

PATENT SPECIFICATION

(11) 1 524 201

1 524 201

(21) Application No. 36307/75 (22) Filed 3 Sept. 1975

(31) Convention Application No. 502 686

(32) Filed 3 Sept. 1974 in

(33) United States of America (US)

(44) Complete Specification published 6 Sept. 1978

(51) INT CL² H05B 41/22; G03B 15/04

(52) Index-at acceptance

H2H 2B7 2B8

G2A 401 403 454 501 502 667 DC

H2A 1T1B

(72) Inventor FRANK DAYTON WOLLSCHLEGER

(19)



(54) FLASH FIRING MECHANISM

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

The present invention relates to the firing of an electronic flash unit by a piezo-electric generator.

Flash-firing mechanisms which include a piezo-electric generator for triggering a flash unit are known.

UK Patent No. 1,347,793 discloses a piezo-electric generator coupled to an electronic flash unit to initiate firing of the flashtube. In one embodiment disclosed therein, the piezo crystal output pulse is applied directly to the trigger electrode of the flashtube. In an alternative embodiment, the crystal pulse is applied to the gate electrode of an SCR which is turned ON to complete a conventional trigger circuit including a transformer, to energize the flashtube.

It has been found that the application of a piezo-electric pulse directly to a flashtube trigger electrode is not reliable, as it does not always fire the flashtube.

An object of the present invention is the provision of a method and means for reliably firing an electronic flashtube from a piezo-electric generator.

In accordance with the present invention there is provided photographic apparatus comprising a piezo-electric generator having output terminals, a flashtube, a flashtube trigger circuit therefor having input terminals connected to the output terminals, and an inductor connected across the input or output terminals.

There is also provided a photographic

camera arranged selectively to receive an electronic flash unit comprising a flashtube and a flashtube trigger circuit, or an electrically ignitable flash bulb or an array of flash bulbs, and comprising a piezo-electric generator and an inductor connectable across output terminals thereof, for firing a received flash device.

There is further provided an electronic flash unit for use in photographic apparatus as above comprising a flashtube, the flashtube trigger circuit having input terminals and wherein said inductor is connected across the input terminals and wherein one of the input terminals is non-inductively connected to the flashtube trigger electrode.

There is also provided a method for illuminating a scene during taking of a photograph thereof, comprising connecting an inductor across the output terminals of a piezo-electric crystal, impacting the piezo-electric crystal to produce an output therefrom and feeding said output to an electronic flash unit to trigger said electronic flash unit.

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 a photographic apparatus comprising a camera having an electronic flash unit mounted thereon;

Fig. 2 is a cross-sectional view of parts of the camera and the electronic flash unit of Fig. 1, showing the electrical connection between a piezo-electric generator located in the camera and the flash unit, the flash unit having an inductor therein;

Fig. 3 is a schematic diagram of an electronic circuit included in the flash unit shown in Fig. 1, together with a piezo-electric crystal, within a camera, for initiating conduction of the flash unit flashtube;

Fig. 4 is a graph, the dashed lines showing

50

55

60

65

70

75

80

85

90

a flash unit trigger signal which is produced utilizing a particular type of prior art piezo-electric trigger mechanism and the solid line showing the flash unit trigger signal with an inductor connected across the output from the piezo-electric crystal;

Fig. 5 is a cross-sectional view of parts of the camera and the electronic flash unit of Fig. 1 showing the electrical connection between a piezo-electric generator located in the camera, an inductor connectable across the piezo-electric crystal and located within the camera, and a flash unit; and

Fig. 6 is a schematic diagram of an electronic circuit included in the flash unit shown in Fig. 1, together with a piezo-crystal, within a camera, for initiating conduction of the flash unit flashtube, and an inductor within the camera.

Because electronic flash units are 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. It is to be understood that flash unit elements not specifically shown or described may take various well known forms.

In Fig. 1 of the drawing, a camera 10 has an enclosed generally light-tight housing 12, in the top 13 of which is located a shutter release member 15. Camera 10 also includes a shutter mechanism (not shown) located to regulate the amount of scene light projected through an exposure aperture 20, the shutter being actuatable in response to a camera operator depressing the shutter release member 15.

As is shown in Fig. 2, there is located within the camera 10 a flash-firing mechanism comprising a piezo-electric generator denoted generally 26 and which includes a piezo-electric crystal 28, a hammer 30 attached to a spring-based lever 31 and an anvil 33 connected to the crystal 28 and located adjacent to the hammer 30. The lever 31, on a pivot 34, is retained releasably in a tensioned position by a spring-biased pivotally-mounted catch 36 which is coupled in a manner (not shown) to the shutter release member 15. The crystal 28 is electrically connected to a pair of spaced, resilient electrical contacts 37a, 37b, located within a flash-receiving socket 38 formed within the top 13. The receptacle 38 includes means (not shown), known in the art, for releasably receiving and retaining a photographic flash bulb or a number thereof arranged in an array, or an electronic flash unit on camera 10 for the purpose of illuminating a scene to obtain a photograph.

