

PATENT SPECIFICATION

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(54) ELECTRONIC FLASH GUN FOR PHOTOGRAPHIC PICTURE-TAKING PURPOSES

(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:—

The present invention relates to an electronic flash gun circuit for photographic picture-taking purposes in which a flash tube discharge is interrupted by a photoelectric measuring device when a predetermined light quantity is reached. In such arrangements a part of the light radiated by the electronic flash and reflected by the subject is measured and the result of the measurement is used to control the duration of the flash tube discharge, in that the discharge is interrupted for example by short-circuiting into the discharge circuit or by takeover of the discharge by connection of a capacitor.

However all circuit arrangements of the stated kind which have become known possess disadvantages. In the short-circuit arrangements the residual energy of the storage capacitor is lost; in the case of feed of a counter-current a great energy is required to quench the discharge, which energy moreover must be maintained until the flash tube is completely de-ionised; in the case of takeover of the discharge on to a capacitor the taken-over energy can in fact be recovered but for this purpose in addition to this capacitor of high electric strength and high capacitance, further de-coupling switching means, that is to say great additional expense, are necessary.

According to the present invention there is provided an electronic flash gun circuit, including a flash tube, a storage capacitor connected with the flash tube for discharge therethrough, a triggerable semiconductor switch connected in series with the flash

tube across the storage capacitor for controlling discharge of the storage capacitor therethrough, a first capacitor and an electronic switch connected in parallel with the semiconductor switch with the electronic switch connected to the negative terminal of the storage capacitor, a bridging resistor also connected in parallel with the semiconductor switch, a resistor connected with the positive terminal of the storage capacitor and the connection point between the series connected first capacitor and electronic switch, a second capacitor connected to the said connection point and connected in series with a resistance voltage divider which is connected to the negative terminal of the storage capacitor, the trigger electrode of the semiconductor switch being connected to the voltage divider, and a photoelectric measuring device connected with the electronic switch for triggering the same, wherein upon initiation of the flash circuit the flash tube is ionised prior to the triggering of the semiconductor switch, such ionisation causing the semiconductor switch to be triggered which effects discharge of the storage capacitor through the flash tube, the photoelectric measuring device being operable to trigger the electronic switch and thereby extinguish the flash tube when said measuring device has been exposed to a predetermined flash light quantity.

In a one advantageous form of embodiment of the invention the resistance voltage divider is bridge over with a capacitor. In order to reduce the current peaks in the switching on of the triggerable electronic switch and in the switching off of the triggerable semiconductor switch, it is expedient to connect an inductance in series with the anode-cathode path of the triggerable electronic switch.

There may be provided an electronic flash gun of the initially stated kind in which a reliable, accurately timed ignition and quenching of the flash tube discharge and thus a precise determination of the light

[[Price 33p]]

pulse duration are achieved with simple means and low expense.

According to a further aspect of the invention there is provided an electronic flash gun including a flash gun circuit as just described.

A constructional embodiment of the present invention will now be described, by way of example with reference to the accompanying drawing which shows a circuit arrangement of an electronic flash gun according to the invention, the parts inessential to the description being omitted.

Referring now to the drawing in more detail there is shown a direct-current voltage transformer 1, from a low battery voltage U_1 of which there is obtained a higher direct-current voltage U_2 necessary for the operation of a flash tube 2 and for charging up the storage capacitor 3. The positive pole of the voltage transformer 1 is connected at the same time with an anode 4 of the flash tube 2, the negative pole with the earth 0 of the circuit arrangement. Parallel with the flash or storage capacitor 3 there lies a voltage divider 5, 6 from which the voltage for an ignition capacitor 7 is taken. On closure of an ignition switch 8 the ignition capacitor 7 discharges through a primary winding 9 of ignition transformer 10; the ignition voltage generated in secondary winding 11 is conducted to an ignition electrode 12 of the flash tube 2.

In series with the flash tube 2, between cathode 13 of the flash tube 2 and the negative connection of the storage capacitor 3, a resistor 14 is connected which in turn bridges over the anode-cathode path 15—16 of a triggerable semi-conductor switch 17. The series connection of a capacitor 18 and the anode-cathode path 19—20 of a further electronic switch 22 which is triggerable by a photoelectric measuring device 21, lies in parallel with the anode-cathode path 15—16 of the semi-conductor switch 17. As represented in the Figure, this switch component 22 can be a triggerable semi-conductor switch, but equally a triggerable electronic switch of other construction style, for example a triggerable gas discharge tube.

Between the capacitor 18 and the anode 19 of the semi-conductor switch 22 an inductance 23, represented in chain lines, can be interposed. The connection point 24 of the capacitor 18 and of the semi-conductor switch 22 is connected through a resistor 25 with the positive connection of the storage capacitor 3.

Between the point 24 and the earth 0 of the circuit arrangement the series connection of a capacitor 26 and a resistance voltage divider 27, 28 is interposed, from which the voltage for the trigger electrode 29 of the semi-conductor switch 17 is tap-

ped. A capacitor 30 is arranged in parallel with the voltage divider 27, 28.

