

PATENT SPECIFICATION

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(54) PHOTOGRAPHIC SHUTTER MECHANISM

(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 generally to shutter mechanisms for use in cameras, and more particularly to shutter mechanisms controlled by light-integrating, timing circuits for establishing shutter speed in accordance with the level of scene illumination.

Many photographic cameras presently available are provided with automatic shutter systems of the type having a light-integrating timing circuit for determining shutter speed. Typically, the timing circuit is activated in synchronization with movement of an opening blade or blade ring to initiate an exposure interval, and the circuit subsequently actuates a closing blade or blade ring to terminate the exposure interval after a time period established by the timing circuit in accordance with the intensity of light received by a photocell in the circuit. There are many known shutter blade arrangements employed in such systems. For example, the opening blade typically is releasably held in an aperture blocking position by a camera release lever, and is moved under the influence of a spring to uncover the aperture. The timing cycle is usually initiated upon actuation of the release lever or upon the movement of the opening blade. The closing blade is usually retained in an aperture unblocking position by an electromagnet attracting a keeper on the blade. When the timing cycle has been completed the control circuit energizes the electromagnet to release the closing blade for movement to an aperture

blocking position, terminating the exposure.

It is an object of the present invention to provide such an improved electronic shutter utilizing a single shutter blade for initiating and terminating exposures.

In accordance with the present invention there is provided an electronic shutter comprising a shutter blade movable from a first exposure aperture blocking position to an aperture unblocking position and thence to a second aperture blocking position means arranged to interrupt the movement from the first to the second aperture blocking position, of the blade, whilst the blade is in the aperture unblocking position, and electronically controlled means for moving the blade so as to disengage the blade from the interrupting means.

Referring to the drawings:—

Fig. 1 is a perspective view of a shutter control apparatus according to the present invention, shown in a cocked condition, with a blade in a first, aperture blocking position;

Fig. 2 is a schematic diagram of a light-integrating timing circuit for controlling exposure time for the apparatus in Fig. 1;

Fig. 3 is an elevation of the apparatus of Fig. 1, shown in an intermediate or exposure aperture unblocking position, including phantom lines showing the position of the blade as an electromagnet attracts the blade;

Fig. 4 is an elevation of the apparatus in Fig. 1, shown in the second aperture blocking position, after termination of the exposure interval;

Figs. 5 and 6 are elevations of the apparatus of Fig. 1 showing the positions of a capping blade in relation to the exposure aperture, and to the blade aperture during operation of the shutter reset;

Fig. 7 is an elevation of another embodiment of the apparatus of Fig. 1, shown with the blade in the first aperture blocking position.

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tion, with the electromagnet positioned to attract the blade, and retain the blade against a stop, when the blade is in the intermediate or aperture unblocking position;

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Fig. 8 is an elevation of the apparatus of Fig. 7 showing the electromagnet retaining the blade against the stop when the blade is in the aperture unblocking position;

10 Fig. 9 is an elevation of the apparatus of Fig. 7, shown in the second aperture blocking position, after the termination of the exposure interval;

15 Fig. 10 is an elevation of another embodiment of the apparatus of Fig. 1 shown with an electromagnet positioned to direct the blade to the intermediate or aperture unblocking position, and to retain the blade against a stop during the exposure interval;

20 Fig. 11 is an elevation of the embodiment of Fig. 10, shown in the aperture unblocking position during the exposure interval; and

25 Fig. 12 is an elevation of the apparatus of Fig. 11, shown in the second aperture blocking position after termination of an exposure interval.

30 Because cameras are well known, the present description will be directed to elements forming part of, or cooperating more directly with the present invention. Camera parts not specifically shown or described may take forms well known to those skilled in the art.

