

United State**Hasegawa et al.**[11] **3,813,679**[45] **May 28, 1974****[54] FOCUS DETECTOR DEVICE****[75] Inventors: Goro Hasegawa; Soichi Nakamoto; Kazuya Hosoe, all of Tokyo, Japan****[73] Assignee: Canon Kabushiki Kaisha, Tokyo, Japan****[22] Filed: Oct. 17, 1972****[21] Appl. No.: 298,185****[30] Foreign Application Priority Data**

Nov. 2, 1971 Japan..... 46-87411

[52] U.S. Cl. 95/44 R, 95/10 CE, 95/44 C**[51] Int. Cl. G03b 3/10****[58] Field of Search..... 95/10 CT, 44 R, 44 C, 45, 95/10 CE; 250/209; 353/101****[56] References Cited****UNITED STATES PATENTS**

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Primary Examiner—Fred L. Braun**Assistant Examiner**—E. M. Bero**Attorney, Agent, or Firm**—Flynn & Frishauf**[57]****ABSTRACT**

A focus detector device of this invention employs flashlight as reference light so that the quantity of such light reflected by an object to be photographed is converted into an electrical signal and stored in a storage capacitor, whereby the focus detection may be effected in accordance with the quantity of the stored signal. The pre-flash is automatically actuated when the ambient light falls below a certain level. For focusing two photodiodes of logarithmic compression characteristics are used. A third photoelectric element measures the amount of ambient light.

