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[54] PHOTOFLASH LAMP

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[52] **U.S. Cl.** **431/93,** 149/30, 149/31, 149/40, 149/44

[51] **Int. Cl.**.....**F21k 5/02**

[58] **Field of Search** 431/93, 94; 149/30, 31

[56] **References Cited**

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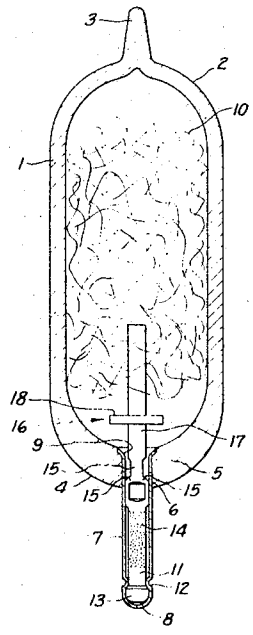
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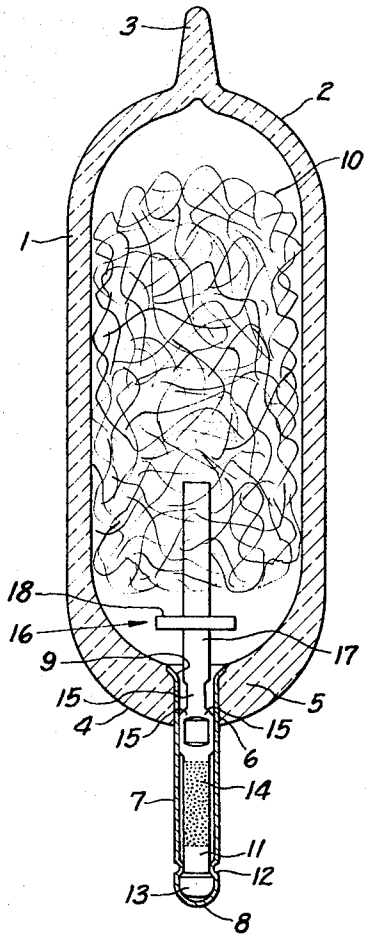
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[57] **ABSTRACT**

A percussion-ignitable type flashlamp is disclosed which includes an improved primer material that is more stable in handling during lamp manufacture and improves performance of the lamp in operation. Said primer material comprises a mixture in percentages by weight of 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium, which mixture can be bonded to form a unitary mass with a polyvinyl alcohol binder. A slurry of the primer material in an aqueous solution of 87–89 percent hydrolyzed polyvinyl alcohol remains substantially gel-free for long time periods and provides a tough and adherent coating in the lamp.

10 Claims, 1 Drawing Figure





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PHOTOFLASH LAMP

CROSS-REFERENCES TO RELATED APPLICATIONS

A related primer material and flashlamp is described and claimed in concurrently filed application Ser. No. 198,547 filed Nov. 15, 1971 and filed in the name of the same inventor, entitled "Photoflash Lamp" and assigned to the assignee of the present invention. Additionally, an undercoating for the primer material in flashlamps is described and claimed in a further concurrently filed application Ser. No. 198,956 **filed Nov.** 15, 1971 and filed in the names of Stephen P. Senft and Vaughn C. Sterling, entitled "Flashlamp Primer Undercoating" and assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

This invention relates in general to photoflash lamps and more particularly to those of the so-called percussion-ignitable type. The photoflash lamps in general use at present comprise a hermetically sealed light-transmitting envelope usually made of glass and containing a combustion-supporting gas such as oxygen together with a loosely distributed filling of a suitable light-producing combustible material such as shredded foil of zirconium, aluminum or hafnium, for example, which upon ignition produces a high intensity flash of actinic light. Suitable ignition means are generally provided in the lamp to initiate the flashing thereof. In the percussive-ignition type photoflash lamps in general use at present, the charge of percussively sensitive primer material is located within a readily deformable metal ignition tube sealed within and projecting from one end of a length of glass tubing which forms the lamp envelope and the other end of which is constricted and tipped off. The ignition tube extends generally axially of the tubular lamp envelope and opens thereinto, and the primer material is in the form of a coating on a wire anvil supported within the ignition tube and extending approximately axially thereof. Flashing of such constructed percussive type photoflash lamps is initiated by a forceful mechanical impact or blow applied against the side of the metal ignition tube to deform it inwardly against the coating of primer material on the wire anvil which causes deflagration of the primer material up through the ignition tube into the lamp envelope where it then ignites the filamentary combustible material disposed therein.

