

PATENT SPECIFICATION

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(54) PHOTOGRAPHIC CAMERAS

(71) We, EASTMAN KODAK COMPANY, a Company organized 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:—

The present invention relates to photographic cameras and, more particularly, to an exposure control apparatus for use therewith.

In accordance with the present invention there is provided a photographic camera having an exposure aperture, a shutter and an exposure control apparatus comprising radiation sensitive means disposed to receive scene radiation, a time delay circuit having an input from the radiation sensitive means and responsive thereto for producing a control signal an exposure interval after opening of the shutter, the exposure interval being dependent on the received scene radiation, a first circuit responsive to the control signal to produce closing of the shutter, a second circuit having an input from the radiation sensitive means, and responsive thereto, and an indicator connected to the output of the second circuit, the second circuit being arranged to energise the indicator when the intensity of the received scene radiation is below a predetermined level prior to production of the control signal and to de-energise the indicator on initiation of closure of the shutter by the first circuit.

In the accompanying drawings:—

Fig. 1 shows an exploded perspective view of the preferred embodiment of the shutter and diaphragm mechanisms for exposure control apparatus in accordance with the present invention;

Fig. 2 shows a circuit diagram for controlling the mechanism shown in Fig. 1,

[Price 33p]

including a time delay circuit controlling the exposure interval, a diaphragm control circuit and a control circuit for an indicator means;

Fig. 3 is an elevation of the photosensitive assembly incorporated in the exposure control circuit of Fig. 2; and

Fig. 4 shows a further embodiment of a circuit diagram for controlling the operation of a shutter mechanism similar to that shown in Fig. 1.

An exposure control system according to the present invention includes an adjustable diaphragm mechanism including a member movable to any position along a path for varying an exposure aperture in accordance with the level of scene light, and a shutter mechanism controlled by an electronic time-delay circuit that establishes the length of an exposure interval. The time-delay circuit preferably is of the integrating type for continuously measuring the total accumulated amount of light energy impinging on a photoresponsive member in the timing circuit. After the diaphragm mechanism has been actuated to adjust the exposure aperture in accordance with the level of scene illumination, the shutter mechanism is then actuated to initiate an exposure interval under the control of the electronic timing circuit that terminates the exposure interval in accordance with the exposure aperture adjustment and in accordance with the amount of illumination actually received during the exposure interval by the photo-responsive member in the timing circuit. The shutter timing circuit can compensate for the exposure aperture setting, for example, by adjustment of an electrical parameter of the timing circuit to vary its time constant, preferably by varying the aperture of the photoresponsive member used in the timing circuit in accordance with the adjustment of the exposure aperture by the diaphragm mechanism.

Price 75p

09 Referring now to the accompanying drawings, Fig. 1 shows an exposure control apparatus according to a preferred embodiment of the invention including an objective 5 10 for forming an image on photographic film F, a two-bladed diaphragm mechanism 12 for establishing a variable exposure aperture in alignment with an optical axis 14 of the objective, and a two-bladed shutter mechanism 16 for initiating and terminating an exposure through the objective.

The diaphragm mechanism 12 includes a pair of blades 18 and 20 that are slidably mounted upon suitable support means (not shown) for equal and opposite movement relative to the lens axis 14. Each of these blades has a tapered aperture 22 and 24, respectively, overlying each other to define an exposure aperture 25 aligned with the optical axis 14. The apertures 22 and 24 are disposed with their tapered portions extending in opposite directions with respect to each other along the line of travel of the two diaphragm blades, such that opposite movement of the blades 18 and 20 will enlarge or diminish the size of the exposure aperture 25. Each of the blades 18 and 20 also has a second tapered aperture 26 and 28, respectively, similar to the tapered aperture 22 and 24, overlying each other to define a second variable aperture 29 overlying a radiation sensitive assembly 30. A lens 32 having an optical axis 33 is positioned to form an image of an object scene on the assembly 30 through the variable aperture 29. Thus, opposite movement of the diaphragm blades 18 and 20 will result in a variation of the size of the aperture 29 over the assembly 30 simultaneously with the variation of the size of the exposure aperture 25. The diaphragm blades 18 and 20 are each connected to opposite ends of an armature 35 rotatably driven by an electro-mechanical transducer 36 which in this illustrative embodiment is a servo motor. The operation of this servo motor will be described in further detail with respect to the circuit in Fig. 2 below.

