

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO SUPPLY CIRCUITS FOR FLASH TUBES

(71) We, FRANKE & HEIDECHE G.m.b.H., 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 a supply circuit for a flash tube of the type in which additional storage capacitors are used to selectively control the amount of charge applied across the flash tube. The main purpose of such systems is to avoid waste of energy.

If desired the control of charge can be achieved automatically by photo-electric means which detect the level of light in which the equipment is to be used.

However, when the additional capacitors are selected by electro-mechanical means, for example switches, and with the various capacitors each charged up to a different level, the switching contacts may be subjected to high loads, as a result of which they burn out. In order to avoid this, resistors may be connected in parallel with the switches, although this leads to losses of energy both in the charging process and in the operation of the flash.

According to the present invention there is provided a supply circuit for a flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

The invention ensures that the two or more capacitors are not combined until the moment of the flash operation i.e. the moment when the voltage across the main capacitor has reached a sufficient level to cause the flash tube to operate. Thus the operating switch is only subjected to a low

trigger current. The equipment also enables comparatively high capacitor charges to be combined without difficulty, and without energy losses, by means of operating switches only subjected to a low load. In view of this low switch loading the invention can also be advantageously applied when photo-electrically or other electronically controlled switching elements are employed in place of mechanical switches.

According to a further feature of the invention there is provided a flash light apparatus including a flash tube, a supply circuit having an output connected with the flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

In order that the invention may be better understood an embodiment thereof will now be described by way of example only and with reference to the accompanying drawing which shows the circuit diagram of an embodiment of the discharge flash equipment of the invention.

Referring to the drawing, the equipment comprises a main capacitor 1 which is charged from a suitable power source (not shown) via an input terminal 1 and a diode rectifier 3. This part of the circuit is conventional in discharge flash apparatus, the capacitor 1 charging up until the threshold voltage of a flash tube (not shown) connected to an output terminal 6 is reached. The flash tube then fires, the capacitor 1 rapidly discharging across the flash tube.

In the present circuit, however, a single additional capacitor 4 is connected as shown and is charged from the terminal 2 via the diode rectifiers 3 and 5. A resistor-capacitor differentiating circuit, comprising resistor 11 and capacitor 9 is connected across the positive terminals of capacitors 1 and 4 in order to detect the rate of change of varia-

tion of voltage difference between the main capacitor 1 and the additional capacitor 4. The output of the differentiating circuit, i.e. the junction of resistor 11 and capacitor 9, is connected to a switch 8 and thence via a diode 10 to the trigger electrode of the thyristor 7.

The thyristor 7 connects the positive terminal of capacitor 4 to the output terminal 6 and its polarity is such that, when switched on, it allows discharge of the capacitor 4 into the flash tube. The thyristor has no effect on the charging process.

A resistor 12 is connected in parallel with the switch 8, diode 10 and resistor 11, and serves to connect one plate of capacitor 9 to the terminal 6 so that upon completion of operation of the supply circuit the plate of capacitor 9 always has the same potential as the cathode and control grid electrodes of the thyristor 7.

The operation of the circuit is as follows:—

The capacitors 1 and 4 charge up from the power source, as described above. When the voltage across the capacitor 1 reaches a sufficient level, the flash tube fires and the capacitor 1 begins to discharge rapidly through the flash tube. The capacitor 4, however, holds its charge in view of the connection of diode 5 and blocked thyristor 7 with the result that the rate of change of voltage at the positive terminals of capacitors 1 and 4 is quite different. The differentiating circuit detects this rate of change and, if switch 8 is closed, triggers the thyristor 7 to conduct, thus allowing capacitor 4 to discharge into the flash tube. Hence with the thyristor 7 switched on, the capacitors 1 and 4 are effectively connected in parallel for discharge purposes thus permitting a greater or lesser charge to be passed to the flash tube in dependence on whether the switch 8 is closed or open.

The switch 8 is provided between the capacitor 9 and the resistor 11 to allow selection of whether only the capacitor 1 is to be discharged or whether after a definite discharging time of the capacitor 1 the capacitor 4 is to be discharged. With the switch contacts of switch 8 closed the circuit operates as described above, however, with the switch contacts open only capacitor 1 discharges via the flash tube connected to terminal 6. As described above the plate of capacitor 9 connected with resistor 12 has the same potential as the cathode and control grid electrodes of the thyristor. Consequently, when the switch 8 is closed unintentional ignition of the thyristor 7 when capacitor 4 is charged and capacitor 1 discharged is prevented. The diode 10 serves as an isolation diode to prevent any oscillations on the control grid of the thyristor 7

from being fed back to capacitor 4 via capacitor 9.

