United States Patent [19]

Chitayat

[11] **3,794,422**

[45] **Feb. 26, 1974**

[54] **METHOD AND APPARATUS FOR PHOTOGRAPHING BY ARTIFICIAL ILLUMINATION**

[76] Inventor: **Anwar Chitayat,** 8 Gilbert Ln., Plainview, N.Y. 11803

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[52] **U.S. Cl.** **355/67,** 95/11.5, 331/94.5

[51] **Int. Cl.** **G03b 27/76**

[58] **Field of Search** 95/11.5; 331/94.5; 355/67

[56] **References Cited**

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Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard A. Wintercorn
Attorney, Agent, or Firm—Joel Halpern

[57] **ABSTRACT**

This invention relates to method and apparatus for simultaneously photographing near and distant objects by means of artificial illumination so as to obtain substantially uniform reflected illumination from such objects on the film of the camera. The invention resides broadly in a greater attenuation of the reflected light returned to the camera from the near objects than from the distant objects.

15 Claims, 21 Drawing Figures

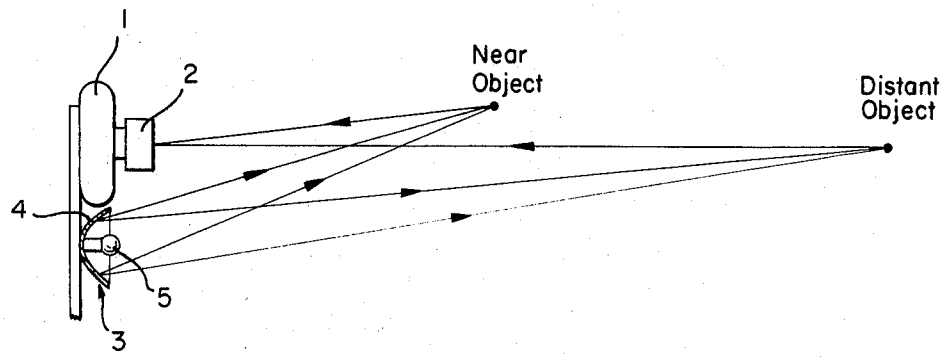
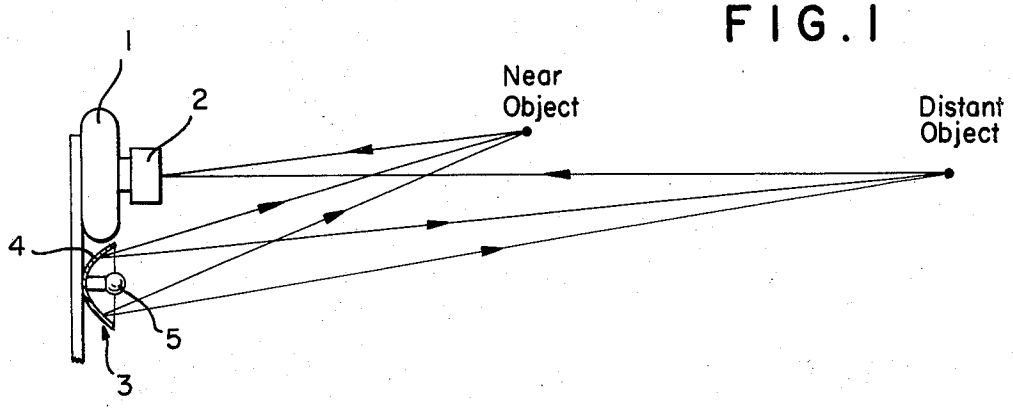


