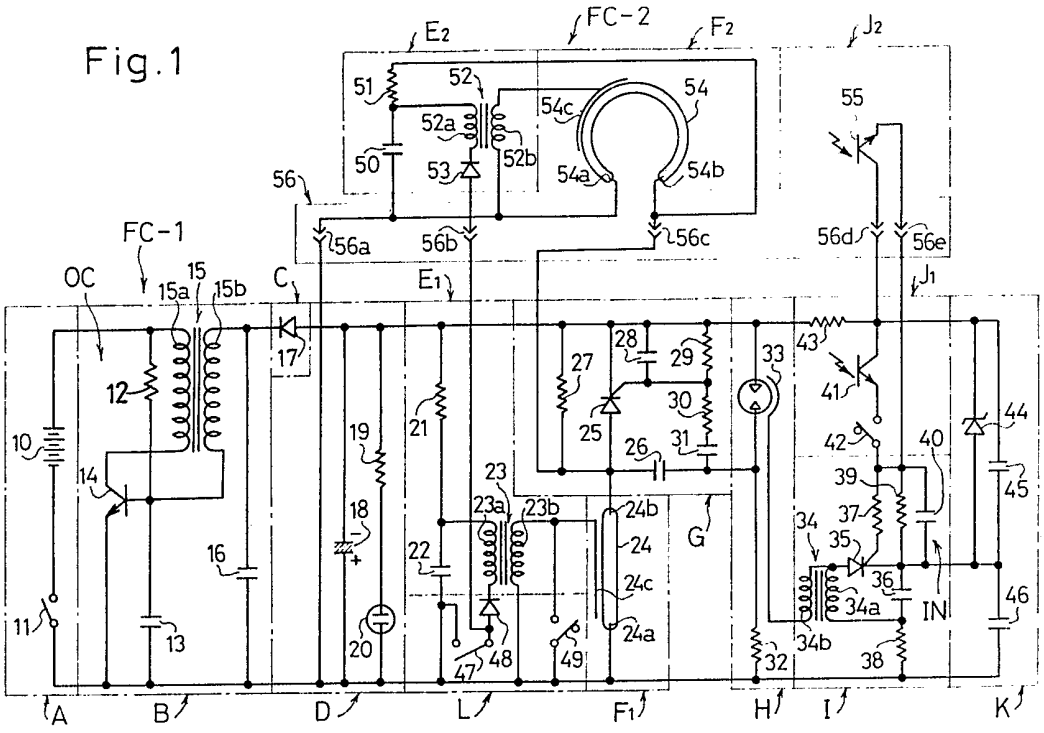
(12) UK Patent Application (19) GB (11) 2 091 442 A

(21) Application No **8136062**
(22) Date of filing **30 Nov 1981**
(30) Priority data
(31) **55/169754**
(32) **1 Dec 1980**
(33) **Japan (JP)**
(43) Application published
28 Jul 1982
(51) **INT CL³**
G03B 15/05
(52) Domestic classification
G2X 1K1
G2A 106 115 120 BJ C16 C1 C27 C30
(56) Documents cited
GB 2061535A
GB 2050642A
GB 2037453A
GB 2025078A
GB 1213617
(58) Field of search
G2A
G2X
(71) Applicant
Fuji Koeki Corporation, 17-1 Toranomon 1 chome, Minato-ku, Tokyo, Japan
(72) Inventor
Yoshiyuki Takematsu
(74) Agents
Boult, Wade & Tennant, 27 Furnival Street, London EC4A 1PQ

(54) Electric Flash Apparatus

(57) The invention provides an electric flash apparatus comprising two flash tubes 24, 54, each with a triggering circuit and both fed from a single main storage capacitor 18. The combined light output of the flash tubes is sensed and the tubes quenched at the same time so that their flash duration is coextensive. The second flash tube circuit can be disconnected so that the first tube can be flashed alone. The first tube can be mounted in a pivotable casing so that the direction of the flash is varied while the second flash tube can be substantially annular and surround the camera lens.

