

PATENT SPECIFICATION

(11) 1 479 844

1 479 844

- (21) Application No. 8972/75 (22) Filed 4 March 1975
(31) Convention Application No. 2 417 242
(32) Filed 9 April 1974 in
(33) Fed. Rep. of Germany (DT)
(44) Complete Specification published 13 July 1977
(51) INT CL² H05B 41/34; G03B 15/05
(52) Index at acceptance

G2A 401 402 403 473 483 497 603 704 711 752 BA BJ
G2E A20A1 A20A5
H2H 14



(54) ELECTRONIC FLASH UNIT WITH AN AUTOMATIC EXPOSURE CONTROL

(71) We, FRANKE & HEIDECHE GMBH, a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECHE, 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:—

The invention relates to an electronic flash unit with an automatic exposure control, which comprises a switching thyristor, which lies in series with the flash tube and which can be blocked by the discharge current of a quenching capacitor, which is charged via a resistor and which is paralleled, in series with a further thyristor, to the switching thyristor.

In a known flash unit of this kind, the quenching capacitor is connected, on the one hand, via a resistor to the positive pole of the main storage capacitor and, on the other hand, to the anode of the switching thyristor. A second resistor is provided, connected in parallel with the switching thyristor. The common connecting point between the quenching capacitor and the first resistor is connected to the cathode of the switching thyristor via a further thyristor, which is triggered by an exposure metering device. As soon as the quantity of light, radiated by the flash tube, has reached a desired value, the exposure metering device emits an impulse to the control electrode of the further thyristor, so that the latter fires. The quenching capacitor is discharged via the further thyristor, which is fully conductive, and the switching thyristor, whereby there is applied to the anode/cathode path of the switching thyristor, for the duration of the discharge, a negative voltage, under the action of which the charge carriers are withdrawn from the blocking layer of the switching thyristor and the switching thyristor blocks. The resistor

which connects the quenching capacitor to the positive pole of the storage capacitor has a resistance value selected in such a way that after the decay of the discharge current from the quenching capacitor the residual current, which flows from the positive pole of the storage capacitor through the resistor and the conducting further thyristor, sinks below the holding current of the further thyristor and the latter thereby blocks. Now the quenching capacitor can be recharged to the operating voltage via the resistor connecting it to the positive pole of the main storage capacitor and in the case of a renewed ignition of the flash tube the quenching circuit for the switching thyristor is ready for operation.

If one wants to generate a rapid sequence of short light impulses with this flash unit, then a minimum time interval between the single impulses has to be observed, the greatest proportion of which interval being determined by the charging time of the quenching capacitor. The charging time constant of the quenching capacitor which is dependent on its capacitance value and the resistance value of the resistor which is connected between the quenching capacitor and the positive pole of the main storage capacitor, cannot be shortened at will, since the capacitance value of the quenching capacitor has to be proportioned to the recovery time of the switching thyristor and the resistor has to be proportioned to the magnitude of the holding current of the further thyristor. The value of resistance must therefore have a specific minimum magnitude, so that the quotient from the operating voltage or the voltage applied to the storage capacitor respectively and the value of resistance is smaller than the holding current of the further thyristor. Only by taking such measures is it ensured that the further thyristor can be returned to its blocking condition. Since the value of the holding current of a thyristor is very small,

15 18 16
the resistance between the quenching capacitor and the anode of the further thyristor respectively and the positive pole of the main storage capacitor has to be very large when using a conventional operating voltage of the flash unit of 360 Volt, whereby the charging time of the quenching capacitor is increased which, in turn, only allows an impulse sequence having a large time interval.

10 An object of the invention is to provide an electronic flash unit of the above kind in which the time span from the emission of a quenching signal to the further thyristor by the exposure metering device until the renewed operating readiness of the quenching circuit for the switching thyristor is substantially shortened compared to the known flash units.

20 According to the present invention there is provided an electronic flash unit with automatic exposure control comprising a flash tube and a switching thyristor connected in series across an energy source;

25 a quenching capacitor and a quenching thyristor connected in series and connected in parallel with the anode-cathode path of the switching thyristor, said quenching capacitor being chargeable from said energy source via a first resistor;

30 a light sensing circuit connected to the control electrode of said quenching thyristor to trigger the latter on receipt of a predetermined quantity of light and discharge said quenching capacitor to effect blocking of said switching thyristor;

35 and means for applying a reverse voltage to said quenching thyristor to effect re-blocking thereof a predetermined time after the blocking of said switching thyristor.

