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(54) EXPOSURE CONTROL APPARATUS

(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 indicating if scene brightness is suitable to expose film, for a battery-powered camera.

In battery powered motion picture cameras which also employ circuitry for indicating if the scene brightness is suitable for film exposure, it is desirable to provide a camera user with convenient means to determine whether the battery potential is sufficient so that an operator will not waste film by operating the camera when the battery potential has decayed below that potential level necessary for proper operation.

There are prior arrangements employing circuitry for determining if scene brightness is suitable and for testing the battery potential level. These arrangements are often complex. Moreover, separate and distinct battery testing arrangements have been used which employ variable deflections of an instrument pointer, which requires operator judgement to determine whether the battery potential is suitable for proper use.

In accordance with the present invention, there is provided an exposure control apparatus, for a battery-powered camera, comprising an indicator, the energisation of which is controlled by an amplifier, for indicating, in a first mode of operation, that the scene brightness is less than a predetermined level and, in a second mode of operation, that the battery potential is above a selected level, a photosensor for producing a first signal responsive to the scene brightness, a further amplifier for amplifying the first signal, means for producing a second

signal responsive to the battery potential, and a switch for connecting either the amplified, first signal or the second signal to the amplifier in the first or second mode of operation respectively.

In the accompanying drawings:—

Fig. 1 is a schematic representation showing the general arrangement of an automatic exposure apparatus, as contemplated by a specific illustrative embodiment of the invention; and

Fig. 2 is a schematic diagram of the indication apparatus represented by a block referenced 15 in Fig. 1.

Exposure control apparatus embodying the invention may be employed in cameras of either the still or motion picture variety. Since such cameras are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with apparatus in accordance with the present invention. It will be understood that parts not specifically shown or described are selectable from those known in the art.

Referring to Fig. 1, there is shown an exposure control apparatus 10 which includes a self-balancing control circuit 9 having a differential amplifier configuration and indicating apparatus 15 shown fully in Fig 2 and described later in this specification. The circuit 9 is magnetically coupled to a core member 18 by means of a "close" winding 14 and an "open" winding 17. The magnetic core member 18 is moved in a downward direction when open winding 17 is energized, as subsequently described, and is moved in an upward direction when close winding 14 is energized. The core member 18 is mechanically coupled to a diaphragm 21 which, as shown, is in the form of an elongated plate, whereby the diaphragm 21 is moved by the magnetic core member 18 in a direction, and to an extent, directly related to the movement of the core 18.

The diaphragm 21 is provided with an aperture 22 through which scene light passes

to a camera objective lens 23 to a film 24, and an aperture 27 through which scene light passes by way of a lens 28 to a photosensitive device 41, such as a photoresistance element in which the resistance varies inversely with the intensity level of illumination instant thereon. The aperture 27 has a generally triangular configuration and will be assumed for the purpose of describing the operation of the system to have a lower tapered portion 27a and an upper tapered portion 27b. The aperture 22 associated with objective lens 23 has a triangular or tapered lower portion 22a and a rectangular upper portion 22b.

The exposure control apparatus 10 is adapted to move the diaphragm 21 back and forth in accordance with variations in scene brightness to maintain a selected level of illumination of the photosensitive device 41. Considering specifically the relative shapes of the apertures 22 and 27, the rectangular portion 22b of the aperture 22 has a width corresponding to the maximum light transmitting capability of lens 23. The diaphragm 21 is movable through a first range of positions wherein the lower portion 27a of aperture 27 and the lower triangular shaped portion 22a of aperture 22 will be positioned relative to the optical axes of lenses 28 and 23, respectively, to vary the effective sizes of the apertures relative to both lenses. The diaphragm 21 is movable through a second predetermined range of movement wherein the upper tapered portion 27b of the aperture 27 and the upper rectangular portion 22b of aperture 22 will be disposed in cooperative relation with the lenses 28 and 23 respectively.

