POSITION DETECTING DEVICE

The present invention relates to a position detecting arrangement for detecting the position of a movable member relative to a reference position.

In a camera equipped with a zoom lens, it is necessary to know the F-number of the zoom lens so that a proper exposure can be calculated. In addition, if the camera has a power zoom lens, the focal length setting must be known so that the camera can control the zooming operation.

A conventional solution to the above problems has been to provide the zoom lens with a code plate located on a cam ring for driving the zoom lens for integral rotation therewith. In such an arrangement, brushes are provided in slidable contact with the code plate for generating a position code that corresponds to the focal length of the lens in dependence upon the zoom code detected as a result of a conductive state between a ground brush that is normally in contact with the conductive pattern of the code plate and code brushes that come into contact with the code plate during switching between conductive areas and non-conductive areas of the code plate as the cam ring is rotated.

Each code brush generates a 1-bit signal that depends on the conductive and non-conductive state of the code plate so that when several such brushes are employed, a multi-bit zoom code signal is produced. However, since the brushes and the code plate form a mechanical configuration, the code brushes can become separated from the code plate and not make proper electrical contact due to external causes, such

as vibrations or dust, dirt, or other foreign matter on the contact surfaces. In such a case, the resulting position code that is calculated from the detected zoom code will not correspond to the actual lens position.

In addition, in determining the position code of the lens (i.e., the focal length of the lens), the exposure control is likely to be improperly set if the position code is not accurately stepped. For example, in a camera having a lens with a range of approximately 35 mm to 60 mm, the camera should preferably have about fifteen position codes to ensure that the exposure is properly calculated.

In a conventional camera, one zoom code corresponds to one position code. That is, an absolute code system is used in which each step of the zoom code has a unique value that is specific to that step and, therefore, is specific to a particular position of the zoom lens.

However, a problem associated with such an arrangement is that if the zoom code is set as an absolute code over the entire range of the zoom lens, the number of brushes that are used in association with the code plate must be increased, resulting in a more complicated code plate structure.

For instance, if information in fifteen steps is to be detected, at least four-bits of information are necessary for the generation of the zoom code. Thus, five brushes would be required, which includes one brush for ground, to cooperate with the code plate. While it is desirable to minimize the number of brushes that are required, so as to produce a more compact camera, it is not practical to reduce the number of steps of the position code.

Some electronically controlled cameras include macro and normal photographing functions which are switchable between a macro mode and a normal mode by a manual switch operation. In either mode, photographing is accomplished by autofocus in accordance with distance measuring information. A particular camera of this type is one in which the normal

mode is constituted by a zoom mode and the camera is switchable between the zoom mode and the macro mode, whereby the lens moves to and stops at a macro position when the macro mode is selected by means of the manual switch and whereby the zoom lens moves to and stops within the zoom range when the zoom mode is selected by means of the manual switch. When the lens is in the zoom mode, operation of a wide switch or a tele switch moves the zoom lens accordingly toward the wide extremity of the zoom range or toward the tele extremity of the zoom range, respectively.

The distance between the subject to be photographed and the camera, as well as the subject light intensity, are measured when the zoom lens is set to a desired position and the shutter button is operated. Based upon the result of the distance measurement, autofocus is effected in both the macro mode and the zoom mode. Photographing is also done in dependence upon the result of the light measurement.

In view of the state of the prior art as discussed above, it is an object of the present invention is to reduce the number of brushes that are required in determining the position of a camera zoom lens without decreasing the number of position code steps, by employing a relative code system in which a given zoom code corresponds to a plurality of position codes. Such a system does not permit one position code to correspond to one focal length. Consequently, a means is provided whereby a current position

code is determined by sequentially rewriting the position code that is stored in a memory by dynamically detecting changes in the zoom code that are counted from the range where the zoom code is an absolute code.

With a camera that would employ a relative zoom code system, however, if the battery in the camera is removed or the battery voltage drops below a predetermined level, the position code data stored in the memory could be lost and determining the correct focal length of the lens, i.e., the correct position code, would present a problem.

An additional object of the present invention is to design a relative zoom code system in which the camera can automatically determine a correct position code even if the data that was stored in the memory is lost.

A still further object of the present invention is the provision of a zoom position detecting device for a zoom lens which can detect the generation of an erroneous zoom code and take corrective action so as not to use the erroneously generated zoom code.

According to one aspect of the present invention, there is provided a position detecting apparatus for detecting a current position of a member movable relative to a reference position, the apparatus comprising:-

a code information carrier having a plurality of codes, each code representing one or more positions of said movable member relative to said reference position and said codes representing a code change pattern of said code information carrier;

a code identifying device operatively associated with said code information carrier for movement relative thereto and for identifying said codes;

detecting means for detecting a code change when said code has changed to a code expected in accordance with said code change pattern;

counting means for counting the number of occurrences of code changes; and

means for determining a position value of said movable member as a function of said number of occurrences of code changes.

Preferably, for a major proportion of said codes, each said code represents two or more positions of said movable member relative to said reference position.

In a preferred embodiment at least one of said codes is an absolute code representing a position of said movable member having a predetermined positional relation with said reference position.

Conveniently, at least two of said codes are absolute codes and the apparatus further includes means for inhibiting said moveable member from being stopped at the position represented by one or more but not all said absolute codes.

Generally, the codes not being absolute codes have at least one boundary, and wherein a said absolute code is located proximate said one boundary.

The codes not being absolute codes are provided as a lengthwise extending series having a first end and a second end, and wherein a said absolute code is located proximate each end of said series.

Preferably, said position determining means determines the position of said movable member as a function of said number of occurrences of code changes relative to a said absolute code.

Conveniently, the portion detecting apparatus further comprising a memory for storing positional information; means for determining whether said positional information is lost from said memory; and means for moving said movable member to said absolute code position when memory is lost.

The apparatus may further comprise a means for providing a warning indication in the case that said information is lost from memory.

In a preferred embodiment, the apparatus further comprises a power source including a removable battery, and wherein said means for determining whether said information stored in memory is lost comprises means for determining whether a predetermined time has elapsed after removal of said battery.

Preferably, the apparatus further comprises means for determining, if said changed value is not indicative of one of said at least one absolute codes, thereby defining an error, whether said error is a result of a malfunction of said code identifying device.

Conveniently, said detecting means temporarily stores an estimated code value and determines a code change if a current code value that has changed during movement of said movable member coincides with said estimated code value.

The apparatus may also further comprise:-

(i) means for determining whether said current code value coincides with an actual position of said movable member with respect to said reference position;

(ii) means for indicating said actual position of said movable member with respect to said reference position; and

(iii) means for inhibiting said means for indicating said actual position of said movable member if said current code value does not coincide with said actual position of said movable member with respect to said reference position.

Preferably, said position determining means further comprises assigning means responsive to detection of a code change by said detecting means to assign a value of a position code, which position code is indicative of respective predetermined positions of said movable member with respect to said reference position.

The apparatus may still further comprise control means actuable by an activation signal to control movement of said movable member to a predetermined initial position, said control means comprising:-

(i) means for temporarily storing a position value of the movable member according to the present code;

(ii) means for causing said movable member to move to an evaluated position for said initial position evaluated according to the stored position value;

(iii) means for temporarily storing the detected position value corresponding to said evaluated position for said initial position;

(iv) means for determining whether said temporarily stored detected position value corresponding to said evaluated position for said initial position agrees with the actual initial position value and controlling said movable member to move to said actual initial position when agreement is not determined.

The activation signal may be produced in response to at least part of said positional information being absent from memory.

In another preferred embodiment said code identifying device further comprises means for repeatedly identifying code information and the apparatus further comprises means for verifying the identification of code information by comparing said code information repeatedly identified a plurality of times until said information identified coincides a predetermined plurality of times.

Said code identifying device may comprise a pick-up member in slidable contact with said code information carrier.

