

PATENT SPECIFICATION

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- (21) Application No. 32297/75 (22) Filed 1 Aug. 1975
 (31) Convention Application No. 493 573 (32) Filed 1 Aug. 1974 in
 (33) United States of America (US)
 (44) Complete Specification published 1 Feb. 1978
 (51) INT. CL.² G03B 15/05 17/18
 (52) Index at acceptance
 G2X 1K1 1K4
 G2A 401 403 454 497 521 526 536 647 667 668 C5 CV
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(54) ELECTRONIC FLASH UNIT

(71) We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America, 343 State Street, Rochester, New York 14650, United States of America, hereby declare the invention for which we pray that a patent may be granted, and the method by which it is to be performed, to be particularly described and by the following statement:

The present invention relates to an electronic flash unit for use with cameras having a flash lamp firing mechanism arranged to fire flash lamps in timed relationship with the operation of a camera shutter.

In photographic cameras having the facility for firing a flash lamp or flashbulb, various arrangements are known for firing the flash lamp in timed relation with the operation of the camera shutter control mechanism. The light intensity from a flash lamp is typically of a duration of 40 milliseconds (ms). The peak light intensity is reached within approximately 10 ms followed by a gradual decay. Because the period of illumination produced by flash lamps is of a relatively long duration and because flash lamps do not reach peak light intensity instantaneously, the time relationship between the opening (and closing) of a camera shutter and the firing of the flash lamp, although important, is not severely limited. In some cameras having flash facilities, the shutter may begin to open before the flash lamp is energized to provide time for the shutter to open initially whereas in other such cameras the flash lamp may actually be fired prior to actuation of the shutter to permit the flash light to approach its peak light intensity before the shutter is opened initially.

On the other hand, electronic flash units, which may have a light source such as a xenon-filled flashtube, have a very short

duration light output, of the order of a millisecond, and reach peak light intensity almost instantaneously. Therefore, it is not feasible to fire an electronic flash unit before the camera shutter is actuated. Care must be taken to fire an electronic flash unit a sufficient period after the camera shutter is actuated to ensure that the shutter is fully open when the flashtube is fired.

To provide an electronic flash unit arranged to be mounted or coupled to a camera flash lamp receiving socket and to be fired from a flash lamp firing mechanism located in the camera presents the problem of synchronizing the shutter opening and flash unit firing operations. This problem is particularly acute when the flash lamp firing mechanism is of the type which is actuated prior to the occurrence of shutter opening movement.

It is known to provide an electronic flash unit for use with cameras arranged to receive and to fire flash lamps, and in which the electronic flash unit is triggered from the same source in the camera used to fire the flash lamp. In particular, it is known to fire an electronic flash unit from a camera having a flash lamp firing mechanism which is actuated prior to the initiation of shutter opening movement.

In these known flash units, where a thyristor is the firing means, it is usual to have the thyristor in series with the primary winding of a transformer, the secondary winding being connected in series with the flash-tube. If the voltage across the firing capacitor is insufficient to fire the flash-tube, then there will be no significant transfer of energy from the transformer primary winding to the secondary winding. As a result the total energy stored in the capacitor will pass through the thyristor. The thyristor will thus require to have a high power rating than is

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otherwise required.

It is therefore an object of the present invention to provide an electronic flash unit, which may be triggered by a pulse from a camera arranged to fire flash lamps, wherein the flash unit will not trigger until the firing capacitor has accumulated enough charge to fire the flash tube.

In accordance with the present invention, there is provided an electronic flash unit, arranged to be triggered by a flash-firing signal from a camera, said flash unit comprising an electronic flash-tube, a firing capacitor for firing the electronic flash-tube, a potential source for charging the firing capacitor, and a switch for enabling a triggering signal to be applied to the flash-tube in response to the flash-firing signal. When the charge on the firing capacitor is sufficient for firing the flash-tube, an delay circuit for delaying the enabled firing signal until a predetermined time after the flash-firing signal.