The shutter mechanism 16 is a conventional two-blade system, which is shown in Fig. 1 in its cocked position preparatory to actuation to affect an exposure. The shutter mechanism includes a pair of shutter blades 44 and 46 which are slidably mounted upon suitable support means (not shown) for movement relative to the optical axis 14. When the blade 44, which is the "opening" blade in this embodiment, is in its cocked position shown it is retained against the bias of a spring 48 by a latch member 50 which is biased by a spring 52 into latching engagement with a detent 53, in which position the latch member engages a pin 54. The "opening" blade 44 has a second detent 56 positioned to engage a detent 58 on the

blade 46, which in this embodiment is the "closing" blade. Thus, blade 46 is retained in its cocked position against the bias of a spring 60 by the interengagement of the detents 56 and 58. In their respective cocked positions the "opening" blade 44 is retained in a covering relationship with respect to the exposure aperture 25, and the "closing" blade 46 is retained in an uncovering position with respect to the exposure aperture. 75 When the blades are in their respective cocked positions, the spring 48 urges the "opening" blade 44 to an uncovering position with respect to the exposure aperture, and the spring 60 urges the "closing" blade 80 46 to a covering position over the exposure aperture.

The "closing" blade 46 also includes a second detent 66 having a cam surface 68 adapted to engage a retaining lever 70 pivotally mounted on a pin 72 and biased by a spring 74 in a counterclockwise direction into engagement with the detent 66. The opposite end of lever 70 is connected to an electro-magnetic keeper 76 positioned adjacent a pole of an electro-magnet 78 when the shutter blade 46 is in its cocked position. The electromagnet 78 is energized and de-energized by an electronic timing circuit discussed in more detail below with respect to Figure 2. When the electromagnet is energized it holds the lever 70 in its retaining position shown in Figure 1, to hold the blade 46 in its uncovering position when the detents 56 and 58 become disengaged upon release of the "opening" blade for movement to its uncovering position, thereby initiating an exposure interval. Thereafter, when the electromagnet 78 is de-energized, the bias of spring 60 overpowers the bias of the weaker spring 74 to cause the detent 66 to cam the lever 70 in a clockwise direction, thereby releasing the "closing" blade 46 for movement to a covering position with respect to the exposure aperture and terminate the exposure interval. 110

For actuation of the shutter mechanism 16 to effect an exposure, it is provided with a shutter actuation button 80 mounted in an external position on the camera so as to be available to a camera operator. The button 80 is mechanically coupled to a rod or bar 82 that is slidably mounted on mounts (not shown) for movement toward engagement with a detent 84 on shutter latch lever 50, when the shutter actuation button 80 is depressed. Initial movement of the slide bar 82 causes a projection 86 thereon to engage a contact of a normally open switch S1, thereby causing the switch S1 to be closed. Continued movement of the slide bar 82 causes it to engage the detent 84 and rotate the latch 50 in a clockwise direction out of engagement with the detent 53 on the "opening" shutter blade 44 thereby releas- 130

ing the blade for movement under the influence of spring 48 to an uncovering position with respect to the exposure aperture 25 to thereby initiate an exposure interval.

5 When the "opening" blade 44 moves away from its cocked position, it moves out of engagement with one of the contacts of a normally closed switch S2 thereby causing switch S2 to open.

10 As shown in Fig. 1, the shutter mechanism is in its cocked position preparatory to actuation of the shutter mechanism to effect exposure by the operator. When the camera operator depresses the shutter actuation
15 button 80, switch S1 closes energizing the exposure control circuit shown in Fig. 2, then latch 50 is rotated clockwise to release the "opening" blade 44 for movement to its uncovering position with respect to the exposure aperture 25 to thereby initiate an exposure interval and open timing switch
20 S2. When shutter blade 44 moves to its uncovering position, the detent 56 moves out of engagement with the detent 58 on the closing shutter blade 46. However, the electromagnet 78 is energized by the exposure control circuit when the switch S1 is closed, as described below, and latch 70 is held in its retaining position by the electromagnet
25 78 to prevent the "closing" blade 46 from moving away from its unblocking position. After a period of time determined by the circuit in response to the level of illumination detected by a photosensitive element
30 in the circuit, the electromagnet 78 is de-energized to release the "closing" blade 46 for movement to its blocking position to terminate the exposure interval. Following an exposure, the shutter blades can be returned to their cocked positions by movement of a cocking lever 62 to engage a
35 detent 64 thereon with the detent 56 on the "opening" blade to move the blades back to their cocked position, shown in Fig. 1.

