLASH LAMP AND IGNITION MEANS THEREFOR

Filed April 29, 1960

FIG. 1.

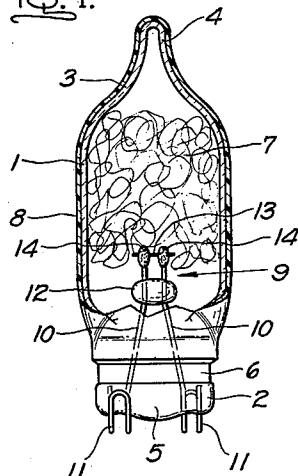


FIG. 2.

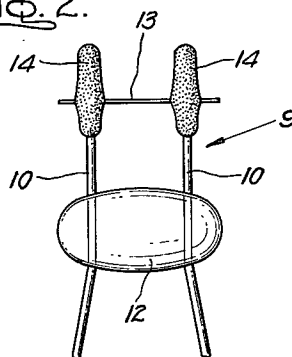
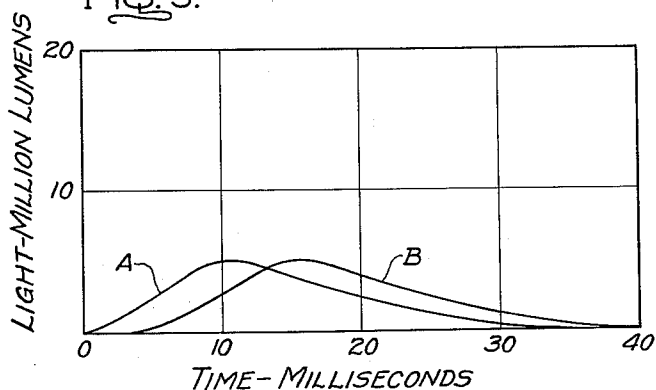


FIG. 3.



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1

3,046,769

FLASH LAMP AND IGNITION MEANS
THEREFORRobert M. Anderson, Euclid, and Louis A. Demchok,
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3 Claims. (Cl. 67-31)

Our invention relates in general to flash lamps of the type used for photographic purposes and comprising a sealed radiation-transmitting bulb in which is enclosed a readily combustible metallic material, together with suitable ignition means therefor, including a primer or fulminating substance, and a combustion-supporting gas filling which, upon ignition of the lamp, enters into a reaction with the combustible material with the resulting emission of a momentary flash of actinic light of high intensity. More particularly, our invention relates to an ignition means for such type flash lamps, and in particular to the composition of the fulminating or primer material thereof. The invention is especially applicable to flash lamps of the type employing, as the combustible light-producing material thereof, metallic filamentary material in the form of wire or ribbon such as the so-called shredded foil and consisting essentially of zirconium or of any other metallic material having a relatively low heat-energy ignition characteristic substantially corresponding to that of zirconium.

Because of the relatively low heat-energy ignition characteristic of zirconium and its resultant exceedingly fast ignition, the peak intensity of the light flash produced by a flash lamp provided with filamentary combustible material composed essentially of zirconium or a material having a similarly fast ignition characteristic substantially corresponding to that of zirconium, occurs within a considerably shorter interval of time, following the closure of the electrical circuit to the ignition filament of the lamp, than it does with a flash lamp of substantially the same construction but provided instead with filamentary combustible material composed of aluminum or aluminum-magnesium alloy such as has been generally employed heretofore. This shorter time to peak intensity characteristic of such zirconium-type combustible material flash lamps is particularly pronounced in the case of extremely small size flash lamps of the type provided with a bulb of less than 2 cc. internal volume, for example. Thus, whereas a flash lamp of such small size and provided with filamentary combustible material consisting essentially of aluminum may possess a time to peak intensity of around 15 milliseconds following the closure of the electrical circuit to the ignition filament of the lamp, the time to peak of a flash lamp of substantially the same construction, except provided instead with filamentary combustible material consisting essentially of zirconium, will occur at anywhere from 10 to 13 milliseconds following the closure of the electrical circuit to the ignition filament of the lamp.

