Sept. 2, 1941. R. LE R. KREIDLER 2,254,849

PHOTOFLASH LAMP

Filed Aug. 27, 1938

Fig. 1.

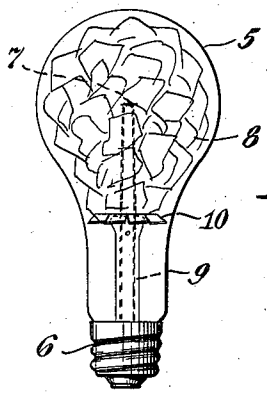


Fig. 3.

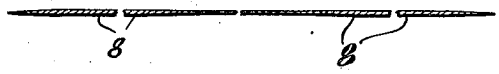


Fig. 2.

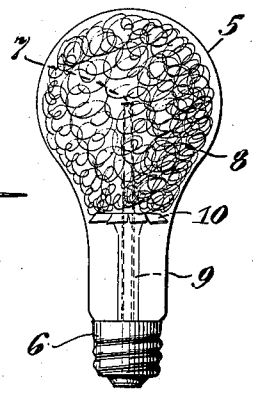


Fig. 4.

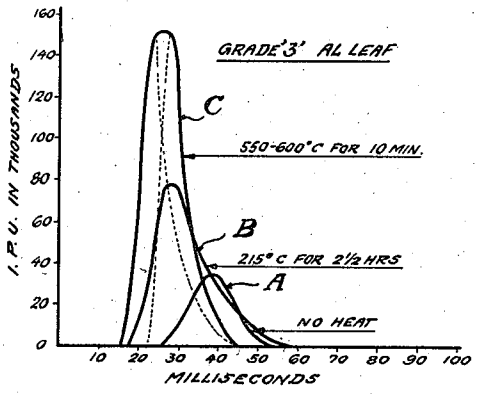
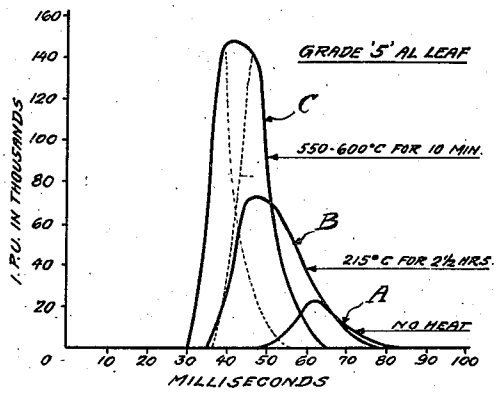


Fig. 5.



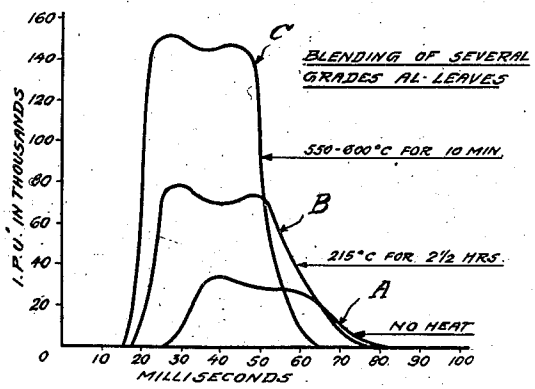


Fig. 6.

INVENTOR
R. L. KREIDLER.
BY J. W. Greenhowe
ATTORNEY

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PHOTOFLASH LAMP

Raymond Le Roy Kreidler, Bloomfield, N. J., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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4 Claims. (Cl. 67—31)

The present invention relates to photoflash lamps which are normally employed with cameras for the taking of photographs.

Lamps of this type are known to the art wherein a metal such as aluminum, magnesium or alloys thereof in the form of foil or wire are disposed in an oxidizing atmosphere within an envelope and ignited by the passage of an electric current through the lamp. Upon energization of the lamp, the foil or wire begins to burn until, after a fractional part of a second, complete combustion occurs with a rise in light intensity from zero to peak and then a decrease again to zero.

The rate of burning or combustion of the foil or wire is naturally dependent upon its physical characteristics such as weight, thickness, strains, etc. which in turn governs the light output of the lamp and particularly the duration of the period of peak intensity. Moreover, due to the mechanical difficulties in producing wire fine enough and foil thin enough to readily burn and ignite easily, the characteristics of photoflash lamps of the prior art have been rather definitely fixed and could not be modified at will.

For example, in lamps utilizing aluminum foil, the individual sheets are beaten as thin as possible, but even after such processing the sheets are somewhat thicker at the center than at the edges and possess mechanical strains which affect the thermal conductivity of the foil. Also the light given off by photoflash lamps employing foil are of comparatively short duration with a high peak intensity, making it somewhat difficult to synchronize complete opening of a camera shutter simultaneously with the moment of peak intensity from the lamp.