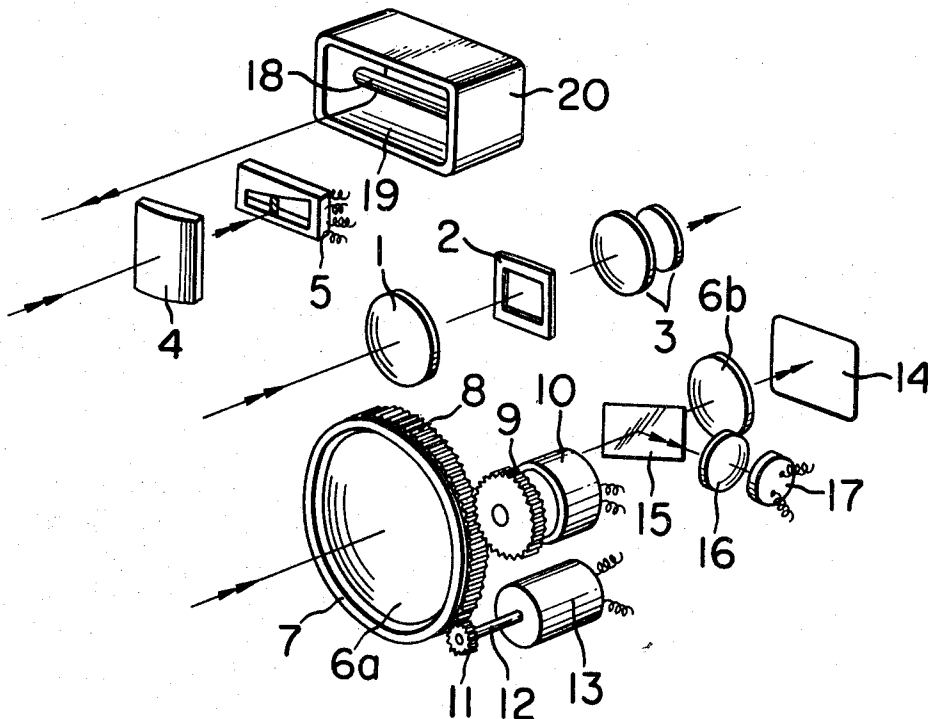
6 Claims, 8 Drawing Figures

FIG. 3

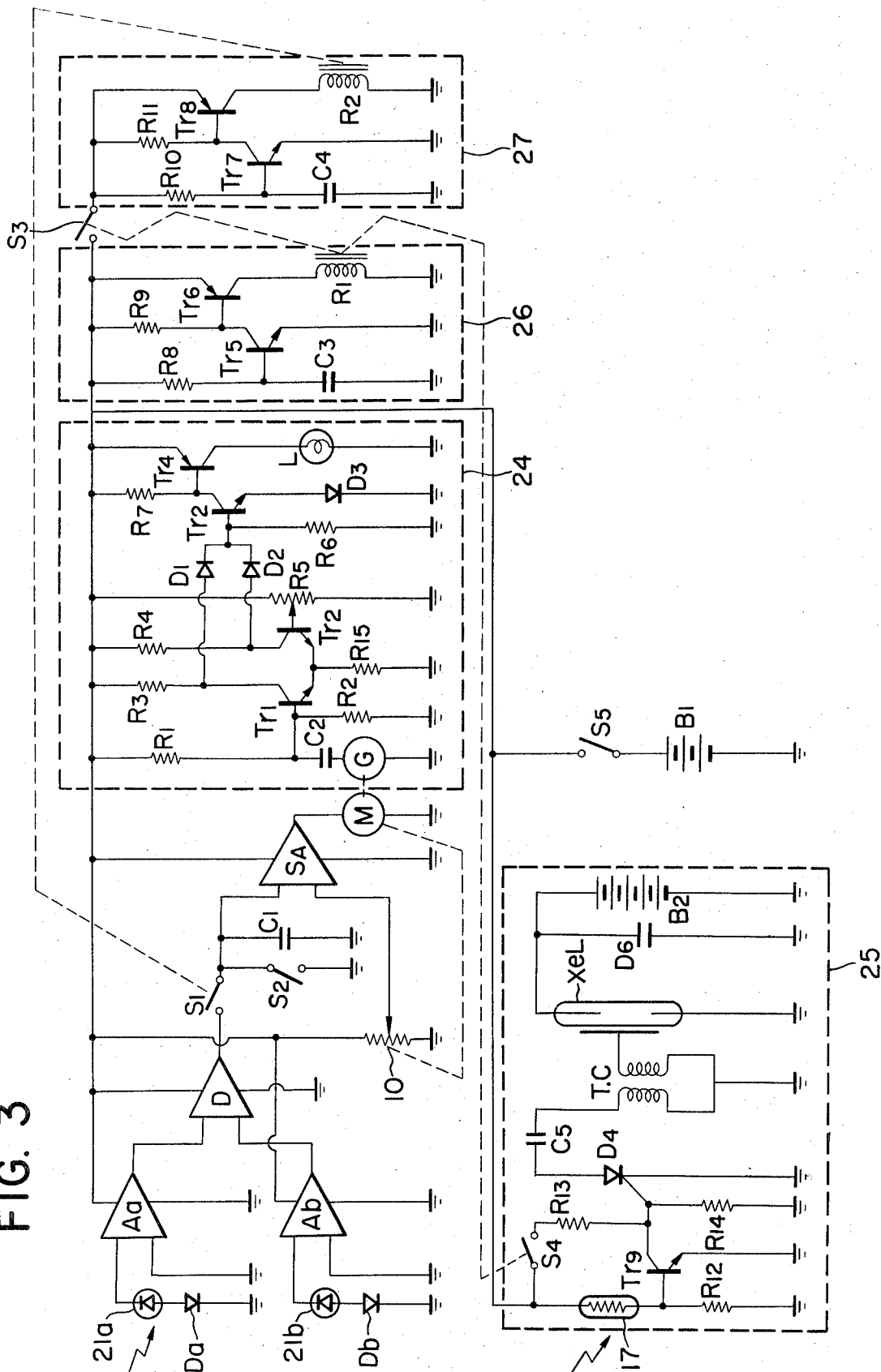


FIG. 5

