

PATENT SPECIFICATION

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(54) EXPOSURE CONTROL MEANS

(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:—

This invention relates to photographic cameras, and more particularly to a camera having an electronic exposure control circuit for controlling a shutter mechanism of the camera.

An object of the present invention is the provision of a photographic camera having an improved electronic exposure control circuit.

According to the present invention, there is provided a photographic camera having an electronically controlled shutter operable in a first or second mode for providing a light dependent or a fixed exposure interval respectively, means for automatically selecting that mode providing the shorter interval, and override means for enabling the shutter to operate in the first mode only.

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

Fig. 1 is a perspective diagram of a portion of a camera with film loaded therein including a camera shutter mechanism adapted to effect exposure control of the film; and

Fig. 2 is a schematic diagram of an electrical circuit, of a camera according to the present invention, for controlling the shutter mechanism shown in Fig. 1.

As photographic cameras are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, that apparatus of the camera in accordance with

the present invention. It is to be understood camera elements not specifically shown or described may take various forms well known to those having skill in the art.

There is shown schematically in Fig. 1, a camera 10 having an objective lens 12 and shutter mechanism 14 for controlling the exposure of film F to light from a scene to be photographed. Objective lens 12 is positioned along an optical axis 16 for receiving and directing scene light onto film F which is located at the camera focal plane. Shutter mechanism 14 is actuated to effect correct exposure of film F, as described hereinafter.

Although not specifically shown, camera 10, like some of the present commercially available cameras, may also include a diaphragm mechanism disposed along axis 16 for forming a variable exposure aperture in alignment with objective lens 12. One mechanism of this type is described in U.S. Patent 3,748,974.

Shutter mechanism 14 includes a pair of opaque shutter blades 22 and 24, each slidably mounted upon suitable support means (not shown) for movement transverse to optical axis 16 between an initial or cocked terminal position as shown in Fig. 1 and a final or released terminal position.

Each of these blades by virtue of their shape or configuration permits scene light, when in one terminal position, to impinge on film F whereas the opaque portions thereof serve to prevent scene light from impinging on the film, when such blades are in their respective other terminal position. That is blade 22, hereinafter called the "opening blade" because actuation thereof initiates the film exposure interval, is in its "light blocking position" when in the cocked position shown in Fig. 1 and is in the "light unblocking position" when in its other terminal position, the released position. Conversely, blade 24, hereinafter called the "closing blade" since actuation thereof

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terminates the exposure interval, is in the "light unblocking position" when in its cocked position, shown in Fig. 1, and is in the "light blocking position" when in its released position.

Opening blade 22 is retained in its cocked position against the bias of a spring 26 by releasable engaging means 28 comprising a pivotally mounted latch member 30 which is biased in the counterclockwise direction as viewed in Fig. 1 by a spring 32 into latching position against a post 34. In this position, an end portion 36 of latch member 30 engages a detent 38 thereby to retain opening blade 22 in its cocked position.

Closing blade 24 is retained in its cocked position against the bias of a spring 40 by releasable engaging means 42 comprising a retaining lever 44 pivotally mounted about a pin 45. Lever 44 is biased in the counterclockwise direction by a spring 46 into its retaining position shown in Fig. 1 wherein an end portion of the lever engages a detent 50 of closing blade 24. The bias force exerted by spring 46 is not sufficient in itself to retain lever 44 in its counterclockwise position. The primary or dominant force which maintains lever 44 in such position is produced by a locking mechanism 52 acting on end portion 53 of the lever, which mechanism comprises an electromagnetic keeper 54 positioned adjacent a pole of an electromagnet 56. Electromagnet 56 is energized and de-energized by an electronic timing circuit illustrated in Fig. 2 and discussed in detail hereinafter.