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

Fig. 1 is a perspective view of an electronic flash unit, which includes a trigger circuit according to the present invention, mounted on a camera of the type arranged to receive and to fire flash lamps; and

Fig. 2 is a schematic diagram of an electronic trigger circuit according to the present invention.

Because electronic flash units are well known, the present invention will be directed in particular to elements forming part of, or cooperating directly with, the trigger circuit of the present invention. Elements not specifically shown or described may take various forms well known in the art.

In Fig. 1 a camera 10, has a shutter release member 15 and a shutter mechanism (not shown) located to regulate the amount of scene light projected through an exposure aperture 20, the shutter being actuable in response to operation of the shutter release member 15.

An electronic flash unit 30 is mountable on the camera 10 and is electrically connectable to camera 10, as is shown schematically in Fig. 2, by a pair of electrically conductive strips 33a, 33b located in the base of the flash unit 30, and making contact, respectively, with corresponding conductors 34a, 34b located within the camera flash-receiving receptacle (not shown) which conductors 34a, 34b are connected to a flash-firing mechanism 35, shown in block form, which mechanism is arranged to produce a flash lamp firing pulse in timed relation to the actuation of

the camera shutter mechanism (not shown).

The flash unit 30 includes an electronic flashtube 36, shown schematically in a circuit 50 in Fig. 2, mounted within the housing 32 of the flash unit 30, behind a flash window 38.

A spring-loaded plunger-operated switch S1, shown in Fig. 2, has an actuator (not shown) protruding from the bottom wall of the housing 32 and the switch is closed when the flash unit 30 is properly inserted into the aforementioned flash-receiving receptacle connecting a flash unit battery (not shown), for the purpose of operating the flash-tube 36.

To fire the flash-tube 36 in response to each flash lamp firing signal occurring at the conductors 34a, 34b in synchronism with the operation of the camera shutter mechanism, the circuit 50 includes a conventional electronic flash circuit 51 having a main firing capacitor 52 connected in parallel with the flash-tube 36 to provide the firing voltage for the flash-tube. The circuit 51 further includes a fixed resistor 53, a trigger capacitor 54, of small capacitance relative to the firing capacitor 52, and an ignition transformer 56, the resistor, trigger capacitor and primary winding 55 of the ignition transformer 56 being interconnected to form a series circuit which is in parallel with the flash-tube 36. The ignition transformer 56 has its secondary winding 57 connected to a trigger electrode 36a of the flash-tube 36.

A reverse-blocking thyristor 58, connected in parallel with the trigger capacitor 54 and the primary winding 55, as shown, constitutes means for triggering the flash-tube 36. With the reverse-blocking thyristor 58 interconnected as shown, the trigger capacitor 54 is discharged through the primary winding 55 when the reverse-blocking thyristor 58 conducts.

To obtain a potential for operating the flash-tube 36, a charging circuit 59, provides an output from the battery at terminals 62, 63, normally sufficient to charge adequately the firing capacitor 52 and the trigger capacitor 54. The charging circuit 59 normally operates from a low voltage battery, and to provide the high voltage required at terminals 62, 63, may include a converter (not shown) of a type well known in the art.

As a safety means for discharging the relatively high voltage, typically 250-300 volts, from capacitors 52, when it is necessary to obtain access to the inside of the flash unit 30, there is provided a bleeder resistor 69 connected in series with a normally open switch S2. This series combination being connected in parallel across the firing capacitor 52. Switch S2 may comprise a resilient conductive member 130

end of which is connected to resistor 69 and the other end of which is held out of contact with capacitor 52 by means such as a rigid finger member (not shown) connected internally to one portion of housing 32. When the housing is opened, the finger is displaced to permit the conductive strip contact capacitor 52 so as to discharge the capacitors 52, 54 through the resistor 69 to a common conductor 65.

