

PATENT SPECIFICATION (11)

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(54) ELECTRONIC FLASH DEVICE

(71) We, FRANKE & HEIDECKE G.m.b.H., a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECKE, of 196 Salzdhumerstrasse, 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 electronic flash apparatus and more particularly to control circuitry for the purposes of controlling photographic exposure wherein part of the light reflected by an object being photographed interrupts a flash tube discharge via a photo-electrical integration measuring arrangement when a predetermined flash light exposure is obtained, a thyristor being arranged in series with the flash tube in a discharge circuit, which thyristor is fired at the same time as the flash tube and to the terminals of which thyristor a capacitor can be connected by means of an electronic switch which capacitor is capable of reducing the thyristor potential at least to the extinguishing potential thereof. Such a control circuit is described and claimed in our British Patent Specification No. 1,314,907.

30 Such an arrangement permits the flash tube discharge to be terminated without the remaining residual charge of the storage capacitor being destroyed. The thyristor in series with the flash tube permits interruption of the flash current by a short pulse, i.e. because of the very brief time of recovery of the thyristor in comparison to the flash tube. Moreover, initiation of a pulse potential which need only correspond to the voltage drop of the flash current on the thyristor is sufficient. Thus a capacitor of low capacitance is sufficient for producing this pulse. The energy of the storage capacitor which has not been used up remains almost entirely preserved.

45 According to the present invention there is provided a control circuit for controlling

electronic flashlight apparatus, including a discharge circuit comprising, connected in series, a storage capacitor, a flash tube connected with the capacitor being operative in response to discharge current of the capacitor and a control element connected with the flash tube for controlling the flow of discharge current through the flash tube; a switch device connected across the control element; a photoelectric integration measuring device connected to operate the switch device so as to quench the control element and terminate the flow of discharge current through the flash tube when a predetermined flash light exposure is reached and a capacitor/resistor network connected in parallel with the control element for rendering the control element conductive upon ignition of the flash tube.

The present disclosure constitutes an improvement and further development of the subject of British Patent Specification No. 1,314,907 in so far as the ignition of the serial thyristor and the flash tube do not result simultaneously from a common firing device but directly from the flash tube or the flash current, i.e. in such manner that only the sudden voltage rise upon ignition of the flash tube triggers the thyristor, while other, slower or weaker signals remain ineffective and furthermore in so far as when the flash tube is extinguished by reduction of the anode potential of the thyristor to zero or to a negative value a negative gate potential is simultaneously produced. Such signals can appear when the thyristor is extinguished by reduction of the anode potential to a negative value; when the anode potential rises again a triggering potential would again arrive at the gate of the thyristor, as upon ignition of the flash tube. Since the circuit to which the present invention is applied cannot respond to a slow rise in potential, a gate potential sufficient for firing the thyristor cannot be produced.

The triggering voltage for the gate of the thyristor is produced and connected to the

gate because of the sudden voltage rise upon the firing of the flash tube, while after extinction of the thyristor and after the temporary reduction of the anode potential to zero or to a negative value the slowly rising voltage cannot grow as far as to produce the triggering potential for the thyristor.

In one embodiment of the invention a resistor on the one hand and on the other hand a capacitor with a voltage divider resistance network whereof the triggering potential of the thyristor is tapped, are connected parallel to the thyristor lying between the flash tube and earth.

A constructional embodiment of the present invention will now be described by way of example with reference to the accompanying drawing which illustrates a schematic diagram of a control circuit according to the invention.

A storage capacitor 1 is charged from a transducer 2 via diodes 3 and 4. The diode 4 separates the flash circuit from the extinction circuit. A voltage divider comprising resistors 5, 6 for deriving the primary ignition voltage for capacitor 7 is connected parallel to the storage capacitor 1. Release means or switch contact 8 is in series with the ignition capacitor 7 and a primary winding 9 of ignition transformer 9a. When the contact 8 is closed the capacitor 7 discharges via the primary winding 9 of the transformer 9a. The transformer secondary winding 10 produces the firing potential for the flash tube 11.

A thyristor 12 is connected in series with the flash tube 11. Parallel to the thyristor 12 there is on the one hand resistor 13 and on the other hand a series connected arrangement of a thyristor firing capacitor 14 with a voltage divider comprising resistors 15, 16. Furthermore, there is connected parallel to the thyristor an extinction capacitor 17 with an electronic switch 18 which is in the form of a switch tube which can be ignited by a photoelectric integration measuring device 20 via an ignition transformer 19. The extinction capacitor 17 is of much lower capacitance than the storage capacitor 1. Between the capacitor 14 and the switch tube 18 there is yet a further capacitor 21 the capacitance whereof is considerably greater than that of the thyristor-firing capacitor 14. The thyristor 12 is triggered by the capacitor 14 and the resistors 15, 16 at the instant of firing the flash tube 11. This combination has the effect of a differentiation, i.e. a rapid voltage rise (when the flash tube is fired) is transmitted via the capacitor 14 and the resistors 15, 16 to the gate of the thyristor 12. A slow voltage rise (during recharging of the extinction capacitor 17) encounters a high apparent resistance in the capacitor 14 and therefore also

produces only a weak signal which is not sufficient to trigger the thyristor 12.

The anode of the thyristor 12 and the cathode of the flash tube 11 are connected to earth via the resistor 13 and during the normal rest period their potential is zero. This potential rises abruptly upon ignition of the flash tube 11. This rapid voltage rise is transmitted via the capacitor 14 and the resistors 15, 16 to the gate of the thyristor 12 and fires the latter. The thyristor 12 then completes the build-up of the anode potential and takes over the flash current.

