

"SHUTTER OPERATING APPARATUS FOR AN
AUTOFOCUS CAMERA"

The present invention relates to a shutter operating apparatus for an autofocus camera.

5 A popular autofocus camera having a lens shutter performs an automatic focus detection which generally relies on the principles of triangulation near the viewfinder in a path differing from the photographic path. In practice, the camera lens is set at a given position according to the results of the detection.

10 However, a single lens reflex (SLR) camera provided with a focal-plane shutter automatically adjusts the focus with high accuracy, because the error associated with the lens-driving portion is taken account of, such error arising from the fact that the lens is brought to a focus by sensing that the light
15 rays which have passed through the lens are focused.

On the other hand, a camera having a lens shutter is better than an SLR camera for flash photography and is more portable. Therefore cameras having a lens shutter have enjoyed wide acceptance.

20 In recent years, multifocal cameras and cameras having a zoom lens have gained popularity. With these cameras, the means employed to bring the camera lens to focus involves measuring the distance externally when the lens is used at a longer focal point. The camera

lens is focused according to the obtained value. In this case, however, errors arising during setting, and errors intrinsically present in the lens system, cannot be neglected. Hence, each step of the manufacturing process requires that adjustments be made with
5 excessively high accuracy.

It is therefore desirable to provide a camera which has a lens shutter but makes automatic focus adjustment equivalent to the adjustment made in SLR cameras, for accurately adjusting the focus.
10

In a camera provided with a lens shutter, the optical path of the camera lens is closed before operation. Therefore, it is impossible to know whether the light rays which would otherwise be transmitted
15 through the optical path would be focused.

If, however, a separate member is used which shields the image plane to be photographed and urges the lens shutter to open, in order to achieve complete shielding, large shielding members such as a pair of focal-plane shutters are necessary, thus rendering the structure complex.
20

According, therefore, to the present invention, there is provided a shutter operating apparatus for an autofocus camera, the said apparatus comprising a camera lens; light attenuation means which may be adjusted so as to increase and decrease light attenuation in the optical path through the camera lens; and automatic focus adjustment means for automatically adjusting the focus of the camera lens in accordance with
25 the position of the object to be photographed prior to the decrease of the said light attenuation required to effect an exposure, the said automatic adjustment of the focus being effected in dependence upon the amount of light from the object transmitted
30

through the camera lens.

5 The light attenuation means preferably comprises shutter means and light-blocking means each of which may be moved into and out of the said optical path, the automatic focus adjustment means being arranged to adjust the focus of the camera lens in dependence upon the amount of light from the object transmitted therethrough when the shutter means is moved out of the said optical path but the light-blocking means remains therein.

10 The control means is preferably arranged in operation first to move the shutter means out of the said optical path while the light-blocking means remains therein, whereby to effect adjustment of the focus of the camera lens in dependence upon the amount of light from the object transmitted therethrough; then to move the shutter means back into the said optical path while the light-blocking means remains therein; then to move the light-blocking means out of the said optical path while the shutter means remains therein; and then to move the shutter means successively out of and back into the said optical path so as to effect an exposure for a predetermined length of time.

20 The automatic focus adjustment means preferably comprises a sensor and a mirror for directing light onto the latter, the mirror being movable by said control means into and out of the said optical path for directing light from the latter onto the sensor.

25

The control means preferably comprises a slidable member sliding movement of which is arranged to effect the movements of the shutter means and light-blocking means into and out of the said optical path.

5 The present invention enables adjustment of focus by sensing whether the light rays which have passed through the camera lens are correctly focused.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

10 Figure 1 is a front elevation of an autofocus camera provided with a shutter operating apparatus according to the present invention,

Figure 2 is a cross-sectional view of the main portions of the camera of Figure 1;

Figure 3 is an enlarged portion of a light-blocking member which forms part of the structure shown in Figure 2;

Figure 4 is an expanded plan view of part of the said shutter operating apparatus;

Figure 5 is an enlarged view of part of the structure shown in Figure 4; and

Figure 6 is a sequential diagram illustrating the operation of the main components of the said shutter operating apparatus.

Terms such as "left", "right", "clockwise" and "counter-clockwise", as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

One embodiment of the present invention is now described in detail by reference to the drawings.

Referring to Figure 1, a camera body 1 has a lens barrel 3 in which a camera lens 2 is mounted. An image of the subject is passed through the lens 2 and focused onto a photosensitive material F (Figure 2) (hereinafter referred to as the film). The film F is located behind a region defined by a field of view 4.

