

"ELECTRONIC FLASH"

This invention relates to electronic flash for photography. In particular, the invention concerns the construction and manner of operation of flash units and the arrangement both of the flash unit and the camera in order to enable information to be transmitted from the flash unit to the camera and from the camera to the flash unit via a connector by means of which the flash unit is connected both mechanically and electrically to the camera body. As cameras and flash units become increasingly sophisticated, the provision of an appropriate coupling becomes more difficult. In particular, where the camera is to send information to the flash unit and vice versa and the camera is to include monitoring of the state of the flash unit, the number of terminals required for the flash unit and which are required to be connected to the camera tends to become greater than can be conveniently used with an ordinary flash connector.

For example, if the camera is used with an automatic flash device it may include a display which indicates the state of readiness of a charging circuit in the flash unit and a display which indicates the setting of the flash unit. Information which governs the displays must be transmitted by way of the terminals of the flash unit.

The present invention particularly concerns the arrangement of the flash unit and in a manner which facilitates the use of a small number of terminals for the flash unit and, in particular, the arrangement of the flash unit for the transmission of an increased number of signals to the camera whilst enabling the use of an ordinary hot shoe or other commonplace connection device for the flash unit, and the invention is based on an arrangement in which the flash unit itself includes circuits for generating signals for transmission to the camera by way of a common terminal of the flash unit and the flash unit includes means for allowing the transmission of only one of the plurality of signals at a time.

There follows a description by way of example only of a particular embodiment of the invention with reference to the accompanying drawings, in which:

Figure 1 is a simplified partly perspective view of part of a camera, including a hot shoe fitting,

and a cooperative fitting for a flash unit;

Figure 2 is a schematic diagram of an electric circuit of a flash unit embodying the invention;

Figure 3 is a diagram illustrating waveforms at various parts of the circuit shown in Figure 2 when a changeover switch is turned off; and

Figure 4 is a diagram of the same character of Figure 3 when the aforementioned changeover switch is turned on.

In Figure 1 is illustrated a flash unit 1 which has a main body 2 including a foot 3. This foot is of generally commonplace form and is intended to enable the body 2 to be temporarily secured to the body of a camera 5 by cooperation with a hot shoe fitting 5.

The foot 3 has sprung terminals X_0 , R_0 and Q_0 which are positioned for cooperation with respective terminal parts X, Q and R of the hot shoe, the terminal X_0 engaging the terminal part X on the hot shoe and so on. The arrangement is preferably such that there is a ground connection from the flash unit to the camera by way of a ground terminal G_0 (not shown in Figure 1) and a camera terminal G (also not shown in Figure 1); these ground terminals may be arranged in accordance with ordinary practice.

Figure 2 is a diagram of the electrical circuit of the relevant parts of the flash unit and the cooperative circuits in the camera. The circuit of the flash unit is denoted by the reference F and the relevant part of the camera circuit is denoted by the reference K.

In the flash unit, a battery E is connected in series with a main switch S. The battery and switch are connected in series across a capacitor C_1 which smooth fluctuations of the terminal voltage of the battery when the battery is supplying power, on closure of the switch S, to a voltage converter 6. This voltage converter may consist of a transformer coupled oscillator which provides an alternating current at a high voltage which is rectified to provide a high direct voltage at the output terminals of the converter.

A main capacitor C_2 is connected between the positive output line of the converter 6 and the common ground line of the flash unit. The upper terminal of the capacitor is connected to the high voltage terminal of a discharge tube 9. A neon lamp 13 is connected in series with a current limiting resistor R_1 and a potential divider consisting of resistors R_2 and R_3 across the main capacitor C_2 . A Zener diode Z_2 is

connected to the junction between the neon lamp 13 and to the ground line.

When the main switch S is closed the converter 6 is activated to provide charging current for the main capacitor C_2 . When the charge accumulated by the capacitor C_2 is sufficient for discharge and the terminal voltage of the capacitor C_2 is correspondingly elevated, the neon lamp 13 illuminates, the Zener diode Z_2 reaching its Zener voltage.

A resistor R_J is connected between the positive terminal of the battery E and a positive rail, the voltage of which relative to the ground line is stabilised by a Zener diode Z_1 .