35 Referring now to the drawings, there is shown in Fig. 1 a shutter mechanism according to one illustrative embodiment of the invention, including an elongated shutter blade 12 having a blade aperture 13, and two end portions 15 and 16, each of which is sufficiently large to cover an exposure aperture 18. In the cocked position of the shutter mechanism, as shown in Fig. 1, the blade 12 is in a first aperture blocking position in relation to the exposure aperture 18, and the end portion 15 of the blade 12 covers the exposure aperture 18. Blocking and unblocking positions of the blade 12 refer to positions that the blade 12 may take with respect to the exposure aperture 18, to block or pass incident scene light through the exposure aperture 18. The blade 12 is mounted on a pin 20 secured on a supporting structure 24, and received in a slot 22 of the blade 12, to permit pivotal movement and lateral movement of the blade with respect to the exposure aperture 18. As further shown in Fig. 1, the blade 12 is retained in the cocked position by a releasable latch member 32, against the bias of a spring 28, secured by a pin 30 on the support structure 24. The latch member 32 is biased to a latching position by a spring 34, and includes a portion

accessible from the exterior of the camera, for manual actuation. The latch member 32 is mounted for axial movement by pins 27 received in slots 29, and in the cocked position of Fig. 1 an extension 36 of the latch member 32 engages an extension 38 of the blade 12.

To operate the shutter mechanism to initiate an exposure, the latch member 32 is depressed and moves axially against the bias of the spring 34. As shown in Fig. 3, axial movement of the latch member 32 brings a downward extending finger 44, on the latch member 32, into contact with, and closes, a normally open switch S1, thereby energizing an electronic timing circuit, to be discussed later. Further axial movement of the latch member 32 releases the extension 36 from the blade 12 to permit the blade 12 to move laterally to the right under the influence of the spring 28. As further shown by the solid lines of Fig. 3, the blade 12 moves to an intermediate exposure aperture unblocking position, and is retained by engagement of a detent 46, integral with the blade 12, with a stop member 48 affixed to the support structure 24. By slidable engagement with the top portion of the blade 12, the stop member 48 also acts as a guide as the blade 12 moves laterally. In the intermediate position, the blade aperture 13 is aligned with the exposure aperture 18. During movement of the blade 12 to initiate an exposure interval, a switch S2 in the electronic timing circuit is opened by engagement with a cam surface 50 on the bottom of the blade 12.

To terminate the exposure at the end of the timed interval, there is provided a transducer, such as for example, an electromagnet 52 as shown in Fig. 1, positioned in a spaced relation to a metal keeper 54 fixedly attached to the bottom portion of the blade 12. The electromagnet 52 is energized by the electronic timing circuit, and as shown by the phantom lines of Fig. 3, the electromagnet 52 will attract the metal keeper 54 on the blade 12, and pivot the blade 12 about the pin 20, to free the detent 46 from the stop member 48. Under the influence of the spring 28, the blade 12 then moves further to the right to a second aperture blocking position as shown in Fig. 4, where the motion of blade 12 is arrested by a pin 56 affixed to the support structure 24. In this second aperture blocking position, the end portion 16 covers the exposure aperture 18.

To control the time interval of the exposure, the circuit shown in Fig. 2 may be employed with the shutter mechanism. The circuit is energized by closure of the switch S1, and includes a voltage source 57, a voltage sensitive trigger circuit 66, the

electromagnet 52, and a light integrating timing network including a photocell 60 in series with a capacitor 62. The photocell 60 may be a conventionally used selenium photocell, which has the property that its resistance varies inversely with the amount of light incident on the photocell. The switch S2, which shunts the capacitor 62, is normally closed so that the capacitor 62 is normally completely discharged. Thus, at initiation of the exposure, when the switch S2 is opened by movement of the blade 12, the voltage at a junction 64 between the photocell 60 and the capacitor 62 charges from its initial value, usually ground potential, to a predetermined value in a period of time depending on the well known time constant R-C of the integrating network. The R-C time constant of the integrating network is determined by the capacitance of the capacitor 62, and the resistance of the photocell 60 as established by the intensity of light incident on the photocell 60. A bright scene condition produces a low resistance value of the photocell 60, to provide a small R-C time constant for the circuit, and would result in a short exposure time. Conversely, a low level of scene brightness produces a high photoresistance value, and a correspondingly longer time constant for the circuit, to produce a longer exposure time.

