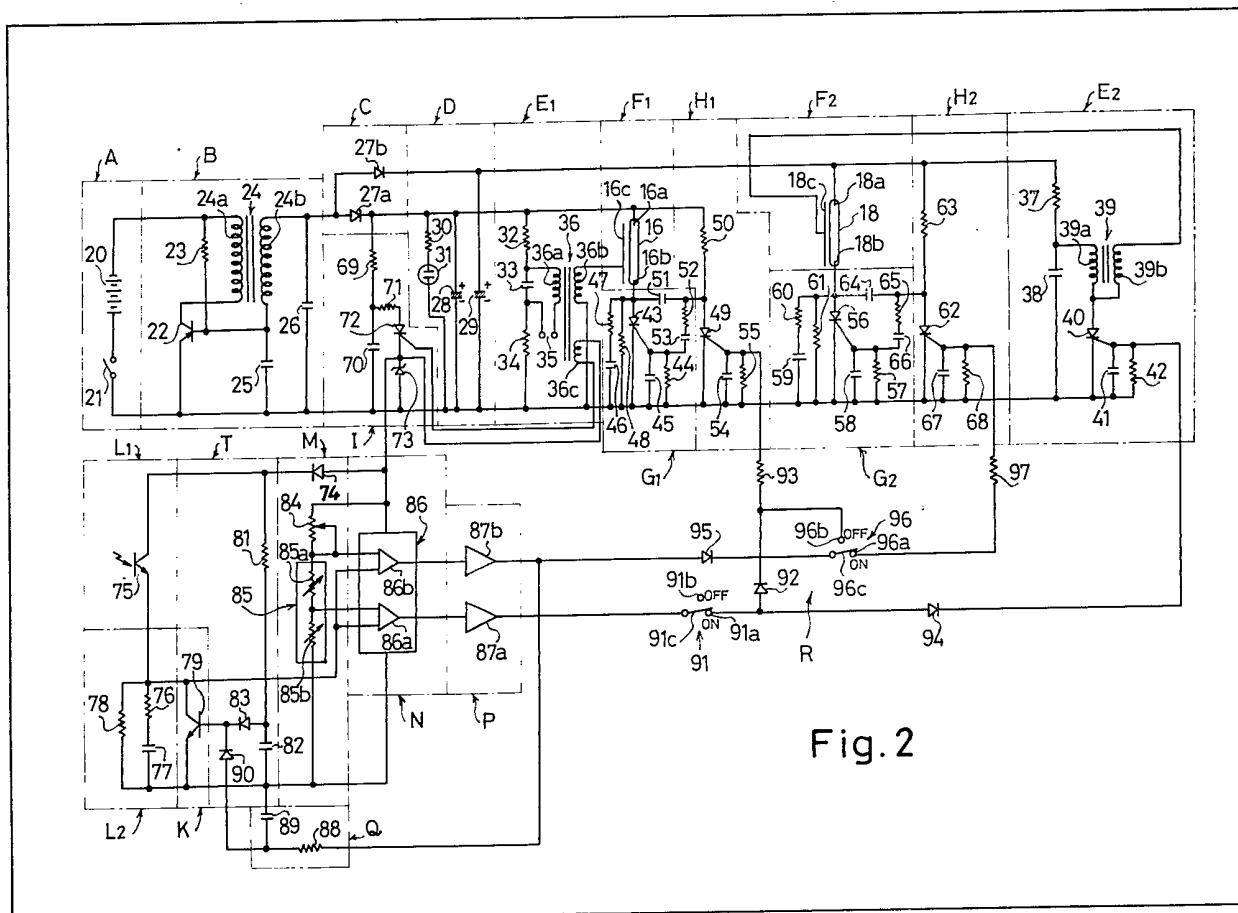


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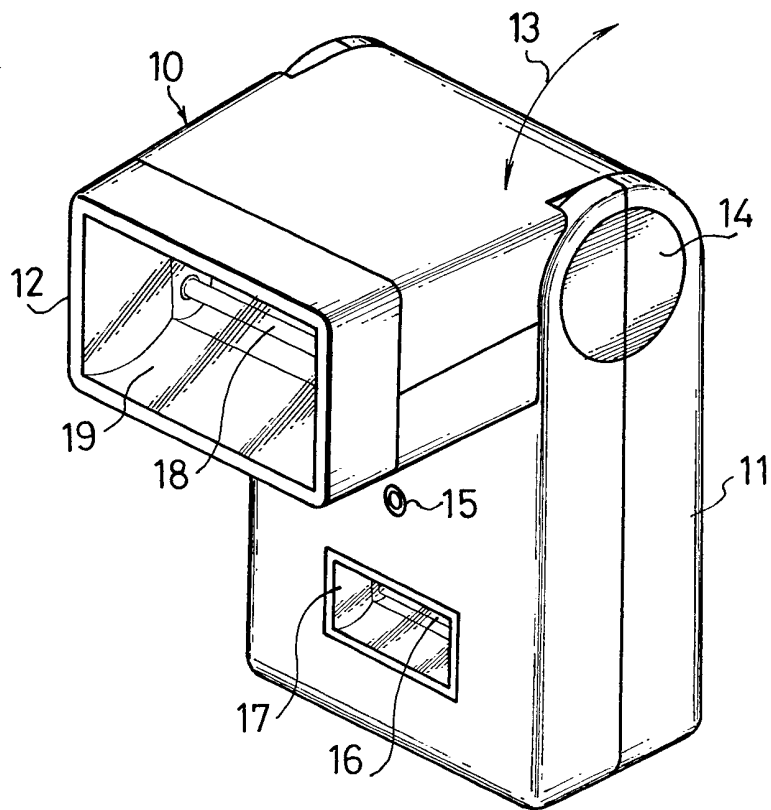
(54) Electric flash apparatus

(57) This invention discloses an electric flash apparatus which comprises electric power supplying means (20), which supplies main storage capacitors 28, 29 flash tubes 16, 18, and their associated triggering circuits, control means for quenching the tubes in response to the quantity of flesh light detected and means for controlling the flash timings of the two tubes. In the embodiments the tubes are fixed sequentially, one tube being in a housing pivotable relative to the other.