A signalling circuit A, shown within chain lines, is energised from the positive rail. The input for this circuit A is determined by the voltage at the junction point between the resistors R_2 and R_3 . To this point is connected the base of a transistor T_1 of which the emitter is connected to the ground line and the collector is connected to the base of a transistor T_2 . The aforementioned collector is connected to the positive rail by way of a resistor R_4 and to the ground line by way of a capacitor C_5 . The transistor T_2 has its emitter connected to the ground line and its collector connected to the junction between two resistors

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R_5 and R_6 which form a potential divider in series with a diode D_1 , these resistors and the diode D_1 being connected between the positive rail and the ground line. The junction point of this voltage divider is connected to the base of a transistor T_3 of which the emitter is connected to the flash unit's terminal R_0 and of which the collector is connected to the positive rail by way of a resistor R_7 .

When the Zener diode Z_1 attains its Zener voltage and the Zener diode Z_2 also reaches its Zener voltage so that the neon lamp 13 is turned on, the transistor T_1 is switched on and discharge of the capacitor C_5 turns off transistor T_2 . Thereupon the transistor T_3 is switched on and a signal is provided at the terminal R_0 of the flash unit. This signal indicates that charging of the main capacitor is complete and may be termed the "charging complete" signal.

The diode D_1 is provided to compensate for possible variation of the working point of transistor T_3 thereby to reduce the dependence of the "charging complete" signal on temperature.

Between the cathode and the Zener diode Z_2 and the terminal X_0 of the flash unit is connected a potential divider, consisting of resistors R_{11} and R_{12} ,

in series with a diode D_2 . The collector's base circuit of a transistor T_5 is connected across the resistor R_{11} , the base of the transistor being connected to the junction point between resistors R_{11} and R_{12} . The emitter of the transistor T_5 is connected to the input of a trigger circuit 8 of which the output terminal is connected to a trigger electrode T_G for the flash tube 9. From the collector of the transistor T_5 to the junction of the resistor R_{12} and the diode D_2 is connected a branch consisting of a resistor R_{25} and a diode D_5 .

The low voltage terminal of the flash tube 9 is connected to the ground line through a thyristor TH_1 of which the gate is connected to the ground line by way of a resistor R_{13} .

The aforementioned X_0 contact is when the flash unit is in position connected to the X contact on the camera. This contact is connected to the camera ground through a switch 15.

When the switch 15 is closed, the transistor T_5 is turned on so as to activate the trigger circuit 8. This trigger circuit may be of commonplace form and it operates to fire the discharge tube 9.

A "light adjustment" circuit 11 is connected to the output line of the converter 6 and to the flash unit's

terminal Q_0 , which is in engagement with the camera terminal Q when the flash unit is in position.

Output line from the light adjustment circuit 11 is connected to the gate of a thyristor TH_2 of which the anode is connected to the aforementioned positive rail and of which the cathode is connected by way of a voltage divider, consisting of resistors R_{16} and R_{17} , to the ground line of the flash unit. The resistors R_{16} and R_{17} form part of a timer circuit C , to be described later. The cathode of the thyristor TH_2 is connected by way of a "light emission termination" circuit 10 to the junction between two resistors R_{15} and R_{14} , which comprise a voltage divider connected between the high voltage terminal of the flash tube 9 (and the output line of the converter 6) and the gate of the thyristor TH_1 , the resistor R_{14} being connected to this gate by way of a capacitor C_4 . A commutation capacitor connects the anode of the thyristor TH_1 to the junction between the resistors R_{15} and R_{14} .

When a "light adjustment" signal is sent to the terminal Q_0 from the camera by way of terminal Q , the light adjustment circuit is activated so as to turn on thyristor TH_2 . This causes the extinction of the thyristor TH_1 by means of the capacitor C_3 so as to terminate the discharge from the tube 9.

The timer circuit C includes a comparator CP_1 of which the inverting input terminal is referenced by a voltage divider consisting of resistors R_{18} and R_{19} connected between the positive rail and the ground line.

