

# PATENT SPECIFICATION

(11)

1 499 032

1 499 032

- (21) Application No. 2972/75 (22) Filed 23 Jan. 1975 (19)  
 (31) Convention Application No. 437,109 (32) Filed 28 Jan. 1974 in  
 (33) United States of America (US)  
 (44) Complete Specification published 25 Jan. 1978  
 (51) INT. CL<sup>2</sup>. G03B 7/08  
 (52) Index at acceptance  
 G2A 401 403 483 526 542 602 616 706 711 BJ  
 (72) Inventor DONALD MALCOLM HARVEY



## (54) CONTROL CIRCUIT FOR A PHOTOGRAPHIC CAMERA

(71) We, EASTMAN KODAK COMPANY, a Company organised under the Laws of the State of New Jersey, United States of America of 343 State Street, Rochester, New York 14650, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electronic exposure control circuits for photographic cameras, and more particularly to a circuit for controlling exposure in low light conditions.

It is known in the prior art to provide apparatus in a camera for limiting the exposure interval to a fixed maximum time interval, for example 1/30 second. The known apparatus generally includes a first scene light dependent shutter timing circuit, and a second light-independent timing circuit having a fixed time constant of 1/30 second. The known apparatus further includes means for energizing each of the timing circuits when the shutter is opened. When this happens, each of the timing circuits functions to produce a control signal for closing the shutter. Whichever timing circuit first produces a control signal having a particular amplitude, that signal serves to close the shutter.

It is possible, therefore with an arrangement of the known type to limit the film exposure interval to 1/30 second. Of course, an extremely underexposed image may result from a 1/30 second exposure if the prevailing scene light is quite low.

Another known approach for limiting exposure time in low light conditions provides photoflash apparatus which modifies the primary light-dependent timing circuit so as to limit exposure time, not at a fixed maximum interval, as mentioned above, but in a manner related in part to scene light intensity. In this second approach, an auxiliary resistor of fixed value is shunted across a light-dependent resistor in the shutter timing circuit in response to attachment of a flash device to the camera.

In this manner, the RC time constant of the timing circuit has an effective total resistance less than either the resistance of the fixed value resistor or of the light-dependent resistor. Under flash light conditions adequate to effect a particular exposure value within a predetermined time period, most of the current by which the timing capacitor is charged flows through the light-dependent resistor and the current through the fixed resistor exerts a smaller influence on the exposure duration. However, when the photoflash light is inadequate to effect a proper exposure within the predetermined time interval, the resistance of the light-dependent resistor is relatively high so the fixed resistor exerts a greater influence in controlling shutter speed in low flash light. Consequently, a maximum exposure interval is established by the fixed resistor. The fixed resistor causes the film exposure interval to be limited to a predetermined value in the most extreme low light conditions. However, because of the continual effect the fixed resistor has on the primary light-dependent timing circuit an underexposed image results for those light conditions adequate to effect a correct exposure value within 1/30 second.

The sensitivity of a particular photographic film to light can be represented by the relationship between film density, that is, the opacity of the film, and the logarithm of film exposure. Such a relationship, if plotted, is typically shaped in the form of a slanted elongate "S" and is commonly known as a DVS log E curve, or characteristic curve, because it illustrates the light sensitivity characteristics of the film. As is well known in the art, a correct exposure is considered to have been made when the film exposure value falls on the straight-line portion of the curve. It is in this portion of the curve that the greatest image contrast exists, and hence, generally, the higher resolving power of the film.