Fig.1



GB 2 091 442 A

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

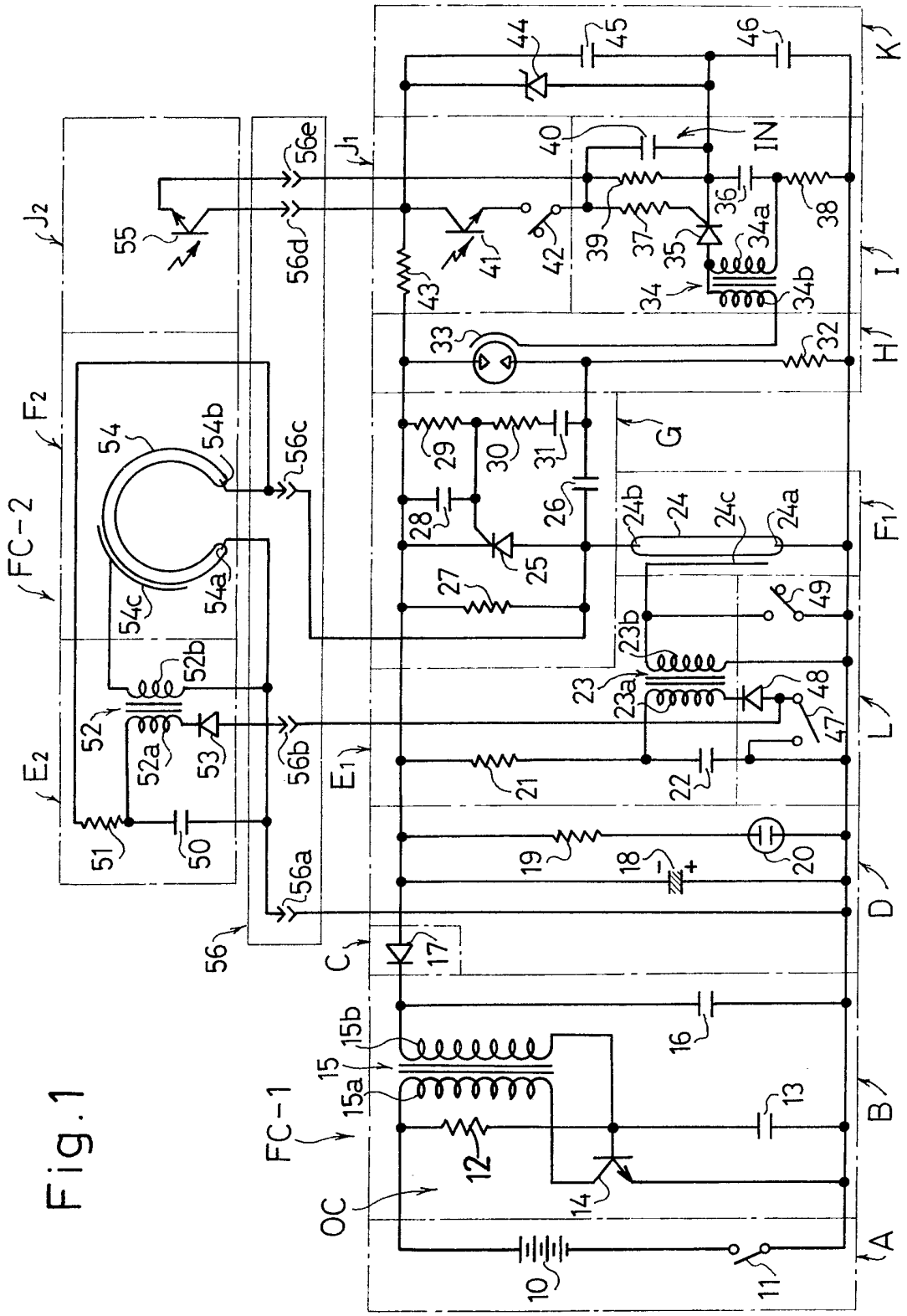

J2
J1
F2
FC-2
E2
E1
FC-1
OC
C
A
B
D
F1
G
H
I
K
L
IN
55
56d
56e
56c
56b
56a
56
54
54a
54b
54c
52
52a
52b
53
51
50
44
45
46
40
41
42
43
39
37
35
36
34a
34b
34
38
33
32
29
30
31
28
26
25
27
24
24a
24b
24c
49
23
23a
23b
48
47
21
22
19
18
20
17
16
15
15a
15b
12
14
13
10
11