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Fig.1



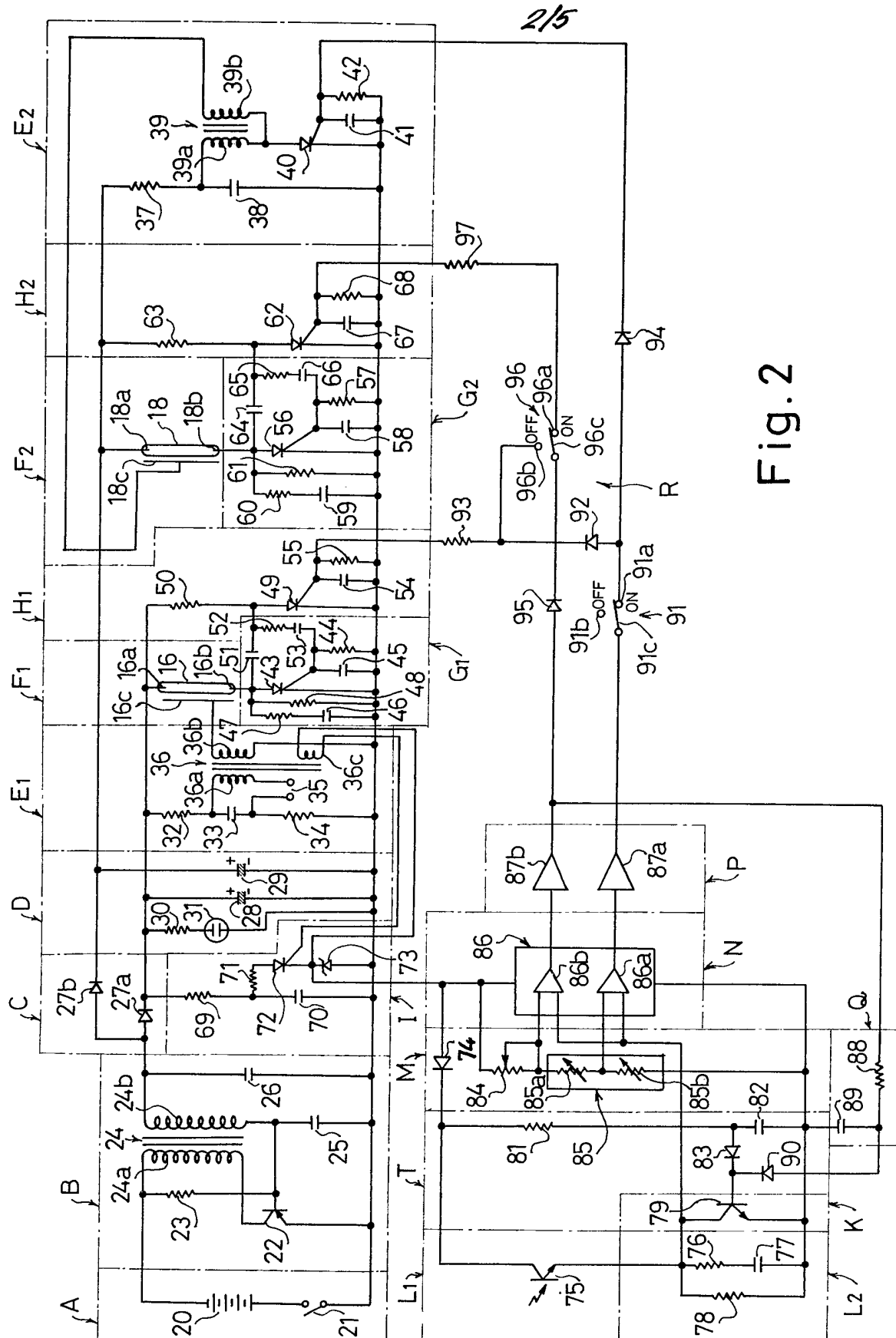


Fig. 2

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Fig. 3

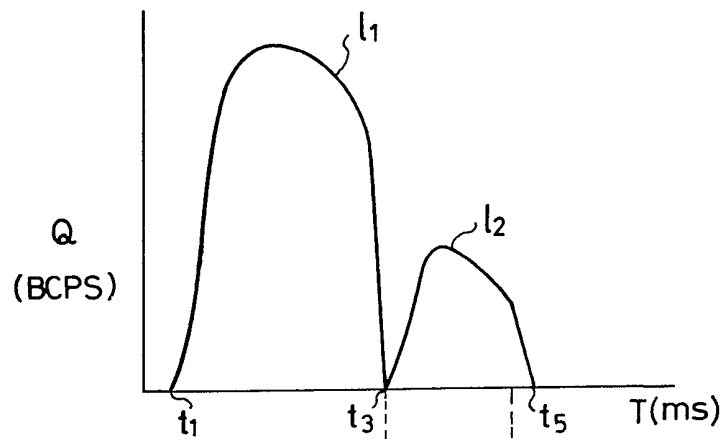


Fig. 4

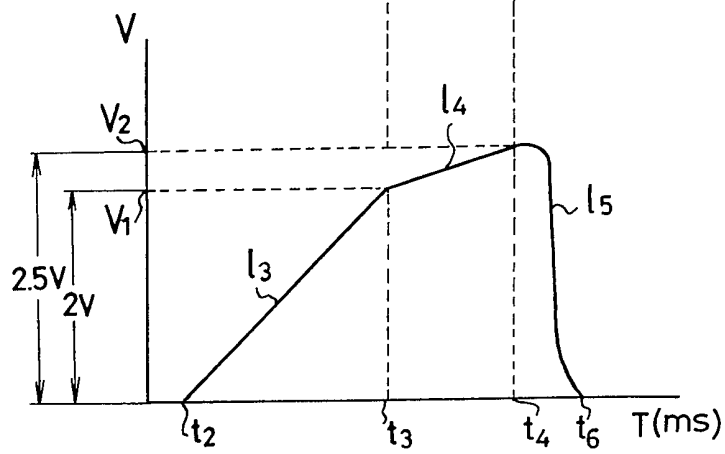
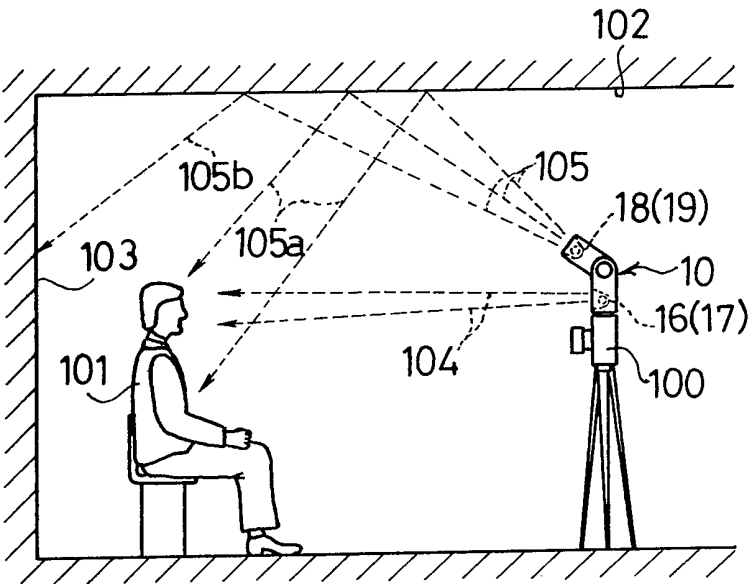
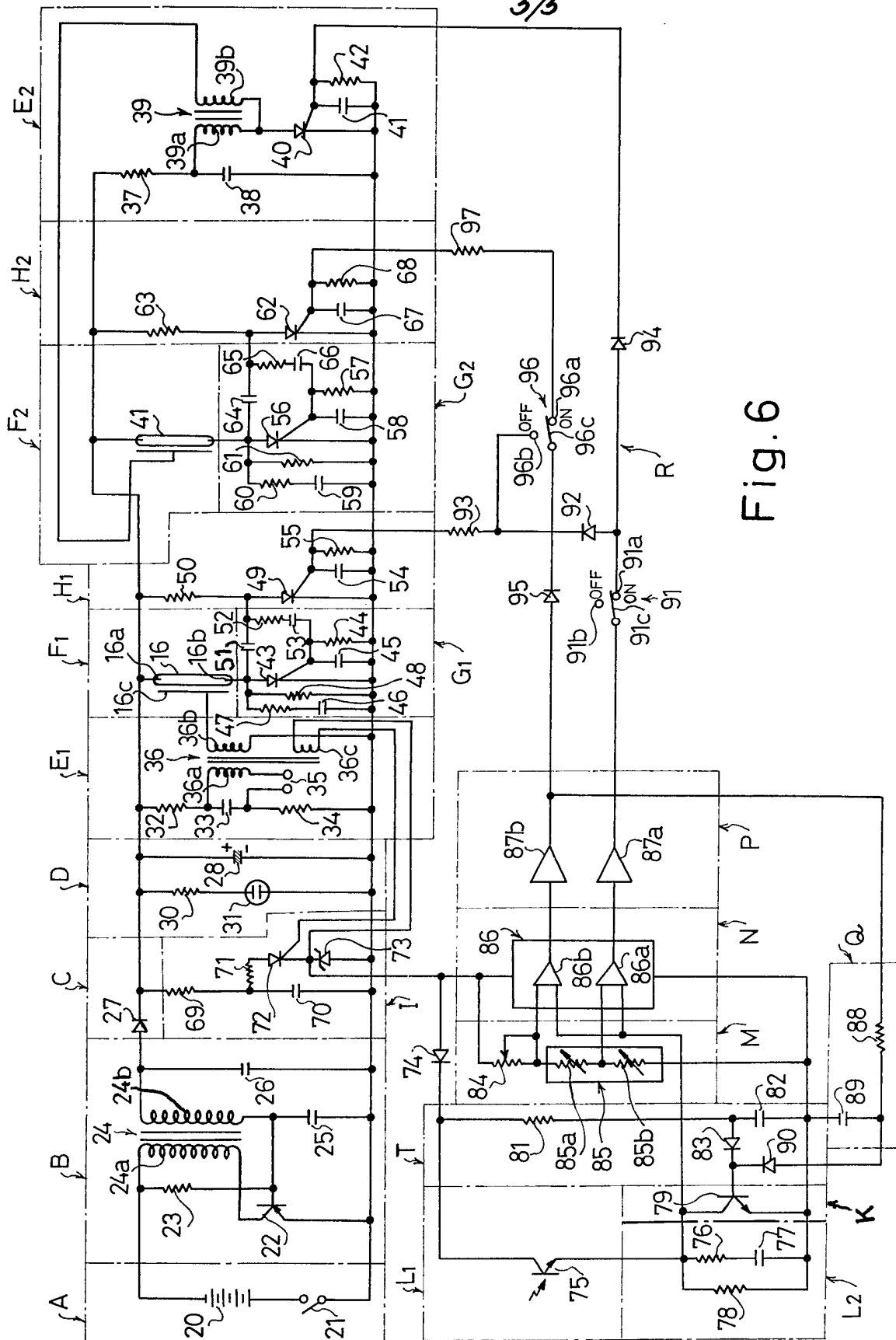


Fig.5





SPECIFICATION

Electric flash apparatus

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

10 In the art of photography, artificial light is commonly used to illuminate an object to be photographed. One form of artificial light which is now widely used is that produced by the so-called electric flash device. In such devices, a flash tube is provided in order to illuminate the object to be photographed.

15 The arrangement is such that the light from the flash tube will illuminate the object but if the surface of the object is contoured the illumination of the surface is uneven. Furthermore, when the flashlight from the electric flash device is employed as direct illumination for the photographic object in a room or a photostudio, a shadow of the photographic object is commonly formed behind the object producing poor photographic results.

20 In order to alleviate these disadvantages of photographic flash devices, it is known to use reflected, or bounced light to illuminate the object. In taking a picture by means of bounced light, there are still problems however, in that the quantity of light incident on the photographic object is much reduced from the predetermined value to which the device is set, particularly when a reflecting surface such as a ceiling surface is not white, and in that an object having an uneven surface cannot be photographed very well, because a significant portion of the light

35 reflected from the object is not incident on the film in the camera.

To alleviate these disadvantages, expensive illuminating equipment is required such as a front light, an umbrella-shaped reflecting plate and a backlight for eliminating the shadow from the background of the photographic object. This equipment, as well as being expensive is also bulky.