While a flash lamp with such a comparatively short time to peak intensity nevertheless may still be used with some degree of effectiveness for so-called class F synchronization wherein a camera shutter is opened to its fully open position, by means of a synchronizer device, at approximately 15 milliseconds following the start of the shutter actuating operation, the considerably shorter time to peak intensity characteristic of such small size zirconium filled flash lamps renders them entirely unsuitable for so-called class M synchronization wherein the camera shutter opens to its fully opened position at approximately 20 milliseconds following the start of the shutter actuating operation. This is because of the fact that by the time the

2

shutter has reached its fully open position at the 20 millisecond time interval, the light intensity of the light flash from the zirconium filled lamp has fallen off to such a low level as to be of practically little effective value for picture-taking purposes. To be effectively utilizable, therefore, for class M synchronization as well as for class F synchronization, such an extremely small size zirconium-filled flash lamp should have its light flash reach its peak intensity at around 15 to 16 milliseconds following the closure of the electrical circuit to the ignition filament of the lamp, and such a peak time should be obtained without any adverse effects on the performance and operability characteristics of the lamp such as its total light output and peak intensity, or the electrical power required to flash the lamp (i.e., the lamp flashability) and the freedom of the lamp from filament burn-out without the lamp flashing. In this way, it is assured that a sufficiently high level of light will still be present, at the 20 millisecond time interval following closure of the electrical circuit to the lamp filament, to be effective for picture-taking purposes with class M synchronization.

While the desired longer time to peak intensity of the light flash produced by such small size zirconium-filled lamps could be easily accomplished by simply reducing the physical size or quantity of the primer coatings or beads on the lead-in wires of the lamp, such an expedient would be impractical from a manufacturing standpoint because of the difficulty of maintaining the degree of control over such smaller size primer coatings on the lead-in wires which would be necessary in order to keep them within the size variation limits required to maintain uniformity in the light performance characteristics of the lamps such as total light, peak light and time to peak. With such smaller size or quantities of the primer coatings on the lead-in wires, the slight variations which are normally encountered in the size or quantity of the final primer coatings, with practical manufacturing procedures such as conventionally employed at present, would in such case be so great as to cause unacceptable variations in the light performance characteristics of the lamps. Accordingly, any solution to the above-mentioned problem of short peak time should not involve the reduction in the size or quantity of the primer coatings or beads on the lead-in wires beyond the minimum "workable" size for effective manufacturing control thereover.

In addition to the undesirably shorter peak time of such extremely small size zirconium-filled flash lamps as constructed heretofore, such lamps are further characterized by their high susceptibility to accidental flash-outs by electrostatic charges. For example, flash lamps of such construction are apt to be flashed by the electrostatic charge which is produced on the bulb surface when the lamp is merely brushed against the clothing of one handling the lamp, as when being placed in a photographer's coat pocket, for instance. In fact, entire packing sleeves and hampers of such lamps have been accidentally set off by electrostatic charges. As a consequence, it has been necessary heretofore, in the manufacture of such extremely small size zirconium-filled flash lamps, to exercise the utmost safety precautions, including the wearing by manufacturing personnel of special apparel not conducive to the production of electrostatic charges, in order to prevent the occurrence of any such accidental flash-outs of the lamps by electrostatic charges with resulting likelihood of sustaining burns or other bodily injury.

It is an object of our invention, therefore, to provide an extremely small size flash lamp of the type provided with filamentary combustible material consisting essentially of zirconium, or of a material having a relatively low heat-energy ignition characteristic substantially corresponding to that of zirconium, and having an appreciably

longer peak time for the light flash produced by the lamp, as compared to prior flash lamps of such type, while capable of producing at least as much total light and peak light intensity.

Another object of our invention is to provide an extremely small size flash lamp of the type provided with filamentary combustible material consisting essentially of zirconium and having a peak time of around 15 to 16 milliseconds, while producing at least as much total light and peak light intensity as prior flash lamps of such type, whereby the lamp is satisfactorily utilizable for both class F and class M synchronization.

Still another object of our invention is to provide an extremely small size flash lamp of the type provided with filamentary combustible material consisting essentially of zirconium and of markedly reduced susceptibility to accidental flash-out, by the electrostatic charges to which the lamp is normally subjected during manufacture and use, as compared to prior flash lamps of such type.

A further object of our invention is to provide an improved primer composition for the ignition means of a flash lamp of the type employing filamentary combustible material composed essentially of zirconium, or of a material having a relatively low heat-energy ignition characteristic substantially corresponding to that of zirconium, which primer composition is effective to not only markedly reduce the susceptibility of such lamps to accidental flash-out by electrostatic charges applied thereto, but to also retard the peak time of the light flash produced by the lamp without any attendant loss in either its total light output or its peak light intensity.

