

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 automatic exposure control means for cameras.

Many cartridge loading cameras having automatic exposure control systems are provided with a compensating light filter which, when placed in optical alignment with the camera objective lens, produces proper exposure of Type A colour film in sunlight. This filter is commonly referred to as a Type A lens filter and is adapted to permit the exposure parameters of Type A and daylight film to be identical when both are exposed in sunlight. When using Type A colour film and artificial lighting is employed, the filter should, of course, be removed from alignment with the camera objective lens. It has heretofore been common practice to remove the filter by inserting an artificial light attachment (or key, when a remote light source is used) in a camera receptacle having means therein for displacing such filter. When employing a camera indoors under artificial lighting, insertion of an artificial light key may be overlooked resulting in improperly exposed film.

Moreover, it has previously been proposed to control the movement of a colour correcting filter to a position in which it modifies the light passing through a camera objective lens or to a position in which said light is unfiltered, by means of two or more photoelectric elements of different spectral characteristics. In another prior proposal, the electrical output of photoelectric means sensitive to the long wavelength region of the visible spectrum is caused to adjust a pair of iris diaphragms, one of which is associated with the camera objective and

the other of which is associated with a second photoelectric means sensitive to the short wavelength of the visible spectrum, the electrical output of the second photoelectric means causing actuation of a graded filter which modifies the light passing through the objective lens.

In accordance with the present invention there is provided a camera having automatic exposure control means comprising a photosensitive device which is primarily responsive to light in the visual portion of the light spectrum and has an electric parameter which varies as a function of incident illumination, a diaphragm which is actuated in response to variations in said parameter and has a first aperture cooperating with an objective lens, a second aperture cooperating with the photosensitive device and a third aperture cooperating with a photocell element which is more sensitive to infrared light than to visible light, the diaphragm when actuated adjusting the values of the first, second and third apertures and functioning so as to maintain the quantity of light entering the objective lens constant, and a compensating light filter which, in response to illumination of the photocell element with daylight, is moved to a position in which it filters light passing through the objective lens, and, in response to the illumination of the photocell element with artificial light which is predominantly infrared, is moved to a position in which the light passing through the objective lens is unfiltered.

In the detailed description of the preferred embodiment of the invention presented below, reference is made to the accompanying drawing which is a schematic diagram of an exemplary exposure control circuit in accordance with the present invention.

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 co-

operating 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.

Turning now to the drawings, there is shown an exposure control apparatus 10 which includes a self-balancing control circuit 9 having a differential amplifier configuration. The circuit 9 is magnetically coupled to a magnetic 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 magnetic core member 18 is mechanically coupled to a diaphragm 21 which, as shown, is in the form of an elongated plate, and is moved by the magnetic core member 18 in a direction, and to an extent, directly related to the movement of the magnetic core member 18.

The diaphragm 21 is provided with an aperture 22 through which scene light passes to an objective lens 23 to a film 24, an aperture 27 through which scene light passes by way of a lens 28 to a photosensitive device 41 and an aperture 44 through which scene light passes to a lens 47. The lens 47 projects light to a photocell 62 described more fully hereinafter. The photosensitive device 41, such as a photocell, is selected from a class in which a parameter, such as resistance, varies inversely with the intensity level of illumination incident thereon. The photosensitive device 41 advantageously may be a cadmium sulphide cell which is characterized by the property that it is most responsive to light in the visible portion of the spectrum, whereas the photocell 62 also has a variable voltage parameter and advantageously is a silicon cell (a photovoltaic device) which is most responsive to infrared light which characterizes artificial lighting conditions used in taking motion pictures indoors.

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 on the photosensitive device 41. 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, 28 and 47 is gradually increased. The increased light projected to the photosensitive device 41 enables the control circuit 9 to produce a null balance condition.

The self-balancing control circuit 9 includes a battery 43 and is energized when a switch 42 is closed. Two NPN transistors 11 and 12 are disposed in a differential am-

plifier configuration with 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 photosensitive device 41 and resistance element 51 respectively and the two arms defined by resistance elements 52 and 53, respectively. The bridge is balanced when illumination incident on the photosensitive device 41 is such that the ratio or the resistance value of photosensitive device 41 to the resistance of resistance element 51 is substantially equal to the ratio of the resistance values of the resistance elements 52 and 53. In such condition, equal currents will pass through the windings 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 resistance elements 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. Thus, the predetermined 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 device 41 will increase thereby increasing the ratio of resistance values of photosensitive device 41 and resistance element 51 to a magnitude greater than that of resistance elements 52 and 53 and cause the amplifier to supply additional energizing current to open winding 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 common resistance 13 to ground. This downward movement of diaphragm 21 is effective to open apertures 22, 27, and 44 increasing the amount of light respectively supplied by these apertures. The light supplied to the photosensitive device 41 will increase until a balanced condition for the circuit 9 is again reached.

