

SPECIFICATION

Camera having an automatic focus control apparatus

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The present invention relates to the improvements in an automatic focus control apparatus of a camera in which there is an accurate focus control of the camera lens.

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It is known to have a camera having an automatic focus control apparatus of the type in which a scanning mechanism of a photoelectric distance measuring instrument is made to rotate in two different directions. A circuit is caused to memorize the maximum or minimum value (This being a value selected by the design of the circuit) in the photoelectric signal detected in the scanning stage in one direction, and when during scanning in the opposite direction a photoelectric signal almost equal to the maximum or minimum value memorized in the former direction is obtained, the camera lens, which is moving for focus regulation, is stopped by a detection signal.

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In the automatic focus control apparatus of such a camera, the lower the scanning speed of scanning mechanism of the photoelectric distance measuring instrument, the higher becomes the accuracy of focus regulation. Usually a camera lens is coupled with scanning mechanism, etc. and is caused to stop moving of the basis of a detection signal of the maximum value (or minimum value) from the distance measuring instrument, but since there is naturally some time lag before some stopping device (eg. magnet) receives said detection signal and acts to stop the movement of the camera lens, the moving speed of a camera lens interlocking with the scanning mechanism becomes slow, if the scanning speed of it is slow and discrepancy of the position of stop of the camera lens lessens. And when the main illuminating light of the subject is a fluorescent lamp or something, the discharge cycle of the fluorescent lamp overlaps the output of a light receiving element. By this, the position of maximum value (or minimum value) is deviated and an error will occur on the originating time of the detection signal. And when a camera lens is stopped by engaging a pawl member in a saw tooth restraining portion, the camera lens must be set at the same place, even if the pawl member engages in any portion of a valley of a saw tooth, where the stop position of the camera lens is determined stagewise, if the moving speed of a camera lens is made slow, the error of the originating time of detection signal due to light of a fluorescent lamp as mentioned above, is sufficiently small; there is obtained the effect that the range within a valley of one saw tooth is obtained, and a camera lens can be stopped at an accurate stage, that is, the position of a camera lens determined by a detection signal. Further, since a camera lens is fairly heavy, a great inertia is applied to a source of energy, whatever form it takes in (such as a spring or a motor). Therefore, the operation becomes unstable and further when a camera lens is stopped, there arises a problem of photographing blur due to vibrations, etc. However, if the moving

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speed of the camera lens is made slow, the above defect can be eliminated.

As mentioned above, in automatic focus control, it can be said that the slower the scanning speed of scanning mechanism of a photoelectric distance measuring instrument and the speed of a camera lens interlocking with the working, therefore the higher is the accuracy of focusing, but since a photographer releases the shutter while watching for a good chance of taking photographs, the time required for automatic focus control naturally has its own limit. Empirically, that seems to be about 100 ms. In short, an ordinary photographer holds a camera in the photographing state for about 100 ms. after pressing a shutter release button, and he thinks that photographing is over if more time than that has elapsed. Of course, if more time than this is needed in focus regulation, a chance of photographing will be lost and the desired photograph can not be taken. For this reason, there arises a limitation that a scanning speed of scanning mechanism of a photoelectric distance measuring instrument cannot be reduced to below a given point.

The present invention provides an automatic focus control apparatus for focusing the adjustable lens of a camera, comprising a pair of photosensitive receiving means on which a pair of auxiliary images of the object to be imaged are formed by a pair of auxiliary optical systems, whereby said two auxiliary images are matched in the sense of image position to each other through a control member by moving an optical element in two different directions, and further comprising signal processing means adapted to compare the signals provided by said pair of photosensitive receiving means, to provide an output signal during movement of said optical element in the second direction on the basis of the maximum value or the minimum value of the photoelectric signals determined during movement of said optical element in the first direction, by which output signal a camera lens, which moves in conjunction with the movement of said optical element in the second direction, is stopped, characterized in that, when a release button is actuated, said optical element is moved in the first direction at a high speed, and in the second direction at a relatively lower speed.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure 1 is a diagram showing one example of a mechanism for two-way scanning of a scanning light path.

Figure 2 shows a working circuit for an automatic focus control apparatus.

Figure 3 shows characteristics of a signal for detecting the position of the subject.