Fig. 1

Fig.2

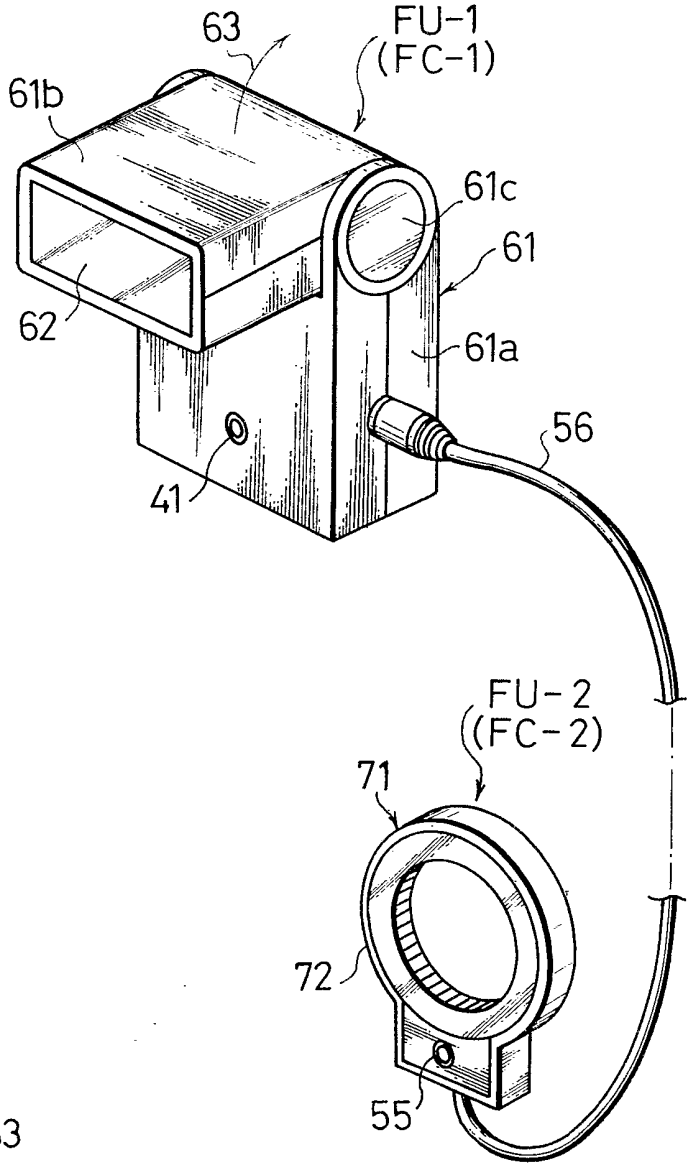

63
FU-1
(FC-1)
61b
61c
61
62
61a
56
41
FU-2
(FC-2)
71
72
55

Fig.3

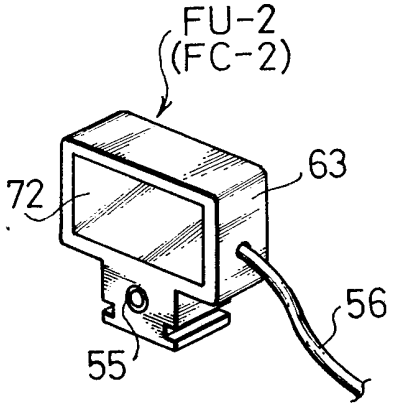
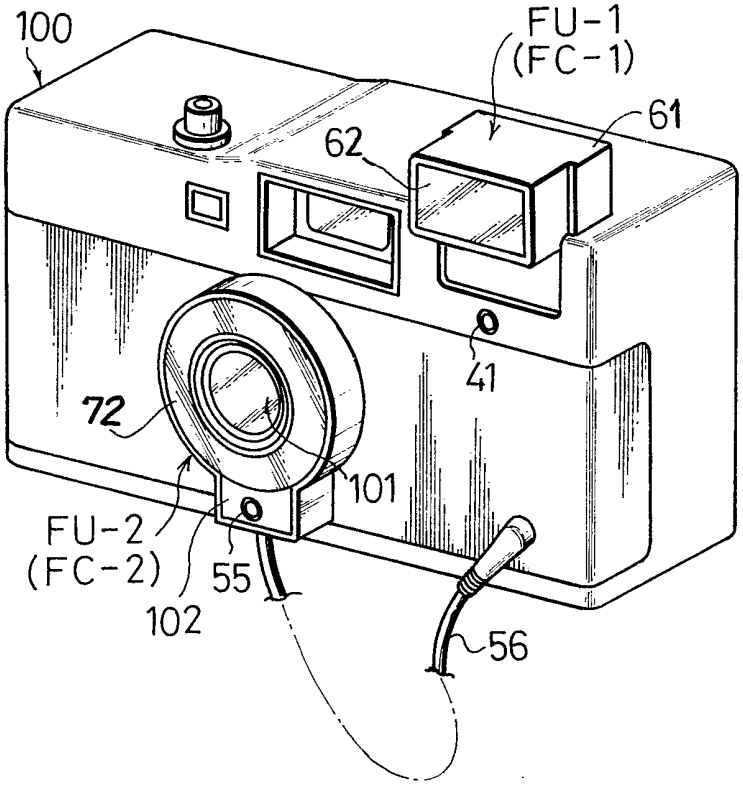

FU-2
(FC-2)
72
63
56
55

Fig. 4



SPECIFICATION

Electric Flash Apparatus

The present invention relates to an electric flash apparatus and, more particularly to an electric flash apparatus for use in an optical apparatus such as a photographic device.