In the case of magnesium or aluminum wire mechanical difficulties are likewise present in that it is difficult to draw wire fine enough, as before mentioned, to readily burn and ignite easily. In addition, lamps employing magnesium wire have a longer period of peak intensity than do aluminum foil lamps, thus facilitating synchronization with a camera shutter; but in contradistinction to aluminum foil lamps, the intensity of magnesium wire lamps is much lower.

It is accordingly an object of the present invention to provide a photoflash lamp wherein the rate of burning of the light producing material and thus the intensity and duration of the flash can be controlled.

Another object of the present invention is the provision of a photoflash lamp employing a combustible material in the form of wire or foil from which cold working strains have been removed by annealing the material.

Another object of the present invention is the provision of a photoflash lamp wherein the combustible material is blended so as to possess a preselected combustion rate giving a desired period of peak intensity of illumination to facilitate synchronization of the photoflash lamp with a camera shutter.

A further object of the present invention is the provision of a photoflash lamp wherein the combustible material is annealed and beaten in such manner as to control its rate of combustion.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein:

Fig. 1 is an elevational view of a photoflash lamp constructed in accordance with the present invention wherein a metal foil of preselected characteristics is employed in order to control the combustion rate and the period of peak intensity of illumination.

Fig. 2 is an elevational view of a modification which the present invention may take and differs from that of Fig. 1 merely in the utilization of combustible material in the form of wire in lieu of foil as in Fig. 1.

Fig. 3 is a cross-sectional view of the combustible material, either in the form of wire or foil, treated in accordance with the present invention.

Fig. 4 is a graphic illustration depicting what has been termed one grade of combustible material in the form of foil or leaf showing the relationship of rate of combustion in milliseconds to international photographic units intensity at different periods of treatment.

Fig. 5 is a graphic illustration depicting another grade of combustible material showing the same relationship as that of the grade of Fig. 4, and

Fig. 6 is a graphic illustration depicting the relationship of rate of combustion in milliseconds to international photographic units intensity at different periods of treatment and wherein the combustible material as employed in the photoflash lamp is blended so as to give a controlled rate of combustion with attendant peak intensity.

Referring now to the drawing in detail, the photoflash lamp as shown in Fig. 1 comprises an envelope 5 provided with the usual screw base 6 to enable it to be disposed in a socket for supplying electrical energy thereto. An ignition element 7 is disposed interiorly of the envelope which, when energized, initiates combustion of the combustible material 8 in the form of metallic foil, such as aluminum leaf, in the presence of an oxygenic atmosphere within the envelope. The envelope is provided with a reentrant stem 9 through which the leading-in conductors for the igniter element are sealed and a baffle member 10 rests upon the stem to prevent the hot products of combustion from falling in

the vicinity of the seal which otherwise might cause explosion of the envelope. The lamp shown in Fig. 2 is substantially identical to that shown in Fig. 1 with the exception that the combustible material 8 in this modification is in the form of metallic wire, such as magnesium or the like.

Aluminum foil, as hereinbefore mentioned, is the most universally used combustible material in leaf form for photoflash lamps, while magnesium is customarily used in wire form. However, in the working of the foil into leaf form the foil is beaten as thin as it can be worked, but such process has always resulted in the individual leaves being thicker at the center than at the edges. The following table shows the variation in thickness of different grades of foil of the same dimensions, and since it is difficult to measure by any linear scale, thickness is given in milligrams per square inch for comparative purposes:

TABLE I

Leaf grade	Thickness in center	Thickness at edge	Total weight of leaf
	Mg./sq. in.	*Mg./sq. in.*	*Milligrams*
1	1.010	.732	20
2	1.137	.895	25
3	1.350	.975	28
4	1.63	1.300	41
4A	1.16	1.30	41
5	2.56	1.38	48
5A	1.48	1.46	48

It is well recognized that the rate of combustion of aluminum foil is dependent upon its thickness. Since such foil has heretofore been thicker in the center than at the edges, the greater portion of its cross-sectional area, when the leaves are folded into the envelope, is in close proximity to the igniter element which burns very slowly. This is due to the fact that the foil is so thin that it cannot be touched by human hands without deteriorating into a powder. Consequently, the sheets are picked up by friction on a stick and pushed or stuffed through a funnel and the neck of the envelope into the bulbous portion thereof which thus inherently folds over the edges of the sheet as the center is pushed into the envelope adjacent the igniter element. Experiments have shown that the rate of combustion and consequently the light output characteristics of a photoflash lamp may be controlled by beating the foil so that the center of the leaf is very thin, while the edge of the leaf can be much thicker, such as shown in Fig. 3.

