June 2, 1942. M. PIPKIN 2,285,125

FLASH LAMP

Filed March 16, 1939

Fig. 1.

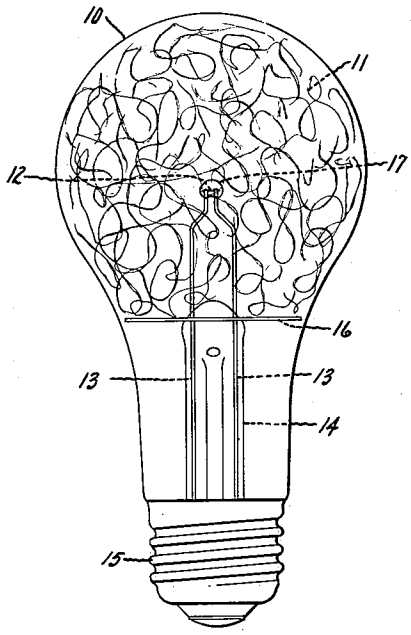
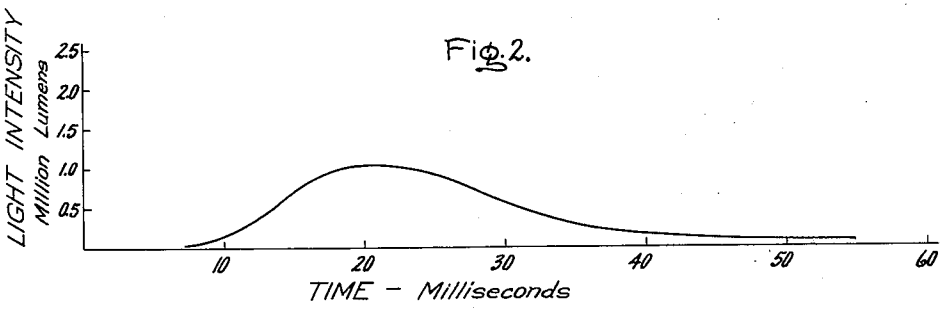


Fig. 2.



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2,285,125

FLASH LAMP

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7 Claims. (Cl. 67—31)

My invention relates to flash lamps and more particularly to that type of flash lamp used for photographic purposes. Such flash lamps usually comprise a sealed transparent bulb in which is enclosed a readily combustible material such as metal foil and/or wire, together with suitable ignition means therefor, and a substance, usually a gas filling, which, upon ignition of the lamp enters into a reaction with the combustible material with the resulting emission of actinic light. Still more particularly, my invention relates to flash lamps employing substantially pure aluminum, in the form of a wire or ribbon, as the combustible material together with effective ignition means therefor.

The combustible materials which have been found most suitable for use in flash lamps consist of either a thin metallic foil or wire which, when ignited in an oxygen or oxygen-containing atmosphere, burns very rapidly with the emission of a substantial amount of actinic light. While foil flash lamps, due to the tremendous amount of actinic light developed upon their ignition and to the relatively great speed of the flash, are particularly advantageous and useful for certain types of photographic work, commonly referred to as the "open flash," wire flash lamps, due to their longer flash period, are preferred for "synchronized flash" work in which the flash of the lamp occurs simultaneously with the opening or tripping of the camera shutter.

To obtain satisfactory flashlight pictures with present day film and photopgraphic equipment, it is necessary that the flash of light produced by the flash lamp have a peak intensity of at least 900,000 lumens or thereabouts. As pointed out in United States Patent No. 2,037,101, issued April 14, 1936 to J. A. M. Van Liempt, it was heretofore considered impossible to employ pure aluminum wire alone as the combustible material in flash lamps for the reason that no means were known for effectively igniting it so as to produce sufficient light for flashlight photography. In addition, pure aluminum could not be drawn fine enough to ignite with the requisite speed. One solution to the problem, as disclosed in the above-mentioned patent, was to use an alloy of magnesium and aluminum as the combustible material, the magnesium serving to facilitate the ignition of the aluminum. Such an alloy, when drawn to a wire or band having a perimeter of 300 microns or less, e. g., 100 microns, will ignite with sufficient speed to produce a flash of light of the required output. Another solution to the problem was to employ a piece of thin aluminum foil to facilitate the ignition of the pure aluminum wire, as disclosed in United States Patent No. 2,142,372, issued January 3, 1939, to R. E. Worstell and the applicant herein.