In the Figures, 1 is a rotatable mirror, 2 is a fixed mirror, 3 is a mirror prism, 4 and 5 are lenses, and 6 and 7 are light-receiving elements consisting of photodiode array. A light path leads to the light-receiving element 6 from the mirror 1 by way of the mirror prism 3 and the lens 4 provides a scanning light path, and makes a scanning rotation in a first direction and a second direction by means of rotations of the mirror 1 in clockwise and anticlock-

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wise directions. A light path leads to the light-receiving element 7 from the fixed mirror 2 by way of the mirror prism 3 and the lens 5 provides a fixed light path. The embodiment illustrated in the Figure

5 shows a distance measuring instrument in which a scanning light path and a fixed light path are used, but in other possible embodiments of the invention both light paths could be scanning light paths and for the scanning mechanism, a prism or lens may be used instead of a mirror. One embodiment of a means of rotating the mirror 1 in opposite directions is as shown in Figure 1. A control member 8 is unlocked by pressing a release button (not shown), whereby it moves to the left (as seen in Figure 1) under the influence of a spring 9, to cause the rotatable mirror to rotate in two different directions in accordance with the movement of a cam 8a through a cam link 10. The cam 8a is shaped to cause the rotatable mirror 1 rotate at high speed in the clockwise direction since it has an initial downwardly extending, steep slope portion, while then causing the mirror to rotate in the opposite direction at a relatively more gentle speed owing to the fact that the remainder of the cam slot has a less steep slope, this time in the upward direction.

A lens-driving portion 8b is mounted on the control member 8 and a driven pin 11a built in a lens mount 11 is engaged with the lens-driving portion 8b. When the control member 8 moves to the left, the lens-driving portion 8b does not act on the driven pin 11a while the mirror 1 is being rotated clockwise at a high speed. When the mirror 1 is rotated in the opposite direction, the portion 8b engages the driven pin 11a and then the camera lens 11b begins to move in correspondence with the scanning rotation of the mirror 1. The movement of the camera lens 11b is caused by the driven pin 11a being moved by its engagement with the lens-driving portion 8b of the control member 8, thereby moving the lens mount 11 and slidably moving a cam pin 11c built in the lens mount in a cam groove of a cam sleeve 12 fixed to the camera body. A switching cam 8c is provided on the control member 8 and closes an enabling switch 13 and when the control member 45 8 causes the mirror 1 to rotate anti-clockwise, the switching cam 8c closes the enabling switch 13 and maintains it closed.

A restraint portion 8d is provided on the control member 8 and when the mirror 1 rotates anti-clockwise and the output due to light receipt of the light-receiving elements 6 and 7 at the closing state of the enabling switch agrees most, that is, when the position of the subject is again arrested when the distance measuring instrument is scanning in the scanning light path in the anti-clockwise direction, a "Stop" signal is applied to solenoid 14 and a pawl 15 is engaged with the restraint portion 8d to stop the control member 8 in that position. Accordingly, the mirror 1 and the camera lens 11b stop at the stage of arresting of the subject. Then, a conventional means (not shown) acts to release a shutter and photographing in accordance with an accurate distance measurement, is carried out. There is shown in Figure 2 an example of a working circuit to operate a solenoid by arresting the position of the subject

while the distance measuring instrument is scanning in the anticlockwise direction, of the scanning light path. As mentioned above, when the rotatable mirror 1 is making a rapid clockwise rotation, the enable switch 13 is open and consequently, the outputs of the light-receiving elements 6 and 7 during that time are compared, and given a detection signal for the focus position by way of a sum amplifier SA, a peak detector circuit PD, an amplifier AMP 1 and a differential circuit, but said signal V_D is intercepted by the switch 13 and does not act on the solenoid 14. The light-receiving elements 6 and 7 are, respectively, composed of photodiode array and the optical image of the subject on the light-receiving elements 6 and 7 is operated with sum amplifier SA as a photoelectric comparative signal and is outputted from the sum amplifier SA as a correlation signal V_{CO} showing a high voltage to the extent that the outputs of the light-receiving elements 6 and 7 agree wholly. The peak detector circuit PD is a circuit taking out a peak detector signal V_{PD} from this correlation signal V_{CO} , and gives its own output signal to a commutating element D, compares detection voltage V_{DT} which has charged a condenser C1 and the voltage of the correlation signal V_{CO} . When the voltage of V_{CO} is higher than V_{DT} , it outputs the voltage of V_{CO} and when the voltage of V_{CO} is lower than the voltage of V_{DT} , it outputs the voltage of the low level. The amplifier AMP 1 makes the peak detector signal V_{PD} into an automatic focus detecting signal V_{AF} by shaping the wave-form. The differential circuit consisting of a condenser C2 and a resistor R3 converts this automatic focus detecting signal V_{AF} into a pulse signal V_D showing a pulse-like focus position. Figure 3 shows the states of each signal corresponding to the position scanned with the rotatable mirror 1, and the range of one scanning time t_1 is the state in which the rotatable mirror 1 makes a rapid forward rotation, and the range of inverse scanning time t_2 is the state in which the rotatable mirror 1 makes a gentle return rotation. In the correlation signal V_{CO} , many maximum values appear as shown in the diagram and one-way scanning tends to issue wrong signals of "Stop" of a lens, and hence, this is the reason why a method by two-way, that is, reciprocating scanning is adopted.