40 In this manner, the selection of the resistance value of the resistor between the quenching capacitor and the positive pole of the storage capacitor can be selected independently of the magnitude of the holding current of the further thyristor, so that with a correspondingly low value of resistance very short charging times of the quenching capacitor are obtained.

50 According to a further development of the invention, it is particularly advantageous to connect the control electrode of the switching thyristor to a circuit arrangement for the generation of an ignition impulse, the time span from the ignition of the further thyristor until the emission of an ignition impulse by the circuit arrangement being proportioned longer than the quenching time of the flash tube. The result of this is that no further structural elements are required for the device for the forced commutation of the further thyristor in addition to the circuit arrangement for the generation of an ignition impulse, since the quenching capacitor for the switching thyristor now

also supplies the quenching current for the further thyristor and the switching thyristor connects this quenching capacitor in parallel with the further thyristor for the purpose of quenching the further thyristor. In this manner, the same quenching circuit is used for quenching the switching thyristor, on the one hand, and for quenching the further thyristor, on the other hand.

70 In an expedient development of the invention, the circuit arrangement comprises a timing element and the timing element comprises an interlocking element which blocks the timing element and which can be released upon the ignition of the further thyristor until at least the impulse emission to the switching thyristor. With the aid of this timing element, the instant of the emission of an ignition impulse to the switching thyristor can be set in a simple manner.

75 The electronic flash unit according to the invention can be used with particularly great advantages as a lighting unit in conjunction with a moving picture camera. If, according to a further proposal of the invention, the ignition of the flash tube of the electronic flash unit is synchronised with the shutter opening position of a moving picture camera, it is possible to achieve the effect that each individual picture of the film is automatically correctly exposed as a result of the measurement of light effected by the exposure control device of the electronic flash unit. The synchronous ignition of the flash tube with the shutter opening position of the moving picture camera is brought about in a simple manner in that, according to a further feature of the invention, the ignition circuit for the flash tube consists of the series connection of a capacitor, which can be charged via a resistor, and the primary winding of an impulse transformer, whose secondary winding is connected to the ignition electrode of the flash tube, the synchronous contact of a moving picture camera being connected in parallel with the series connection of the capacitor and the primary winding. With film cameras which allow a synchronous sound recording of the film by means of a cassette recorder which records, in addition to the sound track, on a pilot track control impulses coming from the camera, such a synchronous contact is guided to the exterior of the camera so as to be accessible, so that the flash unit according to the invention can be connected in a simple manner.

120 The use of such a flash unit in filming has decisive advantages over the hitherto usual illumination by means of halogen lights. In the first place, the considerable reduction of the energy requirement should be mentioned, which makes it possible to operate the lighting plant independently of station-

any voltage networks and thus also allows filming with artificial light at places where such a voltage network is not available. Due to the low energy requirement, the energy can be derived from transportable accumulators of comparatively low weight, so that the person filming has substantially more flexibility with respect to the selection of the objects to be taken by him. Another advantage is the fact that there is no development of heat as with studio lamps, which is felt to be unpleasant with conventional lighting equipment for filming.

The stroboscopic effect of the flash unit of the invention, which may disturb a person that is to be filmed, can be eliminated by a slight modification of the ignition circuit of the electronic flash unit described. For this purpose, it is arranged that the flash unit should emit a plurality of flashes for each picture of the film, so that the flashlight appliance appears to the viewer as a continuously illuminated source of light. If, for example, three flashes are emitted by the flashlight unit for each picture at a filming rate of 25 pictures per second, then the human eye can no longer discern the individual flash impulses separately. However, in this case the threshold level of the exposure metering device, which indicates a sufficient exposure and at which an ignition signal for the quenching thyristor is emitted, has to be reduced by approximately a third, so that the desired exposure of the single picture is only obtained through the sum of the light fluxes emitted by the three single flashes. In a proposal according to the invention, this mode of operation of the electronic flash unit is brought about in that the ignition circuit for the flash tube consists of the series connection of a capacitor which is chargeable via a resistor, and the primary winding of an impulse transformer, whose secondary winding is connected to the ignition electrode of the flash tube, a thyristor, whose control electrode is connected to the output of an impulse generator, being connected in parallel with the series connection of the condenser and the primary winding. The impulse generator is blocked by a further interlocking element, whose blocking effect can be cancelled for the time of the shutter opening of the moving picture camera.

