

Description

The present invention relates to a zoom lens drive system for a lens shutter type of camera.

Most conventional automatic focus cameras having a lens shutter, such as a between-the-lens-shutter, have a fixed focal length. Some cameras of this type permit a user to select one or the other of two separate lenses of different focal lengths for providing, for example, wide angle and telephoto capability. In such cameras, however, stepless variations in focal lengths in the range between these extremes of focal lengths are not possible. Heretofore, only the single lens reflex camera using a focal plane shutter had the capability of taking pictures using a zoom lens. A zoom lens drive system for such camera is described in US-A-4,445,757.

Single lens reflex cameras are more expensive and heavier than between-the-lens-shutter cameras; and accordingly, a photographer unfamiliar with cameras usually does not find it easy or convenient to use a single lens reflex camera, especially in taking action pictures at high speed using flash illumination. Furthermore, because of its relatively large weight and size, a single lens reflex camera is not favored by many photographers or travellers who are concerned with weight and the number of bags that have to be handcarried. Consequently, these individuals hesitate using single lens reflex cameras even if they appreciate the high quality pictures that can be taken by using such a camera. Accordingly, users who hesitate to use single lens reflex cameras have only two choices in a lightweight, small between-the-lens-shutter automatic camera: one with a fixed focal length, and one which has two extreme focal lengths without adjustment therebetween.

The problem to be solved by the present invention is to realize an automatic powered zooming operation and focusing in a small, light and compact camera having a lens shutter in such way that precise focusing is possible also with a light and compact zooming mechanism.

DISCLOSURE OF INVENTION

A zoom lens drive for a camera having a lens shutter includes a motor for moving the lens, in forward and rearward directions, along an optical axis. A first embodiment of the present invention includes switch means operable by an operator to control operation of the motor for moving the lens from an initial position on the axis to a final stationary position that establishes the focal length of the lens, and control means for operating the motor such that movement of the lens from its initial position to its final position always ends after the lens travels to the final position in a predetermined direction. The lens may occupy any position between and including a wide angle terminus or end position that establishes the smallest focal length, and a telephoto terminus or end position that establishes the largest focal length, and may also include a macro position beyond the telephoto terminus position. The invention insures that, regardless of the initial position of the lens relative to the final position, the lens will always be travelling in the predetermined direction when it arrives and halts at the final position.

To reach a final position, the lens may have to travel in a direction opposite to the predetermined direction. In such case, instead of halting the lens when the final position is initially reached, the invention provides for causing the lens to continue to move beyond, or overshoot, the final position before movement of the lens is halted. By thereafter reversing the direction of movement of the lens, and returning it in the predetermined direction to the final position, all of the backlash in the drive system will be taken into account. This arrangement will accurately locate the lens at the final position regardless of the initial position of the lens relative to final position.

A second embodiment of the invention includes switch means having two settings operable by an operator to control operation of the motor for moving the lens from an initial position on the axis to a final stationary position that establishes the focal length of the lens. In addition, this embodiment includes position detector means responsive to the lens position for detecting the position of the lens on the axis, and control means responsive to operation of the switch means to either of said two settings and to the position detector means for operating the motor such that: (1) the final position of the lens is a predetermined number of discrete focal length steps from its initial position; and (2) movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction.

The position of the lens when the switch means is operated by the operator defines the initial position of the lens. Operation of the switch means to one of the settings causes the control means to move the lens in said predetermined direction to its final position located said predetermined number of focal-length steps from its original position. Operation of the switch means to the other one of the settings causes the control means to first move the lens in a direction opposite to said predetermined direction until it is located more than said predetermined number of focal-length steps from its initial position, and then to reverse movement

of the lens and move it in said predetermined direction until it reaches its final position located said predetermined number of focal-length steps from its original position.

A third embodiment of the invention includes switch means having two settings operable by an operator to control operation of the motor for moving the lens from an initial position on the axis defined by the position of the lens when the switch is operated to a final stationary position that establishes the focal-length of the lens. In addition, this embodiment includes position detector means responsive to the lens position for detecting the position of the lens on the axis, and delay means for introducing a predetermined pause in operation of the motor. Finally, this embodiment includes control means responsive to sustained operation of the switch means to either of said two settings, to the position detector means, and to the delay means for operating the motor such that: (1) the final position of the lens is a predetermined number of discrete focal-length stops from its initial position; (2) movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction; and (3) the lens remains stationary at the final position for said predetermined pause before moving to another position located therefrom by said predetermined number of discrete steps. Thus, sustained operation of the switch means to one of the settings causes the control means to repeatedly move the lens through a predetermined number of focal-length steps, pausing for a predetermined period of time between moves.

A fourth embodiment of the invention includes switch means having a plurality of settings selectable by an operator to control operation of the motor for moving the lens from an initial position on the axis defined by the position of the lens when the setting is selected, to a final stationary position that establishes the focal-length of the lens. In addition, this embodiment includes position detector means responsive to the lens position for detecting the position of the lens on the axis, and memory means for storing data representative of a position of the lens on said axis. Finally, this embodiment includes control means responsive to selection of a setting of the switch means, to the position detector means, and to the memory means for operating the motor such that selection of a zoom setting of the switch means by the operation causes said motor to drive the lens from its initial position to a final position determined by the contents of said memory means under the condition that movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction.

BRIEF DESCRIPTION OF DRAWINGS

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Embodiments of the present invention are shown in the accompanying drawings wherein:

Fig. 1 is a schematic block diagram of a first embodiment of the present invention;

Fig. 2 is a schematic block diagram of a second embodiment of the present invention;

Fig. 3 is a schematic block diagram of a third embodiment of the present invention;

Fig. 4 is a schematic block diagram of a forth embodiment of the present invention;

Fig. 5 is a schematic perspective view of between-the-lens shutter camera with a zoom lens according to the present invention;

Fig. 6 is a front elevational view of the lens barrel block of Fig. 5 showing a light emitter and receiver, a macro compensating optical element associated with a distance measuring device, and a zoom motor;

Fig. 7 is a top plan view of a portion of the apparatus of Fig. 6;

Figs. 8 and 9 are sectional views taken along the lines VIII-VIII and IX-IX, respectively, in Fig. 6;

Fig. 10 is a longitudinal sectional view of the lens barrel block of the first embodiment;

Fig. 11 is a developed view of cam grooves of a cam ring for the front and rear lens-element groups associated with the lens barrel block of Fig. 10;

Fig. 12 is an exploded perspective view of the lens barrel block shown in Fig. 10;

Fig. 13 is a developed view of a code plate, showing the lands thereof, and showing a developed view of the cam grooves for the purpose of illustrating the functional relationship therebetween;

Fig. 14 is a chart showing a zoom code carried by the code plate shown in Fig. 13, and showing possible start and stop positions;

Fig. 15, 16 and 17 are front elevational, back elevational, and plan views, respectively, of a camera of the invention showing operational switches;

Figs. 18 and 19 are sectional views of a mode changing switch, and a macro button shown in different operational positions;

Fig. 20 is a block diagram of a controlling device for the present invention;

Fig. 21 is a drive circuit of a zoom motor;

Figs. 22-25 are flow charts of the first embodiment of the present invention;

Fig. 26 is a plane view of a zoom switch in a modified arrangement;

Fig. 27 is a diagram showing a zoom code by a code plate shown in Fig. 13 and stop positions;

Figs. 28-30 are flow charts of a second embodiment of the present invention;

Fig. 31 is a diagram showing a zoom code by a code plate shown in Fig. 13 and stop positions;

Figs. 32 and 33 are flow charts of a third embodiment of the present invention;

Fig. 34 is a diagram showing a zoom code by a code plate shown in Fig. 13 and stop positions; and

Figs. 35 and 36 are flow charts of a forth embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Basic Construction of Between-the-lens Shutter Type of Camera (Figs. 5-13)

A camera having a between-the-lens shutter according to the present invention comprises lens barrel block 1 defining optical axis OA, a finder block comprising finder and strobe block 2, distance measuring device AF comprising light emitter 3 and light receiver 4, and zoom motor 5 for effecting zooming operations. These elements are secured in the manner described below to base 6 which is rigidly attached to a camera housing.

As shown in Figs. 6-10, base 6 includes lens barrel supporting plate portion 6a lying in a plane perpendicular to optical axis OA, flange supporting plate portion 6b extending from one side of plate portion 6a at a right angle thereto, and motor supporting plate portion 6c perpendicular to the plate portion 6b. Lens barrel block 1 is supported on lens barrel supporting plate portion 6a, and zoom motor 5 is secured to motor supporting plate portion 6c located above the center portion of lens barrel block 1. Light emitter 3 and light receiver 4, which are secured to supporting plate portion 6b, are located on opposite sides of zoom motor 5. Finder block 2 is secured to the right portion of supporting plate portion 6b as viewed from the front of the camera. Gear train supporting plate 6e, parallel to support plate 6c, is connected thereto by spacers 6f.

Lens barrel block 1, which is actuated by zoom motor 5, is mounted on base 6 as described below with reference to Figs. 10-12. Rear securing plate 11 of block 1 is mounted to lens barrel supporting plate portion 6a of base 6 by means of fastening screws 10. The rear securing plate has four guide rods 12 secured thereto which are located around the optical axis and extend parallel thereto. Front securing plate 13 is attached to the front ends of the guide rods 12.

Rotatable cam ring 14 is mounted between front and rear securing plates 13 and 11, and is provided, on its outer periphery, with gear 15 fixed thereto by means of set screws 15a (Fig. 10). Pinion 7 (Fig. 8) on the output shaft of motor 5 directly, or indirectly through a gear train, engages gear 15 which may be a sector gear of a size that covers a predetermined range of rotational movement of cam ring 14. The cam ring has zooming cam grooves 20 and 21 for establishing the relative positions of the front and rear lens-element groups, respectively.

Fig. 11 is a development of zooming cam grooves 20 and 21. Cam groove 21, for the rear lens-element group, includes wide angle terminus fixing section 21a, variable magnification section 21b, and telephoto terminus fixing section 21c. Cam groove 20 for the front lens-element group, includes the following sections: section 20a for opening and closing barrier block 30 (Fig. 12), lens retracting section 20b, wide angle terminus fixing section 20c, variable magnification section 20d, telephoto terminus fixing section 20e, macro transferring section 20f, and macro terminus fixing section 20g. Rotational displacement of the front lens group through the angle θ_1 will occur when sections 20a, 20b, and 20c of zooming cam groove 20 are used. This angle is identical to the angle θ_1 of the rear lens group which uses section 21a of the zooming cam groove 21. The angle θ_2 of the variable magnification (variable power) section 20d of groove 20 is identical to the angle θ_2 of the variable magnification (variable power) section 21b of groove 21. Further, the angle θ_3 , which comprises sections 20e, 20f, and 20g of groove 20, is equal to the angle θ_3 of section 21c of groove 21. In the illustrated embodiment, the zooming range is 35 mm - 70mm.

Cam follower roller 17 of front group frame 16 is operatively engaged in cam groove 20, and cam follower roller 19 of rear group frame 18 is operatively engaged in cam groove 21. Front group frame 16 and rear group frame 18 are mounted on guide rods 12 for sliding axial movement parallel to the optical axis. Decorative frame 22 and shutter block 23 (Fig. 10) are secured to front group frame 16 by means of set screws 22a.

Shutter block 23, which controls focusing and exposure, is in operative engagement with front lens frame 24, which supports front lens-element group L1 by means of helicoid 25. Front lens frame 24 includes arm 24a engaged with lens focusing lever 23a of shutter block 23. When lever 23a circumferentially rotates, rotation is imparted to front lens frame 24 relative to frame 22 and block 23 such that the front lens frame moves along the optical axis by reason of helicoid 25 to effect focusing. Rear lens-element group L2 is directly secured to the rear group frame 18.

Shutter block 23 is known per se. It rotates lens focusing lever 23a through a predetermined angular displacement in accordance with a detection signal from the distance measuring device which is described below. Rotation of lever 23a is effected by means of a pulse motor (not shown) incorporated in the camera body to open the sectors of shutter 23b for a predetermined time, and thereafter to close the sectors by returning lever 23a to its initial position. This kind of shutter block is disclosed, for example, in Japanese Unexamined Patent Publication (Kokai) Nos. 60-235126. In the present invention, such a conventional shutter block is used essentially as is.

In the above discussion, the mechanical design of a camera having a between-the-lens shutter camera to which the present invention is applicable has been described. Control systems according to the present invention are explained below.

First embodiment of zoom lens system drive

Referring now to Fig. 1, reference numeral A10 designates, in schematic form, the first embodiment of the present invention which includes zoom lens A11 for a camera having a between-the-lens shutter, and selectively reversible motor A12 coupled to the lens system through drive system A13 for moving the lens in opposite directions as indicated by the arrows in Fig. 1 along an optical axis.

Embodiment A10 comprises switch means A1 operable by an operator to control operation of motor A12 for moving the lens from an initial position on the axis to a final stationary position that establishes the focal length of the lens. This embodiment also includes control means in the form of lens start drive means A2 and lens stop drive means A3 collectively responsive to switch means A1 for operating motor A12 such that movement of the lens from its initial to its final position always occurs after lens A11 travels to its final position in a predetermined direction. This is illustrated schematically within block LX.

This arrangement will accurately position the lens at the final position by always taking into account, to the same degree, any backlash in drive system A13 that connects motor A12 to lens A11.

The camera according to the present invention can be controlled variously according to information, automatically detected, concerning changes in focal length of the zoom lens in lens barrel block 1, changes of the open F value due to changes in focal length, and changes in lens position which can vary from the wide-angle or telephoto terminus, retraction position to macro-photographic position. For detecting lens position, code sheet 90, shown schematically in Fig. 5, is fixed to the outer circumference of cam ring 14 of lens barrel block 1. Fixed frame 91 located adjacent ring 14 carries a plurality of brushes 92 which sliding by contact the code sheet 90.

Fig. 13 is a development plan of code sheet 90, showing the relationship of the conductive portions on code sheet 90 to cam profiles of zooming cam grooves 20 and 21 in the cam ring 14, and the cam profiles of cam grooves 55, 56 and 57 in a cam plate 53 which are depicted above the development plan of the code sheet. Brushes 92 include common terminal C, and terminals T0, T1, T2, and T3. When terminals T0 to T3 are in contact with conductive lands 93 of the code sheet 90, a "0" signal is produced. When they are not in such contact, a "1" signal is derived. The angular position of cam ring 14 is detected from a combination of these "0" and "1" signals. Reference numeral 94 indicates a conductive region isolated from lands 93 by a non-conducting region. The information T0, T1, T2 and T3 is given as zoom code data ZP0, ZP1, ZP2 and ZP3 to a zoom code encoder. Fig. 14 is a table showing the combinations of zoom code data "1" and "0". In the embodiment of Fig. 5, the angular position (POS) of the cam ring 14 is divided into 13 steps ranging from "0" to "9" through "A", "B", and "C" (hexadecimal number). Position "0" corresponds to locking position LOCK and position "C" corresponds to the macro-photographic position (MACRO). Intermediate these positions are different focal-length positions ranging from f0 to f7'. The positions are also depicted at the bottom of code sheet 90 in Fig. 13. As seen in Fig. 14 the zoom code data is a Gray code in that one and only one bit changes from position to position.

The detail of "POS" are described below:

POS 1: The transition from the "LOCK" position to "WIDE" terminus position is detected by a change from "1" to "0" in the data derived from brush T2. Strictly speaking, the "LOCK" position is not "POS 0" but a point between "POS 0" and "POS 1". However, when the camera is in the "LOCK" position, the brush is in "POS 0" which is very close to "POS 1". Similarly, the transition from "WIDE" terminus to variable magnification "f0" is a point between "POS 1" and "POS 2" and is detected by a change data from "0" to "1" in the data derived from brush T0. However, "POS 2" of brush 92 is very close to "POS 1". Accordingly, "POS 1" connotes a range in which cam ring 14 moves from the "WIDE" terminus to "LOCK" and vice versa, and from "WIDE" terminus to "f0".

POS f7': This zone is provided for absorbing the backlash of cam ring 14 (lens system). As shown in Fig. 45, and as described in detail below, during rotation of the cam ring from "POS 0" toward "POS C",

the cam ring halts immediately when a stop signal is given (i.e. when the zoom switch is turned OFF). On the contrary, during rotation of the cam ring from "POS C" toward "POS 0", cam ring 14 reverses only after it overruns a selected position by a predetermined displacement and then it halts at a first changing point of "POS".

5 "POS f7" is the "TELE" terminus, and accordingly, when cam ring 14 is in "TELE" terminus ("TELE" zone: a zone in which the camera operates at the exposure of "TELE"), the brush is in "POS A" which is very close to "POS 9". Focal length information, or the F number information, is fed to the shutter by the code plate and the brush. Accordingly, the same focal length information is fed at the "TELE" zone and the "TELE" terminus. This is the reason that "pos 9" is represented by "f7", and "POS A" is represented by
10 "f7" to distinguish it from "f7". The zone of "f7" is very small and accordingly the zone of "F7" can be basically considered identical to "TELE" terminus.

POS B: This zone is provided to distinguish the transition between "MACRO" and "TELE" terminus, and "TELE" terminus and "POS 7".

15 POS 2 - POS A: These represent the zooming range of the lens and intermediate focal lengths consist of a plurality (nine in the illustrated embodiment) of focal-length steps.

The CPU checks the code information and setting positions of the various switches as soon as power is applied. If the mode changing switch is in "ZOOM", and the cam ring is located in any of "POS 2" - "POS A", no zooming is necessary. If the mode changing switch is in a position other than "ZOOM", namely in any one of "LOCK", an intermediate position between "LOCK" and "WIDE", an intermediate position
20 between "TELE" and "MACRO", or "MACRO", and is then changed to ZOOM, zooming operation is immediately effected. The same is true when the switch is changed to "ZOOM" during reverse rotation of the zoom motor, independently of whether the zoom code is within the range of "POS 2" = "POS A" which is the range in which zooming can be effected. If the zoom code is out of this range, no picture can be taken, and accordingly, the cam ring is moved to the zooming position. In other words, "POS1" and "POS
25 B" are positions in which the cam ring is prohibited from stopping, and in which a picture cannot be taken.