When shutter blades 22 and 24 are in their respective released positions (not shown), such blades may be returned to their cocked positions by movement of a reset lever 58 along a path in the plane of opening blade 22. Reset lever 58 includes an L-shaped detent portion 60 which impacts or strikes a detent 62 of opening blade 22 upon movement of the reset lever toward axis 16 thereby to drive the opening blade back to its cocked position, detent 38 engages cam surface 64 of latching lever 30 temporarily pivoting the latching lever in the clockwise direction until the detent has travelled past the cam surface, at which time the latching lever returns to its latching position under the influence of spring 32 thereby to retain the closing blade in its cocked position. During this movement of opening blade 22 to its cocked position, detent 62 engages an L-shaped detent 66 of closing blade 24, which engagement drives the latter back to its cocked position. Detent 66 also functions to maintain closing blade 24 in its cocked position when electromagnet 56 is not energized.

Opening blade 22 may be actuated to effect movement thereof from its cocked position to its released position, that is from

its light blocking to its light unblocking position to initiate the film exposure interval, upon manual depression of a body release or shutter actuation button 68 mounted in an external position on camera 10 so as to be available to a camera operator. Actuation button 68 is mechanically coupled to a rod or bar 70 that is slidably mounted (not shown) for movement into abutting engagement with a detent 72 on latch member 30, when the button is depressed. Initial movement of bar 70 causes a projection 74 thereon to engage a contact of a normally open switch S1 thereby to cause the switch to be closed. Continued movement of bar 70 causes end portion 76 to engage detent 72 and rotate latch member 30 in a clockwise direction out of engagement with detent 38 of opening blade 22, thereby to release this blade for movement under the influence of spring 26 to an uncovering position with respect to a camera exposure aperture (not shown) and to initiate the film exposure interval. When opening blade 22 moves from its cocked position, detent 62 thereon becomes disengaged from detent 66 on closing blade 24. However, closing blade 24 is retained in its cocked position, in a manner hereinafter described, for a period of time depending on certain exposure parameters to permit film F to be exposed to scene light. At the end of this time period, closing blade 24 is released and the film exposure interval is terminated when this blade is moved under the influence of spring 40 from its cocked position to its released position, that is, from its light unblocking to its light blocking position.

Referring now to Fig. 2, there is shown a circuit 100 for controlling a camera shutter mechanism such as the shutter mechanism 14 shown in Fig. 1. As shown in Fig. 2, circuit 100 comprises generally first and second timing circuits 102 and 104, circuit 102 having a variable time constant which is dependent on prevailing light conditions and circuit 104 having a time constant which is independent of prevailing scene light, a shutter control circuit 106 selectively responsive to either timing circuit for energizing and de-energizing a solenoid coil 108 of electromagnet 56, and a light indicator circuit 110 having an output 111 indicating the adequacy of scene light for permitting quality hand-held photographs and for controlling timing circuit 102 in response to the status of such an output.

First timing circuit 102 comprises a light responsive element 112, such as a photo-resistor, photocell or the like, disposed within camera 10 to receive light from a scene to be photographed and having an internal resistance which, in this particular example, varies inversely as a function of scene light incident thereon and a capacitor 130

114 connected in parallel with element 112 between terminals 122 and 128. Together element 112 and capacitor 114 form a parallel R—C timing circuit having a time constant related to the intensity of scene light. Circuit 102 further includes a control transistor 116, having emitter, base, and collector electrodes 116a, 116b, and 116c, respectively, electrode 116a being connected to electrical ground designated 118, electrode 116b being connected to a biasing resistor 120, and electrode 116c being connected to terminal 122 as shown.

Second timing circuit 104 includes a resistor 124 and a capacitor 126 electrically connected in parallel to each other between terminals 128 and 130 so as to form a conventional parallel R—C timing circuit having a fixed, predetermined time constant. Circuit 104 further includes a control transistor 132 having an emitter, base, and collector electrodes 132a, 132b, and 132c, respectively, electrode 132a being connected to electrical ground 118, electrode 132b being connected to a biasing resistor 132, and electrode 132c being connected to terminal 130 for controlling the voltage appearing at that terminal of the parallel R—C combination prior to actuation of shutter mechanism 14.