Even though pure alumnum can be drawn in a practical manner to a diameter of as low as one mil by the process described in my United States Patent No. 2,215,477, issued Sept. 24, 1940, it has nevertheless been found desirable to employ therewith a small quantity of foil in order to produce a flash of light of sufficient output for photographic purposes. Furthermore, to satisfactorily operate with synchronizing mechanism now in use, it is necessary for the peak of the flash to occur at approximately 0.020 of a second after closure of the circuit through the flash lamp. When wire flash lamps employing drawn pure aluminum of about one mil diameter and ordinary primer or ignition means are flashed, the peak invariably occurs at an appreciably longer intervals of time, following circuit closure, than the desired 0.020 of a second. However, I have discovered that when combustible material consisting solely of pure aluminum wire of about one mil diameter is ignited in flash lamps by a primer mixture according to my invention, a flash of light of the required output is produced with its peak accelerated sufficiently so as to uniformly occur at 0.020 of a second or thereabouts following closure of the circuit through the lamp.

One object of my invention is to provide a flash lamp which will produce, upon ignition, a flash of light of relatively high intensity and of prolonged duration, and having its peak at about 0.020 of a second following energization of the lamp ignition means.

Another object of my invention is to provide a flash lamp, employing a drawn wire or ribbon of pure aluminum as the sole combustible material, which will produce a flash of light of sufficient speed and intensity for flashlight photographic purposes.

Still another object of my invention is to provide a flash lamp, employing as the sole combustible material drawn pure aluminum of a fineness corresponding to a diameter of approximately one mil, with a primer or ignition bead which will cause the fine aluminum to burn quickly so as to produce a flash of light of relatively high intensity having its peak at about 0.020 of a second following energization of the filament embedded in said primer bead.

A further object of my invention is to provide uniformly performing flash lamps in which the

flashes of light produced thereby are uniform in character and occur at approximately the same interval of time following energization of the lamp ignition means.

A still further object of my invention is to provide a primer bead for flash lamps which will ignite uniformly and with great speed, and will be expanded or distributed quickly throughout the lamp bulb upon energization of the filament embedded in such bead.

Further objects and advantages of my invention will appear from the following description of a species thereof and from the accompanying drawing in which:

Fig. 1 is an elevation of a flash lamp comprising my invention; and Fig. 2 is a chart showing the light curve produced by the flash lamp shown in Fig. 1, the abscissa representing time in milliseconds and the ordinate representing intensity of light in millions of lumens.

Referring to Fig. 1, the flash lamp there shown comprises a vitreous transparent envelope or bulb 10 containing a loose filling of combustible material 11 consisting essentially of substantially pure drawn aluminum wire or ribbon having a fineness corresponding to a diameter of approximately one mil or very close thereto. This fine pure aluminum wire may be produced either by conventional mill die-drawing methods or by the special drawing process disclosed in my United States Patent No. 2,215,477 previously referred to, in which the aluminum is drawn to the required size inside a copper jacket and the copper then dissolved off, leaving the bare aluminum wire. The envelope or bulb 10 also contains a filling of oxygen or oxygen-containing gas at a suitable pressure for supporting the combustion of the combustible material 11. The pressure of this gaseous filling will vary depending upon the type of filling, the size of the bulb, and the quantity and type of combustible material therein. For bulb sizes commonly in use at present, and with oxygen being used as the combustion-supporting gas and pure aluminum as the combustible material, the pressure of the gaseous filling will vary up to 500 mm. of mercury. Mounted within the bulb 10 within effective ignition range of the combustible material 11 therein, is a small filament 12 the ends of which are connected to leading-in wires 13, 13 which extend through a stem 14 to a base 15. An insulating disc 16, preferably of asbestos, is mounted on the stem 14 to shield the base end of the lamp from the heat of combustion.

