

# PATENT SPECIFICATION

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## (54) RANGE FINDER INCLUDING PHOTOELECTRIC DEVICES

(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 range finder apparatus having photoelectric devices that receive light reflected from an object and produce signals indicative of the distance of an object relative to a reference position.

Range finder apparatus for photographic applications are known which employ a pair of spaced photosensitive devices having electrical parameters which respectively vary as a function of the brightness of incident light reflected from an object whose distance relative to a film plane is to be determined. Typically, the photosensitive devices are differentially connected in an electrical circuit that produces a signal which varies as a function of variations in the parameter of the devices. In Patent Specification No. 1,203,091 a zone sensing range finder apparatus is disclosed which employs two photosensitive devices.

While the type of range finder apparatus just referred to performs satisfactorily under most conditions, there is a problem when the object whose range is to be determined is relatively narrow and there is a secondary object in the scene which may actually reflect light that also illuminates the photosensitive devices. In such a situation, the photosensitive devices may produce an output signal which causes an incorrect indication of the zone occupied by the primary object.

In accordance with the present invention

[Price 33p]

there is provided a range finder for determining whether an object is disposed within a first range of distances relative to a reference plane or a second range of distances relative to the reference plane and including means for projecting a beam of light towards an object, and first and second photoelectric devices, with each device having a parameter the magnitude of which varies as a function of the brightness of incident illumination reflected from the object: comprising means coupled to said first and second photoelectric devices for producing a signal the magnitude and polarity of which varies in accordance with changes in the magnitude of the parameters of the first and second photosensitive devices, this signal having a first polarity when the object is disposed in the said first range of distances and a second polarity when the object is disposed in the said second range of distances; and means responsive to the said signal when of the said first polarity only when it has a value greater than a predetermined amount above a reference level for indicating that the object is in the said first range of distances, and responsive to the said signal when of the said second polarity only when it has a value more than a predetermined amount below the reference level for indicating that the object is in the said second range of distances.

Also in accordance with the invention there is provided a range finder as specified in the preceding paragraph incorporated in a photographic camera and including means for moving an objective lens of the camera automatically in response to the range determined to a position in which an image of the object in either the first or second range of distances is focused on the film plane of the camera.

The present invention will now be described by way of example with reference

to the attached drawings wherein:

Fig. 1 is a schematic diagram partly in block form of an automatic type range finder according to the invention; and

5 Figs. 2 and 3 show apparatus for indicating in response to the signal produced by the differential amplifier shown in the Fig. 1 apparatus, which range of distances the object is disposed in.

10 A preferred embodiment of the invention is disclosed in connection with an automatic focusing apparatus for a still camera. However, it will be understood that range finder apparatus in accordance with the invention may be used in other types of cameras and in other applications.

15 In Fig. 1 there is shown a camera including an objective lens 14, which is movable in response to operation of a focusing means 10 to a position wherein it is adapted to focus an image of an object 0 to be photographed in a primary image plane P. The focusing means 10 includes a switch 15 adapted to be closed by the user of the camera to couple a battery 18 and energize a source of light 41. Light from the source is projected by a lens 42 toward the scene to be photographed and is modulated at predetermined frequency by appropriate means such as a chopper 44, which may take various forms well known to those skilled in the art, and may for example be an electronic means.

20 The beam of light projected by the lens 42 along a line-of-sight path 43 illuminates a field which includes both a first range of distances (Zone No. 1) relative to the film plane P within the camera and a second different range of distances relative to the film plane P (Zone No. 2). Zone No. 2 is the range of distances between the boundary of Zone No. 1 and infinity. When the object scene is disposed in the centre of the camera viewfinder, light projected by the lens 42 is reflected from the object and an image of the object is formed by a lens 24, disposed in a predetermined spaced relation with respect to the light source 41, on two photosensitive devices 51 and 52.

25 In the specific illustrated embodiment, the photosensitive devices 51 and 52 are photodiodes which are positioned within the camera rearwardly of the receiving lens 24. The photodiodes 51 and 52 are spaced a small distance apart, for example, of the order of two mils and each have a parameter, namely resistance, which varies as a function of the brightness of light incident thereon. The photodiodes 51 and 52 are each electrically connected to a differential amplifier 57 which is also coupled to the battery 18. The differential amplifier 57 produces an output signal in magnitude corresponding to the difference between the voltage drops across the photo-

diodes 51 and 52, each of which is a function of the magnitude of the resistance and thus the intensity of illumination on the respective photodiodes 51 and 52. Since the differential amplifier 57 only responds to voltage differences, voltage drops across both resistance 51 and 52 caused by ambient illumination or "noise" will be substantially eliminated.

30 The output signal from the amplifier 57, at the predetermined frequency of the chopper 44, is applied as an input to logic circuitry 58. The circuitry 58 includes a filter network 60 which has a narrow pass band which permits the predetermined frequency to pass but rejects spurious signal components such as those produced by external light sources which illuminate the photodiodes 51 and 52.

