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A METHOD OF SENDING AND RECEIVING SIGNALS
IN PHOTOGRAPHY WITH CAMERA AND CAMERA
FLASH DEVICE FOR THAT METHOD

The present invention relates to a method of sending
5 and receiving signals in photography with a camera and flash
unit.

Heretofore, when taking a photograph with a flash
unit a signal has been sent and received between the
camera and the flash unit to decide an appropriate
10 photographing condition by sending a camera signal
comprising camera information to the flash unit and by
sending a signal comprising flash information from the
flash unit to the camera.

In this case, if such exchanged information is
15 increased, since such signals are transmitted via
terminals installed at the point where the camera and
flash devices are engaged, it is apparent that an increase
in the number of terminals between the camera and
the flash unit would allow more signals and information
20 to pass therebetween. Recently cameras have been automat-
ized greatly, and their construction are consequently
more complicated. For this reason, the amount of inform-
ation which is exchanged between the camera and flash unit

tends to increase.

However, increasing the number of terminals for sending and receiving such signals, corresponding to the increased amount of information, brings about some problems. That is, the attachment area for a camera hot shoe to attach a clip-on type flash device is extremely limited. Thus, not so many terminals can satisfactorily be attached to the tiny hot shoe and insulation of additional terminals is difficult. Increasing the number of terminals creates difficulties in manufacturing, parts associated with the terminal cannot be easily replaced, and existing parts cannot be used. When connecting a clip-on type flash unit to the camera, the number of conductors of a wire should be increased according to the amount of information. Existing connection wires cannot be used and connector terminals do not match each other.

The present invention provides in one aspect a flash unit which is adapted to cooperate with a camera that is capable of sending a signal to, and receiving a signal from, a common terminal on the camera, the flash unit being detachably attachable to the camera by way of a mounting and including a respective terminal which is in contact with the said common terminal when the flash unit is attached

to the camera, the flash unit also including means for alternatively sending a signal to the camera and receiving a signal from the camera each by way of the said respective terminal.

5 The present invention also provides a combination of a flash unit and a camera, the flash unit being detachably attachable to the camera by means of a mounting which is on the camera and includes a common terminal with which a respective terminal of the flash unit
10 is in contact when the flash unit is attached as aforesaid to the camera, via which common terminal a signal from the camera to the flash unit and a signal to the camera from the flash unit can be alternatively transmitted.

15 An embodiment of the present invention will now be described by way of example with reference to and as illustrated in the accompanying drawings, in which:

 Figure 1 is a partial perspective view of a
20 fixing track to be attached to the flash unit and hot shoe of this invention;

 Figure 2 is a schematic diagram of an electric circuit according to the invention;

 Figure 3 is a time chart which shows the voltage
25 variation with time at different points in the circuit of Figure 2 in one mode of operation of the apparatus; and

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Figure 4 is a time chart which shows the voltage variation with time at different parts in the circuit of Figure 2 when adequate exposure level is reached before X contact is closed.

5 Figure 1 shows an example of a clip-on arrangement of a flash unit 1, and a camera 4 to which this flash unit 1 is removably attachable.

 A fixing lug which has sprung flash terminals XO, RO and QO is attached under a main body 2 of the flash unit. This fixing engages a "hot" shoe 5, on the upper part of the camera 4. Said flash terminals XO, RO and QO are located so as to correspond to the camera terminals X, R and Q of hot shoe 5, so that they contact correspondingly. It is designed that the engagement between the fixing lug 3 and
10 the hot shoe 5 causes the flash grounding terminal GO to contact the camera grounding terminal G (not shown in Figures 1 and 2), so that the electric circuits of the flash unit and the camera have a common 'earth'.
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 Figure 2 shows the electrical circuit F of the
20 flash unit and a camera's electrical circuit K.

 In the circuit F, a battery E is connected in series with a main switch S. A smoothing capacitor C1 is connected across this series circuit, which feeds a voltage converter 6 of which the output is a high
25 voltage. A main charging capacitor C2 is connected to receive the output of the converter 6, one terminal of the capacitor C2 being connected to the high-tension

terminal of a discharge tube 9, the other terminal of the capacitor C2 being connected to the ground terminal G0. One electrode of a neon lamp 10 is connected to said converter 6 by way of a current limiting resistance 5 R1 which is connected to the ground terminal by way of Zener diode Z1. The neon tube 10 is connected to the ground terminal by a voltage divider comprising resistors R2 and R3, the voltage across the divider being stabilised by Zener diode Z2 and being received by a "charging 10 completion" signal circuit 11.