The rotation of cam ring 14 is controlled by mode changeover switch 101 and zoom switch 102. Figs. 15 to 17 show, a typical layout of switches 101 and 102 on the camera body. Reference numeral 99 indicates a multi-position button; when depressed to its first step, light-measuring switch 103 (see Fig. 20) is turned on; and further depressing to the second step turns on release switch 123 (also see Fig. 20).

30 The control system for the camera is described in detail below in reference to Figs. 20 and 25 but first, a brief overview of the control system is provided.

Mode changeover switch 101 is a transfer switch which can take three positions LOCK, ZOOM and MACRO. As shown in Figs. 17 to 19 when macro-photographic button 101a is not pressed, switch lever 101b can be shifted between LOCK and ZOOM positions. By sliding switch lever 101b onto macro-
35 photographic button 101a with the latter kept pressed, mode changeover switch 101 takes the MACRO position. When the mode changeover switch is at the LOCK position, the shutter cannot be released and zooming operation is not possible. With mode changeover switch 101 is set at the ZOOM position, the shutter can be released, and zooming operation is also possible. When switch 101 is set at the MACRO position, the shutter is releasable but zooming operation is not possible. Fig. 26 shows an example of
40 another zoom switch in which pressing the wide-angle button W and telephoto button T, respectively, will cause the lens to move to the zoom and wide-angle positions, respectively.

When released, zoom switch 102 takes a neutral position (OFF). When a force is applied in different directions, the switch is turned on and the setting is changed to either the WIDE or the TELE positions, depending upon the direction of the force. Operating switch 102 will cause zoom motor 5 to rotate in either
45 forward and reverse directions, according to the setting of the switch.

Mode changeover switch 101 and zooming switch 102 cause the camera to work as is described below.

- (1) Moving mode changeover switch 101 to LOCK position causes zoom motor 5 to rotate in the reverse direction. When the position (POS) of cam ring 14 detected by the code sheet 90 and brushes 92 becomes "0" (see Figs. 13 and 14), zoom motor 5 is stopped.
- 50 (2) Moving the mode changeover switch 101 to MACRO position causes zoom motor 5 to rotate in the forward direction. When POS = "C" (see Figs 13 and 14), zoom motor 5 is stopped.
- (3) Moving the mode changeover switch 101 to ZOOM position.

If zoom switch 102 is set at the WIDE position, zoom motor 5 rotates in the reverse direction while the zoom switch is on, and cam ring 15 moves rearwardly. If the mode changeover switch 101 remains set to the WIDE position, after POS becomes "1" (see Figs. 13 and 14), zoom motor 5 keeps rotating in the reverse direction for a short time. The rotation is reversed, and motor 5 rotates in the forward direction until POS becomes "2", at which point motor 5 is stopped.

If switch 102 is set to the TELE position, zoom motor 5 rotates in the forward direction while the switch

is on. While switch 102 remains the TELE position, cam ring 14 moves forwardly until POS = "A" (see Figs. 13 and 14) and zoom motor 5 is stopped.

If zoom switch 102 is turned off (at the neutral position) while zoom motor 5 is rotating forwardly in the TELE direction, the motor is immediately stopped. If switch 102 is turned off while motor 5 is rotating rearwardly in the WIDE direction (reverse), the motor is stopped only after it has been reversed and allowed to rotate in the forward direction for a short time. This forward rotation is intended to eliminate mechanical backlash in the lens drive system barrel block 1 and finder block 2 in order to eliminate a difference between the stop positions of motor 5 when rotating in the WIDE and TELE directions, respectively.

Referring now to Fig. 20, zoom motor control unit 100 (referred to as "ZM/C" hereinafter) is composed of, for example, a single-chip microcomputer having therein a program memory (ROM) in which the programs described below is stored.

ZM/C 100 is supplied with switch data from mode changeover switch 101, zoom switch 102, distance-measuring switch 103, and zoom encoder 104 (shown as a switch equivalent circuit). It also receives, from main control unit 109 (referred to as "MC/U" hereinafter), zoom motor disable signal DIS, serial data transfer clock CLK, and serial signal SI which carries switch checking/operation terminating data which is described below. ZM/C 100 supplies rotation control command RCM to zoom motor drive circuit 107 which controls zoom motor 5, and delivers to MC/U 109 a power-hold signal PH to turn on/off MC/U 109 and serial signal SO carrying zoom encoder data, ZP0 to ZP3 from zoom encoder 104.

Mode changeover switch 101 generates two signals, LOCK and MACRO as shown in Table 1 according to the aforementioned three positions LOCK, ZOOM and MACRO.

Table 1

	Signal	Name
Position	Lock	Macro
Lock	(ON)	(OFF)
Zoom	OFF	OFF
Macro	OFF	ON

Zoom switch 102 takes the three positions WIDE MOMENTARY, OFF, and TELE MOMENTARY.

Light-measuring switch 103 is actuated (to produce a signal SWS) when release button 99 is pressed to the first step to initiate operation of distance-measuring device 120 (comprising light-emitter 3 and photo-detector 4 as mentioned previously) and light-measuring device (A/E) 121.

Zoom encoder 104 converts the angular position of cam ring 14 to zoom codes ZP0 to ZP3 by means of code sheet 90 and brushes 92, and supplies the codes to ZM/C 100.

The switch scan control process effected through the terminal SSC is such that a high voltage "H" is developed at this terminal only when the above-mentioned input from each switch is checked, and a low voltage "L" is developed in other than the checking mode to reduce power consumption.

Voltage regulator 105 is supplied from battery 106 to supply the required drive voltages to ZM/C 100.

Zoom motor drive circuit 107 may be configured, for example, as shown in Fig. 21. The operation of this circuit is based on a rotation control command RCM of 4 bits (FOWN, FOWP, REVN and REVP) from ZM/C 100 for controlling rotation, and to stop zoom motor 5 as shown Table 2 and 3 where "ON" corresponds to a "1" in Fig. 14, and "off" corresponds to a "0".

Table 2

Forward Run					
	FOWN	FOWP	REVP	REVN	FUNCTION
1					OPEN
2	ON	ON	OFF	OFF	RUN FORWARD
3					OPEN
4	ON	OFF	OFF	ON	BRAKE
5					OPEN

Table 3

Reverse Run					
	FOWN	FOWP	REVP	REVN	FUNCTION
1	OFF	OFF	ON	ON	OPEN
2					RUN REVERSE
3					OPEN
4	ON	OFF	OFF	ON	BRAKE
5					OPEN

MC/U 109 maybe composed of, for example, a single-chip microcomputer, and performs the following functions by executing the programs stored in an internal program memory thereof:

- (1) control of the rotation of film takeup motor 111 through takeup drive circuit 110;
- (2) driving and control of shutter block 23 through driver 112;
- (3) control of various display indicators 115 through driver 114;
- (4) control of strobe unit 117 (strobe circuit includes xenon light-emitting tube 58) through interface 116;
- (5) outputting of zoom motor disable signal DIS to ZM/C 100 through interfaced 118;
- (6) outputting of serial transfer clock CLK through interface 118;
- (7) outputting, through interface 118, of serial signal SI which carries switch checking/operating terminating data described below; and
- (8) keeping regulator 124 in operation.

For the purpose of performing the above-mentioned functions, MC/U 109 is supplied with switch data from takeup motor control switch 119 of the film rewinding switch, rear-cover switch, etc., measured light data from the light-measuring device 121, detected distance data from distance-measuring device 120, film sensitivity setting or film sensitivity data from automatic film sensitivity read (ISO) 122, switch data SWR from release switch 123, etc.

MC/U 109 causes voltage regulator 124 to keep operating, or started/stopped depending upon the existence of power hold signal supplied through interface 118. In addition, regulator 124 is also put into operation with the switch data from takeup motor control switch 119; and, when it is in operation, voltage regulator 124 supplies required power to various circuits of the main control system except for the zoom control system.

Referring to the flow charts shown in Figs. 22 to 25, the operation of ZM/C 100 is explained below together with the programs stored in the ROM of ZM/C 100.

Referring to Fig. 22 S1 carries out an initialization process as ZM/C 100 is energized through regulator 105 by battery 106 contained in a battery case (not shown). At S2, the CPU effects a switch scan control process, detecting the state of each of mode changeover switch 101, zoom switch 102, light-measuring switch 103, and zoom encoder 104. Thereafter, S3 checks the status of light-measuring switch 103. If light-measuring switch 103 is ON, the CPU repeats the processes at S2 until light-measuring switch 103 is OFF. When light-measuring switch 103 is found to be OFF, the CPU advances the process to S4 where the status of zoom motor disable signal DIS is checked. If this signal is present, (i.e., DIS in ON, or DIS = "1") the process is advanced to S5; but if the signal is not present, (i.e., DIS = "0"), the process is advanced to S8.

Zoom motor disable signal DIS is provided for the purpose of prohibiting simultaneous operation of takeup motor 111 and zoom motor 5 in order to reduce power consumption and prolong the life of battery 106. Thus MC/U 109 turns on disable signal DIS only when MC/U 109 is actuated by takeup motor control switch 199 to enable operation of takeup motor 111. When zoom motor disable signal DIS is on, power hold signal PH is turned on (for example, "1"). The purpose of the output of power hold signal PH at S5 is to effect operation of takeup motor 111 at the time of MC/U 109 is actuated by takeup motor control switch 119, rather than to let operation of motor 111 take place unconditionally. In other words, operation of motor 111 can take place only after permission is given by the power hold signal supplied from the ZM/C 100. In this way, zoom motor 5 and takeup motor 111 cannot rotate simultaneously.

At S6, the process is suspended until disable signal DIS from MC/U 109 turns off; i.e., until the rotation control of takeup motor 111 by MC/U 109 terminates. When zoom motor disable signal DIS turns off, power hold signal PH is turned off (for example, "0"). At S7, which detects when DIS is off, regulator 124 is turned off, and the process is reset to S2. Even after regulator 124 is turned off, not all power supply stops. For example, power is still supplied to indicator 115.

When the process has advanced to S4 and signal DIS is off, the process then advances to S8 where a

switch scanning procedure is carried out similar to the procedure at S2. The process then advances to S9 where a POS conversion is effected in order to detect the POS values (refer to Figs. 13 and 14) from the zoom encoder, and the zoom code ZP0 to ZP3. At S10, the state of mode changeover switch 101 is tested for the states "LOCK", "ZOOM" or "MACRO", which had been determined previously at S8. If the position is "LOCK", the process is advanced to S11; if it is "ZOOM", to S14; and if it is "MACRO", to S16.

If the state of switch 101 is "LOCK", S11 tests whether the POS conversion at S9 yields $POS = 0$. If so, the process is reset to S2, otherwise the process is advanced to S12 which applies the appropriate signals to drive circuit 107 to effect reverse rotation of motor 5 (refer to the rotation control command in Table 3). A mode subroutine, described below, is then executed at S13, and the process is reset to S2 thereafter.

If the state of switch 101 is "ZOOM", S14 tests whether the POS conversion at S9 yields $POS \leq 1$. If so, the process advances to S17 to enable zoom motor 5 to rotate in the forward direction (refer to the rotation control command in Table 2). A mode subroutine described below is then executed at S13, and the process is reset to S2 thereafter.

In $POS > 1$, S15 tests whether the POS conversion at S9 yields $POS \geq B$. If so, the procedure advances to S12 where a mode subroutine described below is then executed at S13, and the process is reset to S2 thereafter; otherwise, the process advances to S18.

If the state of switch 101 is "MACRO", S16 tests whether the POS conversion at S9 yields $POS = C$. If so, the process jumps to S22; but if $POS = C$, the process is advanced to S17 to enable forward rotation of zoom motor 5. A mode subroutine described below is then called and executed at S13, and thereafter the process is reset to S2.

At S18, the state of zoom switch 102 is checked based on the switch screen at S8. If this switch is set to TELE, the TELE subroutine described below is called and executed at S19, and the process is reset to S2. If the switch is not set to TELE, the process advances to S20.

At S20, the state of zoom switch 102 is checked based on the switch scan at S8. If this switch is set to WIDE, the WIDE subroutine described below is called and executed at S21, and the process is reset to S2. If the switch is not set to WIDE, the process advances to S22 where the state of light-measuring switch 103 is checked based on the switch scan at S8. If switch 103 is not turned on, the process is reset to S2; otherwise the process advances to S23.

Processes S1 to S22 are main processes; and before explaining the processes at S23 and those that follow, the operation of the camera is described as are the mode subroutine at S13, the TELE subroutine at S19 and the WIDE subroutine at S21.

MODE SUBROUTINE OF FIRST EMBODIMENT

Referring to the flow chart of Fig. 23, the mode subroutine is detailed. The flow chart, and others that follow, utilize a flag stored in a register in the RAM of ZM/C 100, the flag being designated Fwide. When this flag is reset to 0, this connotes that the angular position of cam ring 14 is such that the lens system of the camera is located at a position other than its wide angle terminus position adjacent a transition to its variable magnification position (see Figs. 13 and 14). In such position, $POS = 2$ and the lens system is set at f_0 .

At S130, the CPU of ZM/C 100 resets flag Fwide to "0", and then effects sequential processes at S131 and S132 similar to those carried out previously at S8 and S9, respectively. Subsequently, at S133, the state of mode changeover switch 101 is determined based on the switch scan at S131. The process then advances to S134 if switch 101 is in "LOCK" position, to S138 if the switch is in "MACRO" position, or to S142 if the switch is in "ZOOM" position.

If switch 101 is set to "LOCK", the process advances to S134 which tests whether the POS conversion effected at S132 has produced $POS = 0$, namely, the LOCK position. If the result of this test is $POS = 0$, the process advances to S135 which stops rotation of zoom motor 5 (refer to the rotation control command RCM in Table 3) because the motor can be rotating only in reverse (due to S12), and a return process is then executed returning the program to S2 (Fig. 22). On the other hand, if the result of test S134 is $POS \neq 0$, zoom motor 5 may be operating in either its forward or reverse directions, and the process advances to S136 which checks whether the motor is operating in its reverse direction. If it is, the process is reset immediately to S131; otherwise (due to S17), the process advances to S137 which causes ZM/C 100 to issue a rotation control command that causes the motor to operate in the reverse direction; and thereafter the process is reset to S131.

If switch 101 is set to "MACRO", the advance to S138 tests whether the POS conversion effected at S132 has produced $POS = C$, i.e., the MACRO position. If so, the process advances to S139 which effects

braking of zoom motor 5 (refer to rotation control command RCM in Table 2) because the motor can be rotating only in its forward direction and a return process is then executed returning to S2 (Fig. 22). If POS = C, zoom motor 5 may be rotating either forwardly or in reverse, and the process advances to S140 which checks whether the motor is operating in its forward direction. If it is, the process is immediately reset to S131; otherwise, the process advances to S141 where zoom motor 5 is commanded to rotate in the forward direction before the process is returned to S131.

If switch 101 is set to "ZOOM", the process advances to S142 which tests whether the POS conversion effected at S132 has produced $POS \geq A$, $POS \leq 1$ or $2 \leq POS \leq 9$. The process advances to S143 if $POS \leq 1$, to S153 if $2 \leq POS \leq 9$, and to S157 if $POS \leq A$.

Recalling that entry into the mode subroutine can occur with the motor rotating in either forward or reverse, the direction of rotation is tested in the procedures that follow. If the POS conversion at S132 is such that $POS \leq 1$, the process advances to S143 at which a test is made to determine if zoom motor 5 is rotating in the forward direction. If so, the process jumps to S146; otherwise, the motor is rotating in the reverse direction and the process advances to S144 where a standby process is carried out for a predetermined period of time, t msec, for a reason described below. After a delay of t msec, the process advances to S145 where a command is issued to motor 5 to reverse direction and rotate in the forward direction. After this command, the process advances sequentially to S146 and S147.

At S146 and S147, processes similar to those carried out at S8 and S9 in Fig. 22 take place to scan the states of the switches and to effect position conversion. Thereafter, at S148 and S149, the state of switch 101 is decoded to detect whether the operator has changed switch 101 from "ZOOM", to "LOCK" or to "MACRO". The current state of switch 101 is based on the switch scan at S146. If switch 101 has been changed to "LOCK", the process is reset to S134. On the other hand, if switch 101 has been changed to "MACRO", the process is reset to S138. If switch 101 remains "ZOOM", the process advances to S150.

S150 tests whether the POS conversion at S147 yields $POS = 2$. If so, the process is reset to S146; otherwise, the process advances to S151. Recalling that at $POS = 2$, the lens system is located at its wide angle terminus, S151 sets flag Fwide to "1" and the procedure advances to S152 where zoom motor 5 is braked by a suitable command (see Table 2) and stopped. Thereafter, the process is reset to S2 (Fig. 22).

If the POS conversion at S132 is such that $2 \leq POS \leq 9$, the process advances to S153 which tests whether zoom motor 5 is rotating in the forward direction. If so, the process jumps to S156 which causes ZM/C 100 to issue a brake command that stops the zoom motor; thereafter, reset to S2 occurs. On the other hand, if zoom motor is rotating in the reverse direction, the process advances to S154 where a command to rotate motor 5 in the forward direction is sent; and thereafter, the process advances to S155 where a standby process is carried out for a predetermined period of time, t msec, for a reason described below. After an elapse of t msec, the process advances to S156 where a command to brake and thus stop zoom motor 5 is sent. Thereafter, reset to S2 (Fig. 22) occurs.

If the POS conversion at S132 is such that $POS \geq A$, the process advances to S157 which tests whether zoom motor 5 is rotating in the reverse direction. If it is, the process jumps to S159; otherwise, the process advances to S158 at which a command is issued to rotate motor 5 in the reverse direction; thereafter, the process advances to S159.

