

PATENT SPECIFICATION

(11)

1 458 429

1 458 429

- (21) Application No. 33313/74 (22) Filed 29 July 1974
(31) Convention Application No's
2 339 094 (32) Filed 2 Aug. 1973
2 339 119 2 Aug. 1973 in
(33) Germany (DT)
(44) Complete Specification published 15 Dec. 1976
(51) INT. CL.² G03B 15/05
H05B 41/32
(52) Index at acceptance
H2H 14 2B7
G2A 401 403 484 497 667 704 711 BJ
H3T 1P2 2A1S 2S 2T3TX 2T5 2X 3F1



14
15

(54) A CIRCUIT FOR COMMUTATING A THYRISTOR IN AN ELECTRONIC FLASH UNIT

(71) We, FRANK & HEIDRCKE GmbH, 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 present invention relates to an electronic flash unit energised by the discharge of a main capacitor through a photo-electrically controlled flash-emitting tube, a thyristor being connected to the cathode of the flash tube in the capacitor discharge circuit, the thyristor being commutated by means of a further capacitor discharged via the cathode anode path of the thyristor.

15 In the case of circuits of this type already known the commutating capacitor lies parallel to the thyristor. The capacitor is charged with a specific voltage and is discharged by closing a switch generally effected by a second auxiliary thyristor via the cathode anode path of the thyristor. As a rule the charging of the commutating capacitor is effected with the available direct current supply to the thyristor to be commutated. The requisite capacitance value of the commutating capacitor depends, among other things, on the voltage level of the commutating capacitor at the beginning of the commutation. If the voltage is higher, the commutating capacitor required is correspondingly smaller. It is, therefore, preferable to charge the commutating capacitor to the operating voltage given by the available direct current supply.

20 It has, however, been ascertained that with such currents a part of the thyristor may be destroyed when commutation takes place. Even the use of an RC wiring for the thyristor to prevent overloading cannot stop a certain percentage of some types of thyristor breaking down. If the output of the

thyristor in the conducting direction remains the same an appreciable reduction in the failure quota can only be produced by a considerable increase in the size of the thyristor.

25 The present invention seeks to provide a circuit for commutating a thyristor by means of a commutating capacitor so that when thyristors are commutated and are operating at the maximum output limit in conducting direction, failure is avoided, or in other words, a thyristor having a size determined by its through output, can be so wired that failure during the commutation process can safely be precluded.

30 According to the present invention the cathode anode path of the thyristor is bypassed by an anti-parallel connected diode.

35 This ensures that during the commutation process on the thyristor the voltage lying in the reverse direction is very low, thus reducing the resultant power dissipation in the thyristor and consequently the reduced power dissipation can no longer cause an increase in temperature which would destroy the crystalline structure of the thyristor. Furthermore as the relaxation time of the thyristor is dependent on the temperature existing in the semiconducting crystal at the same time of commutation, the extent of change possible in the relaxation time during the commutating phase is also considerably narrowed down by this reduction in power dissipation. The length of the relaxation time determines the turn-off period (=timing constant) of the thyristor commutating circuit and the capacitance value of the commutating capacitor is selected according to the turn-off period of the thyristor commutating circuit. Because, as a result of the minimal power dissipation and the merely negligible increase in temperature associated with it, the relaxation time of the thyristor remains almost constant, the turn-off period selected for the thyristor commutating circuit

can be correspondingly shorter, thus also meaning a reduction in the size of the commutating capacitor.

A particularly suitable design for the commutating circuit is one with a diode having a forward voltage so high that the resultant thyristor power dissipation on commutation of the thyristor can generate a maximum temperature output by which the relaxation time of the thyristor, remains less than the turn-off period of the thyristor commutating circuit.

According to the invention, the commutating circuit of the thyristor is used in an electronic flash unit, where it is desired to use the smallest possible components i.e. in particular to use commutating capacitors with a low capacitance value. The circuit arrangement allows this in no small measure if one takes into consideration that e.g. with an operating voltage of an electronic flash unit of 360 volts and bypassing the thyristor with a diode with a forward voltage approx. 4-6 volts, the capacitance value of the commutating capacitor can be reduced in size by more than a half compared with the circuit arrangement with no diode. Furthermore as a result of the above mentioned reasons, it is possible to use thyristor commutating circuits with shorter turn-off periods than was previously possible so that the flash recycling time can be reduced.