When the camera 10 is set for a picture-taking operation, the lever 31, in a manner not shown, is cocked as shown in Fig. 2, and when the shutter release member 15 is

actuated, the latch 36 is caused to pivot in a clockwise direction, as viewed in Fig. 2, to release the hammer 30 which strikes the anvil 33 under the influence of the spring 39. When this happens, piezo-electric crystal 28 is elastically deformed, which causes a short-duration, high voltage impulse to appear across its electrodes.

Returning to Fig. 1, there is shown an electronic flash unit 42 having an electronic flashtube 43, shown schematically in Fig. 3, mounted within a housing 44 in optical communication with a flash window 46. A flash mounting base 48 shown in Fig. 2 is formed at the bottom of the housing 44 and is adapted to fit the flash-receiving receptacle 38. The base 48 includes a pair of electrically conductive strips 48a, 48b, spaced for making contact, respectively, with the corresponding spaced contacts 37a, 37b, to couple electrically the flash unit 42 to the generator 26.

The electronic flash unit 42 includes an internal circuit denoted generally 50 and shown in Fig. 3.

To obtain an adequate voltage for operating the flashtube 43, a voltage converter circuit denoted generally 52 is provided which is adapted to step-up the relatively low voltage of a battery 54 to a level sufficient adequately to charge a firing capacitor 56. The voltage converter 52 may take any one of a number of well known forms.

To power the flash unit 50, a normally-open switch S1 is closed. This may be done automatically, such as by locating switch S1 on the bottom of the flash unit 42 where it may be engaged by the wall 13 and closed when the flash unit 42 is inserted into the socket 38. With this arrangement, the switch opens automatically when the flash unit is disconnected from the camera and unnecessary battery current drain is avoided when the flash unit is removed. When the switch S1 is closed, current flows from the battery 54 to the voltage converter 52.

Typically a series of positive, repetitive pulses is produced between terminals 60, 62 of the voltage converter 52, which repetitively turn the diode 69 ON and charge the capacitor 56. The repetition rate of the pulsed signal is controlled by the value of the elements of the circuit 52, and the voltage across the capacitor 56 increases at a rate inversely proportional to its capacitance.

A voltage sensitive indicator, such as a neon lamp 70 is connected in series with a resistor 71, the series combination being connected in parallel with the firing capacitor 56. The operational parameters of the lamp 70 and the resistor 71 are selected such that when the firing capacitor 56 is charged to a level sufficient to fire the

10

flashtube 43, the lamp 70 is caused to glow so as to be visible through a flashready window (not shown) located in the rear of the flash unit 42 to indicate to a camera operator that the flash unit 44 is ready to be fired.

As a safety means for discharging the relatively high voltage to which the capacitor 56 is charged, when it is necessary to disassemble the flash unit 44, there is provided a bleeder resistor 72 connected in series with a normally-open switch S2, the series combination being connected in parallel with the firing capacitor 56. Switch S2 may, for example, comprise a resilient conductive strip, one end of which is connected to the resistor 72 and the other end of which is held out of contact with the capacitor 56 by means such as a rigid finger member (not shown) connected internally to the housing 44. When the housing is opened, the finger is displaced to permit the conductive strip to contact the capacitor 56 so as to discharge the capacitor 56 through the resistor 72.

The conduction of the flashtube 43 is triggered by the application of a voltage signal to a trigger electrode 43a of the flashtube 43. This occurs when the piezo-electric crystal 28 is struck by the hammer 30. This signal causes ionisation within the flashtube 43 which sharply reduces the interelectrode resistance of the flashtube 43. When this happens, the firing capacitor 56 discharges rapidly through the flashtube. The result is a brief flash, of the order of a millisecond, of high intensity light.

The circuit 50 includes an inductor 74, connected across the output of the piezo-electric crystal 28. The connection of the inductor 74, as shown makes for more reliable firing of the flashtube 43, the flashtube being able to be fired with a lower voltage on the firing capacitor 56 than when the inductor 74 is not present. When using a specific flashtube piezo-electric crystal combination, an inductor of approximately 10 millihenries produces the most satisfactory results. With this combination, a trigger electrode signal is produced as illustrated by the solid-lined curve shown in Fig. 4 and denoted 76; the dashed curve 40, being the signal produced without the inductor 74. With a signal such as 76, the flash unit 42 has been fired reliably even when the firing capacitor 56 is charged only, for example, to 240 volts whereas with the signal 40 a 240-volt charge on the capacitor 56 is not adequate to fire the flashtube 43 reliably. Acceptable flashtube illumination occurs with the latter trigger signal only in approximately five percent of such firing operations. To obtain the same degree of reliability with the piezo-electric generator 26 where the inductor is not present it has

been found necessary to charge the firing capacitor to at least 265 volts.