A viewfinder 5 that indicates the limits of the field of view 4 and a strobe 6 are mounted in the upper portion of the camera body 1. A shutter release 7 for initiating the operation of the camera is mounted on the top of the camera body 1.

Figure 2 is a cross-sectional view of the main components of the camera. A lens shutter 8 which opens and closes the lens opening is mounted behind the lens 2. The shutter 8 has a single shutter blade or shutter blade assembly or means 8a that normally closes the lens

opening.

A stepper motor 9 is disposed inside the lens barrel 3 and drives a known actuating means D (Figure 4) to adjust the focus of the lens and to open and close the shutter blade means 8a.

The actuating means D that drives the lens 2 causes a helicoid mount (not shown) to move the lens 2 with respect to the optical axis. The helicoid mount is driven by a ring R that rotates around the lens opening.

An electronic circuit 10 which controls the stepper motor 9 comprises a known motor-driving circuit, a sequence control circuit for controlling the timing at which the shutter is driven, and an illumination-measuring circuit. Since all of these circuits are known, none of them are shown. The illumination-measuring circuit includes a light-receiving device 11 (Figure 1) which measures the illumination of the subject. This arrangement is known and described in detail, for example, in Japanese Patent Laid-Open Specification No. 200339/1987.

A mirror M is inclined with respect to the optical axis P and is mounted on a frame 12. The frame 12, and thus the mirror M, is rotatable by rotating a shaft 12a mounted below the viewfinder 5. The shaft 12a, on which the frame 12 is mounted, is rotatably mounted in a light-tight cylinder 13 which extends toward the film surface from the rear of the shutter 8. The whole outer surface of the cylinder 13 is made light-tight. An operation lever 12b and a pin 12c are mounted on the shaft 12a.

The image from an object is reflected toward the viewfinder 5 by the mirror M. A sensor 14 is rigidly fixed to the frame 12 to detect when the focus of the lens 2 is such that the image will be correctly formed

on the film surface. The sensor 14 detects when the lens 2 is focused.

The sensor 14 is connected to a known automatic focusing detection circuit (not shown). An electromagnet 20 (Figure 4) and the stepper motor 9 are actuated according to the output from the focusing detection circuit.

A light-blocking member 16 is disposed between the light-tight cylinder 13 and a flange 15 defining the field of view 4. That is, the light-blocking member 16 is located in part behind the cylinder 13. The flange 15 is positioned ahead of the film surface F. As shown in Figure 3, the light-blocking member 16 comprises sectors 16b-16g and a first actuating lever 16j. The sectors 16b-16g are rotatably mounted on a pin 16a. The first lever 16j is rotatably mounted on a shaft 16h. The sectors 16b-16g have respective grooves in which a pin 16i is fitted. A second actuating lever 16k (Figures 2 and 4) is firmly fixed to the shaft 16h and has a pin 16l.

Figure 4 shows the main portions of the actuating means D that is driven by the stepper motor 9. For simplicity, the members rotating around the lens opening are shown to be expanded onto a plane.

The shutter blade means 8a which opens and closes the lens opening is engaged so as to be actuated by an opening lever 17. In Figure 4, only one of a set of blades is shown. The opening lever 17 is biased to the left by a spring (not shown). The opening lever 17 is biased to the left by a spring (not shown). An actuating pin 17a is mounted at the right hand end of the opening lever 17.

The actuating means D has a groove D₀ so as to be slidably held by a pin 21 mounted therein. The actuating

means D comprises teeth D_1 , a cam portion D_2 for actuating an actuating pin 17a, an abutment portion D_3 at the left end, a first inclined surface D_4 engageable with the pin 12c on the operation lever 12b, and a second inclined surface D_5 engageable with the pin 16l on the second actuating lever 16k. The teeth D_2 are driven by the stepper motor 9 via gears 9a and 9b.

A distance-setting member 18 has grooves 18a and is held by pins 22 therein so as to be slidable from side to side. The distance-setting member 18 is provided with a pin 18b engageable with the ring R, an arm 18c engaging the abutment portion D_3 , a distance-setting ratchet portion 18d, and a raised step portion 18e. The setting member 18 is biased to the right by a spring (not shown).