FIG. 1



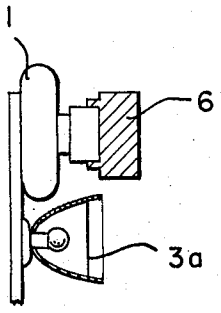


FIG. 2

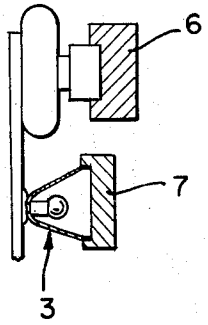


FIG. 3

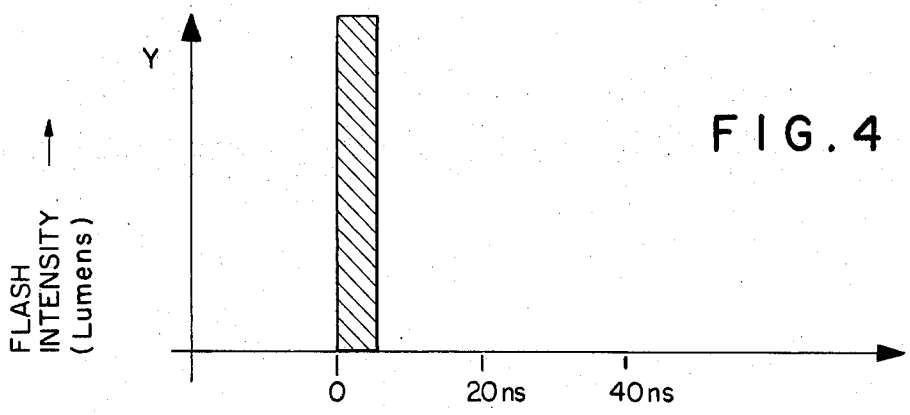


FIG. 4

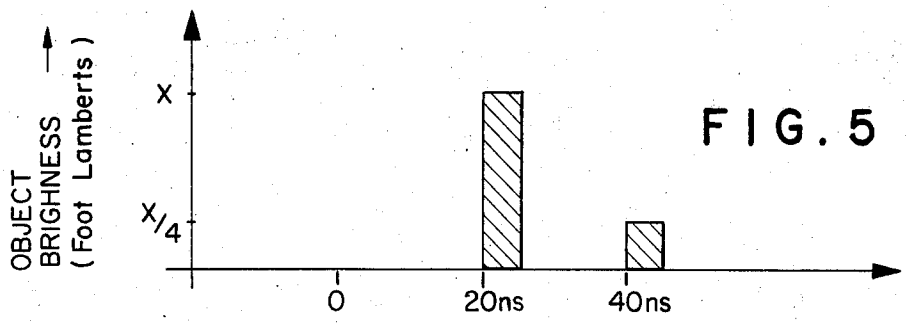
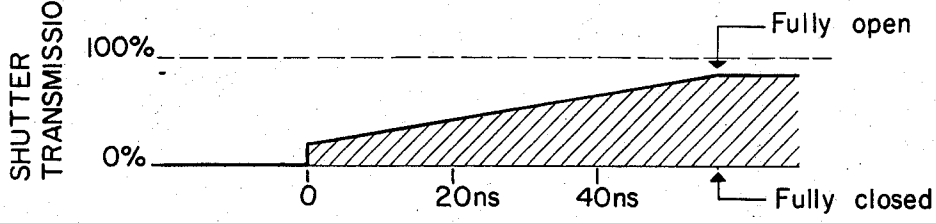