According to another aspect of the present invention, there is provided a power zoom unit for a camera including a position detecting apparatus as defined above, the unit comprising:-

a zoom lens provided in an assembly for permitting focal length variation of said zoom lens;

a zoom motor;

a cam ring having said code information carrier and operatively connecting said zoom lens and said zoom motor to effect a variation in the focal length of said zoom lens assembly by changing the position of said zoom lens with respect to said reference position and wherein said detecting means comprises a plurality of brushes adapted to be fixedly mounted with respect to the body of the camera in sliding conductive contact with said code information carrier for generating a position code related to the position of said zoom lens,

switches for operating said zoom motor for driving said zoom lens in a predetermined manner;

means for controlling said zoom motor in response to said zoom code and as a function of the state of each of said switches for operating said zoom motor.

Preferably, the unit includes means for converting said position code to respective focal lengths of said zoom lens; and means for incremental indicating focal lengths of said zoom lens in response to incremental changes being counted by said means for counting changes in position codes.

The present invention will be

described in the following detailed description of preferred embodiments, with reference to the accompanying drawings, which are given by way of non-limiting examples, in which:

Fig. 1A is a block diagram of a zoom unit embodying the present invention;

Fig. 1B is a block diagram of the zoom unit of Fig. 1A, wherein the zoom lens is electrically operated;

Fig. 1C is a block diagram of an electronically switchable indicator unit that displays information that is relevant to a photographer;

Fig. 2 illustrates a front view of a camera embodying the present invention;

Fig. 3 illustrates a top view of the camera of Fig.2;

Fig. 4 represents a rear view of the camera of Fig. 2;

Fig. 5A illustrates the rear of the camera shown in Fig. 4, wherein a back cover of the camera is in an open position;

Fig. 5B discloses an LCD display panel that is used with the camera of the preferred embodiment;

Fig. 5C illustrates the LCD display panel of Fig. 5B displaying alternative photography information;

Fig. 6 is a schematic perspective view of a lens assembly used in the camera of Fig.2, showing the relationship between a cam ring, code plate and a plurality of brushes;

Fig. 7 is an exploded view of the code plate shown on the lens assembly in Fig.6;

Fig. 8 illustrates a control circuit of the camera embodying the present invention;

Figs. 9 and 10 illustrate the computer software flowchart diagram for a MAIN program that is executed by a CPU in the camera of Fig. 2;

Fig 11 illustrates a software flowchart diagram for a POSITION CODE INITIALIZATION subroutine which is called by the MAIN program shown in Figs. 9 and 10;

Fig. 12 illustrates a software flowchart diagram for a

ZOOM CODE INPUT subroutine that is called by the POSITION CODE INITIALIZATION subroutine of Fig. 11;

Fig. 13 illustrates a software flowchart diagram of a CODE CHECK subroutine that is called by the POSITION CODE INITIALIZATION subroutine of Fig. 11;

Fig. 14 illustrates a software flowchart diagram of a ZOOM REVERSE ROTATION subroutine that is called by the MAIN program shown in Figs. 9 and 10;

Fig. 15 illustrates a software flowchart diagram of a ZOOM FORWARD ROTATION subroutine that is called by the MAIN program shown in Figs. 9 and 10;

Fig. 16 illustrates a software flowchart diagram for a ZOOM WIDE subroutine that is called by the MAIN program shown in Figs. 9 and 10;

Fig. 17 illustrates a software flowchart diagram for ZOOM TELE subroutine that is called by the MAIN program shown in Figs. 9 and 10;

Fig. 18 illustrates a software flowchart diagram for a BACKUP routine that diverges from the MAIN program shown in Figs. 9 and 10;

Fig. 19 illustrates a software flowchart diagram for a BAD CHECK CODE LOOP routine that diverges from the CODE CHECK subroutine of Fig. 13 and the BACKUP routine of Fig. 18;

Fig. 20 illustrates a software flowchart diagram for a RESET routine that is initiated upon initial power-up and also diverges from the BACKUP routine shown in Fig. 18;

Fig. 21 illustrates a software flowchart diagram for a FILM INDICATION subroutine that is called by the MAIN program of Figs. 9 and 10;

Fig. 22 illustrates a flowchart for a series of instructions to perform a LOAD operation, this operation diverging from the MAIN program;

Fig. 23 illustrates the instructions for a WIND PULSE CHANGE subroutine which is called by the LOAD operation;

Fig. 24 illustrates a software flowchart diagram for a

REWIND routine that diverges from the MAIN program shown in Figs. 9 and 10 and the LOAD operation shown in Fig. 22;

Fig. 25 illustrates a software flowchart diagram for a LOCK routine that diverges from the MAIN program shown in Figs. 9 and 10;

Fig. 26 graphically illustrates the zooming operation of the lens system used with the camera embodying the present invention;

Fig. 27A illustrates a MAIN program which is a summary of the flowchart of the MAIN program shown in Figs. 9 and 10;

Fig. 27B illustrates a software flowchart for a series of instructions for a DATA I/O operation that diverges from the MAIN program shown in Fig. 27A;

Fig. 28 is a table that shows the relationship between a distance-measuring step and a lens latch when the camera of the preferred embodiment is in a zoom mode and a macro mode;

Fig. 29 illustrates a flowchart for a MACRO TELE SHIFT subroutine that is called by the DATA I/O operation of Fig. 27B;

Fig. 30 illustrates a flowchart for a LENS LATCH subroutine that is called by the DATA I/O operation of Fig. 27B;

Fig. 31 illustrates a flowchart for a series of instructions for a RELEASE LOCK PROCESSING operation that diverges from the DATA I/O operation shown in Fig. 27B;

Fig. 32 illustrates a series of instructions for a RELEASE SEQUENCE operation that diverges from the DATA I/O operation of Fig. 27B;

Fig. 33 illustrates a series of instructions that form a WIND operation which diverges from the RELEASE SEQUENCE operation of Fig. 32;

Fig. 34 illustrates a summary of the instructions shown in the MAIN program illustrated in Figs. 9 and 10 with additional instructions added to illustrate the steps

involved in a strobe charging operation for a strobe built into the camera;

Fig. 35 illustrates the series of instructions that constitute a STROBE AUTOEXPOSURE/AUTOFOCUS operation that diverges from the MAIN program shown in Fig. 34;

Fig. 36 illustrates the series of instructions that comprise a CHARGE operation that diverges from the MAIN program shown in Fig. 34; and

Fig. 37 illustrates a flowchart for a series of instructions for a RELEASE PROCESSING operation that diverges from the STROBE AUTOEXPOSURE/AUTOFOCUS operation shown in Fig. 35.

Fig. 1A schematically illustrates a zoom position detecting device of the present invention which is described in further detail below. Included is a means 15 for outputting a zoom code; a code plate 13, that is provided on the circumferential surface of a cam ring 12 to effect a change in the focal length of a zoom lens 11; a plurality of brushes 14 that are mounted on the camera body in slidable contact with the code plate 13 so as to generate a relative zoom code based on the conductive condition of the brushes; means 16 for detecting a position which converts the zoom code to a position code corresponding to the focal length of the zoom lens; means 17 for storing a pattern of changes of the zoom code, the pattern of changes being associated with the zooming operation; means 18 for detecting changes of the zoom code and determining whether the changes coincide with the pattern of changes; and means 19 for prohibiting, which examines whether changes of the zoom code are different from the pattern of changes and, if they are different, whether the changes are due to an electrical separation of at least one brush from the code plate, in which case the conversion of the zoom code to a position code is prohibited.