45 As described above when the shutter shutter blade 44. Closure of the switch S1 is closed prior to the release of the opening shutter blade 4. Closure of the switch S1 energizes the circuit, shown in Fig. 2, from
50 a potential source such as a battery 90. When the switch S1 is closed a circuit is completed between the battery 90 and a trigger circuit 92, which may illustratively take the form of the well known "Schmitt
55 Trigger". Because of the bias potential applied by the battery 90 to the trigger circuit 92, the trigger circuit 92 is energized from its first or non-conductive state to its second or conductive state. When the trigger
60 circuit 92 is disposed in its conductive state, a current is caused to flow through a coil 94 associated with the electromagnet 78 to thereby retain the closing shutter blade 46 in its initial uncovering position after
65 the opening blade 44 has moved away from

its initial position.

The trigger circuit 92 has an input terminal 96 which is connected to the common point between a capacitor 100, and the radiation sensitive assembly 30 and in particular, a radiation sensitive element 98
70 whose impedance varies as a function of incident scene illumination. As will be explained later, the capacitor 100 and the radiation sensitive element 98 act as an integrating circuit to control the release of the closing shutter blade 46 to terminate
75 the exposure interval. As shown in Fig. 2, the switch S2 serves to short circuit the capacitor 100 until the opening shutter blade 44 is released from its cocked position and to open the normally closed switch S2 to thereby initiate the exposure interval. Thus,
80 as the opening shutter blade 44 is released to permit scene illumination to be directed to the film F, the capacitor 100 is charged at a rate dependent upon the scene illumination directed through the aperture 29 onto the element 98. The potential stored upon
85 the capacitor 100 will increase to a threshold level to cause the circuit 92 to be switched from its second or conductive state to its first or non-conductive state thereby de-energizing the electromagnet 78. As a
90 result, the lever 70 is no longer attracted by the electromagnet 78, and the bias of spring 60 is sufficient to move the closing shutter blade 46 to its covering position with respect to the exposure aperture 25 and to thereby terminate the exposure interval.
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The assembly 30 includes a second radiation sensitive element 102 having an impedance which varies as a function of incident scene illumination. As shown in Fig. 2, the radiation sensitive element 102 is connected to an input terminal 38 of an aperture control circuit 110. When switch S1
105 is closed, battery 90 applies a suitable biasing potential through terminals 40 and 42 to the aperture control circuit 110 to cause the aperture control circuit 110 to energize a pair of drive coils 112 and 114 of the transducer 36 as a function of an input signal applied to the input terminal from the radiation sensitive element 102. In one example
110 of this invention, the aperture control circuit 110 may take the form of a differential amplifier which serves to vary the energizing current through the drive coils 112 and 114 to thereby rotate the armature 35 in one
115 direction or the other dependent upon whether a greater current is directed through drive coils 112 or 114.

As shown in Fig. 1, the transducer 36 drives the armature 35 in either a clockwise
120 or counterclockwise direction to thereby respectively decrease or increase the size of the apertures 25 and 29. As will be explained in detail later, the diaphragm blades 18 and 20 are initially set so that the aper-
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4 tures 25 and 29 are set at their minimal size
 to thereby minimize the effects of the mem-
 ory of the radiation sensitive elements 98
 and 102. When switch S1 is closed, the
 5 armature 35 of the transducer 36 will nor-
 mally be rotated by the drive coils 112 and 114
 to increase the exposure apertures 25 and
 29 dependent upon the level of illumination
 directed through the aperture 29 onto the
 10 radiation sensitive element 102. As the size
 of aperture 29 increases, more radiation will
 be directed onto the radiation sensitive ele-
 ment 102 to thereby decrease the resistance
 or impedance presented by this element. As
 15 explained above, when switch S1 is closed,
 trigger circuit 92 is disposed in its conduc-
 tive state to thereby complete a circuit from
 the positive terminal of battery 90 through
 the radiation sensitive element 102, a vari-
 20 able resistance 106, the terminals 97 and
 99 of the trigger circuit 92 to the negative
 terminal of the battery 90. A voltage divider
 will be formed by the radiation sensitive
 element 102 and the variable impedance 106
 25 across the battery 90 to provide a varying
 signal at the input terminal 38 that is func-
 tionally related to the level of scene radia-
 tion upon the radiation sensitive element
 102. As the resistance of the element 102
 30 decreases, the potential applied to the input
 terminal increases until the applied potential
 is equal to a predetermined reference
 potential of the aperture control circuit 110.
 At this potential, a null condition is achieved
 35 and the circuit 110 applies equal currents
 through the drive coils 112 and 114 so that
 substantially equal, counter-balanced forces
 are applied to the armature 35. Thus, the
 diaphragm blades 18 and 20 are driven to
 40 set the size of aperture 25 as a function of
 the scene radiation. In this first mode of
 operation, the size of the aperture 25 has
 been adjusted for relatively high levels of
 scene radiation to provide proper exposure
 45 of the film F. The amount of light directed
 onto the radiation sensitive element 102 has
 also been adjusted to a substantially fixed
 quantum dependent upon the intensity of
 this scene illumination as well as the size
 50 of the aperture 29; as a result, the resistance
 of the element 102 will be adjusted as the
 size of aperture 29 varies, to a predeter-
 mined value related to the potential level at
 which the exposure aperture control circuit
 55 110 achieves a null condition. Thus, it may
 be seen that for varying intensities of radia-
 tion within a predetermined first range, the
 diaphragm blades 18 and 20 will be driven
 to vary the size of the apertures 25 and 29
 60 so that a substantially constant amount of
 illumination will be directed onto the ele-
 ment 102 and correspondingly, the imped-
 ance of the element 102 will be adjusted to
 a predetermined value. In a similar manner,
 65 the resistance presented by the radiation