The junction 64 is connected to the input terminal of the trigger circuit 66 which is arranged to conduct current through a winding 68, of electromagnet 52, when the bias potential at the input exceeds a predetermined value, and to be non-conducting when its input is below that value. Thus, when switch S2 is opened, the voltage level at junction 64 begins to increase to the predetermined value, at which value the trigger circuit 66 switches from its non-conductive state to its conductive state. As the trigger circuit 66 conducts, and current flows in the winding 68, the electromagnet 52 is energized and attracts the metal keeper 54, permitting the blade 12 to close. Of course, it is understood that various types of trigger circuits well known in the art may be employed in the practice of this invention. One well known example of such a circuit is a voltage sensitive trigger circuit such as described in British Patent No. 1,051,862. Thus, the exposure interval is initiated substantially simultaneously with the activation of the integrating circuit, and it is terminated by the trigger circuit 66 after a period of time determined by the integrating circuit, in accordance with the scene light incident on the photocell 60.

To enable the shutter mechanism to be cocked, a cocking mechanism 76 is provided, which may be any conventional cocking mechanism such as often used to

reset a shutter mechanism and advance film. As shown in Fig. 1, the cocking mechanism 76 includes a member 80, mounted for rotation about a pin 77, and having an engageable extension 82, accessible from the camera exterior. The member 80 is biased to the position of Fig. 1 by a spring 84 engaging pins 86 and 88, on the camera support structure 24 and the member 80 respectively. The cocking mechanism also includes a lever mechanism 74, pivotally mounted on a pin 75 and operatively coupled to the member 80 by means of an arm 90. The arm 90 is positioned to engage a pin 92 on the member 80 during the cocking of the cocking mechanism 76. The lever mechanism 74 includes a second arm 94, also pivotally mounted on the pin 75. The second arm 94 engages the arm 90 by means of detent 96, and is biased to the position of Fig. 1 by a spring 97, wherein it engages a capping blade 99, pivotally mounted on a pin 95. As the member 80 is rotated about the pin 77, the pin 92 engages the arm 90, moving it against the bias of the spring 97, to move the capping blade 99. As shown in Figs. 5 and 6, the capping blade 99 moves against the bias of a spring 98 to cover the exposure aperture 18 as the return motion of the blade 12 brings the blade aperture 13 over the exposure aperture 18. Movement of the arm 94 brings it into engagement with an extension 93 of the blade 12, and urges the blade 12 into engagement with the latch member 32 to latch the blade 12 in the cocked condition of Fig. 1.

While this invention has been described in connection with a single blade and an electromagnet which attracts the blade to impart pivotal movement to the blade, one skilled in the art will appreciate that the embodiment as shown in Fig. 1, wherein the electromagnet 52 attracts the metal keeper 54 imparting pivotal motion to the blade, may be replaced with an electromagnet or similar transducer device adapted to repel a permanent magnet positioned on the top of the blade 12, thereby again imparting a pivotal motion to the blade 12.

Referring now to Figs. 7-12, alternative embodiments of the invention will be described. Elements that were previously described with reference to the embodiment of Fig. 1, that are common to the alternative embodiments, and whose function does not change, will carry the same numeral as Fig. 1 but will be designated by a suffix (a) or (b).

One alternative embodiment of the invention is shown in Fig. 7, wherein a blade 112, having a blade aperture 113 and ends 115 and 116, is retained in a first blocking position in relation to an exposure aperture 118, by a latch member 132, against

