

SPECIFICATION

Electronic flash circuitry

The present invention relates to control circuitry for a photographic electronic-flash system which system has two sources of illumination and includes means for controlling the amount of illumination automatically.

It is known to use more than one source of flash illumination. For example, if both indirect and direct flash are used in the same exposure each type of illumination will compensate for deficiencies of the other. See, for example, *Amateur Photographer* page 82, February 7, 1979; *Research Disclosure*, #17824, page 67, February 1979 and U.S. Patent 4,085,316.

Similarly, photographers may position a source of illumination at each of several different locations.

It is known to control the amount of illumination from an electronic flash apparatus by a light sensing element either at the flash apparatus or the camera. The light sensing element produces an exposure control signal which initiates quenching of the flash illumination when the received light reflected from the subject indicates the exposure is complete.

An article in *Modern Photography*, page 34, October 1978, described the use of automatic electronic flash apparatus of the quenching type in a simultaneous indirect and direct flash system. Each of two flash units has its own sensing and quenching circuits. The apparatus gives correct total exposure, but the ratio of indirect to direct exposure is not automatically controlled. This is because the sensing circuits can not distinguish between light from the two sources of illumination.

It is an object of the present invention to provide automatic control over the ratio of received light reflected from a subject which light originates from two electronic flash sources.

According to the present invention there is provided actuation control circuitry for an electronic flash system, the electronic flash system including first and second electronic flash sources of illumination both for providing exposure illumination of a photographic film, means for sensing light reflected from a subject and for producing an exposure control signal in response thereto, means for actuating the first source, means for controlling the amount of illumination from the first source in response to the exposure control signal produced thereby and means for controlling the amount of illumination from the second source, wherein the actuation control circuitry includes means for actuating said second source of illumination a sufficient length of time after actuation of the first source so that light from the second source does not adversely affect control of the amount of illumination from the first source.

There is further provided an electronic flash unit including the actuation control circuitry as above and having first and second sources of illumination which are sources of indirect and direct

illumination, respectively.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side elevation of an electronic flash system and a camera in which portions of the two flash reflectors are removed for clarity of illustration; and

Fig. 2 is a circuit diagram for use with the electronic flash system of Fig. 1.

Because electronic flash apparatus is well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention.

Fig. 1 illustrates an electronic flash apparatus 10 including a flashtube 12 and a reflector 13, which are arranged to project a light beam 14 upwardly so that upon reflection from a nearby overhead surface, a subject may be illuminated indirectly.

A further flashtube 15 and a reflector 16 are arranged to project a light beam 17 directly at the subject. The beam 17 provides fill-in flash to soften dark shadows, such as might occur under the subject's eyes or chin.

In accordance with the embodiment illustrated in the drawings, the indirect flash is produced first. When a predetermined amount of light has been reflected from the subject and has been received by a photosensor 18, the flashtube 12 is quenched and the flashtube 15 is energized to produce the direct flash. When the photosensor 18 has sensed a total predetermined amount of reflected illumination, including indirect plus direct, the flashtube 15 is quenched. Thus a subject may be illuminated with both indirect and direct flash illumination and a predetermined ratio of indirect to direct flash illumination maintained, in terms of light reflected from the subject.

The photosensor 18 senses light reflected from a scene that can, of course, include ambient light. Because the intensity of the ambient light is normally much lower than the electronic flash intensity, the ambient light would generally have relatively little effect on the level of illumination sensed.

However, the quantities of indirect and direct flash illumination may be controlled with or without consideration of the effect ambient light by separating the photosensor's output current into 2 components, i.e., one due to ambient light and the other due to electronic flash. The photosensor component relating to the ambient light would in general be substantially DC, indicating the intensity of slowly changing ambient, and the photosensor component relating to the electronic flash would be a pulse indicating the rapidly changing electronic flash. A bandpass filter may be employed to remove the DC component from the photosensor's output so that both the indirect and direct flash illumination may be regulated independently of the ambient light.

The ambient light may effect quenching of the flashtube 12 providing the indirect source of

provides for continuing the firing of the flashtube 12 until the desired amount of indirect flash has been sensed.