Many of today's commercially available films have an exposure latitude which, in cases of limited amounts of underexposure, and for that matter, overexposure per-

55

60

65

70

75

80

85

90

95

100

mits the film to be processed to compensate for what would normally be considered an improperly exposed film, to obtain an adequate processed film. This can be done by selectively varying some of the film processing parameters in a manner known to those having skill in the art. However, with exposure interval limiting arrangements of the type first mentioned above, the difference between the correct film exposure time and the actual exposure time, as determined by such exposure limiting arrangements, is so large for the lowest levels of scene brightness that under-exposure compensation techniques are not generally effective. On the other hand, with an arrangement of the second mentioned type above, the difference between correct exposure time and actual exposure time is reduced for all values of low light and hence such compensation techniques are generally more effective, however, an exposure error is introduced even for those light levels in excess of the light level requiring a 1/30 second exposure. These effects can best be seen upon inspection of Fig. 1 of the accompanying drawings, and, more specifically, comparing the curve therein denoted 10, which illustrates correct exposure time, with the curve denoted 12, which illustrates actual exposure time using exposure control mechanisms of the first mentioned known type, and to the curve denoted 14, which illustrates actual exposure time using a shutter timing circuit of the second mentioned known type.

An object of this invention is the provision of an improved control circuit for use in a photographic camera having electronic exposure control means and operable under low scene light conditions to produce time limited exposures for which film processing exposure compensation techniques may be implemented over a relatively wide range of such light conditions to obtain high quality processed film.

In accordance with the present invention, there is provided a control unit, for a photographic camera having electronic exposure control which regulates the open time of the shutter in dependence upon scene illumination, comprising a trigger circuit responsive to a predetermined level of scene illumination and arranged to change the controlled shutter open time only when scene illumination is below the predetermined level.

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

Figs. 2 and 3 illustrate respectively preferred embodiments of an electronic control circuit for controlling a camera shutter mechanism in accordance with the teachings of this invention; and

Fig. 4 is a graphical illustration representatively showing the range of low scene light values over which quality photographic prints may be obtained from exposures produced with the exposure control circuits shown in Figs. 2 and 3 and the range of low light values over which quality prints may be made utilizing a particular type of prior art low light exposure control device.

Because photographic cameras are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, the electronic control circuit in accordance with the present invention. It is to be understood that camera elements not specifically shown or described may take various forms well known to those having skill in the art.

There is shown, in Fig. 2, a circuit denoted generally 20 energizable by a battery 21 upon actuation of a normally open control switch S<sub>1</sub> for automatically regulating an electronically controllable camera shutter mechanism 22. Shutter mechanism 22 may be any one of a number of well known types of camera shutters. For example, the shutter may include a pair of opaque blades, one preferred to hereinafter as an opening blade and the other referred to as a closing blade, mounted for movement relative to a lens aperture selectively to control the amount of scene light passed through the camera's taking lens and projected toward the camera film plane. The opening blade may be actuated mechanically by a shutter release member to initiate a film exposure interval while the closing blade may be actuated electromechanically by means of sequentially energizing and de-energizing an electromagnet to terminate the exposure interval once a predetermined amount of scene light has been projected onto the film. Such shutters are briefly described merely in a functional manner so as more clearly to illustrate the instant invention in its intended mode of operation.

Operably coupled to shutter mechanism 22 is a control circuit 24 responsive to scene light for controlling the shutter closing blade in accordance with the amount of scene light projected toward the camera film plane. As shown, circuit 24 comprises a photosensitive element 26 connected between a terminal 28 and a terminal 30, to which is also connected the input 32 of a voltage sensitive trigger circuit 34. Connected between terminal 30 and electrical ground 36 is a timing capacitor 38 shunted by a normally closed shutter control switch S<sub>2</sub>, actuable to its open position when the shutter opening blade is moved to its open position so as to initiate the exposure interval.

It will be understood that normally open

control switch  $S_1$  and normally closed switch  $S_2$  are arranged for sequential operation initiated by a manually actuated shutter release member (not shown) or other suitable means well known to those having skill in the art. When switch  $S_1$  is initially closed switch  $S_2$  remains closed for a brief time interval for a reason which will be made apparent hereinafter.

10 Photosensitive element 26 may be any one of a number of such elements conventionally used as light-measuring devices in photographic apparatus, such as a photoconductive element or the like which has a resistance inversely related to the level of light incident thereon. Photoconductor 26 and timing capacitor 38 form an RC integrator circuit which by virtue of the aforementioned photoconductive characteristics has a time constant inversely related to scene light intensity and functions to produce an electrical control signal at terminal 30 having an amplitude related to scene light intensity and time.