Conversely, under conditions when the amount of light reaching photosensitive device 41 and film 24 is greater than the previously established ideal magnitude for good quality pictures, the ratio of the resistance

values of the photosensitive device 41 and resistance element 51 will then be less than the ratio of the resistance values of the resistance elements 52 and 53 and the amplifier will then function to supply additional energizing current to close winding 14 moving the diaphragm 21 in an upward direction. Movement in this direction will be effective to close apertures 22, 27 and 44, so that the light supplied to the photosensitive device 41 will decrease until a balanced condition is reached.

A compensating light filter 54 is movable between a first position in which, as illustrated, it is disposed in the light path of the objective lens 23 and a second position in which it is withdrawn from optical alignment with the objective lens 23. The compensating light filter which may be a so-called Type A filter, a type commonly used when home movies are being taken, should be used only under lighting conditions which approximate daylight illumination and not when bright intensity artificially produced light is being used such as produced by a tungsten filament element. This light is predominantly infrared as compared to the predominantly untraviolet daylight illumination.

The circuit for controlling the position of compensating light filter 54 in relation to objective lens 23 includes a Schmitt trigger type circuit comprising a battery 43a, NPN transistors 55 and 57 having their emitter electrodes connected through a common resistor 58 to ground and a coil 78 disposed in the electrical path between the battery 43a and the collector electrode of the transistor 55. The silicon photocell 62 is connected in one arm of the circuit in series with the battery 43a, a fixed resistive element 71 and a variable resistive element 72. The base electrode of the transistor 55 is electrically connected to the junction of the silicon photocell 62 and fixed resistive element 71. Another fixed resistance element 73 is disposed in another branch of the circuit in the electrical path between the battery 43a and the collector electrode of the transistor 57. Finally, a biasing resistor 74 connects the base electrode of transistor 57 to the collector electrode of the transistor 55.

As indicated by the dotted line, the compensating light filter 54 is mechanically coupled to, and its movement directly related to movement of the magnetic core member 77 which, in turn, is moved in a downward direction by means of coil 78 when the coil is energized. Such downward movement is effective to withdraw the filter 54 from the light path of objective lens 23; a biasing spring 79 provides the means for maintaining the filter 54 in the illustrated position aligned with the objective lens 23 under normal lighting condition.

Under conditions of ambient illumination, the effective voltage produced by the silicon photocell 62 does not change materially and the circuit remains in its quiescent condition with transistor 55 OFF and transistor 57 ON. In order to ensure that the coil 78 will not be energized by ambient scene light, the aperture 44 controls the effective ambient light which passes to the silicon photocell 62. Thus, with increasing scene brightness, the effective size of the aperture 44 will decrease, and conversely, with decreasing scene brightness, it will increase. Under either of these conditions, the arrangement is such that the silicon photocell output will be maintained at a relatively constant value (viz. its variable voltage parameter will be returned to a predetermined value selected so that the transistor 55 will be OFF while the transistor 57 is ON). Variable resistive element 72 provides a means for calibrating the condition when the transistor 55 will be turned on as now will be described. Notwithstanding the effective size of the aperture 44, if it is assumed that a light intensity tungsten lamp is used, the silicon photocell 62 will be subjected to illumination having a high degree of infrared components. The silicon photocell 62 responds to a high degree to the infrared illumination and its effective voltage in the circuit is substantially increased. Under this condition, the transistor 55 is switch ON and a path is closed for energizing coil 78 from the battery 43a, the collector emitter path of transistor 55, and the resistor 58 to ground. Energized coil 78 is effective to exert a force upon the magnetic core member 77 to move it in a downward direction and the compensating light filter 54 is withdrawn from its position in line with objective lens 42 for the duration of the artificial illumination.

When the artificial illumination is extinguished and the voltage developed by the silicon photocell 62 drops, the circuit is restored to its normal condition with the transistor 55 OFF and the coil 78 de-energized. The compensating filter 54 is also restored to its normal position for ambient illumination by the spring 79 referred to above.

Therefore, the present invention provides simple means whereby a compensating light filter is automatically withdrawn from a position of optical alignment with the objective lens when artificial light is being used. Thus, there is no chance of the filter manipulation being overlooked.

WHAT WE CLAIM IS:—

1. A camera having automatic exposure control means comprising a photosensitive device which is primarily responsive to light

values of the photosensitive device 41 and resistance element 51 will then be less than the ratio of the resistance values of the resistance elements 52 and 53 and the amplifier will then function to supply additional energizing current to close winding 14 moving the diaphragm 21 in an upward direction. Movement in this direction will be effective to close apertures 22, 27 and 44, so that the light supplied to the photosensitive device 41 will decrease until a balanced condition is reached.

