

PATENT SPECIFICATION

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(54) ELECTRONIC FLASH/

- (71) We, FRANKE & HEIDECHE GmbH, a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECHE, of 196 Salzdahlumerstrasse, Braunschweig, Germany, 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:—
- 10 The invention relates to an electronic flash unit comprising a flash tube, a storage capacitor, which is dischargeable via the flash tube, a light measuring device to record the quantity of light having been emitted by the flash tube and reflected by the photographic object, a pulse generator circuit, which is capable of being switched on when a predetermined value of the recorded quantity of light is reached, and including a device to quench the flash tube, which device can be switched on by means of a pulse generated by the pulse generator.
- 25 With such electronic flash units, it is often desired that the photographer should be able to keep a constant check on whether the light measuring device, the pulse generator circuit and the flash tube quenching device, which are usually termed the 'computer', have become operative when the photograph was taken.
- 30 On a known electronic flash unit of this kind, the quenching device for the flash tube contains a gas-filled short-circuiting tube or thyatron, which short-circuits the flash tube at the moment when it ignites. Such a thyatron emits, in its current-carrying state, a visible light, which is utilized for checking the operation of the computer.
- 40 This occurs in that there extends from the thyatron to the surface of the unit casing a light guide bar, via which the photographer can observe the lighting-up of the thyatron during the short-circuiting of the flash tube. Since the lighting-up-time of such

a thyatron is only a few milliseconds, a fluorescent, luminescent or phosphorescent disc is provided on the surface of the flash casing at the end of the light guide bar. Due to the afterglow of this disc, it is possible for the photographer to see, even after completion of the flash process, whether the blocking device has become operative during the preceding flash radiation.

This display of the operation of the computer has a decisive disadvantage. Although the afterglow of the fluorescent disc indicates to the operator that the computer has become operative once, when there is a plurality of flash releases in rapid succession he cannot find out whether the computer has worked in each individual case. Therefore, he is also unable to find out when the computer failed for the first time. Moreover, such an indicating device comprising a light guide bar is relatively expensive and, due to the necessary space requirement, it cannot be used in so-called compact flash units, in which all the structural elements are housed in a very narrow space.

Furthermore, such an indicating device is always dependent on the quenching device of the flash tube comprising a structural element which emits a visible light. However, in specific cases of application, particularly in order to achieve high-speed flash sequences, such a gas-filled switching tube, which can only be quenched through the voltage breaking down at its anode-cathode path, has to be replaced by a semiconductor element, preferably a thyristor, which can be forcibly blocked in spite of the fact that voltage is applied to its anode-cathode path. However, such a thyristor does not emit any visible light, so that in these cases there is no basis whatsoever for such an indicating device.

The present invention may provide on an

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electronic flash unit of the kind mentioned at the beginning a device indicating the operation of the flash unit computer, which device, whilst avoiding the disadvantages described above, does not depend on the presence of a structural or switching element emitting a visible light and which will give a signal that is constant in its intensity over a selectable period.

According to the present invention there is provided an electronic flash unit comprising a flash tube, a storage capacitor which is dischargeable via the flash tube, a light measuring device for recording the quantity of light reflected by the photographic object upon operation of the tube, a pulse generator circuit which generates a pulse when a predetermined value of the recorded quantity of light is reached, and a device for quenching the flash tube, which device is actuated by means of the generated pulse and wherein a light emitting diode is connected to a direct current source via an electronic switch, which switch closes in response to the generated pulse or to the actuation of said quenching device to initiate emission of light from said diode and which switch opens automatically after an adjustable closing period to terminate the emission of light from said diode.

In one embodiment of the invention the electronic switch comprises a thyristor, the cathode thereof being connected to the positive plate of a capacitor contained in said pulse generator circuit and to the anode of said light emitting diode, the cathode of said light emitting diode being connected via a diode to the control input of the thyristor and wherein a further capacitor is provided connected between the anode of the thyristor and the cathode of said light emitting diode via a switching element whereby the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period the positive potential of said capacitor is applied to the cathode of the light emitting diode.

In a second embodiment of the invention the quenching device comprises a switching thyristor, which is arranged in series with the flash tube, and a quenching circuit to block the switching thyristor, and wherein the electronic switch comprises a thyristor, the control electrode thereof being connected to the voltage tap of a voltage divider, which divider is connected in parallel with a capacitor, and with the anode and cathode of the switching thyristor, and wherein a further capacitor is provided connected between the anode of the thyristor comprising the electronic switch and

the cathode of said light emitting diode via a switching element whereby the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period, the positive potential of said capacitor is applied to the cathode of the light emitting diode.