The circuit 50 includes an electronic shutter-flash synchronization circuit 70, connected to the conductive strips 33a, 33b for controlling the firing of the flashtube 36 in synchronism with the opening of the camera shutter mechanism. The shutter-flash synchronization circuit 70 includes a current limiting input circuit 71, and a voltage-sensitive indicator, such as a neon lamp 72, connected in series with a fixed resistor 74, forming a branch connected in parallel across the firing capacitor 52. When the firing capacitor 52 is charged to a level sufficient to fire flashtube 36 properly, lamp 72 is caused to glow so as to be visible through a flash-ready window (not shown) located in the rear of the flash unit to indicate to a camera operator that the flash unit is ready to be fired. Furthermore, when the lamp 72 glows, the lamp 72 and the resistor 74 operate as a voltage divider, with the voltage signal that appears at terminal 76 operating to supply gate current to reverse blocking thyristor 77.

The reverse-blocking thyristor 77 in combination with the flashtube 36 and lamp 72 constitutes a switch for an electronic time delay circuit, described in detail hereinafter, to be turned ON when the flash circuit 51 is ready for firing to accomplish the aforementioned synchronous operation. With this arrangement, a camera operator who fails to realize that the firing capacitor 52 is not sufficiently charged to fire the flashtube 36 and who inadvertently actuates the camera flash-firing mechanism, cannot unnecessarily cause the trigger capacitor 54 to discharge.

Connected in series with the reverse-blocking thyristor 77 is a voltage-sensitive neon lamp 78, a variable resistor 80, reverse-blocking thyristor 82 and a timing capacitor 84, forming a voltage-sensitive R-C circuit branch 85 in parallel with the branch 75. The lamp 78, which operates as a current switch, is selected so that conduction is not initiated when the voltage on the firing capacitor 52 approaches a value below which the flashtube 36 will not fire. With this arrangement, when the capacitor 52 discharges through the flashtube 36, the lamp 78 turns OFF just before the flashtube 36 is extinguished. When the lamp 78 turns off the R-C circuit 85 is open cir-

cuit and ceases to conduct. This switching operation is necessary to render branch 85 temporarily non-conductive so as to turn off the reverse-blocking thyristors 77 and 82 to set the conditions of the branch 85 for subsequent flash firings.

The resistor 80 and the timing capacitor 84 operate in providing a delay proportional to the product of the capacitance and the resistance, which product is variable by varying the value of the resistor 80.

When the shutter release member 15 is actuated a flash-firing signal is produced on the conductors 34a, 34b, which signal supplies gate current to the reverse-blocking thyristor 82 through the input circuit 71. Assuming that the firing capacitor 52 is sufficiently charged so as to turn flash-ready lamp 72 ON and to thereby render the reverse-blocking thyristor 77 conductive, the gate current, supplied through the input circuit 71 causes the reverse-blocking thyristor 82 to turn ON and branch 85 to conduct current. When this happens, the timing capacitor 84 charges with a time constant proportional to the product of the resistance of the resistor 80 and the capacitance of the timing capacitor 84. As the capacitor 84 charges to a predetermined voltage level, a voltage signal proportional thereto is produced at terminal 86, which signal is adequate at the predetermined voltage level to supply sufficient gate current to the reverse-blocking thyristor 58 to cause it to conduct. When this occurs, substantially the entire voltage across the trigger capacitor 54 is discharged through the reverse-blocking thyristor 58 and the primary coil 55, which initiates a flash as described above.

As the firing capacitor 52 discharges through the flashtube 36, first the lamp 72 is turned OFF, then the lamp 78 ceases to conduct, both switching operations occurring as the voltage across the firing capacitor 52 drops.

When the lamp 78 is turned OFF, the branch 85 ceases to conduct current. When this happens, the voltage across the timing capacitor 84 continues to discharge through resistors 88, 90, and the synchronization circuit 70 is reset for subsequent flash firings.

It can be seen that the synchronization circuit 70 operates to delay firing of the flashtube 36 for a time interval after a flash lamp firing signal is produced, which time interval is adjustable by the variable resistor 80. In a typical situation, this time interval would be of the order of 10 milliseconds, to allow for dynamic delays during shutter opening movement, as well as any time interval which would be required after the shutter is actuated so as to be open after 130

the flash firing circuit is energized.