As shown in Fig. 1B, the zoom lens of the present invention can also be electrically operated. The electrically operated zoom lens further comprises means 16' for counting and storing changes of the zoom code from the area of the absolute code and storing it in the memory as a position code that corresponds to the focal length of the lens; means 18' for driving the zoom motor 10 so as to change the focal length of the zoom lens 11 by controlling the energization of the zoom motor 10 in accordance with an input from operation switches 17' and the position code stored in the memory; and means 19' for correcting which controls the motor drive means 18' to rotate the cam ring 12 to a position in which the zoom code becomes an absolute code when the position of the count memory means 16' is erased.

In addition, as will be discussed below, the camera includes means for indicating the focal length of the lens so that an operator of the camera knows the setting of the zoom lens.

For instance, assume the frame number of the film in the camera is given priority for indication purposes on the display as the first piece of updatable information which is stored in the first memory, as shown in Fig. 1C. The indication switching means operates to selectively switch the indication on the display to show another piece of updatable information, such as the focal length of the zoom lens.

With reference to Figs. 2-5A, in the preferred embodiment of the invention, the camera comprises a compact type lens shutter camera in which the zoom lens 11 and a finder system 21 are independent of each other. The front of the camera houses a strobe 22, a CdS sensor 23 for photometry sensing and a distance measurement device 24, comprising a position sensor (PSD) 57 and an infrared emitting diode (IRED) 56. The strobe 22 illuminates a subject to be photographed, the CdS photo cell 23 measures the brightness of the subject, and the infrared emitting diode 56 (IRED) emits infrared rays

onto the subject so that the position sensor (PSD) 57 outputs a position signal according to the distance from the subject by receiving the infrared light that is reflected from the subject. The zoom lens 11 is associated with a movable lens barrel 27 which moves relative to a fixed lens barrel 26 connected to camera body 25. The movable lens barrel 27 is displaced between a storage position (shown as a broken line in Fig. 3) and a macro extremity (shown by a solid line in Fig. 3). In this embodiment, the focal length of the zoom lens 11 is variable from approximately 38 mm to 60 mm in the zoom range. In addition, the camera of the present embodiment has a macro position and a lock position.

As shown in Fig. 3 in particular, the upper portion of the camera contains a generally triangularly shaped operation button array 28 which is also used as the zoom button. Front part 28a of the operation button array 28 comprises a 2-stage switch that operates as a photometry switch SWS and shutter release switch SWR. One rear button 28b of the operation button array 28 on the rear side comprises a tele switch SWT for controlling the zoom lens 11, while a second rear button 28c of the operation button array 28 comprises a wide switch SWW for controlling the zoom lens 11. These three switches 28a, 28b and 28c are interrelated in such a fashion that when one switch is operated, the other two switches cannot be operated. Depressing the shutter button 28a halfway activates the photometry switch SWS, while fully depressing the shutter button 28a activates the release switch SWR.

By depressing the portion of the operation button array 28 above the tele switch SWT and, consequently, tilting the generally triangular member downward, the zoom motor 10 is rotated in a direction that causes the zoom lens 11 to extend from the camera body 1. By depressing the portion of the operation button array above the wide switch SWW, the zoom motor 10 is rotated in the opposite direction, such that the zoom lens 11 is retracted into the camera body

1. The rotation of the zoom motor 10 is controlled by the main CPU, which executes a sequence of instructions based upon which switch SWT or SWW, is depressed.

As shown in Figs. 4 and 5A in particular, the rear portion of the camera body 25 comprises a back cover 29 (film compartment cover), a main switch 30, a mode switch 31, an LCD panel 32, a back cover open/close lever 36, a red lamp indicator (LED) Rd, and a green lamp indicator (LED) Gd. A film presence detector switch 33 is operable to detect the presence of film, while a wind pulse switch 34 is operable to generate a wind pulse in response to the advancing of the film. The film presence detector switch 33 is sunk into wall 33a inside the camera when the film cartridge (patron) is placed in film cartridge compartment 35a, the leading end of the film is put on spool 35 with its perforation in contact with the film advance detector switch 34, and the back cover 3 is closed. The film presence detector switch 33 is turned OFF when it is fully sunk into the wall 33a. When the film presence detector switch 33 is in the OFF state, the film is ready to be advanced.

The red lamp indicator Rd blinks when the photometric switch SWS is depressed and strobe emission is needed but is not ready. When the shutter release button SWR is pressed and the strobe 22 emits light, the red lamp indicator Rd is continuously illuminated (that is, the red lamp indicator Rd has a 100 percent ON duty cycle). The green lamp indicator Gd blinks if the subject is too close when the photometric switch SWS is depressed and it is fully illuminated (as described above for the red lamp indicator Rd) when the subject is within the proper distance for the taking of a flash photograph.

The back cover 29 is opened by sliding the back cover open/close lever 36 in the direction of arrow A. The main switch 30 comprises a three position slidable switch, having a lock position SWL, a zoom position SWZ and a macro position SWM. When the main switch 30 is moved in the

direction of arrow B, from the lock position SWL to the zoom position SWZ, or from the lock position SWL to the macro position SWM, power for the camera's components, schematically shown in Fig. 8, such as a motor drive circuit 500, strobe circuit 600, etc., are turned ON by the application of electrical power to a main CPU 100.

The LCD panel 32 operates under the control of the main CPU and has the capability of displaying a free wind-up mark, which indicates the request for a free film feed; a patron mark, which indicates the loading of the film; the frame number of the film; and a focal length value indicating the position of the zoom lens.

A switching operation functions to switch the data that is displayed on the LCD panel 32. For instance, as shown in Fig. 5B, the LCD display panel 32 includes a film status indicator area 32a for indicating film-related information 32r, a mode indicator area 32b for indicating the photographing mode of the camera, such as a normal mode 32s and a battery status indicator area 32c for indicating the condition of camera battery 32t. In the illustration shown in Fig. 5B, the film status indicator 32a serves to initially indicate a blank-shot film advance request L_d (which is a cylindrical film roll case representing the loading of film) when a film is first loaded into the camera, the film frame number, or alternatively, the focal length of the zoom lens 11.

Fig. 5C illustrates the LCD panel 32 indicating alternative information. In this illustration, the film status indicator area 32a has been changed to indicate the focal length of the zoom lens, while the mode indicator area 32b has been changed to indicate a daytime synchronized mode 32x.

The battery status indicator area 32c indicates the condition of the camera battery to the photographer. The camera battery 32t has two indicators 32y and 32z. When a fully charged battery is inserted into the camera, the

outline of the camera battery 32t and the two indicators 32y and 32z are illuminated. When the camera battery is partially discharged, the outline of the camera battery 32t and only one indicator 32z are illuminated. When the camera battery voltage is below a predetermined level (or is fully discharged), every figure displayed in the LCD panel blinks. This blinking feature alerts the photographer to replace the battery.

The main CPU controls a means for indicating a loading request for forcing an indication of the blank-shot film advance request L_d on the liquid crystal panel 32, when the film presence detector switch 33 detects the absence of a film in the camera. The main CPU further controls the liquid crystal panel 32 so as to give display priority to the frame number of the film loaded in the camera. With respect to indicating the status of the film and the focal length of the zoom lens 11 on the display panel 32, the main CPU gives priority to the film frame number. This first piece of updatable information is stored in a first memory. The indication of a second function, such as focal length information, comprises a second piece of updatable information that is also stored in a memory means. The display of the second function on the display panel 32 replaces the display of the first function in response to the operation of the tele switch SWT, wide switch SWW or light measuring switch SWS. The main CPU also receives inputs from the film presence detecting switch 33, the film advance detector switch 34, battery loading information from the battery presence switch SWB, zoom code information and DX contact information which indicates the sensitivity of the film.

Fig. 1C schematically illustrates how the various items of information can be displayed in a limited indication area. An indicator control means enables a first type of information to be stored in the first memory and another type of information to be stored in a second memory. The

information in the first memory is given priority over that in the second memory so that the information in the first memory is displayed in the limited indication area unless a switch that is responsive to the second type of information is operated.