5 The non-inverting terminal of the comparator is connected to the junction between resistors R_{16} and R_{17} , this latter resistor being shunted by the capacitor C_6 . The output terminal of the comparator CP_1 is connected by way of resistor R_{20} to the base of a transistor T_8
10 of which the collector is connected to the positive rail by way of a diode 14 and a resistor R_{22} . The output terminal of the comparator CP_1 is connected to the ground line by way of a resistor R_{21} and a switch 12, hereinafter called changeover switch.

15 When the thyristor TH_2 is turned off, the capacitor C_6 is discharged through resistor R_{17} and after a time delay set by the time constant of the resistor R_{17} and the capacitor C_6 , the output from the comparator CP_1 falls. The time delay may be 1.5 seconds.

20 The diode 14 is a light emitting diode so that it will illuminate when the transistor T_8 is turned on. The light emitting diode thus indicates the operation of the light adjustment circuit 11.

The output terminal of the charging completion
25 signal circuit A is connected to the flash unit's

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terminal R_0 , as is the output terminal of a light adjustment signal circuit B.

The circuit B includes an oscillator 7, which may consist of an astable multivibrator, which is energised from the positive rail. The output of the oscillator 7 is connected to the collector of a transistor T_7 and is also connected to the base of a transistor T_4 by way of a resistor R_8 . The emitter of the transistor T_7 is grounded and its base is connected to the positive rail by way of a resistor R_{27} and is also connected to the collector of a transistor T_6 of which the emitter is grounded and of which the base is connected by way of resistor R_{26} to the upper terminal of the changeover switch 12. To this terminal is also connected the base of transistor T_9 by way of resistor R_{23} , the collector of transistor T_9 being connected by way of resistor R_{24} to the cathode of the Zener diode Z_2 .

The base of transistor T_4 is connected to the ground line by way of two diodes D_3 and D_4 in series. These diodes provide compensation for temperature variation of the working of transistor T_4 . The collector of transistor T_4 is connected to the positive rail by way of resistor R_9 and the emitter of the transistor is connected to the ground line by way of

resistor R_{10} . The emitter of transistor T_4 is connected directly to the emitter of transistor T_3 .

The oscillator 7 oscillates when the transistor T_7 is cut-off. The frequency of oscillation may be for example 2.5 Hz at a duty cycle of 1:3. The output of the oscillator is a "light adjustment display" signal which can be transmitted by way of the emitter of transistor T_4 to the terminal R_0 .

If the circuit 11 is activated when the changeover switch 12 is on, the voltage level at the output of comparator CP_1 becomes high and transistors T_9 and T_6 are turned on. When the transistor T_9 is turned on the voltage across the Zener diode Z_2 is reduced in order to turn off transistor T_1 and to terminate the charging complete signal which is generated by the circuit A. When the transistor T_6 is on, the transistor T_7 is turned off and the output of the oscillator circuit 7 can be transmitted to the base of transistor T_4 and to the terminal R_0 .

Thus the terminal R_0 is a common terminal to which two signals, namely the charging complete signal, and the light adjustment display signal, are sent. The control circuit consisting of transistors T_6 and T_9 is thus arranged to ensure that only one signal at a time is sent through the common terminal R_0 .

It will be appreciated that this interlock arrangement can be used for enabling signals other than the specified two via a common terminal to the camera.

5 If the changeover switch is closed, the voltage across the diode Z_2 is not reduced because the transistor T_9 is cut-off even when the light adjustment circuit 11 is activated. The transistor T_7 is turned on and the output from the oscillator 7 is shunted by
10 way of this transistor so that there is no output from the emitter of transistor T_4 .

 In the camera circuit K, a comparator CP_2 has its inverting terminal connected to the positive terminal of the voltage supply VS_1 and its non-inverting
15 terminal connected to the terminal R. The comparator CP_3 has its inverting terminal connected to the voltage supply VS_2 and its non-inverting terminal likewise connected to the terminal R which is connected to the common terminal R_0 . The output terminal of
20 the comparator CP_3 is connected by way of a resistor R_{28} through a light emitting diode 16 to the camera earth. Accordingly, when either a charging complete signal or a light adjustment display signal arrives at the terminal R_0 , the indicator constituted by the diode 16
25 is turned on.