the bias of a spring 128. In the first blocking position, the blade aperture 113 is positioned above and offset from the exposure aperture 118 so that the end 115 of the blade 112 covers the exposure aperture 118. An electromagnet 152, initially de-energized, is energized as the switch S1 is actuated, and attracts a metal keeper 154 on the blade 112. As shown in Fig. 8, the attraction of the metal keeper 154 to the electromagnet 152 pivots the blade 112 downward, permitting the blade 112 to be urged by the spring 128 to the intermediate position where it engages a pin 119, on a camera structure 124. At the position where the blade 112 engages the pin 119, the apertures 113 and 118 are aligned. During the timed exposure interval, the blade 112 is held in contact with the pin 119 by engagement of the electromagnet 152 and the metal keeper 154. As further shown in Fig. 8, the spring 128 is positioned to exert a bias on the blade 112 in a direction against the direction of the electromagnet's attraction for metal keeper 154, and against the engagement of the blade 112 with the pin 119. In this manner, when the electromagnet 152 is deenergized, at the end of the exposure interval, the bias of the spring 128 will urge the blade 112 up, and to the right, as shown by the phantom lines in Fig. 8, to terminate the exposure.

As with the blade 12, Fig. 1, the blade 112 of Fig. 7 may be cocked by means of a mechanism such as the cocking mechanism 76 of Fig. 1. The capping blade 99 of Fig. 1 is not required in the apparatus of Fig. 7 since the blade 112 is urged upward against the pin 48a and the blade aperture 118 will not come into realignment with the exposure aperture 113 during cocking.

In a further embodiment as shown in Fig. 10, a relatively long metal keeper 254 is positioned along the top edge of a blade 212 and adjacent to an electromagnet 252. The blade 212 has a blade aperture 213 between ends 215 and 216, positioned below and offset from an exposure aperture 218 on a support structure 224. The blade 212 is held in its cocked position, against the bias of a spring 228, by the engagement of a detent 227 on the bottom edge of the blade 212 with a pin 230, secured to the support structure 224. In the cocked position of Fig. 10, the end 215 covers the exposure aperture 218. In this embodiment, the exposure interval is initiated electrically as a member 232 is depressed to close the normally open switch S1. Closure of the switch S1 energizes the electromagnet 252, and the electromagnet 252 attracts the metal keeper 254, pivoting the blade 212 upward and out of engagement with the pin 230. Under the influence of the spring 228, the blade 212

moves to the aperture unblocking position shown in phantom lines in Fig. 11, where the blade aperture 213 and the exposure aperture 218 are aligned. As the blade 212 moves to the right, cam surface 250 engages and opens the switch S2 to initiate the timing cycle. As the blade 212 moves further to the right, to the position of Fig. 11, and the apertures 213 and 218 coincide, a detent 234 positioned on the top edge of the blade 212 engages a pin 236, secured on the support structure 224, to retain the blade 212 in the aperture exposing position during the period that the electromagnet 252 is energized. A leaf spring 238 is also provided positioned on the blade 212 so as to engage a pin 240, secured on the support structure 224, when the blade 212 is in the aperture unblocking position of Fig. 11. In the position of Fig. 11, the leaf spring 238 provides a downward force to the blade 212. In this manner, at the end of the exposure period when the electromagnet 252 is deenergized by the circuit of Fig. 2, the leaf spring 238 pivots the blade 212 to free the detent 234 from the pin 236, permitting the blade 212 to move further to the right under influence of the spring 228, to the position of Fig. 12. In the position of Fig. 12 the end 216 covers the exposure aperture 218 and the blade 212 is held against the pin 240, terminating the exposure. The embodiment of Figs. 10-12 is particularly suited for small cameras, or cameras that do not have sufficient space to mount the usual release members such as the latch member 32 of Figs. 1 and 7.

It is to be understood that the circuit of Fig. 2 may be rearranged to perform the function of energizing or deenergizing the electromagnets 152 and 252 at the initiation of the exposure interval, as well as the deenergization or energization respectively at its termination. For example, to energize the electromagnets 152 and 252 at the initiation of the exposure, the trigger circuit 66 is selected to be normally conducting as switch S1 is closed, and to be switched to the nonconducting state by the input at junction 64 at the end of the exposure interval.