The triggering pulse for the thyristor is taken from the flash tube quenching device, the recovery time of the thyristor being substantially shorter than the quenching time of the flash tube.

In a further development of the invention, the cathode of the light-emitting diode is connected to the negative plate of the storage capacitor, and wherein the switching element comprises a diac connected in parallel with the storage capacitor, and connected in series with an adjustable resistor for adjusting the closing period.

In this way, the capacitor is charged, whilst the thyristor is conductive by the operating voltage of the storage capacitor at a time constant which is determined by the value of resistance of the adjustable resistor until the diac reaches its breakover voltage and suddenly becomes conductive, its current-flow resistance dropping suddenly in known manner. The capacitor is discharged via the diac and thyristor is blocked. The light-emitting diode thus emits light for a specific length of time, the light intensity being constant.

In order to ensure, even in a very rapid succession of flashes, that the computer operation indicating device has always gone out before a new flash is released, the connection point of the capacitor and the diac or the resistor is connected, according to a further development of the invention, via a diode to the synchronous contact of the flash unit, so that upon closure of the synchronous contact the charged capacitor is connected to the thyristor in high-resistance directions and the thyristor consequently changes over to its blocking state, regardless of whether the breakover voltage of the diac has been reached or not.

Embodiments of the object of the invention are shown by way of example in the drawings, in which:—

Figure 1 shows the circuit arrangement of an electronic flash unit comprising a computer operation indicating device, in which the closing pulse for the electronic switch is derived from the pulse generator circuit of the computer; and

Figure 2 shows a circuit arrangement of an electronic flash unit comprising a computer operation indicating device, in which the closing signal for the electronic switch is taken directly from the flash tube quenching device.

In Figure 1, there is designated by 1 a

storage capacitor, which is chargeable to an operating voltage of approximately 360 volts by a direct current source, for example a DC to DC convertor 2, and which is dischargeable via a flash tube 3. For the ignition of the flash tube there is provided an ignition device 4, which consists of a pulse transformer 5 with a primary winding and a secondary winding, an ignition capacitor 6, a resistor 7 and the synchronous contact 8 of the flash unit. The series connected resistor 7, the ignition capacitor 6 and the primary winding of the pulse transformer 5 are connected in parallel with the storage capacitor 1. The series connection of the ignition capacitor 6 and the primary winding of the pulse transformer 5 can be short-circuited via the synchronous contact 8. The secondary winding of the transformer 5 is connected to the ignition electrode 9 of the electronic flash tube 3. Placed in parallel with the flash tube 3 is a gas-filled short-circuiting tube or thyatron 10, whose ignition electrode 11 is connected to the secondary winding of a further pulse transformer 13, which is disposed in a pulse generator circuit 12.

The pulse generator circuit 12 consists of a thyristor 14 connected in parallel with the series connected capacitor 15 and the primary winding of the pulse transformer 13, this parallel connection being connected via a resistor 16 to one plate of the storage capacitor 1, which plate carries a positive potential, and to the voltage tap 17 of a voltage divider consisting of resistors 18 and 19. This voltage divider is connected in series with a capacitor 20 and a resistor 21 across the capacitor 1 and serves for supplying voltage to the light measuring device of the flash unit, which device consists of a photo transistor 22 and an integrating capacitor 23. A Zener diode 24 serves for stabilizing the supply voltage.

The positive pole 25 of a direct current source (not shown) is connected via the series connection of a diode 26, a resistor 27, a thyristor 28 and a light-emitting diode 29 to the common rail connecting capacitor 1 and flash tube 3. This common rail is at zero potential and the pole 25 may have a positive potential of 5 volts, for example, relative to this common rail. The connection point of the cathode of the thyristor 28 and the anode of the light-emitting diode 29 is connected via a diode 30 and a resistor 31 to one plate of the capacitor 15, which plate has a positive potential in its charged state, and to the anode of the thyristor 14 in the pulse generator circuit 12. The cathode of the light-emitting diode 29 is connected via a diode 32 to the control electrode of the thyristor 28. Placed in parallel with the

storage capacitor 1 is the series connection of an adjustable resistor 33 and a diac 34. The connection point between the resistor 33 and the diac 34 is connected, on the one hand, via a capacitor 35 to the anode 70 of the thyristor 28 and, on the other hand, via a diode 36 to one plate of the ignition capacitor 6, which plate carries a positive potential in its charged state, and to the high-tension side of the synchronous contact 8.

