

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 an exposure control apparatus for photographic cameras.

In accordance with the present invention there is provided an exposure control apparatus for a photographic camera, comprising a shutter movable to an open position from a closed position in which it prevents transmission of light through an exposure aperture, means for establishing a first electrical signal of a magnitude related to the intensity of scene illumination, a first switch rendered in a conductive state by the first electrical signal, a first transducer responsive to the first switch in the conductive state to move the shutter to the open position, means for initiating a second electrical coincident with the movement of the shutter to the open position and having a magnitude which increases with time, a second switch rendered in a conductive state upon attainment of a predetermined relationship between the first and second signals whereupon the first switch is rendered in the non-conductive state, and a second transducer responsive to the second switch in the conductive state to move the shutter to the closed position.

In the accompanying drawings:—

Figure 1 shows diagrammatically an automatic exposure control apparatus constructed in accordance with one form of the present invention;

Figure 2 is a curve showing the relationship between a reference voltage established by the apparatus shown in Figure 1 and scene illumination; and

Figure 3 is a curve showing the relationship between exposure time and an increasing voltage level established by an integrating circuit

forming part of the apparatus of Figure 1, for comparison with the reference voltage of Figure 2.

Because certain parts of cameras are well known, the following description is directed in particular to those elements forming, or co-operating directly with, the present invention, it being understood that elements not specifically shown or described may take various forms known in the art.

Referring now to the drawing and, first, particularly to Figure 1, there is shown one illustrative embodiment of the invention, wherein a differential transistor amplifier of conventional design, comprises a first transistor 11 having a base 11a, an emitter 11b and a collector 11c, and a second transistor 12 having a base 12a, an emitter 12b and a collector 12c, and a resistor 17 common to emitters 11b and 12b. A first transducer, such as an electromagnet 13, is coupled to the collector 11c of the transistor 11, and a second transducer, such as an electromagnet 14, is coupled to the collector 12c of transistor 12.

A shutter 18 is effective when in a closed position, the position shown in Figure 1, to prevent the transmission of scene light through aperture 20 to a lens 21 for exposing a film 22. In the illustrative embodiment, the shutter 18 is provided with extension arms 18a and 18b respectively, terminating adjacent to magnetic core members 23 and 24 of the electromagnets 13 and 14 and serving as armatures for the electromagnets 13 and 14. When the electromagnet 13 is energized, as will be described subsequently, the core 23 attracts the arm 18a and the shutter 18 is moved to an open position; when, on the other hand, the electromagnet 14 is energized, the core 24 attracts the arm 18b, and the shutter 18 is moved to a closed position.

A photosensitive element 27, such as a cadmium-sulphide photocell, is mounted in the camera in a position to be subjected to the same scene or ambient illumination as are lens 21 and film 22 when the shutter 18 is open. As is well known in the art, the effective-resistance of a photosensitive element varies

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inversely as its incident illumination varies. Accordingly, as the photosensitive element 27 is included in a voltage divider circuit composed of the photosensitive element 27 and a resistor 43, a voltage V_L at the common connection between the photosensitive element 27 and the resistor 43 will vary substantially as shown by the curve of Figure 2, with variations in the ambient or scene light to which the photosensitive element 27 is exposed. The photosensitive element 27 may be replaced by a photo diode or a photo transistor without affecting the operation of the circuit in performing the functions as herein described.

Switch means are provided for the circuit of Figure 1 in which a switch 28 is normally in the closed position shunting a capacitor 41 to ground, for ensuring the capacitor 41 is fully discharged while in the non-operative state. The switch 28 is mechanically coupled to a switch 42, so that as the switch 28 is moved from the normally-closed position to the open position, the switch 42 will be moved from the normally-open position to the closed position. The switch means may be operated by means not shown, such as a conventional camera release lever.

In operation, the release lever is actuated so that the switch 28 is moved to its open position for initiation of exposure and the switch 42 is moved to the closed position.