sensitive element 98 at null condition will
 be adjusted to a substantially constant, pre-
 determined impedance for varying intensi-
 ties of radiation within the first range.

As shown in Fig. 2, there is provided a 70
 feedback coil 113 disposed to sense the flux
 generated by the drive coils 112 and 114 to
 provide a feedback signal to the differential
 amplifier 110 to retard the rate of change at
 which the drive coils 112 and 114 are driven, 75
 in response to changes of the impedance of
 the radiation sensitive element 102.

In the first mode of operation, the aper-
 ture 29 is opened from its minimal setting
 to an opening at which the size of aperture 80
 25 is adjusted for proper film exposure to
 thereby minimize the memory effect of the
 elements 98 and 102. The resistivity of ele-
 ments 98 and 102 vary as an inverse func-
 tion of the level of incident radiation; after 85
 an initial exposure to a high level of radia-
 tion, the elements 98 and 102 may not re-
 spond accurately to a decrease in the level
 of incident radiation and their resistivity
 may remain relatively low. As a result of 90
 this "memory" effect, the radiation sensi-
 tive elements 98 and 102 are not able to
 respond accurately to lower levels of radia-
 tion once they have been exposed to high
 levels of radiation. Thus, to minimize the 95
 memory effect, the size of aperture 29 is
 increased from its minimal opening until a
 null condition is reached.

In the operation of the shutter mechanism
 and the diaphragm mechanisms shown in 100
 Fig. 1, the shutter actuation button 80 is
 depressed to first close switch S1 to thereby
 adjust the size of the apertures 25 and 29
 through the operation of the aperture con-
 trol circuit 110 as explained above. In one 105
 illustrative embodiment of this invention,
 this operation will require approximately 40
 micro seconds and will be substantially com-
 pleted by the time the opening shutter blade
 44 is released and the switch S2 is opened to 110
 commence the exposure interval and the tim-
 ing operation. Thus, in the first mode of
 operation when the exposure interval com-
 mences, the impedance of the radiation
 sensitive element 98 has been adjusted to 115
 a substantially predetermined value so that
 the capacitor 100 will charge to the thresh-
 old level of the trigger circuit 92 within
 a substantially constant period of time.
 Thus, the exposure intervals for the first 120
 mode of operation will be a substantially
 constant value.

It may be noted however, that the
 mechanism shown in Fig. 1 and the circuit
 shown in Fig. 2 will be mass produced, and 125
 that variations may occur within the manu-
 facturing tolerances of these devices so that
 the impedance of the radiation sensitive ele-
 ment 102 may not always be the exact
 same value, and the apertures 25 and 29 130

may not be adjusted to the correct exposure openings. Under these conditions, the integrating circuit including element 98 and the capacitance 100 may serve to compensate for this variation by adjusting the exposure interval to a slightly different length of time thereby compensating for any slight error in the size of the aperture 25.