When the main capacitor C2 is charged by the closure of the main switch S the operation of the converter 6, and the charge is sufficient for light emission from the discharge tube 9, the neon lamp 10 discharges and the signal 15 circuit 11 is activated to send a signal to the terminal RO.

The anode of a thyristor Th1 is connected between the said discharge tube 9 and the ground terminal. A trigger circuit 12 is connected to the discharge tubes 20 trigger electrode Tg and is controlled from the collector of a transistor T7. The emitter of this transistor is grounded and its base is connected through a resistor R23. The collector of transistor T7 is connected to the collector of a transistor T1 through a resistor R9 and the emitter of 25 transistor T1 is connected to the connection point between the neon lamp 10 and the resistor R2. The base of transistor T1 is connected to the connection point between

two series resistors R7 and R8. A capacitor C3 shunts resistor R7. The resistor R8 is connected to the anode of a diode D1 and the cathode of a diode D2, of which the anode is connected to the connection point between resistors R2 and R3. The cathode of the diode D1 is connected to the terminal X0. This terminal should be connected to the camera's X contact which will be described later. Thus, when x contact 18 is activated, transistor T1 is turned on (after a delay determined by capacitor C3 and resistor R7) to activate the circuit 12 to cause the discharge of the tube.

A light adjustment circuit 13 is connected to convertor 6 and to terminal Q0 so as to receive by way of terminal Q a light adjustment signal from the camera. The output of the circuit 13 controls the gate of a thyristor Th2, of which the anode is connected to the cathode of diode Z1 and of which the cathode is connected to a timer circuit 14.

The input of a light emission termination circuit 15 is connected to the cathode of thyristor Th2 and the circuit output is connected to the anode of thyristor Th1 through a commutation capacitor C4. The connection point between resistors R38 and R39 is connected to the connection point between capacitor C4 and the circuit 15. The resistor R38 is connected to the output of convertor 6 and the resistor R39 is connected to the gate of thyristor Th1 through coupling capacitor C5; this gate is grounded through resistor R14. The circuit 13 is intended

in accordance with known practice to respond to a signal sent from the camera through terminal QO to cut off the output of tube 9 when a photo responsive element (not shown) receives light originating from the flash tube and reflected off the photographic subject.

Thus, for example, when a light adjustment signal is sent from the camera to terminal QO, the circuit 13 is activated to supply a trigger voltage to the gate of thyristor Th2. The light emission termination circuit 15 is activated thereby and thyristor Th1 is turned off to discharge capacitor C4 and terminate emission from the discharge tube 9.

A light adjustment signal circuit 16 is connected in parallel with Zener diode Z1 and transistor T5 is connected to this circuit 16. The base of transistor T5 is connected to the cathode of Zener diode Z1 through resistor R20. The base of transistor T5 is connected to the collector of transistor T4 and the base of this transistor is connected to the output of the timer circuit 14, which is connected to the base of transistor T6 through a resistor R21. The emitter of this transistor is grounded and its collector is connected to the emitter of transistor T1.

When the timer circuit 14 is activated and the level of its output becomes high, transistor T4 is turned on to turn off transistor T5, and an output is obtained from the circuit 16. In this case, the cathode of diode

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D1 is grounded by way of the X contact and the output level of said circuit 11 becomes low as the terminal voltage of Zener diode Z2 falls. However, it is designed that the output of said circuit 11 will be low-level after a fixed time (e.g. after 2 ms).

The resistor R18, the light emitting element 17 and transistor T3 are connected in parallel to the Zener diode Z1. The base of transistor T3 is connected to the output of the timer circuit 14.