The mode of operation of this circuit arrangement is as follows:—

When the electronic flash unit is ready for operation, the storage capacitor 1, the ignition capacitor 6, the capacitor 15 in the pulse generator circuit 12 and the capacitor 20 are charged. Upon the closure of the synchronous contact 8, the ignition capacitor is discharged in known manner 85 and applies an ignition pulse via the ignition transformer 5 to the ignition electrode 9 of the flash tube 3. The latter ignites, and the storage capacitor 1 is discharged via the flash tube, light being radiated. At the same time, the capacitor 20 is discharged via the flash tube 3, the voltage divider 18, 19 and the resistor 21. During this discharging phase of the capacitor 20, a supply voltage that has been kept constant by the Zener diode 24 is applied to the series connection of the photo transistor 22 and the integrating capacitor 23. The photo transistor 22 charges the integrating capacitor 23 with a current that is proportional to the quantity of light which having been emitted by the flash unit, is reflected by the photographic object and impinges on the photo transistor 22. As soon as the integrating capacitor has reached a predetermined threshold value, the thyristor 14 in the pulse generator circuit ignites through, and the capacitor 15 is discharged via the primary winding of the pulse transformer 13, whereby an ignition pulse reaches the ignition electrode 11 of the thyatron 10 and the latter short-circuits the flash tube 3 and extinguishes the flash.

At the moment when the thyristor 14 ignites, the cathode potential of the thyristor 28 of the indicating device is suddenly applied to the plate of the charged capacitor 15, which plate has a low potential. Since the control electrode of the thyristor 28 always has a potential that is reduced relative to the zero potential by the junction voltage of the diode 32, there develops between the control electrode and cathode of the thyristor 28 a voltage difference which ignites the thyristor 28. As a result, a current flows from the positive pole 25 of the direct current source to the zero potential, and the light-emitting diode is lit up, indicating the response of the computer.

Whilst the diode 29 emits light, the

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capacitor 35 is charged via the adjustable resistor 33 until the breakover voltage (approximately 30 Volts) of the diac 34 is reached. Then the diac conducts and the positively charged plate of the capacitor 35 is applied directly to the zero potential. This voltage jump is transferred via the capacitor 35 to the anode of the thyristor 28, so that the anode potential of the latter is substantially lower than its cathode potential for the duration of the discharge of the capacitor. The thyristor 28 is blocked. It is possible to determine the length of time during which the diode emits light by adjustment of the value of resistance of the resistor 33. This length of time corresponds to the time which is required for charging the capacitor 35 to the breakover voltage of the diac 34.

If the light-emission period of the light-emitting diode 29 has been set for a very long time, it may be that the time until the next flash release is shorter than the time that is required for charging the capacitor to the breakover voltage of the diac 34. In this case, the light-emitting diode would still be emitting light when the next flash is released through closure of the synchronous contact 8. To prevent this occurring, the capacitor 35 which has been partially charged is connected via the diode 36 to the synchronous contact 8 so that the thyristor 28 blocks immediately after closure of the synchronous contact 8 due to discharging current through capacitor 35 before the computer can respond to the next flash. Thus it is ensured that the light-emitting diode is switched off in any case when a new flash is to be released and that indicating device can only be switched on directly as a result of the computer response to the emitted flash.

In Fig. 2 a further embodiment of a flash unit is shown in which the closing pulse for the thyristor 28 is not derived from the pulse generator circuit, as shown in Fig. 1, but is derived from the flash tube quenching device. In contrast to Fig. 1, the flash tube quenching device shown in Fig. 2 consists of a switching thyristor 40, which is placed in series with the flash tube 3 and which becomes conductive with the flash tube and which can be blocked at any time by means of a quenching circuit as soon as the quenching device is activated by the pulse emitted by the pulse generator circuit 12. The quenching circuit comprises a quenching capacitor 41 and a thyristor 42, whose control grid is connected to the secondary winding of the pulse transformer 13 in the pulse generator circuit 12.