The exposure control apparatus described above is adapted not only to operate in a first range of levels of scene radiation, but also to expose film to scene radiation of relatively lower intensities which would require longer exposure intervals. If the level of scene radiation is low enough, a supplementary light source or an extended exposure interval may be needed which would require firm camera support. The circuitry shown in Fig. 2 includes a suitable indicator means such as an indicator lamp 122 which operates, when the shutter actuation button 80 is initially pressed to close switch S1 to provide an indication that the scene illumination is too low to provide a normal exposure of the film and that either firm camera support or an additional light source must be used. In order to energize the indicator lamp 122, the radiation sensitive element 102 is connected to an input terminal 116 of a trigger circuit 118 which serves to energize the lamp 122. The trigger circuit 118 may illustratively take the form of the well known "Schmitt Trigger" and operates to provide a conductive path between its output terminal 119 and its terminal 120 in response to the application to its input terminal 120 in response to the application to its input terminal 116 of a potential signal below a predetermined threshold level. When the circuit path between the input terminals 119 and 120 becomes nonconductive, the indicator lamp 122 is de-energized or turned off. As explained above, when switch S1 is closed the trigger circuit 92 is actuated to provide a conductive path between its terminals 97 and 99 thereby establishing a circuit from the positive terminal of the battery 90 through the radiation sensitive element 102, and the variable impedance 106 to the negative terminal of the battery 90. Thus, if the radiation directed onto the radiation sensitive element 102 is below a predetermined level, the impedance of the element 102 will be sufficient that the voltage applied to the input terminal 116 will fall below the threshold value of the trigger circuit 118 and a conductive path is established between its terminals 119 and 120 to thereby energize the indicator light 122. When indicator light 122 is energized the operator is informed that there is insufficient illumination to provide a proper exposure without an additional source of radiation such as a flash cube or that a tripod is

needed for an extended or time exposure. If the operator chooses, he may place the camera on a tripod and continue to press the shutter actuation button 80 to initiate a time or extended exposure of the film F.

In the second mode of operation, the level of radiation is relatively low compared to the first range so that the impedance presented by the element 102 will be correspondingly higher. As a result the potential developed at the input terminal 38 of the aperture control circuit 110 will not be sufficient to achieve a null condition and the circuit 110 will continue to energize the drive coils 112 and 114 to drive the blades 18 and 20 to open the apertures 25 and 29 to their maximum settings. The opening of the apertures 25 and 29 will normally occur within a relatively short period of time before switch S2 is opened to thereby initiate the timing process. In a second mode of operation, sufficient film exposure is not achieved at the maximum opening of the aperture 25 and the predetermined exposure interval used in the first mode of operation. In order to achieve proper film exposure, the exposure interval is extended for a period of time to achieve proper exposure with the aperture 25 set at its maximum opening. More specifically when the switch S2 is opened, the capacitor 100 begins to charge at a rate determined by the impedance of the radiation sensitive element 98, which as explained above is dependent upon the scene radiation directed through the aperture 29 onto the element 98. The capacitor 100 stores the charge until the threshold level of trigger circuit 92 has been reached at which time the trigger circuit 92 is disposed in its first or non-conductive state thereby de-energizing the coil 94 and releasing the closing shutter blade 46 to terminate the exposure interval.

In the second mode of operation, the maximum opening of the aperture 25 is insufficient to provide proper film exposure, and the exposure interval is extended from the relatively fast exposure interval required in the first mode of operation. In one illustrative example, the exposure interval of the first mode of operation is set at approximately 1/200 second. If the exposure interval is extended beyond that period in which the camera may be hand-held the trigger circuit 118 will be actuated as explained in response to the low level of incident radiation to energize the indicator lamp 122. If an extended or time exposure is used, it would be desirable to provide an indication of the termination of the exposure interval. In accordance with the teachings of this invention the termination of the exposure interval by the trigger circuit 92 also affects the indicator means so that the indicator lamp 122 is turned off at the end of the

exposure interval. More specifically, when the trigger circuit 92 is disposed in its non-conductive state, the conductive circuit between terminals 97 and 99 of the circuit 5 92 is rendered non-conductive or disconnected to thereby "break" the circuit between the positive terminal of the battery 90 through the element 102 and the variable impedance 106 to the negative terminal of the battery 90. Therefore, the potential 10 applied to the input terminal 116 of the trigger circuit 118 is raised to a potential approaching the positive potential of the battery 90. The trigger circuit 118 detects 15 a condition similar to that when the element 102 is exposed to a high level of scene radiation. As a result, the threshold level of the circuit 118 is exceeded and the circuit 118 is rendered non-conductive to 20 thereby de-energize the indicator lamp 122. Thus in accordance with the teachings of this invention, a path is provided from the output terminal 97 of the trigger circuit 92 to the input terminal 116 of the trigger 25 circuit 118 to thereby dispose the circuit 118 in its non-conductive mode of operation when the trigger circuit 92 is disposed in its first or non-conductive mode of operation.

