

PATENT SPECIFICATION

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(54) RANGE FINDER

(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 range finders which employ spaced photosensitive means that receive light reflected from an object and which in response to signals produced by the photosensitive devices determine the distance of the object relative to a reference plane. The invention is a modification of and an improvement in the invention claimed in Patent No. 1,270,596 (33567/69).

Automatic range finders for photographic applications have been proposed which employ a pair of spaced photosensitive devices having parameters which respectively vary as a function of the brightness of incident light reflected by an object, whose distance relative to a reference plane is to be determined, from an angularly sweeping light beam. Typically, the photosensitive devices are differentially connected in an electrical circuit which produces a signal which varies as a function of variations in the parameters of the devices. In the apparatus disclosed in Patent Specifications No. 33567/69 and 33568/69 (Serial Nos. 1,270,596 and 1,270,597 respectively), a scanning beam is moved along a predetermined angular path until the magnitudes of the parameters of the two photosensitive devices are equal. At this time, movement of the focus setting member of an objective lens is arrested in a position in which it can set the objective lens to focus an image of the object in a primary image plane.

While this type of range finder performs satisfactorily under most conditions, there is a problem when the object is relatively narrow and a secondary object may also reflect light and cause it to illuminate the photosensitive devices. In such a situation the

photosensitive devices may produce an output signal which causes the apparatus to indicate an incorrect distance of the object relative to the reference plane.

In accordance with the present invention there is provided a rangefinder comprising means for angularly sweeping a light beam to illuminate an object whose range is to be determined, first and second photosensitive means spaced from each other and arranged for the light beam reflected by the object to sweep across the first and second photosensitive means, the photosensitive means having parameters which vary as a function of the brightness of the light incident thereon, means coupled to the first and second photosensitive means for producing a signal having a level which varies in accordance with the differences in magnitudes of the parameters, the signal having a first predetermined level when the magnitudes of the parameters are equal and a second predetermined level when the magnitudes of the parameters are at predetermined relative levels, and means for indicating the range of the object in response to a change of the said signal to the second predetermined level subsequent to having the first predetermined level within a predetermined time interval therebefore.

The said signal may be relatively positive or negative when the first photosensitive means receives more or less light, respectively, than the second photosensitive means, and undergoes a polarity reversal as the light incident thereon becomes equal.

The rangefinder may be associated with an objective lens which is movable to a position in which it can focus in a primary image plane an image of the object, the focus position of the lens being arranged to be determined by the rangefinder.

The means for indicating the range distance may be responsive to the output of an AND gate whose inputs are respectively responsive for a limited time to the said signal at the first predetermined level and at the second predetermined level.

A rangefinder in accordance with the present invention and incorporated in a photo-

[Price 25p]

Price 33p

SEE ERRATA SLIP ATTACHED

graphic camera having an automatic focusing mechanism will now be described by way of example with reference to the attached drawings wherein:—

5 Fig. 1 is a pictorial view of the camera;

Fig. 2 is a schematic diagram partly in block form of the mechanism which is embodied in the camera shown in Fig. 1;

10 Fig. 3 is a curve showing a combined photocell output signal produced by the apparatus of Fig. 2 when the distance of a relatively wide object is to be determined; and

15 Fig. 4 is a curve showing the combined photocell output signal of the apparatus shown in Fig. 2 in the illustrated situation wherein there is a secondary object in the scan field of the projected light beam.

20 In Fig. 1 there is shown a photographic camera 11 which employs automatic focusing apparatus shown in Fig. 2. The camera 11 is provided with an objective lens 12 which is movable along a predetermined path and is adapted to form an image of an object 25 to be photographed in a primary image plane and to focus the image of the object in the plane when the lens 12 is correctly positioned by the focusing apparatus 10 along the path. The camera further includes a shutter adjusting dial 13, a photometric detector 14, a viewfinder 17, a focus release mechanism 18, a shutter release mechanism 21, a film winding member 22, and light projecting and receiving lenses 23 and 30 24 respectively, which are part of the automatic focusing apparatus shown in Fig. 2. Referring now to Fig. 2, after the camera 11 is aimed at an object 27 to be photographed and the focus release mechanism 18 is depressed, a battery V is coupled to and energizes a source of light 41. Light from the source 41 is focused by lenses 42 and 43 to form a beam of light which is then modulated at a selected frequency by appropriate means such as a chopper 44. Alternatively, the energization of the source of light 41 could be modulated at the selected frequency. Light is projected by the lenses 42 and 43 to a movable mirror 47. The mirror 50 47 is provided with a central aperture 47a through which some modulated light passes and illuminates the base of a phototransistor 48.

55 A beam of light is reflected by the mirror 47 and projected by the lens 23 of the camera, the mirror being moved so that the beam scans the field in an anticlockwise sense. As the mirror 47 moves, it causes the beam of light to sweep through an increasing angle θ . The mirror 47 is rotated by a mechanism 29 through a range of angular positions until the mirror moves past a position wherein the brightness of the reflected light from the object 27 imaged upon 65 a pair of photocells 51 and 52 by the lens

24 are at predetermined relative levels as signals produced by the photocells then cause actuation of focus-setting means so that the lens 12 may be positioned to focus an image of the object 27 in the film plane P of the camera.

