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"APERTURE VALUE CONTROL DEVICE UTILIZING A
FREQUENCY SIGNAL FROM A FLASH UNIT ON A CAMERA"

This invention relates to an aperture control device for a camera having a flash unit, such as an automatic electronic flash.

5 When taking a picture with a flash unit, a camera must be set to a predetermined aperture value so that the correct quantity of light will reach the film surface. In a system wherein the quantity of light emitted from the flash unit is controlled according to the quantity of the emitted light which is reflected
10 from an object to be photographed, the correct quantity of light can always be arranged to reach the film surface by setting the aperture to a predetermined value corresponding to a desired setting of the flash unit. However, in the event that the aperture value of the camera is inadvertently changed, then the correct
15 quantity of light will not reach the film surface, making the resulting picture unsatisfactory. Accordingly, it is necessary to take great care in setting the aperture value of the camera whenever a
20 photographing operation is carried out.

It is an object of the present invention to overcome this particular difficulty.

According to the present invention, an aperture control system for a camera having a flash unit
25 comprises generating means arranged to generate an electrical control signal, an aperture value control device which controls the aperture of said camera to a value dependent upon the control signal, and determination means on said flash unit arranged to determine
30 the value of the control signal in accordance with the flash emission characteristics of said flash unit.

14

Thus, the flash unit supplies a signal for controlling the aperture value of the camera to allow the camera to take a picture with the correct quantity of light reaching the film surface. In a preferred embodiment of the.....

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invention, an aperture control signal is transmitted to an aperture control device in accordance with the desired light quantity setting on the flash unit, so that the camera aperture is automatically controlled to a value which properly corresponds to the light setting.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of an aperture control system according to the present invention;

Figure 2 is a time chart for explaining the operation of a gate circuit, which forms part of the control system;

Figure 3 is a block diagram showing in more detail a part of the control system of Figure 1 which is associated with a flash unit; and

Figure 4 is a block diagram showing in more detail a part of the control system of Figure 1 which is associated with a camera.

Referring to Figure 1, the illustrated aperture control system has respective parts which are associated with a flash unit 1 and a camera 7, only those components of the flash unit and the camera which relate to the invention being shown. The part of the control system associated with the flash unit 1 comprises an oscillator 2 which produces a pulse signal at an output thereof, a frequency divider 3 which subjects the pulse signal from the oscillator 2 to frequency division, a switch 4 for selecting any one of three outputs of the frequency divider 3, a terminal 5 through which the selected output is delivered and a control device 6 for controlling the quantity of light emitted by the flash unit. The switch 4 can be constituted by guide number selection means provided on the flash unit where this is of the automatic variety. The control device 6 may comprise a light-emitting unit and means for controlling the operation of

16

the light-emitting unit according to the quantity of light reflected from an object to be photographed. This type of control device is well known in the art, for example as disclosed in published Japanese Patent Application No. 38413/1973.

5 The part of the control system provided in the camera 7 comprises a gate circuit 8, a gate control device 9 which controls the period of time for which the gate circuit 8 is open, a counter 10 which counts a pulse signal from an output of the gate circuit 8, a conversion device 11 which subjects the output of the counter 10 to conversion, an aperture control device 12 which controls the aperture value of the camera with the aid of the conversion device 11, and a switch 13 for causing the flash unit 1 to emit light. Various known techniques can be used to control the aperture value: for example, a desired aperture value may be achieved by controlling the period for which a lens diaphragm is stopped down from a fully open condition and by detecting the actual stopped-down amount. However, since the particular technique does not constitute a part of this invention and is not essential for a proper understanding thereof, a detailed description of the aperture control device 12 will not be given.

20 The operation of the above-described various elements is as follows. As mentioned previously, the oscillator 2 in the flash unit 1 produces at its output a pulse signal having a predetermined frequency. This signal is subjected to frequency division by the frequency divider 3, and a signal of the resultant divided frequency (F1) is selected by means of the switch 4. In the case where the control device 6 is so designed that the user can select the quantity of light

(17)

- 4A -

5 emitted by the flash unit, the frequency selecting operation of the switch 4 is effected in association with such selection. If the device 6 can only provide one predetermined light quantity, the switch 4 would be unnecessary and the signal provided to the gate 8 would always have the same frequency. The circuits of the oscillator 2 and the control device 6 are formed independently of each other, and only the switch 4 is...

18

operated in association with the control device 6.

The above-mentioned signal of frequency F1 is applied to the gate circuit 8 in the camera 7 through the terminal 5 (which is a connecting point other than the usual "X" contact). The gate control device 9 controls the period of time for which the gate circuit 8 is open. Therefore, the number of pulses of the signal of frequency F1 which are supplied to the counter 10 through the gate circuit 8 is determined by the gate control device 9. This will be appreciated more readily from Figure 2, wherein reference character "F1" designates the said signal of frequency F1, and "9's output" denotes the output of the gate control device 9. Assuming that the gate circuit 8 is an AND circuit, three pulses are applied to the counter 10 in this case. The aperture control device 12 is operated by the output signal of the conversion device 11 which is obtained by subjecting the output of the counter 10 to conversion.