40 The present invention provides an electric flash apparatus comprising a first flashing member including at least one first flash tube, a second flashing member pivotably arranged on said first flashing member and including at least one second flash tube, and a flash control circuit arrangement for controlling flash operations of said first flashing member and said second flashing member, said flash control circuit arrangement comprising electric power supply means including a direct current power source, electric charge storing means for storing electric energy, trigger signal generating means triggering said first and second flashing members, and flash stopping means for stopping flash of said first and second flashing members, flash light quantity detecting means for detecting flash light quantity of said flash light generated from

60 at least one of said first and second flashing members by means of comparing an electric value obtained by integrating output of said light receiving circuit with reference voltage, flash timing adjusting means for adjusting flash timing of said first and

65 second flashing members, and flash light quantity

control means for controlling said flash light quantity of said flash light.

70 The present invention further provides electric flash apparatus comprising a flash unit comprising first and second flash tubes, means for generating a trigger signal for triggering said first flash tube to flash, means for sensing the light output of said first flash tube, means for quenching said first flash tube and means for generating trigger signal for triggering said second flash tube to flash when said sensed light output of said first flash tube reaches a particular value, such that said first and second flash tubes emit light during substantially consecutive periods in time, means for sensing the light output of

80 said second flash tube, means for quenching said second flash tube when the sensed light output of said second flash tube reaches a particular value and means for synchronising the operation of the flash tubes with a camera shutter.