Briefly stated, in accordance with one aspect of our invention, the lamp ignition primer or fulminating material in flash lamps of the type employing filamentary combustible material consisting essentially of zirconium, or of a material having a relatively low heat-energy ignition characteristic substantially corresponding to that of zirconium, is modified by the incorporation in the primer material of a definite amount of one or more inert additive materials effective to markedly retard the peak time of the light flash produced by such a lamp without any attendant loss in the total light or in the peak light intensity produced by the lamp.

Further objects and advantages of our invention will appear from the following detailed description of species thereof and from the accompanying drawing.

In the drawing, FIG. 1 is an elevation, partly in section, of a flash lamp comprising our invention.

FIG. 2 is an enlarged view of the ignition means comprising our invention, and

FIG. 3 is a chart showing the time-light characteristic curve of a flash lamp comprising our invention as compared to that of prior flash lamps of comparable size and character.

Referring to FIG. 1, the invention is there shown as embodied in a miniature type flash lamp such as disclosed and claimed in copending application Serial No. 808,981, R. M. Anderson, filed April 27, 1959 and assigned to the assignee of the present invention, and comprising a very small size sealed glass envelope or bulb 1 approximately of tubular shape and consisting of a short length of drawn glass tubing closed at one end by an integral flattened external stem press 2 protruding axially from the bulb, and necked down and closed at its other end by an end wall portion 3 terminating in an exhaust tip 4. The particular bulb 1 illustrated has an internal volume of less than 2 cc. and preferably of the order of 1.2 cc., and the tubular portion of the bulb (i.e., the bulb proper) has an outside diameter of the order of $\frac{7}{16}$ inch and a length of the order of $\frac{3}{4}$ inch. The opposite sides 5 of the stem press 2 are formed as flat surfaces preferably disposed approximately parallel to each other and to the axis of the bulb. As shown, the said flat sides 5 of the stem press 2 are provided with transversely extending guide channelways or grooves 6 for sliding engage-

ment with cooperating guide track means of a lampholding magazine or feeding chamber (not shown) of a lamp flashing apparatus.

The bulb 1 contains a loosely distributed filling of a readily combustible metallic material 7 in filamentary form and consisting of zirconium or an alloy essentially composed of zirconium, or of any material having a relatively low heat-energy ignition characteristic substantially corresponding to that of zirconium. The filamentary combustible material 7 preferably is in the form of fine cut strands of a thin foil of the above-mentioned composition, the said fine cut strands being such as that commercially known as shredded foil and produced by the method and apparatus described and claimed in U.S. Patents 2,297,368 and 2,331,230, Rippl et al., such shredded foil strands having a width ranging from approximately 0.5 to 1.5 mils and a thickness likewise ranging from approximately 0.5 to 1.5 mils. In the case of the preferred form of flash lamp according to the invention, employing a bulb 1 having a volume of approximately 1.2 cc., the bulb is filled with around 24 milligrams of zirconium shredded foil the individual strands of which have a thickness of about 0.0008 inch and a width of about .0012 inch.

The envelope or bulb 1 also contains a filling of a suitable combustion-supporting gas such as oxygen or an oxygen-containing gas at a suitable pressure for supporting the combustion of the combustible material. The oxygen or other combustion-supporting gas is introduced into the bulb 1 through a glass exhaust tubulation at the top end 3 of the bulb which tubulation, after the evacuation of the bulb therethrough and the introduction of the oxygen or other combustion-supporting gas into the bulb, is then tipped off as indicated at 4 to hermetically seal the bulb. In the case of the preferred form of flash lamp according to the invention, the bulb is filled with oxygen at a pressure of at least approximately 5 atmospheres and preferably ranging between 5 to 6 atmospheres. The bulb 1 is coated on its outer surface with a protective lacquer coating 8 such as cellulose acetate to thereby strengthen the bulb and to render it substantially shatterproof.