When timer 14 is activated to turn off transistor T3, light emitting element 17 emits light, as timer circuit 14 is activated by light adjustment circuit 13. Consequently, light emitting element 17 displays the operation status of light adjustment circuit 13. An iris information signal circuit 7 is connected to said Zener diode Z1 in parallel and its output side is grounded through resistors R10 and R11. The base of transistor T2 is connected to the connection point of resistors R10 and R11. Its collector is connected to the cathode of Zener diode Z1 by way of resistor R2 and its emitter is grounded through resistor R13. The output terminal of a comparator CP1 is connected to the output of the circuit 7. The connection point between resistors R5 and R6, which are in parallel with the Zener diode Z1 is connected to the inversion input terminal of this comparator CP1. The non-inversion terminal of comparator CP1 is connected to the connection point between resistors R2 and R3 by way of a resistor R4 and said connection point is grounded

through capacitor C6. Further, the emitter of transistor T2 is connected to terminal Q0. A resistor R24, which is connected in series with diode D3 is connected to said terminal Q0, and the cathode of diode D3 is connected to the base of transistor T7. The iris information signal circuit 7 generates a signal which is sent from the flash unit to the camera. It may be for instance, composed of a stable multi-vibrator, and its output frequency is established to correspond to, for instance, the camera aperture or iris value. This iris information signal is integrated to operate a light receiving unit which receives reflected light from a subject and to operate the circuits which send light adjustment signals to the flash unit. It is also possible to connect said flash unit 1 to the camera in which an automatic iris control can be performed, thereby to allow control of the flash unit.

For this iris information signal circuit 7, an iris information signal is sent to terminal Q0 from the emitter of transistor T2 only when the output level of comparator CP1 is high. That is, said comparator CP1 composes the control which controls sending the iris information signal to terminal Q0. When said main switch S is closed, the voltage at the inversion input terminal of comparator CP1 is higher than that at non-inversion terminal. The output terminal of the comparator is low-level, and so the output voltage from the iris information

signal circuit is low. The capacitor C2 is charged and neon lamp 10 is turned on. The voltage of the non-inversion input terminal of the comparator CP1 becomes higher than that of inversion input terminal after a
5 fixed time determined by the integration circuit composed of capacitor C6 and resistor R3. This occurs when Zener diode 22 reaches Zener voltage and output of the comparator CP1 becomes high. Thus, the output of said iris information signal circuit 7 to terminal Q0 through transistor
10 T2. The output voltage of this transistor is determined by the Zener diode Z1 and resistors R10, R12 and R13 and also by the load resistance (omitted in drawing) of the light adjustment circuit 13. A signal (iris information signal), which is sent to terminal Q0 from iris
15 information signal circuit 7, is also sent to the input terminal of said light adjustment circuit 13. The operation of light adjustment circuit 13 is not affected even when the iris information signal is sent before the discharge of the tube 9 as power is to be supplied to
20 said light adjustment circuit 13 after discharge of light emission tube 9, that is, when the X contact 18 is closed.

In the camera circuit K, the cathode of a light receiving diode 25, which receives reflected light from
25 a subject, is connected to the non-inversion input terminal of an operational amplifier 26, and the anode of diode 25 is connected to the inversion input terminal

of amplifier 26. A switch 24 opened in synchronism with the shutter camera and a capacitor 27 are connected in parallel between the non-inversion terminal and the output terminal of said operational amplifier 26. A
5 variable resistor, set in accordance with the speed rating of the film in use, is connected to inversion input terminal of the amplifier 26. The non-inversion input terminal of a comparator CP2 is connected to the output terminal of the amplifier 26, and the tap of
10 resistor 22 is connected to the inversion input terminal of comparator CP2. The base of a transistor T8 is connected to the output terminal of comparator CP2. A resistor R25 is connected between base and collector of the transistor T8. A constant current supply 23 feeds
15 resistor 22 and the emitter of transistor T8 is grounded through resistors R26 and R27, the division point of which is connected to the base of transistor T9, of which the collector is connected to the collector of transistor T8. The iris information signal circuit 19 is connected to
20 the collector of transistor T9, and the emitter of transistor T9 is connected to a low voltage power supply 21. The non-inversion terminals of comparators CP3 and CP4 are connected to the camera terminal R and constant voltage supplies Vs1 and Vs2 are connected between each
25 inversion input terminal of comparators CP3 and CP4 and terminal G. A resistor R29 and light emitting diode 20 are connected between the output terminal of the comparator CP3 and ground.

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When the switch 24 is opened in synchronism with the camera shutter, integration is started by capacitor 27 and amplifier 26 of the signal produced by diode 25 in response to reflected light. The level of the output from this comparator CP2 eventually goes low and transistor T8 is turned on to send a light adjustment signal to terminal Q; this signal is sent to light adjustment circuit 13 through the flash unit's terminal QO. Thus, terminal QO is the common terminal to which flash and camera signals are sent.