85 Preferred embodiments of the invention will now be described by way of examples with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view of an electric flash apparatus according to the present invention.

90 Figure 2 is a detailed circuit diagram of a control circuit arrangement of an electric flash apparatus according to the present invention.

Figure 3 is a graph showing the quantity of light produced from an electric flash apparatus according to the present invention as measured against time.

95 Figure 4 is a graph showing the operation mode of an electric flash apparatus of the present invention.

Figure 5 is an elevational-side view explaining the operation of an electric flash apparatus according to the present invention when used in the performance of bounced-light flash photography.

Figure 6 is a modification of an electric circuit diagram of an electric flash apparatus of Figure 1.

100 With reference to Figure 1 of the drawings, there is shown an electric flash apparatus according to the present invention. The electric flash apparatus has a flash housing, generally designated by numeral 10 and consisting of a first casing 11 and a second casing 12. The second casing 12 is pivotably connected to the first casing 11 by means of a pivotable connecting member 14. Accordingly, the second casing 12 is rotatable as is shown by an arrow 13 with respect to the first casing 11. The first casing 11 is equipped with a light sensitive element 15 and, recessed in a front surface thereof, a first flash member 17 which includes a first flash tube 16. The second casing 12 is equipped with a second flash member 19 which includes a second flash tube 18. Accommodated in the housing 10 is a flash control arrangement which is constructed as shown in Figure 2.

105 The flash control circuit arrangement comprises a direct current power source circuit A, a voltage converter circuit B for converting and boosting a direct voltage from the power source circuit A to an alternating voltage, a rectifier circuit C for rectifying the alternating voltage from the voltage converter circuit B, an electric charge storing circuit D for supplying the electrical energy to the flash tubes 16 and 18, a trigger pulse generating means for trigger-

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ing a flash tube circuit member, a switching circuit member for actuating the flash tube circuit member, a quenching circuit member for extinguishing the flash tube circuit member and a quench trigger signal generating circuit member for actuating the quenching circuit member.

The flash control circuit arrangement further comprises a voltage generating circuit I activated by an activation signal from the trigger signal generating circuit member and generating voltage signal, a light receiving circuit L₁ for sensing a flash light generated from the flash tube circuit member and reflected from an object to be photographic and conducting in response to the intensity of the reflected light, an integration circuit L₂ in which the charging time interval changes corresponding to conduction of the light receiving circuit L₁, an integration reset circuit K for resetting the integration circuit L₂, a timer circuit T for controlling reset timing of the integration reset circuit K, a reference voltage setting circuit M for setting a plurality of reference voltages, a comparator circuit N receiving a voltage signal from the integration circuit L₂ and a reference voltage signal of the reference voltage setting circuit M, an amplifier circuit P for amplifying an output signal of the comparator circuit N, a time delay circuit Q for delaying the resetting operation of the integration resetting circuit K, and a changeover circuit R for selecting flash of the flash tube circuit member.

In more detail, the voltage converter circuit B has, substantially, an oscillator circuit, and comprises a switch element in the form of a transistor 22 of which an emitter is connected to a positive terminal of a battery 20 by way of a power source switch 21, a transformer 24 having a primary winding 24a connected to the battery 20 by way of a collector-emitter path of the transistor 22 and the power source switch 21, a resistor 23 connected between a negative terminal and a base of the transistor 22, and an oscillating capacitor 25 connected between the emitter and the base of the transistor 22. One terminal of a secondary winding 24b is connected to the base of the transistor 22. A capacitor 26 is connected between a terminal of the secondary winding 26b of the transformer 24 and power source switch 21. The rectifier circuit C comprises a first diode 27a and a second diode 27b of which anodes are connected to a terminal of the secondary winding 24b of the transformer 24. The electric charge storing circuit D comprises a first main storage capacitor 28 which is connected to the diode 27a and the positive terminal of the battery 20, a second main storage capacitor 29 which is connected to a cathode of the diode 27b and the positive terminal of the battery 20, and an indicating lamp in the form of a neon glow lamp 31 connected in parallel to the first main storage capacitor 28 by way of a protecting resistor 30.

The flash tube circuit member consists of a first flash tube circuit F₁ including a flash tube 16 and a second flash tube circuit F₂ including a second flash tube 18. The trigger signal generating means comprises a first trigger signal generating circuit E₁ for triggering the first flash tube 16 of the first flash tube circuit F₁ and a second trigger signal generating

circuit E₂ for triggering the second flash tube 18 of the second flash tube circuit F₂. The switching circuit member comprises a first switching circuit G₁ for controlling flash current of the first flash tube 16 and a second switching circuit G₂ for controlling flash current of the second flash tube 18. The quenching circuit means comprises a first quenching circuit H₁ for controlling the switching operation of the first switching circuit G₁ and a second quenching circuit H₂ for controlling the switching operation of the second switching circuit G₂.

The first trigger signal generating circuit E₁ includes a trigger resistor 32, a synchronizing switch 35, a trigger capacitor 33, a resistor 34 and a first trigger transformer 36. In the first trigger signal generating circuit E₁, one terminal of the trigger resistor 32 is connected to the cathode of the first diode 27a. One terminal of the trigger capacitor 33 is connected to the other terminal of the resistor 32 and the main storage capacitor 28 by way of the resistor 34. The first trigger transformer 26 comprises an input winding 36a, an output winding 36b and a detection winding 36c. The input winding 36a is connected in parallel to the trigger capacitor 33 across the synchronizing switch 35. The output winding 36b of the first trigger transformer 36 is connected to a trigger electrode 16c of the flash tube 16. The second trigger signal generating circuit E₂ includes a trigger resistor 37, a second trigger capacitor 38, a second triggering transformer 39, a switching element in the form of a thyristor 40, a gate capacitor 41 and trigger resistor 42. In the second trigger signal generating circuit E₂, one terminal of the trigger resistor 37 is connected to the second diode 27b, and the second trigger capacitor 38 is connected to the other terminal of the resistor 37. An input winding 39a of the second triggering transformer 39 is connected in parallel to the second trigger capacitor 38 by way of the switching element in the form of the thyristor 40. A capacitor 41 for reducing noise and a resistor 42 for stabilizing the actuation of the thyristor 40 are connected between a gate and a cathode of the thyristor 40.