According to an expedient development of the invention, the interlocking element blocking the impulse generator is carried into effect by a monostable trigger circuit which is connected to the impulse generator and in whose stable condition the impulse generator is blocked and in whose metastable condition the impulse generator is switched on, in which connection the monostable can be triggered into its metastable condition upon the closing of the synchron-

ous contact of the camera and the resetting time of the monostable is set according to the shutter opening time.

An electronic flash unit which is constructed in this manner can be used not only in conjunction with a film camera, as described, but it also presents other advantageous possibilities of use. For example, this unit is particularly suitable for multi-exposure photographs taken with a still picture camera, such as are known for the purpose of demonstrating movement patterns. Whilst in the known methods the shutter of the camera is brought into the open position in a darkened room and single flashes now cover the photographic object in the sequence of its movement, it is possible with the flash unit according to the invention to effect such multi-exposures of the photograph with virtually any desired shutter time, for example in 1/30 sec. When the flash unit according to the invention is used, it is thus possible to take also fast sequences of movement in day light by means of the technique of multi-exposure, an additional advantage being the automatically correct exposure.

An embodiment of the invention is represented in the drawings, in which:—

Figure 1 shows a circuit diagram for a flash unit according to the invention;

Figure 2 shows a modification of the ignition circuit of the flash tube of the electronic flash unit according to Figure 1; and

Figure 3 shows a diagrammatical representation of a film camera, in order to illustrate the mode of operation of the flash unit in conjunction with a film camera.

The storage capacitor 1 (see Figure 1) of the electronic flash unit is charged, via a direct current voltage converter 2, to the operating voltage, for example 360 Volts D.C. The series connection of the flash tube 3 and the switching thyristor 4 is arranged parallel to the storage capacitor 1. The flash tube 3 is ignited by means of an ignition circuit, which consists of an ignition capacitor 5, the primary winding of an ignition transformer 6 and an open contact AB. The synchronous contact 7 of a still or moving picture camera is to be connected to the contact AB. The ignition capacitor 5 can be charged to the operating voltage by the storage capacitor 1 or the voltage converter 2 via a resistor 8. The secondary winding of the ignition transformer 6 is connected to the ignition electrode of the flash tube 3.

In order to quench the switching thyristor 4, the series connection consisting of the quenching capacitor 9 and the quenching thyristor 10 is connected in parallel with it. The quenching capacitor 9 can be charged by the storage capacitor 1 or the voltage converter 2 via a resistor 11. The series

connection of a capacitor 12 and a voltage divider, consisting of the resistors 13 and 14, is connected in parallel with the quenching thyristor 10. The control electrode of the switching thyristor 4 is connected to the divider tap of the voltage divider 13, 14. A diode 15 has a back-to-back connection to the quenching thyristor 10 and a diode 16 has a back-to-back connection to the switching thyristor 4. In addition, a resistor 17 lies in parallel with the switching thyristor 4. A capacitor 18 is furthermore connected in parallel with the voltage divider 13, 14 for the suppression of interference impulses. The quenching thyristor 10 can be ignited via a trigger circuit, consisting of the series connection of a thyristor 19, a capacitor 20 and the primary winding of an impulse transformer 21. For this purpose, the secondary winding of the impulse transformer 21 is connected to the control electrode/cathode path of the ignition thyristor 10. For protection of the thyristor 10, a diode 59 is connected in parallel with the secondary winding. The capacitor 20 can be charged via a voltage divider circuit, which is connected in parallel with the storage capacitor 1 and which consists of the resistors 22 and 23, in accordance with the divider ratio.

The thyristor 19 can be ignited via an exposure metering device, which measures the light emitted by the flash tube and reflected by the object. This exposure metering device consists of the series connection of a photo transistor 24 and an integrating capacitor 25, the control electrode of the thyristor 19 being connected to the connecting point of the photo transistor and the integrating capacitor. A voltage divider circuit, consisting of the resistors 26 and 27, and a Zener diode 28 lies in parallel with this series connection of the photo transistor and the integrating capacitor. The divider tap is connected to the cathode of the thyristor 19. To improve the response of the exposure measurement circuit at close range, a capacitor 29 is connected in parallel with the divider resistor 27. A series connection, consisting of the resistor 30 and the capacitor 31, is disposed between the anode of the flash tube 3 and the anode of the Zener diode 28. It serves for supplying the exposure metering device with power during the flash phase of the electronic flash tube.