This accordingly places the thin center portion of the leaf, when folded, in such position as to be in close proximity to the igniter element so that it is easily ignited and burns rapidly, while the thick portion burns more slowly which increases the duration of light output. Thus by controlling the thickness of the leaf the light output of the photoflash lamp may likewise be controlled.

For comparison purposes foil so beaten is shown in the foregoing table wherein it will be noted that grade 4A has been beaten in the center so as to be thinner than grade 4, although the edges are of the same thickness and the total weight of the leaf remains the same as grade 4. The same may be said of grade 5A which shows the center of the leaf to be considerably thinner than grade 5, while the edges have also been slightly increased in thickness over that of grade 5, although the total weight of grade 5 and 5A is the same.

In addition to controlling the light output characteristics by forming the sheets in the manner above described, tests have shown that heat treating of the foil or wire also controls such characteristics. For example, the following table indicates the effect of heat treatment on peak light output characteristics of the various grades (thickness) of foil:

TABLE II

Peak I. P. U. (international photographic units)

Leaf grade	Not heat treated	Heat treated 5 min. at 550°–600° C.
1	200,000	275,000
2	153,900	245,000
3	61,900	147,500
4	71,400	95,200
4A	30,000	86,000
5	18,900	200,000
5A	62,000	85,000
5B	0	15,400

It will be noted from the foregoing table that in each instance the peak intensity of each grade leaf is increased from 100% to 1000% or more by the expedient of heat treating which, as before stated, removes the cold working strains resulting in an increase in peak intensity. Moreover, the increase in peak intensity is controllable by the ratio of temperature and time combinations as shown by the following table of two grades of leaf of slightly varying thicknesses:

TABLE III

Peak I. P. U.

Leaf grade	Not heated	Leaf heated for 2½ hours at 215° C.	10 min. at 550°–600° C.
5	14,200	76,200	142,600
5	23,800	71,400	152,200
3	14,200	76,200	147,500
3	47,600	76,200	152,500

In each of the above grades, although originally and unheated, of appreciable difference in peak intensity, it will be observed that regardless of the temperature and period of heat treatment, the peak intensity is not only increased but the intensity is made substantially uniform for each period-temperature. Also, the peak intensity increases with increased temperature and inversely to the time period of treatment.

By reference to Fig. 4, wherein the abscissa represents time in milliseconds from closing of the electrical circuit until completion of the flash, and the ordinate represents international photographic units in thousands, the relationship of increase in peak intensity as controlled by heat treatment of one grade leaf will be noted. The curves shown, except as hereinafter noted, represent the maximum and minimum of one grade leaf, since there is naturally a slight variation between various leaves of the same grade.

In this figure the curve A represents a grade 3 leaf which has not been heat treated. As will be seen, a lapse of approximately 25 milliseconds occurs following energization of the lamp before any light is emitted due to combustion and a maximum of only approximately 38,000 i. p. u. peak intensity is obtained with the total period

of the flash lasting for approximately 30 milliseconds.

However, by heat treating this grade 3 leaf for 2½ hours at a temperature of 215° C., the peak intensity is increased, as shown by the curve B, to approximately 79,000 i. p. u. and since the flash begins at approximately 18 milliseconds and lasts until approximately 58 milliseconds, there is a substantial increase in lumens-seconds or light output as represented by the total area of the curve B. Again by increasing the temperature with an inverse variation in the time of heat treating, as shown by the curve C of Fig. 4, a still further increase in peak intensity results approximating 150,000 i. p. u. and the flash begins at approximately 15 milliseconds following energization of the lamp and lasts until approximately 45 milliseconds or a total time period of 30 milliseconds. Thus there is a still further increase in total light output or lumens-second as represented by the total area of curve C. It is also to be noted that the minimum and maximum peak intensity of a grade 3 leaf is shown in dotted lines in connection with curve C to depict the degree of variation due to slight differences in thickness, but such have not been shown in connection with curves A and B for purposes of simplicity.

Fig. 5 is similar in every respect to Fig. 4 with the exception that the curves represent a grade 5 leaf which, as will be noted from Table I, is thicker than that of grade 3, which accounts for a slightly lower peak intensity and a longer period of time before ignition and complete combustion.

In addition to controlling the light output characteristics of photoflash lamps by heat treatment of the aluminum foil, I have found that by blending the leaves the characteristics may be substantially controlled at will. The following table will serve to illustrate the effect of blending both on peak intensity as well as time lag to various points on the curve and duration of specific peak intensities:

TABLE IV

Peak i. p. u.