Movement of the switch 42 to the closed position connects a voltage designated as V_{cc} , from a battery 44, to the circuit, thereby energizing the circuit. The transistor 11 is accordingly biased to an ON condition by the reference voltage V_L . When the transistor 11 is ON, electromagnet 13 is energized. The core member 23 therefore, attracts arm 18a and shutter 18 is moved to the open position. At the time that the switch 42 is closed, the reference voltage V_L that is established by the voltage divider network between resistor 43 and photosensitive element 27 has a magnitude determined by the voltage of the battery 44 and the effective resistance of the photosensitive element 27; that is, the reference voltage is determined at a function of the intensity of the ambient or scene light prevailing at this time. Therefore, the base of the transistor 11 which is connected to a junction point 46 of the voltage divider, biases the transistor 11 to a conductive state. The base of transistor 12, on the other hand, is connected to a common point 48, between a resistor 47 and the capacitor 41, so that the base of transistor 12 is biased by the potential charge on capacitor 41.

When the switch 42 is closed, the battery 44 is coupled to the capacitor 41 through the resistor 47, and the potential charge on capacitor 41 builds up as shown in Figure 3, the slope of the curve being determined by the selected characteristics of the circuit elements, resistance 47 and capacitance 41 as dis-

cussed subsequently. When the biasing potential V_s (Figure 3) applied to the base of transistor 12 exceeds the reference voltage V_L of Figure 2 as established at the point 46, which is biasing transistor 11 to the conductive state, the transistor 12 is switched ON. At this same time, transistor 11 is switched OFF by the regenerative action of the differential amplifier, resulting from the effect of the common emitter resistor 17, and the electromagnet 13 is de-energized. When the transistor 12 becomes conducting, the electromagnet 14 is energized, and core member 24 attracts the arm 18b to move shutter 18 to the closed position, and terminate the exposure interval.

The circuit values are arranged so that the maximum voltage corresponding to minimum scene light is small compared to the voltage of the battery 44 at the closed contact of switch 42, and hence the useful portion of the voltage-time curve of Figure 3 is substantially linear. The value of resistance 47 is R ohms and of capacitor 41 is C farads, and, from the well known equation

$$V_s' = V_{cc} (1 - e^{-t/RC}), V_s$$

being the voltage at the base 12a of transistor 12a of transistor 12. V_s is equal to $0.63 V_{cc}$ for the linear portion of the curve, where the time constant of the resistance 47 and the capacitor 41 are such that $t = RC$, or alternatively,

$$V_s' = V_{cc} \left(1 - \frac{1}{e}\right).$$

Again, V_s is the voltage and t is the time required for the capacitor to charge to the potential at the connection point between capacitor 41 and resistor 47 to switch transistor 12 from the non-conductive to the conductive state.

It will be apparent from the above description that the arrangement provides means for timing the exposure interval as a function of the intensity of ambient illumination. The reference voltage is established solely on the basis of the intensity of the ambient light and the interval is then determined by charging a capacitor until the resulting potential just exceeds the reference voltage.

WHAT WE CLAIM IS:—

1. An exposure control apparatus for a photographic camera, comprising a shutter movable to an open position from a closed position in which it prevents transmission of light through an exposure aperture, means for establishing a first electrical signal of a magnitude related to the intensity of scene illumination, a first switch rendered in a conductive state by the first electrical signal, a first trans-

inversely as its incident illumination varies. Accordingly, as the photosensitive element 27 is included in a voltage divider circuit composed of the photosensitive element 27 and a resistor 43, a voltage V_L at the common connection between the photosensitive element 27 and the resistor 43 will vary substantially as shown by the curve of Figure 2, with variations in the ambient or scene light to which the photosensitive element 27 is exposed. The photosensitive element 27 may be replaced by a photo diode or a photo transistor without affecting the operation of the circuit in performing the functions as herein described.

Switch means are provided for the circuit of Figure 1 in which a switch 28 is normally in the closed position shunting a capacitor 41 to ground, for ensuring the capacitor 41 is fully discharged while in the non-operative state. The switch 28 is mechanically coupled to a switch 42, so that as the switch 28 is moved from the normally-closed position to the open position, the switch 42 will be moved from the normally-open position to the closed position. The switch means may be operated by means not shown, such as a conventional camera release lever.

In operation, the release lever is actuated so that the switch 28 is moved to its open position for initiation of exposure and the switch 42 is moved to the closed position.