In operation, as the intensity of the scene brightness diminishes the diaphragm 21 moves downward and the light transmitted to each of the lenses 23 and 28 will be gradually increased if the diaphragm is in its first range of movement. As the diaphragm 21 moves in its second range of movement, the light transmitted to lens 23 will remain constant and correspond to the maximum light transmitting capability of the lens 23. As will be later described in more detail, the relative shapes of the apertures 22 and 27, which permits the diaphragm 21 to adjust the effective size of aperture 27 while maintaining the effective size of aperture 22 constant in its second range of movement, enables the control circuit to produce a null balance condition during low scene brightness conditions which are still sufficient for suitable film exposure to avoid unnecessary operation of a low light indicator lamp 47 hereinafter described.

The control circuitry for the apparatus 10 may take various forms known in the art. The circuit disclosed in U.S. Patent No. 3,427,941 is especially suitable for use

with the invention as is the circuit described in our copending Application No. 22474/70 (Serial No. 1,312,381). To operate the circuit, a switch 42 is closed which connects a battery 43 into the control circuit 10. Two NPN transistors 11 and 12 are disposed in a differential amplifier configuration which have their emitter electrodes connected to ground through a common resistance 13. The "close" winding 14 is connected as a series element in the base-collector circuit of the transistor 11, and the "open" winding 17 is similarly connected as a series element in the base-collector circuit of the transistor 12. The windings 14 and 17 respectively are oppositely wound so that when energized, they will exert opposite forces on the magnetic core member 18 as indicated by the arrows in the drawing.

The differential amplifier is controlled by a resistance bridge having two arms defined by the photocell 41 and resistance element 51 respectively and the further two arms defined by resistance elements 52 and 53, respectively. The bridge is balanced when illumination incident on the photocell 41 is such that the ratio of the resistance value of the photosensitive device 41 to the resistance of element 51 is substantially equal to the ratio of the resistance values of the elements 52 and 53. In such condition, equal currents will pass through drive coils 14 and 17. Thus, there will be no net force tending to move the core member 18 which will be in an arrested condition. The system is calibrated such as by adjustment of the values of resistors 51 and 53 so that the bridge will be balanced when the amount of light transmitted to the lens 23 is of the desired magnitude for exposing the film 24. The selected resistance value of the photosensitive device 41 corresponds to a desired exposure setting.

If the ambient light drops below a previous level where the circuit 10 was balanced, the resistance of the photosensitive of the device 41 will increase thereby increasing the ratio of resistance values of elements 41 and 51 to a magnitude greater than that of elements 52 and 53 and cause the amplifier to supply additional energizing current to drive coil 17; this is effective, in turn, to cause movement of the diaphragm 21 in a "down" direction. The open winding 17 will be energized from a path leading from the battery 43, the winding 17, the collector-emitter path of transistor 11, and the resistor 13 to ground. This downward movement of diaphragm 21 is effective to "open" apertures 22 and 27, increasing the amount of light supplied to the photocell 41 and film 24 until a balanced condition is again reached.

Conversely, under conditions when the amount of light reaching photocell 41 and

film 24 is greater than the previously established ideal magnitude for good quality pictures, the ratio of the resistance values of the elements 41 and 51 will then be less than the ratio of the resistance values of the elements 52 and 53 and the amplifier will then function to supply additional energizing current to drive coil 14 moving the diaphragm 21 in an upward direction. Movement in this direction will be effective to "close" apertures 22 and 27.

Assuming the diaphragm is in its second range of positions and the camera lens aperture 22 has increased to a maximum size and balancing has not yet been reached, the aperture 27 will further increase in size until balancing is reached or until the upper portion 27b of the aperture 27 is at a size wherein the maximum light transmitting capability of the lens 28 is reached. In the latter case, the aperture 27 can be considered to have reached a maximum size. With the maximum light transmitting capability of the lens 28 being reached, and with scene brightness further diminishing, the potential difference between a terminal 49a (at the electrical junction between the coil 14 and the collector of the transistor 11) and a terminal 49b (at the electrical junction between the coil 17 and the collector of the transistor 12) will increase until a level is reached whereby the indicating apparatus 15 is activated to provide a conductive path from the battery 43 to energize the low light lamp 47.