Leaf grade	Not heat treated	Heat treated 5 min. 550°–600° C.
1+2+3	107,000	231,000
1+4+5	33,300	229,000
1+3+3	59,500	185,600

Leaf grade	Milliseconds lag to—		Peak i. p. u.	Milliseconds duration at—	
	50M i. p. u.	Peak		50M i. p. u.	100M
1 (not heated)	17.0	20.6	85,000	7.18	------
2 (not heated)	20.6	23.5	162,000	9.5	5.23
1+2 (not heated)	24.6	27.4	71,500	8.36	------
1+3 (not heated)	18.8	21.1	62,000	5.50	------
1+4 (not heated)	19.2	22.6	56,500	2.28	------
1 (not heated) +3 (heated)	18.2	22.4	131,000	9.64	2.5
1 (not heated) +4 (heated)	22.2	25.1	87,300	6.6	1.07
2+3 (both heated)	18.3	21.4	157,000	9.0	5.27

Also in Fig. 6 the result of a blending of various grades of aluminum leaf is graphically shown. In the particular instance illustrated in Fig. 6 the various curves have been compiled from grade 3 and grade 5 as shown in Figs. 4 and 5. Hence, curve A represents the results obtained by utilizing unheated grade 3 and 5, curve B grade 3 and 5 heated for 2½ hours at 215° C. and curve C grade 3 and 5 leaf heated for 10 minutes at 550°–600° C.

It will thus be seen from the foregoing that the rate of combustion of aluminum foil and consequently the light output characteristics of a photoflash lamp may be controlled first by beating the individual sheets so that they are thinner at the center than at the edges. Since the thinner portion is disposed in close proximity to the igniter element when the leaves are folded in the envelope, they are easily ignited and burn very rapidly, while the thicker edges burn more slowly, which increases the duration of light output.

Secondly, the light output characteristics may be further controlled by heat treating the leaves over a comparatively wide temperature range in inverse proportion to the time period of treatment. Moreover, by blending the various grades of leaf, each of which have been given preselected light output characteristics, a photoflash lamp can be made in accordance with the present invention wherein the light output characteristics can be controlled substantially at will so that the lamp may be readily synchronized with any camera shutter. It is to be understood that although the utilization of aluminum foil as the combustible material has been described in detail as the preferred embodiment of the present invention, it nevertheless applies with equal facility to aluminum or magnesium in wire form which can likewise be so drawn as to have portions of smaller diameter than other portions, heated, treated and blended.

Although two modifications of the present invention have been shown and described, other embodiments thereof may be made without departing from the spirit and scope of the appended claims.

I claim:

1. A photoflash lamp comprising a sealed envelope provided with a gas containing oxygen, an ignitor element in said envelope, and combustible material disposed in said envelope in close proximity to said ignitor element and combustible with the oxygen in said envelope when said ignitor element is supplied with electrical energy to produce a momentary intense light, said material having a reduced cross-section in the center thereof thinner than the edge portions, and said material being disposed in the envelope, and folded to position the greater portion of the thinned area thereof in closer proximity to the ignitor element than the thicker edge portions of said material.

2. A photoflash lamp comprising a sealed envelope provided with a gas containing oxygen, an ignitor element in said envelope, and combustible material disposed in said envelope in close proximity to said ignitor element and combustible with the oxygen in said envelope when said ignitor element is supplied with electrical energy to produce a momentary intense light, said material comprising a plurality of metallic foil sheets having a thin center portion of less thickness than the edges thereof and devoid of cold working strains to increase the peak intensity and combustion rate of the individual sheets, and said individual sheets having different preselected intensity and combustion characteristics and blended to impart to the material a desired peak intensity and rate of combustion.

3. The method of controlling the rate of combustion and increasing the peak intensity of a photoflash lamp charge which consists in reducing the thickness of the center of a plurality of foil sheets some of which are thicker than others, heat treating such sheets for a preselected time period and at a preselected temperature to remove cold working strains and impart a predetermined peak intensity and combustion rate characteristic to each individual sheet, and blending the heat treated foil sheets of different characteristics in composing the charge to produce a charge having a desired combustion rate and intensity characteristics.

4. The method of controlling the rate of combustion and increasing the peak intensity of a photoflash lamp charge which consists in reducing the thickness of the center of a plurality of foil sheets some of which are thicker than others, heat treating such sheets for a preselected time period and at a preselected temperature to remove cold working strains and impart a predetermined peak intensity and combustion rate to each individual sheet, blending the heat treated foil sheets of different characteristics in composing the charge to produce a charge having a desired combustion rate and intensity characteristic, and positioning the thin-center portions of the sheets in closer proximity to the ignitor element of the lamp than the thicker edge portions thereof.

RAYMOND LE ROY KREIDLER.