With the piezo-electric crystal/flashtube combination tested, improved performance results with an inductor having an inductance of between 5 and 20 millihenries with the most satisfactory performance resulting with an inductor of 10 millihenries. The reactance of the inductor combines with the reactance of the crystal and flashtube in such a manner that the resonant frequency of the trigger circuit is modified to produce the trigger electrode signal 76 as is shown in Fig. 4. The signal 76 differs from the signal 40, owing to the fact that the resonant frequency of the trigger circuit has changed. If an envelope of the respective curves is considered, there is less total energy in the initial portion of the signal 76 but the intermediate and tail portions of the envelope of signal 76 include a larger overall energy level than that of the envelope of the prior art piezo-electric trigger signal 40.

As is known in the art, a flash bulb or an array comprising more than one flash bulb may be fired using a piezo-electric crystal to provide the ignition pulse. Such a flash bulb or array (not shown) may be inserted in the socket 38 for ignition by the piezo-electric crystal 28.

Alternatively, as shown in Figs. 5 and 6, the inductor may be included in the camera 10, being connected across the piezo-electric crystal 28 on attachment of the flash unit 42 to the camera 10.

In Figs. 5 and 6, items performing the same function as the corresponding items in Figs. 2 and 3 respectively have the same reference numerals.

The inductor 74 is connected between contact 37b and a supplementary contact 37c of the socket 38. On insertion of the flash unit 42, contact strip 48a engages both contact 37a and supplementary contact 37c, connecting both the flash-unit 42 and the inductor 74 in parallel across the piezo-electric crystal 28.

When a flash bulb or array (not shown) is inserted in the socket 38 of Figs. 5 and 6, it may be arranged so as to engage contacts 37a and 37b, and not to engage supplementary contact 37c. Accordingly, when a flash bulb or array is inserted in the socket 38, the inductor 74 may not be connected across the output of the piezo-electric crystal 28.

Although the invention has been described in detail with particular reference to preferred embodiments thereof, it will be understood that variation and modifications can be effected within the scope of the invention as defined in the appended claims.

WHAT WE CLAIM IS:—

1. Photographic apparatus comprising a



flashtube 43, the lamp 70 is caused to glow so as to be visible through a flashready window (not shown) located in the rear of the flash unit 42 to indicate to a camera operator that the flash unit 44 is ready to be fired.

As a safety means for discharging the relatively high voltage to which the capacitor 56 is charged, when it is necessary to disassemble the flash unit 44, there is provided a bleeder resistor 72 connected in series with a normally-open switch S2, the series combination being connected in parallel with the firing capacitor 56. Switch S2 may, for example, comprise a resilient conductive strip, one end of which is connected to the resistor 72 and the other end of which is held out of contact with the capacitor 56 by means such as a rigid finger member (not shown) connected internally to the housing 44. When the housing is opened, the finger is displaced to permit the conductive strip to contact the capacitor 56 so as to discharge the capacitor 56 through the resistor 72.

The conduction of the flashtube 43 is triggered by the application of a voltage signal to a trigger electrode 43a of the flashtube 43. This occurs when the piezo-electric crystal 28 is struck by the hammer 30. This signal causes ionisation within the flashtube 43 which sharply reduces the interelectrode resistance of the flashtube 43. When this happens, the firing capacitor 56 discharges rapidly through the flashtube. The result is a brief flash, of the order of a millisecond, of high intensity light.

The circuit 50 includes an inductor 74, connected across the output of the piezo-electric crystal 28. The connection of the inductor 74, as shown, makes for more reliable firing of the flashtube 43, the flashtube being able to be fired with a lower voltage on the firing capacitor 56 than when the inductor 74 is not present. When using a specific flashtube piezo-electric crystal combination, an inductor of approximately 10 millihenries produces the most satisfactory results. With this combination, a trigger electrode signal is produced as illustrated by the solid-lined curve shown in Fig. 4 and denoted 76; the dashed curve 40, being the signal produced without the inductor 74. With a signal such as 76, the flash unit 42 has been fired reliably even when the firing capacitor 56 is charged only, for example, to 240 volts whereas with the signal 40 a 240-volt charge on the capacitor 56 is not adequate to fire the flashtube 43 reliably. Acceptable flashtube illumination occurs with the latter trigger signal only in approximately five percent of such firing operations. To obtain the same degree of reliability with the piezo-electric generator 26 where the inductor is not present it has

been found necessary to charge the firing capacitor to at least 265 volts.