The contacts of the switch 8, being in the low-power trigger circuit of the thyristor pass only a small current and are not therefore liable to early failure. The resistor 11 also serves as the trigger to cathode shunt resistor of the thyristor.

It will be clear that still further additional capacitors may be used if a greater collective charge is required.

WHAT WE CLAIM IS:—

1. A supply circuit for a flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

2. A circuit as claimed in claim 1, wherein one terminal of each of the capacitors is connected together, the remaining terminals being connected to said differentiating means which comprises a resistor-capacitor differentiating circuit whose output is connected to the thyristor trigger electrode.

3. A circuit as claimed in claim 2, wherein the thyristor is connected between said remaining terminal of the or each additional capacitor and an output terminal for connection to the flash tube.

4. A circuit as claimed in any of claims 1 to 3, wherein a manually operable switch is provided in the ignition circuit of the thyristor to provide the selective triggering thereof.

5. A supply circuit for a flash tube substantially as hereinbefore described with reference to the accompanying drawing.

6. A flashlight apparatus including a flash tube, a supply circuit having an output connected with the flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

7. A flash light apparatus as claimed in claim 6 substantially as hereinbefore described with reference to the accompanying drawing.

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tion of voltage difference between the main capacitor 1 and the additional capacitor 4. The output of the differentiating circuit, i.e. the junction of resistor 11 and capacitor 9, is connected to a switch 8 and thence via a diode 10 to the trigger electrode of the thyristor 7.

The thyristor 7 connects the positive terminal of capacitor 4 to the output terminal 6 and its polarity is such that, when switched on, it allows discharge of the capacitor 4 into the flash tube. The thyristor has no effect on the charging process.

A resistor 12 is connected in parallel with the switch 8, diode 10 and resistor 11, and serves to connect one plate of capacitor 9 to the terminal 6 so that upon completion of operation of the supply circuit the plate of capacitor 9 always has the same potential as the cathode and control grid electrodes of the thyristor 7.

The operation of the circuit is as follows:—

The capacitors 1 and 4 charge up from the power source, as described above. When the voltage across the capacitor 1 reaches a sufficient level, the flash tube fires and the capacitor 1 begins to discharge rapidly through the flash tube. The capacitor 4, however, holds its charge in view of the connection of diode 5 and blocked thyristor 7 with the result that the rate of change of voltage at the positive terminals of capacitors 1 and 4 is quite different. The differentiating circuit detects this rate of change and, if switch 8 is closed, triggers the thyristor 7 to conduct, thus allowing capacitor 4 to discharge into the flash tube. Hence with the thyristor 7 switched on, the capacitors 1 and 4 are effectively connected in parallel for discharge purposes thus permitting a greater or lesser charge to be passed to the flash tube in dependence on whether the switch 8 is closed or open.

The switch 8 is provided between the capacitor 9 and the resistor 11 to allow selection of whether only the capacitor 1 is to be discharged or whether after a definite discharging time of the capacitor 1 the capacitor 4 is to be discharged. With the switch contacts of switch 8 closed the circuit operates as described above, however, with the switch contacts open only capacitor 1 discharges via the flash tube connected to terminal 6. As described above the plate of capacitor 9 connected with resistor 12 has the same potential as the cathode and control grid electrodes of the thyristor. Consequently, when the switch 8 is closed unintentional ignition of the thyristor 7 when capacitor 4 is charged and capacitor 1 discharged is prevented. The diode 10 serves as an isolation diode to prevent any oscillations on the control grid of the thyristor 7

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It will be clear that still further additional capacitors may be used if a greater collective charge is required.

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1. A supply circuit for a flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

2. A circuit as claimed in claim 1, wherein one terminal of each of the capacitors is connected together, the remaining terminals being connected to said differentiating means which comprises a resistor-capacitor differentiating circuit whose output is connected to the thyristor trigger electrode.

3. A circuit as claimed in claim 2, wherein the thyristor is connected between said remaining terminal of the or each additional capacitor and an output terminal for connection to the flash tube.

4. A circuit as claimed in any of claims 1 to 3, wherein a manually operable switch is provided in the ignition circuit of the thyristor to provide the selective triggering thereof.

5. A supply circuit for a flash tube substantially as hereinbefore described with reference to the accompanying drawing.

6. A flashlight apparatus including a flash tube; a supply circuit having an output connected with the flash tube comprising a main capacitor for discharge into the flash tube; at least one additional capacitor selectively connectible for discharge into the flash tube via a thyristor; and means for differentiating the difference in voltage across the main capacitor and the or each additional capacitor to generate an ignition pulse to ignite the thyristor.

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