Furthermore, there is provided a circuit arrangement 32 for the generation of an ignition impulse for the switching thyristor 4. It comprises a pnp transistor 33, whose emitter/collector path is connected in series with a resistor 34 to a constant voltage source 44 of, for example, 12 Volts. The base of the transistor 33 is connected, via a resistor 35, to its emitter and, via a resistor

36 and a diode 37, to the anode of the thyristor 19 in the trigger circuit for the quenching thyristor 10. The emitter of a uni-junction transistor 40, whose bases are connected to the constant voltage source 44 via the base resistors 41 and 42, is connected to the collector of the transistor 33 via a fixed resistor 38 and a variable resistor 39. The base resistor 42 is connected to the negative pole of the voltage source. A capacitor 43 lies parallel to the series connection of the emitter-base path of the uni-junction transistor 40 and the base resistor 42. The base of the uni-junction transistor 40, which is connected to the base resistor 42, is connected to the control electrode of the switching thyristor 4 via a resistor 58.

The mode of operation of the electronic flash unit according to the invention is as follows:—

When the electronic flash unit is ready for the flash operation, the storage capacitor 1, the quenching capacitor 9, the ignition capacitor 5, the capacitor 12 and the capacitor 31 are charged to the operating voltage, whilst the capacitor 20 is charged to a voltage value that is reduced according to the divider ratio of the voltage divider 22, 23. The transistor 33 is blocked, since its base is connected via the resistor 35 to the positive pole of the direct voltage source 44. Upon the actuation of the camera release, the synchronous contact 7 of the camera is closed, and this happens when the shutter of the still picture camera or the moving picture camera has reached its maximum opening position. Upon the closure of the synchronous contact 7, the ignition capacitor 5 is discharged via the primary winding of the ignition transformer 6, an ignition impulse being generated in the secondary winding, which impulse ignites the flash tube 3 via the ignition electrode. Upon the ignition of the flash tube, the anode potential of the switching thyristor 4 rises suddenly from zero. This potential rise passes via the capacitors 9 and 12 to the control electrode of the switching thyristor 4, so that the latter turns on. Now the storage capacitor 1 is discharged via the flash tube and the switching thyristor, and the flash tube radiates a light flash. At the same time, the capacitor 31 is also discharged via the resistor 30, the flash tube 3, the thyristor 4 and the voltage divider circuit 26 and 27. The voltage dropped across the resistors 26 and 27 is kept at a constant value by the Zener diode 28, so that a constant supply voltage is applied to the series connection of the photo transistor 24 and the integrating capacitor 25. The flash radiated by the flash tube hits the object to be photographed, is reflected from there and passes onto the photo transistor 24. Current flows through the photo transistor 24 dependent on the

intensity of the reflected light and charges the integrating capacitor 25. When the integrating capacitor 25 reaches a specific adjustable predetermined voltage, equal to the cathode potential of the thyristor plus the ignition voltage of the thyristor 19, the thyristor 19 turns on and the capacitor 20 is discharged via the primary winding of the impulse transformer 21. In the secondary winding there develops an ignition impulse, which passes to the control electrode of the quenching thyristor 10 and turns on the latter. Consequently, the quenching capacitor 9 is discharged in known manner via the conducting quenching thyristor 10 and via the diode 16. For the duration of the discharging of the quenching capacitor 9, which is longer than the recovery time of the thyristor 4, a negative voltage, which corresponds to the on-voltage of the diode 16, is applied to the thyristor 4 to block it. The recovery time of the thyristor is approximately $10 \mu\text{sec}$. As soon as the thyristor 4 has blocked, the capacitor 9 is charged in reversed polarity via the still conductive flash tube 3 and the conducting quenching thyristor 10. With the capacitor 9 charged and the thyristor 4 blocked, the flash tube is then quenched, because the high value of the resistor 17 allows only a very small current, and the flash radiation is interrupted. The quenching time of the flash tube is approximately 100 to 200 μsec , calculated from the moment at which the quenching thyristor 10 is triggered.