Next, the effects of this invention will be explained using the time charts in Figures 3 and 4. When the main switch S is closed at time to the convertor 6 is activated to charge capacitor C2 of which the terminal voltage changes in accordance with waveform $\bar{a}$. (reference point a). The voltage across Zener diode Z1 is shown by $\bar{E}2$. At the time t1 the neon lamp 10 is turned on and the terminal voltage of Zener diode Z2 (see point b) becomes high-level as shown by waveform $\bar{b}$. The cathode of Zener diode Z2 is connected to the charging completion signal circuit 11, which supplies a high-level voltage to terminal RO by inputting this Zener Z2 voltage.

As the voltage of the non-inversion input terminal of comparator CP2 becomes higher than that of the inversion input terminal the output of the comparator CP1 becomes high and the waveform at point c becomes like that of $\bar{c}$ with iris information signal circuit 7

being activated. Signals as shown by waveform $\bar{Q}0$ are supplied to terminal Q0. As the integrating circuit which is composed of capacitor C6 and resistor R3 is connected to the non-inversion input terminal of comparator CP1 through resistance R4, the voltage at point b becomes high. At time t2 the camera shutter is released and the voltage at terminal X0 becomes low-level (waveform $\bar{X}0$). Transistor T1 is turned on after a fixed time controlled by resistor R7 and capacitor C3, and it activates trigger circuit 12 to trigger the tube 9 (waveform $\bar{L}$). Transistor T7 is off. When X contact 18 is closed, the level at the non-inversion input of comparator CP1 exceeds that of the inversion input, the output terminal of the iris information circuit 7 is short circuited and waveform $\bar{c}$ becomes constantly low-level.

The output of the diode 25 is integrated by amplifier 26. The voltage at point 3 becomes high, as shown at $\bar{e}$, when the level of the non-inversion input terminal becomes higher than that of the inversion input terminal. At this time transistor T8 is turned on to supply a high-level voltage to terminals Q and Q0. It also activates light adjustment circuit 13 to supply the trigger voltage to thyristor Th2, and thyristor TH2 is thereby turned on. Thus, light emission termination circuit 15 is activated so that thyristor Th1 is turned off to terminate the light emission from discharge light emission tube 9. As timer circuit 14 is also activated when thyristor Th2 is turned on, timer output becomes

high, as shown in waveform $\bar{d}$. This high level is maintained, for instance, for 1.5 sec. (from time t_3 to t_6).

When X contact 18 is closed, the level $\bar{b}$ changes from high to low, but the output level of the circuit 11 becomes low 2ms after time t_2 , (time t_4). At this time, tube 9 has ceased emission (see dotted line part of waveform $\bar{L}$).

As timer circuit 14 is functioning at the time of t_3 when a light adjustment signal is sent from the camera to the terminal QO, transistor T4 is turned on and transistor T5 is turned off to activate light adjustment circuit 16, and a pulse voltage is sent to terminal RO (waveform $\bar{R0}$).

The voltage at point b becomes high when X contact 18 is opened at time t_5 . However, transistor T4 continues to be on, transistor T5 continues to be off, and transistor T6 continues to be on, as timer circuit 14 retains its high-level output.

When the output level at timer circuit 14 becomes low, transistor T6 is turned off so that the output level of comparator CP1 becomes high and the iris information signal is started to be sent to terminal QO.

Next is a description of the time chart in Figure 4. In the camera, switch 24 is opened in synchronism with the opening of the camera shutter when light receiving diode 25 receives natural light from the subject and the

output level of comparator CP2 becomes high (see waveform $\bar{e}$ at time t_7). Before X contact 18 is closed, the tube 9 does not emit light, as a high-level signal at terminal Q0 turns on transistor T7, and the level of trigger 5 voltage which is supplied to trigger circuit 2 is low, even when X contact is closed. Transistor T1 is turned on (see waveform $\bar{L}$) at the time t_8 . In Figures 3 and 4, waveforms $\bar{g}$ and $\bar{h}$ are those for points g and h at the outputs of comparators CP4 and CP3.