5 A switch S_2 is arranged to close and a switch S_3 is arranged to open, preferably simultaneously, in response to opening a shutter (not shown) of a camera 102, shown in Fig. 1, with which the electrode flash apparatus 10 is used. When the switch S_2 is closed, the photosensor 18 is energized, and a one-shot multivibrator 103 produces a voltage pulse "TRIGGER", the duration of which is at least 40 microseconds.

10 When the photosensor 18 is energized, it produces a current that is proportional to the intensity of the illumination impinging upon it. 15 When the switch S_3 is opened, the photosensor's current charges a timing capacitor 104 at a rate proportional to the magnitude of the current. Accordingly, the photosensor 18 and the capacitor 20 104 constitute a light-sensitive integrating circuit where the voltage across the capacitor 104 corresponds to the time integral of the light sensed by the photosensor 18 after the switches S_2 and S_3 are actuated.

25 A voltage divider circuit 106, which consists of serially connected resistors 107, 108, 109 and 110, is connected parallel to the photosensor 18 and the capacitor 104, as shown. A terminal 112 between the resistor 110 and the resistor 109 is 30 connected to the non-inverting input terminal of a voltage comparator circuit 114, and a terminal 116 between the photosensor 18 and the capacitor 104 is connected to the inverting input terminal of the comparator 114.

35 The voltage divider 106 provides a reference voltage at the terminal 112 corresponding to the aforementioned minimum acceptable amount of light. The voltage divider 106 and the light-sensitive integrating circuit are arranged with 40 respect to each other so that the voltage at the terminal 112 is greater than the voltage at the terminal 116 when photosensor 18 has sensed an amount of light which is less than the minimum acceptable amount of light, and the voltage at the 45 terminal 116 is greater than the voltage at the terminal 112 when the photosensor 18 has sensed light which is greater than the minimum acceptable amount.

50 A terminal 118 between the resistor 109 and the resistor 108 is connected to the non-inverting input terminal of a voltage comparator circuit 120, and the terminal 116 is connected to the inverting input terminal of the comparator 120.

55 The voltage divider 106 provides a reference voltage at the terminal 118 corresponding to a desired predetermined amount of reflected indirect flash. Accordingly, the voltage divider 106 and the light-sensitive integrating circuit are arranged with respect to each other so that the 60 voltage at the terminal 118 is greater than the voltage at the terminal 116 when the photosensor 18 has sensed an amount of light which is less than the desired amount of reflected indirect flash, and the voltage at the terminal 116 is greater than 65 the voltage at the terminal 118 when the

photosensor 18 has sensed light which is greater than the desired amount of indirect flash.

70 A terminal 122 between the resistor 108 and the resistor 107 is connected to the non-inverting input terminal of a voltage comparator circuit 124, and the terminal 116 is connected to the inverting input terminal of the comparator 124.

75 The voltage divider 106 provides a reference voltage at the terminal 122 corresponding to a desired total amount of reflected scene illumination, including indirect plus direct flash. For a 3 to 1 ratio between the reflected indirect and the reflected direct flash the voltage at the terminal 118 would be three quarters of the 80 voltage at the terminal 122. One or more of the resistances in voltage divider 106 may be made variable so that ratios can be varied.

85 The voltage divider 106 and the light-sensitive integrating circuits are arranged with respect to each other so that the voltage at the terminal 122 is greater than the voltage at the terminal 116 when the photosensor 18 has sensed an amount of light which is less than the desired total amount of reflected light, and the voltage at the terminal 90 116 is greater than the voltage at the terminal 122 when the photosensor has sensed an amount of light which is greater than the desired total amount.

95 The comparator 114 is arranged to produce a logic 0 level voltage at its output terminal while the photosensor 18 has sensed an amount of light that is less than the minimum acceptable level, and to change to a logic 1 level voltage when the photosensor has sensed an amount of light that 100 equals the minimum acceptable level.

105 The output terminal of the comparator 114 is connected to the input terminal of an inverter 126. The output terminal of the inverter 126 is connected to one input terminal of a conventional dual-print AND gate 128, which constitutes a low-light switch.

110 The other input terminal and the AND gate 128 is connected to an output terminal of a time-delay circuit 130. The time-delay circuit 130 is arranged to produce a logic 1 level voltage "DELAY" 40 microseconds after the occurrence of the leading edge of the pulse "TRIGGER" which is applied to an input terminal of the time-delay circuit 130.