An ignition pulse occurring on closure of the ignition switch 8 on the ignition electrode 12 of the flash tube 2 effects the ionisation of the gas filling of the flash tube 2, whereby the latter becomes conductive between its anode 4 and its cathode 13. The positive pulse then occurring between the cathode 13 and the zero potential of the circuit arrangement through the resistor 14 is conducted by way of the capacitor 18, the capacitor 26, the voltage divider 27, 28 to the trigger electrode 29 of the semi-conductor switch 17 and effects the switching through of its anode-cathode path 15—16. Thus the resistor 14 is short-circuited except for the very slight residual voltage of the semi-conductor switch 17, and the current necessary for the generation of the full flash energy commences to flow in the flash tube 2.

According to the voltage necessary for the triggering of the semi-conductor switch 17, the voltage divider 27, 28 can also be adjusted so that the full voltage on the connection point of the components 26 and 27 effects the triggering.

The triggering of the semi-conductor switch 17 is not effected in the present arrangement simultaneously with the ignition of the flash tube 2, which would be obvious, but only by the ionisation of the flash tube 2 initiated through the resistor 14 by the ignition. Thus a smooth and uniform onset of the main discharge of the storage capacitor 3 through the flash tube 2 is achieved, since the main discharge proceeds through the semi-conductor switch 17 and the flash tube is ready pre-ionised on commencement of the main discharge. Thus a reliable ignition is ensured and the storage capacitor 3 and the flash tube 2 are protected against an uncontrolled current rise, such as can occur if the flash tube 2 is not pre-ionised.

Since for reasons which will be discussed further below the capacitor 18 is considerably larger than the capacitor 26, the time constant of the series connection of the capacitors 18 and 26 with the resistance voltage divider 27, 28 is determined substantially by the time constant of the series connection of the components 26 and 27, 28. This latter time constant is so selected that the components 26 and 27, 28 form a high-pass filter for the transmission of the frequency proportions, necessary for the triggering of the semi-conductor switch 17, of the pulse occurring over the resistor 14 in the ignition of the flash tube 2, to the trigger electrode 29 of the semi-conductor switch 17.

The high-pass filter 26, 27, 28 effects a differentiation of the trigger pulse for the

semi-conductor switch 17. Thus only a steep voltage rise comes to act on the trigger path 29—16 of the semi-conductor switch 17.

Light 31 radiated by the flash tube 2 is partly reflected by the subject. A part 32 of this reflected light is absorbed by a photoelectric measuring device 21 and converted into a measurement value, for the light quantity at the position of the photoelectric measuring device 21, from the beginning of the flash discharge onwards. When a set value is reached the photoelectric measuring device 21 gives a pulse to the trigger electrode 33 of the triggerable electronic switch 22 whereby the switch path 19—20 of the latter becomes conductive and discharges the capacitor 18 which was charged up after the occurrence of the voltage U_2 , that is after the switching on of the appliance, through the resistors 25 and 14 to the voltage U_2 . Thus the voltage on the anode 15 of the semi-conductor switch 17 goes negative. The discharge circuit is closed through the semi-conductor switch 17 which is conductive at this moment, the discharge current is directed oppositely to the flash tube current, flowing at the same time through the semi-conductor switch 17, and suppresses this current. Since at this moment no trigger signal is present on the trigger electrode 29 of the semi-conductor switch 17. This switch blocks whereby the flash tube circuit is interrupted and the flash tube 2 is extinguished. The capacitance of the capacitor 18 must be sufficiently great so that the negative blocking pulse occurring on the anode 15 of the semi-conductor switch is present during the entire liberation time of the semi-conductor switch 17 and the latter does not switch through again after a premature drop-off of the blocking current. By liberation time there is understood the time which is necessary for the clearing of the P-N-junctions of a triggerable semi-conductor switch from charge carriers.

Since however the liberation time of a triggerable semi-conductor switch is very much less than that of a gas discharge tube, very much less energy is required for its blocking and the capacitor 18 can be substantially smaller than the storage capacitor 3.

The liberation time of a triggerable semi-conductor switch can be reduced if during the blockage by a counter-current pulse a negative voltage is applied between its trigger electrode and its cathode. This is effected in the present arrangement in a simple way by the inverse charging of the capacitor 26, through which the trigger pulse is also conducted to the semi-conductor switch 17. As on the capacitor 18, on the capacitor 26 also a negative voltage pulse occurs, due to the discharge com-

mencing on switching on of the electronic switch 22, at the connection point of the capacitor 26 and of the resistor 27, which pulse is applied for the duration of the discharge through the resistance voltage divider 27, 28 to the trigger electrode 29 of the semi-conductor switch 17. Thus a more rapid clearing of the P-N-junctions and a shorter liberation time are achieved. Consequently the capacitance of the capacitor 18 can be further reduced in comparison with a circuit without this additional negative voltage on the trigger electrode. This signifies that the energy which must be consumed for the termination of the flash tube discharge is reduced. Likewise the charging time of the capacitor 18 is shortened, which is in favour of a more rapid flash sequence.

