Dec. 22, 1942. R. D. EATON 2,305,609

FLASH LAMP

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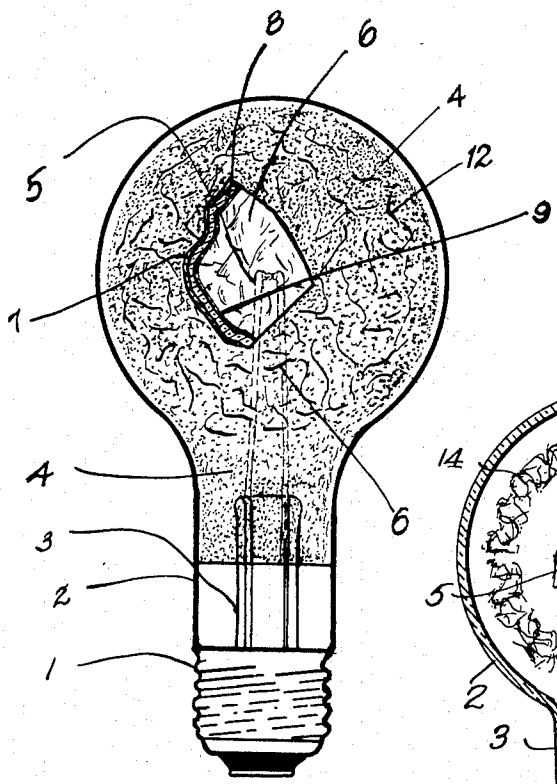
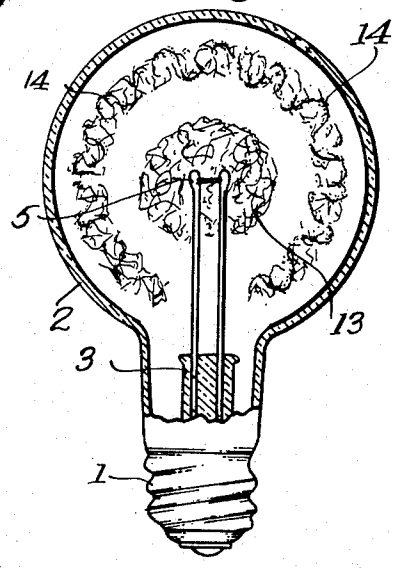



Fig. 1.

Fig. 4.



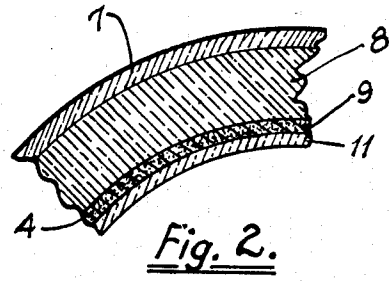




Fig. 2.

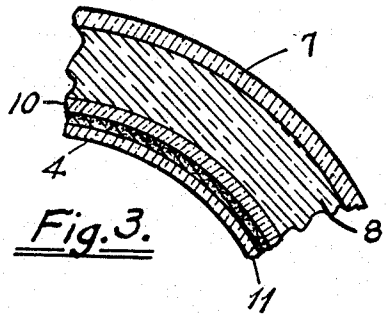



Fig. 3.

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## FLASH LAMP

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9 Claims. (Cl. 67—31)

This invention relates to flash lamps intended for use for photographic purposes and has for its object the provision of a lamp of this character which will be especially useful in color photography.

Photographic flash lamps usually comprise a sealed transparent bulb in which is enclosed a readily combustible material, together with a gaseous substance which, upon ignition, enters into a reaction with the combustible material to produce the emission of actinic light. The combustible materials which are usually employed in lamps of this character are aluminum and magnesium, in the form of either very thin foil or very fine wires. These materials while suitable for ordinary uses, do not give satisfactory results with the present day high-speed panchromatic film and plates. This is because under ignition conditions such materials produce a preponderance of radiation in the ultra-violet, blue-green and infra-red regions of the spectrum. This means that there is a gap in the spectrum for these materials in the green, yellow, orange and red regions and as a result of such gaps photographers, who use the present day high-speed panchromatic film and plates whose spectrum sensitivity covers the entire visible spectrum, are not able with the usual flash lamp to obtain satisfactory results in color photography.