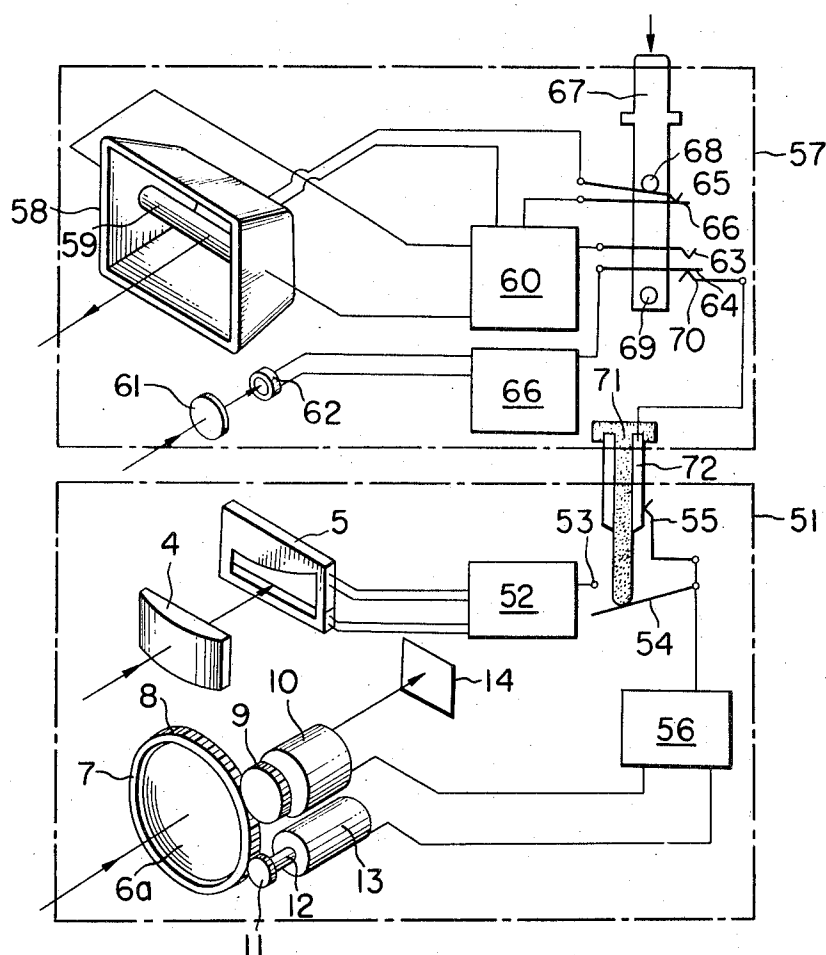


FIG. 6

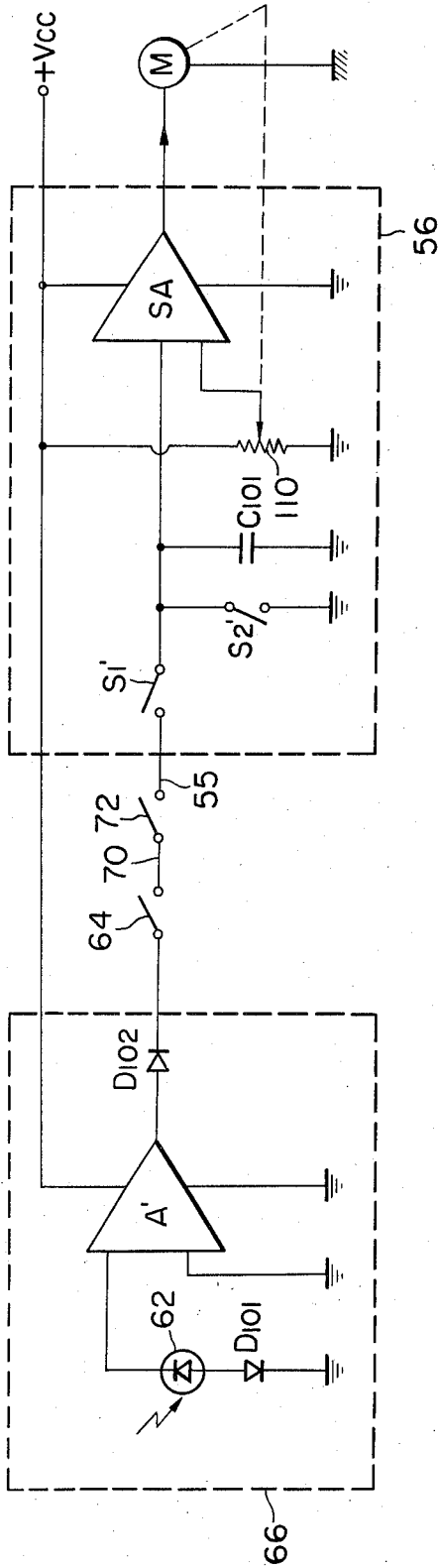
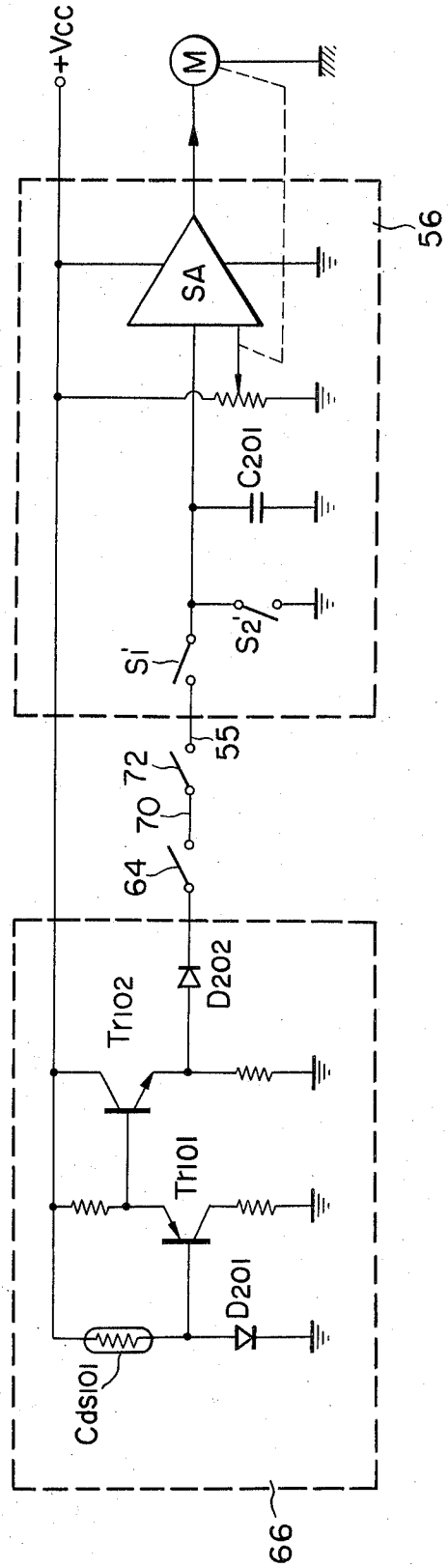