Furthermore, it can be seen that due to the functioning of the flash-ready lamp 72 and the branch 85, that the flash-tube triggering signal cannot occur in the absence of adequate voltage across the firing capacitor 52.

The circuit shown in Fig. 2 and described herein is for use with a camera flash-firing mechanism for firing a flash lamp with an electrical signal, however cameras having firing mechanisms 35 of the type which fire a flash lamp mechanically by means of a percussive flash-firing mechanism may also be used therewith. A percussive flash lamp firing mechanism may include a high energy lever released from a set position in response to displacement of a shutter release member, and operates to actuate the camera shutter and release a flash lamp striker member to percussively fire the lamp in synchronism with shutter-operating movement. To fire an electronic flash unit with a camera adapted to percussively fire flash lamps, the striker member may be with a camera adapted to percussively fire flash lamps, the striker member may be utilized to close a switch connected to a battery and the input terminals to the flash-shutter synchronization circuit, whereby an electrical signal or pulse similar to that provided by the electrical flash-firing mechanism, is applied to the conductive strip.

WHAT WE CLAIM IS:

1. An electronic flash unit, arranged to be triggered by a triggering signal from a camera, said flash unit comprising an electronic flash-tube, a firing capacitor for firing the electronic flash-tube, a potential source for charging the firing capacitor,

and a switch for enabling a triggering signal to be applied to the flash-tube in response to the flash-firing signal only when the charge on the firing capacitor is sufficient for firing the flash-tube, and a delay circuit for delaying the enabled triggering signal until a predetermined time after the flash-firing signal.

2. An electronic flash unit, as claimed in Claim 1, wherein the potential source comprises a low voltage battery and a converter, for producing a potential higher than the battery potential to charge the firing capacitor.

3. An electronic flash unit, as claimed in Claim 1 or 2, having signal means, for providing an optical signal, when the charge on the firing capacitor is sufficient for firing the flash-tube.

4. An electronic flash unit, as claimed in Claim 1, 2 or 3, comprising voltage-sensitive switching means responsive to the discharge of the firing capacitor on firing the flash-tube to reset the delay circuit.

5. An electronic flash unit, as claimed in any preceding claim, wherein the delay circuit is an R-C circuit.

6. An electronic flash unit as claimed in any preceding claim, wherein the switch enables connection of the potential source to the delay circuit.

7. An electronic flash unit as claimed in any preceding claim, wherein the flash-tube is arranged to be triggered by an output from the delay circuit applied as a gate signal to a reverse-blocking thyristor.

8. An electronic flash-unit, substantially as hereinbefore described, with reference to, and as illustrated in, the accompanying drawings.

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WHAT WE CLAIM IS:

1. An electronic flash unit, arranged to be triggered by a triggering signal from a camera, said flash unit comprising an electronic flash-tube, a capacitor for firing the electronic flash-tube, a potential source for charging the firing capacitor,

and a switch for enabling a triggering signal to be applied to the flash-tube in response to the flash-firing signal only when the charge on the firing capacitor is sufficient for firing the flash-tube, and a delay circuit for delaying the enabled triggering signal until a predetermined time after the flash-firing signal.

2. An electronic flash unit, as claimed in Claim 1, wherein the potential source comprises a low voltage battery and a converter, for producing a potential higher than the battery potential to charge the firing capacitor.

3. An electronic flash unit, as claimed in Claim 1 or 2, having signal means, for providing an optical signal, when the charge on the firing capacitor is sufficient for firing the flash-tube.

4. An electronic flash unit, as claimed in Claim 1, 2 or 3, comprising voltage-sensitive switching means responsive to the discharge of the firing capacitor on firing the flash-tube to reset the delay circuit.

5. An electronic flash unit, as claimed in any preceding claim, wherein the delay circuit is an R-C circuit.

6. An electronic flash unit as claimed in any preceding claim, wherein the switch enables connection of the potential source to the delay circuit.

7. An electronic flash unit as claimed in any preceding claim, wherein the flash-tube is arranged to be triggered by an output from the delay circuit applied as a gate signal to a reverse-blocking thyristor.

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