In accordance with the present invention, the combustible material is not used as a source of visible light, as in the usual flash lamp, but as a source of ultra-violet light which is utilized to activate a secondary light emitting material or emitter capable of supplying, as a result of such activation, a radiated light having the required rays to enable it to cover all regions in the visible spectrum and thereby making it possible to produce satisfactory color photographs under conditions which would otherwise be impossible because of the lack of certain rays of the visible spectrum. The secondary emitter contemplated by this invention is a material of a fluorescent or phosphorescent nature, such as, the products of willimite, silicates, sulfides, tungstates, etc., and may be incorporated in the lamp in a manner which is best suited for the purposes for which the lamp was devised. By choosing various fluorescent materials, either individually or as mixtures, it is possible to reproduce any desired color of radiation, for example, the fluorescent materials may be mixed in such manner that they simulate daylight or any specified region of the spectrum. The fluorescent or phosphorescent material may also be so chosen for its "lag" or "time of glowing" characteristics and these may be altered to control long or short exposure times, thus making it possible to provide a flash lamp whose "time of flash" may be lengthened over a considerable period and controlled entirely by choosing the proper phosphorescent material.

It is believed that the purposes and advantages of the invention will be better understood after a perusal of the following description, read in connection with the accompanying drawing, in which Fig. 1 is an elevational view of a flash lamp embodying the invention, the bulb or envelope portion of the lamp being partially broken away to demonstrate its construction more clearly; Fig. 2 is a sectional view of the broken portion of the bulb illustrated in Fig. 1; Fig. 3 is a view similar to Fig. 2 but illustrating a modified form of the invention and Fig. 4 is an elevational view of a lamp, partly in section, showing another modification of the invention.

In the drawing, the reference character 1 indicates the usual threaded end or plug of a flash lamp 2. Contained within the neck of the lamp 2 is the usual filament-supporting glass stem 3 from which the filament 5 extends into the bulb portion of the lamp. The interior of the lamp contains a primary emitter capable of radiating under certain conditions ultra-violet rays in sufficient intensity to activate the secondary emitter which will hereinafter be more fully described. The primary emitter may include gaseous material which fills the interior of the lamp and which is adapted, upon ignition, to enter into reaction with filaments or fine strips of combustible material which are generally indicated in Fig. 1 of the drawing by the reference character 6. It is preferred that the gaseous substance be oxygen and that the combustible material be composed of either caesium, aluminum, magnesium, or mercury or similar materials or a mixture of such materials, as they have been found to be the best ultra-violet emitters and are capable, when ignited with the oxygen, of emitting the ultra-violet light in sufficient intensity to excite the fluorescent or phosphorescent material. In view of the fact that this source of ultra-violet light is very concentrated and would be harmful to operators or photographers if allowed to escape through the walls of the flash lamp, the glass of the lamp should preferably be opaque to ultra-violet light or capable of absorption to some extent of this spectrum region. Preferably also, in order to prevent shattering of the glass as a result of the combustion of such

materials, the glass of the lamp should be coated with a protective coating 7 of a suitable lacquer.

The secondary emitter or light emitting material to be activated by the ultra-violet light from the primary emitter is composed of a fluorescent or phosphorescent material which will be hereinafter referred to simply as a fluorescent material. The light emitting material may be composed of either zinc ortho-silicate, calcium tungstate, magnesium tungstate, zinc beryllium silicate, cadmium silicate, cadmium borate, zinc sulphides, or other fluorescent or phosphorescent materials capable of being activated by the ultra-violet primary emitter to produce the results desired or by any mixture of such substance. The light emitting material may be incorporated in the lamp in any suitable manner and preferably is applied as a coating on the interior surfaces of the lamp, such coating being indicated generally in Fig. 1 of the drawing by the reference numeral 4. The coating 4 of light emitting material is placed on the interior walls of the lamp in such a manner that the maximum fluorescent light is emitted. This requirement necessitates that the material be used as a thin coat, preferably a coating equivalent to 50% transmission of light. This enables light to be emitted from the interior portions of the coating as well as the exterior surfaces thereof. The coating of light emitting material is applied by the use of a suitable binder, such as, lacquer, sodium silicate, ethyl silicate, boro-phosphate, etc. It is preferred that the fluorescent material be contained in a lacquer solution in which is incorporated a selective dye capable of transmitting ultra-violet light while yet preventing all or a relatively small portion of the light from the combustible material from penetrating through the walls of the lamp, such as, for example, any panchromatic dye (pinacriptoi green). By this construction only the activating ultra-violet light is allowed to pass or to be radiated from the lamp. A coating of this character also possesses the advantage that it functions as a heat insulator to protect the glass of the lamp against failure by the action of the products of the combustion of the oxygen and aluminum. A coating of this character is indicated more clearly in Fig. 2 of the drawing, in which the reference numeral 9 designates the lacquer binder for the fluorescent material. In Fig. 3 of the drawing, the coating of fluorescent material 4 may be applied also by first coating the interior of the lamp with a layer 10 of lacquer and then applying to such layer the coating 4 of fluorescent material. This construction also functions as a protection for the glass of the lamp, which is indicated in the drawing by the reference character 8. Preferably also the fluorescent material is covered by a thin protective coating of lacquer 11 which is transparent to ultra-violet rays, so as to prevent molten metal from the combustible materials splattering on the fluorescent material and thereby diminishing its phosphorescent or luminescent action. This protective coating 11 also prevents the molten combustible material from striking the lamp and causing it to crack, thereby protecting both the operator and fluorescent material.