FIG. 7



FOCUS DETECTOR DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a focus detector device, and more particularly to a focus detector device in a camera of the type wherein a photographic lens is focused for an object to be photographed.

2. Description of the Prior Art

Various focus detector devices have heretofore been proposed which automatically detect the distance adjustment of a camera's photographic lens to thereby enable automatic or manual distance adjustment of such lens.

For example, U.S. Pat. No. 3,615,137 proposes a system which searches for an extreme resistance value presented by a photoconductive cell as an object image formed thereon is focused, so that the object image may at the same time be accurately focused on a sensitive film surface.

According to another proposed system, reference light is thrown upon an object from a light source provided on a camera and the light reflected from the object is received to detect a high frequency component in the reflected light until such component reaching its maximum quantity with proper focusing of the object.

In the former system, the extreme value of the photocell resistance is relatively reduced with the reduction in the brightness of the object, and the detection of the extreme value at low light levels becomes difficult. The latter system eliminates such difficulty, but some extraneous light from sources other than the object may be mixed with the modulated light in the form of noise, which raises difficulties in the accurate detection of the focus.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the above noted disadvantages existing in the prior art.

It is another object of the present invention to accomplish accurate focus detection irrespective of the brightness of an object by automatically throwing reference light onto the object when the brightness thereof is below a predetermined value.

It is still another object of the present invention to provide a focus detector device which employs flash light as the reference light and in which the quantity of such light reflected by the object is converted into an electrical signal and stored in a storage means so that the focus detection may be effected in accordance with the quantity of storage.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will become fully apparent from the following detailed description of some specific embodiments thereof taken in conjunction with the accompanying drawings, in which:

FIG. 1(A) is a perspective view showing the entire arrangement of the focus detector device according to the present invention;

FIG. 1(B) schematically illustrates the photographic lens system and light receiving optical system in the device of FIG. 1(A);

FIG. 2 is a front view of a photoelectric image position detector used in the focus detector device of FIG. 1;

FIG. 3 diagrammatically shows the electric circuit in the focus detector device of FIG. 1;

FIG. 4 shows the switch arrangement used in the focus detector device of FIG. 1;

FIG. 5 schematically shows the focus detector device of FIG. 1 with an automatic light control flash means assembled thereto; and

