Dec. 13, 1955 M. PIPKIN 2,726,527

FLASH LAMP

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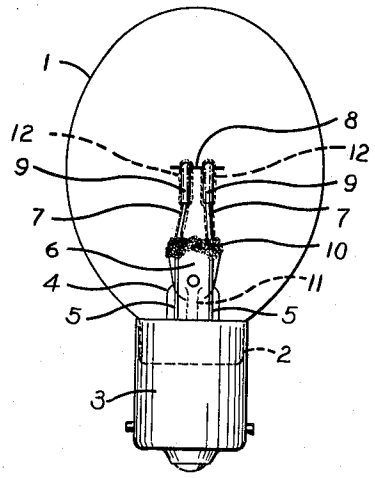

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FLASH LAMP

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My invention relates to flash lamps in general and to a method of manufacture thereof, and more particularly to a flash lamp having means therein adapted, upon leakage of atmospheric air into the lamp envelope, to either provide a visible indication of the defective character of the lamp or render the lamp inoperative, or both.

Flash lamps of the general type in use at present comprise a hermetically sealed glass envelope containing a light-giving charge and a combustion-supporting gaseous filling at a pressure less than atmospheric. When flashed, the light-giving charge reacts with the gaseous filling to produce a momentary flash of light of high intensity suitable for photographic purposes. If the envelope of the flash lamp remains in its hermetically sealed condition at the time of flashing of the lamp, the reaction proceeds in proper manner and in safety, without danger of lamp explosion. However, if the hermetic seal of the envelope is defective for some reason, as by the occurrence of a crack in the glass wall thereof, the leakage of atmospheric air into the envelope dilutes the gas filling and raises the internal gas pressure to a degree such as might result, depending on the type of lamp, either in poor light output or in a violent explosion of the envelope on flashing of the lamp, with resultant danger of flying glass and injury to persons in the immediate vicinity.

It is an object of my invention, therefore, to provide a flash lamp having means for providing a visible indication as to whether or not the lamp envelope is in a hermetically sealed condition and the lamp in a proper or a safe condition for use.

Another object of my invention is to provide a flash lamp having visible means within the envelope thereof for indicating the leakage of atmospheric air thereinto by the absorption of the moisture in such air.

Still another object of my invention is to provide a flash lamp having means therein for rendering the lamp substantially inoperative upon leakage of atmospheric air into the envelope thereof.

A further object of my invention is to provide a method of making a flash lamp having an indicating and/or an inactivating means of the above-mentioned character.

According to one aspect of the invention, the envelope of a flash lamp is provided interiorly thereof with a small quantity of a substance, in an anhydrous state, which is highly deliquescent and which will change its appearance upon absorption of the moisture present in atmospheric air leaking into the lamp envelope. Preferably, the substance is in the form of a coating located on the press portion of the re-entrant glass stem of the lamp.

According to another aspect of the invention, the flash lamp may be further provided with a coating of such a deliquescent substance on the beads of combustible fulminating material which are customarily provided on the inner lead-in wires of the lamp in contact with the ignition filament connected thereacross, which coating, upon absorption of moisture from atmospheric air leaking into the lamp envelope, will wet the fulminating material to

a degree sufficient to render the lamp substantially inoperative.

Further objects and advantages of my invention will appear from the following detailed description of a species thereof and from the accompanying drawing which is an elevation of a flash lamp according to the invention.

While in the drawing I have shown the invention as applied to a flash lamp of the so-called primer type disclosed and claimed in U. S. Patent 2,291,983, M. Pipkin, in which the sole source of actinic light is constituted by beads of a fulminating or primer material located within the envelope, it is to be understood that the invention is also applicable to other flash lamps such as those wherein the source of actinic light is constituted by a filling of combustible material in the form of wire, shredded foil or leaf foil.

Referring to the drawing, the flash lamp there shown comprises a hermetically sealed envelope or bulb **1** of a suitable light-transmitting material such as glass and having a neck portion **2** to which is suitably secured a conventional type base **3**, as by cementing for instance. The bulb **1** is filled with a combustion-supporting gaseous filling such as oxygen at a suitable pressure, preferably less than atmospheric, for instance from 100 mm. of mercury up to a pressure approximating one atmosphere. In the particular primer-type lamp illustrated, the gas filling comprises oxygen at a pressure of approximately 125 mm. of mercury. The bulb is coated on its inner or outer surface, preferably on both surfaces, with a coating of a suitable light-transmitting lacquer or varnish to thereby minimize cracking of the bulb on charge flashing and to render the bulb substantially shatterproof.