At S159 and S160, process similar to those for S8 and S9 in Fig. 22 are carried out; and thereafter, at S161 and S162, processes similar to the processes for S148 and S149 are carried out.

If mode changeover switch 101 remains in "ZOOM" position (as originally ascertained at S159, which is to say that the process advances through S161 and S162) S163 tests whether zoom motor 5 is rotating in the reverse direction. If so, the process advances to S164; otherwise the process advances to S167.

S164 tests whether the POS conversion at S160 resulted in $POS = 9$. If so, the process is reset to S159; otherwise, processes similar to processes carried out at S144 and S145 are effected at S165 and S166, and the process is thereafter reset to S159.

If the process has advanced to S167 because the motor had been operating in the forward direction when S163 was executed, a test is carried out to determine whether the POS conversion at S160 yields $POS = A$ which is indicative of whether telephoto terminus (77' in Fig. 14) has been reached. If $POS = A$, the process is reset to S159; otherwise, the process advances to S168 at which a command is issued to stop zoom motor 5. Thereafter, the process is reset to S2 (Fig. 22).

TELE SUBROUTINE OF FIRST EMBODIMENT

The flow chart of Fig. 24 details the TELE subroutine. At S190, the CPU of ZM/C 100 resets wide-angle terminus flag Fwide to "0", and the process advances to S191 where the result of the POS conversion at S9 (Fig. 22) is tested for $POS = A$. If $POS = A$, the process is immediately reset to S2 (Fig. 22); otherwise,

the process advances to S192 to effect forward rotation of zoom motor 5. Thereafter, the process sequentially advances to S193 to S196. At S193 and S194, processes similar to those of S8 and S9 (Fig. 22) are carried out. At S195, the result of the POS conversion at S194 is tested for $POS = A$. If $POS = A$, the process jumps to S197 where braking and stopping of zoom motor 5 occurs; and thereafter the process is reset to S2 (Fig. 22). If $POS \neq A$, the process advances to S196 which tests whether zoom switch 102 has been changed from "ZOOM" to "TELE" based the switch scan at S193. If switch 102 has been changed to "TELE", the process is reset to S193; otherwise, the process advances to S197 where zoom motor 5 is caused to stop. Thereafter, the process is reset to S2 (Fig. 22).

10 WIDE SUBROUTINE OF FIRST EMBODIMENT

The flow chart of Fig. 25 details the WIDE subroutine. At S210, the CPU of ZM/C 100 tests whether wide-angle terminus flag Fwide has been set to $Fwide = 1$. The test is to determine if motor 5 has stopped at the wide-angle terminus. If $Fwide = 1$, the process is immediately reset to S2 (Fig. 22); otherwise, the process advances to S211.

At S211, zoom motor 5 is commanded to rotate in the reverse direction, and the process advances to S212 which is a standby process that delays advance of the process to S213 for a predetermined period of time, t msec, for a reason described below. After the elapse of t msec, processes similar to those for S8 and S9 (Fig. 22) are effected at S213 and S214 before the process advances to S215 where the POS conversion at S214 is tested for $POS = 1$. If $POS = 1$, the process sequentially advances to S216 and then to S217; otherwise, the process advances to S223.

At S216 and S217, processes similar to the processes of S144 and S145 (Fig. 23) respectively, are executed before the process advances sequentially to S218 and S219, where processes similar to the processes of S8 and S9 (Fig. 22) are executed.

After the position conversion procedure of S219 is executed, the process advances to S220 which tests whether the POS conversion at S219 is $POS = 2$. If $POS = 2$, the process is reset to S218; otherwise a procedure is executed at S221 to set the wide-angle terminus flag Fwide to "1", followed by the execution of procedure S222 which brakes and thus stops rotation of zoom motor 5. The process is thereafter reset to S2 (Fig. 22).

If the test at S215 finds $POS \neq 1$, the process advances to S223 to check whether zoom switch 102 has been changed from WIDE as detected at S214. If switch 102 is still set to WIDE, motor 5, which is operating in reverse, drives the lens mount to $POS = 1$. If switch 102 is not set to "WIDE", the process advances sequentially to S224, S225 and S226, where procedures similar to procedures carried out at S155 and S156 (Fig. 23), respectively, are effected. Thereafter, this process is reset to S2 (Fig. 22).

35 OPERATION OF FIRST EMBODIMENT

The effects of the processes at S1 to S22 in Fig. 22, and those in Figs. 23 to 25 is explained below.

(1) Battery 106 is connected and none of the following switches are manipulated: takeup motor control switch 119, shutter release button 99 (and switch 123), and zoom switch 102.

a) If mode changeover switch 101 is set to LOCK position, the CPU of ZM/C 100 carries out the initialization process at S1 in Fig. 22 and thereafter repeats processes according to the first loop S2 to S4, S8 to S11 and S2 on the condition that the rotational position of cam ring 14 (that controls the motion of the front lens group L1 and rear lens group L2) is $POS = 0$; and no camera operations take place. If, during the above processes, shutter release button 99 is pressed to close switch 123 and to close light-measuring switch 103, the processes for S2 and S3 are executed repeatedly until switch 103 opens; and the operation of the shutter release button 99 is disregarded.

If the rotational position of the cam ring 14 is $POS \neq 0$, the process at S12 in Fig. 22 effects reverse rotation of zoom motor 5 which continues during repetitive execution of processes S131 to S134, S136 and S137 until cam ring 14 has moved to $POS = 0$. At this point, the process is reset to S2 of the first loop.

b) If mode changeover switch 101 is changed from LOCK to ZOOM position, the CPU of ZM/C 100 executes the first loop and then advances the program to S17 causing zoom motor 5 to rotate forwardly, and the process sequentially advances through S130 to S133, and S142 (Fig. 23), and then to S143, S146 and S147 on condition that mode changeover switch 101 is not changed from ZOOM to either LOCK, or to MACRO when procedures S148 and S149 are executed. Loop S150 and S146 to S149 is executed until $POS = 2$; and when this condition is detected at S150, zooming motor 5 is braked to a stop at S152 through S151 before the process is reset to S2 (Fig. 22). In other words, the

rotational stop position of cam ring 14 is the wide-angle terminus ($POS = 2$) where the focal length shown in Fig. 14 is f_0 .

After the process is reset to S2, the CPU of ZM/C 100 repeats processes according to second loop S4, S8 to S10, S14, S15, S18, and S4 on condition that no further switch manipulations are made.

c) If switch 101 is changed from ZOOM to MACRO position when cam ring 14 has stopped at the wide-angle terminus (i.e., $POS = 2$), the CPU of ZM/C 100 causes the program to exit the second loop at S10, and to advance to S16. Because $POS = 2$ at that time, the process at S17 causes zoom motor 5 to rotate in the forward direction, and the sequential processes of S131 to S133, S138, S140 and S131 (Fig. 23) are repetitively executed until $POS = C$ is detected, at which time procedure S139 brakes motor 5 to a stop. When $POS = C$, the process is reset to S2 (Fig. 22), and the processes according to a third loop of S4, S8 to S10, S16, S22 and S4 repeat on condition that no further camera manipulations are made.

d) If mode changeover switch 101 is changed from MACRO to ZOOM position, the CPU of ZM/C 100 causes the program to exit third loop at S10, and to sequentially advance through S14, S15 and S12, because $POS = C$ at that time. The execution of procedure S12 causes motor 5 to rotate in reverse; and thereafter, the procedures of S131-S133, S142, S157, S159 and S160 are sequentially executed. On condition that mode changeover switch 101 remains in ZOOM position, the process drives cam 14 to $POS = 9$ by executing loop S163, S164, and S159 to S163. when $POS = 9$ is detected at S164, a t msec delay occurs at S165 and at S166, after which the rotation of zoom motor 5 is changed from reverse direction to forward direction. The purpose for procedures S165 and S166 are described below.

Changing switch 101 from MACRO to ZOOM position, causes cam ring 14 to stop at $POS = A$ from the $POS = 9$ side. If zoom motor 5 were to stop at $POS = A$ by having its rotation change from reverse direction to forward direction immediately after reading $POS = 9$ from $POS = A$, there is the possibility that backlash due to the gearing of the drive and transmission system associated with zoom motor 5 will prevent proper positioning of cam 14. By having zoom motor 5 continue to rotate in the reverse direction for t msec after detection of $POS = 9$, and by thereafter rotating motor 5 in the forward direction, motor 5 can be stopped precisely at $POS = A$ under the condition that backlash on the forward-rotation side is removed. Procedures S165 and S166 achieve this result. After the motor is commanded to run in the forward direction by executing the procedure at S166, the program will drive cam 14 to $POS = A$ by executing loop S159 to S163, S167 and S159. When $POS = A$ is detected at S167, the process advances to S168 where the motor is braked and stopped. Thereafter, the process is reset to S2 (Fig. 22).

After the process is reset to S2, cam ring 14 will be its telephoto terminus ($POS = A$) where the focal length shown in Fig. 14 is f_7' . The cam ring will remain in this position, which is the same as described in item (b) above, on condition that no switch manipulations are made, after the process is reset to S2 because the second loop is repeatedly executed.

Switch 101 may be changed from MACRO to ZOOM position during the loop process S131-S133, S138, S140, S141, S131 while cam ring 14 is at a position corresponding to $POS = A$ and the motor is running in the forward direction. In such case, branching to S157 occurs as S142. In branch S157, the process at S158 causes zoom motor 5 to reverse its direction of rotation and begin to run in the reverse direction.

(e) If mode changeover switch 101 is changed from ZOOM to MACRO position when cam ring 14 is stopped at its telephoto terminus ($POS = A$), the process that follows will be similar to that described in item (c) above with the exception that the starting point is $POS = A$ instead of $POS = 2$.

(f) The tests performed at S148, S149, S161 and S162 (Fig. 23) mentioned in the descriptions in items (b) to (d) above, determine whether mode changeover switch 101 has been changed from ZOOM to LOCK, or to MACRO position. If the change is to LOCK position, the branch beginning at S134 is entered and the procedures S136, S137 are executed until cam ring 14 stops at $POS = 0$; thereafter, reset to S2 occurs. If the change is to MACRO position, the branch beginning at S138 is entered and the procedures S140, S141 are executed until cam ring 14 stops at $POS = C$; thereafter, reset to S2 occurs.

(g) If mode changeover switch 101 is changed to the ZOOM position while cam ring 14 is at a position corresponding to $2 \leq POS \leq 9$ during either the loop processes of S131 to S133, S138, S140, S141 and S131 (Fig. 23), or the loop processes of S131 to S137 and S131 (Fig. 23), the CPU of ZM/C100 branches in the program occurs at S133, and the process advances to S142 and then to S153.

If zoom motor 5 is rotating in the forward direction, the process jumps from S153 to S156 where zoom motor 5 is immediately braked to a stop, and the process thereafter returns to S2. On the other hand, if zoom motor 5 is rotating in the reverse direction, the process advances to S154, where a delay of t msec occurs to remove backlash on the forward-rotation side, before the process advances to S156 where the motor is braked to a stop. The rotational position of the cam ring 14, when it stops, will be a position where the focal length shown in Fig. 14 lies in the range f_0 to f_7 . While cam ring 14 is in a corresponding position corresponding to $2 \leq \text{POS} \leq 9$, mode changeover switch 101 assumes the ZOOM position according to the operational specifications of zoom switch 102 as will be described below.

h) If mode changeover switch 101 is changed from LOCK to ZOOM position when cam ring 14 is located at $\text{POS} = 1$ while executing procedure S131-S136 (Fig. 23), zoom motor 5 will be operating in the reverse direction driving cam 14 away from $\text{POS} = 2$ which is the desired end point of cam 14 for ZOOM mode of operation. The changed switch position will be sensed at S133 advancing the process to S142 which will advance the process to the branch beginning at S143 (Fig. 23). After a delay of t msec, during which the motor continues to rotate in the reverse direction; motor 5 will begin to operate in the forward direction by sequential execution of the procedures at S144 and S145. The loop S146-S150 will be executed until $\text{POS} = 2$ is detected at S150. Thus, the wide angle terminus position of cam 14 ($\text{POS} = 2$) is reached when motor 5 is running in the forward direction. If motor 5 were permitted to stop at $\text{POS} = 2$ by reversing its reverse rotation to forward direction immediately after cam ring 14 reached $\text{POS} = 1$ from $\text{POS} = 2$, there would be a possibility that zoom motor 5 would stop in the condition that the backlash of the toothed wheels, etc. of the drive and transmission system of the zoom motor 5 would still be present. By causing zoom motor 5 to rotate in the reverse direction for an additional period of t msec, and by causing zoom motor 5 to rotate in the forward direction thereafter, zoom motor 5 can be stopped at $\text{POS} = 2$ under the condition that the backlash on the forward-rotation side is removed.

(2) If motor control switch 119 is changed while the CPU of ZM/C100 is executing a loop process of the type described above, the following occurs:

When the CPU of MC/U109 turns on the zoom motor disable signal DIS, the CPU will advance the process from S4 to S5 in Fig. 22. At S5, by turning on power hold signal PH, MC/U 109 is enabled to rotate takeup motor 111 whose rotation starts. After MC/U 109 terminates control of takeup motor 111, and turns off zoom motor disable signal DIS, the CPU of ZM/C100 advances the process from S6 to S7, turns off power hold signal PH and resets the process to S2.

Branching from the above described first or second loop processes to S4, and then to S7, prevents operation of zooming motor 5 while takeup motor 111 is operating; and manipulations of light-measuring switch 103 and shutter release switch 123 are disregarded at the same time.

(3) If zooming switch 102 is changed to the TELE side while the CPU of ZM/C100 is executing a process according to the above described second loop, the following occurs:

The CPU of ZM/C100 advances the process from S18 to S19 in Fig. 22, and calls and executed the TELE subroutine shown in Fig. 24. After wide-angle extremity flag F_{wide} is reset to "0" at S190, the process advances to S191. If cam ring 14 is already stationary at the telephoto terminus position ($\text{POS} = A$), zoom motor 5 need not be rotated, and the process is therefore immediately reset to S2 in Fig. 22. If cam ring 14 is located at any position other than the telephoto terminus, (e.g., at $2 \leq \text{POS} \leq 9$ when the TELE subroutine is called), the procedure at S192 causes zoom motor 5 to rotate in the forward direction. Thereafter, on condition that zoom switch 102 is not returned to neutral position from the TELE side, loop S193 to S196 and S193 is repeatedly executing until cam ring 14 reaches $\text{POS} = A$. When this occurs, procedure S197 stops further movement of zoom motor 5, and the process is thereafter reset to S2 (Fig. 22).

As above, in the case where zooming switch 102 is manipulated to the TELE side, cam ring 14 stops at the telephoto extremity if switch 102 is not further changed. However, if zoom switch 102 is returned to its neutral position during movement of cam ring 14 toward the telephoto terminus, the process proceeds from S196 to S197, and zoom motor 5 is stopped immediately. In other words, by properly timing the change in zoom switch 102 from TELE side to neutral position, cam ring 14 can be stopped at any desired position (i.e., at any desired focal length of the lens system) corresponding to $2 \leq \text{POS} \leq 9$.

(4) If zoom switch 102 is changed to the WIDE side while the CPU of ZM/C100 is executing a process in the above described second loop, the following occurs:

The CPU of ZM/C100 advances the process from S20 to S21 (Fig. 22), and calls and executed the WIDE subroutine shown in Fig. 25. At first, the state of wide-angle extremity flag F_{wide} is tested at S210; and if $F_{\text{wide}} = 1$, cam ring 14 remains at the wide-angle extremity ($\text{POS} = 2$), and no rotation of

zooming motor 5 occurs because the process is immediately reset to S2 (Fig. 22). If Fwide = 0, S211 causes motor 5 to rotate in reverse.

At S212, a delay of t msec is effected. During this delay, motor 5 continues to run in reverse to take into account the possibility that switch 102 will be returned to its neutral position immediately after it is changed to the WIDE side. In such case, the amount of reverse-rotational operation of zoom motor 5 becomes undefined, and there is the possibility that the amount of reverse rotation that takes place will be too great to be overcome by the backlash-removing operation due to S224 and S225.

After the process at S212 is executed, loop S213-S215, S223-S213 is repeatedly executed until cam ring 15 arrives at POS = 1, on condition that zoom switch 102 is not returned from WIDE to neutral position. When POS = 1, processes similar to the aforementioned processes for S165 and S166 are accomplished at S216 and S217, and the loop of S218 to S220 and S218 is processed to remove backlash as cam 14 is driven to POS = 2.

When cam ring 14 comes to the wide-angle terminus (POS = 2), the process advances to S221 where flag Fwide is set to "1", and then to S222 where rotation of zoom motor 5 is stopped. Thereafter, the process is reset to S2 (Fig. 22).

As above, if zoom switch 102 is changed to the WIDE position, cam ring 14 stops at the wide-angle terminus POS = 2 if the WIDE position setting is maintained. Of course, if zoom switch 102 is opened and returns to its neutral position during movement of cam ring 14 towards the wide-angle terminus, a backlash-removing process similar to the aforementioned process at S154 and S155 in Fig. 23 is effected at S223 to S224 and S225; and zoom motor is subsequently stopped at S226. In other words, by returning zoom switch 102 from its WIDE position to its neutral position at the appropriate time, cam ring 14 will stop at any desired position (desired focal length) in the range $2 \leq \text{POS} \leq 9$.

Turning now to the processes after S22 in Fig. 22, while the CPU of ZM/C 100 is executing a process in the above described second loop, actuation of shutter release button turns on light-emitting switch 103 (on condition that takeup motor control switch 119 does not turn on), and the CPU of ZM/C 100 advances the process from S22 to S23.

At S23, power hold signal PH is turned on to actuate MC/U 109. Next at S24, the presence of zooming motor disable signal DIS from MC/U 109 is tested to confirm actuation of MC/U 109. If the actuation is confirmed, a serial-transfer of the result of the POS conversion at S9 is made to MC/U 109 at S25. The result of the POS conversion (zoom code data) is set in an output register; and the data thus set is converted into the serial signal SO synchronously with clock CLK supplied from MC/U 109 for serial-transfer to MC/U 109. The process waits for the above-mentioned transfer process to terminate at S26, and proceeds to S27 upon termination.