FIG. 5

FIG. 6



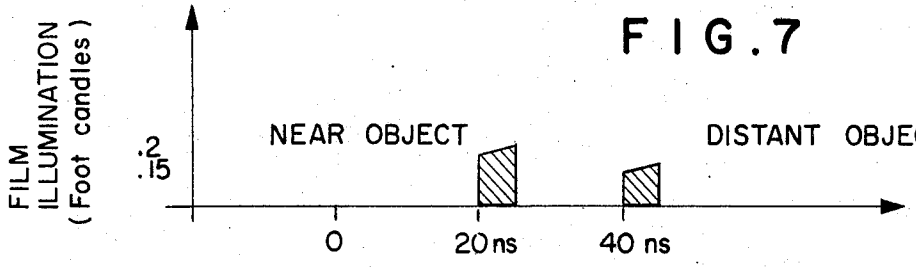


FIG. 7

FIG. 8

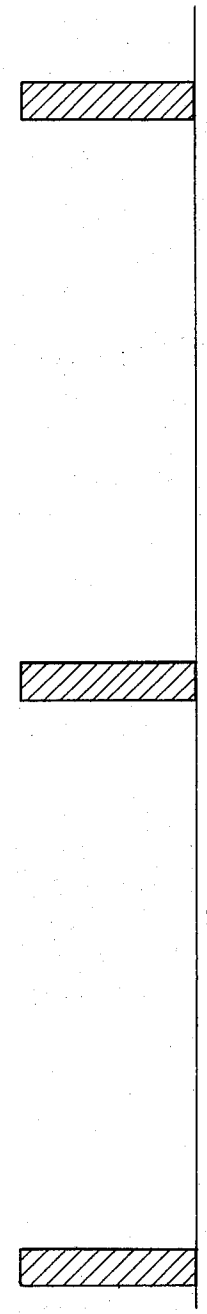


FIG. 9

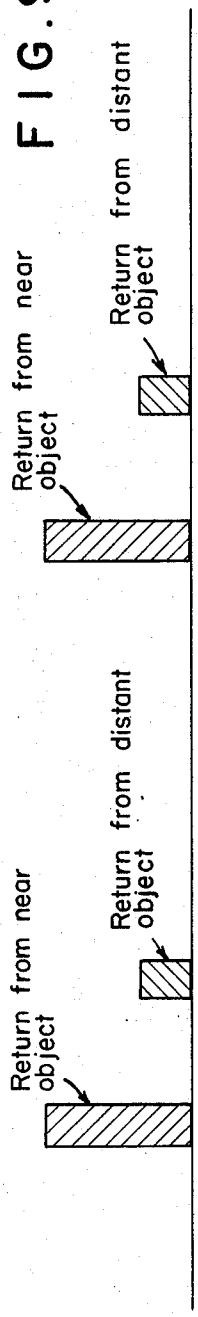


FIG. 10

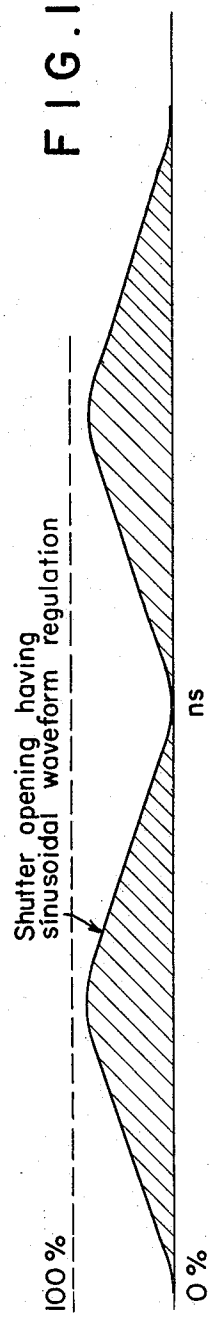


FIG. 11

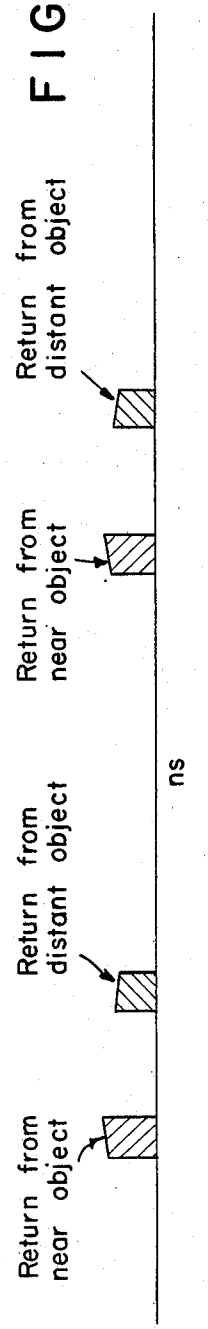
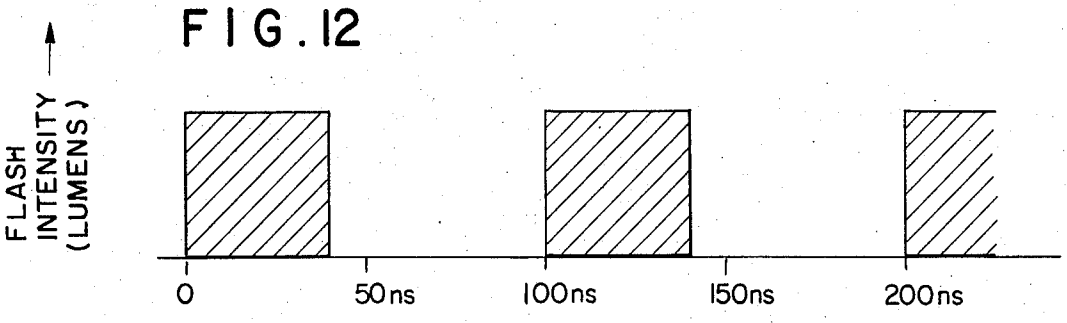


