

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN AND RELATING TO ELECTRONIC FLASH

(71) We, AGFA-GEVAERT AKTIEN-
GESSELLSCHAFT, a body corporate organised
according to the laws of the Federal Re-
public of Germany, of Leverkusen, Federal
5 Republic of 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 particu-
larly described in and by the following
10 statement:—

The invention relates to ignition of elec-
tronic flash apparatus, and especially in
photographic equipment.

A flashbulb requires a certain time in
15 which to reach its maximum brightness and
therefore in photographic applications the
ignition point is advanced in relation to the
opening of a camera shutter so that the
maximum light intensity is generated when
20 the shutter is fully open. In contrast, the
ignition of an electronic flash tube must be
retarded with respect to the point at which
the camera shutter becomes fully open be-
cause an electronic flash tube has a faster
25 response than a flash bulb.

An object of the invention is to provide
a device in which an initiating voltage pulse
which may be used to ignite a flashbulb is
utilised for the ignition at the correct time
30 of the electronic flash tube of an electronic
flash apparatus.

According to the invention electronic
flash apparatus which, in operation, is ig-
nited by an initiating voltage pulse but at
35 a predetermined time after the initiating
voltage pulse occurs, comprises a flash tube
and a voltage converter adapted to accept
an input voltage and to provide an output
voltage on output terminals which are con-
40 nected to the flash tube, an ignition circuit
for the flash tube comprising an ignition
capacitor which is arranged to be charged
by a current from the voltage converter, a
pulse transformer connected to the ignition
45 capacitor, and a threshold switch, a timing

circuit including a stabilised voltage source
connected to the output of the voltage con-
verter and an electronic switch arranged such
that a, in operation, the electronic switch is
turned on by the initiating voltage pulse and 50
conducts for a time during which current
from the stabilised source and flowing in
the timing circuit is accumulated and used
to trigger the threshold switch, the electronic
switch being arranged to turn off sub- 55
sequently, the threshold switch, when turned
on, discharging the ignition capacitor
through the pulse transformer and thereby
applying to the flash tube an igniting volt-
age pulse which follows the initiating volt- 60
age pulse by a time interval equal to the
delay between the turn-on of the electronic
switch and the turn-on of the threshold
switch.

The electronic flash apparatus may in- 65
clude a piezoelectric transducer connected
to the electronic switch serving to switch on
a delay stage, the delay stage being linked
to the threshold switch the supply voltage
to the delay stage being stabilised. 70

Because the supply voltage of the delay
stage is stabilised the ignition delay time be-
comes less affected by the voltage fluctua-
tions of the supply voltage to the electronic
flash apparatus. In addition, mechanical 75
switches such as the synchronising contact,
for example, can be dispensed with in a
photographic camera.

Advantageously, the electronic flash
apparatus is arranged as a flash gun and the 80
piezoelectric transducer is arranged in a
photographic camera. This produces the
advantage that a single piezoelectric trans-
ducer arranged in the photographic camera
can be used both for igniting an electronic 85
flash apparatus and for igniting a flashbulb
apparatus. The fact that adjusting means
for regulating the two types of flash appara-
tus or separate terminals for them can be
dispensed with, is a further advantage. 90

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Advantageously, the electronic switch is a thyristor included in the timing circuit, the supply voltage to the timing circuit being stabilised by means of a glow lamp which is present for indicating purposes, or by means of a Zener diode. Thus, the supply voltage for the timing circuit becomes less affected by fluctuations of the supply voltage for the flash apparatus, which supply voltage varies between a high value before the ignition of the flash tube and a lower voltage value during ignition.

Preferably, the stabilised voltage supply for the timing circuit includes a storage capacitor which can be charged via a high value resistor which also serves to supply current to the thyristor when it is switched on, the resistor being chosen to limit this supply current to a value below the holding current level for the thyristor. Instead of this resistor, a quenching capacitor may be placed in series with the thyristor so that it remains conductive while the capacitor is drawing a substantial charging current and it is extinguished as the capacitor becomes fully charged.

The stabilised supply voltage of the timing circuit may be switched by the thyristor, the conduction period of the thyristor being set by the timing circuit. The thyristor conduction period is greater than the ignition delay. This timing circuit operates like a gate circuit and the ignition pulse to the flash tube occurs during this "gate open" period.