At S27 the transfer of serial signal SI containing switch check/operation termination data from MC/U 109 is completed; and at S28, the input data is checked. The process advances to S29 if the input data is the operation termination data (power hold turning-off request data) END showing that the operation of MC/U 109 has terminated; to S31 if the input data is light-measuring switch check data SWSCHK; or to S34 if the input data is mode changeover switch LOCK check data LOCKCHK.

When the process advances to S29, power hold signal PH is turned off because the operation of MC/U 109 will have terminated, and the process advances to S30 where zoom motor disable signal DIS from MC/U 109 is turned off. The process is thereafter reset to S2.

When the process advances to S31, power hold signal PH is temporarily turned off in order to inform MC/U 109 that switch 103 is turned on, and the process advances to S32, where input of data on each switch is carried out by a process similar to the process at S2. At S33, a test is made to determine if light-measuring switch 103 is turned based on the data read at S32. If light-measuring switch 103 is not turned on, the process waits at S30 for zoom motor disable signal DIS to turn off; thereafter, the process is reset to S2. This signifies that power hold signal PH was turned off at S31 in case light-measuring switch 103 is off.

If light-measuring switch 103 is turned on, the process advances to S36 which tests whether mode changeover switch 101 is positioned at the LOCK position based on the data at S32. If mode changeover switch 101 is found to have changed to the LOCK position, the process is reset to S2 through S3 because it is unnecessary to determine if light-measuring switch 103 is turned on. However, if mode changeover switch 101 is found not to have been changed, power hold signal PH is again turned on at S37, and the process is reset to S27. In other words, when MC/U 109 tests whether light-measuring switch 103 is turned on, the CPU of ZM/C 100 informs MC/U 109 of that fact by turning on and off the power hold signal PH if switch 103 is turned on.

Finally, at S34 to S37 and S30, MC/ 109 is informed whether mode changeover switch 101 is changed to the LOCK position.

The zoom code data (the result of POS conversion), and light-measuring switch 103 turned-on data to be transferred from ZM/C 100 to MC/U 109 at S23 to S37 is utilized by MC/U 109 as described below. The zoom code data represents the F stop value of the lens which varies according to the variable power position. These data are supplied to a circuit (not shown) for controlling the shutter speed of shutter block 23.

POS = C represents the position of the lens at its MACRO position. An indication of POS = C is applied to indicator 115 in the viewfinder in case the distance measurement data developed by distance-measuring device 120 is not within the MACRO range to provide a visual indication to the photographer, and to disable actuation of shutter release switch 123. Finally, data indicating that light-measuring switch 103 is turned-on is available to initiate operation of light-measuring device 121.

In the above-described first embodiment, regulator 105 is unconditionally actuated at the point when battery 106 is mounted in the battery case; however, it is alternatively possible, for example, to insert a manually operable switch into the power supply line from battery 106 to regulator 105 for effecting manual starting of the actuation of ZM/C 100 by the photographer.

SECOND EMBODIMENT OF ZOOM LENS DRIVE

Referring now to Fig. 2, reference numeral B10 designates, in schematic form, a second embodiment of the present invention which includes zoom lens B11 for a camera having a between-the-lens shutter including motor B12 for moving the lens (through a mechanical coupling, not shown) in forward rearward directions as indicated by the arrows in Fig. 2 along an optical axis. Switch means B2 has two operator input settings to control operation of motor B12 for moving lens B11 from an initial to a final, stationary position establishing the focal length of the lens. Embodiment B10 also includes position detection means B1 for detecting the position of the lens, and control means B3 response to operation of switch means B2 to either of its two positions for operating the motor such that:

- (1) lens B11 moves a predetermined number of discrete focal-length steps from its initial position to its final position; and
- (2) movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction.

In the second embodiment of the invention, the manner of driving the lens is different from the manner of driving the lens in the first; but only a change in program is required. Before describing this embodiment in detail, the manner of driving the lens is first described.

1) When mode changeover switch 101 is set to LOCK position and cam ring 14 is located at any position other than POS = 0, zoom motor 5 rotates in the reverse direction driving cam ring 14 in the rearward direction until POS = 0 (see Figs. 13 and 27) is detected, and then stops.

2) When mode changeover switch 101 is set to MACRO position and cam ring 14 is located at any position other than POS = "C", zoom motor 5 rotates in the forward direction driving cam ring 14 forwardly until POS = "C" (see Figs. 13 and 27) and then stops.

3) When mode changeover switch 101 is set to ZOOM position, and cam ring 14 is located at any position other than POS = "2" (i.e., at any of focal-length steps f_0 to f_7):

- a) each time zoom switch 102 is changed to TELE position, zoom motor 5 rotates in the forward direction and stops after cam ring 14 has experienced a change of one focal-length step; and
- b) each time zoom switch 102 is changed to WIDE position, ZOOM motor 5 rotates in the reverse direction until cam ring 14 experiences a change in two focal-length steps, then reverses after passage of a predetermined period of time, and rotates in the forward direction until the cam ring experiences a change of one focal-length step, with the result that a decrease of one focal-length step occurs relative to the step at which switch 102 was changed to WIDE position. The reason for so driving the cam ring is that the mechanical backlash at lens barrel block 1 and finder block 2 is eliminated for no difference between the stop positions of zoom motor 5 when the latter stops either after rotating in the WIDE direction, or stops after rotating in the TELE direction, respectively.

The entire control system, including the above-described control, of the camera is described below in reference to Figs. 28 to 30. The main flow chart of the second embodiment is identical with that shown in Fig. 22, and the explanation thereof is the same as in the first embodiment.

The flow chart of the mode subroutine (Fig. 28) for the second embodiment is different from the flow chart of the mode subroutine of the first embodiment. In the mode subroutine of Fig. 28, the CPU of ZM/C 100 resets wide-angle terminus flag (the wide-angle terminus being POS = 2, or f_0 in Figs. 13 and 27) Fwide to "0" at S130A (this flag resetting is optional in the second embodiment). At S131A and S132A, procedures similar to those at S8 and S9 in Fig. 22 are executed. At S133A, mode changeover

switch 101 is tested for "LOCK", "ZOOM" or "MACRO" based on the switch scan at S132A. The process advances to S143A if switch 101 is set to "LOCK" position, to S138A if switch 101 is set to "MACRO" position, and to S142A if switch 101 is set to "ZOOM" position.

5 If switch 101 is set to "LOCK" position, S134A tests whether the conversion at S132A has resulted in POS = 0. If so, zoom motor 5 is braked to a stop at S135A (refer to the rotational control command RCM in Table 3) because the motor is rotating in the reverse direction; and the process is thereafter reset to S2 (Fig. 22). On the other hand, if POS ≠ 0, S136A tests whether zoom motor 5 is rotating in the reverse direction. If it is, the process is immediately reset to S131A; otherwise, the process is reset to S131A after the process at S137A causes motor 5 to rotate in the reverse direction.

10 If switch 101 is set to "MACRO" position, S138A tests whether the conversion at S132A has resulted in POS = C. If so, zoom motor 5 is braked at S139A because the motor is rotating in the forward direction; and thereafter, the process is reset to S2 (Fig. 22). If POS ≠ C, S140A tests whether motor 5 is rotating in the forward direction. If it is, the process is immediately reset to S131A; otherwise, the process is reset to S131A after the process at S141A causes motor 5 to rotate in the forward direction.

15 If switch 101 is set to "ZOOM" position, S142A tests whether the POS conversion at S132A is POS ≥ A, or POS ≤ 1, or 2 ≤ POS ≤ 9. The process advances to S143A if POS ≤ 1, to S153A if 2 ≤ POS ≤ 9, or to S165A if POS ≥ A. If POS ≤ 1, S143A tests whether zoom motor 5 is rotating in the forward direction. If it is, the process jumps to S146A; otherwise the procedure at S144A is executed.

20 At S144A, a standby process is executed whereby further advance of the process is delayed for a predetermined period of time, t msec for the reason described below. After the elapse of t msec, S145A changes the direction of zoom motor 5 from reverse direction to forward direction.

Next, at S146A and S147A, processes similar to those for S8 and S9 in Fig. 22 are conducted; and thereafter, at S148A and S149A, tests are made to determine if switch 101 has been changed from "ZOOM" to either "LOCK" or "MACRO" based on the switch scan at S146A. If the position has been 25 changed to "LOCK", the process is reset to S134A; but if the position has been changed to "MACRO", the process is reset to S138A. If the position remains "ZOOM", the process advances to S150A.

S150A tests whether the POS conversion at S147A has resulted in POS = 2. If so, the process advances to S151A; otherwise the process jumps to S146A. Recalling that at POS = 2, the lens system is located at its wide-angle terminus, flag Fwide is set to "1" at S151A (this flag setting is only optional in 30 this embodiment), and the process advances to S152A where zoom motor 5 is braked to a stop; thereafter, the process is reset to S2 (Fig. 22).

If the POS conversion at S132A is such that 2 ≤ POS ≤ 9, the process advances from S142A to S153A which tests whether motor 5 is rotating in the forward direction. If so, the process jumps to S160A where the result of the POS conversion at S132A is stored in register MPOS. Thereafter, at S161A and 35 S162A, processes similar to those at S8 and S9 in Fig. 22 are effected.

The motor is now running in the forward direction driving cam ring 14 in the direction of f7'. At S162A, a POS conversion is done; and at S163A, POS = Mpos + 1 is evaluated. If true, POS has changed by one focal-length step in the TELE direction; and S164A brakes zoom motor 5 to a stop; and thereafter, the process is reset to S2. If POS = Mpos + 1 evaluates to false, the process repeatedly 40 executes S161A, S162A until POS = Mpos + 1 evaluates to true.

If the test at S153A shows that zoom motor 5 is rotating in the reverse direction, the process advances to S154A where the result of the POS conversion at S132A is stored in register Mpos. After scanning the switches at S155A, and making a POS conversion at S156A, the process advances to S157A where POS = Mpos - 1 is evaluated. If true, POS has changed by one step in the "WIDE" 45 direction, and the process thereafter advances to S158A. If POS = Mpos - 1 evaluates to false, the process repeatedly executes S155A, S156A until Mpos - 1 evaluates to true; thereafter, the process advances to S160A. At S158A and S159A, processes similar to the above-described processes at S144A and S145A are carried out. Thereafter, the processes at S160A to 164A are effected, and the process is thereafter reset to S2 (Fig. 22).

50 If the POS conversion at S142A is such that POS ≥ A, the process advances to S165A which tests whether motor 5 is rotating in the reverse direction. If it is, the process jumps to S167A; otherwise, the process advances to S166A which reverses motor 5 before the process advances to S168A.

At S167A and S168A, processes similar to those for S8 and S9 in Fig. 22 are executed; and at S169A and S170A, processes similar to the processes for S148A and S149A are executed.

55 If mode changeover switch 101 remains in "ZOOM" position (as ascertained at S167A), S171A tests whether zoom motor 5 is rotating in the reverse direction. If so, the process advances to S172A; and, if not, to S175A. At S172A, the POS conversion at S168A is tested for POS = 9. If POS = 9, the process is reset to S167A; otherwise, the process is reset to S167A after executing the procedures at S173A and

S174A which are similar to the procedures at S144A and S145A described above. S175A tests whether the POS conversion at S168A has resulted in $POS = A$, namely, whether the telephoto terminus (f7' in Fig. 27) has been reached. If $POS = A$, the process is reset to S167A; otherwise, the process is reset to S2 (Fig. 22) after executing the procedure at S176A at which motor 5 is braked to a stop.

5

TELE SUBROUTINE OF SECOND EMBODIMENT

Referring now to the flow chart of the TELE subroutine in Fig. 29, at S190A the CPU of ZM/C 100 checks whether the POS conversion at S9 in Fig. 22 has resulted in $POS = A$.

10 If $POS \neq A$, namely $2 \leq POS \leq 9$, the process advances to S191A where the result of the POS conversion at S9 (Fig. 22) is stored in register Mpos; thereafter, at S192A, motor 5 is caused to rotate in the forward direction.

Subsequently, at S193A and S194A processes similar to those at S8 and S9 in Fig. 22 are effected. Afterwards, S195A tests whether the POS conversion at S194A has resulted in $POS = Mpos + 1$ to determine if the position of cam ring 14 has changed by one focal-length step in the TELE direction. If $POS = Mpos + 1$ evaluates to true, motor 5 is braked at S196A and stops; and the process thereafter advances to S197A. If $POS \neq Mpos + 1$, the processes at S193A to S195A are repeated until $POS = Mpos + 1$, i.e., until the position of cam ring 14 has increased by one focal-length step; thereafter, the process advances to S197A where the procedures described below are executed. If $POS = A$, the process jumps to S197A which scans the switches, and then advances to S198A which checks whether zooming switch 102 is still positioned at the TELE side. If so, the processes at S197A and S198A are repeatedly executed because the lens is properly positioned at the telephoto terminus. However, if switch 102 is not positioned at the TELE side, the process returns to S2 (Fig. 22).

25 WIDE SUBROUTINE OF SECOND EMBODIMENT

Referring now to the flow chart of the WIDE subroutine in Fig. 30, at S210A, the CPU of ZM/C 100 first tests whether the POS conversion at S9 in Fig. 22 has resulted in $POS = 2$, which indicates that zoom motor 5 has positioned cam ring 14 at the wide-angle terminus. If $POS = 2$, the process jumps to S222A where a scan of the switches is carried out before advancing to S223A, which tests whether zoom switch 102 is still set at the WIDE position. If so, the processes at S222A and S223A are repeatedly executed awaiting a change. If switch 102 is not set to the WIDE position, the process is reset to S2 in Fig. 22.

If the result of the POS conversion at S9 in Fig. 22 is $POS \neq 2$, the process advances to S211A where the result of POS conversion at S9 in Fig. 22 is stored in register Mpos. At S212A, zoom motor 5 is commanded to rotate in the reverse direction driving the cam ring towards the WIDE angle terminus.

At S213A and S214A, processes similar to those at S8 and S9 in Fig. 22 are executed; and subsequently, at S215A, $POS = Mpos - 2$ is evaluated using the result of the POS conversion at S214A. If $POS = Mpos - 2$, which means that the cam ring has moved two steps from its original position in the direction of the WIDE terminus, the process advances to S216A; otherwise, the processes at S213A to S215A are repeatedly executed until $POS = Mpos - 2$.

At S216A and S217A, processes similar to processes at S144A and S145A in Fig. 28 are effected, and subsequently at S218A and S219A, processes similar to the processes at S8 and S9 in Fig. 22 are effected before the process advances to S220A.

At S217A, the cam ring has been moved from its initial position two focal-length steps closer to the WIDE angle terminus and the motor begins to run in the forward direction driving the cam ring away from the WIDE angle terminus. At S220A, the POS conversion at S216A is tested for $POS = Mpos - 1$ to determine if the cam ring has advanced away from its initial position by one step. If $POS \neq Mpos - 1$, the processes at S218A to S220A are repeatedly executed until $POS = Mpos - 1$. If $POS = Mpos - 1$, the process advances to S221A where motor 5 is braked to a stop; otherwise, S218A, S219A are repeatedly executed until $POS = Mpos - 1$ evaluates to true.

OPERATION OF SECOND EMBODIMENT

The effects of the processes at S1 to S22 in Fig. 22, and those in Figs. 28 to 30 are explained below. Explanations of operations that are identical with their counterparts in the first embodiment are omitted.

(1) Battery 106 is mounted in the battery case (not shown), and none of the following switches are manipulated: takeup motor control switch 119, shutter release button 99, and zoom switch 102.

a) If mode changeover switch 101 is set to the LOCK position, the processes carried out are the same

as described in paragraph (1)(a) in the description of the first embodiment.

b) If the setting of mode changeover switch 101 is changed from LOCK to ZOOM position, the processes carried out are the same as described in paragraph (1)(b) in the description of the first embodiment.

5 c) If the setting of mode changeover switch 101 is changed from ZOOM to MACRO position when cam ring 14 has stopped at the wide-angle terminus, the processes carried out are the same as described in paragraph (1)(c) in the description of the first embodiment.

d) If the setting of mode changeover switch 101 is changed from MACRO to ZOOM position, the processes carried out are the same as described in paragraph (1)(d) in the description of the first embodiment.

10 e) If the setting of mode changeover switch 101 is changed from ZOOM to MACRO position when cam ring 14 has stopped at the telephoto terminus (POS = A), the processes carried out are the same as in paragraph c) above with the exception that the starting point is POS = A instead of POS = 2.

15 f) When the tests at S148A, S149A, S169A and S170A in Fig. 28, described in paragraphs b) to d) above, determine that the setting of mode changeover switch has been changed from ZOOM position to either LOCK, or MACRO positions, the respective loop process of S136A, S137A, or S131A to S134A are executed. At S135A, which is reached because of a mode change to LOCK position, cam ring 14 is driven until it reaches and stops at POS = $\emptyset$. At S139A, which is reached because of a mode change to MACRO position, cam ring 14 is driven until it reaches and stops at POS = C.

20 g) If the setting of mode changeover switch 101 is changed to the ZOOM position while cam ring 14 is located at a position in the range $2 \leq \text{POS} \leq 9$ during the loop process of S131A to S133A, S138A, S140A, S141A to S131A, or during the loop process of S131A to S137A to S131A in Fig. 28, the CPU of ZM/C 100 branches the process from the above-mentioned loops at S133A, and advances it to S142A.