Upon the firing of the thyristor 19, a negative potential is applied to the base of the transistor 33 of the switching arrangement 32 for the duration of the discharging of the capacitor 20. The transistor 33 becomes conductive and the capacitor 43 can be charged at a time constant determined by the resistor 39. As soon as the capacitor voltage exceeds the breakdown voltage of the uni-junction transistor 40, there develops at the base resistor 42 a voltage impulse which passes to the control electrode of the switching thyristor 4 and ignites the latter once again. The charging time of the capacitor 43 is designed to be longer than the quenching time of the flash tube 3, so that at that moment when the thyristor 4 is ignited once again, the flash tube is already blocked. Since the plate of the quenching capacitor 9 connected to the anode of the switching thyristor 4, now has a positive potential, the quenching capacitor 9 is discharged via the conductive thyristor 4 and the diode 15 when this switching thyristor fires, so that a negative voltage is applied to the quenching thyristor 10 for the duration of the discharging of the quenching capacitor 9 and the quenching thyristor 10 is therefore blocked. The capacitor 9 is now charged rapidly via the resistor 11, which can

be of low resistance and the conductive switching thyristor 4 which time is determined by the value of the resistor 11 and the capacitance value of the capacitor 9. As soon as the charging current through the capacitor 9 and the thyristor 4 falls below the value of the holding current of the thyristor 4, the thyristor 4 blocks and the electronic flash unit is again ready for a flash operation. Upon the decay of the discharge of the capacitor 20 in the trigger circuit, via the thyristor 19, the transistor 33 blocks again, too, so that the circuit arrangement 32 cannot emit any further impulse to the control electrode of the thyristor 4.

In Figure 3, a moving picture camera is shown diagrammatically. The light from the subject being filmed is received through the objective lens 45 of the camera via the picture gate 46 onto the film 47 that is to be exposed. Between the objective lens and the picture gate a rotary disc shutter 48 is arranged, which comprises the opaque sectors 48a and the transparent sectors 48b, the size of which can be varied according to the prevailing exposure conditions. The rotary disc shutter is driven at a constant speed via a toothed gearing 49 and a motor 50. The drive (not shown) for the film strip 47 is also synchronously coupled with the shutter drive. A cam disc 51, which carries two cams 52a and 52b, rotates with the rotary shutter 48. A synchronous contact 53 is arranged in such a way that respectively the cams 52a and 52b close the contact as soon as they abut the lever arm 53a of the synchronous contact, which lever arm projects into their circular path. The cams are arranged in such a way that the synchronous contact is closed whenever the rotary disc shutter completely opens the picture gate to allow the light to reach the film. The connecting wires for the synchronous contact 53 are connected to a socket 54 in the housing wall 55 of the camera. From here they can be connected to the contacts A and B in Figure 1 via a connecting cable 56 terminating in a plug 57. Now the synchronous contact 53 is closed each time the rotary disc shutter 48 completely opens the picture gate, whereby the flash unit emits a flash in the described manner. As soon as the quantity of light that is required for an optimum exposure of the picture has been measured by the exposure metering device, the flash radiation is interrupted in the described manner. Since 18 or 24 pictures are taken per second with a film camera a corresponding number of electronic flashes is triggered via the synchronous contact 53 of the film camera. The exposure of each individual picture is measured automatically and when the correct light value is attained, the flash radiation is interrupted.

In order to bring about the effect that the

individual flash impulses can no longer be perceived by the human eye, it is possible, by way of a simple supplement to the electronic flash unit according to the invention, to trigger several flashes in succession with the rotary shutter fully opened during the single closure of the synchronous contact, so that the flash frequency is increased to such a considerable extent that the flash unit appears as a continuously illuminated source of light to the eye, due to the slow response of the latter. In order to bring about the respective correct exposure of the individual pictures of the picture strip, the threshold value of the integrating capacitor at which value the thyristor 19 ignites, has to be reduced according to the number of the individual flashes per frame. The sum of the flashes which pass onto a picture then gives the desired optimum exposure of the photographic picture. An embodiment of this further development of the invention is shown in Figure 2.