WHAT WE CLAIM IS:—

1. An electronic shutter comprising a shutter blade, movable from a first exposure aperture blocking position to an aperture unblocking position and thence to a second aperture blocking position, means arranged to interrupt the movement from the first to the second aperture blocking position, of the blade, whilst the blade is in the aperture unblocking position, and electronically controlled means for moving the blade so as to disengage the blade from the interrupting means.
2. A shutter according to Claim 1 the



the bias of a spring 128. In the first blocking position, the blade aperture 113 is positioned above and offset from the exposure aperture 118 so that the end 115 of the blade 112 covers the exposure aperture 118. An electromagnet 152, initially de-energized, is energized as the switch S1 is actuated, and attracts a metal keeper 154 on the blade 112. As shown in Fig. 8, the attraction of the metal keeper 154 to the electromagnet 152 pivots the blade 112 downward, permitting the blade 112 to be urged by the spring 128 to the intermediate position where it engages a pin 119, on a camera structure 124. At the position where the blade 112 engages the pin 119, the apertures 113 and 118 are aligned. During the timed exposure interval, the blade 112 is held in contact with the pin 119 by engagement of the electromagnet 152 and the metal keeper 154. As further shown in Fig. 8, the spring 128 is positioned to exert a bias on the blade 112 in a direction against the direction of the electromagnet's attraction for metal keeper 154, and against the engagement of the blade 112 with the pin 119. In this manner, when the electromagnet 152 is deenergized, at the end of the exposure interval, the bias of the spring 128 will urge the blade 112 up, and to the right, as shown by the phantom lines in Fig. 8, to terminate the exposure.

As with the blade 12, Fig. 1, the blade 112 of Fig. 7 may be cocked by means of a mechanism such as the cocking mechanism 76 of Fig. 1. The capping blade 99 of Fig. 1 is not required in the apparatus of Fig. 7 since the blade 112 is urged upward against the pin 48a and the blade aperture 118 will not come into realignment with the exposure aperture 113 during cocking.

In a further embodiment as shown in Fig. 10, a relatively long metal keeper 254 is positioned along the top edge of a blade 212 and adjacent to an electromagnet 252. The blade 212 has a blade aperture 213 between ends 215 and 216, positioned below and offset from an exposure aperture 218 on a support structure 224. The blade 212 is held in its cocked position, against the bias of a spring 228, by the engagement of a detent 227 on the bottom edge of the blade 212 with a pin 230, secured to the support structure 224. In the cocked position of Fig. 10, the end 215 covers the exposure aperture 218. In this embodiment, the exposure interval is initiated electrically as a member 232 is depressed to close the normally open switch S1. Closure of the switch S1 energizes the electromagnet 252, and the electromagnet 252 attracts the metal keeper 254, pivoting the blade 212 upward and out of engagement with the pin 230. Under the influence of the spring 228, the blade 212

moves to the aperture unblocking position shown in phantom lines in Fig. 11, where the blade aperture 213 and the exposure aperture 218 are aligned. As the blade 212 moves to the right, cam surface 250 engages and opens the switch S2 to initiate the timing cycle. As the blade 212 moves further to the right, to the position of Fig. 11, and the apertures 213 and 218 coincide, a detent 234 positioned on the top edge of the blade 212 engages a pin 236, secured on the support structure 224, to retain the blade 212 in the aperture exposing position during the period that the electromagnet 252 is energized. A leaf spring 238 is also provided positioned on the blade 212 so as to engage a pin 240, secured on the support structure 224, when the blade 212 is in the aperture unblocking position of Fig. 11. In the position of Fig. 11, the leaf spring 238 provides a downward force to the blade 212. In this manner, at the end of the exposure period when the electromagnet 252 is deenergized by the circuit of Fig. 2, the leaf spring 238 pivots the blade 212 to free the detent 234 from the pin 236, permitting the blade 212 to move further to the right under influence of the spring 228, to the position of Fig. 12. In the position of Fig. 12 the end 216 covers the exposure aperture 218 and the blade 212 is held against the pin 240, terminating the exposure. The embodiment of Figs. 10-12 is particularly suited for small cameras, or cameras that do not have sufficient space to mount the usual release members such as the latch member 32 of Figs. 1 and 7.