With the piezo-electric crystal/flashtube combination tested, improved performance results with an inductor having an inductance of between 5 and 20 millihenries with the most satisfactory performance resulting with an inductor of 10 millihenries. The reactance of the inductor combines with the reactance of the crystal and flashtube in such a manner that the resonant frequency of the trigger circuit is modified to produce the trigger electrode signal 76 as is shown in Fig. 4. The signal 76 differs from the signal 40, owing to the fact that the resonant frequency of the trigger circuit has changed. If an envelope of the respective curves is considered, there is less total energy in the initial portion of the signal 76 but the intermediate and tail portions of the envelope of signal 76 include a larger overall energy level than that of the envelope of the prior art piezo-electric trigger signal 40.

As is known in the art, a flash bulb or an array comprising more than one flash bulb may be fired using a piezo-electric crystal to provide the ignition pulse. Such a flash bulb or array (not shown) may be inserted in the socket 38 for ignition by the piezo-electric crystal 28.

Alternatively, as shown in Figs. 5 and 6, the inductor may be included in the camera 10, being connected across the piezo-electric crystal 28 on attachment of the flash unit 42 to the camera 10.

In Figs. 5 and 6, items performing the same function as the corresponding items in Figs. 2 and 3 respectively have the same reference numerals.

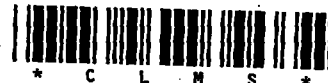
The inductor 74 is connected between contact 37b and a supplementary contact 37c of the socket 38. On insertion of the flash unit 42, contact strip 48a engages both contact 37a and supplementary contact 37c, connecting both the flash-unit 42 and the inductor 74 in parallel across the piezo-electric crystal 28.

When a flash bulb or array (not shown) is inserted in the socket 38 of Figs. 5 and 6, it may be arranged so as to engage contacts 37a and 37b, and not to engage supplementary contact 37c. Accordingly, when a flash bulb or array is inserted in the socket 38, the inductor 74 may not be connected across the output of the piezo-electric crystal 28.

Although the invention has been described in detail with particular reference to preferred embodiments thereof, it will be understood that variation and modifications can be effected within the scope of the invention as defined in the appended claims.

WHAT WE CLAIM IS:—

1. Photographic apparatus comprising a



(12)

4
5 piezo-electric generator having output terminals, a flashtube, a flashtube trigger circuit therefor having input terminals connected to the output terminals, and an inductor connected across the input or output terminals.

10 2. A photographic camera arranged selectively to receive an electronic flash unit comprising a flashtube and a flashtube trigger circuit, or an electrically ignitable flash bulb or an array of flash bulbs, and comprising a piezo-electric generator and an inductor connectable across output terminals therefor, for firing a receiving flash device.

15 3. A photographic camera as claimed in Claim 2, wherein the piezo-electric generator comprises a piezo-electric crystal and means for impacting the crystal to produce an electrical output therefrom.

20 4. A photographic camera as claimed in Claim 2 or 3, further including socket means for receiving an electronic flash unit, an electrically ignitable flash bulb or array of flash bulbs, and for presenting the output terminals thereto.

25 5. A photographic camera as claimed in Claim 4, wherein the socket means includes means, responsive to the insertion of an electronic flash unit therein, for connecting the inductor across the output terminals.

30 6. A photographic camera substantially as hereinbefore described with reference to and as illustrated in Figs. 1, 5 and 6 of the accompanying drawings.

35 7. An electronic flash unit for use in the

apparatus of Claim 1 comprising a flashtube, the flashtube trigger circuit having input terminals and wherein said inductor is connected across the input terminals and wherein one of the input terminals is non-inductively connected to the flashtube trigger electrode.

40 8. An electronic flash unit as claimed in Claim 7, having a switch arranged on operation, by connection of the flash unit to a photographic camera, to connect a battery of the flash unit in the power circuit thereof.

45 9. An electronic flash unit as claimed in Claim 7 or 8, including a safety switch arranged to be closed, on disassembly of the flash unit, to discharge the firing capacitor thereof.

50 10. An electronic flash unit substantially as hereinbefore described with reference to and as illustrated in Figs. 1, 2 and 3 of the accompanying drawings.

55 11. A method for illuminating a scene during taking of a photograph thereof, comprising connecting an inductor across the output terminals of a piezo-electric crystal, impacting the piezo-electric crystal to produce an output therefrom and feeding said output to an electronic flash unit to trigger said electronic flash unit.

60 12. A method for illuminating a scene during taking of a photograph therefore as claimed in Claim 11, and substantially as hereinbefore described.

65
L. A. TRANGMAR, BSc, CPA,
Agent for the Applicants.