After the blocking of the semi-conductor switch 17 and the discharge of the capacitors 18 and 26, the voltage on the anode 15 of the semi-conductor switch 17 rises for the time until the flash tube 2 is de-ionised. The de-ionisation time of the flash tube 2 is considerably longer than the liberation time of the semi-conductor switch 17. However as a result of the recharging of the capacitor 18 through the resistors 25 and 14 this rise is delayed, so that through the high-pass filter 26, 27, 28 no voltage adequate for the triggering of the semi-conductor switch 17 can arrive at its trigger electrode 29. Due to the high-pass filter action thus switching through of the semi-conductor switch 17 and thus renewed ignition of the flash tube 2 before its de-ionisation are prevented.

The resistor 25 must be so dimensioned that the holding current of the electronic switch 22 is not reached after the discharge of the capacitors 18 and 26, that is this switch becomes non-conductive. This contradictory to the requirement for a rapid recharging of the capacitor 18, equivalent to a rapid renewed operational readiness of the electronic flash gun. The capacitor 30 lying in parallel with the resistance voltage divider 27, 28, together with the capacitor 26 in series with it, acts at the commencement of re-charging through the resistor 25 as short-circuit of the switch pulse 19, 20 of the electronic switch 22 and thus reduces the voltage on the latter so far as the fall short of the holding current. Thus reliable switching off of the electronic switch 22 is guaranteed.

The inductance 23 lying in series with the electronic switch 22 reduces the peak current and the current slope in the semi-conductor switch 17 and in the electronic switch 22 and thus opposes destruction of these components. Moreover due to the inductance 23 the blocking pulse occurring on the anode 15 of the semi-conductor switch 17 on switching on of the electronic

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switch 22 becomes wider, so that the voltage on the anode 15 is negative for a longer time and thus the preservation time of the semiconductor switch 17 is increased, that is the time in which it cannot be made conductive by triggering. A further advantageous effect of the inductance 23 is a slight increase of the trigger pulse for the semiconductor switch 17 occurring over the resistor 14 on ignition of the flash tube 2.

WHAT WE CLAIM IS:—

1. An electronic flash gun circuit, including a flash tube, a storage capacitor connected with the flash tube for discharge therethrough, a triggerable semiconductor switch connected in series with the flash tube across the storage capacitor for controlling discharge of the storage capacitor therethrough, a first capacitor and an electronic switch connected in parallel with the semiconductor switch with the electronic switch connected to the negative terminal at the storage capacitor, a bridging resistor also connected in parallel with the semiconductor switch, a resistor connected with the positive terminal of the storage capacitor and the connection point between the series connected first capacitor and electronic switch, a second capacitor connected to the said connection point and connected in series with a resistance voltage divider which is connected to the negative terminal of the storage capacitor, the trigger electrode of the semiconductor switch being connected to the voltage divider, and a photoelectric measuring device connected with the electronic switch for triggering the same, wherein upon initiation of the flash

circuit the flash tube is ionised prior to the triggering of the semiconductor switch, such ionisation causing the semiconductor switch to be triggered, which effects discharge of the storage capacitor through the flash tube, the photoelectric measuring device being operable to trigger the electronic switch and thereby extinguish the flash tube when said measuring device has been exposed to a predetermined flash light quantity.

2. A circuit as claimed in Claim 1, wherein the time constant of the series-connection of the second capacitor and of the resistance voltage divider is such that these form a high-pass filter for the transmission to the trigger electrode of the semiconductor switch, of the frequency proportions, necessary for the triggering of the semiconductor switch, of the pulse occurring over the bridging resistor on ignition of the flash tube.

3. A circuit as claimed in Claim 1 or 2, wherein the resistance voltage divider is bridged over with a third capacitor.

4. A circuit as claimed in Claim 1, 2 or 3, further comprising an inductance connected in series with the anode-cathode path of the triggerable electronic switch.

5. A flash gun circuit substantially as described herein with reference to, and as illustrated by, the accompanying drawing.

6. An electronic flash gun including a flash gun circuit as claimed in Claim 1.

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circuit the flash tube is ionised prior to the triggering of the semiconductor switch, such ionisation causing the semiconductor switch to be triggered, which effects discharge of the storage capacitor through the flash tube, the photoelectric measuring device being operable to trigger the electronic switch and thereby extinguish the flash tube when said measuring device has been exposed to a predetermined flash light quantity.

2. A circuit as claimed in Claim 1, wherein the time constant of the series-connection of the second capacitor and of the resistance voltage divider is such that these form a high-pass filter for the transmission to the trigger electrode of the semiconductor switch, of the frequency proportions, necessary for the triggering of the semiconductor switch, of the pulse occurring over the bridging resistor on ignition of the flash tube.

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