It is to be understood that the circuit of Fig. 2 may be rearranged to perform the function of energizing or deenergizing the electromagnets 152 and 252 at the initiation of the exposure interval, as well as the deenergization or energization respectively at its termination. For example, to energize the electromagnets 152 and 252 at the initiation of the exposure, the trigger circuit 66 is selected to be normally conducting as switch S1 is closed, and to be switched to the nonconducting state by the input at junction 64 at the end of the exposure interval.

WHAT WE CLAIM IS:—

1. An electronic shutter comprising a shutter blade, movable from a first exposure aperture blocking position to an aperture unblocking position and thence to a second aperture blocking position, means arranged to interrupt the movement from the first to the second aperture blocking position, of the blade, whilst the blade is in the aperture unblocking position, and electronically controlled means for moving the blade so as to disengage the blade from the interrupting means.

2. A shutter according to Claim 1 the



shutter blade having a blade aperture therein, there being means for moving the shutter blade pivotally and slidably from the first aperture blocking position to the aperture unblocking position wherein the blade aperture is aligned with the exposure aperture.

3. A shutter according to Claim 1 or Claim 2 comprising an electromagnetic transducer the state of energization of which is changable by an electronic circuit at the end of the interval of exposure, the shutter blade being mounted such that when the transducer changes its state of energization, the shutter blade is caused to pivot free from the interrupting means to permit the moving means to move the shutter blade to the second aperture blocking position.

4. A shutter according to any preceding claim wherein the electronic circuit includes a photosensitive means disposed to receive scene light, the photosensitive means having a parameter variable with the intensity of scene light and arranged to provide an output signal from the electronic circuit after an interval of time dependent upon the intensity of the scene light.

5. A shutter according to any preceding claim including a capping blade movable from a first position to a second position as the shutter blade moves from the second aperture blocking position to the first aperture blocking position, the capping blade, in its second position, blocking the exposure aperture when the shutter blade aperture and the exposure aperture are aligned.

6. A shutter according to Claim 3 or any claim appendant thereto wherein the shutter blade is mounted so that upon energization the transducer is arranged to pivot the shutter blade to move the shutter blade to the aperture unblocking position.

7. An electronic shutter according to Claim 6 wherein the shutter blade includes detent means for engaging a stop member when the shutter blade is in the aperture unblocking position, and the moving means is disposed relative to the shutter blade for pivoting the shutter blade to free the detent from the stop member upon deenergization of the transducer.

8. A shutter according to Claim 6 or 7

wherein the shutter blade includes keeper means for engaging the transducer when the transducer is energized and the shutter blade is in the aperture unblocking position.

9. A shutter according to Claim 1 or 2 having means for retaining the shutter blade in the first aperture blocking position and an electromagnetic transducer actuable by the electronic circuit for releasing the shutter blade from the retaining means so that the blade moves toward the aperture unblocking position and for retaining the blade in engagement with interrupting means during an interval of exposure, the transducer being deactuable at the end of the interval for permitting the moving means to move the blade to the second aperture blocking position.

10. A shutter according to Claim 9 wherein the retaining means comprises a first detent on the shutter blade disposed to engage a first stop means when the shutter blade is in the first aperture blocking position.

11. A shutter according to Claim 10 wherein the interrupting means comprises a second detent and keeper means on the shutter blade, the keeper means being attracted toward the transducer when the transducer is actuated to pivot the shutter blade into engagement with a second stop member and to align the blade aperture with the exposure aperture.

12. A shutter according to Claim 9, 10 or 11 wherein the means for moving comprises first and second spring means, the first spring means comprising a leaf spring disposed to engage a stop member when the shutter blade is in the aperture unblocking position, the first spring means urging the shutter blade pivotally, and the second spring means urging the shutter blade laterally.

13. A shutter constructed substantially as hereinbefore described with reference to, and as shown in Figs. 1-6 or Figs. 7-9 or Figs. 10-12 of the accompanying drawings.

14. A photographic camera including an electronic shutter as claimed in any preceding claim.

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