The first switching circuit G₁ includes a thyristor 43, a gate resistor 44, capacitors 45 and 46, a resistor 47 and a commutation resistor 48. The thyristor 43 is connected in series to the first flash tube 16 of the first flash tube circuit F₁. The capacitor 46 is connected between an anode and a cathode of the thyristor 43 across the resistor 47.

The first quenching circuit H₁ includes a switching element in the form of a thyristor 49, a resistor 50, a commutation capacitor 51, a resistor 52, a capacitor 53, a gate capacitor 54 and a gate resistor 55, and connected as shown.

The second switching circuit G₂ includes a thyristor 56, a gate resistor 57, capacitors 58 and 59, a resistor 60 and a commutation resistor 61. The thyristor 56 is connected in series to the second flash tube 18 of the second flash tube circuit F₂. The capacitor 59 is connected between an anode and a cathode of a thyristor 56 across the resistor 60.

The second quenching circuit H₂ includes a switching element in the form of a thyristor 62, a resistor 63, a commutation capacitor 64, a resistor 65, a

capacitor 66, a gate capacitor 67 and a gate resistor 68, and connected as shown.

The first flash tube 16 is provided with a pair of main current conducting electrodes 16a, 16b and a trigger electrode 16c which is positioned adjacent but external to the flash tube 16. The second flash tube 18 is also provided with main current conducting electrodes 18a, 18b and a trigger electrode 18c which is also positioned adjacent but external to the flash tube 18. As explained in the foregoing in Fig. 1, the first flash tube 16 is arranged in the first flash member 17 which is recessed in a front surface of the first casing 11, and the second flash member 17 mounted on an end portion of the second casing 12.

One main current conducting electrode 16a of the first flash tube 16 is connected to the first main storage capacitor 28 and other main current conducting electrode 16b is connected to the anode of the thyristor 43 of the first switching circuit G₁. The trigger electrode 16c of the first flash tube 16 is connected to the output winding 36b of the first triggering transformer 36. One main current conducting electrode 18a of the second flash tube 18 is connected to the second main storage capacitor 29, and other main current conducting electrode 18b is connected to the anode of the thyristor 56 of the second switching circuit G₂.

There are certain criteria, in the first flash tube member 17 and the second flash tube circuit member 19, that must be met in both flash tubes 16 and 18 for satisfactory operation according to an embodiment of the present invention. To operate effectively, the current to be supplied to the first tube 16 must be relatively small compared with that to be supplied to the second flash tube 18, in order to make the quantity of the flash light generated by the first flash tube 16 to be smaller than that of the flash light from the second flash tube 18. To ensure this the first flash tube 16 must have a relatively low impedance compared with the second flash tube 18. To provide such low impedance, the first flash tube 16 should have a low gas pressure and a small electrode spacing, in comparison with the second flash tube 18. That is to say, length and diameter of the second flash tube 18 is set to be larger than that of the first flash tube 16 such that the light quantity of the second flash tube 18 becomes greater than that of the first flash tube 16. Capacity of the second main storage capacitor 29 is set to be larger than that of the first main storage capacitor 28, since the light quantity of the second flash tube 18 is greater than that of the first flash tube 16. Moreover, an internal resistance value of the first flash tube 16 is adjusted and set to be large in comparison with a conventional flash tube in order to make the flash durations of the first and second flash tubes 16 and 18 the same or approximately the same, because the flash light duration increases as the internal resistance value increases. In this case, the intensity of the light emitted by each of the flash tubes 16 and 18 is approximately the same. Accordingly, it is unnecessary to provide an impedance element between the first diode 27a and the first flash tube 16, and the power loss which would result from provision of this element is avoided.

The voltage generating circuit I comprises a capacitor 70 which is connected to the first diode 27a of the rectifier circuit C by way of a protecting resistor 69, a switching element in the form of a thyristor 72 of which an anode electrode is connected to the capacitor 70 by way of a protecting resistor 71 and a constant voltage generating element in the form of a Zener diode 73 which is connected between the thyristor 72 and the capacitor 70. The Zener diode 73 is connected to the light receiving circuit L₁, the integration circuit L₂, the timer circuit T, the reference voltage setting circuit M and the comparator circuit N.

The light receiving circuit L₁ comprises a light receiving element in the form of a phototransistor 75. The integration circuit L₂ comprises a resistor 76 and an integration capacitor 77. The phototransistor 75 of the light receiving circuit L₁ is connected to the Zener diode 73 of the voltage generating circuit I by way of the diode 74. The integration capacitor 77 of the integration circuit L₂ is connected to the phototransistor 75 by way of the integration resistor 78.

The integration reset circuit K comprises a transistor 79 of which a collector-emitter path is connected to the integration capacitor 75 of the integration circuit L₂ and diodes 83 and 90. The integration reset timing circuit in the form of a timer circuit T comprises a charging resistor 81 and a capacitor 82 which is connected to the voltage generating circuit I by way of the resistor 81. The reference voltage setting circuit M comprises a voltage divider 85 which is connected to a juncture of the thyristor 72 and the Zener diode 73 of the voltage generating circuit I by way of a variable resistor 84. The comparator circuit N comprises a plurality of comparator elements 86a and 86b, each of which is activated by different operation voltages such as, 2 volts and 2.5 volts. The comparator elements are, respectively, connected to the integration circuit L₂ and the reference voltage setting circuit M. Each of the comparator elements 86a and 86b is set so as to be operated by a different voltage and is connected to corresponding taps of the resistor elements 85a and 85b of the voltage divider 85 and the integration circuit L₂ and the integration reset circuit K.

The amplifier circuit P comprises an amplifier element 87a which is connected to the comparator element 86a and an amplifier element 87b which is connected to the comparator element 86b of the comparator circuit N. The time delay circuit Q comprises a resistor 88 connected to an output terminal of the amplifier element 87b of the amplifier circuit P, a capacitor 89 connected to the resistor 88 and the capacitor 82 of the timer circuit T. The anode of diode 90 is connected to a juncture of the resistor 88 and the capacitor 89 and the cathode of diode 90 is connected to the base electrode of the transistor 79 of the integration reset circuit K. The flash selecting circuit R comprises a first changeover switch 91, a blocking diode 92 and a resistor 93 and a diode 94. The changeover switch 91 has stationary contacts 91a and 91b and a movable contact 91c. The movable contact 91c of the changeover switch 91 is connected to an output terminal of the comparator element 87a. The stationary contact 91a is connected

to the anode of the blocking diode 92 and the anode of the diode 94. The cathode of diode 92 is connected to the gate of the thyristor 49 of the first quenching circuit H₁ by way of the resistor 93. The cathode of the diode 94 is connected to the gate of the thyristor 40 of the second trigger signal generating circuit E₂. A second changeover switch 96 has stationary contacts 96a and 96b and a movable contact 96c. The movable contact 96c is connected to the output terminal of the amplifier element 87b by way of a diode 95. The stationary contact 96a is connected to the gate of the thyristor 62 of the second quenching circuit H₂ by way of resistor 97. The stationary contact 96b of the second changeover switch 96 is connected to the thyristor 49 of the first quenching circuit H₁ by way of the resistor 93.