Now, when the rotatable mirror 1 enters into a gentle return rotation, the enable switch 13 is closed, the outputs of the light-receiving elements 6 and 7 are compared, the correlation signal V_{CO} output from the sum amplifier SA is compared with the maximum voltage which charged the condenser C1 at the time of the previous forward rotation of the rotatable mirror in the peak detector signal V_{PD} which has the same voltage as the correlation signal only when the voltage of the correlation signal is more than said maximum voltage. The voltage of the correlation signal V_{CO} becomes more than the maximum voltage at the forward rotation of the rotatable mirror only when the distance measuring instrument arrests the position of the subject because attenuation of charge of the condenser C1 is very little; accordingly, the peak detector signal V_{PD} gives the time when the distance measuring instrument

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arrests the position of the subject accurately. And the peak detector signal V_{PD} is shaped with the amplifier AMP 1, becomes the automatic focus detecting signal V_{AF} , further is converted into the pulse signal V_D , passes through the enable switch 13 and is input to an amplifier AMP 2. The amplifier AMP 2 converts the pulse signal V_D into a step signal in which only pulse rise in the forward direction is utilized, inputs into the solenoid 14 said step signal as a solenoid "Stop" signal, and stops the lens mount directly, as shown in Figure 2, or indirectly by way of the control member as shown in Figure 1. Further, S in the Figure is the film surface and $R_1 - R_3$ in Figure 2 are resistance.

As mentioned above, in the present invention, since accuracy of a focus detecting signal in which the distant measuring instruments arrests the position of the subject by scanning in the two opposite directions of the scanning path is hardly influenced by the time distribution in the two directions, that is, by the ration of the speeds of rotation in such directions, the speed of scanning in the anticlockwise direction and the corresponding lens moving speed are delayed and stopping of the lens at the focus position on the basis of a focus detecting signal having a high accuracy is arranged to be accurately conducted. Hence, according to the present invention, an accurate automatic focus regulation can be conducted without lengthening the total scanning time of a distance measuring instrument, in the two directions that is, without losing a shutter chance.

In the present invention, scanning of a distance measuring instrument may go to the nearest distance and return to an infinitely long distance and vice versa, and each of light-receiving elements may be of a single composition, instead of plural combined elements or circuit construction in which a pulse signal is found by the minimum value detection and solenoid is worked by the utilization of signal rise may be changed.

Further, the scanning mechanism of a photoelectric distance measuring instrument does not necessarily need to make its optical system a separate body from a camera lens, and the present invention can be readily applied to a single lens reflex camera if the scanning mechanism is made into that of "through the lens" type and the moving speed of a camera lens is changed.

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CLAIMS

1. An automatic focus control apparatus for focusing the adjustable lens of a camera, comprising a pair of photosensitive receiving means on which a pair of auxiliary images of the object to be imaged are formed by a pair of auxiliary optical systems, whereby said two auxiliary images are matched in the sense of image position to each other through a control member by moving an optical element in two different directions, and further comprising signal processing means adapted to compare the signals provided by said pair of photosensitive receiving means, to provide an output signal during movement of said optical element in the second

direction on the basis of the maximum value or the minimum value of the photoelectric signals determined during movement of said optical element in the first direction, by which output signal a camera lens, which moves in conjunction with the movement of said optical element in the second direction, is stopped, characterized in that, when a release button is actuated, said optical element is moved in the first direction at a high speed, and in the second direction at a relatively lower speed.

2. An automatic focus control apparatus according to claim 1 in which said apparatus includes a cam portion of a control member for moving a cam member of said optical element, said cam portion being so adapted that when it is moved in a single direction it causes said optical element to move in said two different directions successively, is provided with a pair of oppositely extending slopes of different inclinations so as to move the optical element at a high speed in the first direction and a relatively lower speed in the second direction, said control member also including a follower portion which, at the start of movement of the optical element in the second direction, engages a lens mount to focus said camera lens.

3. An automatic focus control apparatus according to claim 1 or claim 2, in which said optical element is a mirror.

4. An automatic focus control apparatus according to claim 1 or claim 2 in which said optical element is a lens adapted to be rotated in front of a photosensitive receiving means about an axis extending perpendicularly in the optical axis thereof.

5. A camera having an automatic focus control apparatus as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

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