25 Because $2 \leq \text{POS} \leq 9$ in this case, the process advances to S153A. If zoom motor 5 is rotating in the forward direction, the process jumps from S153A to S160A allowing execution of S160A to S164A whereby zoom motor 5 advances to the location where POS is changed by +1 in the direction of the telephoto terminus. On the other hand, if zoom motor 5 is rotating in the reverse direction, the process advances from S153A to S164A as POS temporarily changes by -1 in the direction of the WIDE angle terminus. However, motor 5 continues to rotate in the reverse direction for t msec. Thereafter, rotation of zoom motor 5 reverses and begins to rotate in the forward direction eventually stopping when POS has changed by +1 to the TELE side. In other words, when the initial position of the lens is in the zooming range, $2 \leq \text{POS} \leq 9$, the position of cam ring 14 changes by one step, either forwardly or rearwardly, depending on the setting mode switch 101.

30 While the cam ring is located in a position corresponding to $2 \leq \text{POS} \leq 9$, independently of the case described above, mode changeover switch 101 assumes the ZOOM position according to the operational specifications of the zoom switch 102 which is described below.

h) If the setting of mode changeover switch 101 is changed from LOCK to ZOOM position while cam ring 14 is located at a position corresponding to POS = 1 in the loop process of S131A to S136A to S131A in Fig. 28, the processes carried out are the same as described in paragraph (1)(h) in the description of the first embodiment.

(2) If takeup motor control switch 119 is manipulated while the CPU of ZM/C 100 is executing a loop process due to the above-described first loop, second loop, etc. the processes carried out are the same as described in paragraph (2) in the description of the first embodiment.

45 (3) If zooming switch 102 is manipulated to the TELE side while the CPU of ZM/C 100 is executing a process in the above described second loop, the procedures described below are executed.

The CPU of ZM/C 100 advances the process from S18 to S19 in Fig. 22, and then calls and executes the TELE subroutine shown in Fig. 29. If cam ring 14 has stopped at the telephoto terminus (POS = A), it is unnecessary to rotate zoom motor 5, and the processes to invalidate manipulation of zoom switch 102 at S197A and S198A are executed. If cam ring 14 has stopped at a location other than the telephoto terminus (i.e., $2 \leq \text{POS} \leq 9$ when the TELE subroutine is called), the above described process of moving the value of POS to register Mpos is effected at S191A, and forward rotation of motor 5 at S192A is effected until cam ring 14 is driven to a location where POS = Mpos + 1. At such location, S196A stops zoom motor 5. Thereafter, the processes to invalidate manipulation of zooming switch 102 are subsequently carried out, and the process is reset to S2 in Fig. 22. Thus, each time zoom switch 102 is moved to the TELE side, cam ring 14 moves one step in the direction of the telephoto terminus. In this way, the cam ring can be moved step-by-step from POS = 2 (f6) to POS = A (f7'),

whereby cam ring 14 can be position at a desired focal-length as shown in Fig. 27.

(4) If zoom switch 102 is moved to the WIDE side while the CPU of ZM/C 100 is executing a process due to the above described second loop, the procedures discussed below are executed.

The CPU of ZM/C 100 calls and executes the WIDE subroutine shown in Fig. 30 by advancing the process from S20 to S21 in Fig. 22. At S210A, a test for $POS = 2$ is carried out. If $POS = 2$, cam ring 14 has stopped at the wide angle terminus, and hence it is unnecessary to rotate zoom motor 5; and the processes to invalidate the manipulation of zooming switch 102 at S222A and 223A are executed. If $POS \neq 2$, the above described process of moving the value of POS into register Mpos is effected at S211A, and, at S212A motor 5 is commanded to rotate in the reverse direction thereafter.

After the motor rotates in the reverse direction, cam 14 is driven to $POS = Mpos - 2$ by executing loop S213A to S215A. When $POS = Mpos - 2$, processes similar to the above described processes at S165 and S166 in case of the first embodiment, are executed at S216A and S217A, to eliminate backlash, and the loop process of S218A to S220A is executed until $POS = Mpos - 1$. When $POS = Mpos - 1$, S221A stops rotation of zoom motor 5, and the processes to invalidate the manipulation of zoom switch 102 are subsequently executed at S222A and S223A, thereafter, the process is reset to S2 in Fig. 22.

Thus, each time zoom switch 102 is moved to the WIDE side cam ring 14 moves one step in the direction of the WIDE terminus in a manner that eliminates backlash. In this manner, the cam ring can be moved step-by-step from $POS = A (f'')$ to $POS = 2(f_0)$ whereby cam ring 14 can be positioned at a desired focal-length as shown in Fig. 27.

THIRD EMBODIMENT OF ZOOM LENS SYSTEM DRIVE

Referring now to Fig. 3, reference numeral C10 designates, in schematic form, a third embodiment of the invention as shown in schematic form. Embodiment C10 includes zoom lens C11 for a camera having between-the-lens shutter including motor C12 for moving the lens (through a mechanical coupling, not shown) in forward and rearward direction, as indicated by the arrows in Fig. 3. Switch means C2 has two operator-selected input settings to control operation of motor C12 for moving the lens from an initial position, defined by the position of the lens when the switch is operated, to a final stationary position establishing the focal length of the lens. Embodiment C10 also includes position detector C1 for detecting the position of the lens, delay means C6 for introducing a predetermined pause in operation of the motor, and control means C3 responsive to sustained operation of switch C2, to position detector means C1, and to delay means C6 for operating the motor such that: (1) the final position of the lens is a predetermined number of discrete focal-length steps from its initial position; (2) movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction; and (3) the lens remains stationary at its final position for said predetermined pause before moving to another position located therefrom by said predetermined number of discrete focal-length steps.

In the third embodiment of the present invention, the manner of driving the lens is different from the manner of driving the lens in the two previously described embodiments, but only a program change is required. Before describing this embodiment in detail, the manner of driving the lens is first described.

(1) If mode changeover switch 101 is set to LOCK position and cam ring 14 is located any position other than $POS = \emptyset$, zoom motor 5 rotates in the reverse direction driving cam ring 14 in the rearward direction until $POS = \emptyset$ (see Figs. 13 and 31) is detected, and then stops.

(2) If mode changeover switch 101 is set to MACRO position and cam ring 14 is located at any position other than $POS = "C"$, zoom motor 5 rotates in the forward direction driving cam ring 14 forwardly until $POS = "C"$ (see Figs. 13 and 31) and the stops.

(3) If mode changeover switch 101 is set to ZOOM position and cam ring 14 is located at any position other than $POS = "2"$ (i.e., at any of focal-length steps of f''):

a) If zoom switch 102 is set at TELE position, and remains there, zoom motor 5 rotates in the forward direction and stops after cam 14 has experienced a change of one focal-length step in the forward direction (i.e., in a direction toward the telephoto terminus). After pausing at the new focal-length step for a time t' msec, the previous step is repeated. As a result, the cam ring moves forwardly one focal-length step at a time, step-by-step, pausing between steps until the cam ring reaches the telephoto terminus. If switch 102 is moved to its neutral position, further stepping of the cam ring terminates.

b) If zoom switch 102 is momentarily set to WIDE position, zoom motor 5 first rotates in the reverse direction until cam ring 14 has experienced a change of two focal-length steps rearwardly from its initial position, then further rotates in the reverse direction for a predetermined time t' msec, and then reverses rotation and runs in the forward direction until the cam ring has experienced a net change of

one focal-length step rearwardly of its initial position; and then, the motor stops rotating. The cam ring is so driven at the WIDE position of switch 102 to remove mechanical backlash of lens barrel block 1 and finder block 2 for minimizing the difference between the stop position of the zoom motor 5 when the latter stops rotating in the WIDE direction, and when it stops rotating in the TELE direction. If switch 102 remains at its WIDE position, the cam ring moves rearwardly one focal-length step at a time, step-by-step, pausing between steps until the cam ring reaches the wide angle terminus.

The entire control system, including the above-described control of the camera is described below in reference to Figs. 32 and 33. The main flow chart for the third embodiment of the invention is identical with that shown in Fig. 22; the mode subroutine is identical with that shown in Fig. 28, and the explanation with respect to them is the same as their counterparts in the descriptions of the first and second embodiments. The TELE and WIDE subroutines, however, are different.

TELE SUBROUTINE FOR THIRD EMBODIMENT

Referring to the flow chart of the TELE subroutine in FIG. 32, at S190B, the CPU of ZM/C 100 tests whether $POS = A$ as a result of the POS conversion at S9 in Fig. 22. If $POS = A$, the process is reset to S2 in Fig. 22. If $POS \neq A$, namely if $2 \leq POS \leq 9$, the process advances to S191B to store the result of the POS conversion at S9 in Fig. 22 (initial position of the cam ring) in register Mpos. At S192B, motor 5 is commanded to rotate in the forward direction.

At S193B and S194B, processes similar to those at S8 and S9 in Fig. 22 are executed; thereafter, at S195B, the result of the POS conversion at S194B is tested for $POS = Mpos + 1$ to determine if the cam ring has moved one focal-length step from its initial position in the direction of the telephoto terminus. If $POS = Mpos + 1$, S196B causes zoom motor 5 to stop, and scanning of the switches occurs at S197B. If zoom switch 102 is not set to the TELE side when S198B is executed, the process is reset to S2 in Fig. 22; otherwise, switch 102 remains at the TELE side and the process advances to S199B which executed a delay of t msec. Consequently, the cam ring will have been moved by one focal-length step from its initial position in the forward direction and will pause at its new position for t msec.

After the delay, S200B causes the switches to be scanned. If zoom switch 102 remains at the TELE side, S201B is executed and the process is reset to S190B to repeat the above-described process. If the switch has been changed from the TELE side, the process is reset to S2 in Fig. 22.

At S195B, if $POS \neq Mpos + 1$, the processes at S193B to S195B are repeated until $POS = Mpos + 1$.

WIDE SUBROUTINE FOR THIS EMBODIMENT

Referring to the flow chart of the WIDE subroutine in Fig. 33, at S210B the CPU of ZM/C 100 tests whether $POS = 2$ as a result of the POS conversion at S9 in Fig. 22, i.e., whether zoom motor 5 is already stopped at the wide-angle terminus. If $POS = 2$, the process is reset to S2 in Fig. 22; otherwise the process advances to S211B where the result of the POS conversion at S9 in Fig. 22 (initial position of the cam ring) is stored in the register Mpos. At S212B, the zoom motor is commanded to rotate in the reverse direction driving the cam ring rearwardly toward the wide angle terminus.

At S213B and S214B, processes similar to those for S8 and S9 in Fig. 22 are effected; and thereafter, at S215B, $POS = Mpos - 2$ is evaluated using the result of the POS conversion at S214B to determine if the cam ring has moved two focal-length steps from its initial position in the direction of the wide angle terminus. If $POS = Mpos - 2$ evaluates to true, the process advances to S216B; otherwise, the processes at S213B to S215B are repeatedly executed until $POS = Mpos - 2$ evaluates to true.

At S216B and S217B, processes similar to the above-described processes for S165 and S166 in Fig. 23 are executed to delay reversal of motor rotation for t msec; and afterwards at S218B and S219B, processes similar to the above-described processes for S8 and S9 in Fig. 22 are executed.

The motor is now rotating in the forward direction. At S220B, if $POS = Mpos - 1$ based on the POS conversion at S219B, which is to say that the cam ring has moved one focal-length step from its initial position in the direction of the WIDE terminus, the process advances to S222B where the motor is braked to a stop. If $POS \neq Mpos - 1$, the processes at S218B to S220B are repeated until $POS = Mpos - 1$. The switches are scanned at S222B; and at S223B, and the state of zoom switch 102 is tested. If the setting of this switch has changed, the process is reset to S2 in Fig. 22; otherwise, S224B executes a waiting process of t msec before the switches are again scanned at S225B. At S226B, the state of switch 102 is tested. If this switch remains set to the WIDE side, the process is reset to S210B to repeat the above-described procedure. If the setting of switch 102 has been changed, the process is reset to S2 in Fig. 22.

OPERATION OF THIRD EMBODIMENT

The effects of the processes at S1 to S22 in Fig. 22 and those in Figs. 28, 32, and 33 are explained below. Explanations of operations that are identical with their counterparts in case of the first and second embodiments are omitted.

(1) Battery 106 is mounted in the battery case (not shown) and none of the following switches are manipulated: takeup motor control switch 119, shutter release button 99, and zoom switch 102.

a) If the setting of mode changeover switch 101 is in LOCK position, the processes executed are the same as described in paragraph (1)a) in the description of the first and second embodiments.

b) If the setting of mode changeover switch 101 is changed from LOCK to ZOOM position, the processes executed are the same as described in paragraph (1)b) in the descriptions of the first and second embodiments.

c) If the setting of mode changeover switch 101 is changed from ZOOM to MACRO position when cam ring 14 has stopped at the wide-angle terminus ($POS = 2$), the processes executed are the same as described in paragraph (1)c) in the descriptions of the first and second embodiments.

d) If the setting of mode changeover switch 101 is changed from MACRO to ZOOM position, the processes executed are the same as described in paragraph (1)d) in the description of the first and second embodiments.

e) If the setting of mode changeover switch 101 is changed from ZOOM to MACRO position when cam ring 14 has stopped at the telephoto terminus ($POS = A$), the processes executed are the same as in paragraph c) above with the exception that the starting point is $POS = A$ instead of $POS = 2$.

f) When the tests at S148A, S149A, S169A and S170A in Fig. 28 in the processes described in paragraphs b) to d) above determine that the mode changeover switch has been changed from ZOOM to either LOCK, or MACRO position, the processes executed will be the same as in paragraph (1)f) in the description of the second embodiment.

g) If the setting of mode changeover switch 101 is changed to the ZOOM position while cam ring 14 is located at $2 \leq POS \leq 9$ during the loop processes of S131A to S133A, S138A, S140A, S141A to S131A, or during the loop process of S131A to S137A to S131A in Fig. 28, the processes executed will be the same as in paragraph (1)g) in the description of the second embodiment.

h) If the setting of mode changeover switch 101 is changed from LOCK to ZOOM position while cam ring 14 is located at a position corresponding to $POS = 1$ in the loop processes of S131A to S136A to S131A in Fig. 28, the processes carried out are the same as described in paragraph (1)h) in the first and second embodiments.

(2) If takeup motor control switch 119 is manipulated while the CPU of ZM/C 100 is executing a loop process due to the above-described first loop, second loop, etc., the processes carried out will be the same as described in paragraph (2) in the description of the first and second embodiments.

(3) If zoom switch 102 is moved to the TELE side while the CPU of ZM/C 100 is executing a process in the above-described second loop, the procedures described below are executed.

The CPU of ZM/C 100 advances the process from S18 to S19 in Fig. 22, and then calls and executes the TELE subroutine shown in Fig. 32. If cam ring 14 has stopped at the telephoto terminus ($POS = A$), rotation of the zoom motor is not necessary; and the process is therefore immediately reset to S2 in Fig. 22. If cam ring 14 has stopped at a location other than the telephoto terminus (i.e., $2 \leq POS \leq 9$) when the TELE subroutine is called, the above-described process of moving the value of POS to register Mpos is effected at S191B (to establish the initial position of the cam ring), and forward rotation of motor 5 at S192S is effected until cam ring 14 is driven, by procedure S193B to S195B, until $POS = Mpos + 1$. When $POS = Mpos + 1$ evaluates to true, S196B causes zoom motor 5 to stop. At S197B and S198B, zoom switch 102 is scanned and then tested. If the switch is set to TELE-off, the process is reset to S2 in Fig. 22; but, if the switch is set to TELE-on, a pause of t' msec is effected at S199B. Only if TELE-on is thereafter reconfirmed by the processes at S200B and S201B, is execution of the process at S192B repeated to cause zoom motor 5 to again rotate in the forward direction.

Thus, as zoom switch 102 is manipulated to the TELE side for turning-on the motor, cam ring 14 repeatedly moves toward the telephoto terminus, in one focal-length steps, step-by-step, in the forward direction, pausing between steps until the range $POS = 2$ to $POS = A$ is traversed, step-by-step. By having TELE turned on sufficiently long, cam ring 14 is driven to and stops at the telephoto terminus.

(4) If zooming switch 102 is manipulated to the WIDE side while the CPU of ZM/C 100 is executing the above-described second process, the following occurs:

a) The CPU of ZM/C 100 calls and executes the WIDE subroutine shown in Fig. 33 by advancing the process from S20 to S21 in Fig. 22. At S210B, $POS = 2$ is tested. If $POS = 2$, cam ring 14 is

stationary at the wide-angle terminus and it is unnecessary to immediately rotate zoom motor 5. Thus, the process is reset to S2 in Fig. 22. If $POS \neq 2$, S211B moves the value of POS into register Mpos to store the initial position of the cam ring, and S212B commands zoom motor 5 to rotate in the reverse direction driving the cam ring rearwardly.

5 After the process of S212B is executed, loop S213B to S215B is executed causing cam ring 14 to be driven until $POS = Mpos - 2$ after which processes S216B and S217B are executed. When motor reversal occurs at S217B, the cam ring will be between two and three focal-length steps displaced from its initial position in the direction of the WIDE angle terminus. These processes are similar to the above-described processes at S165 and S166, in case of the first embodiment, for eliminating backlash.

10 Thereafter, the loop process of S218B to S220B are executed until $POS = Mpos - 1$. When this condition is detected, S221B stops rotation of zoom motor 5, and the cam ring is displaced one focal-length step from its initial position, S223B then tests whether switch 102 is currently set to WIDE-on. If it is, a t' msec pause is effected at S224B, and zoom motor 5 is caused to restart rotation in the reverse direction by the process at S212B. If the scan at S222B shows that switch 102 is set to WIDE-off, the process is

15 reset to S2 in Fig. 22.

Thus, if zoom switch 102 is maintained at WIDE-on, cam ring 14 repeats, during the time the switch remains set to WIDE-on, a sequence of move, stop and pause operations as the cam ring moves in one focal-length steps, step-by-step, toward the WIDE angle terminus, pausing for t' msec between steps. This step-by-step progress of the cam ring in the rearward direction is carried out in a way that

20 eliminates backlash. By leaving WIDE-on sufficiently long, cam ring 14 is driven to and stops at the wide-angle terminus.