In recent years, cameras having "built-in" flash units have become very popular. However, such units provide insufficient illumination except at close range and often the illumination is either too flat or produces undesirable shadows. It is known to employ bounce flash, but its usefulness is vitiated by the reduction in illumination of the object compared with the direct illumination of the object using a flash source of the same power.

In closeup photography, an auxiliary flash tube is, generally, mounted on the outside of a lens of the camera in addition to a main flash tube of a main flash unit which is mounted on the camera body. In such prior art flash apparatus, each individual flash unit requires a flash control circuit arrangement having a power source circuit, a voltage converter circuit for boosting a voltage derived from the power source circuit, a rectifier circuit for rectifying an alternating voltage from the voltage converter circuit, an electric charge storing circuit including a main storage capacitor, a triggering circuit for triggering a flash tube, and an automatic flash light controlling circuit. Accordingly, such flash apparatus becomes complicated and large as well as being costly.

In a preferred embodiment of the invention there is provided an electric flash apparatus comprising a first control circuit arrangement, a second flash control circuit arrangement, a connecting member for connecting electrically said first flash control circuit arrangement to said second flash control circuit arrangement, flash timing control means for controlling flash time durations of said first flash control circuit arrangement and said second flash control circuit arrangement, and trigger signal control means for supplying triggering signals to said first flash control circuit and said second flash control circuit arrangement, said first flash control circuit arrangement comprising electrical energy storing means for charging an electrical energy to a main storage capacitor, and a first flash tube circuit including a first flash tube and a first trigger signal generating circuit for making said main storage capacitor supply the electrical energy to said first flash tube of said first flash tube circuit, said second flash control circuit arrangement comprising a second flash tube circuit including a second flash tube, and a second trigger signal generating circuit for making said main storage capacitor supply the electrical energy to said second flash tube of the second flash tube circuit.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a detailed circuit diagram of a control circuit arrangement of an electric flash apparatus according to the present invention.

Figure 2 is a perspective view of the mechanical construction of an electric flash apparatus according to the present invention.

Figure 3 is a perspective view of a modification of an electric flash apparatus according to the present invention.

Figure 4 is a perspective view of a camera employing an electric flash apparatus according to the present invention.

Referring to Figure 1 of the drawings, there is shown a detailed insert diagram of a control circuit arrangement of a preferred embodiment of an electric flash apparatus according to the present invention. The flash apparatus comprises a first flash control circuit arrangement FC-1 and a second flash control circuit arrangement FC-2 electrically connected to the first flash control circuit arrangement FC-1. The first control circuit arrangement FC-1 comprises a direct current power source circuit A, a voltage converter circuit B for converting a direct voltage from the power source circuit A to a high alternating voltage, a rectifier circuit C for rectifying the alternating voltage from the voltage converter B, an electric charge storing circuit D for supplying the electrical energy to the flash tube, trigger signal generating means for triggering the flash tube, a flash tube circuit F_1 including a flash tube, a switching circuit G, a quenching circuit H for controlling the switching circuit G, a quench controlling circuit I for controlling the quenching circuit H, a first light receiving circuit J_1, a constant voltage circuit K, and a trigger signal controlling circuit L for controlling the trigger signal to be supplied to the flash tube.

The power source circuit A includes a battery 10 and a power switch 11 in series therewith. The converter B comprises a blocking oscillator OC which includes a bias resistor 12 and an oscillating capacitor 13. The bias resistor 12 is connected between a positive terminal of the battery 10 and the base of a switching transistor 14, of which the collector is connected to the positive terminal of the battery 10 by way of a primary winding 15a of a transformer 15. The base of the transistor 14, which is preferably a high performance silicon transistor, is connected to its emitter by way of the capacitor 13. The emitter of the transistor 14 is connected to the negative terminal of the battery 10 by way of the power source switch 11. The transformer 15 has a secondary winding 15b of which one end is connected to the base of the transistor 14. A surge absorbing capacitor 16 is connected in parallel to the secondary winding 15b of the transformer 15 and the base-emitter path of the transistor 14.