FIGS. 6 and 7 show examples of the electric circuit in the assembly of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is a viewfinder optical system which comprises an objective lens 1 for phototaking an object to be focus-detected, a view field mask 2 and an eyepiece 3 for magnifying the image of the object formed on the view field mask. Parallel to and suitably spaced apart from the optical axis of the viewfinder's optical system, there is disposed another system which comprises a cylindrical lens 4 and a photoelectric image position detector 5. The cylindrical lens 4 acts to focus the object aimed at by the viewfinder system linearly on the photoelectric image position detector 5 to the rear of the lens 4. The detailed construction of the detector 5 is shown in FIG. 2, and its function is to generate an output variable with the position of a linear image formed on the photoelectric element and thereby detect the position of the image. In the present device, the photoelectric image position detector 5 is disposed at a base distance from the viewfinder's optical system so as to provide a so-called base range finder. Therefore, the position of the image formed on the photoelectric image position detector 5, i.e. the point *a* or *b* in FIG. 1(B) is variable with the object distance, i.e. the position of the object *A* or *B* in FIG. 1(B). The output of the photoelectric image position detector 5 corresponds to the object distance. Parallel to the optical axis of the base range finder, there is also disposed a photographic optical system 6*a*, 6*b*. The focus adjusting means 6*a*, which comprises a casing 7 having a gear 8 securely formed over the outer periphery thereof, is operatively associated with a potentiometer 10 via gear 8 and pinion 9 so that the distance for which the photographic optical system is being properly focused may be taken out in the form of electrical signal. The movement of the focus adjusting means 6*a* corresponds to the variation in the electrical output of the potentiometer 10. A signal representing the object distance provided as the output from the photoelectric image position detector 5 may be compared with a signal representing the position of the photographic optical system, by an electric circuit which will be fully described with respect to FIG. 3. In accordance with the difference between the two signals, a motor 13 may be driven by a conventional servo-circuit through the agency of pinion 11 and shaft 12 connected to the gear 8 secured to the focus adjusting means 6*a* of the photographic optical system, thereby ensuring the object image formed through the photographic optical system to be properly focused on a film surface 14. All the above-described arrangement constitutes an automatic focusing device.

A half-mirror 15 is disposed to direct part of the light from the object in the direction perpendicular to the

optical axis of the photographic optical system so that such part of the light may be used for metering. A metering system comprises an image forming lens 16 and a metering light receiving element 17 which is especially provided to automatically control the light of a later-described auxiliary light source in accordance with the brightness of the object to be photographed. The auxiliary light source of the present invention, designated by 18, is provided with a reflector 19 and held by and within a casing 20 which may be mounted on the camera body. The auxiliary light source 18 serves to illuminate an object to be focus-detected, and may be a flash light source such as xenon lamp or a strobe which has often been used with cameras. Although a flash light source is shown in the illustrated embodiment of the present invention, a tungsten lamp or other light source means may be used as will readily be apparent.

FIG. 2 shows the construction of the photoelectric image position detector used in the device of FIG. 1. The detector comprises a pair of photoelectric elements 21a and 21b with a boundary therebetween disposed in the direction of movement of a linear object image 22 (horizontal direction in FIG. 2), and a mask 23 provided on these photoelectric elements, the mask having an opening whose length is variable in the direction of movement of the image. From such construction it will be seen that the photoelectric element 21a produces an output variable with the position of the image 22, but depending on the variations in the factors such as the brightness of the object, the output of the photoelectric element may fail to properly correspond to the position of the image. It is to compensate for the variations in such factors that the photoelectric element 21b is provided. Thus, if the output ratio of these two photoelectric elements is obtained, the position of the object image will correspond to the output ratio of the two elements. To obtain a ratio, logarithmic subtraction may be used.