When the flash current is to be disconnected the electronic switch 18 is ignited by means of a signal emitted by the photoelectric integration measuring device via transformer 19. Thereby the capacitor 17 is discharged. This discharge current is opposed to the flash current and since this current in this low-ohmic circuit may be larger than the flash current, the anode current in the thyristor 12 may even become negative for a brief period of time. Since at this point in time no signal is applied to the thyristor 12 the latter is rendered non-conductive. Subsequently, however, the anode potential rises again, because of the interconnection between the transducer 2, diode 3, capacitors 21, 14 and resistor 13. But because of the recharging of the capacitor 17 this rise is considerably slower than the rise in this potential upon ignition of the flash tube. A triggering voltage for the thyristor 12 could again arise across the resistor 16, via the capacitor 14, but the combination of capacitor 14 and the resistors 15, 16 is so calculated that with the given slower voltage rise a potential which would be sufficient to trigger the thyristor 12 does not develop across the resistor 16.

Thus by virtue of this comparatively simple circuit arrangement the thyristor 12 is triggered or fired by the flash current upon ignition of the flash tube. Furthermore, the triggering potential is additionally reduced to zero when the thyristor 12 is extinguished and a renewed rise of the triggering potential to thyristor-igniting voltage is prevented. It is, of course, a pre-condition of the functioning of the arrangement that the anode current must be zero or negative for a specific interval, being of such a length of time as is required for clearing the PN-transition interface, i.e. for as long as it takes for the thyristor to become non-conductive.

The process of clearing or this period of becoming non-conductive can be shortened if the gate of the thyristor is negatively biased during this period. This is achieved by the capacitor 21, the capacitance of which must be very much greater than that of the ignition capacitor 14. Since

this capacitor 21 is connected to the extinction capacitor 17 and to the anode of the switch tube 18 it is correspondingly discharged upon ignition of the switch tube 18. The discharge current of capacitor 17 produces, *via* the resistor 16 and thus at the gate of the thyristor 12, a negative potential. The resistor 15 delays this process. The extent of the negative potential is thus confined within limits and the effect of the negative potential remains until the potential at the gate of the thyristor 12 is raised sufficiently by the charging of capacitors 14, 17. The capacitor 21 assumes yet a further task. Since during the extinction process the discharge current of the capacitor 21 also negatively modulates the capacitor 14 no triggering signal can develop at the thyristor. As a result of the additionally shortened time of becoming non-conductive the capacitance of the extinction capacitor 17 can be reduced, i.e. the inevitable loss of energy is reduced and the recharging time of the capacitor 17 is, of course, shortened.

The ignition of the thyristor has additional advantages. When a thyristor is triggered by a synchro-contact along with the flash tube, as hitherto, the chatter of the synchro-contact may have a detrimental effect on the triggering. Such faulty triggering could destroy the thyristor. In the past a triggering signal had to be prepared which generally necessitated the use of active switch elements. Moreover, there was a lengthy time interval between ignition of the flash tube and formation of the flash current as compared to ignition of the thyristor. The triggering potential must be applied to the thyristor at least until the flash current flows. In the present circuit the thyristor is only triggered when the flash tube is already fully lit. Consequently, when there is failure to fire, the extinction devices are not activated so that waiting periods can be avoided. Furthermore, the triggering signal has a shape which can be determined by dimensioning and is always reproducible in the same shape. In the arrangement according to the invention these problems require an unusually low circuitry expenditure.

WHAT WE CLAIM IS:—

1. A control circuit for controlling elec-

tronic flashlight apparatus, including a discharge circuit comprising, connected in series, a storage capacitor, a flash tube connected with the capacitor being operative in response to discharge current of the capacitor and a control element connected with the flash tube for controlling the flow of discharge current through the flash tube; a switch device connected across the control element; a photoelectric integration measuring device connected to operate the switch device so as to quench the control element and terminate the flow of discharge current through the flash tube when a predetermined flash light exposure is reached and a capacitor/resistor network connected in parallel with the control element for rendering the control element conductive upon ignition of the flash tube.

2. A control circuit as claimed in claim 1, wherein the capacitor/resistor network comprises an ignition capacitor connected in series with two resistors across the control element.

3. A control circuit as claimed in claim 2, including an additional capacitor connected between the junction of the ignition capacitor and the two resistors, and the switch device.

4. A control circuit as claimed in claim 2 or 3, wherein the control element consists of a thyristor and wherein a further capacitor and the switch device are connected in series across the terminals of the said thyristor, the gate of the thyristor being connected with the junction between the two resistors.

5. A control circuit as claimed in any one of the preceding claims, wherein the switch device consists of a switch tube having its ignition electrode connected with the photoelectric integration measuring device.

6. A control circuit as claimed in any one of the preceding claims, comprising a further resistor connected in parallel with the control element.

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

For the Applicants:
MATTHEWS, HADDAN & CO.,
Chartered Patent Agents,
33 Elmfield Road,
Bromley, Kent, BR1 1SU.



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5. A control circuit as claimed in any one of the preceding claims, wherein the switch device consists of a switch tube having its ignition electrode connected with the photoelectric integration measuring device.
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6. A control circuit as claimed in any one of the preceding claims, comprising a further resistor connected in parallel with
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