The known primer materials generally consist of a mixture of a readily combustible fuel such as phosphorus with an oxidizer compound for the fuel such as alkali metal chlorates and perchlorates. The primer material also further generally includes a powdered combustible incandescable metal such as zirconium, hafnium, thorium, aluminum, magnesium, boron, silicon or their alloys which upon being heated spews into the envelope to burn the filamentary combustible material when the mixture has been detonated. The known primer materials have been prepared as liquid suspensions in an organic or aqueous solvent for coating the anvil member in a percussive type flashlamp, and soluble binders are generally included to provide adhesion of the coating to the anvil member. A known organic liquid suspension for the primer material utilizes nitrocellulose as the binder agent and requires careful handling during storage and lamp manufacture to avoid accidental ignition. A less sensitive aqueous suspension of the primer material which is known uses hydroxyethyl cellulose or methoxy cellulose as the soluble binder agent.

Various problems exist with the known primer materials both in the preparation and application as a coating upon the anvil member or in the operation of a flashlamp having such coatings. The liquid suspensions have been found unstable in that the suspended material settled out or aggregated so as to preclude being able to obtain a uniform liquid coating of the primer material on the anvil member. In a dip method of coating it was also found that solid materials from the coating composition adhered to the sides of the container holding the coating composition with said adhered material proving to be unwettable when additions of the liquid composition were supplied to the container. A still different problem encountered with aqueous suspensions of the primer material which contain a substantially insoluble constituent such as potassium chlorate occurs from recrystallization of this constituent to form oversized lumps in the liquid coating composition. The final solid coatings obtained with conventional primer materials further lack adequate adherence to the anvil member and are brittle which has a deleterious effect upon the lamp operation.

For the solid primer composition to operate satisfactorily when the lamp is actuated, it becomes necessary for the material to exhibit both the proper ignition sensitivity as well as to ignite the filamentary combustible material properly so as to obtain the desired light output and light peak time. More particularly, the primer material must be sensitive enough in oxygen or another combustion-supporting gas to reliably ignite the flashlamp. Additionally, the blast characteristics of the primer material must distribute hot burning metal sufficiently for the principal combustion reaction which produces the light output from the lamp to take place at a desired light level and time span but without excessive blast velocity. If the blast velocity of the primer material is excessive, then the filamentary combustible material becomes packed in the lamp envelope with subsequent reduction in light output or slower burning rate.

SUMMARY OF THE INVENTION

An improved primer material has been discovered which can be applied reliably as a coating for the anvil member in a percussion-ignitable flashlamp to provide proper ignition sensitivity and improved blast characteristics in the lamp upon actuation. The low blast velocity and high impact sensitivity of the present primer material compared with currently used primers permits the lamp to flash reliably with a high constant light output at a primer weight range between 0.5 and 1.2 milligrams. By reason of the improved efficiency and operational characteristics of the new primer material, it becomes possible to achieve a mean light output of approximately 520 zonal lumen-seconds from flashlamps containing 18 milligrams of a zirconium filamentary material and 4.5 cc of oxygen compared with the 19 milligrams of said foil and 5 cc of oxygen being utilized in the conventional flashlamps.

The improved flashlamp construction of the present invention comprises a hermetically sealed light-transmitting envelope, a quantity of filamentary combustible material loosely distributed within said envelope, a filling of combustion-supporting gas in said envelope, and a percussive-ignition system secured at one end and in communication with the interior of said envelope, said percussive-ignition system including a quantity of primer material comprising a mixture in percentage by weight of 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium. The combined weight percent of potassium chlorate and sodium chlorate in the primer mixture does not exceed 25 percent in the preferred compositions to maintain a proper balance between safety and handling and sensitivity in lamp operation to provide the aforementioned performance advantages. Likewise, the primer mixture is adhesively bonded to the anvil member with a polyvinyl alcohol binder in the preferred embodiments which provides a tough, flexible and abrasion-resistant coating that does not crack or peel off as readily during lamp manufacture or other handling than was found with conventional primer formulations.