Connected to terminal 130 in parallel across the collector-to-emitter junction of control transistor 132 is a normally opened time control switch S₃. As is diagrammatically shown in Fig. 2 and illustrated in further detail in Fig. 1, switch S₃ is coupled or ganged to normally closed control switch S₄ which is connected to terminal 122 as shown. Switch S₃ may be actuated manually from its opened to its closed position and, simultaneously, switch S₄ from its closed to its opened position upon slidable movement of actuable member 133. Member 133 is mounted in an external position on camera 10 to be available to a camera operator for such movement for a reason made apparent hereinafter.

Shutter control circuit 106 comprises logic circuitry such as an OR gate 136 or the like responsive to a signal appearing at either of terminals 122 and 130, and a trigger circuit 138 having dual inputs 139 and 140 connected, respectively, to the output of the OR gate and terminal 128, and an output designated 141. Trigger circuit 138 may be of the type known in the art as a comparator circuit and, more specifically, may be a Schmitt trigger circuit having a normally nonconducting input stage and an output of the type which is normally conducting. As shown in Fig. 2, output 141 is connected in series with solenoid 108 which controls electromagnet 56.

Light indicator circuit 110 includes a resistor 144 connected in series with a light

responsive element such as a photoresistor or a photocell 146, which has a resistance which, in this particular example, varies as an inverse function of scene light incident thereon. Connected to terminal 147 between resistor 144 and element 146 is an input 148 of a trigger circuit 150 of the type such as the aforementioned Schmitt trigger circuit. The series combination of resistor 144 and element 146 functions to divide the voltage appearing across terminals 128 and 118 in a manner related to the resistance of the element with the voltage appearing at junction 147 serving as an input signal to the input stage of trigger circuit 150. The resistance of resistor 144 and of element 146 are selected or selectively controllable such that the voltage signal which appears at junction 147 is adequate to turn the normally conducting output stage of trigger circuit 150 OFF only if there is sufficient scene illumination to permit a particular film exposure value of less than 1/30 second. A time period of 1/30 second is considered to be the maximum for hand held photography if "camera shake" is to be avoided.

Connected across the junction consisting of the other input to trigger circuit 150, that is input 152, and output 111 is an indicator means 154 of the type for indicating directly the status of a particular parameter such as the adequacy of scene light for permitting a proper exposure with a hand-held camera within 1/30 second. In accordance with a preferred embodiment, indicator means 154 consists of a light emitting diode (LED) although other suitable ON-OFF devices known to those having skill in the art may be used. Connected as shown between the cathode of LED 154 and terminal 122 is a diode 158 for enabling the voltage signal appearing at output 111 to serve as a control signal for overriding the operation of light dependant timing circuit 102 as described hereinafter. The anode of diode 158 is connected in series to one terminal of control switch S₄ as shown.

To expose film F to scene light, a camera operator depresses actuation button 68 firstly to close switch S₁ thereby to apply electrical power from a power source such as a battery 160 to circuit 100 across terminals 128 and 118. When switch S₁ is initially closed, switch S₂ is still open thereby permitting control transistors 116 and 132 to be turned ON as current flows through a resistor 162 and base electrode biasing resistors 120 and 134, respectively. Transistors 116 and 132 are driven into saturation so that the voltages appearing at terminals 122 and 130, the collector-to-emitter junction voltages, are relatively small and are inadequate for turning ON the normally nonconducting input stage of trigger circuit 138. The instant switch S₁ is closed, voltage is 130

also applied to first and second timing circuits 102 and 104 to charge capacitors 114 and 126, respectively, to approximately the full potential of battery 160.