A circuit constructed in accordance with the foregoing description operates as follows.

When the power source switch 21 is made ON, the voltage converter circuit B activates an oscillating operation, and thereby a high voltage is induced at the secondary winding 24b of the transformer 24. The boosted alternating voltage is rectified by the rectifier circuit C, and thereafter electric charge is stored on the first main storage capacitor 28 and the second main storage capacitor 29. When the main storage capacitors 28 and 29 are fully charged up to a predetermined voltage, the neon glow lamp 31 lights, indicating that the device is in readiness for the flash tubes 16 and 18 to be fired. Simultaneously the trigger capacitors 33 and 38 are charged by the high D.C. voltage from the rectifier circuit C. After charging of capacitors 28 and 29 to the predetermined voltage, the operation of flash tube 16 is initiated by closing of switch 35 of the first trigger pulse generating circuit E₁. Switch 35 also controls the opening of a shutter of a lens of the camera and so the initiation of the flashing of flash tube 16 is in synchronism with the camera shutter opening operation. Closing switch 35 enables the first flash tube 16 to fire. When the switch 35 is closed, the electric charge of the trigger capacitor 33 is discharged through the switch 35 and the input winding 36a of the triggering transformer 36. By the discharge of the capacitor 33, triggering pulses are generated from the output winding 36b and the detection winding 36c of the triggering transformer 36. The stored voltage on the first main storage capacitor 28 appears across the electrodes 16a and 16b of the first flash tube 16. The triggering pulse generated from the output winding 36b is applied to the trigger electrode 16c of the first flash tube 16, and thereby the first flash tube 16 is triggered. Immediately before the flashing of the first flash tube 16, a glow current of the first flash tube 16 flows through the commutation capacitor 51, the resistors 52 and 44 and the capacitor 53, and thereby the thyristor 43 of the switching circuit G₁ is biased to be conductive.

The thyristor 72 of the voltage generating circuit I is triggered and fired by a triggering signal from the detection winding 36c of the triggering transformer 36. By the firing of the thyristor 72, a voltage of the capacitor 70 is applied to the Zener diode 73 to generate a predetermined constant voltage such as 20 volts. The constant voltage produced by the Zener

diode 73 is applied to the light receiving circuit L₁, the integration circuit L₂, the reference voltage setting circuit M, the comparator circuit N and the timer circuit T.

Under these conditions, the phototransistor 75 of the light receiving circuit L₁ receives light which has been produced by the first flash tube 16 of the first flash tube circuit F₁ and has been reflected from the object to be photographed (not shown in Figure 2) and becomes conductive in response to the intensity of incident reflected light. By the conduction of the phototransistor 75, electric charge is stored on the integration capacitor 77 of the integration circuit L₂ and thereby the charging voltage of the integration capacitor 77 increases to a predetermined value which corresponds to the intensity of reflected light incident on phototransistor 75. The charging voltage of the integration capacitor 77 is applied to the comparator circuit N. The reference voltage setting circuit M produces a plurality of reference voltages to be applied to the comparator circuit N. In an embodiment of the invention, the reference voltage setting circuit M is set so as to produce a plurality of reference voltages such as, for example, 2 volts and 2.5 volts and the comparator circuit N comprises a comparator element 86a activated at 2 volts and a comparator element 86b activated at 2.5 volts.

When the charging voltage of the integration capacitor 77 attains a predetermined value such as, for example, 2 volts, the comparator element 86a generates an output signal. The output signal of the comparator element 86a is amplified by an amplifier element 87a and supplied as the gating signal to the thyristor 49 of the first quenching circuit H₁ through switch 91 which is made ON, diode 92 and resistor 93 and, at the same time, is supplied to the thyristor 40 of the second trigger signal generating circuit E₂ through the diode 94, enabling thyristors 49 and 40 to be conductive. By conduction of the thyristor 49 of the first quenching circuit H₁, electric charge on the commutation capacitor 51 discharges through the thyristor 49 and the commutation resistor 48, thereby to produce across the commutation resistor 48 a voltage, such that the voltage at the cathode of thyristor 43 is made positive with respect to the anode of thyristor 43 after a time interval which is dependent upon a time constant determined by the commutation capacitor 51 and the commutation resistor 48. This induced voltage across the resistor 48 causes the thyristor 43 to turn off. When the thyristor 43 becomes nonconductive, the first flash tube 16 is simultaneously extinguished.

By the conduction of the thyristor 40 of the second trigger signal generating circuit E₂, electric charge stored on the second trigger capacitor 38 is discharged through the input winding 39a of the triggering transformer 39 and a high voltage pulse is generated at the output winding 39b. The high voltage pulse produced at the output winding 39b is applied to the trigger electrode 18c of the second flash tube 18, and thereby the second flash tube 18 is triggered to flash. In this case, the charging voltage of the integration capacitor 77 of the integration circuit L₂ continues to increase. The phototransistor 75 further senses reflected light which is generated

from the second flash tube 18 of the second flash tube circuit F_2 and is reflected from the object to be photographed. The charging voltage further increases due to the reflected light of the second flash tube 18. When the charging voltage of the integration capacitor 77 attains to 2.5 volts, the second comparator element 86b activates and generates an output signal. The output signal of the comparator element 86b is amplified by amplifier 87b. The output signal of the amplifier 87b is supplied as an operating signal to the thyristor 62 of the second quenching circuit H_2 to cause the thyristor 62 to be conductive. By the conduction of the thyristor 62, the electric charge of the commutation capacitor 64 discharges through the thyristor 62 and the commutation resistor 61, thereby to produce across the commutation resistor 61 a voltage, such that the voltage at the cathode of thyristor 56 is made positive with respect to the anode of thyristor 56 after a time interval which is dependent upon a time constant determined by the commutation capacitor 64 and the commutation resistor 61. This induced voltage across the resistor 61 causes the thyristor 56 to turn off. When the thyristor 56 becomes nonconductive, the second flash tube 18 of the second flash tube circuit F_2 is extinguished.