35 The output from amplifier 57 is at a reference level such as zero level when an object is disposed at the common boundaries or crossover location between Zones 1 and 2. More specifically, when an object is disposed at the crossover location the brightness of reflected illumination incident on each of the photodiodes 51 and 52 is substantially equal and the filtered voltage signal will be at a zero level. If the object is disposed in Zone 1, the photodiode 51 will receive more incident illumination and the filtered signal will swing relatively positive. On the other hand, if the object is disposed in the far Zone 2, the photodiode 52 will receive more incident illumination and the filtered signal will swing relatively negative.

40 It will be noted that the photodiodes and amplifier have been described as producing a zero reference signal when the object is disposed at the crossover position. However, this reference level can have other values which may be arbitrarily selected, such as + or - 5 volts. Accordingly, whenever the term polarity is used in this disclosure, it should be taken in a relative sense. Thus, the term positive polarity means a potential more positive than the reference level (viz. the potential when the object is at the crossover level). Similarly, the term negative polarity means a potential which is negative or less positive than the reference level. In this specification and claims the term polarity is intended to include the phase sense of an alternating signal.

45 The logic circuitry 58 is adapted to control a zone indicating apparatus 16 which includes two impedance elements 82 and 84. In Fig. 1, the elements 82 and 84 are coils which may be wound in a motor which is adapted to move the lens 14 along a path shown by the arrows. Thus, as viewed in Fig. 1, if the coil 82 is energized, the motor moves the lens 14 to the left and

If the coil 84 is energized the motor will move the lens 14 to the right. In Fig. 3, the elements 82'' and 84'' are also coils, whereas in Fig. 2, the elements 82' and 84' are filaments of lamps.

Returning to Fig. 1, when a low level voltage is applied to the circuitry 58 indicating that the object is in proximity to the crossover or boundary line between Zones 1 and 2, neither of the elements 82 and 84 will be energized. In the disclosed embodiment the logic circuitry 58 energizes element 82 in response to the existence of two conditions. The first condition is that the filtered output signal of the differential amplifier is at a positive polarity and the second condition is that the magnitude of the signal is greater than or equal to a predetermined voltage, such as  $x$  volts above a reference level. Similarly, the logic circuitry 58 energizes the element 84 in response to the existence of two conditions, namely, the output of the differential amplifier 57 is at a negative polarity, and the magnitude of the filtered signal is greater than or equal to the difference,  $x'$ , between another predetermined voltage, of lesser voltage level, and the reference level.

To accomplish the result described above the logic circuitry 58 includes a circuit 62 which produces a signal corresponding to the absolute value of the magnitude of the filtered differential amplifier signal. The output of circuit 62 is applied to a threshold level detector 64 which establishes an input signal to AND gates 66 and 68 when the signal input to detector 64 reaches a predetermined threshold magnitude or level which in the instant case will be whenever the signal is greater than  $x$  volts or  $x'$  volts. In this embodiment the absolute value of the voltage levels  $x$  and  $x'$  are equal. The AND gate 66 will provide a conductive path to energize impedance element 82 whenever the threshold level detector 64 produces an output and a positive polarity detector 70 provides an output. Similarly impedance element 84 will be energized when a negative polarity detector 72 produces an output and the threshold level detector 64 provides an output.

By means of the foregoing arrangement, the indicating apparatus 16 will properly indicate which zone the primary object is in. However, if the primary object is near the crossover location then neither element 82 or 84 will be energized in response to this object. Typically, should a second object at a different range distance also reflect light from the beam toward the photodiodes 51 and 52, the signal produced at the output of the amplifier 57 will not be of a sufficient magnitude to cause the threshold level detector 64 to establish an

output. Hence, neither of the elements 82 or 84 will be energized.

In Fig. 2, the zone indicating apparatus 16' operates in conjunction with a viewfinder 90 having lenses 91 and 92. The construction of the viewfinder 90 has only been shown in schematic form since viewfinders are well understood to those skilled in the art. The indicating apparatus 16' comprises a housing 94 which forms two open ended cylindrical chambers, 96 and 98. The chamber 96 receives a lamp 82' and a transparency 100 with a positive image which indicates to the user that the primary object is in zone 1. The chamber 98 receives a lamp 84' and a transparency 101 with a positive image which indicates that the object is in zone 2. A mirror 102 is disposed to receive the positive image from the transparency 100 when the lamp 82' is energized and project the image into the field of the lens 92 of the viewfinder 90 to indicate to a user that the object is in zone 1.

Similarly, a mirror 104 receives the positive image from the transparency 101 when the lamp 84' is energized and projects it into the field of the lens 92 for viewing by the user. If neither lamp is illuminated, the operator knows the object is in the region of the crossover location. The user will then make the appropriate adjustment of the camera objective lens 14 to focus an image of the object in the film plane P. Alternatively, optical light pipes could be used to transmit images to the mirrors 102 and 104. Still further, an opaque mask could be disposed to be movable between positions to cover or uncover a selected one of the lamps to indicate which zone the object is disposed in.