The filament 12 is embedded in a bead 17 of fulminating substance similar to that disclosed in my co-pending United States application Serial No. 203,890, filed April 23, 1938, to thereby form the ignition means for the lamp. According to the invention, the fulminating substance is applied to the filament 12 in the form of a paste consisting of an extremely sensitive metal powder or powders and a suitable oxidizing agent mixed with a suitable binder. In the preferred composition of the fulminating substance 17, the sensitive metal powder consists of a mixture of the grade "M" and grade No. 3 zirconium metal powders manufactured and sold commercially by the Foote Mineral Company of Philadelphia, Pennsylvania. The grade No. 3 zirconium metal powder has a fineness of approximately 325 mesh or finer and has a relatively high ignition temperature, while the grade "M" zirconium metal powder is considerably finer than the grade No. 3 zirconium powder and has a relatively low ignition temperature. Chemically pure (C. P.) crystal potassium perchlorate powder, having a fineness of approximately 325 mesh or finer, is employed as the oxidizing agent. To prevent the formation of enlarged internal cavities in the primer bead during the drying thereof, a slow-drying and preferably non-gummy binder, such as glue, is employed. The preferred composition of the above primer bead material is approximately as follows:

1 per cent glue water	cc. 5
Potassium perchlorate (C. P.) powder	grams 4
Zirconium No. 3 metal powder	do 2.6
Zirconium "M" metal powder	do 2.6

The primer bead mixture is prepared as follows: 4 grams of crystal potassium perchlorate (C. P.) is first ground to a fineness of 325 mesh or finer and then added to 5 cc. of the one per cent glue water, the powdered potassium perchlorate being stirred in thoroughly. Next, 2.6 grams of zirconium No. 3 metal powder is added and stirred in thoroughly, after which 2.6 grams of zirconium "M" metal powder is added and stirred in thoroughly. To obtain a homogeneous mixture and to thin out the same, an additional amount of water is added, the additional water effecting a more complete solution of the potassium perchlorate powder. The excess water is then evaporated by blowing the mixture with an air jet until the correct consistency is obtained. The filament 12, together with its associated leading-in wires 13, 13, is then dipped into the above mixture to form a bead covering the filament and adjacent portions of the leading-in wires. Two applications by dipping have been found to produce the right size primer bead. After the bead has dried, an insulating or protective coating of suitable material is applied thereover to thereby add mechanical strength to the bead and also to protect the same from premature ignition during the testing of the completed flash lamp. The said protective coating may consist of either cellulose acetate or a 4 per cent solution of nitrocellulose. A suitable amount of potassium perchlorate or other similar oxidizing agent may be added to the coating to thereby facilitate the burning of the same.

If desired, a 4 per cent solution of cellulose acetate, consisting of approximately 8 grams of cellulose acetate, 100 cc. of acetone and 100 cc. of ethyl lactate, may be employed as the binder material instead of glue. In this case, the preferred composition for the primer bead material is approximately as follows:

4 per cent cellulose acetate	cc. 5
Potassium perchlorate C. P. powder	grams 5
Zirconium No. 3 metal powder	do 3¼
Zirconium "M" metal powder	do 3¼

Also, if desired, the zirconium "M" metal powder may be replaced by tungsten metal powder having a fineness of approximately 325 mesh or finer. The preferred composition for the primer bead material is then approximately as follows:

4 per cent cellulose acetate	cc. 3
Potassium perchlorate C. P. powder	grams 5
Zirconium No. 3 metal powder	do 2.6
Tungsten metal powder	do 4

The cellulose acetate binder in the above composition may be replaced, if desired, by 4 cc. of a one per cent solution of glue water.