Preferably, a series circuit comprising thyristor, Zener diode and a resistor, is arranged in parallel with the storage capacitor, the period of conduction of the Zener diode being determined by this resistor in conjunction with the storage capacitor.

Several forms of apparatus constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of the apparatus.

Figure 2 is a perspective view of a flash bulb housed in a container suitable for attachment to a camera, and does not form part of the present invention.

Figure 3 is a perspective view of a detail of a camera suitable for use with the apparatus shown in Figure 1 and the flash bulb shown in Figure 2.

Figure 4 is a diagram of the circuit in one form of the apparatus;

Figure 5 is a diagram of the circuit in a second form of the apparatus; and

Figure 6 is a diagram of the circuit in a third form of the apparatus.

Referring to Fig. 1 of the accompanying drawings, the apparatus is in the form of a flash apparatus (commonly referred to as a

flash gun) 1, which includes an electronic flash tube 2 and the electrical components necessary for operating the flash tube 2. The base 100 of the flash apparatus 1 is designed to fit into an attachment shoe normally provided on a camera for a flash gun. The attachment shoe is shown as 6 and 7 on Fig. 3.

Referring now to Fig. 2, a flash gun 3 is shown, this flash gun employing a flash bulb 4. The base 300 of the flash gun 34 is also designed to fit into the attachment shoe, such as the attachment shoe shown as 6 and 7 of Fig. 3, on the camera. The flash gun shown in Fig. 2 does not form part of the present invention.

The parts of a camera immediately associated with a flash gun are shown in Fig. 3, the plate 5 being a camera surface which carries the attachment shoe shown as 6 and 7, both the flash apparatus 1 and the flash gun 3 being suitable for attachment to the camera by their respective base portions 100 and 300. The camera carries a piezo-electric crystal 9 having two output terminals, one of which is connected to the part 7 of the shoe and the other is connected to an electrical contact 8 which is insulated from the part 7 of the shoe and is situated between the attachment shoe shown as 6 and 7. By this arrangement a flash gun mounted on the camera makes electrical contact with the output terminals of the piezo-electric crystal 9, contact being through the part 7 of the shoe and the contact 8. Associated with the piezo-electric crystal 9 is a lever 10 which is pivoted at one end which lies on one side of the piezo-electric crystal 9, and which is free at the other end which lies on the other side of the piezo-electric crystal 9. Near the free end of the lever 10, a spring 12 is attached and arranged to rotate the lever about the pivoted end and towards the piezo-electric crystal 9, and the lever may be restrained from striking the piezo-electric crystal 9 by means of a movable stop 14. The spring 12 is under tension when the lever 10 is being restrained by the stop 14. An initiating voltage pulse for a flash gun is provided at the contact 8 by moving the stop 14 to release the lever 10 which then strikes the piezo-electric crystal 9 under the influence of the spring 12.

When the flash apparatus 1 is used with a camera of the type shown in Fig. 3, the initiating voltage pulse available at the contact 8 would ignite the flash tube before the camera shutter opens fully. A delayed pulse must be provided for the flash tube and this delayed pulse is provided by the circuit shown in Fig. 4, which is the first form of the invention, which may be powered by a battery shown as 15 and via an on-off switch 16. The first form of the

flash apparatus, shown in Fig. 4 includes an electronic flash tube 2, a d.c. to d.c. voltage converter consisting of a transistor 17 in the collector circuit of which is a first primary winding 18 of a transformer 19 and in the base circuit of which there is a second primary winding 20 of the transformer 19, via which second primary winding the base of the transistor 17 is connected to a resistor 21 in series with a capacitor 22. The secondary winding 23 of the transformer 19 is linked to a storage or filter capacitor 25 via a diode 24. Connected in parallel with the filter capacitor 25 is a series circuit of a high-ohmic resistor 26 and a glow lamp 27. Connected in parallel with the glow lamp 27 is a series circuit consisting of a high-ohmic resistor 28 and a storage capacitor 29. The storage capacitor 29 is connected in parallel with a series circuit consisting of a resistor 30, a thyristor 31 and a capacitor 32, in that order. The control electrode of the thyristor 31 is connected to the terminal 8 of the piezo-electric crystal 9. The values of the resistors 26 and 28 are such that after the storage capacitor 29 has discharged the current flowing through the resistors 26 and 28 and through the thyristor 31 is less than the holding current value of the thyristor, so that the thyristor then turns off.