Further, when switch S1 is initially closed electrical power is applied to light indicator circuit 110. Element 146 and resistor 144 thereof divide the voltage of battery 160 in a manner functionally related to the amount of scene illumination incident on the light responsive element. In discussing the operation of light indicator circuit 110, it is necessary to consider two levels of scene illumination. If scene light is inadequate or too low for permitting film F to be properly exposed within the aforementioned 1/30 second interval, the voltage signal appearing at junction 147 will be relatively low and inadequate to turn the input stage of trigger circuit 150 ON. When this condition occurs, the output stage of circuit 150 remains conducting permitting current to flow through LED 154 and thereby to cause the LED to glow indicating a low scene light condition. Under this operating condition, the voltage appearing at terminal 111 is relatively low so that collector electrode 116c of control transistor 116 is effectively at ground potential, thereby electrically grounding first timing circuit 102.

On the other hand, if scene light is normal or adequate for permitting proper film exposure within a predetermined time period, e.g. the aforementioned 1/30 second, the voltage appearing at terminal 147 is relatively high causing the input stage of circuit 150 to be turned ON and therefore the output stage thereof to be turned OFF. In this state, the output voltage signal at terminal 111 is high, approximately the value of battery 160 so that LED 154 is OFF and does not glow, thereby indicating adequate scene light. Diode 158 is reversed biased by this output signal and does not conduct so that timing circuit 102 is electrically isolated from light indicating circuit 110 during a normal scene light condition. Under this condition, first timing circuit 102 is not clamped to ground, as in the aforementioned low scene light condition, and functions to produce a timing signal as described hereinafter.

Still further, when switch S1 is initially closed, solenoid 108 is instantly energized thereby enabling electromagnet keeper 54 magnetically to latch closing blade 24 in its light unblocking position independent of the retaining force applied to the closing blade by the action of detent 62 co-operatively engaging detent 66 when opening blade 22 is in its cocked position.

Consider now the operation of circuit 100 when switch S2 is actuated and is thereby closed. Switch S2 is actuated in response to movement of opening blade 22 from its light

blocking position toward its light unblocking position, a condition obtained when shutter actuation button 68 continues to be depressed such that end portion 76 engages detent 72 disengaging latch member 30 from detent 38. When this happens, opening blade 22 is moved to its light unblocking position under the influence of spring 26, thereby permitting switch S2 to close. When switch S2 is closed, base electrodes 116b and 132b are electrically grounded causing control transistors 116 and 132, respectively simultaneously to be turned OFF.

When this condition occurs, timing circuit 102 and timing circuit 104 begin to produce a time variable control signal for terminating the film exposure interval. Second timing circuit 104 functions to produce the control signal for terminating the exposure interval under low scene light conditions because first timing circuit 102 is effectively grounded, as started hereinbefore, whereas under scene light conditions adequate to permit correct film exposure within time intervals of 1/30 second or less first timing circuit 102 functions to terminate the exposure interval as described hereinbelow.

Firstly consider a low scene light level and the operation of second timing circuit 104. When base electrode 132b is grounded thereby to turn control transistor 132 OFF, capacitor 126 discharges through resistor 124. This causes the voltage at terminal 130 to increase (i.e. to approach the voltage at terminal 128) exponentially in a manner related to the product of the resistance of resistor 124 and the capacitance of capacitor 126, these values being selected or selectively controllable such that the trigger or threshold voltage for trigger circuit 138 is reached in 1/30 second, at which point the normally non-conducting input stage of trigger circuit 138 is turned ON, thereby switching its output stage OFF de-energizing solenoid 108. When this happens, electromagnetic keeper 54 releases retaining lever 44 permitting closing blade 24 to move to its light blocking position under the influence of spring 40 to terminate the film exposure interval at 1/30 second. During this time, circuit 100 functions overall as if first timing circuit 102 was not present since terminal 122 is effectively at ground potential due to the low potential at terminal 111 when LED 154 is ON under a low scene light level.