25 Trigger circuit 34 may be of the type known in the art as a comparator circuit and, more specifically, as a Schmitt trigger circuit or the like of the particular type having a normally non-conducting input stage and an output stage which is normally conducting, for maintaining the shutter closing blade in its open position. As long as the signal at terminal 30 is below a predetermined level, called the threshold voltage, the input stage is OFF while its output stage is ON. When the signal exceeds the threshold voltage, the input stage is turned ON and the output stage is turned OFF, which condition releases the closing blade and the camera shutter is closed.

Operably coupled to the shutter control circuit 24 is a light level indicator circuit 42 for indicating the adequacy of scene light for permitting quality hand-held exposures within a predetermined time interval, for example 1/30 second or less and for modifying or altering the time dependency of the shutter control signal when insufficient scene light exists for effecting such an exposure.

Light level indicator circuit 42 includes a PNP control transistor 44, having emitter, base, and collector electrodes 44a, 44b, and 44c, respectively, electrode 44a being connected to terminal 28, electrode 44b being connected to a terminal 46 and electrode 44c being connected to a current limiting resistor 47, which is in turn coupled to timing capacitor 38 as shown. Connected between terminals 28 and 46 is a light emitting source 48 such as an indicator lamp, light emitting diode (LED) or the like for indicating the adequacy of scene light to effect a correct film exposure value within the aforementioned 1/30 second. Also connected

to terminal 46 is the output 49 of a trigger circuit 50 which is similar to the aforementioned Schmitt trigger circuit but differs therefrom in that circuit 50 has a reversal functional relationship between its respective input and output stages. That is, trigger circuit 50 is of the type having an input stage which is normally conducting and, in so doing the trigger circuit conducts only when its input signal is greater than a particular predetermined threshold voltage which may be of a different value than the threshold of trigger circuit 34. As shown, input 51 of circuit 50 is connected to a terminal 52 to which is also connected a voltage regulating resistor 53 and a photoconductive element 54 as shown. When control switch  $S_1$  is closed, the series combination of photoconductor 54 and resistor 53 functions as a voltage divider to produce an instantaneous voltage at terminal 52 inversely related to the resistance of photoconductor 54. Such voltage is directly related to the light incident on photoconductive element 54.

In discussing the operation of light level indicator circuit 42, it is necessary to consider two levels of scene illumination. The electrical characteristics of resistor 53 and photoconductor 54 are selectively controlled so that the instantaneous voltage appearing at terminal 52 is adequate to maintain normally conducting input stage 51 of circuit 50 ON only if there is sufficient scene illumination to permit a proper exposure value within 1/30 second. If there is insufficient scene light so to do, the photoconductor current is relatively low, which condition produces a relatively low voltage signal at terminal 52. When this happens, the normally non-conducting output stage of circuit 50 is turned ON, which condition serves to establish an electrical circuit through indicator lamp 48 and through circuit 50 to ground 36 to turn the lamp ON. When this occurs, the voltage at terminal 46 drops an amount equal to the voltage dropped across lamp 48, which causes transistor 44 to turn ON or conduct and collector electrode current to flow through resistor 47 to terminal 30 thereby connecting the resistor 47 in parallel with the photosensitive element 26.

From the aforementioned operational description of circuit 42, it can be seen that control transistor 44 does not conduct in scene light conditions adequate to effect a proper exposure within 1/30 second.

Consider now the operation of shutter control circuit 24 when indicator lamp 48 is energized to indicate a low light condition. Once switch  $S_2$  is actuated and is thereby opened, timing capacitor 38 immediately begins to charge at a rate inversely related to the product of its capacitance and

the resistance of photoconductor 26, that is, at a rate related to scene light intensity. In a scene light condition inadequate to effect a correct value within 1/30 second, this product would normally be high and capacitor 38 would charge very slowly. However, capacitor 38 is charged more rapidly to the threshold voltage of trigger circuit 34 because it also receives charging current through the parallelly-connected resistor 47.