FIG. 12



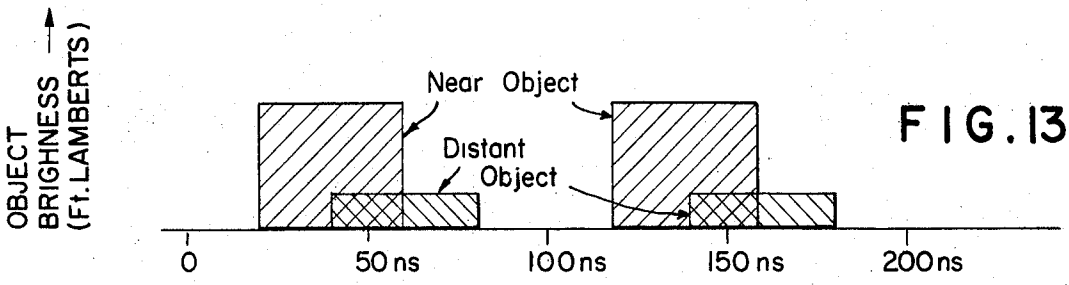


FIG. 13

FIG. 14

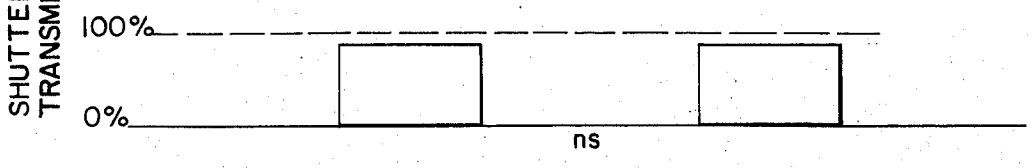


FIG. 15

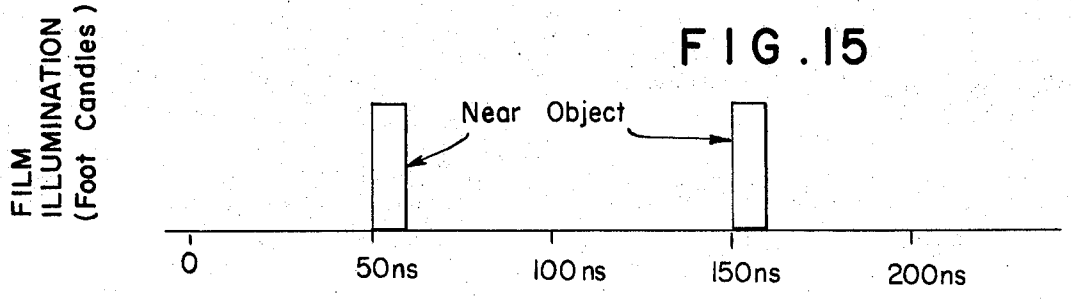


FIG. 16

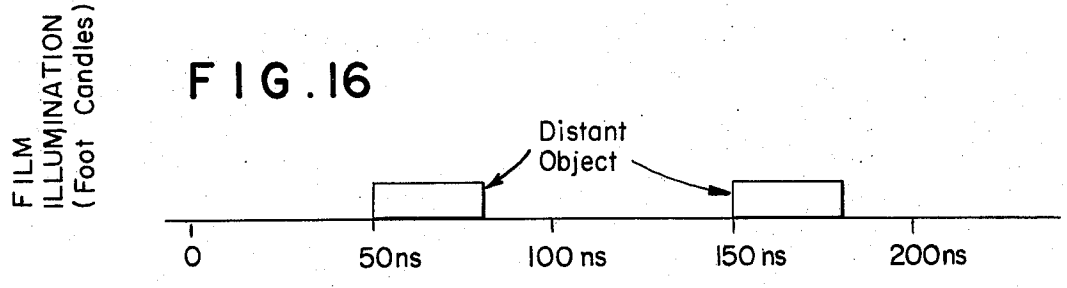
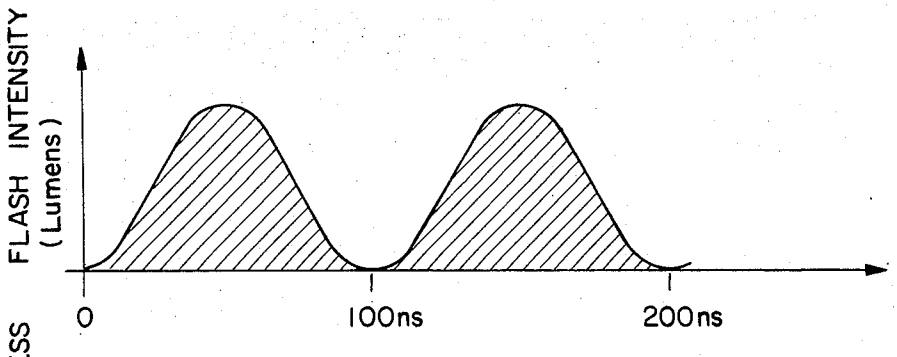