The primer material applied to the filament

12, upon drying, forms a uniformly porous bead consisting of an intimate mixture of the sensitive metal powders and the potassium perchlorate powder bonded together by the dried binder material. Due to the slow and uniform drying characteristics of the binder, the bead 17 shrinks down onto the embedded filament 12 so that no enlarged and objectionable internal cavities are formed in the bead. The filament is thus entirely embedded in, and is completly covered over its entire surface area with the hardened fulminating substance 17. Every bead made from the above-described mixture will therefore be of uniform internal physical structure, so that the firing action or speed of ignition of each bead tends to be uniform. Flash lamps provided with such uniformly acting primer beads are thus rendered more uniform in flash performance, thereby facilitating the synchronization of a camera shutter with the light peak of such flash lamps. Uniformly in the firing action of the primer bead is further promoted by the use of the water-soluble potassium perchlorate powder as the oxidizing agent since it readily goes into solution with the water present in the bead mixture, thus insuring a uniform distribution of the oxidizing powder throughout the bead and producing a very intimate mixture of such powder with the sensitive metal powders.

The potassium perchlorate powder employed in the primer mixture according to the invention provides an extremely abundant supply of oxygen for supporting the combustion of the sensitive metal powders. As a result, the primer bead ignites very quickly and with great rapidity as compared to conventional primer mixtures heretofore used. The burning particles of primer material are projected with tremendous speed from the filament 12 and are quickly distributed through the bulb, thus causing the fine aluminum wire to ignite with great speed,—much faster than takes place when conventional primer mixtures are employed. Consequently, the use of such a quick-igniting primer bead in accordance with the present invention makes it possible to employ drawn pure aluminum wire as the sole combustible material in flash lamps, for such a primer bead will effectively ignite the aluminum wire in the lamp. Drawn pure aluminum wire having a size corresponding to a diameter of 1.0 or 1.1 mils, or slightly larger, can therefore be successfully employed in flash lamps for the production, upon ignition by a primer bead according to the invention, of a flash of light of sufficient intensity and output for flashlight photographic purposes. Furthermore, the flashes of light produced by such flash lamps successfully meet present day requirements for satisfactory synchronized flashlight photography, i. e., they are characterized by a relatively high intensity for a prolonged period of time with their peak uniformly occurring at approximately 0.020 of a second following the closure of the electrical circuit through the flash lamp.

Referring to the chart shown in Fig. 2, the curve there illustrated is the time-light intensity curve produced by a representative flash lamp according to the invention. The particular lamp producing this curve consisted of a bulb, commercially known as an A15 bulb, filled with approximately 40 mg. of 1.0 mil regular die-drawn pure aluminum wire and 400 mm. of oxygen, and containing a one-half mil diameter tungsten filament embedded in a bead of primer material according to the preferred composition specified hereinabove. This lamp produced a flash of light having a total of approximately 22,100 lumen seconds, with a peak intensity of approximately 1,000,000 lumens. As is evident from the chart, the time-light intensity curve is more or less flattened or broad in nature, with the peak occurring at approximately 20 milliseconds following energization of the filament. Thus, the flash of light produced by the lamp has both the desired prolonged duration and timing characteristics necessary for satisfactory synchronized flashlight photography.

When any type of flash lamp is flashed, the resulting products of combustion are deposited principally on the surface of the lamp bulb. Obviously, where these products of combustion are black or otherwise dark in color, there is a possibility that such a deposit may mask a portion of the actinic light produced by the combustion of the material within the lamp and so prevent the same from emanating from the bulb. However, with a flash lamp according to the present invention employing substantially pure aluminum wire as the combustible material and the improved primer mixture disclosed hereinabove, the products of combustion are principally white in character. Accordingly, there is very little or practically no tendency for the deposit on the bulb to mask or absorb any portion of the light produced by the combustion of the material within the bulb. Thus, substantially all of the actinic light produced within the bulb is allowed to pass out through the bulb, so that maximum utilization of the available actinic light results.