An armature lever 19 comprises an armature member 19a and a detent portion 19b. The armature member 19a is controlled and attracted to the electromagnet 20 when the latter is energised. The detent portion 19b engages the distance-determining member 18. The lever 19 is biased clockwise by a spring 19c.

Figure 5 is an enlarged view of the cam portion D_2 of the actuating means D. The cam portion D_2 is shown to be comprised of cams D_{21} , D_{22} , D_{23} , D_{24} , D_{25} , and D_{26} . The cam D_{21} locks the actuating pin 17a against the action of a spring (not shown) to bring the shutter blade means 8a into its closed position before the camera is operated. The cam D_{22} moves the shutter blade means 8a into its open position when the operation of the camera is started. The cam D_{23} maintains the shutter blade means 8a in its open state while automatic focusing adjustment is being made. The cam D_{24} acts to return the shutter blade means 8a to its closed position. When the mirror M and the light-blocking member 16 are being

withdrawn, the cam D_{25} keeps the shutter blade means 8a in its closed position. The cam D_{26} opens and closes the shutter blade means 8a for the exposure operation.

The method of operating the camera is next described. In the conditions illustrated in Figure 4, if the shutter release 7 (Figure 1) is depressed to take a picture, the electronic circuit 10 is brought into operation. The electromagnet 20 is energized to attract the armature member 19a and thereafter to rotate the stepper motor 9. This moves the actuating means D to the right. The cam D_{22} actuates the opening lever 17 to move the shutter blade means 8a from the illustrated first position shown in Figure 4 to a second position where the lens opening is opened. Then, the optical path to the sensor 14 is unblocked. As a result, the automatic focusing detection (AF) circuit is brought into operation.

The sensor 14 receives the image of the subject transmitted through the camera lens 2. When the camera lens 2 arrives at the optimum focal point, the AF circuit (not shown) stops the output from the sensor 14 and de-energizes the electromagnet 20 by known means.

More specifically, when the stepper motor 9 is driven, the actuating means D shifts to the right. The arm 18c of the distance-determining member 18 follows the abutment portion D_3 , and is moved to the right by a spring (not shown). The detent portion 19b of the armature lever 19 is pushed by the raised step portion 18e so that the armature member 19a is pressed against the electromagnet 20. Thus, the lever 19 is attracted to and retained by the electromagnet 20. When the electromagnet 20 is de-energized at the focal point as described above, the armature lever 19 is rotated clockwise by the spring 19c. The detent portion 19b of

the lever 19 engages the setting ratchet portion 18d corresponding to the focal point of the lens 2. The ring R is driven to set the lens 2 at the focal point.

5 In the sequence diagram of Figure 6, the operation is shown as being started after time t_1 elapses. The AF circuit begins to operate at instant t_2 . The camera lens 2 is stopped. The illustrated condition is just prior to instant t_3 .

10 The stepper motor 9 rotates further to move the actuating means D to the right. The cam D_{24} rotates the opening lever 17 to the right. The shutter blade means 8a moves into the first position where the opening is closed. The first inclined surface D_4 actuates the pin 12c of the operation lever 12b to rotate the mirror M
15 about the shaft 12a. The mirror is moved out of the optical path P of the lens 2 and thus out of the field of view 4 defined by the flange 15.

20 The pin 16 l of the second actuating lever 16k of the light-blocking member 16 is actuated by the second inclined surface D_5 . The first actuating lever 16j is rotated clockwise about the shaft 16h. Thus, the pin 16i rotates the sectors 16b-16g about the shaft 16a, thereby opening the aperture provided by the flange 15. That is, the operation is complete until time t_5 elapses
25 as shown in Figure 6.

30 Subsequently, the stepper motor 9 turns to move the actuating means D further to the right. The cam D_{26} actuates the opening lever 17 to cause the shutter blade means 8a to open the lens opening. Since the sectors 16b-16g are withdrawn from the field of view 4 defined by the flange 15, the film F is exposed to light. When a desired length of exposure has been obtained by known means, the motor 9 is reversed by the sequence control circuit. Then, the exposure operation is completed. That

is, the operation is complete by time t_6 shown in Figure 6.

If the stepper motor 9 further rotates counter-clockwise, the sectors 16b-16g return to their original positions where they cover the field of view 4 set by the flange 15, while the shutter blade means 8a is closed. The mirror M goes back to the optical path P. The shutter blade means 8a is driven by the cams D_{24} , D_{23} , D_{22} , D_{21} , and returns to the position in which it closes the opening. In this way, preparations for photography are complete.

