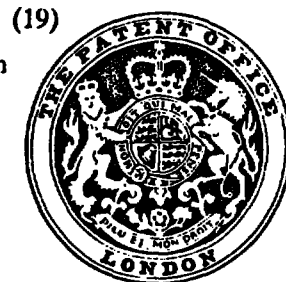


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(54) PHOTOGRAPHIC CAMERA HAVING LIGHT DISCRIMINATION APPARATUS

(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 apparatus for discriminating between light emitted from sources having respectively different ratios of brightest to dimmest intensities during a given time period. Such apparatus is particularly useful in cameras wherein one or more corrective filters, which compensate for differences in colour temperature of light sources, may be moved into and out of the optical path to provide correct colour balance and exposure. Alternatively, the film may be exposed and encoded so that compensation may be effected during printing.

It is well known that colour film which is sensitized to be balanced for indoor tungsten illumination must be used with a colour compensating filter if it is to be used outdoors in natural daylight. Of course, film sensitized for natural light would need a filter when used with artificial light. In prior art cameras having automatic colour filter control, electrical means have been provided for measuring the spectral characteristics of scene illumination and for automatically moving filters into and out of the optical path to correct the spectral transfer characteristics of the camera lens system, depending upon the scene illumination characteristics and the spectral characteristics of the film.

In determining whether the scene is illuminated by natural or artificial light, some prior art devices measure the amount of infrared components in the scene light, as for example in U.S. Patent No. 3,651,749. Other known cameras, operating on the same "spectral characteristic" principle, have means for comparing the relative amounts of red and blue light from the scene. By assuming that when the scene light is predominately red, the photograph is being taken indoors and that when the scene light is mostly blue, the scene is outdoors, the camera can automatically adjust its filtering system in accordance with the perceived illumination source. U.S. Patent No. 3,475,616 discloses such a system.

While such devices normally work well for their intended purposes, they can be "fooled" as, for instance, when there is an unusual amount or lack of infrared light in a naturally or artificially lighted scene, or when a scene is dominated by single colours which might be used by the camera mechanism to indicate the light source.

Further, the prior art devices do not readily enable discrimination between different sources of artificial light, such as for example between fluorescent and tungsten lamp sources.

Different light sources have characteristic temporal "signatures" or flicker ratios (the ratio of the brightest light to the dimmest light) emitted by the source. Further, this flicker ratio for a given type of light source is substantially constant over a wide range of powers.

According to the present invention, there is provided a photographic camera comprising sensing means for sensing scene illumination and producing an output signal which is a function of the flicker ratio of this illumination, and means for exposing the photosensitive material in the camera in accordance with this output signal either by modifying the image-wise exposure of the photosensitive material or by encoding the photosensitive material with information indicative of the flicker ratio.

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

Figure 1 is a schematic diagram of an exposure control circuit and related components embodying the present invention; and

Figure 2 is a plot of filter movement and/or control current versus the voltage across the bridge circuit of Figure 1.

5 The present description will be directed in part to elements forming part of, or co-operating more directly with, apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art. For instance, exposure control apparatus embodying the invention may be employed in cameras of either the still or motion picture variety.

10 Referring to Figure 1, there is shown an exposure control apparatus which includes a photocell 12 (photovoltaic in the illustrative embodiment) which responds logarithmically to light intensities, producing a voltage whose AC component varies with the power frequency of the incident light. The power frequency is twice the line frequency to an artificial light source. The voltage produced by the photocell 12 would have a DC component proportional to the average light intensity.

15 If the intensity of the brightest light in the power frequency cycle is represented by I_b and that of the dimmest light by I_d , the AC voltage V produced by photocell 12 and seen by an AC coupling capacitor 14 would be proportional to $\log I_b$ minus $\log I_d$, or $\log (I_b/I_d)$.

20 Capacitor 14 blocks the DC component of the AC voltage V , passing only the AC component to a high input impedance AC amplifier 16. Amplifier 16 includes an operational amplifier 18 with a resistive feedback loop 20. The voltage gain K of the amplifier 16 is given by:

$$K = R_1/Z \quad (1)$$

25 where R_1 is the value of the resistor 20 and Z is the impedance of capacitor 14 and a resistor 22.