Sealed into the stem press end 2 of the bulb 1 is a lamp ignition mount 9 comprising a pair of lead-in wires 10 which, in the manufacture of the lamp, are sealed into the stem press 2 so as to extend therethrough and into the bulb 1 in a direction approximately longitudinally of the bulb and in more or less side-by-side closely spaced relation. Outwardly of the stem press 2, the lead-in wires 10 are bent or looped back upon themselves, with their free ends reentered and sealed in the glass of the stem press 2, to thereby form loop-shaped wire terminal contact members 11 which are respectively bent around the end of the stem press to extend alongside the opposite flat sides 5 thereof but terminating short of the guide channelways 6 therein. Interiorly of the bulb 1, the lead-in wires 10 are rigidly tied together and held in place by a support bead 12 of glass or other suitable insulating material in which the lead-in wires are embedded.

Mounted on and connected across the inner ends of the lead-in wires 10, within effective ignition range of the combustible material 7 in the bulb, is a lamp ignition filament 13 preferably consisting of a short straight length of fine tungsten wire having a diameter preferably of the order of 0.7 mil. The inner ends of the lead-in wires 10, and the portions of the ignition filament 13 at the points of connection thereof to the lead-in wires 10, are coated with a layer of fulminating substance or primer material 14 to form beads of such material which become ignited when the ignition filament 13 is energized and heated. The fulminating or primer material 14 is applied to the lead-in wires 10 and filament 13 in the form of a paste consisting, in general, of extremely sensitive metal powder and suitable powdered oxidizing material mixed with a suitable binder.

The fulminating or primer material 14 which has been found to be most satisfactory and has been most commonly employed for the effective ignition of flash lamps of the type employing filamentary combustible material consisting of either substantially pure aluminum or pure zirconium, has been of the general composition disclosed in U.S. Patents 2,280,598, Meredith, and 2,756,577, Anderson, and comprising a powdered mixture of zirconium, magnesium and potassium perchlorate powders bonded together by a suitable binder such as a solution of nitrocellulose in amyl acetate. For best results, and particularly where the ignition filament 13 is of a diameter of the order of 0.7 mil, it is preferred that the relative proportions by weight of the above-named powder ingredients be within the particular ranges disclosed and claimed in the above-mentioned Anderson Patent 2,756,577, such ranges being of the order of, by weight, from 60-90% zirconium, 1-8% magnesium, and 9-35% potassium perchlorate.

In the case of extremely small size zirconium-filled flash lamps of the character with which the invention is particularly concerned, it has been found that when the material employed for the primer beads 14 is of the composition disclosed and claimed in either the aforesaid Meredith Patent 2,280,598 or in the Anderson Patent 2,756,577, the peak intensity of the light flash produced by the lamp occurs at a comparatively short interval of time, i.e., from 10 to 13 milliseconds, following the closure of the electrical circuit to the ignition filament 13 of the lamp. As previously mentioned, while flash lamps with such a short time to peak intensity may still be satisfactorily employed for so-called class F or fast type camera shutter synchronizer arrangements, they are unsuitable for use with the slower class M camera shutter synchronizer arrangements because of the insufficient intensity of light from the lamp at the 20 millisecond time interval when the camera shutter reaches its fully open position with such class M synchronization, the intensity of the light by such time having fallen off to such a low level as to be ineffective for picture-taking purposes.

In accordance with the invention, we have found that the incorporation in such primer compositions of definite amounts of one or more inert (i.e., non-combustible), and non-hygroscopic additive materials of low oil-absorption character and having a high temperature decomposition characteristic will operate to retard or delay the peak time of the light flash produced by such small size zirconium-filled lamps without causing any attendant decrease either in the total amount or the peak intensity of the light produced by the lamp. In other words, by the addition of such inert additive material to the primer composition, the time-light intensity characteristic curve of such small size zirconium-filled flash lamps is simply bodily shifted or displaced farther along the time scale from one exhibiting a comparatively short time to peak of around 10 to 13 milliseconds as shown by the curve A in FIG. 3 of prior small size zirconium-filled flash lamps, to one having a longer time to peak of at least 15 to 16 milliseconds or so as shown by the curve B of a flash lamp constructed according to the invention. As a result of such displacement of the time-light characteristic curve to that shown by the curve B, sufficient light intensity is therefore still present, at the 20 millisecond time interval following energization of the lamp ignition filament, to render the lamp utilizable for so-called class M synchronization wherein the camera shutter is in its fully opened position at such 20 millisecond time interval.