It can be seen that in an environment where there is insufficient scene light to effect a correct exposure within 1/30 second, the indicator lamp 48 functions to notify the camera operator of such a condition and further to cause an auxiliary current signal to be produced so as to achieve a more rapid exposure interval, which interval is functionally related to existing scene light conditions.

As mentioned previously herein, it is possible to process certain underexposed films so as to obtain a good useable photograph. In accordance with the teachings of the instant invention, it is possible to produce a high quality photograph through selective modification of the film processing parameters, over a wide range of low scene light conditions while still achieving a correct exposure time for scene light conditions adequate to effect a correct exposure value in less than 1/30 second. This result can perhaps be most clearly illustrated by referring to Fig. 4 and the graphical illustrations therein which serve to enable comparison, on a qualitative basis, of the low light brightness range over which an acceptable photograph can be made with an exposure control circuit in accordance with the teachings of the present invention; curve 16, with an exposure control mechanism having a fixed maximum exposure interval; curve 12. It will of course be understood that when the light conditions are adequate to effect an exposure value in less than 1/30 second the actual exposure time follows the correct exposure time and there is no need to modify the processing parameters under such light conditions as is necessary with the exposure control arrangement of the kind providing exposure times illustrated by curve 14 shown in Fig. 1.

Consider now another preferred embodiment of the present invention which is shown in Fig. 3 where elements structurally or functionally similar to elements shown in Fig. 2 have been identified with the same numerals. As shown in Fig. 3, light conducting means 60, such as a light pipe or an optical arrangement comprised of light directing mirrors or the like, constitutes means for directing light from indicator lamp 48 onto a photoconductor 26. When, under low light conditions, the lamp 48 is

energised, the resistance of photoconductor 26 is caused to be lowered due to the combined effect of the scene light and the lamp light to produce a faster RC time constant for shutter control circuit 24. In this manner, the exposure time is still limited under low scene light conditions, but is modified so as to produce a wider low light range over which an acceptable photograph can be made as is done with the embodiment shown in Fig. 2.

It should be pointed out that with the exposure control circuits of the present invention some reduction in quality may result due to the extension of the exposure time beyond 1/30 second in low light conditions which may produce operator-induced image smear in the exposed film. However, it has been found that the reduction in resolution in the photograph is more than offset by the more correct exposure achievable over the wider range of low light levels, and that overall, a higher quality photograph is achieved with the improved exposure control circuits of the present invention.

This is perhaps best understood because of the fact that those exposures having an exposure time which has been increased the largest increment beyond 1/30 second, and which therefore are most likely to have the greatest smear component, are also those exposures which would be the most underexposed with a fixed maximum exposure interval and, therefore, the least likely to be viewable. Whereas those exposures having the smallest exposure time extension beyond 1/30 second not only are the most easily corrected with known processing techniques but tend to have the smallest smear component.

The invention has been described in detail with particular reference to two preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention as defined in the appended claims.

#### WHAT WE CLAIM IS:—

1. A control unit, for a photographic camera having electronic exposure control which regulates the open time of the shutter in dependence upon scene illumination, comprising a trigger circuit responsive to a predetermined level of scene illumination and arranged to change the controlled shutter open time only when scene illumination is below the predetermined level.
2. A circuit as claimed in Claim 1, for use in a camera, the electronic exposure control of which includes a capacitor the rate of charge of which controls the open time of the shutter, the trigger circuit being arranged to increase the rate of charge of



the resistance of photoconductor 26, that is, at a rate related to scene light intensity. In a scene light condition inadequate to effect a correct value within 1/30 second, this product would normally be high and capacitor 38 would charge very slowly. However, capacitor 38 is charged more rapidly to the threshold voltage of trigger circuit 34 because it also receives charging current through the parallelly-connected resistor 47.

It can be seen that in an environment where there is insufficient scene light to effect a correct exposure within 1/30 second, the indicator lamp 48 functions to notify the camera operator of such a condition and further to cause an auxiliary current signal to be produced so as to achieve a more rapid exposure interval, which interval is functionally related to existing scene light conditions.