The construction of the light measuring device and the pulse generator circuit is identical with the portion B which is sur-

rounded by dash-dotted lines in Fig. 1. The series connection of the quenching capacitor 41 and the thyristor 42 is connected in parallel with the switching thyristor 40, the connecting point of the anode of the thyristor 42 and the quenching capacitor 41 being connected via a resistor 52 to the plate of the storage capacitor 1, which plate has a positive potential. Due to the ionization of the flash tube 3, the switching thyristor 40 is automatically ignited as soon as an ignition pulse is applied to the ignition electrode 9 of the flash tube. To this end, a resistor 43 is connected in parallel with the thyristor 40 and the series connection of a capacitor 44 and a voltage divider, consisting of resistors 45 and 46, is connected, together with the capacitor 41, in parallel with the storage capacitor. The voltage tap of the voltage divider 45, 46 is connected to the control electrode of the switching thyristor 40.

The indicating device for checking the operation of the computer part is identical in construction with the indicating device shown in Fig. 1, so that identical structural parts have been provided with identical reference symbols. Only the connection of the light-emitting diode cathode to the control electrode of the thyristor 28 via the diode 32 is eliminated. In this case, the control electrode of the thyristor 28 is connected to the voltage tap of a voltage divider consisting of resistors 47 and 48. This voltage divider is placed in parallel with a capacitor 49, which is connected to the cathode and the anode of the switching thyristor 40. There is furthermore inserted in the connecting line from the thyristor anode to the capacitor 49 a diode 50, and the connecting point of the capacitor and cathode of this diode is connected via a further diode 51 to the anode of the flash tube 3.

The mode of operation of this circuit arrangement is as follows:—

Upon the ignition of the flash tube, the switching thyristor 40 also becomes conductive, and the storage capacitor 1 is discharged via the flash tube 3 and the switching thyristor 40. The light reflected by the photographic object is recorded in the light measuring device and when a specific value of the measured quantity of light is reached, the thyristor 42 is ignited via the pulse generator circuit 12. The quenching capacitor 41, which has been charged to the operating voltage, is discharged via the thyristor 42 and the resistor 43, so that a negative voltage is applied to the switching thyristor 40 during the period in which the capacitor 41 is discharged and the switching thyristor 40 blocks. Since the recovery time of the thyristor is substantially shorter than the time

required for deionization of the flash tube 3, there still flows a current from the storage capacitor 1 via the flash tube 3, the diode 50 and the capacitor 49 after the switching thyristor has blocked, whereby the capacitor 49 is charged. As soon as the capacitor has been charged, the flash tube 3 goes out. When a specific voltage value has been reached by the capacitor 49, a voltage is applied to the resistor 48 of the voltage divider which is sufficient to ignite the thyristor 28 in the indicating device. The light-emitting diode 29 lights up and indicates the preceding operation of the computer. The quenching of the light-emitting diode 29 follows after a specific pre-selectable time, as described in conjunction with Fig. 1, and so does the quenching of the light-emitting diode when the synchronous contact 8 closes for the next flash release.

An alternative indication system for an electronic flash unit is disclosed in copending Patent application 32227/75 (Serial No. 1 484 803).

WHAT WE CLAIM IS:—

1. An electronic flash unit comprising a flash tube, a storage capacitor which is dischargeable via the flash tube, a light measuring device for recording the quantity of light reflected by the photographic object upon operation of the tube, a pulse generator circuit which generates a pulse when a predetermined value of the recorded quantity of light is reached, and a device for quenching the flash tube, which device is actuated by means of the generated pulse and wherein a light emitting diode is connected to a direct current source via an electronic switch, which switch closes in response to the generated pulse or to the actuation of said quenching device to initiate emission of light from said diode and which switch opens automatically after an adjustable closing period to terminate the emission of light from said diode.

2. An electronic flash unit as claimed in claim 1, wherein the electronic switch comprises a thyristor, the cathode thereof being connected to the positive plate of a capacitor contained in said pulse generator circuit and to the anode of said light emitting diode, the cathode of said light emitting diode being connected via a diode to the control input of the thyristor and wherein a further capacitor is provided connected between the anode of the thyristor and the cathode of said light emitting diode via a switching element whereby

the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period the positive potential of said capacitor is applied to the cathode of the light emitting diode.