As shown in Fig. 8, the motor drive circuit 500 controls the zoom motor 10 and a film winding motor 510. The motor drive circuit 500 is controlled by the main CPU 100. The mode switch 31 operates to switch between a normal photographing mode and a daytime synchro photographing mode. When the mode switch 31 is switched to the normal photographing mode, the daytime synchro photographing mode is selected. When the mode switch 31 is switched to the daytime synchro photographing mode, the normal photographing mode is selected. The selected mode is displayed on the LCD panel 32.

As noted above, the main CPU controls the function of advancing the film for a predetermined number of blank-shots when a new roll of film is placed in the camera in accordance with the loading request indication control means, with which the blank-shot film advances are executed by operating a film advance motor 510 in dependence upon the operation of the main switch 30 and the release switch SWR. The operation of the film advance motor 510 is stopped when the predetermined number of blank-shot frames have been taken, in response to the output detection of the film advance detector switch 34.

Winding spool 35 has a spool axis about which the film is wound as the film advances from one frame to another.

The main CPU 100 performs the transfer of information with a sub CPU via a drive IC. In the preferred embodiment, the main CPU, sub CPU, drive IC and autofocus IC have been incorporated into the main CPU using system integrated very large scale integrated circuitry (VLSIC) to create a custom IC. The sub CPU functions to

transfer photometry information from the photometric element 23 and distance measurement device 24 to the main CPU 100. In addition, the sub CPU also controls the transfer of information with an autofocus IC. The autofocus IC controls the emission from the infrared light emitting diode 56 (IRED), and transfers output information from the position sensor 57 (PSD), which receives the infrared light reflected from a subject to provide distance measurement information to the sub CPU.

As shown in Fig. 8, the camera comprises a photometric switch SWS and a shutter release switch SWR (both of which are activated by depressing the shutter button 28a), a power source 300, and a strobe circuit 600 which causes the strobe 22 to flash. The strobe circuit includes a capacitor (not illustrated) which is charged by a voltage booster circuit and boost circuit. Current charging this capacitor is sent to strobe 22 so that it flashes.

Referring to Fig. 6, cam ring 12 is installed around the zoom lens 11 and is linked to zoom motor 10 through sector gear 12a and pinion 10a, which advances and withdraws the zoom lens 11 according to the rotation of the zoom motor 10 by a cam mechanism, which is not shown in the drawing.

In the camera embodying the present invention, information concerning a change in the focal length of the lens 11, a change in the open-aperture F-number according to the focal length change and a determination as to whether the lens is at the wide extremity, the tele extremity, the macro photographing position, or the lock position, is automatically detected for performing various operations according to the detected information. To obtain the required information, a code plate 13 is secured to the circumference of cam ring 12, while four brush terminals 14 (ZCO, ZC1, ZC2, and GND) contact the code plate 13. One brush operates as a ground terminal (GND), while the remaining three brushes (ZC0, ZC1 and ZC2) are used for code detection.

Fig. 7 is an exploded "flattened" view of the code

plate 13. When terminals ZC0, ZC1 and ZC2 come in contact with a conductive land of the code plate, shown by hatches in the drawing, a signal "0" is generated, while when a brush does not contact a conductive land, a signal "1" is generated. Thus, a three-bit information detection signal generated by the conductive relationship of the brushes ZC0-ZC2 with the ground brush GND corresponds to a zoom code ZC.

Shown below the code plate 13 (in Fig. 7) is a position code POS that corresponds to the zoom code ZC, as shown in Table 1. The position code POS represents a hexadecimal value from "0_H" to "E_H".

In the camera, there are 15 detection steps that correspond to the focal length of the lens. Hence, there are 15 position codes POS. It should be noted that the focal length indication is set to 6 steps that correspond to the position code POS.

To detect the 15 positions using three brushes, it is necessary to create a relative (non unique) code, ie a code which can have the same zoom code value for different step positions. In the embodiment, an absolute code is set by providing a one to one (unique) correspondence between the part where the position code POS equals "0_H", "1_H", "D_H" and "E_H" and the zoom code ZC equals "0", "1", "2" and "3", while the relative code is set by providing a repeated correspondence between the position code equalling "2_H" to "C_H" and the zoom code ZC equalling "4" to "7".

When POS equals "0_H", the zoom lens 11 is drawn into the fixed lens barrel 26 and the front of the lens 11 is covered by a barrier (not shown) to set the lens to a lock mode. A position code POS of "2_H" to "C_H" denotes a zoom capable range, while a position code POS of "E_H" indicates a macro position that is used for close-up photography. The boundary section between the lock position and the zoom range, as well as the zoom range and the macro position, denotes a stop prohibiting range.

Table 1

POS	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
ZC2	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0
ZC1	1	0	0	0	1	1	0	0	1	1	0	0	1	1	0
ZCO	1	1	1	0	0	1	1	0	0	1	1	0	0	0	0
ZC	3	1	5	4	6	7	5	4	6.	7	5	4	6	2	0
Indication (mm)	38	38	38	42		46		50		55		60		60	60
LOCK		STOP prohibited	Zooming area											STOP prohibited	Macro
Absolute Code			Relative code											Absolute Code	

The circuit configuration used with the camera embodying the present invention will be further explained with reference to Fig. 8. The operation of the camera will be explained with reference to a plurality of flowcharts, shown in Figs. 9-23. In the following description, the details for the zoom-related processing concerning this invention is explained, while processing relating to the shutter control or the advancement of the film will only be briefly described.

The main CPU 100 has four serial signal lines. A shutter AF unit, which performs shutter-related processing, is connected to the four serial signal lines. Battery 300 supplies power to the main CPU 100 via a regulator 310. The

LCD panel 32, zoom motor 10 and other components of the camera are controlled according to the inputs from the above-mentioned switches. A backup capacitor 320 supplies current to the main CPU 100 when the battery 300 is removed from the camera.

A motor operation circuit 400 comprises a plurality of PNP transistors 401-404, NPN transistors 405 and 406 and multiple biasing resistors, which function to control the forward and reverse rotation of the lens, as well as the stopping of the zoom motor 10 according to four-bit signals FOW N, REV P, REV N and FOW P outputted from the main CPU 100, as shown in Tables 2 and 3.

The zoom motor 10 rotates in a forward direction to cause the zoom lens 11 to extend out of the camera body 25 so as to change the focal length of the lens to the tele range. When the zoom motor rotates in a reverse direction, the zoom lens 11 is drawn into the camera body so as to change the focal length of the lens 11 to the wide extremity.

Table 2

Normal Rotation

	FOW N	FOW P	REV P	REV N	
1					Open
2	ON	ON			Normal rotation
3					Open
4	ON			ON	Brake
5					Open

Table 3

Reverse Rotation

	FOW N	FOW P	REV P	REV N	
1					Open
2			ON	ON	Normal rotation
3					Open
4	ON			ON	Brake
5					Open

The following switches provide information to the main CPU 100:

(1) Lock switch SWL, which is set to ON when the main switch 30 is set to the lock position;

(2) Macro switch SWM, which is set to ON when the main switch 30 is set to the macro position;

(3) Film switch SWF (element 33 in Fig. 5A), which is depressed by the film loaded into the camera, and is set to OFF when the back cover 29 is closed;

(4) Battery switch SWB, which is set to ON by mechanically detecting the presence of a battery;

(5) Brushes ZC0, ZC1 and ZC2, which come into contact with the code plate 13 to detect zoom codes ZC (these brushes are not technically switches, however, as they function as switches in the circuit, they are expressed as switches for convenience);

(6) Photometry switch SWS, which is set to ON by depressing the front switch 28a of the operation button array 28 by one step;

(7) Release switch SWR, which is set to ON by depressing the front switch 28a of the operation button

array 28 by two steps;

(8) Zoom tele switch SWT, which is set to ON by depressing rear switch 28b of the operation button array 28; and

(9) Zoom wide switch SWW, which is set to ON by depressing rear switch 28c of the shutter button 28.