The inert additive material which, in accordance with the invention, is incorporated into the primer coating 14 should be one having a high temperature decomposition characteristic so that it does not excessively rob, from the sensitive zirconium and magnesium powder particles of the primer beads 14, the heat which is normally supplied thereto by the ignition filament 13 when heated by the passage of electrical current therethrough. In addition,

the additive material should be one which does not hydrate, i.e., it should be of non-hygroscopic character, so as not to pick up any moisture, during lamp fabrication, such as would cause loss of adherence of the powder particle ingredients of the primer beads 14 and result in flaking or crumbling of the primer material off the lead-in wires 10. It is of most importance, however, that the additive material incorporated into the primer composition comprising our invention should be one of low oil-absorption character so as to require very little binder to hold it together. As a result, little if any increase in the binder ingredient of the primer composition is required in order to insure the required interadherence of the primer particles and prevent the primer beads 14 from crumbling. If a substantially greater amount of binder were required to obtain the necessary primer particle interadherence, the added binder would, in effect, desensitize the primer coatings or beads 14, the binder in such case acting to coat the sensitive zirconium and magnesium particles of the primer composition so as to insulate them to some degree from the heat supplied by the ignition filament, when energized, and thus either entirely preventing them from being heated to their ignition temperature or else undesirably delaying their being heated to such ignition temperature.

For the purposes of the invention, we have found that certain oxides and salts of the alkaline earth metals such as magnesium oxide and barium sulfate, as well as titanium dioxide, are entirely satisfactory as additive materials for incorporation into the primer composition according to the invention. The material preferably employed for such purpose, however, and which has been found to be particularly suitable for the purposes of the invention because of its outstandingly low oil-absorption characteristic and its ready availability and low cost, is calcium carbonate, otherwise known as marble flour.

The amount of the inert additive material which is normally required to be present in the primer composition in order to achieve the objects of the invention is in the general range of from approximately 5 to 35% by weight of the total powder ingredients of the primer composition. Thus, the primer or fulminating material employed for the ignition beads 14 of the flash lamp according to the invention consists essentially of a powder admixture of magnesium, zirconium and potassium perchlorate in the approximate proportions by weight of between 1-8% of magnesium, 60-90% of zirconium and 9-35% of potassium perchlorate and containing approximately 5-35% by weight of the inert additive material. Expressed in terms of percentage by weight of the total powder admixture, the primer material comprising our invention is of the following composition:

	Percent
Magnesium powder.....	0.5-7.5
Zirconium powder.....	40-85
Potassium perchlorate powder.....	5-33
Inert additive material.....	5-35

Within the above general range of compositions, and particularly where marble flour is employed as the inert additive material, the following primer composition by weight has been found to be particularly advantageous:

	Percent
Magnesium powder.....	5-7
Zirconium powder.....	43-57
Potassium perchlorate powder.....	19-26
Marble flour.....	10-33

A specific primer admixture composition which has been found to be especially suitable for the purposes of the invention consists of the above ingredients in the following approximate proportions by weight:

	Percent
Magnesium powder.....	6
Zirconium powder.....	51
Potassium perchlorate powder.....	23
Marble flour.....	20

The zirconium, magnesium and potassium perchlorate powders employed in the primer admixture are of extremely fine character, preferably of the order of 325 mesh or finer. The particles of the inert additive material are likewise of such a fineness. The zirconium metal powder preferably is that commercially known as No. 3 grade, manufactured and sold by the Foote Mineral Company of Philadelphia, Pennsylvania, the said No. 3 grade zirconium powder having a relatively high ignition point as compared to other forms of zirconium powders. The magnesium metal powder employed is preferably that manufactured by the United States Magnesium Company of Pleasant Valley, New York, and known as their 325 mesh magnesium powder. Chemically pure (CP) grade crystal potassium perchlorate powder is employed as the oxidizing agent in the primer composition.