3. An electronic flash unit as claimed in Claim 1, wherein the quenching device comprises a switching thyristor, which is arranged in series with the flash tube, and a quenching circuit to block the switching thyristor, and wherein the electronic switch comprises a thyristor, the control electrode thereof being connected to the voltage tap of a voltage divider, which divider is connected in parallel with a capacitor, and with the anode and cathode of the switching thyristor, and wherein a further capacitor is provided connected between the anode of the thyristor comprising the light emitting diode via a switching element whereby the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period, the positive potential of said capacitor is applied to the cathode of the light emitting diode.

4. An electronic flash unit as claimed in Claim 2 or 3, wherein the cathode of the light-emitting diode is connected to the negative plate of the storage capacitor, and wherein the switching element comprises a diac connected in parallel with the storage capacitor, and connected in series with an adjustable resistor for adjusting the closing period.

5. An electronic flash unit as claimed in Claim 2 or 3 including a flash tube ignition device, in which a capacitor chargeable via a resistor can be short-circuited by means of a synchronous contact connected in parallel with the switching element whereby the emission of light from said diode is terminated on closure of the synchronous contact if said closing period has not elapsed.

6. A flash unit as claimed in Claim 5, wherein a diode is inserted in the connecting line from said switching element to the synchronous contact.

7. A flash unit, substantially as described herein with reference to and as illustrated by the accompanying drawing.

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required for deionization of the flash tube 3, there still flows a current from the storage capacitor 1 via the flash tube 3, the diode 50 and the capacitor 49 after the switching thyristor has blocked, whereby the capacitor 49 is charged. As soon as the capacitor has been charged, the flash tube 3 goes out. When a specific voltage value has been reached by the capacitor 49, a voltage is applied to the resistor 48 of the voltage divider which is sufficient to ignite the thyristor 28 in the indicating device. The light-emitting diode 29 lights up and indicates the preceding operation of the computer. The quenching of the light-emitting diode 29 follows after a specific pre-selectable time, as described in conjunction with Fig. 1, and so does the quenching of the light-emitting diode when the synchronous contact 8 closes for the next flash release.

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1. An electronic flash unit comprising a flash tube, a storage capacitor which is dischargeable via the flash tube, a light measuring device for recording the quantity of light reflected by the photographic object upon operation of the tube, a pulse generator circuit which generates a pulse when a predetermined value of the recorded quantity of light is reached, and a device for quenching the flash tube, which device is actuated by means of the generated pulse and wherein a light emitting diode is connected to a direct current source via an electronic switch, which switch closes in response to the generated pulse or to the actuation of said quenching device to initiate emission of light from said diode and which switch opens automatically after an adjustable closing period to terminate the emission of light from said diode.

2. An electronic flash unit as claimed in claim 1, wherein the electronic switch comprises a thyristor, the cathode thereof being connected to the positive plate of a capacitor contained in said pulse generator circuit and to the anode of said light emitting diode, the cathode of said light emitting diode being connected via a diode to the control input of the thyristor and wherein a further capacitor is provided connected between the anode of the thyristor and the cathode of said light emitting diode via a switching element whereby

the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period the positive potential of said capacitor is applied to the cathode of the light emitting diode.

3. An electronic flash unit as claimed in Claim 1, wherein the quenching device comprises a switching thyristor, which is arranged in series with the flash tube, and a quenching circuit to block the switching thyristor, and wherein the electronic switch comprises a thyristor, the control electrode thereof being connected to the voltage tap of a voltage divider, which divider is connected in parallel with a capacitor, and with the anode and cathode of the switching thyristor, and wherein a further capacitor is provided connected between the anode of the thyristor comprising the electronic switch and the cathode of said light emitting diode via a switching element whereby the further capacitor is charged during said closing period to a positive potential and on actuation of said switching element after said closing period, the positive potential of said capacitor is applied to the cathode of the light emitting diode.

4. An electronic flash unit as claimed in Claim 2 or 3, wherein the cathode of the light-emitting diode is connected to the negative plate of the storage capacitor, and wherein the switching element comprises a diac connected in parallel with the storage capacitor, and connected in series with an adjustable resistor for adjusting the closing period.

5. An electronic flash unit as claimed in Claim 2 or 3 including a flash tube ignition device, in which a capacitor chargeable via a resistor can be short-circuited by means of a synchronous contact connected in parallel with the switching element whereby the emission of light from said diode is terminated on closure of the synchronous contact if said closing period has not elapsed.

6. A flash unit as claimed in Claim 5, wherein a diode is inserted in the connecting line from said switching element to the synchronous contact.

7. A flash unit, substantially as described herein with reference to and as illustrated by the accompanying drawing.

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