The main CPU 100 performs the following functions by executing stored programs:

(1) Zoom control based on the conductive condition of brushes;

(2) Control the zoom motor 10 according to inputs from the switches and the zoom code;

(3) Hold and store in memory changes in the zoom code as the position code by counting the changes from the absolute code section;

(4) Hold the pattern of changes of code information associated with the zooming operation;

(5) Detect changes in the zoom code and examine whether or not the change coincides with the pattern of changes;

(6) If the change in the zoom code is different from the pattern of changes, determine whether the change is due to a separation of at least one brush from the code plate and, if the change is due to a brush separation, prohibit the conversion of the zoom code to a position code after the detected change; and

(7) Control the zoom motor so that the cam ring is turned to a position in which the zoom code becomes an absolute code when the memory for counting is erased.

MAIN Program

The MAIN program flowchart is illustrated in Figs. 9 and 10. The MAIN program specifies the basic operation of the camera. Associated programs, called subroutines, are executed after being called by an instruction of the MAIN program. Steps 1-22 of Fig. 27A is a summary flowchart of the MAIN program illustrated in Figs. 9 and 10. Fig. 27A discloses the instructions necessary to perform a DATA I/O

operation, whereas this operation has been summarized in steps 51-64 of Fig. 10. The instructions that are shown in the MAIN program flowchart of Fig. 27A have been labelled such that they correspond to the instructions listed in Figs. 9 and 10.

In step (referred to in the drawings as "S" before an instruction number) 1, the status of each switch is inputted to the main CPU 100, which stores the detected settings in a memory so as to provide a series of initial switch values. A position flag F_{POS} is examined to determine if the flag has been set to 1. The position flag indicates the reliability of the position code. If the flag is set to 1, processing advances to step 3. If the flag is set to 0, a POSITION CODE INITIALIZATION (POS INI) subroutine is executed at step 4, which will be described below. The POS INI subroutine is run when the relative code is used for the POS detection and has the characteristics of a component specific to this invention.

In step 3, the status of the switches are inputted once more. The purpose of this step is to detect any dynamic changes in the setting of the switches by comparing the re-read settings with the data stored in memory.

In step 5, battery switch SWB is examined to determine if it is set to ON. If this switch is set to OFF, that is, if the battery is removed, processing advances to step 6 to diverge to a BACKUP series of instructions, to be described below. The camera embodying the present invention keeps the data stored in the memory for a certain period of time if the battery 300 is removed (i.e., due to a battery replacement operation) by means of the energy that is stored in the capacitor 320. When the backup power supply is used (i.e., capacitor 320), operations requiring a large power consumption must be prohibited. This is accomplished by diverging to the BACKUP instructions.

When operating the camera, the first step is to load the film. Automatic film loading is performed by pulling

out the film to the point where its tip end is laid on winding spool 35. To control the film loading, a film loading request flag F_{LDRQ} and a loading end flag F_{LDEND} are used. These flag operations are performed in step 257 of the BACKUP instructions (Fig. 18), step 309 of a series of instructions to perform a RESET operation (Fig. 20), steps 350 and 352 of a series of instructions to perform a LOAD operation (Fig. 22) and steps 398, 400 and 401 of a series of instructions to perform a LOCK operation (Fig. 25), as well as in the MAIN program.

When it has been determined that the battery is loaded (step 5), steps 7-14 are performed to determine whether the film switch SWF is in a condition whereby it can be estimated from the film loading flags. If the condition is different from what was estimated, an indication of the film frame is shown on the LCD panel 32, while if it is the same as what was estimated, the previous indication (namely, either the focal length or film frame indication) is maintained on the LCD panel 32 and processing continues to step 15.

Thus, in step 7, it is determined whether the loading end flag F_{LDEND} is set to 1. This flag is initially set to 0, meaning that the film loading has not yet taken place. If this flag is set to 0, a determination of whether the loading request flag F_{LDRQ} is set to 1 is made in step 8. F_{LDRQ} is initially set to 0.

When it is determined that both flags are negative (i.e., set to 0), the film switch SWF is checked in step 9. When the end of the film is pulled out so that it is placed on the winding spool 35 and the back cover 29 is closed, film switch SWF is set to OFF and the loading request flag F_{LDRQ} is set in step 10 so that the film loading operation is ready to be performed.

When this flag is set and the program loops back to this step again, the test performed in step 8 is positive. When the film loading is complete, the decision of step 7 is

positive. Therefore, the same test is made in step 11 as was performed in step 9. The film switch SWF is set to ON after the flags F_{LDRQ} or F_{LDEND} have been set when the back cover 29 is opened or the film has been rewound. In the former case, flags F_{LDRQ} and F_{LDEND} are cleared (steps 12 and 13) and then the film status is indicated on the LCD panel 32 (step 14). The film indication is shown with priority given to the focal length indication, except when the LCD panel is temporarily switched to display another indication.

In step 15, a test is made to determine if the loading request flag F_{LDRQ} is set to 1. If this flag is set to 1, the status for the macro switch SWM and the lock switch SWL are tested (steps 16 and 17) to determine whether they have changed since their setting was stored in memory. If they have changed, processing diverges to a LOAD operation (step 18). If there have been no changes, the MAIN program proceeds to step 19.

In step 19, the status of the lock switch SWL is judged by examining the data input for this switch that was obtained from step 3. The lock switch SWL is set to ON when the camera is placed in a storage or non-use condition. In this case, the position code POS is examined to determine if it is equal to "0_H", that is, whether the lens has been moved to the lock position (step 20). If the lens is already in the lock position, processing advances to step 21 and the LOCK subroutine is called. If the lens is not in the lock position, a ZM REV subroutine (step 22) is performed so as to reverse the rotation of the zoom motor, retracting the zoom lens into the camera body into the lock position.

When the lock switch SWL is set to OFF, the following operations are performed:

First, in step 23, the status of the macro switch SWM is examined. If the macro switch SWM is set to ON, as is required to set the lens into the position needed for close-up photography, an examination is made of the position code

POS (step 24) to determine if it is equal to "E_H". When POS equals "E_H", the lens is already in the macro position. Therefore, processing advances to point A shown in Fig. 10.

If POS is not equal to "E_H", processing advances to steps 25 and 26, wherein an indication related counter SCANT is set to 8 and a ZM FOW subroutine is called to rotate the zoom motor in a forward direction. Step 25 is a timer instruction which causes the focal length of the lens to be displayed on the LCD panel for a period of one second. Thereafter, the MAIN program is re-executed.

When it is determined that the macro switch SWM is set to OFF in step 23, the lens needs to be in the range where POS equals "2_H"-"C_H". That is, the lens needs to be in the zoom range. Therefore, if the position code POS is greater than or equal to "2_H" (step 27), the next question to be answered is whether the position code POS is less than or equal to "C_H" (step 28).

When POS is less than "2_H" (that is, POS equals "0_H" or "1_H"), the lens is in the lock position or the boundary area between the lock position and the zoom range. Therefore, to pull the lens out to the zoom range to allow photographing, the above-mentioned operation to set the counter of step 25 is performed. Then, the processing for the zoom motor forward rotation of step 26 is carried out. When POS is larger than "C_H", the lens is in the macro position or the boundary area between the macro extremity and the zoom range. Therefore, after the indication counter SCANT is set to "8", in step 29A, the subroutine for the zoom motor reverse rotation is called in step 22.