The series connection of a voltage divider, consisting of the resistors 61 and 62, and a synchronous contact 63, which can be carried into effect for instance by the synchronous contact 53 of the moving picture camera shown in Figure 3 or by the synchronous contact of any desired still picture camera, is arranged parallel to a constant voltage source 60, for example 6 Volts d.c. Parallel thereto, the emitter/collector path of a transistor 66 is arranged, in the collector branch thereof a resistor 67 is inserted and the base thereof is connected to the divider tap of the voltage divider 61, 62. The direct voltage source 60 delivers at the same time the supply voltage for an impulse generator 64 and a monostable trigger circuit 65. The collector of the pnp transistor 66 is connected to the one switching transistor 70 of the monostable trigger circuit 65 via a resistor 68 and a capacitor 69. The monostable trigger circuit comprises two npn switching transistors 70, 71, in the collector branch of each a resistor 72 and 73 respectively is inserted. The collector of the switching transistor 70 is connected to the base of the switching transistor 71 via a capacitor 74 and a diode 75. The connecting point between the capacitor 74 and the diode 75 is connected to the positive pole of the supply voltage source 60 via an adjustable resistor 76 and a further resistor 77. The base of the switching transistor 70 is connected via a resistor 78 to the collector of the switching transistor 71 which collector is also connected, via a resistor 79 to the base of a npn transistor 80. The transistor 80 has a resistor 81 and a resistor 91 provided in the collector branch thereof parallel to the direct voltage source 60. Its collector is also connected via the resistor 91 to the base of a pnp transistor 82, which is part of an impulse

generator 64. In the collector branch of the transistor 82, which is also arranged parallel to the direct voltage source 60, there is provided a resistor 83, with which the series connection of a fixed resistor 92, and a variable resistor 84 is provided together with a capacitor 85 connected in parallel. The emitter of a uni-junction transistor 86, whose bases are connected to the direct voltage source 60 via the resistors 87 and 88, is connected to the connecting point between the resistor 84 and the capacitor 85. The base resistor 88 is applied to the negative pole of the direct voltage source 60. The control electrode of a thyristor 90 is connected via a resistor 89 to the base of the uni-junction transistor 86 connected to the resistor 88. The anode of the thyristor 90 is connected to the contact A and the cathode of the thyristor 90 is connected to the contact B shown in Figure 1, the synchronous contact 7 shown in Figure 1 being dispensed with.

The mode of operation of this circuit arrangement, as shown in Figure 2 in conjunction with Figure 1, is as follows:—

The electronic flash unit is in a position of readiness. The transistor 66 is blocked, the transistor 71 is conductive, since its base is connected to the positive pole of the direct voltage source via the diode 75 and the adjustable resistor 76. But when the transistor 71 is conductive, the base of the switching transistor 70 is applied to the negative pole of the direct voltage source, so that the same is blocked and the monostable circuit is in its stable condition. Due to the conducting transistor 71, the transistor 80 is also blocked and, as a result, the transistor 82 is also not conductive, so that the impulse generator 64 is switched off. If the synchronous contact 63 is now closed, then the transistor 66 becomes conductive and a positive impulse passes to the base of the switching transistor 70, which pulse causes the transistor 70 to conduct. When the transistor 70 becomes conductive, a negative impulse passes to the base of the transistor 71 via the capacitor 74, so that this transistor blocks and the base of the transistor 70 is connected to the positive pole of the direct voltage source via the resistors 73 and 78. With the blocking of the transistor 71 the transistor 80 becomes conductive and consequently also the transistor 82. The capacitor 85 is now charged at a time constant that is determined by the adjustable resistor 84 until the breakdown voltage of the uni-junction transistor 86 is reached and the capacitor is discharged via the emitter/base path of the uni-junction transistor and the resistor 88. Through the voltage drop at the resistor 88 an ignition impulse develops at the control electrode of the thyristor 90, so that the thy-

ristor 90 becomes conductive. The firing of the thyristor 90 corresponds to the closing of the synchronous contact 7 in the description relating to Figure 1, so that there now follows the above-described process of the ignition of the flash tube, the light measurement and the switching-off of the flash radiation. Whilst the flash tube is quenched again in the described manner, the capacitor 85 has been discharged to such an extent that the uni-junction transistor 86 blocks again and the charging of the capacitor 85 occurs once more via the resistor 84. When the threshold voltage is reached, the uni-junction transistor ignites once more, the thyristor 90 becomes conductive once more and the flash tube is again ignited in the described manner, the light radiated by its is measured and after an adjustable time dependent on the reflected light the flash radiation is again interrupted by the ignition of the thyristor 19 (of Figure 1). The frequency of the ignition impulses for the thyristor 90, and consequently the number of flashes, is adjustable by means of the variable resistor 84. The minimum charging time of the capacitor 85 must be considered which elapses with a maximum distance of the flash unit (or the camera respectively) from the subject being filmed from the moment of the ignition of the flash tube to the moment of the recharging of the quenching capacitor 9 according to the description relating to Figure 1.