The amplified output signal of the second amplifier element 87b of the amplifier circuit P is further supplied to the integration resetting circuit K by way of the time delay circuit Q. In more detail, the output signal of the second amplifier 87b is supplied to the base electrode of the transistor 79 by way of the resistor 88 and the diode 90, and thereby the transistor 79 is made conductive after a time interval due to the time delay circuit Q. When the transistor 79 becomes conductive, the electric charge of the integration capacitor 77 of the integration circuit L_2 is discharged through the collector-emitter path of the transistor 79 to reset the integrating operation of the integrator circuit L_2 . When the distance between the object to be photographed and the flash device is small, the integrating operation of the integration circuit L_2 is by-passed by the resistor 78, and the charging voltage of the integration capacitor 77 is by-passed by the resistor 78.

Figures 3 and 4 are representative of the operating characteristics of the flash apparatus of Figure 1. As is best shown by a curve ℓ_1 of Figure 3, it should be assumed that the first flash tube 16 flashes at the time denoted by t_1 after the switch 35 is closed, and ceases to flash, after a time interval, at the time denoted by t_3 . When the first flash tube 16 begins to flash, the voltage generating circuit I produces a voltage, and the light receiving circuit L_1 receives light reflected from the object to be photographed. Phototransistor 75 is made conductive in response to the intensity of light reflected from the object to be photographed and electric charge is stored on the integration capacitor 77 which charging operation is represented by a curve ℓ_3 of Figure 4. When the charging voltage of the integration capacitor 77 attains a predetermined value V_1 such as for example 2 volts, the comparator circuit N is activated and operates the first quenching circuit H_1 and the second trigger signal generating circuit E_2 .

The signal supplied from the comparator element of the comparator circuit N activates the first quenching circuit H_1 to stop the flash operation of the first flash tube 16 at the time denoted by t_3 of the curve ℓ_1 and, at the same time, the second trigger signal generating circuit E_2 is activated to start the flash operation of the second flash tube 18 as is shown by a curve ℓ_2 of Figure 3.

Flashing of the second flash tube 18 causes the charging voltage of the integration capacitor 77 to further increase as is shown by a curve ℓ_4 of Figure 4 and attain the predetermined value V_2 such as for example 2.5 volts. When the charging voltage of the integration capacitor 77 attains, for example, 2.5 volts, the comparator element 86b is activated in order to operate the second quenching circuit H_2 . By the activation of the second quenching circuit H_2 , the flashing of the second flash tube 18 ceases at the time t_5 . In this case, the actual flash stopping time is denoted by time t_4 as is shown by the curve ℓ_4 of Figure 4. Accordingly, the integration resetting time of the timer circuit T is set to a time point t_6 which is later than the time point t_5 , as is shown by curve ℓ_5 of Figure 4, by means of the time delay circuit Q.

When the changeover switches 91 and 96 are switched to OFF states, the second trigger signal generating circuit E_2 and the second quenching circuit H_2 are switched out of operation. Accordingly, only the flashing operation of first flash tube circuit F_1 can be performed.

Figure 5 shows the manner in which the above described electric flash apparatus can be used in reflected flash light photography in a room or a photostudio. The flash housing 10 is on a top of a camera 100. The flash member 17 of the first casing 11 is directed towards an object to be photographed, such as a man 101. The second casing 12 is set at a suitable angular orientation with respect to the first casing 11, and the second flash member 19 is directed towards a surface such as a ceiling 102, in order to reflect the bounced flash light towards the object to be photographed. That is to say, flash light 105 from the second flash member 19 is directed toward a surface of the ceiling 102. The flash light 105 reflects at the surface of the ceiling 102 and thereafter constitutes the bounced light. A portion 105a of the reflected light produced by the reflection of the flash light 105 is incident on the man 101, and another portion 105b of the bounced light is incident on a background surface such as a wall 103 of the room. The portion 105a is superimposed with the flash light 104 from the first flash member 17, while the portion of the bounced light eliminates shadow in the background of the object. As mentioned earlier, the quantity of the flash light 105 may be set to be greater than the quantity of the flash light 104 produced from the first flash tube 16 by making the internal impedance of the second flash tube 18 to be higher than that of the first flash tube 19.

Accordingly, in the photographing arrangement shown in Figure 5, the brightness of the object to be photographed, such as the man, is increased and made uniform. The durations of the periods of emission of direct light by the first flash tube 16 and the bounced light from the second flash tube 18 are

set so as to be same or approximately the same. This permits effective use of first and second main storage capacitors of reduced rated capacity even though the apparatus is equipped with two flash tubes.

In accordance with the electric flash apparatus of Figure 2, good flash performance can be obtained, since the flash timing of the second flash tube 18 is adjusted by the light receiving circuit L_1 , the integration circuit L_2 , the reference voltage setting circuit M, the comparator circuit N and the time delay circuit Q. Further, the electric flash apparatus may be operated in varying circumstances and operating conditions since the flashing of the first flash tube 16 and the second flash tube 18 can be selected by changing over the first selector switch 91 and the second selector switch 96, which are actuated simultaneously.

Figure 6 shows a further embodiment of the electric flash apparatus of the present invention. The flash apparatus of Figure 6 comprises means for storing the electric charge, a power source circuit A, a voltage converter circuit for boosting and converting a direct voltage of the power source circuit A to an alternating voltage, a rectifier circuit C for rectifying the alternating voltage to a direct voltage and an electric charge storing circuit D for storing an electric charge supplied from the rectifier circuit C, trigger signal generating means for generating a trigger signal and including a first trigger signal generating circuit E_1 and a second trigger signal generating circuit E_2 , flash light generating means for generating flash light and including a first flash tube circuit F_1 and a second flash tube circuit F_2 . The flash apparatus of Figure 6, also comprises flash light control means including a light receiving circuit L_1 , an integration circuit L_2 for integrating the current supplied from the light receiving circuit L_1 , an integration resetting circuit K for resetting the integrating operation of the integration circuit L_2 , and flash timing adjusting means for adjusting the flash timing of the first flash tube circuit E_1 and the second flash tube circuit E_2 . The flash timing adjusting means comprises a reference voltage setting circuit M for setting a plurality of setting voltages, a comparator circuit N for comparing the reference voltages of the reference voltage setting circuit M and the integration voltages of the integration circuit L_2 , and a time delay circuit Q for delaying the resetting operation of the integration resetting circuit K. In the arrangement of Figure 6, a rectifier circuit C is provided with only one diode 27 and an electric charge storing circuit D is provided with only one main storage capacitor 28. The first flash tube 16 and the second flash tube 41 are conjointly connected to the main storage capacitor 28 of the electric charge storing circuit D and the diode 27 of the rectifier circuit. In accordance with the flash apparatus of Figure 6, the same operations and advantages are performed as the flash apparatus of Figure 2.