When the judgment of steps 27 and 28 are both affirmative, the lens is in the zoom range. Thus, the condition of the zoom wide switch SWW is examined (step 29B). When this switch is set to ON, the indication on the LCD panel is switched from the film indication to display the focal length of the lens (step 30) and the indication counter SCANT is set to "8" (step 31). Then, wide extremity

flag F_{WIDE} is examined to determine if the lens is at the wide extremity (step 32). The wide extremity flag F_{WIDE} is set to a value in step 116 of the POS INI subroutine (Fig. 11), step 162 of the ZM REV subroutine, steps 185 and 189 of the ZM FOR subroutine and step 211 of a WIDE subroutine. If this flag is set to 1, the lens is already at the wide extremity and cannot be moved any further. Therefore, processing advances to point A, shown in Fig. 10. If the wide extremity flag F_{WIDE} is set to 0, the WIDE subroutine is called at step 33.

When it is determined that the wide switch SWW is set to OFF in step 29B, processing advances to point B, shown in Fig. 10, so that the status of the zoom tele switch SWT can be determined. When the tele switch SWT is set to ON, the LCD display is switched to indicate the focal length of the lens (step 35) and the counter SCANT is set to a value of "8" (step 36). Thereafter, the position code POS is examined to determine if it is equal to "C_H". When POS is equal to "C_H", the lens is already at the tele extremity. Therefore, processing jumps to step 49. When POS is not equal to "C_H", a TELE subroutine is called at step 38 of the MAIN program.

When the tele switch and wide switch are not set to ON, processing advances to step 39. In steps 39-42, the display of the LCD panel is switched according to the indication counter SCANT. In step 39, the counter SCANT is checked to see if it has been set to "0". As described above, SCANT is set to "8" when the zoom switches SWW and SWT are set to ON. If SCANT is not equal to "0", one count is subtracted from the indication counter SCANT (step 40). The MAIN program executes a loop between steps 2 and 50 every 125 milliseconds (ms). Therefore, a period of one second can be counted by successively reducing by "1" the value of the counter SCANT, which has previously been set to a value of "8".

Step 41 determines whether the indication counter SCANT

has become "0" as a result of the above subtraction operation. If the counter is "0", one second has passed. When SCANT becomes "0", the indication on the LCD panel is switched from indicating the focal length of the lens to indicating the film frame number (step 42), while when it is not equal to "0", step 42 is skipped and the focal length indication of the lens is kept on the LCD display.

When it is judged that SCANT equals "0" in step 39, steps 40-42 are skipped.

In step 43, the loading request flag F_{LDRQ} is checked to see if it is set to 1. If it is set to 1, the current setting of the release switch SWR is compared to its memory setting to determine if there has been a change (steps 44 and 45). When the release switch SWR has changed from being OFF to being ON, the LOAD instructions are executed by diverging from step 46. If the status of the release switch SWR has not changed or it has changed from ON to OFF, processing returns to the MAIN program. However, when the loading request flag F_{LDRQ} is set to 1, the testing of the status of the photometry SWS in step 47 is not performed. Therefore, the operation of the photometry switch SWS has no effect on the camera.

When the loading request flag F_{LDRQ} is set to 0, the setting of the photometry switch SWS is compared to its setting that is stored in memory (step 47) to determine if it has changed. If there is no change, or the setting has changed from ON to OFF, step 49 is executed so as to rewrite the switch data into the memory in step 3, after pausing for a period of 125 ms (step 50) before looping back to step 2.

Also, in the case where the macro switch SWM is set to ON and the lens is in the macro position or the wide switch SWW is set to ON and the lens is in the wide extremity or the tele switch SWT is set to ON and the lens being is in the tele extremity, processing advances to step 49.

When the photometry switch SWS is changed from OFF to ON, (step 48) the indication counter SCANT is set to "1" (step 51) and

the indication on the LCD panel is switched to display the focal length of the lens (step 52).

In step 53, exposure value EV is calculated from the brightness information of a subject that is obtained from the CdS sensor and the film sensitivity that is calculated from the film DX code.

In steps 54-64, the status of the photometry switch SWS, battery switch SWB, release switch SWR and lock switch SWL are inputted and successively tested to determine if they are ON or OFF. First, in step 55, the status of the photometry switch SWS is determined. If this switch is set to OFF, processing returns to the start of the MAIN program. As the indication counter SCANT was set to "1" in step 51, SCANT becomes "0" in step 40 for the first loop and the focal length indication on the LCD panel is switched to indicate the number of film frames in step 42.

When the photometry switch SWS is ON (step 55), the battery switch SWB is tested to determine if it is ON (step 56). When the battery switch SWB is OFF, the BACKUP instructions are executed by diverging from step 57, while when the switch is ON, step 58 is executed to determine the setting of the release switch SWR.

When the release switch is set to ON, an EXPOSURE subroutine is called in step 59. This subroutine controls the operation of the camera shutter. Thereafter, a WIND subroutine is called in step 60 to advance the film by one frame. After the WIND subroutine has been completed, a decision needs to be made as to whether to rewind the film (step 61). When the winding is finished normally, step 61 is negative. Thus, processing returns to the start of the MAIN program. If it is determined that the end of the film has been reached, a series of instructions to execute a REWIND operation are performed by diverging from step 62. If the release switch SWR is determined as being OFF in step 58, the status of the lock switch SWL is checked in step 64. When the lock switch SWL is ON, processing returns to the

start of the MAIN program, while when the lock switch is OFF, processing loops back to step 54.

By the above explanation, each step of the MAIN program has been described. The following discussion will explain the operations that are performed by the various subroutines that are called by the MAIN program.

POSITION CODE INITIALIZATION (POS INI) Subroutine

Fig. 11 illustrates the initialization operations called for in step 4 of the MAIN program. Position code flag F_{POS} is set to 0 when a RESET subroutine (shown in Fig. 20) is called or the zoom code ZC shows an abnormal value during a CODE CHECK subroutine (shown in Fig. 13). In the former case, the subroutine is executed the first time a battery is inserted into the camera, or where the battery is removed from the camera and not replaced within approximately seventeen minutes.

As the backup capacitor 320 current is usually lower than that required to maintain the camera memory after the battery is removed and left out of the camera for a period exceeding seventeen minutes, the camera embodying the present invention is designed to clear its memory when this situation occurs.

The initialization operation is intended to move the lens from the zoom range, where the zoom code is a relative code, through the wide extremity section to the absolute code section so as to restart the count for the amount of the lens movement from the absolute code section.

Accordingly, the first instruction that is executed (step 101) is to input the zoom code ZC based upon the conductive condition of the brushes that are in contact with the code plate. This is accomplished by calling a ZOOM CODE INITIALIZATION (ZC IN) subroutine, which is illustrated in Fig.12.

In step 102, the position code POS is tentatively set according to the input zoom code ZC. In addition, the change estimation values ZC FOW and ZC REV of the zoom code

and tentative zoom code are stored in the camera's memory.

As shown in Table 1, the fifteen-step position code POS is obtained from a three-bit eight-step zoom code ZC. Accordingly, the position code POS is determined from the particular relationship of the zoom code ZC values to the position code POS values. Specifically, the "absolute" values of the zoom code ZC ("0", "1", "2", and "3") correspond in a one-to-one relationship with position code POS values of "0_H", "1_H", "D_H", and "E_H" and the "relative" code ZC values ("4", "5", "6", and "7") correspond in a multiple-to-one relationship with POS values of "2_H"-"C_H".

In the relative code section, position code POS equalling "3_H", "7_H" or "B_H" corresponds to a zoom code ZC of "4"; POS equalling "2_H", "6_H", or "A_H" corresponds to a zoom code ZC of "5"; POS equalling "4_H", "8_H", or "C_H" corresponds to a zoom code ZC of "6"; and POS equalling "5_H" or "9_H" corresponds to a zoom code ZC of "7". The temporary setting of the position code POS forcibly sets the zoom code to "4", "5", "6" or "7", corresponding to the relative code "B_H", "A_H", "C_H" or "9_H", respectively. When the photographing lens is in the range of POS equals "2_H"-"8_H", the value different from that for the actual lens position is set.