FOURTH EMBODIMENT OF THE ZOOM LENS SYSTEM DRIVE

25 Referring now to Fig. 4, reference numeral D10 designates a fourth embodiment of the invention in schematic form. Embodiment D10 includes zoom lens D11 for a camera having between the lens shutter including motor D12 for moving the lens (through a mechanical coupling, not shown) in forward and rearward direction, as indicated by the arrows in Fig. 4. Switch means D2 has a plurality of settings selected by an operator to control operation of motor D12 for moving the lens from an initial position; defined by the

30 position of the lens where the switch is operated, to a final stationary position establishing the focal-length of the lens. Embodiment D10 also includes position detector D1 for detecting the position of the lens, memory means D6 for storing data representative of the position of the lens, and control means D5 responsive to selection of a setting of switch D2, to position detector means D1, and to memory means D6 for operating the motor such that selection of a zoom setting of the switch means causes motor D12 to drive the lens

35 from its initial position to a final position determined by the contents of memory means D6 under the condition that movement of the lens to its final position always occurs while the lens is travelling in a predetermined direction.

In the fourth embodiment of the invention, the manner of driving the lens differs from that used to drive the lens in the previous embodiments, but only a change in the program is required. Before describing this

40 embodiment in detail, the manner of driving the lens is first described.

- (1) When mode changeover switch 101 is set to LOCK position and cam ring 14 is located any position other than $POS = \emptyset$, zoom motor 5 rotates in the reverse direction driving cam 14 rearwardly until $POS = \emptyset$ (see Figs. 13 and 34), and then stops.
- (2) When mode changeover switch 101 is set to MACRO position and cam ring 14 is located at any
- 45 position other than $POS = "C"$, zoom motor 5 rotates in the forward direction driving cam ring 14 forwardly until $POS = "C"$, and then stops.
- (3) When mode changeover switch 101 is set to ZOOM position, and zoom motor 5 is rotating in the reverse direction, setting zoom switch 102 to its WIDE position will cause the motor to stop and then rotate in the forward direction. If the switch is set to TELE position, the motor stops when $POS = "A"$. If
- 50 switch 101 is set to WIDE position, zoom motor 5 rotates continuously in the reverse direction for a short time after $POS = "1"$, and then rotates in the forward direction. When $POS = "2"$, motor 5 stops rotating. If zoom switch 102 is turned off (placed at the neutral position) during the rotation of zoom motor 5, the latter, if it is rotating in the TELE direction (forward), stops immediately. If the motor is rotating in the WIDE direction (reverse) it will stop after rotating in the forward direction for a short time.
- 55 The rotation for this short time is intended to eliminate mechanical backlash from the lens barrel block 1 and finder 2 in order to eliminate differences between the stop positions of the motor 5 when rotating in the WIDE and TELE directions, respectively.
- (4) If the setting of mode changeover switch 101 is changed from LOCK or MACRO position to ZOOM

position:

- a) if switch 101 is changed from LOCK to ZOOM position, the motor 5 rotates in the forward direction, and
- b) if switch 101 is changed from MACRO to ZOOM position, the motor rotates in the reverse direction and stops at the last lens position at which the switch had been previously changed from ZOOM to LOCK position.

The operation effected when mode changeover switch 101 is shifted from MACRO to ZOOM includes the above-described operation that eliminates backlash.

Also, in this embodiment, because the lens position is detected in stepwise fashion (there are 13 steps from "0" to "C"), a specific lens position value for example Pos = 5, does not establish a unique lens position. For this reason, when any of the lens positions within the range of Pos = "2" to "A" is restored, zoom motor 5 is caused to stop at a change point whereby the lens does not precisely return to the initial position but to a position very near it.

The whole control system, including the above-mentioned control, of the camera is described below in further detail with reference to Figs. 35 and 36.

The flow chart shown in Fig. 35 is essentially the same as the flow charts illustrated and explained with respect to the previous embodiments, except for the processes added between the S9 and S12 in the preceding three embodiments in order to implement the action peculiar to this embodiment.

After Pos conversion at S9C, S10C tests for the condition $2 \leq \text{Pos} \leq A$. If the condition is true, S11C causes the POS value to be moved to and stored in register Mpos in the CPU or RAM. If Pos > A or Pos < 2, the process jumps from S10C to S12C without saving the POS value. Periodic execution of the processes at S10C and S11C saves the current lens position within the zooming range of the zoom lens each time the program returns to S2C. In the preferred embodiment, the initial Mpos value is set by the position to Mpos = 2.

MODE SUBROUTINE OF FOURTH EMBODIMENT

Referring now to the flow chart of the mode subroutine in Fig. 36, the CPU of ZM/C 100 executes each of the processes at S150C to S161C which are similar to those at S130 to S141 in the preceding embodiments, according to the mode as established by the setting of mode changeover switch 101.

If mode changeover switch 101 is set to ZOOM, S162C tests whether the result of the Pos conversion at S152C is Pos < Mpos, namely, whether the current position of the cam ring is closer to the WIDE angle terminus than the focal-length step occupied by the cam ring when step S11C was executed. If Pos < Mpos, the process advances to S163C, but if Pos $\geq$ (Mpos), the process advances to S173C.

If Pos < (Mpos), S163C tests whether the zooming motor 5 is rotating in the forward direction. If so, the process jumps to S165C; otherwise, S164C reverses rotation of the motor which thereafter runs in the forward direction.

Processes similar to those at S8C and S9C in Fig. 35 are executed at S165C and S166C. Thereafter, at S167C and S168C, based on the switch scan at S165C, a determination is made as to whether the setting of mode changeover switch 101 has been changed from ZOOM to either LOCK, or MACRO. If switch 101 has been changed to LOCK, the process returns to S154C; and if the switch has been changed to MACRO, the process returns to S158C. If the switch position remains at ZOOM, the process advances to S169C.

S169C tests whether the result of the Pos conversion made at S166C is Pos = Mpos (i.e., whether the cam ring has been returned to the stored location). If Pos $\neq$ Mpos, the process returns to S165C. If Pos = Mpos, the process advances to S170C which stops further rotation of zoom motor 5 because the cam ring has returned to the stored location.

S171C tests whether the result of the Pos conversion at S166C is Pos 2. If Pos = 2, the cam ring has stopped at the wide angle terminus; and in such case wide-angle terminus flag Fwide is set to "1", and thereafter, the process returns to S2C in Fig. 35. If POS $\neq$ 2, the process immediately returns to S2C without setting flag Fwide.

If Pos > Mpos as a result of the test at S162C, the process advances to S173C which tests whether zoom motor 5 is rotating in the reverse direction. If so, the process jumps to S175C; otherwise, motor 5 is rotating in the forward direction, and S174C causes rotation of the motor to reverse and to run in the reverse direction; thereafter, the process advances to S175C.

At S175C and S176C, processes similar to those at S8C and S9C in Fig. 35 are executed; and at S177C and S178C, processes similar to those at S167C and S168C are executed.

If the position (mode) of mode changeover switch 101 remains set at ZOOM, S179C tests whether the result of the Pos conversion at S176C is Pos = Mpos - 1, namely, whether the current position of the cam

aring is one focal-length step closer to the WIDE angle terminus than when the focal-length step of the cam ring was stored in Mpos at S11C. If $Pos \neq Mpos - 1$, the process returns to S175C and this loop S175C to S179C is repeatedly executed until $Pos = Mpos - 1$. When $Pos = Mpos - 1$, S180C executes a standby process for the t msec for the reasons explained above; afterwards, the process advances to S164C. Thereafter, $Pos = Mpos$ is attained by executing the processes at S164C to S172C. Thus, the cam ring is returned to the stored location after moving to such location in the forward direction.

The TELE subroutine and the WIDE subroutine in this embodiment are the same as the respective subroutines in the first embodiment. For this reason, no further explanation is required.

10 OPERATION OF THE FOURTH EMBODIMENT

The effects of the processes at S1C to S24C in Fig. 35 and those in Fig. 36 are explained below. However, the explanation of operations identical to processes having counterparts in the previous embodiments are omitted.

15 (1) Battery 106 is connected and none of the following switches are manipulated: takeup motor control switch 119, shutter release button 99, and zoom switch 102.

a) If mode changeover switch 101 is in the LOCK position, a first loop is executed as described in paragraph a) in the description of the first to the third embodiments.

20 b) If mode changeover switch 101 is changed from LOCK to ZOOM position, the CPU of ZM/C 100 exits the above mentioned first loop and advances to S16C. Because $Pos = "0"$, the process advances to S19C which causes zoom motor 5 to rotate in the forward direction, and then branches to the WIDE subroutine (Fig. 36) and executed the procedures S163C, S165C, and S166C through S150C, S153C and S162C. Under the condition that mode changeover switch 101 has not been shifted from ZOOM to either LOCK or MACRO at S167C and S168C, the loop process of S169C, S165C and S168C causes the motor to drive the cam ring until $Pos = Mpos$. Then, after S170C stops zoom motor 5, the process returns to S2C in Fig. 35 through S171C or S171C and S172C.

When shipped from the factory, "2" is stored in M_{pos} . Thus, when the camera is first used after shipment from the factory, cam ring 14 is driven from $POS = \emptyset$ to the wide-angle terminus ($Pos = 2$) where the focal length is f_0 . The next time the camera is used, the cam ring is driven from $POS = \emptyset$ to the position where zooming was done in the last zooming mode (i.e., the position stored in register Mpos at S11C). After the CPU of ZM/C returns to S2C, each process of the second process loop (S4C, S8C to S12C, S16C, S17C, S20C, S22C, S24C and S4C) is repeated under the condition that none of the camera controls is changed. However, because the Pos data remains unchanged throughout a certain range of zoom positions, the previous zoom position will not always coincide exactly with the stop position attained under the stop control of Pos data change point based on the Mpos value. However, the error is only a small one; and if the cam ring returns to a position very close to the previous zoom position, a zoom position very close to the photographer's choice is automatically determined making use of the camera very convenient.

30 c) If mode changeover switch 101 is changed from ZOOM to MACRO position under the condition that cam ring 14 is located at the wide-angle terminus, the effect will be the same as described in paragraph c) in the descriptions of the previous embodiments.

40 d) If mode changeover switch 101 is changed from the MACRO to ZOOM position, the CPU of ZM/C 100 causes the process to exit the loop at S12C and advance to S16C. Because $Pos = C$, the process at S17C is executed and the process advances to S14C where zoom motor 5 is commanded to rotate in the reverse direction. The process then branches to the mode subroutine of Fig. 36 and advances through S151C to S153C. If switch 101 remains in the ZOOM position, the process advances to S162C, S173C, S175C, and S176C. After executing S177C and S178C, the loop S175C, S176C to S179C is repeatedly executed until $Pos = Mpos - 1$. When $Pos = Mpos - 1$, S180 C causes the motor to continue to rotate in the reverse direction for a time of t msec before S164C reverses rotation of zoom motor 5, and causes it to rotate in the forward direction.

50 Cam ring 14 is stopped as soon as it arrives at a position corresponding to $Pos = Mpos$ from a position corresponding to $Pos = Mpos - 1$. Note that if zoom motor 5 were rotating in the reverse direction driving the cam ring from $POS = A$ toward $POS = Mpos$, and were stopped at $Pos = Mpos - 1$ before being driven in the forward direction toward $Pos = Mpos$, zoom motor 5 is likely to stop without eliminating the backlash of the gears, etc. in the transmission system driving the cam ring. However, the processes at S180C and S164C cause zoom motor 5 to continue to operate in the reverse direction for a time t msec following detection of $Pos = Mpos - 1$ before the rotation of motor is reversed, motor 5 will return the cam ring to a position corresponding to $Pos = Mpos$ while rotating

in the forward direction, and can be stopped at such position with the elimination of backlash in the forward-rotation direction.

After completion of the process at S164C, the process loop of S165C to S169C is repeatedly executed until $POS = Mpos$; thereafter, zoom motor 5 is stopped at S170C, and the process advances through either S171C, or through S171C and S172C to S2C in Fig. 35. Thus, cam ring 14 is stopped at wide-angle terminus ($Mpos$) if no zooming had been done since the camera had been shipped from the factory. If a zooming operation had been carried out previously, the cam ring will be stopped at the previous zoom position stored in $Mpos$. The zoom position at which the cam ring stops based on $Mpos$ does not always precisely coincide with the precedent zoom position, but is very close as has been described above.

After the CPU of ZM/C 100 returns to S2C as in paragraph b) above, each process executed during the previously mentioned second loop is repeated under the condition that none of the switch settings has been altered.

In case the process advances from S162C to S173C because mode changeover switch 101 has been changed from MACRO to ZOOM position, the above process will also take place if mode changeover switch 101 is changed to ZOOM position while cam ring 14 is located at a position corresponding to $Pos > A$ during execution of loop S151C to S153C to S158C, S160C, S161C and S151C. However, in this case, zoom motor 5 is rotating in the forward direction when the process at S174C causes the motor to rotate in the reverse direction.

e) If mode changeover switch 101 is changed from ZOOM to MACRO position under the condition that cam ring 14 is stopped at $POS = A$, the same process described in paragraph c) above will be executed except that the starting point corresponds to $Pos = A$, not $Pos = 2$.

f) If the tests at S167C, S168C, S177C and S178C in Fig. 36 referred to in paragraph b) and d) show that mode changeover switch 101 has been changed from ZOOM position to LOCK position, or to MACRO position, the processes executed as a result are the same as described in connection with the previous embodiment.

g) If mode changeover switch 101 is changed from LOCK to ZOOM position when cam ring 14 is located at $POS = 1$ during the loop process of S151C to S156C and S151C in Fig. 36, the CPU of ZM/C 100 advances the process from S153C through S162C and S163C to S164C at which motor 5 is commanded to rotate forwardly. Thereafter, the processes that follow are the same as described in paragraph d).

(2) If takeup motor control switch 119 is actuated while the CPU of ZM/C 100 is executing any of the various loops described above, the effect will be the same as described in the above in connection with the previous embodiments.

(3) If zoom switch 102 is changed to the TELE side while the CPU of ZM/C 100 is executing the above described second loop, the effect will be the same as described in paragraph (3) in the description of the first embodiment.

When the CPU returns to the above described second loop after cam ring 14 is stopped at any location within the zooming range ($2 \leq Pos \leq A$), the resultant data indicative of the zoom position (lens position) are stored in register $Mpos$ at S11C, and the current position of the cam ring becomes the initial zoom position during a subsequent zoom mode of operation.

(4) If zoom switch 102 is changed to the WIDE side while the CPU of ZM/C 100 is executing the above second loop, the effect of the processes that are executed will be the same as described in paragraph (4) in the description of the first embodiment. If CPU returns to the above-described second loop after cam ring 14 is stopped at any position with the zooming range ($2 \leq Pos \leq A$), the Pos data indicative of the zoom position is stored in register $Mpos$ at S11C.

(5) If the mode changeover switch 101 is changed from ZOOM to LOCK and back to ZOOM, or from ZOOM to MACRO and back to ZOOM, cam ring 14 is moved as shown in Fig. 34.

In the fourth embodiment, the data $2 \leq Pos \leq A$ are stored in register $Mpos$ in the CPU or RAM. However, this embodiment may be so arranged that the data $2 \leq Pos \leq A$ is stored in a non-volatile memory such as E^2 PROM to maintain the data even when the battery 106 is removed from the camera.

The above description of the various embodiments emphasizes that backlash is eliminated when rotation of motor 5 is changed from reverse to forward using the TELE terminus location as reference. However, the invention can also be implemented to eliminate the backlash when rotation of zoom motor 5 is changed from the forward to reverse using the WIDE terminus as reference.

Also for the first and fourth embodiments, the power of the lens can be set continuously, not merely in steps, like $f2$ to $f7$; and other types of position detectors, such as potentiometer which detect a continuous value, can be used.

The extra time t msec that the zoom motor runs in the reverse direction to ensure elimination of backlash has an absolute value that is dependent upon actual conditions such as the precision of the mechanical coupling between the motor and the cam ring, the physical of the focal-length steps, etc. The pause time t' msec, which is the time the cam ring pauses between stepping from one focal-length step to the next in the second through fourth embodiments, is dependent on design considerations such as the desirability for quickly scanning the zoom range, or providing more time for the photographer to decide whether he has properly framed the subject to be photographed.

Claims

1. A zoom lens drive system for a lens shutter type of camera comprising:
 - a) a zoom lens (1);
 - b) a reversible motor (5) operable for moving the lens (1) along an optical axis in forward and rearward directions between and including spaced end positions for establishing the focal length of the lens (1);
 - c) switch means operable by an operator, said switch means (101, 102) including at least a zoom switch (102) for causing movement of said lens (1) towards a final position of said lens (1); and
 - d) control means (100) responsive to the switch means (101, 102) for operating the motor (5) for movement of the lens (1) from an initial position, determined by the position of the lens (1) when the operator begins to operate the switch means (101, 102) to a final position, determined by the switch means (101, 102) operation, **characterized** in that said control means (100) controls said movement in such a way that the final position is always reached in one and the same direction, said direction being predetermined, independent of the final position selected by the switch means (101, 102) and of the initial position of the lens (1).
2. A zoom lens drive system according to claim 1, wherein said control means (100) includes:
 - a) direction detection means for detecting the directional movement of said lens (1); and
 - b) logic means responsive to the switch means (101, 102) and to the direction detection means, said logic means comprising means for operating the motor (5) in a direction such that the lens (1) moves towards the final position identified by said switch means (101, 102), said logic means thereafter either:
 - 1) stopping operation of the motor (5), if the lens (1) arrives at said final position moving in said predetermined direction; or
 - 2) continuing operation of the motor (5), if the lens (1) arrives at said final position moving in a direction opposite to said predetermined direction, thereafter reversing the direction of rotation of said motor (5) and causing said motor (5) to move the lens (1) in said predetermined direction.
3. A zoom lens drive system according to claim 2, wherein said logic means comprises means for continuing operation of the motor (5) in said opposite direction for a predetermined period of time prior to reversing the direction of rotation of the motor (5).
4. A zoom lens drive system according to one of claims 1 to 3, including:
 - a) a between-the lens shutter (23) mounted for movement with the lens (1);
 - b) means for focusing the lens (1) on a subject to be photographed as a function of the distance of the subject from the camera; and
 - c) means for effecting focus of the lens (1) only after the lens (1) arrives at said final position.
5. A zoom lens drive system according to claim 3 or 3 and 4 wherein said logic means comprises means for effecting motor operation and movement of the lens (1) in said predetermined direction after the end of said predetermined time in order to:
 - a) move the lens (1) back to the identified final position if said identified final position has been reached by the lens (1) during movement of said lens in a direction opposite to said predetermined direction; or
 - b) move the lens (1) away from said identified final position, if the operator selection of the selected operational position of the zoom switch (102) occurs before the lens (1) has reached the identified final position.
6. A zoom lens drive system according to any one of claims 2 to 5, wherein:



The extra time t msec that the zoom motor runs in the reverse direction to ensure elimination of backlash has an absolute value that is dependent upon actual conditions such as the precision of the mechanical coupling between the motor and the cam ring, the physical of the focal-length steps, etc. The pause time t' msec, which is the time the cam ring pauses between stepping from one focal-length step to the next in the second through fourth embodiments, is dependent on design considerations such as the desirability for quickly scanning the zoom range, or providing more time for the photographer to decide whether he has properly framed the subject to be photographed.