The primer material is applied to the lead-in wire tips in the form of a paste or suspension of the powder particles in a suitable binder consisting of around 8% solids and 92% volatile solvents. The subsequent volatilization of the solvents in the binder then leaves a hardened residue 14 composed almost entirely of the zirconium, magnesium, potassium perchlorate and inert additive powder ingredients of the primer paste. The binder preferably employed is a low percentage (i.e., around 5 to 10%) solution of nitrocellulose in amyl acetate, such a binder preferably consisting of around 8% solids. Enough binder is employed to impart the desired consistency to the primer paste to produce the required size primer beads 14 on the inner lead-in wire tips for a given manufacturing application procedure. Using the above-mentioned specific binder consisting of an approximately 8% solution of nitrocellulose in amyl acetate, the amount of binder solution employed will generally amount to around 18% by weight of the primer paste composition. A specific example of a primer paste according to the invention which has been found to be particularly satisfactory is of the following approximate composition:

Magnesium powder-----	grams--	4
Zirconium powder-----	do-----	33
Potassium perchlorate powder-----	do-----	15
Marble flour-----	do-----	13
8% nitrocellulose solution in amyl acetate-----	cc-----	18

The primer paste material may be prepared in the following manner: the formula quantities of magnesium powder and zirconium powder are first thoroughly mixed with enough of the formula quantity of binder to form a thin paste, the amount of binder required for such purpose being added a little at a time to the zirconium-magnesium powder admixture and being thoroughly mixed together therewith after each such addition. The remaining portion of the formula quantity of binder is next added, a little at a time, to the formula quantities of potassium perchlorate powder and inert additive material and thoroughly mixed therewith after each such addition. The mixture of potassium perchlorate, inert additive material and binder thus formed is then added to and thoroughly intermixed with the zirconium-magnesium-binder mixture to form the finished primer paste composition.

The use of the primer composition according to our invention, in small size zirconium-filled lamps of the type referred to hereinabove, not only acts to retard the peak time of the lamp so as to occur around 15 to 16 milliseconds following closure of the electrical circuit to the lamp ignition filament, without causing any corresponding significant loss in the total light or peak intensity of the lamp, but it also serves to markedly lessen the susceptibility of such lamps to accidental flash-out by electrostatic charges such as are normally encountered in the manufacture and use of the lamps. Thus, we have found that by the use of a primer composition according to the invention in small size zirconium-filled

flash lamps, the number of lamp flash-outs resulting from electrostatic charges has been reduced by as much as 50% or more, depending upon the amount of the inert additive material present in the primer composition.

A most important aspect of our invention, moreover, is the fact that the above-mentioned advantages are obtained while maintaining the size of the primer beads or coatings 14 at so-called "workable" sizes below which it would become impractical, from a manufacturing standpoint, to control the size of the primer beads within the limits necessary to achieve satisfactory uniformity in the light performance and operating characteristics of the lamps.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A flash lamp comprising a sealed envelope having an oxidizing atmosphere therein, a quantity of filamentary combustible material loosely arranged within said envelope and consisting essentially of material of the group consisting of zirconium and metallic materials having a low heat-energy ignition characteristic substantially corresponding to that of zirconium, and ignition means disposed in said envelope within effective ignition range of said combustible material, said ignition means comprising a fulminating substance consisting essentially of magnesium, zirconium, potassium perchlorate and marble flour in the approximate proportions by weight of between 0.5-7.5% of magnesium, 40 to 85% of zirconium, 5-33% of potassium perchlorate and 5 to 35% of marble flour, said admixture ingredients being bonded together by a suitable binder.

2. A flash lamp comprising a sealed envelope having an oxidizing atmosphere therein, a quantity of filamentary combustible material loosely arranged within said envelope and consisting essentially of material of the group consisting of zirconium and metallic materials having a low heat-energy ignition characteristic substantially corresponding to that of zirconium, and ignition means disposed in said envelope within effective ignition range of said combustible material, said ignition means comprising a fulminating substance consisting essentially of a powder admixture of magnesium, zirconium, potassium perchlorate and marble flour in the approximate proportions by weight of between 5-7% of magnesium, 43-57% of zirconium, 19-26% of potassium perchlorate and 10-33% of marble flour, said admixture ingredients being bonded together by a suitable binder.

3. A flash lamp comprising a sealed envelope having an oxidizing atmosphere therein, a quantity of filamentary combustible material loosely arranged within said envelope and consisting essentially of material of the group consisting of zirconium and metallic materials having a low heat-energy ignition characteristic substantially corresponding to that of zirconium, and ignition means disposed in said envelope within effective ignition range of said combustible material, said ignition means comprising a fulminating substance consisting essentially of a powder admixture of magnesium, zirconium, potassium perchlorate and marble flour in proportions, by weight, of the order of 6% magnesium, 51% zirconium, 23% potassium perchlorate and 20% marble flour, said admixture ingredients being bonded together by a suitable binder.

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