Turning now to Fig. 2, the indicating apparatus 15 is shown coupled to the exposure control circuit terminals 49a and b and includes a manually operated switch 48, which in the first of two selectable positions, conditions the apparatus 15 to indicate whether the scene illumination is at a level which has been determined to be too low to permit suitable film exposure, and in the second position permits the apparatus 15 to determine whether the DC potential of the battery 43 is above a selected level.

The terminal 49a is connected to ground by way of a voltage dividing network comprised of resistors 55 and 56. In accordance with the invention there is provided a first amplifier stage which includes a transistor 50, having its base connected at the junctions of the resistors 55 and 56 and its emitter connected to the terminal 49b. The switch 48 is shown in its first position wherein it connects the collector of the transistor 50 through resistor 57 to the base electrode of a PNP transistor 60 which is disposed in a second amplifier stage. The transistor 60 has its collector electrode connected to ground through the low light indicator lamp and its emitter electrode connected to the battery 43.

During normal operation the voltage dif-

ference between the terminals 49a and b will be negligible and the transistor 50 will be in a cut-off condition. However, when the potential level at the terminal 49a becomes positive with respect to the terminal 49b and reaches a selected level determined by the voltage dividing resistive network 55 and 56, the transistor 50 will be driven from cut-off into an active mode of operation.

Returning momentarily to the time when the transistor 50 was nonconductive, there would be no substantial voltage difference between the collector base junction of the transistor 60, and the transistor 60 would also be in a cut-off mode of operation. However, when the transistor 50 conducts, the transistor 60 will be driven into the active region of operation and a substantial current will flow through the collector-emitter path of the transistor 60 which is sufficient to energize the lamp 47 signaling a warning of an unsuitable exposure condition.

To test the battery potential 43, the switch 48 is moved to its second position which open circuits the connection between the collector of the transistor 50 and the base of the transistor 60, and now disposes the base of the transistor 60 at the electrical junction of resistors 64 and 68 which comprise a voltage dividing network. The resistance elements 64 and 68 are serially connected to the battery 43 and are selected to have values such that the transistor 60 will conduct when the battery 43 has a selected potential level, which is considered necessary for suitable operation of the exposure control apparatus 10. With such a battery potential level, the transistor 60 will be turned on and driven into an active condition sufficient to energize the lamp 47.

Reviewing, the low light indicator lamp 47 is not energized immediately upon the maximum light transmitting capability of objective lens 23 being reached, but is energized only if the ambient light continues to decrease in intensity, and downward movement of diaphragm 21 continues until the scene brightness is at a level which has been determined to be unsuitable for film exposure.

WHAT WE CLAIM IS:—

1. An exposure control apparatus, for a battery-powered camera, comprising an indicator, the energisation of which is controlled by an amplifier, for indicating, in a first mode of operation, that the scene brightness is less than a predetermined level and, in a second mode of operation, that the battery potential is above a selected level, a photosensor for producing a first signal responsive to the scene brightness, a further amplifier for amplifying the first signal, means for producing a second signal responsive to the battery potential, and a switch

film 24 is greater than the previously established ideal magnitude for good quality pictures, the ratio of the resistance values of the elements 41 and 51 will then be less than the ratio of the resistance values of the elements 52 and 53 and the amplifier will then function to supply additional energizing current to drive coil 14 moving the diaphragm 21 in an upward direction. Movement in this direction will be effective to "close" apertures 22 and 27.

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for connecting either the amplified first signal or the second signal to the amplifier, in the first or second mode of operation respectively.

- 5 2. An apparatus as claimed in Claim 1, wherein the indicator is a lamp, and the amplifier includes a first transistor which is conducting to energise the lamp, and cut-off to de-energise the lamp.

- 10 3. An apparatus as claimed in Claim 1 or 2, wherein the further amplifier includes a second transistor, and the means for producing the second signal is a voltage dividing network.

4. An apparatus as claimed in Claim 1, 15
2 or 3, further comprising film aperture control means and photosensor aperture control means, the photosensor aperture control means being moved, in use, to control 20
the light incident upon the photosensor, to maintain the light at a predetermined level.

5. An exposure control apparatus, as claimed in Claim 1, substantially as hereinbefore described, with reference to and as 25
illustrated in the accompanying drawings.

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