FIG. 17



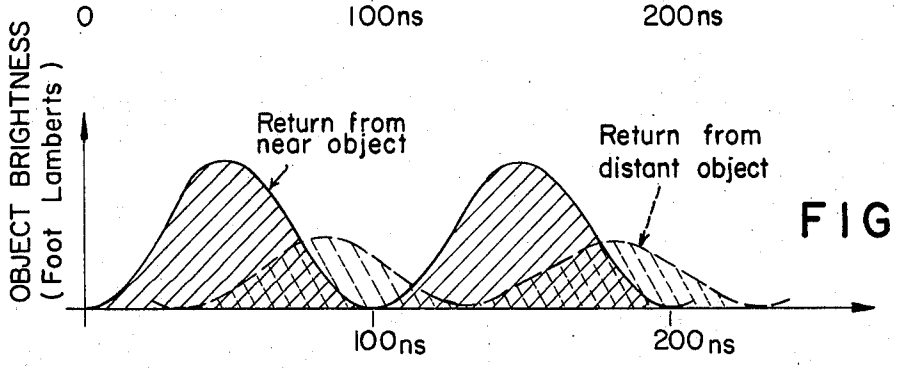


FIG. 18

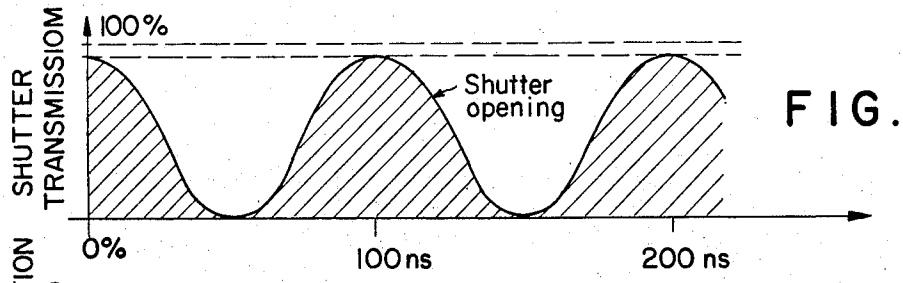


FIG. 19

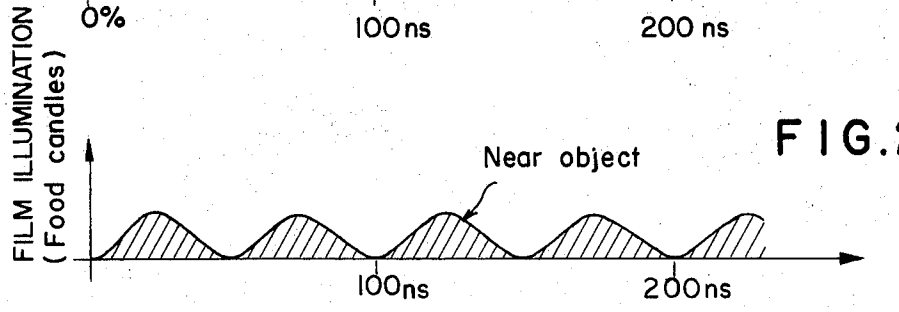
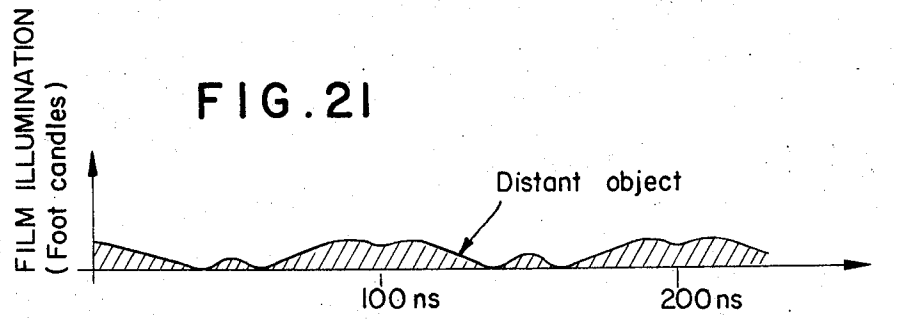


FIG. 20

FIG. 21



METHOD AND APPARATUS FOR PHOTOGRAPHING BY ARTIFICIAL ILLUMINATION

The present invention relates to photography by artificial illumination, and more particularly to method and apparatus for photographing near and distant objects simultaneously under the influence of such light so as to provide for substantially uniform reflected illumination from said objects upon the film of the camera.

The desirability of taking photographs with flash cameras or by means of flood lamps or other known artificial lighting has long been appreciated, and the art is already in an advanced state of technology. Nevertheless, it has been well recognized that one of the fundamental problems which has thus far defied solution is the apparent inability to compensate for the substantially different brightness values of the images projected upon the film of the camera representative of the near and distant objects being simultaneously photographed.

Lacking any system of compensation the result is a photograph where near objects tend to be overexposed whereas the more distant objects tend to be underexposed. Attempts have been made to compensate for this shortcoming in flash camera apparatus such as by providing for synchronization of the flash and shutter so that the correct degree of exposure can be obtained for objects at a specific distance. However, when proper exposure is secured for near objects the distant objects will tend to be underexposed, and vice versa, when proper exposure of the distant objects is attained the near objects will tend to be overexposed. Thus, no progress has been made towards a solution of the problem dealt with by the present invention.

One system existing heretofore for the synchronization of the flash and shutter, and which exemplifies the approach of the prior art, is disclosed in U.S. Pat. No. 3,294,002 granted Dec. 27, 1966 to Alexandre Vitkine. The patentee offers no suggestion whatever for simultaneously obtaining the correct exposure for both near and distant objects so as to make possible a photograph in which all objects within a desirable range from the camera possess substantially uniform brightness.

It is, therefore, one object of the invention to provide a photographic method and apparatus whereby near and distant objects which are simultaneously photographed under artificial light possess substantially uniform exposure values.

It is another object of the invention to provide method and apparatus for simultaneously photographing near and distant objects under artificial light in which the light source and the shutter of the camera are so synchronized, and the shutter so regulated, that the near and distant objects have their images produced upon the film of the camera with substantially uniform intensity of illumination.

It is still another object of the invention to provide flash photographic method and apparatus in which near and distant objects are simultaneously photographed under modulated lighting and at a progressively changing shutter transmission synchronized with the light source such that the images of the near and distant objects produced upon the film of the camera possess substantially uniform intensity of illumination.

It is yet another object of the invention to provide flash photographic method and apparatus in which near and distant objects are simultaneously photographed under such conditions that the reflected light from said objects is regulated so as to produce a photograph in which the near and distant objects all possess correct exposure.