Sealed into the bulb **1** and extending thereinto from the neck portion **2** thereof is a mount structure comprising a re-entrant stem **4** having a pair of leading-in wires **5**, **5** sealed into the press portion **6** of the stem and extending therethrough to the terminals of the base **3**. The leading-in wires **5**, **5** are provided with juxtapositioned parallel inner lead portions **7**, **7** across the inner ends of which is connected a small ignition filament **8** consisting of a straight length of wire of a suitable refractory metal such as tungsten. Mounted on the inner ends of the leading-in wires **5**, **5**, and at least partly embedding the filament **8**, are beads or coatings **9**, **9** of a suitable primer or fulminating material such as disclosed in the aforesaid Patent 2,291,983, the said substance constituting the sole source of actinic light generated by the lamp. The light-giving material **9** preferably consists of a mixture of zirconium metal powder, potassium perchlorate powder and sodium chlorate powder bonded together by a suitable binder such as nitrocellulose.

In accordance with the invention, the lamp envelope **1** is provided, at a readily visible location interiorly thereof, with a small quantity **10** of one or more substances, in an anhydrous state, which are deliquescent (i. e., which become liquid by absorption of moisture from the surrounding atmosphere) and which undergo a change in their appearance upon transformation from their anhydrous (solid) to their hydrated (liquid) state. Upon leakage of atmospheric air into the envelope, such as occurs when a crack develops in the glass wall of the envelope, the anhydrous substance **10** absorbs the moisture which is present in the air which has thus penetrated into the envelope, and undergoes a transformation in its appearance which provides a visible indication to the user that the lamp is defective or in an unsafe condition to use.

The indicator substance **10** is preferably located within the envelope **1** at a point adjacent the neck **2** thereof where it will be exposed to the heat utilized to seal the mount into the envelope neck, such heat serving to expel the water of hydration from the substance **10** and trans-

form it into its anhydrous state. Also, the indicator substance **10** is preferably located on a part of the lamp, such as the stem press **6** as shown, other than the inner wall of the envelope **1** for the reason that the inside lacquer coating with which the inside wall of the envelope is customarily provided prevents the substance **10** from readily absorbing moisture when placed on such a lacquered inside wall.

There are a number of materials known as hydrates which are suitable for use as indicator substances **10** according to the invention, the only requirements being that they be of a highly deliquescent character and that when once placed in their dehydrated or partially dehydrated solid state they not only absorb moisture readily upon exposure thereto and become transformed into a partially or completely hydrated liquid state, but in doing so they also undergo a change in their appearance. Examples of deliquescent hydrates which may be satisfactorily utilized as the indicator material **10** are lithium bromide, lithium perchlorate, lithium chloride, lithium nitrate, strontium perchlorate, copper sulphate or chloride, cobalt chloride, nickel chloride, nickel bromide and sodium nitrate.

Of the various deliquescent hydrates suitable for the purposes of the invention, it is preferable to employ a deliquescent hydrate of the type which, when in its partially or completely dehydrated state, is in the form of a readily visible powder of spongy or foam-like appearance and for that reason will absorb moisture more readily and quickly upon exposure thereto and transform itself into a liquid state. In addition, it is also preferable to employ a deliquescent hydrate which is as hygroscopically sensitive as possible to effect the desired appearance change therein, i. e., one that requires the smallest amount of moisture absorption to effect its appearance transformation and therefore will be effective to indicate the presence of water vapor even when present in minute amounts. For such reasons, therefore, it is preferred to employ a deliquescent hydrate such as lithium bromide or strontium perchlorate, each of which possesses the above-described properties. Lithium bromide, however, has been found to be the most suitable material up to the present because even if it should be heated to an excessive temperature during the heating thereof to effect its dehydration, it nevertheless still retains its capacity to readily absorb moisture and undergo a transformation in its appearance.

To produce a flash lamp according to the invention provided with a visible indicator means such as described above, a small quantity of a saturated solution of a suitable deliquescent hydrate, such as lithium bromide for example, is placed on the press portion **6** of the glass stem **4** of the lamp mount, and the latter then sealed into the envelope **1**. The heat of sealing is conducted through the glass stem to the press portion **6** and causes the water of hydration in the indicator substance to be evaporated therefrom and the residue (anhydrous lithium bromide in this case) to assume a highly porous, foam-like, white appearance which is readily visible. The envelope **1** is then immediately exhausted and filled with oxygen or other combustion-supporting gas to the desired pressure through the conventional exhaust tube **11** which is then tipped-off to hermetically seal the envelope while the indicator substance **10** is still in its dehydrated state. As long as the lamp envelope **1** remains hermetically sealed, the anhydrous lithium bromide retains its white spongy appearance. However, if a crack develops in the glass envelope **1**, the anhydrous lithium bromide **10** readily absorbs the moisture carried into the envelope by the atmospheric air penetrating thereinto, thereby causing its white appearance to disappear and the material to turn water clear, thus indicating the defectiveness of the lamp.