The zoom code value, which is supposed to change when the lens zooms to the tele or the wide extremity, is set for a change estimation value ZC FOW and ZC REV, respectively. However, this value is rewritten, together with the change of the position code POS in the CODE CHECK subroutine.

In step 102 of this subroutine, when the zoom code input in step 101 is set to "5", the position code POS is tentatively set to "A_H" and as a result, ZC FOW is set to "4" and ZC REV is set to "7".

In step 103, the output of terminal ZC2 is checked to determine if it is equal to 0. As shown in Table 1, the output of terminal ZC2 becomes 0 when the zoom code ZC is an absolute code. In the present instance, the temporary

setting of the position code POS is correctly set. Thus, the subroutine sets the POS flag F_{POS} to 1 (step 104) and then returns to the MAIN program.

When the output of terminal ZC2 is 1, the zoom code ZC is the relative code and the temporarily set position code POS may not coincide with the actual position of the lens. Therefore, the zoom motor is rotated in the reverse direction (step 105) to move the lens into the absolute code section adjacent the wide extremity.

In step 106, the indication prohibition flag F_{NODSP} is set to 1. This flag is used to determine if the focal length of the lens should be indicated when the CODE CHECK subroutine (to be discussed below) is executed. When this flag is set to 1, an incorrect focal length indication, which occurs when the temporarily set position code POS does not coincide with the actual photographing lens position, is prohibited from being displayed on the LCD panel. This flag is also used for the WIDE subroutine, which will also be discussed below.

In step 107, a CODE CHECK (CODE CHK) subroutine (see Fig. 13) is called to verify the position code. Processing loops through steps 107 and 108 until the position code POS is equal to "1_H". When the position code POS is equal to "1_H", step 109 is executed so as to introduce a delay period of t_1 ms before the zoom motor is activated to rotate in the forward direction so as to eliminate backlash of the mechanical system.

Thereafter, the CODE CHECK subroutine is re-run (step 111), a plurality of times if necessary, until the position code POS is equal to "2_H" (step 112). When the position code is equal to "2_H", the indication prohibition flag F_{NODSP} is set to 0 (step 113) and the zoom motor is stopped in step 114.

Finally, the position code flag F_{POS} and wide extremity flag F_{WIDE} are set to 1 (steps 115 and 116) prior to returning to the MAIN program.

ZOOM CODE INPUT (ZC IN) Subroutine

Fig. 12 shows the ZOOM CODE INPUT subroutine that is performed in the POSITION CODE INITIALIZATION subroutine and the CODE CHECK subroutine.

This subroutine improves the reliability of the zoom code that is detected by the interfacing of the brush terminals ZC0, ZC1 and ZC2 with the code plate. The outputs of the brushes are compared by repeating the input of the zoom code ten times. When the results coincide three times, the zoom code for these results are defined.

When considering the contact relationship between the code plate and the brush terminals, an OFF (signal level "1") signal may be detected due to a momentary separation of a terminal, when the position should really be an ON (signal level "0") signal. Therefore, the detection results are electrically AND'ed together and the particular terminal is considered as being conductive if it is detected as conductive at least once in every ten tests. This prevents a brush terminal from being incorrectly read due to the momentary separation of a terminal with the code plate.

When this subroutine is called, the zoom code ZC stored in REGISTER 2, i.e., ZCREG2, of the memory is read and a Z counter is set to "3". Then, the AND'ed result obtained by inputting the zoom code ten times is stored in REGISTER 1, ZCREG1, (steps 120-122). The value of REGISTER 1 is then compared with that of REGISTER 2 (step 123). If the two registers are different, the value of REGISTER 1 is moved to REGISTER 2 in step 124.

In steps 124-126, the Z counter is set to "1" and the subroutine is placed in a standby mode for 500 microseconds (μs) before another zoom code is inputted. When the detection result of this cycle is the same as that of the previous cycle, REGISTER 2 becomes equal to REGISTER 1. Therefore, the Z counter is examined (step 127) to decide if it is equal to "3". When the Z counter is not equal to "3", it is incremented by "1" (step 128) and processing returns

to step 122 after a pause of 500 μs.

When the Z counter is equal to "3" (in step 127), meaning that REGISTER 1 has been equal to REGISTER 2 for three successive cycles of steps 122 and 123 after the zoom code ZC has shown different values from the zoom code memory, the value of REGISTER 2 is defined as the zoom code ZC (step 129') and processing returns to the point from which ZC IN subroutine was called.

CODE CHECK (CODE CHK) Subroutine

Fig. 13 illustrates the CODE CHECK subroutine which changes the position code POS according to the zoom code ZC, which itself changes following a zooming operation. This subroutine is frequently used in the zoom-related processing shown in Figs. 14-17, in addition to the above-mentioned POSITION CODE INITIALIZATION subroutine.

In step 130, data relating to the lock switch SWL, macro switch SWM, battery switch SWB, wide switch SWW and tele switch SWT are inputted. In step 131, the status of the battery switch SWB is determined. If this switch is OFF, the brake is applied to the zoom motor (step 132), register stack processing of the CPU 100 is performed (step 133) and processing diverges to the BACKUP instructions, shown in Fig. 18.

When the battery switch is ON, the zoom code ZC is inputted by executing the above-described ZOOM CODE INPUT subroutine (step 134). Thereafter, a code change flag F_{CHNG} is cleared and set to 0 (step 135) prior to comparing the content of the zoom code ZC and the zoom code stored in memory (step 136). The code change flag F_{CHNG} is used only for this CODE CHECK subroutine to determine whether the position code POS has been rewritten in the zoom related processing.

If the zoom code is equal to the value stored in memory, the subroutine exits, returning to the point from which it was called. However, as the zoom motor rotates, the zoom code value becomes different from that stored in

memory. When the zoom code is different from that stored in memory, it is necessary to decide if the zoom motor is rotating in the forward direction (step 137).

When the zoom motor is rotating in the reverse direction, it is determined whether the changed zoom code ZC coincides with the change estimation value ZC REV (step 138). When this CODE CHECK subroutine is called in the zoom operations shown in Figs. 14-17, the changed zoom code normally coincides with the changed estimation value. Accordingly, in step 139, the value "1_H" is subtracted from the position code POS, the zoom code stored in memory is rewritten to the value obtained after the zoom lens has moved and the change estimation values ZC FOW and ZC REV are reset to correspond to the position code POS obtained after the subtraction is performed. The value of the indication prohibition flag F_{NODSP} is then examined to determine if it has been set to 1. If this flag has been set to a value of 0, the focal length of the lens is indicated on the display panel (step 141). When the value of the prohibition flag is set to 1, step 141 is skipped. Regardless of whether the focal length of the lens is displayed or not, the code change flag F_{CHNG} is then set to 1 in step 142 before the subroutine returns to where it was called.

However, when the CODE CHECK subroutine is called in step 107 of the POSITION CODE INITIALIZATION subroutine (Fig. 11), the zoom code after the lens has moved may be different from the change estimation value. In the same way as that for the above-mentioned example, when the temporarily set POS is "A_H", ZC REV is "7", ZC FOW is "4", while when the actual lens position before changing is POS equals "2_H", the zoom code ZC after the lens moves becomes equal to "1" for a change code estimation ZC REV of "7". As a result, the two are not equal and processing advances from step 138 to step 143. In step 143, the zoom code ZC after changing is tested to determine if it is equal to "1" while the zoom code before changing is equal to 5. If the

comparison of the two is affirmative, processing advances to step 144, where the camera concludes that the lens has moved from a position code POS of "2_H" to a position code POS of "1_H". As a result, the position code POS is forcibly set to "1_H", and stored in memory, ZC FOW is set to "5" and ZC REV is set to "3". Thereafter, control returns to the point from which the subroutine was called.