The capacitor 32 is connected to the control electrode of another thyristor 33, the anode of which is connected to a high-ohmic resistor 34 which is chosen such that it supplies less than the holding current of the thyristor 33.

An ignition capacitor 35 and the primary winding of a pulse transformer 36 are connected in parallel with the thyristor 33 and the secondary winding of the pulse transformer is connected to the ignition electrodes of the flash tube 2. By this arrangement the ignition capacitor 35 is charged through the resistor 34 by the power supply and is discharged abruptly through the primary winding of the pulse transformer 36 and the thyristor 33 when the thyristor is triggered, triggering being effected when the capacitor 32 becomes charged to the thyristor trigger voltage. A commutating capacitor 37 is connected from the anode of the thyristor 33 to the anode of thyristor 31 to transmit a negative pulse to the anode of thyristor 31 when thyristor 33 switches on. This ensures that thyristor 31 switches off as thyristor 33 switches on.

When the thyristor 31 is non-conductive, the capacitor 29 becomes charged to the threshold voltage of the glow lamp 27. The threshold voltage of the glow lamp 27 is a constant. The initial voltage of the capacitor 29 is therefore always the same during discharge of the capacitor 29, the current available via the resistor 28 tends to return

the capacitor potential to its initial value.

If the catch 14 is tilted by a release force P, then the striking lever 10 strikes against the piezo-electric crystal 9. The electrical pulse produced in the piezo-electric crystal causes the thyristor 31 to switch on. The storage capacitor 29 discharges from its initial voltage via resistor 30 into capacitor 32. When the voltage of the charging capacitor 32 exceeds the gate threshold value of the thyristor 33, this is switched on and discharges the ignition capacitor 35 through the pulse transformer 36. The electronic flash tube 2 ignites, upon which the voltage between its two main electrodes decreases as a result of the reduction in the internal resistance. At least up until the ignition capacitor 35 is discharged, the storage capacitor 29 ensures that the current does not fall below the holding current value of the thyristor 31. When the capacitor 29 has discharged, the current to the thyristor 31 falls because the resistors 26 and 28 alone then supply the current to the thyristor 31. This current level is below the thyristor holding current. The electronic flash tube 2 is therefore ignited by a delayed pulse from the flash apparatus and the instant at which the pulse recurs can be chosen to be that at which the camera shutter is fully open. The thyristors 31 and 33 conduct for a period and then switch off. The flash apparatus therefore resets itself.

In the second form of the apparatus, shown in Fig. 5, the glow lamp 27 is not used as a voltage stabiliser, but is retained as a "power on" indicator. A Zener diode 44 provides a stabilised voltage to the capacitor-resistor series combination 45 and 46. Connected in parallel with the main capacitor 25' is the series circuit of a high-ohmic value resistor 40 and a storage capacitor 41. Connected in parallel with the storage capacitor 41 is the series circuit of a resistor 42, a thyristor 43 and the Zener diode 44. The Zener diode delivers a constant supply voltage to the resistor-capacitor combination 45 and 46 when the thyristor 43 is switched on, the storage capacitor 41 then discharging through the Zener diode 44 and delivering the supply current for the Zener diode 44 for as long as the capacitor voltage exceeds the Zener voltage plus the voltage drop across thyristor 43, and the current in the circuit exceeds the holding current for the thyristor 43. The resistor 40 is chosen such that the current it supplies is less than the holding current for the thyristor 43. After the capacitor 40 has discharged, the current flowing through the thyristor 43 falls below the holding current value of the thyristor 43 and the thyristor begins to turn off. In addition, the ignition of the electronic flash tube 2' causes the tube supply voltage to drop, further reducing the current

(X) (12)

being driven through the thyristor and assisting in turning the thyristor off.