With the known electronic flash units usually a storage capacitor is charged together with a commutating capacitor from a transformer. When the flash tube is triggered also the thyristor is rendered conductive and the energy stored in the storage capacitor is discharged via the flash tube so that it emits a flash. Part of the light quantity emitted is reflected by the object and is captured by a photocell of a light-measuring device. The light quantity measured is integrated, and, at a given nominal value, a signal is transmitted to an electrical switch which thereby becomes conductive. By means of the switch the recharged commutating capacitor is connected to the thyristor so that its discharge current is in opposite direction to that of the thyristor. During the commutation phase the commutating capacitor takes the discharge current from the storage capacitor so that the thyristor current drops below the holding current and the thyristor blocks when the relaxation time is exceeded.

With these known circuits it is to be observed that at the moment of the commutation of the thyristor the light emission by the flash tube is increased. As the control circuit always emits a signal in order to interrupt the flash tube discharge whenever the light-measuring device measures the light required for the correct exposure of the photograph, this phenomenon leads to

an over exposure of the photograph which is especially evident with exposures in the close-up range, as, in this case, the supplementary light quantity required for the correct exposure of the photograph is very high.

The reason for this phenomenon is to be found in the fact that during commutation, the discharge current still flows through the flash tube to accommodate the change in charge of the commutating capacitor. By lowering the potential at the cathode of the flash tube at the moment of commutation, the discharge current of the storage capacitor being directed for a short period via the flash tube, is moreover increased.

With another already known electronic flash unit, by means of a capacitor a bias is applied to the main electrode of the flash tube with the extent of this bias effecting the disconnection and being determined in consideration of a rapid discharge of the charge carrier of the thyristor.

For this purpose the commutating capacitor must be charged up to a higher voltage than the storage capacitor. For this reason the commutating capacitor cannot be recharged by the charging device of the storage capacitor, but requires a separate charging device. The latter can be dispensed with if, with the known electronic flash unit, an inductor is put in the discharge circuit of the storage capacitor between the cathode of the thyristor and storage capacitor at the centre tap of which the positive capacitor plate of the commutating capacitor can be set for the purpose of commutating the thyristor. Such a relatively voluminous T-choke, however, requires additional space in the flash unit and increases the cost of production.

The present invention may enable correct exposure photographs to be taken with flash units of the above mentioned type without being faced with these disadvantages.

As during commutation there is now remaining only a very low voltage, approx. 4 to 6 Volts, at the thyristor in backward direction the charge of the commutating thyristor can be changed very quickly so that the current for the recharge and/or change of charge flowing via the flash tube into the commutating capacitor is very low. Thereby not only an incorrect exposure of the photographs by an undesirable supplementary light emission of the flash tube, but also an unnecessary discharge of the storage capacitor during commutation is prevented.

The consequence of this is that energy is saved, and a higher flash capacity of the flash unit is obtained with the same capacity of the storage capacitor without recharging the storage capacitor.

On account of the low voltage in the backward direction of the thyristor during commutation the power dissipation of the thy-

ristor is also very low. Therefore it is possible to use, with the capacity being unchanged, smaller thyristors. As furthermore the relaxation time of the thyristor depends on the temperature in the semiconductor crystal during commutation, this temperature increase during commutation without a diode in the shunt has to be taken into consideration inasmuch as the turn-off period of the commutating circuit must be selected to be much longer than the actual relaxation time of the thyristor. Long turn-off periods, however, require a high capacitance value in the commutating capacitor. By means of shunting the diode, however, the power dissipation in the thyristor is decreased considerably and the thyristor is only subject to a hardly noticeable temperature increase during commutation. Thus the relaxation time of the thyristor during commutation does not change at all or only very slightly so that the turn-off period of the commutating circuit can be considerably shorter. By that means not only considerably shorter flash recycling times but also much small capacitance values of the commutating capacitor are obtained whereby the size of the flash unit can be reduced yet again.

An especially optimum design of the commutating circuit is obtained by providing for a diode the forward voltage of which is so high that the power dissipation of the thyristor during commutation can generate a maximum temperature at which the relaxation time of the thyristor remains shorter than the turn-off period of the thyristor-commutating circuit.

A constructional embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:—

Fig. 1 shows a circuit arrangement; and

Fig. 2 shows a flash unit according to one embodiment of the present invention, having a circuit in accordance with the principles of the arrangement shown in Figure 1.