30 Further, a path is provided from the output terminal 97 of the trigger circuit 92 to the input terminal 38 of the aperture control circuit 110 to thereby cause the aperture control circuit 110 to energize the 35 drive coils 112 and 114 and to drive the shutter blades 18 and 20 to set the apertures 25 and 29 at their minimum opening. As explained above, it is desirable to initiate each sequence of the operation of the aperture control apparatus at the minimum opening 40 of the aperture 29 to thereby minimize the problems associated with the storage or memory of the radiation sensitive elements 98 and 102. More specifically, radiation 45 sensitive material such as photoconductive materials which exhibit a change of resistivity in response to changes of intensity of incident radiation, tend to remember or store high levels of radiation even after that 50 radiation has been removed, i.e. the resistivity of a photoconductive element will remain relatively low. However, the memory effect of such photoconductive materials tends to be less when exposed to relatively 55 low levels of incident radiation, and elements made up of such materials will tend to vary its resistivity more quickly and more accurately when the level of radiation is increased from a relatively low level to a 60 higher level. With regard to Fig. 2, the path extends from the output terminal 97 of the trigger circuit 92 to the input terminal 38 of the aperture control circuit 110 so that when the trigger circuit 92 is rendered 65 to its first or non-conductive state to there-

by terminate the exposure interval, a higher potential approaching that of the positive terminal of the battery 90 is applied to the input terminal 38, to thereby cause the apertures 25 and 29 to assume their minimal 70 openings. As a result, the apertures 25 and 29 may be adjusted in the next sequence of operation, from their minimal opening to an opening determined by scene radiation to thereby reduce the storage effects of the 75 elements 98 and 102.

Preferably, the photoconductive cells 98 and 102 are constructed as two independent photoconductive portions of a single structure. An example of such a structure is 80 shown in Figure 3 in which the photocell includes a layer of photoconductive material on which is located three discrete electrodes 132, 134 and 136, connected respectively to three terminals 132a, 134a and 136a. The 85 outer electrodes 132 and 134 include strip portions 132b and 134b, respectively, which are interlined with respect to each other in spaced parallel relation. The centre electrode 136 comprises a single elongated strip that 90 undulates between the strip portions of the outer two electrodes in spaced parallel relation with those electrode strip portions. This structure provides a first photoconductive resistance between the terminals 95 136a and 132a, and a second photoconductive resistance between the terminals 136a and 134a. The photoconductive areas of each of these two discrete photocells are thus defined as two side-by-side undulating 100 paths defining a plurality of alternate strips of photoconductive material in interlined, spaced, parallel relation. This multiple photocell unit provides a single, structure 105 for detecting illumination over the entire field of a scene with two photoconductive output signals.

Referring now to Fig. 4, there is shown a circuit for controlling a shutter mechanism similar to that shown in Fig. 1. More specifically, the circuit of Fig. 4 operates to control 110 the movement of the opening and closing shutter blades 44 and 46 without the need of the diaphragm blades 18 and 20 and the servo motor 36 for varying the size of the 115 apertures 25 and 29. In a manner similar to that described above, a switch S1' is closed upon actuation of the shutter button 80 to connect a battery 190 in circuit with a trigger circuit 192, which serves as will 120 be explained to energize a coil 194 associated with the electro magnet 78. Upon application of the potential, the trigger circuit 192 is immediately disposed from its first or non-conductive state to its second or 125 conductive state to thereby establish a conductive path between its terminals 197 and 199 to thereby connect the coil 194 in circuit with the battery 190. As a result, the electro magnet 78 attracts the lever 70 to retain the 130

closing shutter blade 46 in its open position once the opening shutter blade 44 has been released. If the illumination directed onto a radiation sensitive assembly 130 is insufficient to properly expose the photographic film F, an indicator lamp 222 will be energized to provide an indication thereof. More specifically, the assembly 130 includes first and second radiation sensitive elements 198 and 202 which are responsive to the incident scene radiation to vary a parameter, e.g. electrical resistivity, as a function of the incident scene radiation. It is noted that in the embodiment of the camera apparatus to be used with the exposure control circuit of Fig. 4, that the exposure aperture 25 and the photocell aperture 29 through which radiation is directed onto the assembly 130 are fixed and cannot be varied as explained and shown with regard to Fig. 1. When the trigger circuit 192 is disposed in its first or conductive state, a circuit is established through radiation sensitive element 202, variable impedance 206 to the negative terminal of the battery 190 so that the impedance 206 and element 202 form a voltage dividing network the junction point of which is connected to an input terminal 216 of a trigger circuit 218. If the resistivity of the radiation sensitive element 202 exceeds a predetermined value, i.e. the incident scene radiation is below a predetermined level, a signal will be applied to the input terminal 216 which will dispose the trigger circuit 218 from its first or non-conductive state to a second or conductive state to thereby provide a conductive path between its terminals 220 and 217 and to energize the indicator lamp 222. The energized lamp 222 indicates that the incident scene illumination is too low to provide a normal exposure without the aid of an additional light source or camera support.