Considering now scene light levels adequate to permit film F to be exposed correctly in less than 1/30 second and, in this regard, the operation of circuit 100 and in particular first timing circuit 102. Timing circuit 102 begins to produce a control signal at terminal 122 the instant switch S2 is closed grounding control transistor 116. This control signal is functionally related to

the resistance of the light responsive element 112, i.e. the scene light incident thereon. The instant S2 is closed, capacitor 114 begins to discharge through element 112. When this happens, the voltage at terminal 122 begins to increase exponentially at a rate determined by the product of the element 112 resistance and the capacitance of capacitor 114. Thus, the voltage signal established at terminal 122 is related to scene light and, similarly to timing circuit 104, when in excess of the threshold voltage of trigger circuit 138, functions to turn ON the normally non-conducting input stage thereof, thereby turning OFF its output stage de-energizing solenoid 108. As described previously herein, de-energization of solenoid 108 causes electromagnetic keeper 54 to release retaining means 48 to permit closing blade 24 to move to its light blocking position under the influence of spring 40 thereby terminating the exposure interval.

During this time, second timing circuit 104 is functioning as described previously hereinbefore but has no effect on actuating closing blade 24 as, under higher scene light levels, its time constant is greater than the R—C time constant of timing circuit 102, and, consequently, does not effect actuation of the closing blade.

The camera operator may prefer not to limit the exposure interval to 1/30 second in a low light condition. This would be so for a number of reasons such as, for example, in the event the camera was mounted on a stationary platform which would avoid the need to limit exposure time or in the event it was desired to obtain photographs having certain "special effects."

To obtain an extended time photograph, the operator slides release member 133 from right to left as viewed in Fig. 1, which condition causes switch S₃ to close and switch S₄ to open. When switch S₃ is closed, light independent timing circuit 104 is electrically grounded at terminal 130 and is thereby rendered ineffective to control solenoid coil 108 through circuit 106. With switch S₄ open, light indicator circuit 110 is electrically disconnected from light dependant timing circuit 102 and, therefore, does not function to ground that circuit when LED 154 is conducting under a low light condition. Under these conditions, timing circuit 104 is overridden and shutter control circuit 106 is under the exclusive or sole control of light dependent timing circuit 102, which condition permits an extended time exposure under a low light condition.

The invention has been described in detail

with particular reference to a preferred embodiment 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 photographic camera having an electronically controlled shutter operable in a first or second mode for providing a light dependant or a fixed exposure interval respectively, means for automatically selecting that mode providing the shorter interval, and override means for enabling the shutter to operate in the first mode only.

2. A camera as claimed in Claim 1 including a light dependant timing circuit and a fixed time timing circuit respectively for controlling operation of the shutter in the first and second modes.

3. A camera as claimed in Claim 1 or 2 further including a means for determining when light conditions are such that the fixed exposure interval would be exceeded, and means for indicating such conditions to a camera operator.

4. A camera as claimed in Claim 3 wherein the light conditions determining means comprises a light responsive trigger circuit controlling a warning lamp for indicating when the fixed exposure interval would be exceeded to a camera operator.

5. A camera as claimed in Claim 4 wherein the trigger circuit, when the lamp is energised, serves also to exhibit operation of the shutter in the first mode.

6. A camera as claimed in Claims 2 and 5, wherein inhibition of the operation of the shutter in the first mode is effected by grounding of the light dependant timing circuit via the output of the trigger circuit.

7. A camera as claimed in any preceding claim wherein the override means comprises a manually operable switch.

8. A camera as claimed in Claims 2, 4, 6 and 7 wherein the manually operable switch serves to disconnect the output of the trigger circuit from the light dependant timing circuit.

9. A camera as claimed in Claim 8 further including a second switch for grounding the fixed time timing circuit, the switch being ganged to the manually operable switch to operate simultaneously and out of phase therewith.