In Fig. 1 an arbitrary load 101 connected to a direct current supply 103 by a thyristor 102 is shown. The control grid of the thyristor is controlled by a control device 104 which allows the grid to render the thyristor conductive when required. Parallel to the thyristor can be connected a commutating capacitor 105 which is chargeable, in a way commonly known, to the polarity represented in the drawing. 106 is a switch, frequently in the form of a second auxiliary thyristor, which when closed places the positive plate of the capacitor at the cathode of the thyristor 102. A diode 107 is placed parallel to the cathode-anode path of the thyristor 101. The diode has a very low forward voltage.

On closing the switch the capacitor 105 is discharged via the diode 107. The com-

mutating capacitor takes over the charge current of the thyristor during the commutation phase so that the thyristor current drops below the value of its holding current and, after exceeding the recovery time, the thyristor blocks. The voltage, across the diode 107 when capacitor 105 is discharged or the polarity of its charge is changed, is located in the direction cathode-anode at the thyristor and guarantees a negative anode voltage at the thyristor during the turn-off period, so that the control grid of the thyristor is completely discharged during the recovery time and the thyristor securely blocks after change in charge of the capacitor 105 and at the associated return of the full anode voltage. The power dissipation in the thyristor during commutation is very small because of the low voltage lying in the backward direction and does not result in temperature increase detrimental to the structure of the thyristor.

Figure 2 shows the practical application of the thyristor commutating circuit in an electronic flash unit with a photoelectrically controlled flash limiting unit.

A storage capacitor 1 chargeable via a direct current supply is situated in series with a flash tube 2, and a thyristor 3 which controls the flash tube discharge, a resistor 4 being connected in parallel to the thyristor. The flash tube 2 is triggered by a triggering device 5 which, for example, is operated by closing the known synchro-contact on the camera. Parallel to the flash tube 2 is the arrangement of a resistor 6 and a commutating capacitor 7. Connected between the connecting point of the resistor 6 and the commutating capacitor 7 and the cathode of the thyristor 3 is the arrangement in series of a further capacitor 8 and two resistors 9 and 10 where the resistor 10 lies parallel to the triggering path. Parallel to this arrangement in series with capacitor 8 and resistors 9 and 10 is an inductor 11 and a commutating thyristor 12 connected in series. The commutating thyristor is triggered, in a manner known, by an electrically operated light measuring device 13 which measures the light emitted from the flash tube and reflected by the object by means of a photocell, is integrated and, when a given nominal value is reached, a control signal is transmitted to the grid of the commutating thyristor 12. A diode 14 is connected parallel to the thyristor 3 so that the conducting direction of the diode is situated in the backward direction of the thyristor i.e. in the direction cathode anode. Comparing figures 1 and 2 gives the following corresponding components:

Commutating capacitor 105 corresponds to capacitor 7, thyristor 102 corresponds to thyristor 3, switch 106 corresponds to commutating thyristor 12, diode 107 corresponds

to diode 14.

The mode of operation of the circuit of an electronic flash unit represented in figure 2 is as follows:

- 5 Firstly the storage capacitor 1 is charged to the operating voltage. When the storage capacitor is charged the commutating capacitor 7 and the capacitor 8 are similarly charged to operating voltage via the resistor
- 10 6. The full operating voltage lies between the anode and cathode of the electronic flash tube 2 whereas anode and cathode of the thyristor 3 lie on the same potential. By operating the triggering device 5 a trigger
- 15 impulse is produced which ionizes the discharge path of the flash tube 2 and thus causing the flash tube to trigger. When the flash tube is triggered the potential at the anode of the thyristor 3 or as the case may be
- 20 at the cathode of the flash tube 2 suddenly increases. As a result of this rapid increase in potential a positive impulse is transmitted to the control grid of the thyristor 3 via the capacitor 7 and the capacitor 8 and also
- 25 via the potentiometer circuit consisting of resistors 9 and 10. The thyristor ignites and the complete flash current flows through the flash tube 2 so that now almost all the operating voltage of the storage capacitor 1
- 30 lies at the flash tube. The flash tube 2 thereby emits a flash of a specific light intensity.
- The light emitted from the flash tube 2 is reflected by the object and is captured
- 35 by the photocell of the light measuring device 13. When the light measuring device 13 determines the amount of light required for correct illumination this device transmits a trigger impulse to the commutating
- 40 thyristor 12 which is thereby rendered conductive. The capacitor 7 which is charged almost to operating voltage is discharged very quickly as a result of the low resistance in the commutating circuit via the inductor
- 45 11, the diode 14 and so causes the discharge current flowing through the thyristor 3 to drop below the holding current of the thyristor and with that the thyristor blocks and

this ends the discharge process of the storage capacitor 1. As already described in Fig. 1 there is a negative voltage in the backward direction of the thyristor resulting from the voltage drop at the diode during the close period of the thyristor commutating period so that the control grid is discharged within 55 the recovery time of the thyristor and the thyristor securely blocks on return of the anode - cathode voltage.