FIG. 3 illustrates the electrical connection in the device of FIG. 1. The pair of photoelectric elements 21a and 21b forming the photoelectric image position detector have their outputs serially connected with diodes Da and Db, respectively, so that these outputs are subjected to logarithmic compression by the diodes Da and Db. The logarithmically compressed outputs are applied to separate amplifiers Aa and Ab for amplification, respectively. These outputs are compared with each other by a differential amplifier D, whose output represents the output ratio of the two photoelectric elements which have already logarithmically compressed, thus providing a signal representing the object distance. The output of the differential amplifier is stored by a capacitor C1 through a normally closed switch S1 and then supplied therefrom to a servo-amplifier SA as an object distance signal. On the other hand, the output of the potentiometer 10 responsive to the movement of the photographic optical system is applied as one input to the servo-amplifier SA, which rotates a servomotor M in a direction corresponding to the difference between the two outputs, which in turn rotates the photographic optical system and accordingly the potentiometer 10 until a point of balance is detected.

A focus indicator circuit 24 is provided to enable the photographer to recognize the focus-detected condition. More specifically, a differential circuit comprising transistors Tr1 and Tr2 is provided to detect a point at

which the output voltage from a tachogenerator G mounted on the shaft of the servomotor M is equal to the potential of a pre-adjusted zero point adjusting potentiometer R5, and the detection signal is applied through diodes D1, D2 and transistors Tr3, Tr4 to turn off a lamp L which is turned on during non-focused condition, thus enabling the focusing to be recognized.

The flashing of the auxiliary light source is accomplished by a flashing circuit 25. In the flashing circuit 25, the output from the metering photoelectric element 17 is normally applied as input to the base of transistor Tr9 through resistor R12 to close a normally open switch S4. The resistance value of the photoelectric element 17 is above a predetermined level when the brightness of the object is below a predetermined value. Therefore, the trigger circuit utilizing the transistor Tr9 and the controlled rectifier (thyristor) D4 is operated to discharge the capacitor C which has been charged from a high voltage source B2, thereby causing flashing of xenon lamp XeL. Conversely, when the brightness of the object is high and the resistance value of the photoelectric element 17 is below a predetermined value, the trigger circuit is not operated and no flashing occurs. Delay circuits 26 and 27 are provided to operate switches S3, S4 and then switch S1 sequentially after predetermined time intervals, thereby energizing relays R1 and R2 in accordance with the time constants determined by R8, C3 and R10, C4, respectively.

The thinner dashed lines indicate the operative association maintained between the members at the opposite ends of the respective lines.

FIG. 4 shows a shutter release mechanism employed to effect picture-taking with the device of the present invention. A push button 28 is secured to the top of a release member 29, which is slidable in the direction of arrow 32 due to the cooperation between stepped screws 31 provided at a portion 30 of the camera body and an elongated slot 33 formed through the member 29. The release member 29 is normally biased upwardly by a spring 34, as viewed in the figure, and has studded pins 35 and 36 adapted to actuate switch S5 and shutter starting member 37 during the downward movement of the member 29. The member 29 also has a small notch 39 engageable with a leaf spring 38 provided on the camera body to detect a predetermined amount of displacement of the member 29, and further has a projection 40 for actuating switch S2 when the shutter starting member 37 is started.

In this arrangement, when the button 28 is depressed, the normally open switch S5 is closed and almost simultaneously therewith, the leaf spring 38 is engaged with the notch 39, thus enabling the completion of a first stage movement to be recognized. Further depression of the button causes the projection 40 to actuate the normally open switch S2 into closed position and at the same time, the pin 36 actuates the shutter starting member 37 to start the shutter. When the depression of the button 28 is stopped, the release member 29 is quickly returned to its initial position by the action of the spring 34, so that the switches S5 and S2 restore their open positions.

In the device of the present invention as described above with respect to FIGS. 1 to 4, the procedures involved in picture-taking and the operation of the device will now be described. The photographer aims at an ob-

ject to be photographed through the viewfinder's optical system 1,2,3, whereafter he depresses the release button 28. After the button is displaced a predetermined amount, the switch S5 is closed. At this point, the photographer recognizes the engagement between the leaf spring 38 and the small notch 39 and such engagement is maintained. In this position, the automatic focus adjusting system is supplied with a voltage from voltage source B1 and enters into its operative condition, so that the delay circuit 26 closes switch S4 to permit the auxiliary light source to automatically flash after a predetermined time in dependence of the brightness of the object so as to illuminate the object. The light beam projected on the object is received by the photoelectric element 21a and 21b and stored as an object distance signal by the capacitor C1 through the process described previously. With the switch S3 closed by the action of the delay circuit 26, the delay circuit 27 is operated to open the switch S1 after a predetermined time to allow the storage of the object distance signal. Since the automatic focus adjusting system is already in operative condition, the servo-amplifier and servomotor are then operated to stop the photographic optical system at a position for properly focusing the object image on the film surface. The output of the tachogenerator directly connected to the servomotor is then zero so that, as described previously, the lamp L is turned off to enable the photographer to know the completion of the focusing of the object and further depress the release button 28.