CLAIMS:

1. A flash unit which is adapted to cooperate with a camera that is capable of sending a signal to, and receiving a signal from, a common terminal on the camera, the flash unit being detachably attachable to the camera by way of a mounting and including a respective terminal which is in contact with the said common terminal when the flash unit is attached to the camera, the flash unit also including means for alternatively sending a signal to the camera and receiving a signal from the camera each by way of the said respective terminal.

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2. A combination of a flash unit and a camera, the flash unit being detachably attachable to the camera by means of a mounting which is on the camera and includes a common terminal with which a respective terminal of the flash unit is in contact when the flash unit is attached as aforesaid to the camera, via which common terminal a signal from the camera to the flash unit and a signal from the flash unit to the camera can be alternatively transmitted.

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3. A flash unit according to claim 1 or a combination according to claim 2 in which the mounting comprises a hot shoe and the flash unit is adapted for mounting on the hot shoe.

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4. A flash unit according to claim 1 or claims 1 and 3 or a combination according to claim 2 or claims 2 and 3, wherein the flash unit comprises means for sending said signal from the flash unit to the camera in the form of a signal denoting an aperture value and further comprises means responsive to the said signal from the camera to terminate a flash light produced by the flash unit.

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5. A combination according to claim 2 or either claim 3 or claim 4 taken with claim 2, wherein the camera and flash unit have at least one additional pair of cooperative terminals and the camera is arranged to send to the flash unit by way of said pair of terminals a signal initiating the discharge of a flash tube in the flash unit.

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6. A combination according to claim 5 wherein the camera includes a photometric circuit responsive to light reflected from an object to be photographed to produce the signal which terminates the flash light.

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7. A flash unit detachably attachable to and adapted to cooperate with a camera that is capable of sending a light adjustment signal to and receiving an iris information signal from a common terminal on the camera, the unit comprising:

a discharge tube for producing light emissions;

a trigger circuit for effecting discharge of said discharge tube;

a first terminal disposed to contact a respective camera terminal and to receive therefrom a signal which activates the trigger circuit of the discharge tube;

a second terminal disposed to contact said common terminal of the camera;

means coupled to the said second terminal to terminate emissions from said discharge tube in response to the light adjustment signal;

means for producing said iris information signal when the voltage across a capacitor for energizing the discharge tube has reached a predetermined value, said iris information signal being composed of a periodic pulse train, the cycle of which corresponds to the extent of opening of said iris; and

a control circuit for transferring the iris information signal through said second electrical terminal, said control circuit being further operable to terminate the transfer of said iris information signal before discharge of light from said discharge tube.



8. In combination, a mutually detachably attachable camera and flash unit, the flash unit comprising a discharge tube, a trigger circuit for effecting discharge of the discharge tube, first and second electrical terminals disposed for connection to respective first and second terminals on the camera, means for producing and applying to the first terminal of the flash unit an iris information signal composed of a periodic pulse train of which the period denotes an iris aperture value, means responsive to a light adjustment signal received from the camera by way of the first terminal to terminate the discharge, and a control circuit operable to terminate the iris information signal before emission of light from the discharge tube the trigger circuit being responsive to a signal from the second terminal of the unit, and the camera comprising a shutter, an iris having a variable aperture, a photometric circuit, means for receiving the iris information signal from the first camera terminal, means controlled by the photometric circuit to apply to the first camera terminal the light adjustment signal and means for applying to the second camera terminal the said signal for the trigger circuit in synchronism with the opening of the shutter.



32

- 20 -

9. A method for transmitting signals between a photographic camera and a flash unit the camera and the flash unit each having a plurality of electrical terminals through which signals are transmitted between the camera and the flash device, said method comprising the steps of;

transmitting an iris information signal, which signal is produced in said flash unit and is composed of a periodic pulse train, to said camera through one of said electrical terminals of the flash device and through a corresponding one of said electrical terminals of the camera;

transmitting from the camera to the flash unit, by way of respective terminals other than the said one terminal and the said corresponding terminal, a signal initiating light emission from a discharge tube of the flash unit;

terminating said iris information signal;
generating in said camera a light adjustment signal upon detection of a predetermined light level by a photometric circuit; and

supplying the light adjustment signal to the unit through said corresponding one of said electrical terminals of the camera and through said one of said electrical terminals of the flash unit so as to stop the light emission from the discharge tube of said flash unit.