The switch 13 is a switch for the "X" contact on the camera body which causes the flash unit 1 to emit light. The switch 13 may be connected through a hot shoe or, if an additional contact is provided, through a cord.

According to the invention, the above components are operated in a sequence such that, before the flash unit 1 emits light, the aperture value of the camera is controlled to the proper predetermined value which, in conjunction with the amount of emitted light, will result in a proper exposure. This will now be described in more detail with reference to Figures 3 and 4. As shown in Figure 3, the flash unit 1 includes a power switch S₁, a DC-DC converter 14, a trigger circuit 15, a trigger electrode 16, a light tube 17 and an integration circuit 18, all of which operate in a conventional manner. The

oscillator 2 in the flash unit 1 is a conventional astable multivibrator using a comparator in this case. The operation of the multivibrator itself is well known and therefore will not be described here. The frequency F_0 of the output signal of the oscillator 2 is determined from the time constants of resistors R_1 to R_5 and a capacitor C_2 .

The output signal of the oscillator 2 is applied to an input terminal of the frequency divider 3. The frequency divider 3 may be a conventional one made up of flip-flop circuits, and has different frequency division output terminal Q_1 to Q_4 . Obviously, more flip-flop circuits may be added to the frequency divider 3 to obtain other frequencies. Terminals a, b and c of switch 4 are connected to the frequency divider 3 so that output frequencies $F_0/2$, $F_0/4$ and $F_0/16$ are obtained from the frequency divider 3 at these terminals respectively. The switch 4 can thus select any one of these frequencies, and for the purpose of the following description it will be assumed that a frequency F_1 has been chosen. Thus, the frequency F_1 should correspond to an aperture value which will result in a proper exposure in combination with the amount of light that will be emitted by the flash unit, which latter is determined by the integration circuit 18 of the control device 6 in a known manner. Accordingly, the selection operation effected by the switch 4 is performed in association with the operation of a switch 19 by means of which the quantity of light emitted by the flash unit can be chosen.

By way of example, upon selection of terminals a, b and c in the switch 4, aperture values of F_{16} , F_{11} and $F_{5.6}$ are respectively chosen.

The frequency F_1 selected by the switch 4 is applied to a circuit 20 which converts the output signal of the frequency divider 3 to a voltage level which satisfies the input conditions of the camera 7. A temperature

compensating semiconductor element D_1 is preferably provided in the circuit 20 so that the voltage level is not affected by temperature.

On the output side of the circuit 20, the emitter of a transistor T_1 is connected to a resistor R_9 . The connecting point between the transistor T_1 and the resistor R_9 is coupled through the Q terminal 5 of the flash unit 1 to the gate circuit 8 of the camera 7. The gate circuit 8 is a two-input unit AND circuit, and has the frequency signal F1 from the flash unit 1 applied to one of its two input terminals, while a gate signal from the gate control device 9 is applied to the other input terminal thereof. The gate circuit 8 is maintained open when the gate signal is at a high logic level, such that a pulse signal is produced at its output and is applied to the counter 10.

The gate control device 9 comprises an oscillator 21 and a frequency division circuit 22 which subjects an output signal of the oscillator 21 to frequency division. The circuit 22 applies signals required for setting a gating time to a generating circuit 23, to a circuit 25 adapted to generate a reset signal for resetting the counter 10, and to a circuit 24 adapted to generate a latch signal for a latch circuit 26. When the reset signal generated by the circuit 25 is at a low logic level, the output signal of the gate circuit 8 is supplied to an input of the counter 10. The output signal of the counter 10 is applied to the latch circuit 26, and the signal applied to the latch circuit 26 is held in response to the latch signal generated by the circuit 24.

The signal thus held in the latch circuit 26 is supplied to an input of a coincidence circuit 27. A pulse signal provided by the aperture control device 12 in the camera is applied to a counter 33 in the conversion

device 11, and an output signal of the counter 33 is also applied to the coincidence circuit 27. When the two input signals to the circuit 27 coincide with each other, an output signal is applied from the circuit 27 to a drive circuit 28 in the aperture control device 12 to drive an aperture control electro-magnet 38.

A photo-interrupter 36 is provided in the aperture control device 12 on the camera side. The photo-interrupter 36 operates in association with a stopping-down mechanism which controls the aperture of the lens diaphragm: i.e. it is turned in associated with a stopping-down operation. The photo-interrupter 36 has a plurality of slits therein, and a light-emitting diode 34 and a photo-transistor 35 are fixedly disposed in such a manner that they confront one another through each slit in turn as the photo-interrupter 36 is rotated. A peripheral portion of the photo-interrupter 36 is formed into a ratchet wheel 35. An end of a locking pawl 37 is caused to contact the ratchet wheel 35 by the operation of the aperture control electromagnet 38 to arrest rotation of the photo-interrupter 36 and thereby achieve control of the diaphragm aperture.