With regard to Fig. 1, as the shutter actuation button 80 is continued to be closed, normally closed switch S2' is opened to thereby disconnect the shortcircuit across capacitor 200, and to initiate the exposure interval. More specifically, a time integration circuit is formed by the capacitor 200 and the radiation sensitive element 198. In a manner similar to that described above, the capacitor 200 charges at a rate determined by resistivity of the element 198, which in turn is a function of the incident scene radiation. When the capacitor 200 has charged to a level corresponding to the threshold level of the trigger circuit 192, the conductive state to its first or non-conductive state to thereby de-energize the coil 194 and to release the closing shutter blade 46 thereby terminating the exposure interval. In accordance with the teachings of this invention, a path is provided between the output terminal 197 of the trigger circuit

192 and the input terminal 216 of the trigger circuit 218. As a result, when the trigger circuit 192 is disposed in its first or non-conductive state, the circuit between the input terminal 216 of the trigger circuit 218 through the variable impedance 206 and the negative terminal of the battery 190 is broken and the potential applied to the input terminal 216 approaches that potential of the positive terminal of the battery 190. At this more positive potential, the trigger circuit 218 is disposed in its first or non-conductive state to thereby de-energize the indicator lamp 122. As a result of the aforesaid path, the indicator lamp 122 is used to not only indicate a low light condition under which sufficient film exposure cannot be achieved without the aid of an additional light source or camera support, but also to indicate the termination of an extended or timed exposure.

When the indicator lamp 122 (or 222) is energized, the operator may choose to use an auxiliary light source such as a flash cube. With reference to the circuit of Fig. 2, the insertion of a flash cube serves to dispose the normally open switch 124 to its closed position to thereby connect a resistor 126 in parallel across the radiation sensitive element 98 and in circuit with capacitor 100. In the flash mode, the primary source of illumination is normally derived from the flash device and the exposure interval must be adjusted primarily as a function of the illumination derived from the flash device. The resistance of the resistor 126 is chosen to determine the exposure interval as a function of light derived from the auxiliary source and is connected in circuit by the switch 124 with the capacitor 100 to control the exposure interval. In a similar fashion, the circuit of Fig. 4 includes a resistor 226 which is connected in circuit with capacitor 200 by a switch 224 when a flash cube is coupled to the camera, to determine the exposure interval for flash operation. In an illustrative embodiment, the camera includes a lens adjustment mechanism which permits the focal length of the lens to be focused for relatively close objects. The setting of the lens adjustment mechanism for short distances closes a normally open switch 228 to thereby connect a resistor 230 in parallel with resistor 226 and in circuit with capacitor 200. The value of resistance 230 is chosen to reduce the composite value of resistances 226 and 230 by an amount sufficient to reduce the exposure intervals taken at the shortened distances.

WHAT WE CLAIM IS:—

1. A photographic camera having an exposure aperture, a shutter and an exposure control apparatus comprising radiation sensitive means disposed to receive



closing shutter blade 46 in its open position once the opening shutter blade 44 has been released. If the illumination directed onto a radiation sensitive assembly 130 is insufficient to properly expose the photographic film F, an indicator lamp 222 will be energized to provide an indication thereof. More specifically, the assembly 130 includes first and second radiation sensitive elements 198 and 202 which are responsive to the incident scene radiation to vary a parameter, e.g. electrical resistivity, as a function of the incident scene radiation. It is noted that in the embodiment of the camera apparatus to be used with the exposure control circuit of Fig. 4, that the exposure aperture 25 and the photocell aperture 29 through which radiation is directed onto the assembly 130 are fixed and cannot be varied as explained and shown with regard to Fig. 1. When the trigger circuit 192 is disposed in its first or conductive state, a circuit is established through radiation sensitive element 202, variable impedance 206 to the negative terminal of the battery 190 so that the impedance 206 and element 202 form a voltage dividing network the junction point of which is connected to an input terminal 216 of a trigger circuit 218. If the resistivity of the radiation sensitive element 202 exceeds a predetermined value, i.e. the incident scene radiation is below a predetermined level, a signal will be applied to the input terminal 216 which will dispose the trigger circuit 218 from its first or non-conductive state to a second or conductive state to thereby provide a conductive path between its terminals 220 and 217 and to energize the indicator lamp 222. The energized lamp 222 indicates that the incident scene illumination is too low to provide a normal exposure without the aid of an additional light source or camera support.