In the third form of the apparatus, shown in Fig. 6, the voltage converter consisting of the transistor 17", the transformer 19", resistor 21" and capacitor 22" are the same as for Fig. 4, and the rectifier 24" and capacitor 25" are also the same as Fig. 4. The glow lamp 27" and the resistor 26" provide a stabilised voltage as in Fig. 4, the glow lamp 27" also providing an indication of "power on". Capacitor 29" is charged by the supply voltage through resistors 28" and 26" to the voltage level of the glow lamp 27", after which the voltage across capacitor 29" remains equal to the glow lamp striking voltage. The diode 51 and the second glow lamp 50 act as a switch, and when this switch is closed the capacitor 29" discharges through the resistor 30", the diode 51 and the glow lamp 50, charging the capacitor 32". The glow lamp 50 is triggered by a pulse from the piezo-electric crystal 9", the diode 51 assisting in this triggering action by preventing any of the pulse energy from travelling towards the resistor 30". The diode 51 and the glow lamp 50 together behave in the same way as the thyristor 31 of Fig. 4. The function of the remainder of the circuit is the same as in Fig. 4, already described.

WHAT WE CLAIM IS:—

1. Electronic flash apparatus which, in operation, is ignited by an initiating voltage pulse but at a predetermined time after the initiating voltage pulse occurs, comprising a flash tube and a voltage converter adapted to accept an input voltage and to provide an output voltage on terminals which are connected to the flash tube, an ignition circuit for the flash tube comprising an ignition capacitor which is arranged to be charged by a current from the voltage converter, a pulse transformer connected to the ignition capacitor, and a threshold switch, a timing circuit including a stabilised voltage source connected to the output of the voltage converter and an electronic switch so arranged that, in operation, the electronic switch is turned on by the initiating voltage pulse and conduits for a time during which current from the stabilised source and flowing in the timing circuit is accumulated and used to trigger the threshold switch, the electronic switch being arranged to turn off subsequently, the threshold switch, when turned on, discharging the ignition capacitor through the pulse transformer and thereby applying to the flash tube an igniting voltage pulse which follows the initiating voltage pulse by a time interval equal to the delay between the turn-on of the electronic switch and the turn-on of the threshold switch.

2. Apparatus as claimed in claim 1, wherein the electronic switch that, in operation, is turned on by the initiating voltage pulse is a thyristor, the thyristor being arranged, when turned on, to conduct current from the stabilised voltage source to a further capacitor and a resistor in series, the thyristor being arranged to turn off when the conducted current falls below its holding current.

3. Apparatus as claimed in claim 1, wherein the electronic switch that, in operation, is turned on by the initiating voltage pulse is the series combination of a glow lamp and a semiconductor diode, the cathode terminal of the diode being connected to the glow lamp, the point common to the diode and the glow lamp being arranged to receive the initiating voltage pulse, the glow lamp and the diode being arranged, when the glow lamp is turned on, to conduct current from the stabilised voltage source to a further capacitor and a resistor in series, the glow lamp turning off when the applied voltage falls below its striking potential voltage.

4. Apparatus as claimed in any one of the preceding claims, wherein the stabilised voltage source includes a Zener diode and a resistor connected in series across the output terminals of the voltage converter.

5. Apparatus as claimed in any one of claims 1 to 3, wherein the stabilised voltage source includes a glow lamp and a resistor connected in series across the output terminals of the voltage converter.

6. Apparatus as claimed in any one of the preceding claims, wherein the threshold switch is a thyristor arranged, when switched on, to connect the ignition capacitor across the primary winding of the pulse transformer, one terminal of the secondary winding of the pulse transformer being connected to the ignition electrode of the flash tube.

7. Apparatus as claimed in any one of the preceding claims, and further including a piezo-electric transducer having electrical terminals connected to the electronic switch and which is arranged to generate the initiating voltage pulse when struck.

8. Photographic apparatus comprising the combination of electronic flash apparatus as claimed in any one of claims 1 to 6, with a photographic camera which includes a piezo-electric transducer having electrical terminals connected to the electronic switch of the electronic flash apparatus, the piezo-electric transducer being so arranged that, in operation, the piezo-electric transducer generates an initiating voltage pulse in synchronism with the opening of the camera shutter, when the camera is operated.

(X) (12)



being driven through the thyristor and assisting in turning the thyristor off.