Movement of the switch 42 to the closed position connects a voltage designated as V_{cc} , from a battery 44, to the circuit, thereby energizing the circuit. The transistor 11 is accordingly biased to an ON condition by the reference voltage V_L . When the transistor 11 is ON, electromagnet 13 is energized. The core member 23 therefore, attracts arm 18a and shutter 18 is moved to the open position. At the time that the switch 42 is closed, the reference voltage V_L that is established by the voltage divider network between resistor 43 and photosensitive element 27 has a magnitude determined by the voltage of the battery 44 and the effective resistance of the photosensitive element 27; that is, the reference voltage is determined at a function of the intensity of the ambient or scene light prevailing at this time. Therefore, the base of the transistor 11 which is connected to a junction point 46 of the voltage divider, biases the transistor 11 to a conductive state. The base of transistor 12, on the other hand, is connected to a common point 48, between a resistor 47 and the capacitor 41, so that the base of transistor 12 is biased by the potential charge on capacitor 41.

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cussed subsequently. When the biasing potential V_s (Figure 3) applied to the base of transistor 12 exceeds the reference voltage V_L of Figure 2 as established at the point 46, which is biasing transistor 11 to the conductive state, the transistor 12 is switched ON. At this same time, transistor 11 is switched OFF by the regenerative action of the differential amplifier, resulting from the effect of the common emitter resistor 17, and the electromagnet 13 is de-energized. When the transistor 12 becomes conducting, the electromagnet 14 is energized, and core member 24 attracts the arm 18b to move shutter 18 to the closed position, and terminate the exposure interval.

The circuit values are arranged so that the maximum voltage corresponding to minimum scene light is small compared to the voltage of the battery 44 at the closed contact of switch 42, and hence the useful portion of the voltage-time curve of Figure 3 is substantially linear. The value of resistance 47 is R ohms and of capacitor 41 is C farads, and, from the well known equation

$$V_s' = V_{cc} (1 - e^{-t/RC}), V_s$$

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Again, V_s is the voltage and t is the time required for the capacitor to charge to the potential at the connection point between capacitor 41 and resistor 47 to switch transistor 12 from the non-conductive to the conductive state.

It will be apparent from the above description that the arrangement provides means for timing the exposure interval as a function of the intensity of ambient illumination. The reference voltage is established solely on the basis of the intensity of the ambient light and the interval is then determined by charging a capacitor until the resulting potential just exceeds the reference voltage.

WHAT WE CLAIM IS:—

1. An exposure control apparatus for a photographic camera, comprising a shutter movable to an open position from a closed position in which it prevents transmission of light through an exposure aperture, means for establishing a first electrical signal of a magnitude related to the intensity of scene illumination, a first switch rendered in a conductive state by the first electrical signal, a first trans-



- ducer responsive to the first switch in the conductive state to move the shutter to the open position, means for initiating a second electrical signal coincident with the movement of the shutter to the open position and having a magnitude which increases with time, a second switch rendered in a conductive state upon attainment of a predetermined relationship between the first and second signals whereupon the first switch is rendered in the non-conductive state, and a second transducer responsive to the second switch in the conductive state to move the shutter to the closed position.
2. An exposure control apparatus according to Claim 1, wherein the predetermined relationship between the first and second signals is attained when the second signal exceeds the first signal.
3. An exposure control apparatus according to Claim 1 or 2, wherein the shutter comprises a shutter member having two control members, and the first transducer attracts one of the control members in one direction for opening the shutter and the second transducer attracts the other control member in a direction opposite to said one direction, for closing the shutter.
4. An exposure control apparatus according to Claim 1, 2 or 3, wherein the first and

second switches comprise first and second transistors forming a differential transistor amplifier having a common emitter impedance.

5. An exposure control apparatus according to Claim 4, wherein the means for establishing a first electrical signal of the magnitude related to the intensity of the scene illumination comprises photosensitive means which is subject to scene illumination and is coupled with the first transistor for applying thereto the first electrical signal so as to bias the first transistor to a conducting state, and the means for initiating the second electrical signal of increasing magnitude comprises a capacitor and an impedance forming a charging path for the capacitor.

6. An exposure control apparatus for a photographic camera, substantially as hereinbefore described with reference to, and as illustrated, in the accompanying drawings.

7. A photographic camera having an exposure control apparatus substantially as hereinbefore described, with reference to, and as illustrated in the accompanying drawings.

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