Thereby, the shutter is started while the switch S2 is closed to nullify the object distance signal stored in the capacitor C1 which is already used up. Subsequently, when the depression of the release button is stopped, it is returned to its initial position and the switches S2 and S5 are opened so that the capacitors C3 and C4 in the delay circuits 26 and 27 may discharge through the base-emitter of transistors Tr5, Tr7. These capacitors are thereby reset so as to be ready for a subsequent cycle of photography.

FIG. 5 illustrates the operation of the device when an automatic light control flash means is used therewith.

A camera 51 is provided with a cylindrical lens 4 and a photoelectric image position detector 5. The photographic optical system 6a in the camera comprises a casing 7 having a gear 8 securely formed over the outer periphery thereof, and is operatively associated with a potentiometer 10 via gear 8 and pinion 9 so that the distance for which the photographic optical system is being properly focused may be taken out in the form of electrical signal. The movement of the focus adjusting means 6a corresponds to the variation in the electrical output of the potentiometer 10. As described above with respect to FIG. 1, the object distance signals provided from the photoelectric image position detector 5 are passed through amplifier-comparator circuit 52 and control circuit 56 to motor 13 when switch contacts 53 and 54 are connected together, thereby driving the motor 13 and accordingly the photographic optical system through the pinion 11 and shaft 12 connected to the gear 8 secured to the focus adjusting means 6a of the photographic optical system in accordance with the difference between the two signals, and thus ensuring the object image to be properly formed on the film surface 14 through the photographic optical system. Numeral 57 generally designates an automatic light con-

trol device, i.e. a device in which the flash light from discharge tube 59 impinging on an object and reflected therefrom is passed through a lens 61 to a photoelectric element 62 and when such light is made to reach a quantity of light corresponding to the then object distance by an amplifier-detector means 66 connected to the element 62, a control means 60 controls the quantity of light projected on the object. When the device 57 is mounted to the camera 51, an insulating rod 71 is adapted to disconnect the switch contacts 53 and 54 in the camera 51 while engaging a contact member 72 with a contact 55. A flash button 67, provided with insulating dowels 68 and 69, may be depressed from outside the device to disconnect contacts 63 and 64 which connect the detector means 66 to the control means 60, while engaging the contact 64 with a contact 70 connected to the contact member 72 and closing contacts 65 and 65' which trigger the discharge tube 59, as shown.

Thus, when the device 57 is mounted to the camera 51, the photoelectric image position detector and its comparator circuit in the camera 51 are disconnected from the control means 56. Before taking a picture, an initial stage of depression of the button 67 connects the control means 56 with the distance detector 66 of the device 57, and a second stage of depression of the button 67 closes the contacts 65 and 65' to permit the discharge tube 59 to emit a predetermined quantity of light to the object. The reflected light from the object is passed through the lens 61 and photoelectric element 62 into the detector means 66, and the signal corresponding to the then object distance is passed through the contacts 70,72,55 into the control means 56 to drive the motor 13 and the potentiometer 10, which in turn moves the photographic lens 6a to thereby focus the object image on the film surface 14. Thereafter, an ordinary picture-taking operation may be effected to provide a properly focused photograph. The operation for providing a proper exposure on the film surface may be done entirely in a conventional manner and need not be described herein.

FIG. 6 shows a block diagram of the FIG. 5 detector means and the electric circuit of the driving means 56. As shown, photodiode 62 is connected with a log diode D101 of logarithmic compression characteristic and the point of connection therebetween is connected with the input of amplifier A'. Further seen are back-flow preventing diode D102, switches S1' and S2' corresponding to the switches S1 and S2 in the foregoing embodiment, storage capacitor C101, differential amplifier Sa, motor M, and potentiometer 110 corresponding to the aforesaid potentiometer 10 and driven by the motor M. After the discharge tube 59 in FIG. 5 flashes to illuminate the object, the reflected light is received by the light receiving cell 62. Since the quantity of light received by the cell 62 is proportional to the object distance, the output of the cell 62 is converted into a logarithmic signal by the diode D101 and passed through the diode D102 and switch S1' into the capacitor C101 for storage. The motor M is driven by the amplifier SA' for an amount corresponding to the potential difference between the potentiometer 110 and the capacitor C101 to displace the lens 6a until the potential difference is zero. As a result, the lens 6a is displaced in proportion to the voltage value stored in the capacitor C101, i.e. in proportion to the object distance, thus automatically accomplishing the distance