In the third form of the apparatus, shown in Fig. 6, the voltage converter consisting of the transistor 17", the transformer 19", resistor 21" and capacitor 22" are the same as for Fig. 4, and the rectifier 24" and capacitor 25" are also the same as Fig. 4. The glow lamp 27" and the resistor 26" provide a stabilised voltage as in Fig. 4, the glow lamp 27" also providing an indication of "power on". Capacitor 29" is charged by the supply voltage through resistors 28" and 26" to the voltage level of the glow lamp 27", after which the voltage across capacitor 29" remains equal to the glow lamp striking voltage. The diode 51 and the second glow lamp 50 act as a switch, and when this switch is closed the capacitor 29" discharges through the resistor 30", the diode 51 and the glow lamp 50, charging the capacitor 32". The glow lamp 50 is triggered by a pulse from the piezo-electric crystal 9", the diode 51 assisting in this triggering action by preventing any of the pulse energy from travelling towards the resistor 30". The diode 51 and the glow lamp 50 together behave in the same way as the thyristor 31 of Fig. 4. The function of the remainder of the circuit is the same as in Fig. 4, already described.

WHAT WE CLAIM IS:—

1. Electronic flash apparatus which, in operation, is ignited by an initiating voltage pulse but at a predetermined time after the initiating voltage pulse occurs, comprising a flash tube and a voltage converter adapted to accept an input voltage and to provide an output voltage on terminals which are connected to the flash tube, an ignition circuit for the flash tube comprising an ignition capacitor which is arranged to be charged by a current from the voltage converter, a pulse transformer connected to the ignition capacitor, and a threshold switch, a timing circuit including a stabilised voltage source connected to the output of the voltage converter and an electronic switch so arranged that, in operation, the electronic switch is turned on by the initiating voltage pulse and conduits for a time during which current from the stabilised source and flowing in the timing circuit is accumulated and used to trigger the threshold switch, the electronic switch being arranged to turn off subsequently, the threshold switch, when turned on, discharging the ignition capacitor through the pulse transformer and thereby applying to the flash tube an igniting voltage pulse which follows the initiating voltage pulse by a time interval equal to the delay between the turn-on of the electronic switch and the turn-on of the threshold switch.

2. Apparatus as claimed in claim 1, wherein the electronic switch that, in operation, is turned on by the initiating voltage pulse is a thyristor, the thyristor being arranged, when turned on, to conduct current from the stabilised voltage source to a further capacitor and a resistor in series, the thyristor being arranged to turn off when the conducted current falls below its holding current.

3. Apparatus as claimed in claim 1, wherein the electronic switch that, in operation, is turned on by the initiating voltage pulse is the series combination of a glow lamp and a semiconductor diode, the cathode terminal of the diode being connected to the glow lamp, the point common to the diode and the glow lamp being arranged to receive the initiating voltage pulse, the glow lamp and the diode being arranged, when the glow lamp is turned on, to conduct current from the stabilised voltage source to a further capacitor and a resistor in series, the glow lamp turning off when the applied voltage falls below its striking potential voltage.

4. Apparatus as claimed in any one of the preceding claims, wherein the stabilised voltage source includes a Zener diode and a resistor connected in series across the output terminals of the voltage converter.

5. Apparatus as claimed in any one of claims 1 to 3, wherein the stabilised voltage source includes a glow lamp and a resistor connected in series across the output terminals of the voltage converter.

6. Apparatus as claimed in any one of the preceding claims, wherein the threshold switch is a thyristor arranged, when switched on, to connect the ignition capacitor across the primary winding of the pulse transformer, one terminal of the secondary winding of the pulse transformer being connected to the ignition electrode of the flash tube.

7. Apparatus as claimed in any one of the preceding claims, and further including a piezo-electric transducer having electrical terminals connected to the electronic switch and which is arranged to generate the initiating voltage pulse when struck.

8. Photographic apparatus comprising the combination of electronic flash apparatus as claimed in any one of claims 1 to 6, with a photographic camera which includes a piezo-electric transducer having electrical terminals connected to the electronic switch of the electronic flash apparatus, the piezo-electric transducer being so arranged that, in operation, the piezo-electric transducer generates an initiating voltage pulse in synchronism with the opening of the camera shutter, when the camera is operated.

(13) (12)

9. Electronic flash apparatus substantially as hereinbefore described with reference to, and as shown in, Figs. 1 and 4 or Figs. 1 and 5 or Figs. 1 and 6 of the accompanying drawings.

10. Photographic apparatus comprising the combination of electronic flash apparatus as claimed in claim 9, with a photo-

graphic camera substantially as hereinbefore described with reference to, and as shown in, Fig. 3 of the accompanying drawings.

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