30 A capacitor 24 blocks the DC component of the amplifier output which is fed to a bridge circuit 26 having diodes 28-31 for rectifying the current to an electromechanical control means 32. The capacitor 24 could, of course, be eliminated if the amplifier 16 was adjusted so that its DC output component was reduced to zero. The control means 32 functions to convert the rectified current to a rotational drive (shown symbolically by broken line 34) which is applied to a cam 36. Rotation of the cam 36 deflects an arm 38 against a restoring force such as a spring, not shown. Arm 38 is pivoted at one end 40 and carries a graded filter 42 at the other end, part of which covers a lens aperture 44. The filter has three distinct areas 42a, 42b and 42c which colour compensate the light for the spectral characteristics of the film. 35 For instance area 42a might compensate for natural light, area 42b for incandescent light and area 42c for fluorescent light. Of course, one of the filter areas may have no filter element if the film is colour corrected for the associated light source.

40 Assuming that the light source was operating at 60 cycles per second, there would be a residual 240 cycle per second ripple current (or four times the line frequency) at control means 32. A capacitor 46 across control means 32 shorts out this AC component. A zener diode 48 is arranged across control means 32 to break down at a predetermined voltage. However, a resistance load 50 in series with zener diode 48 ensures that some portion of the current will pass through control means 32 after the diode has broken down.

45 Assuming that an artificial light source is operating on a power line of, say, 60 cycles per second, the power frequency will be twice the line frequency, or 120 cycles per second. Tungsten and fluorescent lamps reproduce the power frequency with different fidelity. That is, the instantaneous illumination from a fluorescent lamp will much more closely follow the power curve than will the illumination from a tungsten lamp, the latter tending to have less difference between the brightest and dimmest illumination during a cycle. Of course the intensity of light from natural sources does not vary significantly with frequencies in the order of 60 Hertz, and will exhibit substantially constant illumination.

50 As stated hereinbefore, the flicker ratio of a light source is the ratio of intensities of the brightest light to the dimmest light during a given time period. Therefore, the flicker ratio of a fluorescent lamp will be much greater than that of an incandescent lamp. Natural light will have a flicker ratio of approximately one, as will direct current powered light.

55 When light from one of these sources impinges upon photocell 12, the photocell will respond logarithmically, producing an AC output voltage proportional to the log of the flicker ratio. It has been observed that this quantity is as much as ten times greater for fluorescent as for incandescent sources regardless of the wattage of the lamps.

60 The output of capacitor 14, which is determined by the fractional variation in light intensity rather than the magnitudes of illumination, is amplified by the amplifier 16 and rectified by the bridge circuit 26. The bridge current drives control means 32 so that for low currents (representative of natural scene light) filter area 42a covers the lens aperture 44. For medium currents (representative of incandescent sources) area 42b covers the lens aperture 44 and 65 for high currents (representative of fluorescent light) filter area 42c covers the lens aperture

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On a scale of ten, it has been found that the following approximate ranges of voltage will be found across bridge 26 for natural, incandescent and fluorescent light:

5	Source	Approximate Voltage Range	5
	Natural	0 to 0.1	
	Incandescent	0.5 to 1.0	Table 1
10	Fluorescent	9 to 10	10

15 If control means 32 is a linear device, the graded filter 42 will move linearly with the current through the control means. In order to make it possible to space filter areas 42a, 42b and 42c uniformly along the arc of filter 42, the zener diode 48 and resistor 50 are provided. In the described illustrative embodiment, the zener diode 48 is chosen so that it will break down at the lowest voltage indicative of the incandescent light (0.5 on the scale of 10 in Table I). The resistor 50 is chosen to have a value which is 1/20th of the internal resistance of the control means 32 so that upon breakdown of the diode 48, 95% of the current is shunted through the resistor 50 and 5% of the current is supplied to the control means 32.