WHAT WE CLAIM IS:—

1. An electronic flash unit energised by 60 the discharge of a main capacitor through a photoelectrically controlled flash-emitting tube, a thyristor being connected to the cathode of the flash tube in the capacitor discharge circuit, the thyristor being commutated by means of a further capacitor dischargeable via the cathode-anode path of 65 the thyristor, wherein the cathode-anode path of the thyristor is bypassed by an anti-parallel connected diode.
2. An electronic flash unit as claimed in Claim 1, wherein the diode has a forward voltage which is so high that the thyristor power dissipation occurring on commutation 70 of the thyristor can generate a maximum temperature at which the recovery time of the thyristor remains less than the turn-off time of the thyristor commutating circuit.
3. An electronic flash unit as claimed in Claim 1 or 2, wherein the thyristor is inserted into the flash discharge circuit comprising of a storage capacitor and flash tube 80 of an electronic flash unit.
4. An electronic flash unit as claimed in Claim 1, substantially as hereinbefore described. 85
5. An electronic flash unit substantially as described herein with reference to and as illustrated by Figure 2 of the accompanying 90 drawing.

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

to diode 14.

The mode of operation of the circuit of an electronic flash unit represented in figure 2 is as follows:

- 5 Firstly the storage capacitor 1 is charged to the operating voltage. When the storage capacitor is charged the commutating capacitor 7 and the capacitor 8 are similarly charged to operating voltage via the resistor
- 10 6. The full operating voltage lies between the anode and cathode of the electronic flash tube 2 whereas anode and cathode of the thyristor 3 lie on the same potential. By operating the triggering device 5 a trigger
- 15 impulse is produced which ionizes the discharge path of the flash 2 and thus causing the flash tube to trigger. When the flash tube is triggered the potential at the anode of the thyristor 3 or as the case may be
- 20 at the cathode of the flash tube 2 suddenly increases. As a result of this rapid increase in potential a positive impulse is transmitted to the control grid of the thyristor 3 via the capacitor 7 and the capacitor 8 and also
- 25 via the potentiometer circuit consisting of resistors 9 and 10. The thyristor ignites and the complete flash current flows through the flash tube 2 so that now almost all the operating voltage of the storage capacitor 1
- 30 lies at the flash tube. The flash tube 2 thereby emits a flash of a specific light intensity.

- 35 The light emitted from the flash tube 2 is reflected by the object and is captured by the photocell of the light measuring device 13. When the light measuring device 13 determines the amount of light required for correct illumination this device transmits a trigger impulse to the commutating
- 40 thyristor 12 which is thereby rendered conductive. The capacitor 7 which is charged almost to operating voltage is discharged very quickly as a result of the low resistance in the commutating circuit via the inductor
- 45 11, the diode 14 and so causes the discharge current flowing through the thyristor 3 to drop below the holding current of the thyristor and with that the thyristor blocks and

this ends the discharge process of the storage capacitor 1. As already described in Fig. 1 there is a negative voltage in the backward direction of the thyristor resulting from the voltage drop at the diode during the close period of the thyristor commutating period so that the control grid is discharged within the recovery time of the thyristor and the thyristor securely blocks on return of the anode - cathode voltage.

WHAT WE CLAIM IS:—

1. An electronic flash unit energised by the discharge of a main capacitor through a photoelectrically controlled flash-emitting tube, a thyristor being connected to the cathode of the flash tube in the capacitor discharge circuit, the thyristor being commutated by means of a further capacitor dischargeable via the cathode-anode path of the thyristor, wherein the cathode-anode path of the thyristor is bypassed by an anti-parallel connected diode.
2. An electronic flash unit as claimed in Claim 1, wherein the diode has a forward voltage which is so high that the thyristor power dissipation occurring on commutation of the thyristor can generate a maximum temperature at which the recovery time of the thyristor remains less than the turn-off time of the thyristor commutating circuit.
3. An electronic flash unit as claimed in Claim 1 or 2, wherein the thyristor is inserted into the flash discharge circuit comprising of a storage capacitor and flash tube of an electronic flash unit.
4. An electronic flash unit as claimed in Claim 1, substantially as hereinbefore described.
5. An electronic flash unit substantially as described herein with reference to and as illustrated by Figure 2 of the accompanying drawing.

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