A compensating light filter 54 is movable between a first position in which, as illustrated, it is disposed in the light path of the objective lens 23 and a second position in which it is withdrawn from optical alignment with the objective lens 23. The compensating light filter which may be a so-called Type A filter, a type commonly used when home movies are being taken, should be used only under lighting conditions which approximate daylight illumination and not when bright intensity artificially produced light is being used such as produced by a tungsten filament element. This light is predominantly infrared as compared to the predominantly ultraviolet daylight illumination.

The circuit for controlling the position of compensating light filter 54 in relation to objective lens 23 includes a Schmitt trigger type circuit comprising a battery 43a, NPN transistors 55 and 57 having their emitter electrodes connected through a common resistor 58 to ground and a coil 78 disposed in the electrical path between the battery 43a and the collector electrode of the transistor 55. The silicon photocell 62 is connected in one arm of the circuit in series with the battery 43a, a fixed resistive element 71 and a variable resistive element 72. The base electrode of the transistor 55 is electrically connected to the junction of the silicon photocell 62 and fixed resistive element 71. Another fixed resistance element 73 is disposed in another branch of the circuit in the electrical path between the battery 43a and the collector electrode of the transistor 57. Finally, a biasing resistor 74 connects the base electrode of transistor 57 to the collector electrode of the transistor 55.

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Under conditions of ambient illumination, the effective voltage produced by the silicon photocell 62 does not change materially and the circuit remains in its quiescent condition with transistor 55 OFF and transistor 57 ON. In order to ensure that the coil 78 will not be energized by ambient scene light, the aperture 44 controls the effective ambient light which passes to the silicon photocell 62. Thus, with increasing scene brightness, the effective size of the aperture 44 will decrease, and conversely, with decreasing scene brightness, it will increase. Under either of these conditions, the arrangement is such that the silicon photocell output will be maintained at a relatively constant value (viz. its variable voltage parameter will be returned to a predetermined value selected so that the transistor 55 will be OFF while the transistor 57 is ON). Variable resistive element 72 provides a means for calibrating the condition when the transistor 55 will be turned on as now will be described. Notwithstanding the effective size of the aperture 44, if it is assumed that a light intensity tungsten lamp is used, the silicon photocell 62 will be subjected to illumination having a high degree of infrared components. The silicon photocell 62 responds to a high degree to the infrared illumination and its effective voltage in the circuit is substantially increased. Under this condition, the transistor 55 is switch ON and a path is closed for energizing coil 78 from the battery 43a, the collector emitter path of transistor 55, and the resistor 58 to ground. Energized coil 78 is effective to exert a force upon the magnetic core member 77 to move it in a downward direction and the compensating light filter 54 is withdrawn from its position in line with objective lens 42 for the duration of the artificial illumination.

When the artificial illumination is extinguished and the voltage developed by the silicon photocell 62 drops, the circuit is restored to its normal condition with the transistor 55 OFF and the coil 78 de-energized. The compensating filter 54 is also restored to its normal position for ambient illumination by the spring 79 referred to above.

Therefore, the present invention provides simple means whereby a compensating light filter is automatically withdrawn from a position of optical alignment with the objective lens when artificial light is being used. Thus, there is no chance of the filter manipulation being overlooked.

WHAT WE CLAIM IS:—

1. A camera having automatic exposure control means comprising a photosensitive device which is primarily responsive to light



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5 in the visual portion of the light spectrum
and has an electric parameter which
varies as a function of incident illumination,
a diaphragm which is actuated in response
to variations in said parameter and has a
first aperture cooperating with an objective
lens, a second aperture cooperating with the
photosensitive device and a third aperture
cooperating with a photocell element which
is more sensitive to infrared light than to
visible light, the diaphragm when actuated
adjusting the values of the first, second and
third apertures and functioning so as to
maintain the quantity of light entering the
objective lens constant, and a compensating
light filter which, in response to illumination
of the photocell element with daylight, is
moved to a position in which it filters light
passing through the objective lens and, in
response to the illumination of the photo-
cell element with artificial light which is pre-
dominantly infrared, is moved to a position

in which the light passing through the ob-
jective lens is unfiltered.

2. A camera according to Claim 1, 25
wherein the compensating light filter is con-
nected to a magnetic member magnetically
coupled to a winding which, when ener-
gized, exerts an unbalancing force on the
magnetic member to move the filter, the 30
winding being electrically coupled to a
Schmitt trigger circuit and and the photo-
cell element so as to be energized when the
photocell element is illuminated with artifi-
cial light which is predominantly infrared 35
to move the compensating light filter out
of alignment with the objective lens.

3. A camera according to Claim 1, con-
structed substantially as hereinbefore de-
scribed with reference to, and as shown in, 40
the accompanying drawing.

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Agent for the Applicants.