As mentioned previously herein it is possible to process certain underexposed films so as to obtain a good useable photograph. In accordance with the teachings of the instant invention, it is possible to produce a high quality photograph through selective modification of the film processing parameters, over a wide range of low scene light conditions while still achieving a correct exposure time for scene light conditions adequate to effect a correct exposure value in less than 1/30 second. This result can perhaps be most clearly illustrated by referring to Fig. 4 and the graphical illustrations therein which serve to enable comparison, on a qualitative basis, of the low light brightness range over which an acceptable photograph can be made with an exposure control circuit in accordance with the teachings of the present invention, curve 16, with an exposure control mechanism having a fixed maximum exposure interval, curve 12. It will of course be understood that when the light conditions are adequate to effect an exposure value in less than 1/30 second the actual exposure time follows the correct exposure time and there is no need to modify the processing parameters under such light conditions as is necessary with the exposure control arrangement of the kind providing exposure times illustrated by curve 14 shown in Fig. 1.

Consider now another preferred embodiment of the present invention which is shown in Fig. 3 where elements structurally or functionally similar to elements shown in Fig. 2 have been identified with the same numerals. As shown in Fig. 3, light conducting means 60, such as a light pipe or an optical arrangement comprised of light directing mirrors or the like, constitutes means for directing light from indicator lamp 48 onto a photoconductor 26. When, under low light conditions, the lamp 48 is

energised, the resistance of photoconductor 26 is caused to be lowered due to the combined effect of the scene light and the lamp light to produce a faster RC time constant for shutter control circuit 24. In this manner, the exposure time is still limited under low scene light conditions, but is modified so as to produce a wider low light range over which an acceptable photograph can be made as is done with the embodiment shown in Fig. 2.

It should be pointed out that with the exposure control circuits of the present invention some reduction in quality may result due to the extension of the exposure time beyond 1/30 second in low light conditions which may produce operator-induced image smear in the exposed film. However, it has been found that the reduction in resolution in the photograph is more than offset by the more correct exposure achievable over the wider range of low light levels, and that overall, a higher quality photograph is achieved with the improved exposure control circuits of the present invention.

This is perhaps best understood because of the fact that those exposures having an exposure time which has been increased the largest increment beyond 1/30 second, and which therefore are most likely to have the greatest smear component, are also those exposures which would be the most underexposed with a fixed maximum exposure interval and, therefore, the least likely to be viewable. Whereas those exposures having the smallest exposure time extension beyond 1/30 second not only are the most easily corrected with known processing techniques but tend to have the smallest smear component.

The invention has been described in detail with particular reference to two preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention as defined in the appended claims.

#### WHAT WE CLAIM IS:—

1. A control unit, for a photographic camera having electronic exposure control which regulates the open time of the shutter in dependence upon scene illumination, comprising a trigger circuit responsive to a predetermined level of scene illumination, and arranged to change the controlled shutter open time only when scene illumination is below the predetermined level.
2. A circuit as claimed in Claim 1, for use in a camera, the electronic exposure control of which includes a capacitor the rate of charge of which controls the open time of the shutter, the trigger circuit being arranged to increase the rate of charge of

the capacitor when scene illumination is below the predetermined level.

3. A circuit as claimed in Claim 2, for use in a camera including a photoresponsive device exposed to scene illumination for controlling the rate of charge of the capacitor, having a resistance connectable in parallel with the photoresponsive device, the trigger circuit being arranged to make such parallel connection when scene illumination is below the predetermined level.

4. A circuit as claimed in any preceding Claim including a low light warning device operated when scene illumination is below the predetermined level.

5. A circuit as claimed in Claim 4, wherein the low light warning device is a lamp and a photoresponsive device of the camera's electronic exposure control is exposed both to scene light and to light from the lamp when the latter is energized.

6. A control circuit, for a photographic camera, substantially as hereinbefore described with reference to and as illustrated in Fig. 2 or Fig. 3 of the accompanying drawings.

L. A. TRANGMAR, B.Sc., C.P.A.,  
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1978.  
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY  
from which copies may be obtained.