adjustment. Since the flashing time of the discharge tube 59 is short, the voltage stored in the capacitor C101 may be all discharged if the switch S1' remains closed. In this connection, the diode D102 is provided to prevent the lost current from flowing back into the amplifier A'.

FIG. 7 shows a modification of the FIG. 6 circuit which employs a photocell CdS 101 instead of the photodiode, but this embodiment is identical in operation with the embodiment of FIG. 6 and need not be described further.

According to the above-described arrangement, the distance adjustment can be accomplished automatically or semiautomatically by the detector means in the camera during ordinary daylight photography. In the dark environments or in case of an object of low contrast, the aforesaid device 57 may be used with the distance detector mechanism thereof connected to the control means in the camera, to thereby provide a focusing mechanism which is highly accurate and simple in operation.

We claim:

1. A focus detector device in a photographic camera having a focussable photographic lens, comprising:
 - optical means offset from said photographic lens for forming therethrough an image of an object to be photographed, said optical means being sufficiently offset to cause the position of said image to be detectably displaced laterally in accordance with the distance of said object from said camera;
 - first photoelectric converter means disposed substantially in the focal plane of said optical means and having a light receiving surface of such a configuration as to cause said converter means to produce an electrical output corresponding to the object distance;
 - focus detection control circuit means electrically connected so that the input thereof receives the output from said first photoelectric converter means, said focus detection control circuit means including: driving power means for operating the focusing movement of said photographic lens;
 - a drive control circuit for controlling said driving power means, including means producing a signal corresponding to the position of said photographic lens, means for comparing said signal with the output of said first photoelectric converter means and means for operating said driving power means to cause said signal to balance the output of said first photoelectric converter means;
 - a light source for illuminating at least a portion of said object;
 - an illumination control circuit for controlling the illumination of said light source, said light source being electrically connected with the input of said illumination control circuit; and
 - means including a second photoelectric converter means and switching circuit means operated

thereby, said second photoelectric converter means being responsive to the brightness of said object and arranged to operate said switching circuit means when the brightness of the object is below a predetermined brightness level to turn on said illumination control circuit, said switching means being connected to said illumination control circuit, and thereby to improve the operation of said first photoelectric converter means under low brightness light conditions.

2. A focus detector device according to claim 1, wherein said first photoelectric converter means comprises two photodiode means of logarithmic compression characteristic, and said focus detection control circuit means further includes a differential amplifier having differential inputs connected with said photodiode means and an output connected with said focus detection control circuit means one of said photodiode means producing an output corresponding to the image position of the object which is variable in accordance with the position of the object, and the other producing an output corresponding to the lighting of the object regardless of image position.

3. A focus detector device according to claim 2, wherein said focus detection control circuit means further includes a storage capacitor connected with the output of said differential amplifier.

4. A focus detector device according to claim 3, wherein said focus detection control circuit means includes a delay circuit having an electric timer circuit and a start switch responsive to camera release operation and switching means connected to the timer circuit so as to change over in response thereto, said switching means being connected between said capacitor and said differential amplifier circuit so as to be opened after a predetermined time to thereby electrically disconnect said capacitor and said differential amplifier circuit.

5. A focus detector device according to claim 3, wherein said light source is a xenon tube.

6. A focus detector device according to claim 1, wherein said focus detection control circuit means further includes a circuit for confirming the focus-detected condition, said circuit having:

- generator means drivingly connected with said driving power means for producing a signal while said driving power means is operating;
- a variable resistor in said drive control circuit variable with the position of said photographic lens;
- a differential amplifier circuit in said drive control circuit having differential inputs connected with said generator means and said variable resistor; and

indicating means electrically connected with the output of said differential amplifier circuit so as to indicate the completion of a focusing cycle in accordance with said differential output.

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