With regard to Fig. 1, as the shutter actuation button 80 is continued to be closed, normally closed switch S2' is opened to thereby disconnect the short circuit across capacitor 200, and to initiate the exposure interval. More specifically, a time integration circuit is formed by the capacitor 200 and the radiation sensitive element 198. In a manner similar to that described above, the capacitor 200 charges at a rate determined by resistivity of the element 198, which in turn is a function of the incident scene radiation. When the capacitor 200 has charged to a level corresponding to the threshold level of the trigger circuit 192, the conductive state to its first or non-conductive state to thereby de-energize the coil 194 and to release the closing shutter blade 46 thereby terminating the exposure interval. In accordance with the teachings of this invention, a path is provided between the output terminal 197 of the trigger circuit

192 and the input terminal 216 of the trigger circuit 218. As a result, when the trigger circuit 192 is disposed in its first or non-conductive state, the circuit between the input terminal 216 of the trigger circuit 218 through the variable impedance 206 and the negative terminal of the battery 190 is broken and the potential applied to the input terminal 216 approaches that potential of the positive terminal of the battery 190. At this more positive potential, the trigger circuit 218 is disposed in its first or non-conductive state to thereby de-energize the indicator lamp 122. As a result of the aforesaid path, the indicator lamp 122 is used to not only indicate a low light condition under which sufficient film exposure cannot be achieved without the aid of an additional light source or camera support, but also to indicate the termination of an extended or timed exposure.

When the indicator lamp 122 (or 222) is energized, the operator may choose to use an auxiliary light source such as a flash cube. With reference to the circuit of Fig. 2, the insertion of a flash cube serves to dispose the normally open switch 124 to its closed position to thereby connect a resistor 126 in parallel across the radiation sensitive element 98 and in circuit with capacitor 100. In the flash mode, the primary source of illumination is normally derived from the flash device and the exposure interval must be adjusted primarily as a function of the illumination derived from the flash device. The resistance of the resistor 126 is chosen to determine the exposure interval as a function of light derived from the auxiliary source and is connected in circuit by the switch 124 with the capacitor 100 to control the exposure interval. In a similar fashion, the circuit of Fig. 4 includes a resistor 226 which is connected in circuit with capacitor 200 by a switch 224 when a flash cube is coupled to the camera, to determine the exposure interval for flash operation. In an illustrative embodiment, the camera includes a lens adjustment mechanism which permits the focal length of the lens to be focused for relatively close objects. The setting of the lens adjustment mechanism for short distances closes a normally open switch 228 to thereby connect a resistor 230 in parallel with resistor 226 and in circuit with capacitor 200. The value of resistance 230 is chosen to reduce the composite value of resistances 226 and 230 by an amount sufficient to reduce the exposure intervals taken at the shortened distances.

WHAT WE CLAIM IS:—

1. A photographic camera having an exposure aperture, a shutter and an exposure control apparatus comprising radiation sensitive means disposed to receive

scene radiation, a time delay circuit having an input from the radiation sensitive means and responsive thereto for producing a control signal an exposure interval after opening of the shutter, the exposure interval being dependent on the received scene radiation, a first circuit responsive to the control signal to produce closing of the shutter, a second circuit having an input from the radiation sensitive means, and responsive thereto, and an indicator connected to the output of the second circuit, the second circuit being arranged to energise the indicator when the intensity of the received scene radiation is below a predetermined level prior to production of the control signal and to de-energise the indicator on initiation of closure of the shutter by the first circuit.

2. A photographic camera according to Claim 1, including a diaphragm for varying the size of the exposure aperture, a diaphragm control circuit coupled to the radiation sensitive means and responsive thereto for actuating the diaphragm to vary the size of the exposure aperture as a function of scene radiation incident on the radiation sensitive means when the intensity of the received scene radiation is above the predetermined level.

3. A photographic camera according to Claim 2, wherein the radiation sensitive

means comprises two radiation sensitive elements constructed in a single unit.

4. A photographic camera according to Claim 3, wherein the diaphragm further varies the size of a second aperture disposed to direct scene radiation onto the two radiation sensitive elements, the diaphragm control circuit being responsive to the input from the second radiation sensitive element for actuating the diaphragm to vary the size of the exposure aperture and the second aperture as a function of the level of radiation incident thereon, and the first radiation sensitive element is coupled to the time delay circuit for producing the control signal an exposure interval after the uncovering of the exposure aperture, as a function of scene radiation incident thereon.

5. A photographic camera as claimed in Claim 4, wherein the output of the first circuit is coupled to the input of the diaphragm control circuit, whereby upon closure of the shutter, the second aperture is driven to a minimum aperture condition.

6. A photographic camera according to Claim 1, substantially as hereinbefore described with reference to, and as shown in Figs. 1, 2 and 3, or Figs. 1, 3 and 4 of the accompanying drawings.

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