In Fig. 3, the apparatus 16'' includes a permanent magnet 120 having a first core portion 122 about which is wound the impedance element 82' and a second core portion 124 about which is wound the second impedance element 84''. The apparatus further includes a member 130 which is rotatably mounted on a pin 132 fixed to the member 120. The member 130 is provided with a permanent magnet 140 intermediate its remote ends and carries at one remote end an objective lens 14'. If the coil 82'' is energized a force will be exerted on the member 130 causing it to be swung to the near position so that the objective lens 14' will be disposed in the optical path of the camera as shown in dotted line. However, if the coil 84'' is energized, the member 130 will be swung to the far position and the lens 14' positioned out of the optical path of the camera. The camera will be understood to include a further fixed objective lens system. Only one coil need be provided and a spring could maintain

the member 130 in one position until the coil is energized, at which time a force would be exerted to overcome the urging of the spring and position the member 130 in the other position. A similar arrangement could also be provided wherein the camera objective lens 14 is on a helical mount and is movable along the optical path of the camera to different positions depending upon which coil is energized.

WHAT WE CLAIM IS:—

1. A range finder for determining whether an object is disposed within a first range of distances relative to a reference plane or a second range of distances relative to the reference plane and including means for projecting a beam of light towards an object, and first and second photoelectric devices, with each device having a parameter the magnitude of which varies as a function of the brightness of incident illumination reflected from the object: comprising means coupled to said first and second photoelectric devices for producing a signal the magnitude and polarity of which varies in accordance with changes in the magnitude of the parameters of the first and second photoelectric devices, this signal having a first polarity when the object is disposed in the said first range of distances and a second polarity when the object is disposed in the said second range of distances; and means responsive to the said signal when of the said first polarity only when it has a value greater than a predetermined amount above a reference level for indicating that the object is in the said first range of distances, and responsive to the said signal when of the said second polarity only when it has a value more than a predetermined amount below the reference level for indicating that the object is in the said second range of distances.

2. Apparatus as claimed in Claim 1, wherein the said signal producing means comprises a differential amplifier, and the said signal responsive means comprises logic circuitry.

3. Apparatus as claimed in Claim 1 or Claim 2, wherein the said signal responsive means comprises an indicator lamp which

is arranged to be energized to indicate that the object is disposed in the zone associated with the lamp.

4. Apparatus as claimed in any preceding Claim, wherein the means for projecting the beam of light is arranged to cause the beam to pulsate at a predetermined frequency, and wherein signal filtering means is provided, so that the signal produced by the photoelectric devices is produced in response to the pulsating beam.

5. Apparatus as claimed in Claim 2, wherein the logic circuitry is arranged to produce first or second logic signals when the said signal is respectively of a first, positive, polarity and of a magnitude greater than the predetermined amount, or of a second, negative, polarity and of a magnitude greater than the predetermined amount, and wherein the means for indicating which range of distances the object is in comprises first and second indicating means respectively responsive to the first and second logic signals.

6. Apparatus as claimed in any preceding Claim, in combination with a photographic camera and adapted to indicate whether an object is in a first or second range of distances from the film plane of the camera.

7. Apparatus as claimed in any of Claims 1 to 5, incorporated in a photographic camera and including means for moving an objective lens of the camera automatically in response to the range determined to a position in which an image of the object in either the first or second range of distances is focused on the film plane of the camera.

8. A range finder substantially as hereinbefore described with reference to Figure 1, to Figures 1 and 2, or to Figures 1 and 3 of the accompanying drawings.

9. A photographic camera incorporating a range finder substantially as hereinbefore described with reference to Figure 1, or to Figures 1 and 2, or to Figures 1 and 3 of the accompanying drawings.

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1. A range finder for determining whether an object is disposed within a first range of distances relative to a reference plane or a second range of distances relative to the reference plane and including means for projecting a beam of light towards an object, and first and second photoelectric devices, with each device having a parameter the magnitude of which varies as a function of the brightness of incident illumination reflected from the object: comprising means coupled to said first and second photoelectric devices for producing a signal the magnitude and polarity of which varies in accordance with changes in the magnitude of the parameters of the first and second photoelectric devices, this signal having a first polarity when the object is disposed in the said first range of distances and a second polarity when the object is disposed in the said second range of distances; and means responsive to the said signal when of the said first polarity only when it has a value greater than a predetermined amount above a reference level for indicating that the object is in the said first range of distances, and responsive to the said signal when of the said second polarity only when it has a value more than a predetermined amount below the reference level for indicating that the object is in the said second range of distances.

2. Apparatus as claimed in Claim 1, wherein the said signal producing means comprises a differential amplifier, and the said signal responsive means comprises logic circuitry.

3. Apparatus as claimed in Claim 1 or Claim 2, wherein the said signal responsive means comprises an indicator lamp which

is arranged to be energized to indicate that the object is disposed in the zone associated with the lamp.

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6. Apparatus as claimed in any preceding Claim, in combination with a photographic camera and adapted to indicate whether an object is in a first or second range of distances from the film plane of the camera.

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8. A range finder substantially as hereinbefore described with reference to Figure 1, to Figures 1 and 2, or to Figures 1 and 3 of the accompanying drawings.

9. A photographic camera incorporating a range finder substantially as hereinbefore described with reference to Figure 1, or to Figures 1 and 2, or to Figures 1 and 3 of the accompanying drawings.

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