Claims

1. A zoom lens drive system for a lens shutter type of camera comprising:

- a) a zoom lens (1);
- b) a reversible motor (5) operable for moving the lens (1) along an optical axis in forward and rearward directions between and including spaced end positions for establishing the focal length of the lens (1);
- c) switch means operable by an operator, said switch means (101, 102) including at least a zoom switch (102) for causing movement of said lens (1) towards a final position of said lens (1); and
- d) control means (100) responsive to the switch means (101, 102) for operating the motor (5) for movement of the lens (1) from an initial position, determined by the position of the lens (1) when the operator begins to operate the switch means (101, 102) to a final position, determined by the switch means (101, 102) operation, characterized in that said control means (100) controls said movement in such a way that the final position is always reached in one and the same direction, said direction being predetermined, independent of the final position selected by the switch means (101, 102) and of the initial position of the lens (1).

2. A zoom lens drive system according to claim 1, wherein said control means (100) includes:

- a) direction detection means for detecting the directional movement of said lens (1); and
- b) logic means responsive to the switch means (101, 102) and to the direction detection means, said logic means comprising means for operating the motor (5) in a direction such that the lens (1) moves towards the final position identified by said switch means (101, 102), said logic means thereafter either:
 - 1) stopping operation of the motor (5), if the lens (1) arrives at said final position moving in said predetermined direction; or
 - 2) continuing operation of the motor (5), if the lens (1) arrives at said final position moving in a direction opposite to said predetermined direction, thereafter reversing the direction of rotation of said motor (5) and causing said motor (5) to move the lens (1) in said predetermined direction.

3. A zoom lens drive system according to claim 2, wherein said logic means comprises means for continuing operation of the motor (5) in said opposite direction for a predetermined period of time prior to reversing the direction of rotation of the motor (5).

4. A zoom lens drive system according to one of claims 1 to 3, including:

- a) a between-the lens shutter (23) mounted for movement with the lens (1);
- b) means for focusing the lens (1) on a subject to be photographed as a function of the distance of the subject from the camera; and
- c) means for effecting focus of the lens (1) only after the lens (1) arrives at said final position.

5. A zoom lens drive system according to claim 3 or 3 and 4 wherein said logic means comprises means for effecting motor operation and movement of the lens (1) in said predetermined direction after the end of said predetermined time in order to:

- a) move the lens (1) back to the identified final position if said identified final position has been reached by the lens (1) during movement of said lens in a direction opposite to said predetermined direction; or
- b) move the lens (1) away from said identified final position, if the operator selection of the selected operational position of the zoom switch (102) occurs before the lens (1) has reached the identified final position.

6. A zoom lens drive system according to any one of claims 2 to 5, wherein:



- a) the lens (1) is movable to a macro position beyond a telephoto end position for effecting close-up photography,
b) said mode switch (101) has a macro position selectable by an operator; and
c) said logic means is responsive to operator selection of the macro position of the mode switch (101) for operating the motor (5) such that the lens (1) is moved to the macro position regardless of the position of the lens (1) when the operator selects the macro position of the mode switch (101).
7. A zoom lens drive system in accordance with any one of claims 2 to 6, wherein:
a) the lens (1) is movable to a lock position beyond a wide angle end position for parking the lens (1) when the camera is not in use;
b) said mode switch (101) has a lock position selectable by the operator; and
c) said logic means is responsive to operator selection of the lock position of the mode switch (101) for operating the motor (5) such that the lens (1) is moved to said lock position regardless of the position of the lens (1) when the operator selects the lock position of the mode switch (101).
8. A zoom lens drive system according to claim 6 or 7, wherein the distance between said wide angle and said telephoto end positions is divided into a plurality of discrete focal-length steps, wherein said logic means is responsive to operator selection of an operational position of the zoom lens (1) by said zoom switch (102) for stopping movement of said lens (1) at a final position spaced from an initial position, said initial position comprising a position of the lens (1) when the operator selects an operational position of the zoom switch (102), the final position of the lens (1) being spaced from the initial position of the lens (1) by a predetermined number of said steps.
9. A zoom lens drive system according to any one of claims 2 to 8, wherein said identified final position is a wide angle end position, wherein said logic means disables operation of said motor (5) after said lens (1) has moved in a direction opposite to said predetermined direction, over a predetermined distance beyond said wide angle end position, and therefore reverses movement of said lens (1) back to said wide angle end position.
10. A zoom lens drive system according to claim 8 or 9, wherein said logic means comprises means for effecting motor operation and further movement of the lens (1) after the lens (1) reaches a final position spaced from the initial position by at least one focal length step, if the lens (1) has moved to said final position in a direction opposite to said predetermined direction.
11. A zoom lens drive system according to claim 10, wherein said logic means comprises means for stopping motor operation for a predetermined period of time after said further movement of said lens (1), said further movement being in a direction opposite to said predetermined direction.
12. A zoom lens drive system according to anyone of claims 8 to 11, wherein said lens (1) moves in single focal length step increments.
13. A zoom lens drive system according to anyone of claims 8 to 12, further including delay means (C6 in Fig. 3) for introducing a predetermined pause in operation of the reversible motor (5), said logic means being responsive to arrival of the lens (1) at said final position when said lens (1) moves in said predetermined direction and to effect operation of said delay means (C6 in Fig. 3) to stop movement of said lens (1) for a predetermined time at said final position when the selected operational position of said zoom switch (102) is maintained.
14. A zoom lens drive system according to anyone of claims 2 to 13, wherein said control means (100) includes memory means for storing data representative of the position of said lens (1) along said optical axis, and wherein said logic means is responsive to a change in the operational position of the zoom switch (102) for storing the position occupied by the lens (1) in the memory means whenever the operational position of said zoom switch (102) is changed.
15. A zoom lens drive system according to claim 14, wherein said logic means is further responsive to an operator change in the setting of the mode switch (101) from a zoom position to either a macro or a lock position by memorizing the last stored position occupied by the lens (1) prior to said mode switch change in said memory means whenever the operational position of said mode switch (101) is changed



from said zoom position.

16. A zoom lens drive system in accordance with claim 14 or 15, wherein a position detecting means comprises a code sheet (93) attached to the outer circumference of a cam ring (14) attached to said lens system (1).
17. A zoom lens drive system in accordance with claim 16, wherein said code sheet (93) comprises a plurality of conductive portions (94) and a plurality of non-conductive portions, said apparatus further comprising a plurality of conductive brushes (92) adapted to selectively contact said conductive portions (94) of said code sheet (93) and to produce signals representative of the angular position of said cam ring (14).
18. A zoom lens drive system in accordance with claim 17, wherein said signals comprise cam ring positional information in the form of zoom code data which is fed to a zoom code encoder (104).
19. A zoom lens drive system in accordance with claim 18, wherein said code sheet (93) is divided into a plurality of steps representative of different angular positions of the cam ring (14), each of said steps representing a distinct focal length position for said camera and said lens system (1), said steps further comprising a lock position and a macro photographic position.
20. A zoom lens drive system in accordance with anyone of claims 16 to 19, wherein said logic means comprises a zoom motor control unit (100) which includes a first CPU, said zoom motor control unit (100) being adapted to receive data from said mode changeover switch (101), said zoom switch (102), and from the zoom code encoder having data representative of the position of said cam ring.
21. A zoom lens drive system in accordance with claim 20, wherein said zoom code encoder comprises means for converting the angular position of said cam ring (14) detected by said conductive brushes (92) into zoom code data and means for supplying said zoom code data to said first CPU.
22. A zoom lens drive system in accordance with claim 20 or 21, further comprising a main control unit (109) which includes a second CPU, said main control unit comprising means for controlling the rotation of a film take-up motor (111), for driving and controlling a shutter block (23), for controlling operation and movement of a strobe unit (117), and for selectively outputting a motor disable signal to said first CPU in order to disable said driving source.
23. A zoom lens drive system in accordance with claim 22, wherein said means for generating said motor disable signal comprise means for generating said signal when a film take-up drive motor (111) is activated.

Revendications

1. Système d'entraînement d'objectif zoom pour un type d'appareil photo à obturateur d'objectif comprenant:
 - a) un objectif zoom (1) ;
 - b) un moteur réversible (5) pouvant être mis en oeuvre pour déplacer l'objectif (1) le long d'un axe optique dans les sens vers l'avant et vers l'arrière entre, et en les incluant, des positions d'extrémité espacées pour établir la distance focale de l'objectif (1) ;
 - c) un moyen de contacteur manœuvrable par un opérateur, ledit moyen de contacteur (101, 102) comprenant au moins un contacteur de zoom (102) pour provoquer le déplacement dudit objectif (1) en direction d'une position terminale dudit objectif (1) ; et
 - d) un moyen de commande (100) réagissant au moyen de contacteur (101, 102) pour mettre en oeuvre le moteur (5) pour le déplacement de l'objectif (1) à partir d'une position initiale, déterminée par la position de l'objectif (1) lorsque l'opérateur commence à manœuvrer le moyen de contacteur (101, 102) jusqu'à une position finale, déterminée par la manœuvre du moyen de contacteur (101, 102), caractérisé en ce que ledit moyen de commande (100) commande ledit déplacement d'une façon telle que la position finale soit toujours atteinte dans un seul et même sens, ledit sens étant prédéterminé, indépendant de la position finale sélectionnée par le moyen de contacteur (101, 102) et de la position initiale de l'objectif (1).



2. Système d'entraînement d'objectif zoom selon la revendication 1, dans lequel ledit moyen de commande (100) comprend :
- a) un moyen de détection de sens pour détecter le sens de déplacement dudit objectif (1) ; et
 - b) un moyen logique sensible au moyen de contacteur (101, 102) et au moyen de détection de sens, ledit moyen logique comprenant un moyen pour mettre en oeuvre le moteur (5) dans un sens tel que l'objectif (1) se déplace vers la position finale identifiée par ledit moyen de contacteur (101, 102), ledit moyen logique, ensuite, soit:
 - 1) arrêtant la mise en oeuvre du moteur (5), si l'objectif (1) arrive à ladite position finale en se déplaçant dans ledit sens prédéterminé ; soit
 - 2) continuant la mise en oeuvre du moteur (5), si l'objectif (1) arrive à ladite position finale en se déplaçant dans le sens opposé audit sens prédéterminé, en inversant ensuite le sens de rotation dudit moteur (5) et en faisant en sorte que ledit moteur (5) déplace l'objectif (1) dans ledit sens prédéterminé.
3. Système d'entraînement d'objectif zoom selon la revendication 2, dans lequel ledit moyen logique comprend un moyen pour continuer la mise en oeuvre du moteur (5) dans ledit sens opposé pendant une période de temps prédéterminée avant d'inverser le sens de rotation du moteur (5).
4. Système d'entraînement d'objectif zoom selon l'une des revendications 1 à 3, comprenant :
- a) un obturateur (23) au diaphragme monté pour se déplacer avec l'objectif (1) ;
 - b) un moyen de mise au point de l'objectif (1) sur un objet à photographier en fonction de la distance de l'objet à partir de l'appareil photo ; et
 - c) un moyen pour effectuer la mise au point de l'objectif (1) seulement après que l'objectif (1) est arrivé à ladite position finale.
5. Système d'entraînement d'objectif zoom selon la revendication 3 ou les revendications 3 et 4, dans lequel ledit moyen logique comprend un moyen pour effectuer la mise en oeuvre du moteur et le déplacement de l'objectif (1) dans ledit sens prédéterminé après la fin de ladite durée prédéterminée afin de :
- a) déplacer l'objectif (1) en retour jusqu'à la position finale identifiée, si ladite position finale identifiée a été atteinte par l'objectif (1) pendant le déplacement dudit objectif dans le sens contraire dudit sens prédéterminé ; ou
 - b) déplacer l'objectif (1) en l'écartant de ladite position finale identifiée, si la sélection de l'opérateur de la position de mise en oeuvre sélectionnée du contacteur de zoom (102) se produit avant que l'objectif (1) n'ait atteint la position finale identifiée.
6. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 2 à 5, dans lequel :
- a) l'objectif (1) peut être déplacé jusqu'à une position macro au-delà d'une position d'extrémité téléobjectif pour effectuer une photographie de près ;
 - b) ledit contacteur de mode (101) comporte une position macro qui peut être sélectionnée par un opérateur ; et
 - c) ledit moyen logique réagit à la sélection par l'opérateur de la position macro du contacteur de mode (101) pour mettre en oeuvre le moteur (5) de manière à ce que l'objectif (1) soit déplacé vers la position macro quelle que soit la position de l'objectif (1) lorsque l'opérateur sélectionne la position macro du contacteur de mode (101).
7. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 2 à 6, dans lequel :
- a) l'objectif (1) peut être déplacé jusqu'à une position de verrouillage au-delà de la position d'extrémité grand angle pour le rangement de l'objectif (1) lorsque l'appareil photo n'est pas en cours d'utilisation ;
 - b) ledit contacteur de mode (101) possède une position de verrouillage qui peut être sélectionnée par l'opérateur ; et
 - c) ledit moyen logique réagit à la sélection par l'opérateur de la position de verrouillage du contacteur de mode (101) pour mettre en oeuvre le moteur (5) de manière à ce que l'objectif (1) soit déplacé jusqu'à la position de verrouillage quelle que soit la position de l'objectif (1) lorsque l'opérateur sélectionne la position de verrouillage du contacteur de mode (101).
8. Système d'entraînement d'objectif zoom selon la revendication 6 ou la revendication 7, dans lequel la



- distance entre lesdites positions d'extrémités grand angle et téléobjectif est divisée en une pluralité de pas de distance focale discrets, dans lequel ledit moyen logique réagit à la sélection par l'opérateur d'une position de mise en oeuvre de l'objectif zoom (1) par ledit contacteur de zoom (102) pour arrêter le déplacement dudit objectif (1) au droit d'une position finale espacée d'une position initiale, ladite position initiale étant constituée par la position de l'objectif (1) lorsque l'opérateur sélectionne une position de mise en oeuvre du contacteur de zoom (102), la position finale de l'objectif (1) étant espacée de la position initiale de l'objectif (1) d'un certain nombre prédéterminé desdits pas.
9. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 2 à 8, dans lequel ladite position finale identifiée est une position d'extrémité grand angle, dans lequel ledit moyen logique désactive la mise en oeuvre dudit moteur (5) après que ledit objectif (1) se soit déplacé dans le sens contraire dudit sens prédéterminé, sur une distance prédéterminée, au-delà de ladite position d'extrémité grand angle, et ensuite inverse le déplacement dudit objectif (1) en retour vers ladite position d'extrémité grand angle.
10. Système d'entraînement d'objectif zoom selon la revendication 8 ou la revendication 9, dans lequel ledit moyen logique comprend un moyen pour effectuer la mise en oeuvre du moteur et le déplacement ultérieur de l'objectif (1) après que l'objectif (1) a atteint une position finale espacée de la position initiale par au moins un pas de distance focale, si l'objectif (1) s'est déplacé vers ladite position finale dans le sens contraire dudit sens prédéterminé.
11. Système d'entraînement d'objectif zoom selon la revendication 10, dans lequel ledit moyen logique comprend un moyen pour arrêter la mise en oeuvre du moteur pendant une période de temps prédéterminé après ledit déplacement ultérieur dudit objectif (1), ledit déplacement ultérieur étant effectué dans le sens contraire dudit sens prédéterminé.
12. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 8 à 11, dans lequel ledit objectif (1) se déplace en des incréments d'un seul pas de distance focale.
13. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 8 à 12, comprenant de plus un moyen de retard (C6 à la figure 3) pour introduire un temps d'arrêt prédéterminé dans la mise en oeuvre du moteur réversible (5), ledit moyen logique réagissant à l'arrivée de l'objectif (1) au droit de ladite position finale lorsque ledit objectif (1) se déplace dans ledit sens prédéterminé et pour mettre en oeuvre ledit moyen de retard (C6 à la figure 3) pour arrêter ledit déplacement dudit objectif (1) pendant un temps prédéterminé au droit de ladite position finale lorsque la position de mise en oeuvre sélectionnée dudit contacteur de zoom (102) est maintenue.
14. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 2 à 13, dans lequel ledit moyen de commande (100) comprend un moyen de mémoire pour mémoriser une information représentative de la position dudit objectif (1) le long dudit axe optique, et dans lequel ledit moyen logique réagit à un changement de la position de mise en oeuvre du contacteur de zoom (102) pour mémoriser la position occupée par l'objectif (1) dans le moyen de mémoire toutes les fois que la position de mise en oeuvre dudit contacteur de zoom (102) est changée.
15. Système d'entraînement d'objectif zoom selon la revendication 14, dans lequel ledit moyen logique réagit en outre à un changement par l'opérateur dans le réglage du contacteur de mode (101) à partir d'une position zoom vers soit une position macro soit une position de verrouillage, en mémorisant la dernière position mémorisée occupée par l'objectif (1), avant que ledit contacteur de mode ne soit changé, dans ledit moyen de mémoire toutes les fois que la position de mise en oeuvre dudit contacteur de mode (101) est changée à partir de ladite position de zoom.
16. Système d'entraînement d'objectif zoom selon la revendication 14 ou la revendication 15, dans lequel un moyen de détection de position comprend une plaque de codage (93) fixée à la circonférence extérieure d'un anneau de came (14) fixé audit système d'objectif (1).
17. Système d'entraînement d'objectif zoom selon la revendication 16, dans lequel ladite plaque de codage (93) comprend une pluralité de parties conductrices (94) et une pluralité de parties non conductrices, ledit dispositif comprenant en outre une pluralité de balais conducteurs (92) conçus pour contacter de



manière sélective lesdites parties conductrices (94) de ladite plaque de codage (93) et pour produire des signaux représentatifs de la position angulaire dudit anneau de came (14).