As is apparent from the above description, the embodiment of the electric flash apparatus of the present invention disclosed herein has the following advantages.

An advantage over the prior art is that the invention provides an electric flash apparatus which can accurately have a desired flash light intensity emitted from each flash member by providing a respective main storage capacitor for each flash member.

Further advantage is that the efficiency of the apparatus is improved, since a main storage capacitor is fully employed for providing charge for supply to the respective flash member.

Furthermore, the apparatus can be used to perform bounce flash photography by setting a second flash member at a desired angle with respect to a first flash member, since the first flash member and the second flash member are rotatably connected together.

A further advantage is that good flash performance can be obtained, since the apparatus is provided with automatic flash light control means for controlling the light emitted from and flash timing of the flash tubes.

An embodiment of the invention as described hereinabove provides an electric flash apparatus which performs good flashing operations which is reliable and which is inexpensive and economical.

CLAIMS

1. An electric flash apparatus comprising a first flashing member including at least one first flash tube, a second flashing member pivotably arranged on said first flashing member and including at least one second flash tube, and a flash control circuit arrangement for controlling flash operations of said first flashing member and said second flashing member, said flash control circuit arrangement comprising electric power supply means including a direct current power source, electric charge storing means for storing electric energy, trigger signal generating means triggering said first and second flashing members, and flash stopping means for stopping flash of said first and second flashing members, flash light quantity detecting means for detecting flash light quantity of said flash light generated from at least one of said first and second flashing members by means of comparing an electric value obtained by integrating output of said light receiving circuit with reference voltage, flash timing adjusting means for adjusting flash timing of said first and second flashing members, and flash light quantity control means for controlling said flash light quantity of said flash light.

2. An electric flash apparatus as claimed in claim 1, wherein said power supply means further comprises a voltage converter circuit for boosting and converting an output voltage of said direct current power source to an alternating current voltage, a rectifier circuit for rectifying an alternating output of said voltage converter circuit, and electric charge storing circuit including at least one main storage capacitor for storing electric energy of a direct current voltage of said rectifier circuit, and said flash stopping means for stopping flash of the flash light generating means comprises a quench controlling circuit having a switching circuit turning on and off

said flash tubes of the flashing members, a quenching circuit for controlling on and off operation of said switching circuit.

3. An electric flash apparatus as claimed in claim 1, wherein said flash light quantity detecting means comprises a light receiving circuit including a light receiving element, an integration circuit for integrating a current of said light receiving circuit, a reference voltage setting circuit including a plurality of voltage dividing resistor, and a comparator circuit for receiving a plurality of reference voltage and charging voltage of an integration capacitor of said integration circuit.

4. An electric flash apparatus as claimed in claim 1 further comprising flashing operation controlling means for controlling flashing operation of at least one of said first flash tube of the first flashing member and said second flash tube of the second flashing member in response to output signals from said flash light quantity detecting means.

5. An electric flash apparatus as claimed in claim 1 further comprising a voltage generating circuit applying voltage to said light quantity detecting means.

6. An electric flash apparatus as claimed in claim 1 further comprising an integration resetting circuit for making the voltage of said integration circuit of said light quantity detecting means approximately zero after a predetermined time interval from a time point after flashing of said second flash tube.

7. An electric flash apparatus as claimed in claim 2, wherein said electric charge storing means comprises a first main storage capacitor and a second main storage capacitor of which capacity is larger than capacity of said first main storage capacitor.

8. An electric flash apparatus as claimed in claim 1, wherein said trigger signal generating means comprises a first trigger signal generating circuit for triggering said first flash tube, and a second trigger signal generating circuit for triggering said second flash tube, and said flash stopping means comprises a first quenching circuit for quenching said first flash tube and a second quenching circuit for quenching said second flash tube.

9. An electric flash apparatus as claimed in claim 8 further comprising flashing operation controlling means for controlling operations of said first and second quenching circuits and said first and second trigger signal generating circuit.

10. An electric flash apparatus as claimed in claim 9, wherein said flashing operation controlling means having a first selector switch for selecting the operation of said second trigger signal generating circuit, and a second selector switch for selecting operation of said quenching circuit or operation of said second quenching circuit.

11. An electric flash apparatus as claimed in claim 10, wherein said first selector switch is connected between a comparator circuit of the flash light quantity detecting means and said first quenching circuit and said second trigger signal generating circuit, and said second selector switch is connected between said first and second quenching circuits and said comparator circuit.

12. An electric flash apparatus as claimed in

claim 1 further comprising integration reset timing means for adjusting the resetting timing of an integration resetting circuit for resetting an integrating operation of said integration circuit.

13. An electric flash apparatus as claimed in claim 12, wherein said integration reset timing means comprises a timer circuit for setting an operation timing of said integration resetting circuit.

14. An electric flash apparatus as claimed in claim 13 further comprising a time delay circuit for operating said integration resetting circuit when the second flash tube is extinguished.

15. An electric flash apparatus as claimed in claim 14, wherein said time delay circuit is arranged between a comparator circuit and said integration resetting circuit.

16. An electric flash apparatus substantially as hereinbefore described with reference to and as illustrated in Figure 2 and Figure 6.

17. Electric flash apparatus comprising a flash unit comprising first and second flash tubes, means for generating a trigger signal for triggering said first flash tube to flash, means for sensing the light output of said first flash tube, means for quenching said first flash tube and means for generating a trigger signal for triggering said second flash tube to flash when said sensed light output of said first flash tube reaches a particular value, such that said first and second flash tubes emit light during substantially consecutive periods in time, means for sensing the light output of said second flash tube, means for quenching said second flash tube when the sensed light output of said second flash tube reaches a particular value and means for synchronising the operation of the flash tubes with a camera shutter.

18. Apparatus as claimed in claim 17 wherein the light output of the second flash tube is substantially greater than that of the first flash tube.

19. Apparatus as claimed in claim 17 or claim 18 wherein the direction in which said second flash tube projects light can be altered.

20. Apparatus as claimed in any one of claims 17 to 19 wherein said means for quenching said first flash tube and said means for generating a trigger signal for triggering said second flash tube are activated when a first integrated version of the sensed output of said first flash tube attains a first threshold.

21. Apparatus as claimed in claim 20 wherein said means for quenching said second flash tube are activated when a second integrated version of the sensed output of said first flash tube and said second flash tube attains a second threshold, said second threshold being greater than said first threshold.

22. Apparatus as claimed in claim 21 wherein said first and second integrated version of the sensed output are compared to first and second reference voltages respectively.

23. Apparatus as claimed in claim 17 wherein said second flash tube may be disconnected from said means for synchronising such that only said first flash tube can flash.