The rectifier circuit C includes an electric valve in the form of a diode 17 of which the cathode is connected to the secondary winding 15b. The electric charge storing circuit D comprises a main storage capacitor 18 in parallel with the series combination of a current limiting resistor 19 and an indicating lamp in the form of a neon glow lamp 20. One terminal of the main storage

capacitor 18 is connected to the anode of the diode 17 and the other terminal of the main storage capacitor 18 is connected to the emitter of the transistor 14 and to the negative terminal of the battery 10 by way of the power switch 11.

The first trigger signal generating circuit E_1 comprises a triggering capacitor 22 and a triggering transformer 23 having a primary winding 23a and a secondary winding 23b. One terminal of the primary winding 23a of the triggering transformer 23 is connected to a juncture of a protecting resistor 21 and the triggering capacitor 22. The first flash tube circuit F_1 includes a flash tube 24 having a pair of main current conducting electrodes 24a and 24b and a trigger electrode 24c which is adjacent but external to the flash tube 24. The trigger electrode 24c is connected to one terminal of the secondary winding 23b of the triggering transformer 23; one main current conducting electrode 24a is connected to the terminal of the main storage capacitor 18 of the electric charge storing circuit D.

The switching circuit G has a switching element in the form of a thyristor 25, a commutation capacitor 26 connected to an anode electrode of the thyristor 25, a commutation resistor 27 connected in parallel to the thyristor 25, a gate capacitor 28, gate resistor 29 and gate resistor 30 in series with a capacctor 31. The quenching circuit H comprises a protecting resistor 32 connected to the first flash tube 24 and a quench tube 33 one electrode of which is connected to the anode electrode of thyristor 25 by way of the commutation capacitor 26.

The quench controlling circuit I comprises a quenching transformer 34 having a primary winding 34a and a secondary winding 34b, a thyristor 35 the anode electrode of which is connected to the primary winding 34a of the quenching transformer 34, a capacitor 36 connected to the primary winding 34a of the quenching transformer 34 by way of the thyristor 35, a gate resistor 37, a protecting resistor 38 and an integration circuit IN comprising the parallel-connected resistor 39 and capacitor 40.

The light receiving circuit J_1 comprises a first light receiving element in the form of a phototransistor 41 of which the collector is connected to the anode of the diode 17 of the rectifier circuit C by way of a resistor 43, and a switch 42 connected between the emitter of the phototransistor 41 and the gate resistor 37 and the integration circuit IN of the quench controlling circuit I. The constant voltage circuit K comprises a constant generating element in the form of a Zener diode 44, capacitors 45 and 46, connected as shown.

The trigger signal controlling circuit L comprises a synchronous switch 47 activated in synchronisation with a camera-shutter (not shown in the drawings) which is connected to the triggering capacitor 22, a blocking diode 48 of which the anode is connected to the synchronous switch 47 and of which the cathode is connected to the primary winding 23a of the triggering transformer 23 and a switch 49 connected in parallel with the secondary winding 23b of the triggering transformer 23.

The second flash control arrangement FC-2 comprises a trigger signal generating circuit E_2, a flash tube circuit F_2 and a light receiving circuit J_2.

In more detail, the trigger signal generating circuit E_2 of the second flash control circuit arrangement FC-2 comprises a triggering capacitor 50 and a triggering transformer 52 having a primary winding 52a and a secondary winding 52b. The triggering capacitor 50 is connected to the emitter of the transistor 14 of the converter circuit B of the first flash control circuit arrangement FC-1 by way of a contact 56a of a connector 56. One terminal of the primary winding 52a of the triggering transformer 52 is connected to a juncture of the capacitor 50 and a triggering resistor 51. The cathode of a blocking diode 53 is connected to other terminal of the primary winding 52a of the triggering transformer 52. The anode of the diode 53 is connected to a juncture of the switch 47 and the anode of the diode 48 of the trigger signal controlling circuit L by way of a contact 56b of the connector 56.

The flash tube circuit F_2 includes a flash tube 54 which is ring shaped. The flash tube 54 has a pair of main conducting electrodes 54a and 54b and a trigger electrode 54c. The main current electrode 54a is connected to the main storage capacitor 18 by way of the contact 56a of the connector 56. The main current electrode 54b is connected to the flash tube 24 by way of a contact 56c of the connector 56.

The light receiving circuit J_2 includes a light receiving element in the form of a phototransistor 55. The transistor 55 is connected between the light receiving circuit J_1 and the quench controlling circuit I of the first flash control circuit arrangement FC-1 by way of contacts 56d and 56e of the connector 56.