According to the present invention there is provided a method for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images upon the film of a camera having substantially uniform brightness values, comprising regulating the shutter of said camera in predetermined synchronization with the actuation of the source of illumination so as to effect a greater attenuation of the reflected light returned to the camera from the near objects than from the distant objects.

According to the present invention there is also provided apparatus for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images upon the film of a camera having substantially uniform brightness values, comprising a camera having a shutter, a source of artificial illumination, and means for regulating said shutter in predetermined synchronization with the actuation of said source of illumination so as to effect a greater attenuation of the reflected light returned to said camera from the near objects than from the distant objects.

In order that the invention may be more fully comprehended it will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. **1** is a schematic representation of conventional flash camera apparatus;

FIG. **2** is a schematic representation of a first embodiment of the invention;

FIG. **3** is a schematic representation of a second embodiment of the invention;

FIG. **4** is a plot of a single pulse of light output vs. time;

FIG. **5** is a plot of reflected or diffused light from near and distant objects returned to the shutter of the camera in accordance with the generation of illumination as shown in FIG. **4** and not employing the concept of the invention;

FIG. **6** is a plot of shutter actuation vs. time in accordance with the concept of the invention;

FIG. **7** is a plot of reflected light from near and distant objects returned to the film of the camera utilizing the shutter control depicted in FIG. **6**;

FIG. **8** is a plot of light output from a series of pulses vs. time;

FIG. **9** is a plot of reflected light from near and distant objects returned to the shutter of the camera in accordance with the generation of illumination as shown in FIG. **8** and not employing the concept of the invention;

FIG. **10** is a plot of sinusoidal shutter actuation vs. time in accordance with the concept of the invention;

FIG. **11** is a plot of reflected light from near and distant objects returned to the film of the camera utilizing the shutter control illustrated in FIG. **10**;

FIG. **12** is a plot of light output from a modulated long duration pulse;

FIG. **13** is a plot of reflected light from near and distant objects returned to the shutter of the camera in accordance with the generation of illumination as shown

in FIG. 12 and not employing the concept of the invention;

FIG. 14 is a plot of shutter actuation of the square wave-form type in accordance with the concept of the invention;

FIG. 15 is a plot of reflected light from a near object returned to the film of the camera utilizing the shutter control shown in FIG. 14;

FIG. 16 is a plot similar to that of FIG. 15 for the reflected light returned to the film of the camera from the distant object;

FIG. 17 is a plot of light output from a light source which is modulated by a sinusoidal wave-form;

FIG. 18 is a plot of reflected light from near and distant objects returned to the shutter of the camera in accordance with the generation of illumination as shown in FIG. 17 and not employing the concept of the invention;

FIG. 19 is a plot of sinusoidal wave-form shutter actuation vs. time in accordance with the concept of the invention;

FIG. 20 is a plot of reflected light from a near object returned to the film of the camera utilizing the shutter control shown in FIG. 19; and

FIG. 21 is a plot similar to that of FIG. 20 for the reflected light returned to the film of the camera from the distant object.

Referring to FIG. 1 of the accompanying drawings, it will be seen that conventional artificial lighting means may cmprise a camera 1 having a shutter 2, flash illumination means 3 generally including a light reflector 4 and flash bulb means 5. Where desired, means may be provided (not shown) for automatically controlling the flash illumination or shutter duration in order to obtain the proper exposure for an object at a particular distance from the camera. It will be observed that the light output at the flash propagates waves which travel to both the near and distant objects and are thence reflected back to the shutter of the camera.

The present invention is predicated upon the utilization of two basic principles as incorporated in two well known formulae. However, these principles are combined in a unique manner in order to achieve the objectives of the invention heretofore considered unattainable. Specifically, it is known to take t units of time for emitted light to travel from a flash means of a camera to an object and back to the shutter of the camera. This period of time t is determined by the first formula: $t=2d/v$ where v is the velocity of light and d is the linear distance between the camera and the object. This time is of the order of 2×10^{-8} seconds per meter of object distance.

The second principle is incorporated in the formula $I=K/d^2$ where I is the intensity of illumination measured generally in foot-candles, K is a constant dependent upon the particular flash lamp and reflector employed, and d is the flash-to-object distance. As will be noted, the illumination reaching the object is inversely proprotional to the square of the distance. Thus, at twice the distance one obtains only one fourth of the illumination. It becomes apparent, therefore, that the images formed upon the film of the camera will possess differing brightness values dependent upon whether such images are formed by the reflected light from near or distant objects.

It has been found that the brightness values of all images formed upon the film of the camera can be made uniform by attenuating the reflected light from the near objects as hereinafter set forth.

In FIG. 2 of the drawings there is shown a camera 1 provided with an electro-optic shutter 6. A shutter of this character is considered essential to the invention since the attenuation of reflected light must be carried out within a time span measured in nanoseconds, and conventional mechanical shutters are not capable of meeting such time limitations. Although FIG. 2 depicts the flash illumination means 3a as being a modulated source, other light sources are contemplated. For example, a laser may be employed, or an electronically modulated light source may be used. Further, the electro-optic shutter 6 may be made integral with the camera or it may be in the form of an attachment thereto.