It will be evident from the foregoing, that the ultra-violet light of high intensity which is emitted by the primary emitter, namely, combustible material, and which itself is in the non-visible portion of the spectrum, activates or excites the secondary emitter or the fluorescent material in the coating 4 to produce a fluorescent flash of light which contains light rays covering the range of the visible spectrum. By choosing particular fluorescent materials or mixtures of such materials, it is possible to produce any desired visible color or radiation. The mixtures may be such that they simulate daylight or any specified region of the spectrum. Thus it is possible to simulate any desired condition under which a colored film may be taken. Due to the fact that such materials, particularly those materials which are predominantly phosphorescent in nature, have a "lag" or "time of glowing" characteristics which may be altered to control long or short exposure times, it is possible to make a flash lamp whose "time of flash" may be predetermined and controlled entirely by choosing the proper phosphorescent material. The after glow effects of such materials may thus be controlled to last for a considerable time after the combustible materials have gone out or ceased to exit. This may be accomplished by varying the amount of chemical activator in the material. Thus zinc sulphide, which has a relatively long "lag" of approximately one-tenth of a second, can be given a lag of up to ten minutes by varying the amount of chemical actuator to be incorporated in the material, in a manner well known to those skilled in the art. This is of considerable importance where the flash lamp is to be utilized, for example, in aero flares whose use require that they give light for considerably longer periods than the ordinary flash lamp.

It will be seen that the flash lamp of this invention differs sharply from the usual flash lamp which depends for its visible light upon the combustion of magnesium or the like and a gaseous substance, in that it includes two light emitters, namely, a primary emitter capable of radiating ultra-violet rays of the required intensity and a secondary emitter capable of being activated by the ultra-violet rays to radiate rays in the visible spectrum. Thus whereas the combustion products in the usual flash lamp are utilized as the light source, the secondary emitter of the instant flash lamp is utilized as the light source. Furthermore, while there is a gap in the visible spectrum radiated by the usual flash lamp which makes it unsatisfactory for color photography, the instant lamp, by controlling the composition of the fluorescent material of the secondary emitter, can produce lighting effects suitable for any required condition of colored photography. In other words, any desired color radiation under which a colored film might be taken can be simulated and the time of glow can be controlled and be maintained for substantial periods after the primary emitter has ceased to radiate. Furthermore, a greater intensity of light is obtained with the instant lamp than with the usual flash lamp because of the utilization of the ultra-violet light to produce the required results. It has also been found that a lower gas pressure can be utilized in the lamp of this invention to obtain satisfactory results than is utilized in the usual flash lamp. For example, satisfactory results are obtained with a gas pressure corresponding to approximately 50 mm. of mercury pressure, which is far below that of the gas in the usual flash lamp. The secondary emitter is also a very good heat insulator and therefore reduces to a considerable extent the danger of the glass in the lamp shattering as a result of the stresses created by the combustion gases in the lamp. Furthermore, as ultra-violet light travels very fast compared with

the velocity of incandescent gases, such gases do not reach the bulb wall before the ultra-violet light does, thereby assuring a perfect operation of the secondary emitted because it will not be dirty during the time it is activated.