The impulse generator 64 can work as long as the monostable circuit is in its metastable condition, i.e. as long as the switching transistor 71 is blocked and the transistor 70 is conductive. The monostable period is determined by the charging of the capacitor 74 via the adjustable resistor 76. With the transistor 70 conducting, the capacitor 74 is charged, whereby a positive potential reaches the base of the transistor 71. When the potential at the plate of the capacitor 74 connected to the anode of the diode 75, exceeds the emitter potential of the transistor 71 by the voltage drop of the diode 75 and of the base/emitter junction of the transistor 71, then the transistor 71 becomes conductive, whereby a negative potential reaches both the base of the transistor 70 and the base of the transistor 80. The transistors block, the monostable resumes its stable condition and the impulse generator 64 is switched off. The resetting time (monostable period) circuit of the monostable must therefore be adapted to the shutter opening time of the still picture camera or film camera, so that upon a renewed closure of the synchronous contact with the shutter opened once more, the described process can be initiated again.

The circuit arrangement according to Figure 2 in conjunction with Figure 1 can be

advantageously used not only for moving picture cameras but also for still picture cameras when so-called multi-exposure photographs are to be taken, i.e. when the same picture is exposed several times. If the adjusting resistor 76 is coupled with the setting mechanism for the shutter opening time and the setting of the resistor 76 is adapted to the selected shutter opening time accordingly, it is possible to bring about, with optional shutter opening times, any desired number of exposures for each picture by means of the adjustable resistor 84.

WHAT WE CLAIM IS:—

1. An electronic flash unit with automatic exposure control comprising a flash tube and a switching thyristor connected in series across an energy source;

a quenching capacitor and a quenching thyristor connected in series and connected in parallel with the anode-cathode path of the switching thyristor, said quenching capacitor being chargeable from said energy source via a first resistor;

a light sensing circuit connected to the control electrode of said quenching thyristor to trigger the latter on receipt of a predetermined quantity of light and discharge said quenching capacitor to effect blocking of said switching thyristor;

and means for applying a reverse voltage to said quenching thyristor to effect reblocking thereof a predetermined time after the blocking of said switching thyristor.

2. An electronic flash unit as claimed in Claim 1, wherein said means for applying a reverse voltage to effect reblocking of said quenching thyristor comprises a circuit connected to said light sensing circuit and to said switching thyristor to detect the triggering of said quenching thyristor and to provide retriggering of said switching thyristor after the quenching of the flash emission to effect rapid blocking of said quenching thyristor.

3. An electronic flash unit as claimed in Claim 2, wherein said circuit provides a retriggering pulse to the control electrode of the switching thyristor after a time, exceeding the quenching time of the flash tube.

4. An electronic flash unit as claimed in Claim 2 or 3, wherein said circuit comprises a timing element and an interlocking element which blocks the timing element and which can be unlocked upon the ignition of the quenching thyristor for at least said predetermined time period.

5. A moving picture camera in combination with an electronic flash unit as claimed in any one of the preceding claims, wherein ignition of the flash tube is synchronised with the open shutter position of the moving picture camera.

6. An electronic flash unit as claimed in



1,479,844

7

ristor 90 becomes conductive. The firing of the thyristor 90 corresponds to the closing of the synchronous contact 7 in the description relating to Figure 1, so that there now follows the above-described process of the ignition of the flash tube, the light measurement and the switching-off of the flash radiation. Whilst the flash tube is quenched again in the described manner, the capacitor 85 has been discharged to such an extent that the uni-junction transistor 86 blocks again and the charging of the capacitor 85 occurs once more via the resistor 84. When the threshold voltage is reached, the uni-junction transistor ignites once more, the thyristor 90 becomes conductive once more and the flash tube is again ignited in the described manner, the light radiated by its is measured and after an adjustable time dependent on the reflected light the flash radiation is again interrupted by the ignition of the thyristor 19 (of Figure 1). The frequency of the ignition impulses for the thyristor 90, and consequently the number of flashes, is adjustable by means of the variable resistor 84. The minimum charging time of the capacitor 85 must be considered which elapses with a maximum distance of the flash unit (or the camera respectively) from the subject being filmed from the moment of the ignition of the flash tube to the moment of the recharging of the quenching capacitor 9 according to the description relating to Figure 1.