In the embodiment, the photocells 51 and 52 are photodiodes which are positioned within the camera rearwardly of receiving lens 24. Photodiodes 51 and 52 are spaced apart a small predetermined distance, for example, of the order of two mils, and each have a parameter, namely, resistance, which varies directly as a function of the brightness of light incident thereon.

During rangefinding the beam of light projected by the lens 23 moves through its scan field, and if the object being scanned is one of substantial width, such as a house wall which occupies the entire scan area, the combined signal of the photocells will then be as shown in Fig. 3. As the brightness of the reflected light incident upon the first photodiode increases, the output gradually builds up to a maximum and then decreases to the point of polarity reversal X following which the mirror image of the signal in a negative direction is produced as the brightness of light incident on the opposite photodiode increases.

In Patent Specification No. 1,270,596 (33567/69) which describes and claims an arrangement similar to that so far disclosed, the point of the scan at which the crossover or phase reversal point of the combined signal occurs is used to indicate that a predetermined triangulation relationship exists between the rangefinder and the object whose range is being determined. The range distance is thus determined, in that arrangement, at the crossover or phase reversal point of the curve. While this gives an accurate indication in the instance of a wide area object, an accurate indication may not be possible in the instance when both a narrow subject and a secondary object are included in the scan field. More particularly, if the field through which the light beam moves includes a secondary object 28, as shown in Fig. 2, light reflected by the secondary object 28 and projected by the lens 24 upon the photocells 51 and 52 may cause the distance to be incorrectly determined.

As indicated schematically in Fig. 2, as the beam of light projected by the lens 23 moves through its scan field by the action of the movable mirror 47, the light beam will first impinge upon and illuminate the secondary object 28. As reflected light traverses the surface of photodiode 51, the output signal as shown in Fig. 4 (which for our purpose can be considered to be the output of the detector circuitry 58) first builds up to a maximum value in a positive direction. However, as the secondary object 28 is com-

paratively narrow with respect to its reflecting surface, a point is soon reached (at a scan angle θ_1), wherein the projected light beam passes out into space with but little reflection. At this time, substantially no reflected light is received by photodiode 51 and the output signal level drops abruptly to a level X which is the same as the crossover level of Fig. 3. As the sweep continues and the beam impinges upon object 27 (at the scan angle θ_2) and there will again be reflection to the surface of photodiode 51 and the signal will rise abruptly to a maximum and then decrease again to the crossover level; and substantially, pass into the negative half cycle as scanning continues and the brightness of illumination incident upon the photodiode 51 decreases and the brightness of illumination incident on the photodiode 52 increases.

As shown in Fig. 4, at the angle θ_1 , the signal level drops to the level at crossover, which with the apparatus of Patent Specification No. 1,270,596 (33567/69) may cause the objective lens to be incorrectly positioned. To overcome the foregoing problem, in accordance with the present invention, a determination of the distance of the object 27 from the camera 11 is not made until the signal has first reached and passed the crossover level and then reaches a predetermined level relative to the level at crossover as shown by the point Y on the curve in Fig. 4. This will be described in more detail below.

Returning to Fig. 2, during the scanning of the field, a voltage drop is produced across each of the load resistors 53 and 54 and is applied to preamplifier 57. Preamplifier 57 and certain other elements of the circuitry, particularly amplifier-detector 58 and amplifier 71, may follow the general arrangement of the similar elements described in detail in Patent Specification No. 1,270,596 (33567/69). Preamplifier 57 preferably includes a differential amplifier which measures the difference between the input voltages, which is, of course, a function of the magnitude of the resistance of the respective photo-diodes 51 and 52. Since the preamplifier 57 only deals with voltage differences, voltage drops across both resistors 53 and 54 caused by ambient illumination and noise in the photocells will be substantially eliminated.

The phototransistor 48 is a junction transistor and is positioned so that the light transmitted through the aperture in mirror 47 can impinge upon its base electrode. Illumination of the phototransistor 48 is effective to increase the current flow through the reverse bias collector junction 72. The emitter electrode of phototransistor 48 is coupled to synchronous signal amplifier 71 which, in turn, produces synchronous reference signals S_1 and S_2 . Amplifier 71 will

preferably include suitable high pass and low pass filters eliminating most of the signal components and leaving only substantially rectangular synchronous pulses at the selected frequency.