The coating slurry for the primer materials of the present invention comprises a suspension of the aforementioned solid mixture in an aqueous solution of polyvinyl alcohol. More particularly, the solid mixture can be suspended in equal part by weight of a 2 percent by weight solution of polyvinyl alcohol in water. The preferred type of polyvinyl alcohol resin is approximately 87–89 percent hydrolyzed which provides greater flexibility and adhesion in the final coating film as well as greater dispersing power in the aqueous slurry than can be found with a completely hydrolyzed polyvinyl alcohol. The dispersion power of polyvinyl alcohol is important in the present coating compositions by reason of the presence of both potassium chlorate and sodium chlorate which interact in solution by reason of a common ion effect. While the greater solubility of the sodium chlorate serves to reduce the solubility of the potassium chlorate and minimize recrystallization of the latter material which can produce large lumps in the coating composition, it becomes necessary to have these materials uniformly dispersed in the coating composition for the desired effect to take place.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, the single FIGURE is a cross-sectional view partly in elevation of a percussion-type flashlamp of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, the flashlamp according to the invention comprises a glass bulb or envelope 1 which, as shown, may be formed of a short length of glass tubing, for example, about ⅜ inch outside diameter, which is constricted and rounded off at one end as indicated at 2 and closed off thereat by an exhaust tip 3 and is formed at the other or base end 4 with a fused seal 5 about a readily deformable metal ignition tube 6 which may comprise a thin-walled (for example, 0.003-inch wall thickness) tube of a suitable metallic composition such as a nickel-chromium iron alloy, for instance. The envelope 1 is made of a glass which is capable of forming a good hermetic seal to the particular metallic material employed for the ignition tube 6. As shown, the ignition tube 6 which may have an outside diameter of about one-sixteenth inch, for example, is sealed into the base end 4 of the tubular lamp envelope 1 in a position extending longitudinally and preferably axially thereof, and it projects endwise from the envelope end 4 to provide an exposed section 7. The ignition tube 6 has a closed outer end 8 and an open inner end 9 which opens into the interior space of the lamp envelope 1 and, as shown, terminates approximately at the inner wall thereof. A quantity of filamentary combustible material 10 such as a shredded foil of zirconium, aluminum or hafnium, for example, is loosely distributed within the interior space of the envelope 1 which also contains a filling of a suitable combustion-supporting gas such as oxygen.

Disposed within the metal ignition tube 6 and extending substantially coaxially therethrough is a wire anvil 11 of a suitable metallic composition of high temperature resistance and low thermal conductivity such as, for example, a stainless steel. The wire anvil 11 is suitably held or fastened in place in the ignition tube 6 as by a circumferential indenture 12 of the tube 6 near its outer end which laps over an enlarged head 13 or other suitable protuberance on the outer or lower end of the wire anvil. As shown, the wire anvil 11 is of a slightly smaller diameter in the inside diameter of the ignition tube 6 so as to be spaced a slight distance, for example, about 0.05 inch or so from the inside wall thereof, and it is provided with a thin coating 14 of a percussively ignitable primer material over an appreciably lengthwise extent of that portion of the wire anvil located within the projecting portion 7 of the ignition tube 6. The coating 14 of primer material is of a thickness such as to be spaced a slight distance of around a few thousandths of an inch or so, for example, 0.004 inch, from the inside wall of the ignition tube.

To aid in supporting the wire anvil 11 substantially coaxially within the ignition tube 6 and insure clearance between the coating 14 of primer material in the inside wall of the ignition tube 6, the wire anvil 11 is formed near the open inner or mouth end of the ignition tube 6 with three or more protuberances or lobes 15 spaced apart more or less uniformly around the circumferential extent of the wire anvil and having, along with the head 13 on the wire anvil, a close sliding fit within the ignition tube. The anvil centralizing lobes 15 are of minimal thickness circumferentially of the wire anvil 11 so as to leave substantially unobstructed the annular space between the ignition tube 6 and the wire anvil 11 for the passage therethrough and into the lamp envelope 1 of the ignited particles of the primer material 14 on ignition and deflagration thereof. In the particular case illustrated, the anvil centralizing lobes 15 are formed by flattening the wire anvil 11 at two closely adjacent points along the length of the anvil and in two different planes at approximately right angles to one another. The lamp is also provided with a deflector shield 16 which is located just inwardly of the open inner mouth end 9 of the ignition tube 6 on an inwardly extending portion 17 of the wire anvil 11 that extends into the lamp envelope 1 from the mouth opening 9 of the ignition tube 6. The deflector shield 16 can be con-

stituted by a glass bead fusion-sealed to the wire anvil 11.

The coating of primer material in the above embodiment can be applied to the anvil member as a stabilized aqueous suspension of the present invention in various known ways. For example, the anvil member can be dipped into the aqueous slurry followed by drying in air or with heat to remove the liquid and produce a solid adhered coating having the desired characteristics previously described. Alternately, the aqueous slurry can be sprayed on the anvil members and thereafter processed to provide a solid coating exhibiting comparable performance.