10. A camera as claimed in Claim 2 or any claim appendant thereto wherein the respective outputs of the light dependant and fixed time timing circuits are fed to respective inputs of an OR gate the output

the resistance of the light responsive element 112, i.e. the scene light incident thereon. The instant S2 is closed, capacitor 114 begins to discharge through element 112. When this happens, the voltage at terminal 122 begins to increase exponentially at a rate determined by the product of the element 112 resistance and the capacitance of capacitor 114. Thus, the voltage signal established at terminal 122 is related to scene light and, similarly to timing circuit 104, when in excess of the threshold voltage of trigger circuit 138, functions to turn ON the normally non-conducting input stage thereof, thereby turning OFF its output stage de-energizing solenoid 108. As described previously herein, de-energization of solenoid 108 causes electromagnetic keeper 54 to release retaining means 48 to permit closing blade 24 to move to its light blocking position under the influence of spring 40 thereby terminating the exposure interval.

During this time, second timing circuit 104 is functioning as described previously hereinbefore but has no effect on actuating closing blade 24 as, under higher scene light levels, its time constant is greater than the R-C time constant of timing circuit 102, and, consequently, does not effect actuation of the closing blade.

The camera operator may prefer not to limit the exposure interval to 1/30 second in a low light condition. This would be so for a number of reasons such as, for example, in the event the camera was mounted on a stationary platform which would avoid the need to limit exposure time or in the event it was desired to obtain photographs having certain "special effects."

To obtain an extended time photograph, the operator slides release member 133 from right to left as viewed in Fig. 1, which condition causes switch S₁ to close and switch S₂ to open. When switch S₁ is closed, light independent timing circuit 104 is electrically grounded at terminal 130 and is thereby rendered ineffective to control solenoid coil 108 through circuit 106. With switch S₂ open, light indicator circuit 110 is electrically disconnected from light dependant timing circuit 102 and, therefore, does not function to ground that circuit when LED 154 is conducting under a low light condition. Under these conditions, timing circuit 104 is overridden and shutter control circuit 106 is under the exclusive or sole control of light dependent timing circuit 102, which condition permits an extended time exposure under a low light condition.

The invention has been described in detail

with particular reference to a preferred embodiment 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.

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1. A photographic camera having an electronically controlled shutter operable in a first or second mode for providing a light dependant or a fixed exposure interval respectively, means for automatically selecting that mode providing the shorter interval, and override means for enabling the shutter to operate in the first mode only.

2. A camera as claimed in Claim 1 including a light dependant timing circuit and a fixed time timing circuit respectively for controlling operation of the shutter in the first and second modes.

3. A camera as claimed in Claim 1 or 2 further including a means for determining when light conditions are such that the fixed exposure interval would be exceeded, and means for indicating such conditions to a camera operator.

4. A camera as claimed in Claim 3 wherein the light conditions determining means comprises a light responsive trigger circuit controlling a warning lamp for indicating when the fixed exposure interval would be exceeded to a camera operator.

5. A camera as claimed in Claim 4 wherein the trigger circuit, when the lamp is energised, serves also to exhibit operation of the shutter in the first mode.

6. A camera as claimed in Claims 2 and 5, wherein inhibition of the operation of the shutter in the first mode is effected by grounding of the light dependant timing circuit via the output of the trigger circuit.

7. A camera as claimed in any preceding claim wherein the override means comprises a manually operable switch.

8. A camera as claimed in Claims 2, 4, 6 and 7 wherein the manually operable switch serves to disconnect the output of the trigger circuit from the light dependant timing circuit.

9. A camera as claimed in Claim 8 further including a second switch for grounding the fixed time timing circuit, the switch being ganged to the manually operable switch to operate simultaneously and out of phase therewith.

10. A camera as claimed in Claim 2 or any claim appendant thereto wherein the respective outputs of the light dependant and fixed time timing circuits are fed to respective inputs of an OR gate the output



of which controls a further trigger circuit in turn controlling an electromagnetic means for terminating an exposure interval.

and as illustrated in the accompanying drawing.

11. A photographic camera substantially as hereinbefore described with reference to

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