FIG. 3 shows a modification of the apparatus illustrated in FIG. 2 in that an electro-optic modulator 7 is utilized with flash illumination means 3 in order to provide the desired modulation of light. It is to be understood by those skilled in the art that various types of light modulators are readily available on the market such as Pockels cells and Kerr cells manufactured by Lasermetrics Inc. of Rochelle Park, New Jersey, and laser modulators such as manufactured by Datalight Incorporated of Bloomfield, Connecticut. The present invention is not limited to the use of any particular type of light modulating device.

In order to more fully appreciate how this invention has overcome the aforementioned problem with exposure reference is now made to FIG. 4 of the drawings which plots the output of a single pulse of light. A substantial portion of the total light generated travels to both the near and distant objects within the field of the camera, and a significant portion thereof is reflected back to the camera. As shown in FIG. 5, the light reflected back to the camera from the near object has taken one half the time as that of the light being reflected back from the distant object. Its intensity, therefore, as may be computed from the second formula set forth above, is four times as great as that of the reflected light from the distant object.

In accordance with one embodiment of this invention, and as shown in FIG. 6, the reflected light from the near object is attenuated by regulating the shutter opening such that it is only partially open initially while the reflected light from the near object is beginning to reach the shutter, whereas it is gradually and progressively opened wider. Thus, while the reflected light from the distant object is reaching the shutter the aperture is larger, thereby permitting a higher proportion of the reflected light from the distant object to enter the camera and from its image upon the film. Effectively, therefore, the reflected light from the near object has been attenuated to a greater extent than has the reflected light from the distant object. As can be seen from FIG. 7, the brightness values of the images upon the film from the near and distant objects respectively have been made substantially uniform. A photograph printed from such film will show correct exposure for all of the objects being simultaneously photographed regardless of distance from the camera. There are, however, practical limitations to the maximum and minimum distances where optimum pictures can be obtained. For example, the maximum flash energy, even with the shutter fully open, may be insufficient to provide adequate exposure for objects that are very distant whereas objects which are too close may be out of fo-

cus. Consequently, a practical range for proper exposure of both near and distant objects is, for example, 3 to 12 feet or 4 to 20 feet.

In FIG. **8** there is shown the light output from a series of light pulses in which the pulses are continuously repeated for relatively short periods of time. For example, the pulses may be spaced 11×10^{-9} seconds apart over a total duration of 0.001 second. During this time interval, therefore, 10^4 pulses can be emitted.

FIG. **9** indicates graphically the magnitude of the reflected pulses of illumination from the near and distant objects respectively as returned back to the shutter of the camera. It can be clearly observed that there is a marked difference in the amount of light being reflected back to the shutter. According to another embodiment of the invention, as depicted in FIG. **10** of the drawings, the shutter opening is regulated in accordance with a sinusoidal wave-form between the open and closed positions. The results of such shutter control are shown in FIG. **11** where the film illumination can be seen as being substantially equal for both near and distant objects utilizing the light source illustrated in FIG. **8.**

In FIG. **12** there has been recorded the light output from a source where pulses are emitted at an extremely rapid rate, e.g. of the order of 10^{-7} seconds (100 nanoseconds) per cycle. The reflected light returned to the camera is shown in FIG. **13** from which it can be concluded that there is still a marked difference between the quantity of light returned to the camera from the near object as contrasted with that amount of light returned from the distant object.

According to another modification of the invention, but within the broad inventive concept, the shutter may be regulated according to a square wave-form whereby the shutter is sequentially completely open and then completely shut. As may be seen from FIGS. **15** and **16,** since the shutter, when fully open, is slightly out of phase with the time period during which light from the near object is being returned to the shutter, the reflected light from the near object is attenuated. On the other hand, the shutter is completely open during the entire time that reflected light from the distant object reaches the shutter. The result is a more uniform image intensity upon the film than without the shutter regulation depicted in FIG. **13.** It will, of course, be understood that the regulation of the shutter may also be effected by means of triangular or repetitive exponential wave-form control alternatively to the square wave-form (FIG. **14**) or sinusoidal wave-form (FIG. **10**).

FIGS. **17–21** are similar to those of FIGS. **12–16** except that sinusoidal wave-form illumination and shutter control are substituted for the square wave-form regulation. This particular technique possesses an inherent practical advantage in that since only sinusoidal waves are utilized the operative costs are kept to a minimum since sinusoidal waves are relatively inexpensive to produce. The same sinusoidal wave-form is applied both to the shutter and light source; however, the modulation is delayed in phase from each other. FIG. **19** shows that the shutter is approximately 50 nanoseconds out of phase with the intensity of the flash. Maximum illumination of the film is provided when the return illumination is delayed to the extent that the light reflected and the shutter are in phase. Consequently, a distant object (see FIG. **18**) is returned with a slight delay due to the velocity of light, thereby resulting in an approximately in phase relationship with the shutter. The attenuation of the shutter for a distant object is small, thereby resulting in the film illumination shown in FIG. **21.** On the other hand, a near object is returned out of phase with the shutter, thereby resulting in a much greater attenuation as shown in FIG. **20.** The result of this configuration is the illumination of the film by both the near and distant objects to substantially the same degree.