115 The time-delay circuit 130 and the combination of the comparator 114 and the inverter 126 are arranged with respect to the AND gate 128 so that logic 1 level voltages appear concurrently at both input terminals of the AND gate 128 only if, 120 at the end of the 40 microsecond interval immediately following the occurrence of the leading edge of the pulse "TRIGGER", photosensor 18 has sensed an amount of light that is less than the minimum acceptable level of reflected light. 125 When logic 1 level voltages appear concurrently at both input terminals, the AND gate 128 produces a logic 1 level voltage "Q EARLY", which indicates that an adequate amount of indirect flash has been sensed during the initial 40 microsecond 130 interval.

gate 131 produces the voltage "Q AND F", and the SCR 70 and the SCR 62 conduct, thereby causing the flashtube 12 to be quenched to extinguish the indirect flash, and the flashtube 15 to be actuated to produce the direct flash, respectively.

Because the direct flash is produced when the indirect flash is extinguished, the photosensor 18 senses only the indirect flash or the direct flash at any one time. When the photosensor 18 has sensed a total desired amount of reflected scene illumination, the capacitor 104 is charged to a voltage, which causes the comparator 124 to produce the voltage "Q FILL".

In response to the voltage "Q FILL", the SCR 73 conducts, thereby causing the capacitor 30 to discharge to turn the SCR 62 OFF. When the SCR 62 turns OFF, the current through the flashtube 15 is limited by the resistor 64, and the direct flash is thereby extinguished.

Any predetermined ratio of indirect to direct flash may be achieved by varying the relative values of the resistors of the voltage divider circuit 106. Furthermore, the delay circuit 130 may be arranged to change the interval used to determine the adequacy of the reflected indirect flash. In particular, for an outdoor flash exposure, an adjustable member could be provided, preferably, accessible to a camera operator, to reduce the delay to zero so that substantially all the flashtube firing energy may be delivered to the flashtube 15 for illuminating a subject solely with direct flash.

The preferred embodiment described above provides two flashes with no overlap and with little time gap between flashes. An alternative embodiment provides either an overlap or a time gap.

In one such embodiment quenching of the first flash source is anticipated and electronically "locked in" prior to flash termination, at which point the second source can be actuated since it no longer can adversely affect quenching of the first source. This has the disadvantage of requiring more costly circuitry for only a small gain in exposure time.

In another embodiment, two flash units having separate quench circuits are utilized substantially as in the prior art except that a fixed time delay is built into the actuation circuitry of one source. For example, a delay of .002 seconds in the actuation circuitry of a direct source would permit the first source to finish quenching in most situations. This has the advantage of more simple circuitry than the preferred embodiment described above but has the disadvantage of a substantially longer flash time. With this embodiment the invention may be used with a slave flash unit with the delay in the slave unit.

In all embodiments (except that using the slave unit) the additional circuitry may be in either flash unit, in the camera or in some intermediate structure, such as a flash support or special adapter. It is not limited to direct and indirect flash, but may be used with other combinations of two or more flash sources. However, the invention is especially advantageous when one source is indirect because the amount of light reaching the photocell 18 from that source varies greatly as the characteristics of the reflecting surface vary.

70 CLAIMS

1. Actuation control circuitry for an electronic flash system, the electronic flash system including first and second electronic flash sources of illumination both for providing exposure illumination of a photographic film, means for sensing light reflected from a subject and for producing an exposure control signal in response thereto, means for actuating the first source, means for controlling the amount of illumination from the first source in response to the exposure control signal produced thereby and means for controlling the amount of illumination from the second source, wherein the actuation control circuitry includes means for actuating said second source of illumination a sufficient length of time after actuation of the first source so that light from the second source does not adversely affect control of the amount of illumination from the first source.

2. Actuation control circuitry according to claim 1 for use with a flash system in which the means for controlling the amount of illumination from the first source is of the type which generates a quenching signal upon receipt by the sensing means of a given amount of light, and wherein said means for actuating said second source is arranged to actuate said second source in response to said quenching signal.

3. Actuation control circuitry according to claim 1 or 2 further including means for terminating illumination from the first source if the level of sensed light after actuation of said first source is below a given level.

4. Actuation control circuitry substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

5. An electronic flash unit including the actuation control circuitry according to any of the preceding claims and having first and second sources of illumination which are sources of indirect and direct illumination respectively.

6. An electronic flash system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



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