According to the flash apparatus shown in Figure 1, there are certain criteria, in the flash control circuit arrangements, that must be met by the flash tubes 24 and 54. For satisfactory operation, the current supplied to the flash tube 24 must be relatively large compared with that supplied to the flash tube 54, in order that the intensity of the flash light generated by the flash tube 24 be greater than that of the flash light from the flash tube 54. To ensure this, the flash tube 54 of the flash tube circuit E_2 should have a relatively low threshold impedance compared with the flash tube 24 of the flash tube circuit E_1. To provide such low impedance, the flash tube 54 should have a low gas pressure and a small electrode spacing in comparison with the flash tube 24. Moreover, the internal resistance of the flash tube 54 is chosen to be larger than usual in order to make the maximum flash durations of the flash tubes 24 and 54 approximately the same. The internal impedance of the flash tube 54 could be smaller than that of the flash tube 24, an impedance such as a resistor or choke coil being

connected in series with the flash tube 54. If the flash tube 54 has a low impedance compared with the flash tube 24, the initiation of flashing of the flash tube 54 tends to occur earlier than that of the flash tube 54, the impedance element may be provided to avoid this.

The electric flash apparatus constructed as described above operates as follows.

When the power source switch 11 is turned ON, the voltage converter circuit B starts oscillating and a high voltage is induced at the secondary winding 15b of the transformer 15. This voltage is rectified by the rectifier circuit C, and electric charge is stored on the main storage capacitor 18. Electric charge is accumulated on the capacitors 22, 26, 36, 45, 46 and 50 also. When the main storage capacitor 18 is charged to a predetermined voltage, the neon glow lamp 20 lights, indicating that the device is ready for the firing of the flash tube 24. The operation of the flash tube circuits is initiated by the trigger signal controlling circuit L, and in particular when the switch 47 is closed. Thereupon the capacitor 22 is discharged round the loop comprising the switch 47, the diode 48 of the trigger signal controlling circuit L and the primary winding 23a of the triggering transformer 23. A trigger pulse is generated across the secondary winding 23b and is applied to the trigger electrode 24c of the flash tube 24 when the switch 49 is turned off, and thereby the flash tube 24 is triggered to flash. Simultaneously when the switch 47 is made ON, the triggering capacitor 50 of the trigger signal generating circuit E_2 is discharged round the loop comprising the contact 56a of the connector 56, the switch 47, the contact 56b and the primary winding 52a of the triggering transformer 52. A trigger pulse is generated across the secondary winding 52b and is applied to the trigger electrode 54c of the flash tube 54, and thereby the flash tube 54 is triggered to flash. The main capacitor 18 discharges simultaneously into the flash tubes 24 and 54. The thyristor 25 conducts, being biassed for this purpose by the voltage across the capacitor 28. Unless terminated otherwise, the flash continues until the main storage capacitor 18 has discharged through the tubes 24 and 54 to the point where the voltage across the main electrodes will no longer support the conduction of the tubes. That usually occurs after several milliseconds.

The light receiving circuits J_1 and J_2 sense the illumination provided by the flash tubes 24 and 54, and the phototransistors 41 and 55 become conductive. The switch 42 of the light receiving circuit J_1 is made OFF by the insertion and connection of the connector 56. Accordingly, when switch 42 is made OFF an electric charge is stored on the integration capacitor 40 of the integration circuit IN.

When the capacitor 40 becomes charged to a predetermined voltage after a given time interval, the thyristor 35 is biassed into conduction. Thereupon the capacitor 36 is discharged through the primary winding 34a of the quenching transformer 34 and a high voltage pulse is induced at the secondary winding 34b. The pulse fires the quench tube 33.

When the quench tube of the quenching circuit H becomes conductive, the discharging current to be supplied to the flash tube 24 and the flash tube 54 is by-passed by the quench tube 33 and, at the same time, electric charge stored on the commutation capacitor 26 discharges through the quench tube 33 and the commutation resistor 27 so that, after a time interval dependent upon a time constant determined by the combination of the commutation capacitor 26 and the commutation resistor 27, the thyristor 25 is turned off, the flash tubes 24 and 54 being then immediately extinguished. Thus the flash durations of the tubes 24 and 54 are the same or approximately the same, the flash of the flash tube 24 being greater in intensity than that of the flash tube 54.

In the control circuit arrangement of the flash apparatus shown in Figure 1, when the switch 49 of the trigger signal controlling circuit L is made ON, the secondary winding 23b of the triggering transformer 23 becomes short-circuited by the switch 49, so that a high voltage is not generated across the secondary winding 23b. Under these conditions, the flash tube 24 is not fired, and only the flash tube 54 is fired. Accordingly, closeup photography can be performed by switching the switch 49 of the trigger signal controlling circuit L into the ON position.