18. Système d'entraînement d'objectif zoom selon la revendication 17, dans lequel lesdits signaux comprennent une information de position d'anneau de came sous la forme d'une information de code de zoom qui est délivrée à un codeur de code zoom (104).
19. Système d'entraînement d'objectif zoom selon la revendication 18, dans lequel ladite plaque de codage (93) est divisée en une pluralité de pas représentatifs de positions angulaires différentes de l'anneau de came (14), chacun desdits pas représentant une position de distance focale distincte pour ledit appareil photo et ledit système d'objectif (1), lesdits pas comprenant en outre une position de verrouillage et une position de macrophotographie.
20. Système d'entraînement d'objectif zoom selon l'une quelconque des revendications 16 à 19, dans lequel ledit moyen logique comprend une unité de commande de moteur de zoom (100) qui comprend une première CPU (unité centrale de traitement), ladite unité de commande de moteur de zoom (100) étant conçue pour recevoir de l'information issue dudit contacteur de permutation de mode (101), dudit contacteur de zoom (102), et issue du codeur de code zoom contenant une information représentative de la position dudit anneau de came.
21. Système d'entraînement d'objectif zoom selon la revendication 20, dans lequel ledit codeur de code zoom comprend un moyen pour convertir la position angulaire dudit anneau de came (14) détectée par lesdits balais conducteurs (92) en une information de code zoom et un moyen pour délivrer ladite information de code zoom à ladite première CPU.
22. Système d'entraînement d'objectif zoom selon la revendication 20 ou la revendication 21, comprenant de plus une unité de commande principale (109) qui comprend une seconde CPU, ladite unité de commande principale comprenant un moyen pour commander la rotation d'un moteur de bobinage de film (111), pour entraîner et commander un bloc obturateur (23), pour commander la mise en oeuvre et le déplacement d'une unité de flash (117), et pour émettre de manière sélective un signal de désactivation de moteur vers ladite première CPU afin de désactiver ladite source d'entraînement.
23. Système d'entraînement d'objectif zoom selon la revendication 22, dans lequel ledit moyen de production dudit signal de désactivation de moteur comprend un moyen pour produire ledit signal lorsqu'un moteur d'entraînement de bobinage de film (111) est activé.

Patentansprüche

1. Variooptiksteuersystem einer Kamera mit Zentralverschluß mit:
 - a) einer Varioobjektivanordnung (1);
 - b) einem Motor (5) mit umkehrbarer Drehrichtung, der betreibbar ist, um das Varioobjektiv (1) entlang einer optischen Achse (OA) in Vorwärts- und Rückwärtsrichtung zwischen und einschließlich zwei voneinander entfernt angeordneten Endstellungen der Objektivanordnung (1) zu betreiben, um die Brennweite des Objektives (1) festzulegen;
 - c) durch eine Bedienperson bedienbaren Schaltmitteln (101, 102) einschließlich mindestens einem Varioschalter (102) zum Veranlassen einer Bewegung der Objektivanordnung (1) in eine Endstellung und mit
 - d) einem auf die Schaltmittel (101, 102) ansprechenden Steuermittel (100) zum Betreiben des Motors (5) zum Bewegen des Objektives (1) aus einer Ausgangsstellung in eine Endstellung, wobei die Ausgangsstellung durch die Stellung des Objektives festgelegt ist, wenn die Bedienperson beginnt, die Schaltmittel zu bedienen und wobei die Endstellung durch das Bedienen der Schaltmittel (101, 102) festgelegt ist,
 dadurch gekennzeichnet, daß das Steuermittel (100) die Bewegung derart steuert, daß die Endstellung immer in ein und derselben Richtung erreicht wird und daß diese Richtung vorgegeben ist, unabhängig von der durch die Schaltmittel (101, 102) ausgewählten Endstellung und von der Ausgangsstellung des Objektives (1).
2. Variooptiksteuersystem nach Anspruch 1, dadurch gekennzeichnet, daß das Steuermittel (100) ent-



hält:

- a) Richtungsdetektionsmittel zum Erfassen der Bewegungsrichtung des Objektives (1) und
- b) auf die Schaltmittel (101, 102) und die Richtungsdetektionsmittel ansprechende Logikmittel, die Mittel zum derartigen Betreiben des Motors (5) in einer Richtung enthalten, daß das Objektiv (1) sich
- 5 gegen eine durch die Schaltmittel (101; 102) festgelegte Endstellung hin bewegt, woraufhin diese Logikmittel entweder:
 - 1) den Betrieb des Motors (5) anhalten, wenn das Objektiv diese Endstellung durch eine Bewegung in besagter vorgegebener Richtung erreicht oder
 - 2) den Betrieb des Motors (5) fortsetzt, wenn das Objektiv die besagte Endstellung durch eine
 - 10 Bewegung in einer der vorgegebenen Richtung entgegengesetzten Richtung erreicht, daraufhin die Drehrichtung des Motors (5) umkehrt und den Motor (5) veranlaßt, das Objektiv (1) in der vorgegebenen Richtung zu bewegen.
3. Varioobjektivsteuersystem nach Anspruch 2, dadurch **gekennzeichnet**, daß die Logikmittel geeignete
- 15 Mittel enthalten, um vor einer Drehrichtungsumkehr des Motors (5) für eine vorgegebene Zeitdauer den Betrieb des Motors (5) in besagter entgegengesetzter Richtung fortzusetzen.
4. Variooptiksteuersystem nach einem der Ansprüche 1 bis 3, das enthält:
 - a) einen Zentralverschluß, der eingebaut ist, um mit dem Objektiv (1) bewegt zu werden;
 - 20 b) Mittel zum Scharfeinstellen des Objektives (1) auf einen zu fotografierenden Gegenstand als eine Funktion des Abstandes des Gegenstandes von der Kamera und
 - c) Mittel, um nur nach Erreichen der Endstellung durch das Objektiv (1) eine Scharfeinstellung der Objektivanordnung zu bewirken.
- 25 5. Variooptiksteuersystem nach einem der Ansprüche 3 oder 3 und 4, dadurch **gekennzeichnet**, daß die Logikmittel Mittel zum Bewirken des Motorbetriebes und der Objektivbewegung in der vorgegebenen Richtung nach Ablauf der vorgegebenen Zeitdauer enthalten, um:
 - a) das Objektiv (1) zurückzubewegen in die identifizierte Endstellung, wenn diese identifizierte
 - 30 Endstellung von der Objektivanordnung (1) während einer Bewegung in einer Richtung erfolgt, die der vorgegebenen Richtung entgegengesetzt ist oder
 - b) die Objektivanordnung (1) von der identifizierten Endstellung wegzubewegen, wenn die Bedienperson das Anwählen der gewählten Betriebsstellung des Varioschalters (102) beendet, bevor die Objektivanordnung (1) die identifizierte Endstellung erreicht hat.
- 35 6. Variooptiksteuersystem nach einem der Ansprüche 2 bis 5, **gekennzeichnet** durch folgende zusätzliche Merkmale:
 - a) die Objektivanordnung (1) ist zum Erstellen von Nahaufnahmen in eine MACRO-Stellung bewegbar, die sich jenseits der äußersten Telefotostellung befindet;
 - 40 b) der Betriebsartschalter (101) hat eine von der Bedienperson anwählbare MACRO-Stellung und
 - c) die Logikmittel sind ausgestaltet, um ansprechend auf ein Auswählen der MACRO-Stellung des Betriebsartschalters (101) durch die Bedienperson den Motor (5) derart zu betreiben, daß die Objektivanordnung (1) in die MACRO-Stellung bewegt wird, unabhängig von der Stellung der Objektivanordnung (1), wenn die Bedienperson die MACRO-Stellung an dem Betriebsartschalter (101) auswählt.
 - 45
7. Variooptiksteuersystem nach einem der Ansprüche 2 bis 6, in dem:
 - a) die Objektivanordnung ist in eine jenseits der äußersten weitwinkelstellung befindlichen Verriegelungsstellung bewegbar, um die Objektivanordnung (1) in eine Ruhestellung zu bringen, wenn die Kamera benutzt wird;
 - 50 b) der Betriebsartschalter (101) hat eine durch die Bedienperson anwählbare Verriegelungsschaltung (LOCK); und
 - c) das Logikmittel ist ausgestaltet, um ansprechend auf das Anwählen der Verriegelungsposition (LOCK) des Betriebsartschalters (101) durch die Bedienperson den Motor (5) derart zu betreiben, daß die Objektivanordnung (1) in diese Verriegelungsposition bewegt wird, unabhängig von der
 - 55 Stellung, in der sie sich befindet, wenn die Bedienperson die Verriegelungsstellung (LOCK) an dem Betriebsartschalter (101) wählt.
8. Variooptiksteuersystem nach Anspruch 6 oder 7, dadurch **gekennzeichnet**, daß der Abstand zwischen



- der äußersten Weitwinkel- und der äußersten Telefotostellung in eine Vielzahl von diskreten Brennweitenschritten aufgeteilt ist, daß das Logikmittel ansprechend auf ein Anwählen einer Betriebsstellung des Varioobjektives (1) durch eine Bedienperson mit Hilfe des Varioschalters (102) in geeigneter Weise ausgestaltet ist, um die Bewegung der Objektivanordnung (1) an einer von einer Ausgangsstellung entfernten Endstellung anzuhalten, wobei die Ausgangsstellung die Stellung der Objektivanordnung (1) ist, in der sie sich zu dem Zeitpunkt befindet, wenn die Bedienperson an dem Varioschalter (102) eine Betriebsstellung auswählt und wobei die Endstellung der Objektivanordnung (1) von deren Ausgangsstellung um eine vorgegebene Anzahl von besagten Schritten entfernt ist.
9. Variooptiksteuersystem nach einem der Ansprüche 2 bis 8, dadurch **gekennzeichnet**, daß die identifizierte Endstellung die äußerste Weitwinkelstellung ist, daß das Logikmittel den Betrieb des Motors (5) unterbindet, nachdem die Objektivanordnung (1) über eine vorgegebene Distanz jenseits der äußersten Weitwinkelstellung hinaus in eine Richtung, entgegengesetzt zur vorgegebenen Richtung, bewegt worden ist und daraufhin die Bewegungsrichtung der Objektivanordnung (1) umkehrt, zurück in die äußerste Weitwinkelstellung.
10. Variooptiksteuersystem nach einem der Ansprüche 8 oder 9, dadurch **gekennzeichnet**, daß das Logikmittel geeignete Mittel enthält, um ein Betreiben des Motors und ein Weiterbewegen der Objektivanordnung (1) zu bewirken, nachdem die Objektivanordnung (1) eine Endstellung erreicht hat, die von ihrer Ausgangsstellung um mindestens einen Brennweitenschritt entfernt ist, wenn die Objektivanordnung (1) in diese Endstellung in einer der vorgegebenen Richtung entgegengesetzten Richtung bewegt wird.
11. Variooptiksteuersystem nach Anspruch 10, dadurch **gekennzeichnet**, daß das Logikmittel ein Mittel enthält, um nach dem besagten Weiterbewegen der Objektivanordnung (1) den Motorbetrieb für eine vorgegebene Zeitdauer anzuhalten, wobei diese weitere Bewegung in einer der vorgegebenen Richtung entgegengesetzten Richtung abläuft.
12. Variooptiksteuersystem nach einem der Ansprüche 8 bis 11, dadurch **gekennzeichnet**, daß sich die Objektivanordnung (1) in Schritten bewegt, die jeweils einem Brennweitenschritt entsprechen.
13. Variooptiksteuersystem nach einem der Ansprüche 8 bis 12, **gekennzeichnet** durch zusätzliche Verzögerungsmittel (C6 in Fig. 3) zum Einfügen einer vorbestimmten Pause in den Betriebsablauf des umsteuerbaren Motors (5), wobei das Logikmittel auf das Erreichen der Endstellung der Objektivanordnung (1) anspricht, wenn diese sich in vorgegebener Richtung bewegt und das Logikmittel den Betrieb des besagten Verzögerungsmittels (C6 in Fig. 3) bewirkt, um die Bewegung der Objektivanordnung (1) in dieser Endstellung für eine vorgegebene Zeitdauer anzuhalten, falls die gewählte Betriebsstellung des Varioschalters (102) aufrechterhalten wird.
14. Variooptiksteuersystem nach einem der Ansprüche 2 bis 13, dadurch **gekennzeichnet**, daß das Steuermittel (100) Speichermittel zum Speichern von für die Stellung der Objektivanordnung (1) entlang der optischen Achse (OA) repräsentativen Daten enthält und daß das Logikmittel auf eine Änderung der Betriebsstellung des Varioschalters (102) anspricht, um die Stellung, die die Objektivanordnung (1) innehat, in das Speichermittel zu speichern, so oft die Betriebsstellung des Varioschalters (102) geändert wird.
15. Variooptiksteuersystem nach Anspruch 14, dadurch **gekennzeichnet**, daß das Logikmittel außerdem auf ein Ändern der Stellung des Betriebsartschalters (101) aus der Variostellung (ZOOM) entweder in die MACRO- (MACRO) oder in die Verriegelungsstellung (LOCK) anspricht durch Aufzeichnen der letzten gespeicherten Stellung in das Speichermittel, die die Objektivanordnung (1) vor der Änderung der Betriebsartschalterstellung innehatte, so oft die Betriebsstellung des Betriebsartschalters (101) aus der Variostellung heraus wechselt.
16. Variooptiksteuersystem nach einem der Ansprüche 14 oder 15, **gekennzeichnet** durch ein Stellungen-detektionsmittel, das ein an dem äußeren Umfang eines an der Objektivanordnung (1) angebrachten Nockenrings (14) angebrachtes Code-Blatt (93) enthält.
17. Variooptiksteuersystem nach Anspruch 16, dadurch **gekennzeichnet**, daß dieses Code-Blatt (93) eine



vielzahl von leitenden Bereichen (94) und eine Vielzahl von nichtleitenden Bereichen umfaßt, daß diese Vorrichtung außerdem eine Vielzahl von leitenden Kontakten (92) umfaßt, die zum selektiven Kontaktieren der leitenden Bereiche (94) auf dem Code-Blatt (93) und zum Produzieren von Signalen vorgesehen sind, wobei diese Signale repräsentativ für die Winkelstellung des Nockenringes (14) sind.

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18. Variooptiksteuersystem nach Anspruch 17, dadurch **gekennzeichnet**, daß diese Signale Nockenringsteuerelemente in der Form von Variocodedaten enthalten, die an einen Variocodeverschlüssler (104) gegeben werden.

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19. Variooptiksteuersystem nach Anspruch 18, dadurch **gekennzeichnet**, daß das Code-Blatt (93) in eine Vielzahl von Schritten unterteilt ist, die jeweils für die unterschiedlichen Winkelstellungen des Nockenringes (14) repräsentativ sind, daß jeder dieser Schritte eine unterschiedliche Brennweitenstellung der Kamera und des Objektivsystemes (1) repräsentiert und daß diese Schritte außerdem eine Verriegelungsstellung und eine MACRO-Fotostellung umfassen.

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20. Variooptiksteuersystem nach einem der Ansprüche 16 bis 19, dadurch **gekennzeichnet**, daß das Logikmittel eine Variomotorsteuereinheit (100) enthält, die eine erste CPU einschließt, daß diese Variomotorsteuereinheit (100) geeignet ist, von dem Betriebsartumschalter (101), dem Varioschalter (102) und dem Variocodeverschlüssler Daten zu empfangen, wobei der Variocodeverschlüssler Daten bereitstellt, die für die Stellung des Nockenringes (14) repräsentativ sind.

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21. Variooptiksteuersystem nach Anspruch 20, dadurch **gekennzeichnet**, daß der Variocodeverschlüssler Mittel zur Umwandlung der durch die leitenden Kontakte (92) detektierten Winkelstellung des Nockenringes (14) in Variocodedaten enthält und außerdem Mittel zum Liefern dieser Variocodedaten an die erste CPU.

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22. Variooptiksteuersystem nach einem der Ansprüche 20 oder 21, dadurch **gekennzeichnet**, daß außerdem eine Hauptsteuereinheit (109) vorgesehen ist, die eine zweite CPU hat, daß diese Hauptsteuereinheit (109) Mittel enthält zum Steuern der Drehbewegung eines Filmtransportmotors (111), zum Ansteuern und Steuern einer Verschlusseinheit (23), zum Steuern des Betriebes und der Bewegung einer Blitzlichteinheit (117) und zum selektiven Ausgeben eines Signales für fehlende Betriebsbereitschaft des Motors (5) an die erste CPU, um die Antriebsquelle zu unterbrechen.

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23. Variooptiksteuersystem nach Anspruch 22, dadurch **gekennzeichnet**, daß das Mittel zum Generieren des Signales fehlender Betriebsbereitschaft des Motors (5) Mittel umfaßt, die dieses Signal ausgeben, wenn ein Filmtransportmotor (111) aktiviert ist.

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