The impulse generator 64 can work as long as the monostable circuit is in its metastable condition, i.e. as long as the switching transistor 71 is blocked and the transistor 70 is conductive. The monostable period is determined by the charging of the capacitor 74 via the adjustable resistor 76. With the transistor 70 conducting, the capacitor 74 is charged, whereby a positive potential reaches the base of the transistor 71. When the potential at the plate of the capacitor 74 connected to the anode of the diode 75, exceeds the emitter potential of the transistor 71 by the voltage drop of the diode 75 and of the base/emitter junction of the transistor 71, then the transistor 71 becomes conductive, whereby a negative potential reaches both the base of the transistor 70 and the base of the transistor 80. The transistors block, the monostable resumes its stable condition and the impulse generator 64 is switched off. The resetting time (monostable period) circuit of the monostable must therefore be adapted to the shutter opening time of the still picture camera or film camera, so that upon a renewed closure of the synchronous contact with the shutter opened once more, the described process can be initiated again.

The circuit arrangement according to Figure 2 in conjunction with Figure 1 can be

advantageously used not only for moving picture cameras but also for still picture cameras when so-called multi-exposure photographs are to be taken, i.e. when the same picture is exposed several times. If the adjusting resistor 76 is coupled with the setting mechanism for the shutter opening time and the setting of the resistor 76 is adapted to the selected shutter opening time accordingly, it is possible to bring about, with optional shutter opening times, any desired number of exposures for each picture by means of the adjustable resistor 84.

WHAT WE CLAIM IS:—

1. An electronic flash unit with automatic exposure control comprising a flash tube and a switching thyristor connected in series across an energy source;

a quenching capacitor and a quenching thyristor connected in series and connected in parallel with the anode-cathode path of the switching thyristor, said quenching capacitor being chargeable from said energy source via a first resistor;

a light sensing circuit connected to the control electrode of said quenching thyristor to trigger the latter on receipt of a predetermined quantity of light and discharge said quenching capacitor to effect blocking of said switching thyristor;

and means for applying a reverse voltage to said quenching thyristor to effect re-blocking thereof a predetermined time after the blocking of said switching thyristor.

2. An electronic flash unit as claimed in Claim 1, wherein said means for applying a reverse voltage to effect reblocking of said quenching thyristor comprises a circuit connected to said light sensing circuit and to said switching thyristor to detect the triggering of said quenching thyristor and to provide retriggering of said switching thyristor after the quenching of the flash emission to effect rapid blocking of said quenching thyristor.

3. An electronic flash unit as claimed in Claim 2, wherein said circuit provides a retriggering pulse to the control electrode of the switching thyristor after a time, exceeding the quenching time of the flash tube.

4. An electronic flash unit as claimed in Claim 2 or 3, wherein said circuit comprises a timing element and an interlocking element which blocks the timing element and which can be unlocked upon the ignition of the quenching thyristor for at least said predetermined time period.

5. A moving picture camera in combination with an electronic flash unit as claimed in any one of the preceding claims, wherein ignition of the flash tube is synchronised with the open shutter position of the moving picture camera.

6. An electronic flash unit as claimed in

22



1,479,844

3

- any one of Claims 1 to 4, wherein an ignition circuit for the flash tube comprises a second capacitor connected in series with the primary winding of an impulse transformer which capacitor is chargeable via a second resistor, said transformer including a secondary winding connected to the ignition electrode of the flash tube.
7. A moving picture camera in combination with an electronic flash unit as claimed in Claim 6, wherein the synchronous contact of the moving picture camera is connected in parallel with the series connection of said second capacitor and the primary winding of said impulse transformer.
8. An electronic flash unit as claimed in Claim 6, wherein a further thyristor having a control electrode connected to the output of a pulse generator, is connected in parallel with the series connection of said second capacitor and the primary winding of said impulse transformer.
9. A moving picture camera or still camera in combination with electronic flash unit as claimed in Claim 8, wherein inhibit means are provided to block the pulse generator, the blocking effect thereof being

removable for the time when the shutter of the moving picture camera or the still picture camera is opened.

10. A combination as claimed in Claim 9, wherein said inhibit means comprises a monostable circuit connected to the pulse generator and during the stable state thereof the pulse generator is blocked and during the metastable state thereof the pulse generator is switched on.

11. A combination as claimed in Claim 10, wherein said monostable circuit is triggered into the metastable condition on closure of the synchronous contact of the camera and remains in this condition for a period dependent on the shutter opening time.

12. An electronic flash unit, substantially as described herein with reference to and as illustrated by the accompanying drawings.

13. A camera in combination with a flash gun substantially as described herein.

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