The output of preamplifier 57 is fed to the amplifier-detector 58 as are the synchronous signals S_1 and S_2 supplied by amplifier 71. The output from amplifier-detector 58, after low-pass filtering, is a voltage which is at a zero level at the point of phase reversal or cross-over when the circuitry is balanced by the reception of equal brightness of illumination incident on the photodiodes 51 and 52 and which swings relatively positive or negative depending upon which one of the photodiodes 51 and 52 receives the greater radiation. This output voltage is applied over line 77 to logic circuitry 78. The logic circuitry 78 is adapted to energize an SCR 81. However, before the circuitry 78 can energize the SCR 81, the two conditions referred to above must be satisfied; the first is that the level at crossover be reached and the second condition is that the level of the signal then declines to a predetermined level relative to the level at crossover. To accomplish this function, the logic circuit includes a timing circuit 90 which includes a threshold level detecting circuit energized upon the signal reaching the crossover level and produces, for a predetermined time interval, an input signal to an AND gate 91. A threshold level detector 92 also provides an input signal to the AND gate 91 but only when the output signal from the detector declines to the predetermined level below the level at crossover. If both conditions are satisfied, the AND gate 91 will provide a positive voltage pulse over lead 135 to the gate electrode 131 of SCR 81.

When potential is applied to gate electrode 131, it causes the SCR 81 to conduct and a closed circuit path is established for energization of a solenoid 138. In effect, a source of positive potential is applied through a resistor 141 to the solenoid coil. To prevent current surges through the SCR 81, a capacitor 142 is connected in parallel across the solenoid and SCR 81. The solenoid 138, when energized, positions a cam member (not shown) to indicate the range distance and to determine the focused position of the objective lens 12. Reference is made to Patent Specification Nos. 1,270,596 and 1,270,597 (33567/69 and 33568/69) identified above, for the detailed description of such a cam and cam positioning mechanism. After the solenoid 81 is energized, the lens shutter release member is actuated by the camera user, and the objective lens 12 then moves into contact with the stop now provided by the locked cam member and is arrested thereby at a position wherein the image of the object 27 is

focused in the film plane P of the camera 11.

The invention has been described in detail with particular reference to a rangefinder incorporated in a photographic camera, but it will be understood that the rangefinder may be used in other types of cameras and in other applications.

WHAT WE CLAIM IS:—

1. A rangefinder comprising means for angularly sweeping a light beam to illuminate an object whose range is to be determined, first and second photosensitive means spaced from each other and arranged for the light beam reflected by the object to sweep across the first and second photo-sensitive means, the photosensitive means having parameters which vary as a function of the brightness of the light incident thereon, means coupled to the first and second photosensitive means for producing a signal having a level which varies in accordance with differences in magnitudes of the parameters, the signal having a first predetermined level when the magnitudes of the parameters are equal and a second predetermined level when the magnitudes of the parameters are at predetermined relative levels, and means for indicating the range of the object in response to a change of the said signal to the second predetermined level subsequent to having the first predetermined level within a predetermined time interval therebefore.

2. A rangefinder as claimed in Claim 1, wherein the said signal is relatively positive or negative when the first photosensitive means receives more or less light, respectively, than the second photosensitive means, and undergoes a polarity reversal as the light incident becomes equal.

3. A rangefinder as claimed in Claim 1 or Claim 2, associated with an objective lens which is movable to a position in which it can focus in a primary image plane an image of the object, the focus position of the lens being arranged to be determined by the rangefinder.

4. A rangefinder as claimed in any preceding Claim, wherein the means for indicating the range is responsive to the output of an AND gate to whose inputs are respective by applied signals predetermined level, for the predetermined time interval, and at the second predetermined level, the signal responsive to the second predetermined level occurring within the predetermined time interval, to provide the output.

5. A rangefinder adapted to operate sub-

stantially as hereinbefore described with reference to the accompanying drawings.

6. A photographic camera incorporating a rangefinder substantially as hereinbefore described with reference to the accompanying drawings.

7. A rangefinder circuit, comprising: first and second photosensitive transducer means arranged in spaced relationship and adapted to receive in turn, amplitude modulated light from a subject whose range is to be determined, this light being produced as a reflection if an amplitude-modulated angularly sweeping light beam; differential amplifier means connected to the photosensitive transducer means to provide amplified difference a.c. signals; split phase amplifier means connected to the differential amplifier means and adapted to receive the amplified difference a.c. signals and to provide push-pull outputs; reference signal means for providing two synchronous pulse signals at the same frequency as the modulation of the amplitude modulated light, one being 180° out of phase with the other, being full wave synchronous detector means connected to receive the push-pull outputs of the split phase amplifier means, and connected to receive the two synchronous pulse-signals from the reference signal means, to provide an a.c. output signal which has a positive or negative half cycle, depending upon which photosensitive means is then receiving the greater incident radiant energy; and logic circuit means coupled to the full wave synchronous detector means to enable zero cross-over detection for providing a first signal for a predetermined time interval initiated at an instant in the sweep period when the a.c. output signal goes to zero and the reflected light causes equal illumination of the photo sensitive transducer means, and a second signal when the a.c. output signal goes through a predetermined non-zero level subsequent to the initiation of the first signal and for providing an output control signal when the first and second signals exist simultaneously.

8. A rangefinder incorporated in a camera and including a rangefinder circuit as claimed in Claim 7, wherein the output control signal is arranged to indicate correct setting of the camera focussing means.

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Agent for the Applicants.



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