While I have hereinabove described a preferred embodiment of the invention, it will be evident that modifications and changes may be made without departing from the spirit of the invention, as will be well understood by those familiar with the art. For example, instead of coating the glass bulb of the lamps with the material, the fluorescent material may be suspended or carried on fibres of glass, rayon or metal wires for the purpose of eliminating the loss of light through the 50% transmission wall of the bulb. A lamp of this construction is illustrated in Fig. 4 of the drawing, in which the threaded plug, bulb or envelope, filament-supporting stem and filament have been given the same reference designations as the same parts bear in Fig. 1 of the drawing. In this lamp, as in the previously described lamp, the primary emitter is composed of combustible material which is capable of reacting with the gas within the bulb to produce ultra-violet light in sufficient intensity for the intended purposes and which is designated generally by the reference numeral 13. Surrounding the combustible material 13 is a mass 14 composed of glass, rayon or metal filaments or strips which have been coated with the fluorescent material. It is to be understood also that it is within the contemplation of the invention that the mass 14 may be constituted of transparent foil which has been coated with the fluorescent material. An advantage of this construction is that the light is enabled to be emitted from all sides of the fluorescent material. The material carrying the fluorescent material in this construction also aids as a cushion to the shock presures caused by combustion taking place within the envelope and thereby protects the lamp. The amount of light emitted by the secondary emitter of the instant lamp will be directly proportional to the amount of ultra-violet light emitted by the primary emitter. Instead of the inorganic fluorescent materials mentioned hereinabove, fluorescent inorganic dyes may be used to equal advantage. In addition, they have the advantage that the time of flash of such dyes may be readily controlled because they are usually destroyed by high temperatures and the time of flash can be controlled by the time it takes to destroy such dyes. Ultra-violet light transmitting bulbs or envelopes may also be utilized and in this case the fluorescent material may be coated on the outside of the bulb.

I claim:

1. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum, primary combustible emitter means contained in said envelope and composed of combustible material and a gas capable of reacting with the same to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and secondary emitter means composed of fluorescent material, which is capable of being activated by the ultra-violet light from the primary combustible emitter means, to radiate light rays of the visible spectrum.

2. A flash lamp comprising a bulb made of a material capable of transmitting at least some rays of the spectrum, primary combustible emitter means contained in said bulb and composed of combustible material and a gas capable of reacting with the same to produce a sudden momentary supply of ultra-violet light of sufficient intensity to activate secondary emitter means, and secondary emitter means composed of fluorescent material which is capable of being activated by the ultra-violet light from the primary combustible emitter means to radiate light rays of the visible spectrum, said secondary emitter means being applied to the surfaces of said bulb in the form of a coating.

3. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum, primary combustible emitter means contained in said envelope and composed of combustible material and a gas capable of reacting with the same to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and secondary emitter means composed of material substantially inert to the ultra-violet light and positioned to intercept the rays of ultra-violet light emitted from said primary emitter, said material being coated with a fluorescent substance which is capable of being activated by the ultra-violet light from the primary emitter means to radiate light rays of the visible spectrum.

4. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum and containing primary combustible emitter means composed of a combustible material selected from the group consisting of caesium, aluminum, magnesium or mercury, and a gas capable of reacting with such material to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and a secondary emitter means composed of a fluorescent material selected from the group consisting of zinc ortho-silicate, calcium tungstate, magnesium tungstate, zinc beryllium silicate, cadmium silicate, cadmium borate, zinc sulphides or a fluorescent dye capable of being activated by the ultra-violet light to radiate light rays of the visible spectrum.

5. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum, primary combustible emitter means contained in said envelope and composed of combustible material and a gas capable of reacting with the same to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and secondary emitter means composed of fluorescent material capable of being activated by the ultra-violet light to radiate visible light rays and of a composition to reproduce a predetermined color of radiation for a predetermined time.

6. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum, primary combustible emitter means contained in said envelope and composed of combustible material and a gas capable of reacting with the same to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and secondary emitter means composed of fluorescent material capable of being activated by the ultra-violet light to radiate visible light rays and of a composition to reproduce such rays for a predetermined period time lag or afterglow after the primary emitter has been extinguished.

7. A flash lamp comprising an enclosing envelope made of a material capable of transmitting at least some rays of the spectrum, combustible primary emitting means contained in said envelope and composed of combustible material and a gas capable of reacting with the same to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, and secondary emitter means in the form of a coating applied to the envelope, said coating being composed of a fluorescent material capable of being activated by the ultra-violet light from said primary emitter to radiate light rays of the visible spectrum and capable of acting as a heat insulator to prevent shattering of the envelope during the use of the lamp.

8. A flash lamp comprising an enclosing envelope composed of a material opaque to ultra-violet light but capable of transmitting visible light rays, primary emitting means contained in said envelope composed of a combustible material and a gas capable of reacting with said substances to produce a sudden and momentary supply of ultra-violet light in sufficient intensity to activate secondary emitter means, said gas being contained in said envelope at a pressure of approximately from one-quarter to one-half of an atmosphere to produce a gas atmosphere within the envelope that is very transparent to ultra-violet light and thereby reducing the light filtering action of the gas to a minimum, and secondary emitting means in the form of a coating applied to the interior surfaces of said envelope, said coating being composed of fluorescent material capable of being activated by the ultra-violet light from said primary emitter to radiate light rays of the visible spectrum.

9. A flash lamp such as is defined in claim 1, in which said secondary emitter means has a predetermined ultra-violet light saturation to control the light intensity output of the lamp.

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