The aperture control device 12 further comprises a control signal generating circuit 29 which is operated in association with the camera. The control signal generating circuit 29 controls a drive circuit 30 which turns on the light-emitting diode 34 according to the settings of the camera in operating an automatic aperture control device, and also controls a circuit 31 which generates a pulse signal when the photo-transistor 35 receives light emitted by the diode 34 through one of the slits.

The circuit 29 also controls a circuit 32 which generates a reset signal for resetting the contents of the counter 33 whenever the camera shutter is operated. More specifically, when the camera is set for automatic

aperture control, in association with the operation of the camera, the control circuit 29 applies a control signal to the reset circuit 32. As a result, the reset circuit 32 produces the reset signal to reset the contents of the counter 33. When the conditions necessary for automatic aperture control are set, the circuit 29 operates the drive circuit 30 to turn on the light-emitting diode 34. As a result, the photo-transistor 35 receives light emitted by the diode 34 through the slits in the photo-interrupter 36. Therefore, as the aperture stops down and the photo-interrupter 36 rotates, the pulse signal generating circuit 31 is controlled to convert the output signal of the photo-transistor 35 into a pulse signal as described above.

The output pulse signal of the circuit 31 is applied to the counter 33. Generation of the pulse signal by the circuit 31 is continued until, in the coincidence circuit 27, the output of the counter 33 coincides with the data which has been applied to the coincidence circuit 27 from the flash unit 1. At this point, the aperture value corresponds to that selected by the switch 4, and the output signal of the coincidence circuit 27 is then applied to the drive circuit 28 to drive the electromagnet 38 and disengage the locking pawl 37 therefrom. As a result, rotation of the photo-interrupter 36 is stopped, and accordingly the stopping-down mechanism operating in association with the rotation of the photo-interrupter 36 is also stopped at the aperture value which has been set for the flash unit 1.

With the above system configuration, when the amount of light emitted by the flash unit is changed by the switch 19, the switch 4 will be correspondingly changed to select a different frequency signal for application through the gate 8 to the counter 10. For example, if the selected light output is doubled, the aperture value should be changed by one stop to maintain a proper

exposure. Accordingly, the switch 4 will select a higher frequency signal for application to the counter 10 so that the value held in the latch circuit 26 will be larger. Thus, the stopping-down operation will last longer before coincidence is detected, and the final aperture value will be the proper size such that, even with the different light emission value, the quantity of light reaching the film surface will remain the same and a proper exposure will be achieved.

As is apparent from the above description, according to this invention, the flash unit 1 supplies a signal for controlling the aperture value of the camera. Therefore it is unnecessary to manually operate the lens diaphragm, so that an erroneous or inadvertant change in the aperture value can never occur, with the result that the correct quantity of light reaches the film surface at all times. Since the aperture control signal is supplied in frequency form, the frequency can be readily changed by use of the frequency divider, and erroneous effects caused by noise, for example in an analogue signal, can be eliminated.

24

CLAIMS

1. An aperture control system for a camera having a flash unit, comprising generating means arranged to generate an electrical control signal, an aperture
5 value control device which controls the aperture of said camera to a value dependent upon the control signal, and determination means on said flash unit arranged to determine the value of the control signal in accordance with the flash emission characteristics
10 of said flash unit.
2. An aperture control system as claimed in Claim 1, wherein the control signal is a count value.
3. An aperture control system as claimed in Claim 1
20 or 2, wherein the value of the control signal is variable, and the determination means includes variation means for varying the value of the control signal.
4. An aperture control system as claimed in Claim 3,
20 wherein the variation means comprises an oscillator on said flash unit and a variable frequency divider receiving an output signal of the oscillator and providing an output signal having a frequency which varies in accordance with a desired aperture value, and wherein the generating means includes reception means
25 on said camera arranged to receive the output signal from the variable frequency divider and to generate a control signal whose value is dependent upon the frequency of said output signal.



5. An aperture control system as claimed in Claim 4, wherein the reception means comprises a gate circuit having an input at which said variable frequency signal is received and an enabling terminal, gate signal generating means arranged to provide to the enabling terminal a gate signal of predetermined duration, and counter means arranged to receive the variable frequency signal from the gate circuit for the duration of the gate signal, the counter counting at a rate corresponding to the frequency of the variable frequency signal, the value in the counter at the end of the gate signal comprising said control signal.

6. An aperture control system as claimed in Claim 4 or 5, wherein the variable frequency divider comprises a frequency divider circuit having a plurality of outputs of different frequencies and a selection switch for selecting one of said plurality of outputs.

7. An aperture control system as claimed in Claim 6, wherein the flash unit includes a switch for varying the light emission characteristics thereof, which switch is ganged to the selection switch.

8. An aperture control system for a camera having a flash unit, substantially as hereinbefore described with reference to the accompanying drawings.