An example of a coating composition made in accordance with the present invention which is both safe to handle and exhibits the desired sensitivity in lamp operation is as follows:

Ingredients	Parts by Weight
Titanium	620
Potassium chlorate	100
Red phosphorus	180
Sodium chlorate	100
Water (with 2% polyvinyl alcohol binder)	620

This primer suspension can be mixed in a conventional manner to produce a smooth, even blend of the constituents which is stable in storage over long time periods. All solid materials except the sodium chlorate can have a particle range from a fine mesh size to a micron size which insures a smooth and uniform primer coating. By changing the ratio of the solid materials in the primer within the ratios of the weight ratios above specified, it is possible to make the final percussively ignitable material more or less explosive and more or less sensitive in air or oxygen. The formulation can be varied to make the final primer safer to handle wet or dry and still be made sensitive enough in oxygen or some other combustion-supporting gas to reliably ignite the flashlamp. Consequently, the proper balance between safety and sensitivity will specify the particular formulation best fitted for a given application.

Surprisingly, it has been found that raising the phosphorus level in the primer mixture above the minimum level specified has only slight effect on light output and variation in light output when the lamp is actuated. Correspondingly, there is only slight effect upon light output and time to peak when the potassium chlorate level is increased above the minimum level hereinbefore specified. On the other hand, it has also been found that mixtures of the potassium chlorate and sodium chlorate oxidizers within the weight ratios specified are significantly more sensitive to impact than would be an equivalent amount of potassium chlorate alone. Sodium chlorate cannot be substituted entirely for potassium chlorate in the primer mixture since the time to peak occurs too quickly in a flashlamp along with "salting out" of the polyvinyl alcohol binder in the aqueous slurry at the levels of oxidizer needed.

While the best mode of carrying out the present invention has been set forth above, it will be understood that additions, changes and modifications may be made thereto without departing from the spirit and scope of the invention as defined in the appended claims. For example, it will be apparent that extenders such as finely divided silica and suspending agents can be added to the aqueous slurry for greater stability if the need arises. Likewise, defoamers can be added to the aqueous slurry which may facilitate more immediate application of a freshly prepared coating composition. It is intended to limit the present invention, therefore, only to the scope of the following claims.

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

1. A flashlamp comprising a hermetically sealed light-transmitting envelope, a quantity of filamentary combustible material loosely distributed within said envelope, a filling of combustion-supporting gas in said envelope, and a percussive-ignition system secured at one end and in communication with the interior of said envelope, said percussive-ignition system including a quantity of primer material which comprises a mixture in percentages by weight of 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium.

2. A flashlamp as in claim 1 wherein the combined weight percent of potassium chlorate and sodium chlorate does not exceed 25 percent.

3. A flashlamp as in claim 1 wherein the primer material is bonded into a unitary mass with a polyvinyl alcohol binder.

4. A flashlamp comprising a hermetically sealed light-transmitting envelope, a quantity of filamentary combustible material loosely distributed within said envelope, a filling of a combustion-supporting gas in said envelope, and a percussive-ignition system for said lamp comprising a readily deformable metal ignition tube sealed in and projecting from one end of said envelope enclosed off at its outer end, a wire anvil of a high temperature resistant and low thermal-conducting material disposed within and substantially coaxially with said ignition tube, said wire anvil being coated with a quantity of primer material which comprises a mixture in percentages by weight of 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium.

5. A flashlamp as in claim 4 wherein the combined weight percent of potassium chlorate and sodium chlorate does not exceed 25 percent.

6. A flashlamp as in claim 4 wherein the coating of primer material is bonded to the anvil with a polyvinyl alcohol binder.

7. A flashlamp as in claim 6 wherein the polyvinyl alcohol binder is approximately 87–89 percent hydrolyzed polyvinyl alcohol.

8. A primer material which comprises a solid mixture having in percentages by weight 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium which is bonded into a unitary mass with a polyvinyl alcohol binder.

9. A stabilized slurry of primer material which comprises a solid mixture containing in percentages by weight of said solid mixture 4–50 percent phosphorus, 10–25 percent potassium chlorate, 4–10 percent sodium chlorate, and the remainder being titanium with said mixture being suspended in an aqueous solution of polyvinyl alcohol.

10. A stabilized slurry as in claim 9 wherein the polyvinyl alcohol is approximately 87–89 percent hydrolyzed.

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