Moreover, when the second flash control circuit arrangement FC-2 is disconnected from the first flash control circuit arrangement FC-1 by disconnection of connector 56 the switch 42 of the light receiving circuit J_1 becomes ON so that the phototransistor 41 is connected to the quench controlling circuit I. Under these conditions, the first flash control circuit arrangement FC-1 can be used, alone, as a usual flash device.

Referring to Figure 2, there is shown schematically an electric flash apparatus according to an embodiment of the present invention. The flash apparatus comprises a first flash unit FU-1, incorporating the first flash control circuit arrangement FC-1, and a second flash unit FU-2, incorporating the second flash control circuit arrangement FC-2 which are connected together mechanically and electrically by the connector 56.

The first flash unit FU-1 is accommodated in a flash housing 61 consisting of a first part 61a and a second part 61b, pivotably connected to the first part 61a by means of a pivot 61c. Accordingly, the second part 61b is rotatable with respect to the first part 61a as is shown by an arrow 63. The first part 61a is equipped with a light sensor in the form of the phototransistor 41 and a flashing window 62 in front of the flash tube 24 (not shown).

The second flash unit FU-2 comprises a flashing member 72, in a substantially ring-shaped frame 71, incorporating the second flash control circuit arrangement FC-2 which has the

flash tube 54 (not shown) and a light sensor in the form of the phototransistor 55. The second flash unit FU-2 is connected to the first flash unit FU-1 by the connector 56. The described apparatus can be used to provide both direct and bounce flash illumination. The second flash unit FU-2 provides direct flash illumination, whereas the first flash unit FU-1 may provide bounce flash illumination if the second part 61b of the flash housing 61 is set at a suitable angle with respect to the first part 61a.

Figure 3 shows a further embodiment of the electric flash apparatus of the present invention. The second flash unit FU-2 has a rectangular casing 63 incorporating a flashing member 72. The flashing member 72 has a tubular flash tube (not shown in the drawings). The second flash control circuit arrangement FC-2, with the flash tube 54 being replaced by the tubular flash tube (not shown) is incorporated into the substantially rectangular casing 63 which is mountable on a camera body. A light sensor in the form of the phototransistor 55 is provided on a front surface of the casing 63. In the flash apparatus of Figure 3, the flashing member may be provided with at least two flash tubes dependent upon the intensity of illumination required.

Figure 4 shows a further embodiment of the electric flash apparatus according to the present invention. As is shown in Figure 4, the flash apparatus comprises a first flash unit FU-1 having a substantially rectangular flash housing 61 mounted on a camera 100, and a second flash unit FU-2 provided on the outside of a lens 101 of the camera 100. The first flash unit FU-1 has a flash window 62 in front of a flash tube (not shown). The first flash control circuit arrangement FC-1 shown in Figure 1 is incorporated within the camera 100, and a light sensor in the form of a phototransistor 41 is provided on a front surface of the camera 100. The first flash control circuit FC-1 operates the first flash unit FU-1. The second flash unit FU-2 comprises the second flash control circuit arrangement FC-2 as shown in Figure 1. The second flash control circuit arrangement FC-2 is incorporated within a flash housing 102 of the camera 100. The flashing member 72 incorporating the ring-shaped flash tube 54 (not shown) of the second flash control circuit arrangement FC-2, is accommodated on the outside of the lens 101 of the camera 100. A light sensor in the form of a phototransistor 55 is provided on a front surface of the flash housing 102 of the camera 100. The first flash control circuit arrangement FC-1 is electrically and mechanically connected to the second flash control circuit arrangement FC-2 by a connector 56.

Claims

1. An electric flash apparatus comprising a first flash control circuit arrangement, a second flash control circuit arrangement, a connecting member for connecting electrically said first flash control circuit arranged to said second flash control circuit arrangement, flash timing control means for controlling flash time durations of said first flash control circuit arrangement and said second flash control circuit arrangement, and trigger signal control means for supplying triggering signals to said first flash control circuit arrangement and said second flash control circuit arrangement, said first flash control circuit arrangement comprising electrical energy storing means for charging an electrical energy to a main storage capacitor, and a first flash tube circuit including a first flash tube and a first trigger signal generating circuit for making said main storage capacitor supply the electrical energy to said first flash tube of the first flash tube circuit, said second flash control circuit arrangement comprising a second flash tube circuit including a second flash tube, and a second trigger signal generating circuit for making said main storage capacitor supply the electrical energy to said second flash tube of the second flash tube circuit.