20 A plot of the current through control means 32 versus the voltage across the bridge circuit 26 is shown in Figure 2. When the scene is illuminated with natural light, the voltage is less than 0.1 on the scale depicted in Table I, and filter 42 rests against a stop 52 (Figure 1). For incandescent illumination, the voltage is between 0.5 and 1 on the scale, and filter area 42b is moved into the optical path of the lens aperture 44. As the voltage reaches 9 on the scale, filter 42 comes to rest against a stop 54 so that filter area 42a will be in the optical path of the lens aperture 44. Filter 42 will track the current through control means 32 except when the filter rests on either of stops 52 and 54.

25 It will be appreciated that the scene may be illuminated by mixtures of light, i.e., light from a plurality of different source types. The voltage across the bridge circuit 26 would be somewhere between (1) 0.1 and 0.5 on the scale if the light were a mixture of natural and incandescent light and (2) 1.0 and 9.0 if the light were a mixture of incandescent and fluorescent light. If such conditions were anticipated, appropriate filters could be placed between areas 42a and 42b and between areas 42b and 42c on the graded filter 42 to compensate for the light mixtures.

30 It has also been found desirable to place a minus infrared filter, such as heat absorbing glass, over photocell 12. This ensures that the photocell sees and responds to only visible light.

35 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. For example, the circuit shown in Figure 1 is purely exemplary, and equivalent circuits will be apparent to those skilled in the art.

40 In a further alternative the basic circuit of Figure 1, or an equivalent circuit, is used to produce a signal, such as that applied to control means 32, which is a function of the flicker ratio, and this signal is applied to a control means for encoding the film with information indicative of the flicker ratio. Thus this control means may actuate means for flashing the frame edge of the film in the camera with a code corresponding to the illumination used during the picture-taking exposure. This code could be used to adjust a film printer to provide the required colour correction. Thus the colour filtration may be modified in accordance with the code adjacent a frame of a negative film when making a print from this frame.

45 WHAT WE CLAIM IS:-

50 1. A photographic camera comprising sensing means for sensing scene illumination and producing an output signal which is a function of the flicker ratio of this illumination, and means for exposing the photosensitive material in the camera in accordance with this output signal either by modifying the imagewise exposure of the photosensitive material or by encoding the photosensitive material with information indicative of the flicker ratio.

55 2. A photographic camera according to Claim 1 including electro mechanical means, responsive to the said output signal, for selectively moving a filter across the camera aperture to modify the colour temperature balance of the scene illumination passing therethrough.

60 3. A photographic camera according to Claim 1 or 2 wherein the sensing means includes a photovoltaic cell which produces a voltage having AC and DC components, the AC component of which is proportional to the logarithm of the flicker ratio of the scene illumination.

65 4. A photographic camera according to Claim 3 wherein the sensing means includes a capacitor which blocks the DC component of the voltage produced by the photovoltaic cell.

5. A photographic camera according to Claim 1, 2 or 3 wherein the sensing means

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50 **WHAT WE CLAIM IS:-**

1. A photographic camera comprising sensing means for sensing scene illumination and producing an output signal which is a function of the flicker ratio of this illumination, and means for exposing the photosensitive material in the camera in accordance with this output signal either by modifying the imagewise exposure of the photosensitive material or by enclosing the photosensitive material with information indicative of the flicker ratio.
2. A photographic camera according to Claim 1 including electro mechanical means, responsive to the said output signal, for selectively moving a filter across the camera aperture to modify the colour temperature balance of the scene illumination passing therethrough.
3. A photographic camera according to Claim 1 or 2 wherein the sensing means includes a photovoltaic cell which produces a voltage having AC and DC components, the AC component of which is proportional to the logarithm of the flicker ratio of the scene illumination.
4. A photographic camera according to Claim 3 wherein the sensing means includes a capacitor which blocks the DC component of the voltage produced by the photovoltaic cell.
5. A photographic camera according to Claim 1, 2 or 3 wherein the sensing means



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includes a high input impedance AC amplifier and a diode bridge circuit for rectifying the output of the amplifier.

5 6. A photographic camera according to Claim 5 wherein the sensing means includes a zener diode connected in series with a resistor across the output terminals of the diode bridge circuit.

7. A photographic camera substantially as hereinbefore described with reference to the accompanying drawing.

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