In the embodiment described above, the opening lever 17 may be retained by a separate engaging means to permit the lever 17 to reach the cam D_{21} while the shutter blade means 8a is kept closed by the cam D_{25} when the motor 9 is reversed. Another means may be provided to release the opening lever 17 when the actuating means D returns to its initial position.

Also in the embodiment described above, the exposure operation is performed by the lens shutter comprising the shutter blade means 8a. It is also possible, however, to fabricate the light-blocking member 16 from a focal-plane shutter. In this case, the cams D_{24} , D_{25} , and D_{26} of the actuating means D are unnecessary. The second inclined surface D_5 may start the focal-plane shutter with a further delay.

In this case, if the ability of the focal-plane shutter to block light is relatively inferior, the function can nevertheless be performed sufficiently. Therefore, the shutter can be made simple in structure.

The second inclined surface D_5 and the first inclined surface D_4 are provided to actuate the light-blocking member 16 and the mirror M. They may, however, be actuated by other power means such as a motor or a

spring. In this case, the actuating means D may be designed to be used only to start them.

5 The withdrawal of the mirror M does not form part of the present invention. A known half mirror may be fixed. Further, the mirror M may perform the function of the light-blocking member 16. It may be moved out of the optical path during photography.

10 The stepper motor 9 can take other forms such as an ultrasonic motor, as long as it can be rotated both forwardly or rearwardly.

In the embodiment described above, the lens opening is closed by the shutter blade means 8a prior to operation. It is not necessary that the opening be totally closed. If the opening opens slightly, no
15 problems take place, provided that light does not leak to the film F through the light-blocking member 16.

Also, a separate shutter blade which performs the same function, or other means such as a liquid crystal member which attenuates the light, may be provided.

20 If the sensor 14 cannot perform the automatic focus adjusting function, weak light from the strobe 6 may be projected to continue the operation.

As will be understood from the above description, the light passing through the optical path of the camera lens 2 is usually attenuated. The field of view 4 is
25 shielded by the light-blocking member 16. During photography, the optical path is no longer blocked, and the light transmitted through the lens 2 is used to carry out an automatic focus adjusting operation. Errors intrinsic to individual cameras are accommodated.
30 Consequently, focus control operation can be performed automatically with high precision. The field of view 4 is shielded by the sectors 16b-16g only substantially immediately prior to the exposure operation and so the

sectors 16b-16g can be made simple in structure and small. The sectors can, moreover, be fabricated from an inexpensive light-blocking member.

CLAIMS

1. A shutter operating apparatus for an autofocus camera, the said apparatus comprising a camera lens; light attenuation means which may be adjusted so as to increase and decrease light attenuation in the optical path through the camera lens; and automatic focus adjustment means for automatically adjusting the focus of the camera lens in accordance with the position of the object to be photographed prior to the decrease of the said light attenuation required to effect an exposure, the said automatic adjustment of the focus being effected in dependence upon the amount of light from the object transmitted through the camera lens.
2. Apparatus as claimed in claim 1 in which the light attenuation means comprises shutter means and light-blocking means each of which may be moved into and out of the said optical path, the automatic focus adjustment means being arranged to adjust the focus of the camera lens in dependence upon the amount of light from the object transmitted therethrough when the shutter means is moved out of the said optical path but the light-blocking means remains therein.
3. Apparatus as claimed in claim 2 comprising control means arranged in operation first to move the shutter means out of the said optical path while the light-blocking means remains therein, whereby to effect adjustment of the focus of the camera lens in dependence upon the amount of light from the object transmitted therethrough; then to move the shutter means back into the said optical path while the light-blocking means



remains therein; then to move the light-blocking means out of the said optical path while the shutter means remains therein; and then to move the shutter means successively out of and back into the said optical path so as to effect an exposure for a predetermined length of time.

4. Apparatus as claimed in claim 3 in which the automatic focus adjustment means comprises a sensor and a mirror for directing light onto the latter, the mirror being movable by said control means into and out of the said optical path for directing light from the latter onto the sensor.

5. Apparatus as claimed in claim 3 or 4 in which the control means comprises a slidable member sliding movement of which is arranged to effect the movements of the shutter means and light-blocking means into and out of the said optical path.

6. A shutter operating apparatus for an autofocus camera substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