2. An electric flash apparatus as claimed in claim 1, wherein said flash timing control means includes an inner impedance of said first flash tube and an inner impedance of said second flash tube set to greater than that of the first flash tube.

3. An electric flash device as claimed in claim 1, wherein said trigger signal controlling means comprises a trigger signal controlling circuit commonly connected to said first trigger signal generating circuit of said flash control circuit arrangement and said second trigger signal generating circuit of said second flash control circuit arrangement.

4. An electric flash apparatus as claimed in claim 3, wherein said trigger signal controlling circuit includes a synchronous switch operated in synchronism with a shutter operation of a camera.

5. An electric flash apparatus as claimed in claim 4, wherein said trigger signal generating circuit further includes blocking means for blocking the current to be supplied to the second trigger signal generating circuit.

6. An electric flash apparatus as claimed in claim 4, wherein said trigger signal controlling circuit further includes blocking means for blocking the current to be supplied to the first trigger signal generating circuit.

7. An electric flash apparatus as claimed in claim 3, wherein said trigger signal controlling circuit includes a switch for inhibiting a generation of the trigger signal from said first trigger signal generating circuit.

8. An electric flash apparatus as claimed in claim 5, wherein said blocking means includes a diode connected to said synchronous switch and said first trigger signal generating circuit.

9. An electric flash apparatus as claimed in claim 6, wherein said blocking means includes a diode connected to synchronous switch and said second trigger signal generating circuit.

10. An electric flash apparatus as claimed in claim 1, wherein at least one of said first flash control circuit arrangement and said second flash control circuit arrangement having a light

receiving circuit activated by a resultant light quantity of said first flash tube circuit and said second flash tube circuit and a quench controlling circuit operated by a signal from said light receiving circuit and for controlling flash stopping operation of said first flash tube circuit and said second flash tube circuit.

11. An electric flash apparatus as claimed in claim 10, wherein said first flash control circuit arrangement having a first light receiving circuit activated by a flash light of said flash tube circuit and said second flash tube circuit and a quench controlling circuit operated by a signal from at least one of said first light receiving circuit and said first light receiving circuit and for controlling flash stopping operations of said first flash tube circuit and said second flash tube circuit.

12. An electric flash apparatus as claimed in claim 10, wherein said first light receiving circuit comprises a light receiving element and a switch for connecting and disconnecting said to the quench controlling circuit in response to connection and disconnection of a connector.

13. An electric flash apparatus as claimed in claim 10, wherein said first flash control circuit arrangement comprises a switching circuit for actuating said flash tube circuit and said second flash tube circuit and a quenching circuit for extinguishing a first flash tube of said first flash tube circuit and a second flash tube of said second flash tube circuit by a quench controlling signal from said quench controlling circuit.

14. An electric flash apparatus as claimed in claim 1, wherein said first and the second trigger signal generating circuits having, respectively, a trigger capacitor and a triggering transformer having a primary winding connected to said trigger capacitor and a secondary winding electrically connected to a trigger electrode of the flash tube.

15. An electric flash apparatus as claimed in claim 1, wherein said first flash control circuit arrangement said electric charge storing means comprises a voltage converter circuit for converting a direct current voltage of a direct current power source circuit to an alternating current voltage and a rectifier circuit for rectifying said alternating current voltage to a direct current voltage.

16. An photographic electric flash apparatus comprising a first flash unit mounted externally of the camera body, a second flash unit mounted externally of the camera body, the second flash unit comprising at least one flash tube, means for generating a trigger signal for triggering said at least one flash tube to flash, means for sensing the combined light output of said first and second flash units, and means for detachably connecting said first and second flash units, such that said second flash unit can be disconnected from the first flash unit, only said first flash unit being able to operate independently of the other flash unit, and such that said second flash unit can be disconnected from means for controlling the flash durations in synchronism with a shutter of the camera, said first and second flash units being such that the light output of the first flash unit is substantially greater than that of the second flash unit, and means for controlling the flash durations of the units so that the durations are substantially coextensive.

17. Apparatus as claimed in Claim 16 wherein the second flash unit is substantially ring-shaped and surrounds a lens of the camera.

18. Apparatus as claimed in Claim 16 wherein said first flash unit has a part, including a flash window, which is adjustable so that the direction in which the first unit projects light can be altered.

19. Apparatus as claimed in any of Claims 16 to 18 wherein the means for controlling the flash durations comprise a starting switch arranged in synchronism with a shutter of the camera, means for sensing the combined light output of the flash units and means for quenching the flash tubes at the same time or approximately the same time when an integraged version of the sensed output attains a threshold.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.