Figure 3 indicates the operation of the circuit of Figure 2 when the changeover switch 12 is open. It is assumed that the main switch S is closed at time t_0 so that thereafter the converter 6 is activated to charge the main capacitor C_2 . The terminal voltage across the main capacitor is shown as $\bar{a}$ in Figure 3. In this case, the voltage at the positive rail is shown as $\bar{E}_2$.

When the voltage $\bar{a}$ reaches the value $\bar{V}_T$, at the time t_1 , the neon lamp 13 illuminates, the transistor T_1 is turned on, the transistor T_2 is turned off and transistor T_3 is turned on. The voltage $\bar{e}$, at the base of the transistor T_3 rises as shown in Figure 3. Thus the voltage at point c, the emitters of transistors T_3 and T_4 , will be high, as will be the voltage ($\bar{R}_0$) at the terminal R_0 . This comparatively high voltage at the terminal R_0 will cause the output levels from the comparators CP_2 and CP_3 in the camera to become high. The camera shutter is released at time t_2 . The voltage ($\bar{X}_0$) at the terminal X_0 becomes low level when the switch 15 (operated in synchronism with the camera shutter) is closed. The transistor T_5 is turned on to activate the trigger circuit 8 and to cause discharge of the flash tube 9. This discharge is indicated by the waveform $\bar{L}$.

At that time the transistor T_1 is turned off but the transistor T_3 is not immediately turned off owing to the time constant of discharge of the capacitor C_5 . The transistor T_3 will be turned off approximately 2 milliseconds after time t_0 , that is to say at time t_4 . During this interval the flash tube emits substantially all its light. It may happen, if an automatic exposure control camera is used, that the discharge light emission level is insufficient for proper illumination of the subject and the photometric circuits in the camera operate the auto shutter control circuit to keep the shutter open. This may result in a blurred photograph and to avoid this the capacitor C_5 delays the fall in level of the charging complete signal.

If the light received by the sensors in the camera reach an adequate level at a time of, for example, t_3 and a light adjustment signal is sent to the terminal Q_0 and the light adjustment circuit 11 is activated, the light emission termination circuit 10 is activated to terminate the discharge from the tube 9. Thus the comparator CP_1 produces a high level output (indicated by $\bar{F}$). At the same time the transistor T_6 is turned on in order to turn off transistor T_7 and the output from the oscillator 7 arrives at the terminal R_0 . The

output from the oscillator, namely at point b in Figure 2, is shown by the waveform $\bar{b}$ in Figure 3.

At that time the output of the comparator CP_3 will be as shown by waveform $\bar{h}$ and the light emitter 16 will flicker.

The timer circuit C maintains a high voltage level signal at the point f for approximately 1.5 seconds (until time t_6). Thus even if the X-contact switch 15 is open during that time the light adjustment indication signal is sent to the terminal R_0 because transistors T_9 and T_6 are continually on.

When the voltage at the point f becomes low level at the time t_6 , the transistors T_9 and T_6 are turned off and only a "charging complete" signal can arrive at the terminal R_0 .

Figure 4 illustrates the case where the changeover switch 12 is closed. In this case, the light adjustment circuit 11 is activated at the time t_3 to increase the voltage level at the output terminal of the comparator CP_1 . The transistors T_6 and T_9 are still off even when the diode 14 emits light. A light adjustment display signal (waveform $\bar{b}$) will not be generated and only a charging complete signal can be sent to the terminal R_0 after time t_5 .

The changeover switch enables the generation of



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a charging complete signal even though the light adjustment signal is generated. The point of this is that successive flash photographs can be taken more rapidly than the time constant of the timing
5 circuit C provided that the changeover switch 12 is turned on.



CLAIMS:

1. A flash unit for use with a camera and including a terminal connector having at least one
5 terminal, respective circuits for generating at least two signals each of different functional purpose for transmission to the camera by way of said one terminal and an interlock which prevents simultaneous trans-
mission of the said signals to the camera.

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2. A flash unit according to claim 1 in which the interlock comprises a circuit which is arranged, when either of the said circuits provides its respective signal to the said one terminal, to
15 short-circuit the output of the other circuit.

3. A flash unit according to claim 1 or claim 2 in which the terminal connector is adapted to engage the hot shoe of a camera.