It will be seen, from the foregoing, that an effective solution has been provided to the problem hereinabove discussed. By so regulating the shutter of a camera so as to provide f0r either the progressive opening thereof or the sequential opening and closing of same in a predetermined time relationship with the emission of illumination from the light source it is now possible to effect the desired attenuation of reflected light from the near objects. In this manner the images produced upon the film of the camera from near and distant objects have been made to possess substantially the same level of brightness.

It will also be understood that the light propagated by the light source may be any form of artificial light, although the presently preferred form is the flash lamp. It is also generally preferred at present to employ a pulsating light source although a constant light source may be utilized. Such constant light source may or may not be modulated by means of one of techniques described above.

Although the invention has been described with a certain degree of particularity, it will be understood that the disclosure has been made only by way of example, and that changes in both the method and apparatus may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A method for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images of substantially uniform brightness upon the film of a camera, comprising regulating the electro-optic shutter of said camera in predetermined synchronization with the actuation of the source of illumination by continuously varying the shutter opening between predetermined relatively closed and open positions so as to admit a first proportion of the reflected light returned from a first object and a greater proportion of the reflected light returned from a second more distant object, whereby a greater attenuation of the reflected light returned to the camera from the near object is effected than of the reflected light returned to the camera from the more distant object.

2. A method according to claim **1,** wherein the shutter opening is changed by progressively increasing same between predetermined relatively closed and open positions.

3. A method according to claim **7,** wherein said shutter opening is varied from a partially opened initial position to a progressively increasingly open position.

4. A method for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images of substantially uniform brightness upon the film of a camera, comprising regulating the electro-optic shutter of said camera in predetermined synchronization with the actuation of the source of illumination by sequentially opening and closing the shutter in predetermined phased time relationship with the emission of illumination by said source of artificial illumination so as to admit a first proportion of the re-

flected light returned from a first object and a greater proportion of the reflected light from a second more distant object, whereby a greater attenuation of the reflected light returned to the camera from the near object is effected than of the reflected light returned to the camera from the more distant object.

5. A method according to claim **4**, wherein said shutter is regulated so as to be open during a period of time which is out of phase with the time period during which reflected light from selected near objects reach the shutter and so as to be open during a period of time which is in phase with the time period during which reflected light from selected distant objects reach the shutter.

6. A method according to claim **5**, wherein the artificial illumination of said objects is carried out by means of a modulated light source.

7. A method according to claim **4**, wherein the shutter is sequentially opened and closed according to a wave-form pattern selected from square, sinusoidal, repetitive exponential and triangular wave-forms.

8. Apparatus for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images of substantially uniform brightness upon the film of a camera, comprising a camera having an electro-optic shutter, a source of artificial illumination, and means for regulating said shutter in predetermined synchronization with the actuation of said source of illumination, said regulating means being adapted to vary the shutter opening between predetermined relatively closed and open positions so as to admit a first proportion of the reflected light returned from a first object and a greater proportion of the reflected light returned from a second more distant object, whereby a greater attenuation of the reflected light returned to the camera from the near object is effected than of the reflected light returned to the camera from the more distant object.

9. Apparatus for photographing near and distant objects simultaneously by means of artificial illumination so as to produce images of substantially uniform brightness upon the film of a camera, comprising a camera having an electro-optic shutter, a source of artificial illumination, and means for regulating said shutter in predetermined synchronization with the actuation of said source of illumination, said regulating means being adapted to sequentially open and close the shutter in phased time relationship with the emission of illumination by said source of artificial illumination so as to admit a first proportion of the reflected light returned from a first object and a greater proportion of the reflected light returned from a second more distant object, whereby a greater attenuation of the reflected light returned to the camera from the near object is effected than of the reflected light returned to the camera from the more distant object.

10. Apparatus according to claim **9**, wherein said source of illumination is a modulated light source.

11. Apparatus according to claim **10**, wherein said light source is modulated by means of an electro-optic shutter provided therefor.

12. Apparatus according to claim **9**, wherein said shutter is adapted for regulation such that the opening thereof can be sequentially varied in accordance with a wave-form pattern selected from square, sinusoidal, repetitive exponential and triangular wave-forms.

13. Apparatus according to claim **12**, wherein said source of illumination is a modulated light source adapted to be modulated in accordance with a wave-form pattern selected from square, sinusoidal, repetitive exponential and triangular wave-forms.

14. Apparatus according to claim **13**, wherein said light source is provided with an electro-optic modulator.

15. A method according to claim **1**, wherein the shutter is sequentially opened and closed according to a wave-form pattern selected from square, sinusoidal, repetitive exponential and triangular wave-forms.

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