In order to render it as sensitive as possible, the indicator substance **10** preferably is only partially dehydrated, only enough of its water of hydration being expelled to effect a transformation in its appearance. By only partially dehydrating it to the point where it first attains its transformed anhydrous appearance, the indicator substance **10** does not need to absorb as much moisture to transform itself back to its hydrous condition as it normally would if it were excessively or completely dehydrated. Also, as small a quantity as possible of the indicator substance **10** is employed while still providing a readily visible deposit, in order to minimize the amount of moisture required to be present in the lamp envelope and absorbed by the indicator substance to transform it into its hydrated state, thereby rendering the indicator substance **10** as sensitive as possible.

As an alternative to the indicator means **10**, but preferably in addition thereto, the flash lamp according to the invention may be provided with an inactivating means for rendering the flash lamp substantially inoperative upon leakage of atmospheric air into the lamp envelope **1**. For this purpose the primer or fulminating beads **9** of the lamp are each coated with a layer **12** of a deliquescent substance such as that employed for the indicator means **10**. Upon leakage of atmospheric air into the envelope **1**, the deliquescent coatings **12** on the primer beads **9** absorb the moisture in the air and change into a solution which then wets the material of which the primer beads are made, thereby rendering them substantially incapable of combustion or, in any event, retarding their combustion to a degree sufficient to negative any possibility of the lamp exploding when operated, or flashing with the requisite speed to produce the normal light flash. As long as the lamp envelope **1** remains sealed to the atmosphere, however, the coatings **12** on the primer beads **9** remain in their dehydrated state and do not adversely affect the combustion characteristics thereof in any objectionable manner. Thus, the lamp will possess substantially the same light-flash characteristics which it normally would possess if it were not provided with the coatings **12** on the primer beads **9**.

The coatings **12** of deliquescent material may be conveniently applied to the primer beads **9** in any suitable manner, preferably by dipping the lamp mount, filament end first, into a saturated solution of the deliquescent substance to a depth sufficient to coat not only the primer beads **9** but also the inner leads **7** and at least a part of the stem press **6** as well. In this manner both the lamp inactivating coatings **12** and the indicator coating **10** are applied simultaneously to the lamp mount. Also, if desired, the inner leads **7** may be coated with a layer of the deliquescent material prior to the application of the primer beads thereto. The dipping operation may be automatically performed on the same apparatus customarily employed to automatically apply the primer beads **9** themselves to the lamp mount, such an apparatus being shown in Flaws patent 2,449,648, dated September 21, 1948. After the application of the coatings **10** and **12** to the lamp mount, the latter is then sealed into the lamp envelope **1** and the coatings **10** and **12** properly dehydrated by the heat of the sealing operation as before, whereupon the lamp envelope **1** is immediately exhausted and gas-filled and then tipped-off to hermetically seal it while the deliquescent coatings **10** and **12** are still in their dehydrated state.

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

1. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture, a lamp mount structure sealed in said envelope, a light-giving charge in said envelope, a combustion-supporting gaseous filling in said envelope, and a quantity of a deliquescent substance in an anhydrous solid state located in said envelope on said mount structure, said substance being changeable in appearance and physical structure from its said solid state to a liquid state upon exposure to and absorption of moisture entering the envelope.

2. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture, combustible means in said envelope comprising a bead of fulminating material, a combustion-supporting gaseous filling in said envelope, and a coating of a deliquescent substance in an anhydrous solid state on said bead of fulminating material.

3. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture and provided with a re-entrant stem having a press portion, a pair of lead-in wires sealed through said press portion, ignition means in said envelope comprising a filament connected across said lead-in wires, a light-giving charge in said envelope, a combustion-supporting gaseous filling in said envelope, and a coating of a deliquescent substance in an anhydrous solid state on said stem press portion, said substance being changeable in appearance and physical structure from its said solid state to a liquid state upon exposure to and absorption of moisture entering the envelope.

4. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture and provided with a re-entrant stem having a press portion, a pair of lead-in wires sealed through said press portion, ignition means in said envelope comprising a filament connected across said lead-in wires, a bead of fulminating material located on each of said lead-in wires and at least partially embedding said filament, a combustion-supporting gaseous filling in said envelope, and coatings of deliquescent substances in an anhydrous solid state on said stem press portion and on each of said beads of

fulminating material, the deliquescent substance on said stem press being changeable in appearance and physical structure from its said solid state to a liquid state upon exposure to and absorption of moisture entering the envelope.

5. A flash lamp as set forth in claim 1 wherein the said deliquescent substance comprises a hydrate which has a white porous appearance in its anhydrous solid state and turns water clear upon absorption of moisture and transformation into its hydrated liquid state.

6. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture, a lamp mount structure sealed in said envelope, a light-giving charge in said envelope, a combustion-supporting gaseous filling in said envelope, and a quantity of anhydrous lithium bromide located in said envelope on said mount structure.

7. A flash lamp comprising a hermetically sealed light-transmitting envelope interiorly free of moisture, a lamp mount structure sealed in said envelope, a light-giving charge in said envelope, a combustion-supporting gaseous filling in said envelope, and a quantity of anhydrous strontium perchlorate located in said envelope on said mount structure.

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