From the above description it is evident that a flash lamp according to the invention, employing drawn substantially pure aluminum wire as the sole combustible material, will produce a flash of light of relatively prolonged duration having a peak intensity of at least 900,000 lumens or thereabouts, which is sufficiently high to enable the taking of satisfactory flashlight pictures. Furthermore, the ignition and combustion of the combustible material within the lamp is effected in such a manner that the light peak of every lamp uniformly occurs at approximately 20 milliseconds following energization of the lamp ignition means. Consequently, the lamp will operate satisfactorily with synchronizing mechanism now in general use.

While in the description above I have referred to the combustible material as being in the form of wire, which is generally considered to be circular in cross-section, it is obvious that the said material may be of any other filamentary form of equivalent cross-sectional area such as, for instance, ribbon. Accordingly, in the appended claims the term "wire" is intended to include any substantial equivalent, such as ribbon.

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

1. A flash lamp comprising a sealed envelope containing an oxygenous atmosphere, a quantity of a relatively difficultly ignitable combustible material loosely arranged in said envelope, and ignition means within said envelope comprising an electrical energy translation element and a primer of fulminating material associated therewith, said primer comprising an intimate admixture of substantial amounts of two different powders and an oxidizing agent which readily gives up its oxygen, the two powders being so selected for particle size and composition that one of said powders is very readily ignitable and the other is less readily ignitable but has an appre-

ciably higher heat capacity than the first-mentioned powder, the oxidizing agent and first-mentioned powder causing ignition of the primer with great rapidity so as to violently project burning particles of the second-mentioned powder throughout the envelope, and the said second-mentioned powder carrying sufficient heat to initiate combustion of the combustible material at points scattered throughout the envelope.

2. A primer composition for flash lamps having combustible material loosely arranged in an enclosing envelope, said primer comprising an intimate admixture of substantial amounts of two different powders and an oxidizing agent which readily gives up its oxygen, the two powders being so selected for particle size and composition that one of said powders is very readily ignitable and the other is less readily ignitable but has an appreciably higher heat capacity than the first-mentioned powder, the oxidizing agent and first-mentioned powder causing ignition of the primer with great rapidity so as to violently project burning particles of the second-mentioned powder throughout the envelope, and the said second-mentioned powder carrying sufficient heat to initiate combustion of the combustible material at points scattered throughout the envelope.

3. A flash lamp comprising a sealed container having an oxidizing atmosphere therein, a quantity of combustible material within said container, and means for igniting said combustible material, said means comprising an electrical energy translation element and a bead of fulminating substance associated therewith, said bead of fulminating substance containing the proportions of approximately 2.6 grams of one type of zirconium metal powder having a relatively low ignition temperature, 2.6 grams of another type of zirconium metal powder having a larger particle size and a relatively high ignition temperature, 4 grams of chemically pure potassium perchlorate powder, and 5 cc. of a one per cent solution of glue water.

4. A flash lamp comprising a sealed container having an oxidizing atmosphere therein, a quantity of combustible material within said container, said combustible material consisting of substantially pure filamentary aluminum of a size corresponding to a diameter of the order of one mil, and ignition means within said container comprising an electrical energy translation element and a bead of fulminating substance associated therewith, said fulminating substance comprising an admixture of one type of zirconium metal powder having a relatively low ignition temperature, another type of zirconium metal powder having a relatively high ignition temperature and potassium perchlorate powder bonded together with a binder.

5. A flash lamp comprising a sealed container having an oxidizing atmosphere therein, a quantity of combustible material within said container, said combustible material consisting of substantially pure filamentary aluminum of a size corresponding to a diameter of the order of one mil, and ignition means within said container comprising an electrical energy translation element and a bead of fulminating substance associated therewith, said bead of fulminating substance containing the proportions of approximately 2.6 grams of one type zirconium metal powder having a relatively low ignition temperature, 2.6 grams of another type of zirconium metal powder having a relatively high ignition temperature, 4 grams of chemically pure potassium perchlorate powder, and 5 cc. of a one per cent solution of glue water.

6. A flash lamp as set forth in claim 1 wherein the relatively difficultly ignitable combustible material has a filamentary form.

7. A flash lamp as set forth in claim 1 wherein the relatively difficultly ignitable combustible material has a filamentary form and consists of substantially pure aluminum.

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