Due to the above operation, if there is an error in the temporarily set position code, it is corrected.

Returning to step 137, if it is determined that the zoom motor is rotating in the forward direction, the subroutine proceeds to step 145, where it is decided whether the zoom code ZC after the lens has moved is equal to the change estimation value ZC FOW. If they are the same, the position code POS is increased by "1_H", the zoom code is stored in memory, and the change estimation codes ZC FOW and ZC REV are set (step 146). For example, if the lens is moved to a point where the position code POS is equal to "4_H", ZC FOW will be equal to "7" and ZC REV will be equal to "4". Then, the value of the indication prohibition flag F_{NODSP} is examined to determine if it has been set to 1. If this flag has been set to a value of 0, the focal length of the lens is indicated on the display panel (step 148). When the value of the prohibition flag is set to 1, step 148 is skipped. Regardless of whether the focal length of the lens is displayed or not, the code change flag F_{CHNG} is then set to 1 in step 149 before the subroutine returns to where it was called.

It is not always determined in step 136 that the zoom code stored in memory is different from the zoom code inputted in step 134 when the lens zooms by the change caused by actually switching the zoom code, as mentioned above. Namely, it is supposed that even though the lens is actually in the position which has the same position code bit, which should be 0, it is detected as 1 due to a brush not contacting the code plate. This separation of the brush

from the code plate can occur due to camera vibration or the existence of dust on the code plate, to name a few causes. Thus, the zoom code input does not agree with the value stored in memory. In this case, the zoom code ZC does not agree with the change estimation value ZC REV and ZC FOW and the test performed in step 143 generates a negative result.

Therefore, the zoom code input in step 134 is electrically OR'ed to reverse the logic of the zoom code stored in the memory. This reversed value is tested to determine if it is equal to "111_{binary}" (step 150). Because an electrical OR'ing operation is performed for the reverse and positive logic of two codes detected in the position where the same POS values are obtained, the result always becomes equal to "111_{binary}", even if a bit, which should be 0, is interpreted as a 1 and the judgment in step 150 becomes affirmative.

For example, when the zoom code stored in memory is the normal value "001_{binary}" at the position where POS equals "7_H" and an incorrect code "011_{binary}" is detected because terminal ZC1, which should be conductive, becomes OFF, "111_{binary}" is obtained by electrically OR'ing for the reverse logic of the value in memory "110_{binary}" and the code "011_{binary}". This prevents an erroneous position code POS reading when a brush terminal, that should be detected as ON is detected as OFF.

With the present invention, any change in the zoom code due to the separation of a brush from the code plate is not considered as resulting in a change in the position code but, rather, is handled as an erroneous reading of the position code. The construction of a camera system as described herein makes it possible to produce a more accurate lens position detecting system while also preventing inaccurate exposure operations.

When the zoom code becomes an abnormal value, due to a cause other than the above-mentioned described momentary

brush terminal separation situation, steps 151-153 are executed. In these steps, the POS flag F_{POS} is set to 0 in step 151, the focal length of the lens is indicated on the display panel and CPU register stack processing is performed. Then, processing diverges to a series of instructions (shown in Fig. 19) to execute a BAD CODE (BC LOOP) operation.

As an example, assume the camera has a memorized zoom code of "001_{binary}". This yields a reverse code of "110_{binary}". Further, assume a new code is inputted, having a value of "110_{binary}". Electrically OR'ing the reverse code with the new inputted code produces a value "110_{binary}". Because the electrical OR'ing operation did not equal "111_{binary} ", processing goes to the BAD CODE LOOP (BC LOOP) Operation. Thus, when the position code equals "7_H", but the data indicates the lens is at the point where the position code POS equals "0_H", processing diverges to the BAD CODE LOOP (BC LOOP) Operation.

ZOOM REVERSE ROTATION (ZMREV) Subroutine

Fig. 14 illustrates the flowchart for the ZOOM MOTOR REVERSE ROTATION subroutine which is called in step 22 of the MAIN program. This subroutine pulls the lens into the lock position when the lock switch SWL is ON, when the lock switch is set to OFF in the zoom range during an operation to pull in the lens, and the operation which returns the lens from the macro position to the zoom range when the macro switch is set to OFF. To stop the lens in the zoom range, a forward rotation operation is included to remove any possible backlash.

When this subroutine is called, the focal length of the lens is indicated on the LCD panel as the lens is rotated in the reverse direction (steps 160 and 161). Thereafter, wide extremity flag F_{WIDE} is cleared and reset to 0.

The ZMREV subroutine calls the CODE CHK subroutine to obtain the position code of the lens (step 163). The position code POS is then tested to determine whether it is

greater than or equal to "D_H". Until the position code is at least equal to "D_H", processing loops between steps 163 and 164. When the position code becomes greater than or equal to "D_H", the lens is in the zoom range or in the lock position and processing continues to step 165.

In step 165, the lock switch SWL is checked to determine if it is set to ON. If this switch is ON, processing goes to the CODE CHK subroutine step 166 . The position code POS is then checked to determine if it is greater than or equal to "2_H". When the position code is greater than or equal to "2_H", the lens is in the zoom range. Thus, processing loops between steps 165-167. When the position code POS becomes smaller than "2_H", the execution of the loop is terminated and processing proceeds to step 168.

In step 168, the CODE CHK subroutine is recalled. Thereafter, the position code POS is checked to determine if it is equal to "0_H". Until the position code is "0_H", a loop is executed between the operation of executing the CODE CHK subroutine and testing the position code (steps 168 and 169). Once the position code is "0_H", step 170 is executed to apply a zoom motor brake to stop the movement of the lens. Control then returns to the MAIN program.

However, when the lock switch SWL is detected as being OFF in step 130 of the CODE CHECK subroutine (that was called in step 166 of the present subroutine), while the lens is judged to be in the zoom range in step 167, the position of the lock switch SWL in step 165 will be judged to be OFF. Accordingly, processing will proceed to steps 171-178.

When the lock switch SWL is determined as being OFF in step 165, the indication prohibition flag F_{NODSP} is set to 1 (step 171). The CODE CHK subroutine is then executed (step 172), after which the code change flag F_{CHNG} is tested (in step 173) to determine if it has been set to 1 (in step 139 of the CODE CHECK subroutine). Until the code change flag is

set to 1, processing loops through steps 172 and 173. After it is determined that the code change flag F_{CHNG} has been set to 1, that is, the position code POS has been renewed, processing pauses for t_1 ms (step 174) before rotating the zoom motor in a forward direction in step 175.

When the position code POS is renewed in the loop of steps 176 and 177, the indication prohibition flag F_{NODSP} is cleared in step 178. The zoom motor brake is then applied (step 170) and control returns to the point from which this subroutine was called. The stop position of the lens in this operation has twelve steps, shown by circles in Fig. 26.

In the ZOOM MOTOR REVERSE subroutine, the zoom motor is stopped at the point where the position code POS is renewed by rotating the zoom motor forward after the motor has once passed the boundary section of a position code POS. This cancels any possible backlash that may occur. For example, as shown in Fig. 26, when the lock switch SWL is changed from ON to OFF at the position where POS equals "7_H" and the focal length indication is not prohibited, the value "46 mm" is indicated on the display panel. When the zoom motor causes the lens to enter the area where POS equals "6_H", the display is changed to indicate "50 mm" when it enters the area of POS equals "7_H". This may give a user the impression that the camera is malfunctioning by switching to the tele range just before the stop operation, despite the fact that the operation shifts the focal length of the lens to the wide extremity. Therefore, to prevent such a misconception, the indication prohibition flag F_{NODSP} is set to 0 (step 178) so that the focal length indication of the lens is shown again at the point when the zoom motor stops rotating.

When this subroutine is called in step 22 of the MAIN program, the focal length indication is maintained on the display for a period of one second, in response to the indication counter SCANT being set to "8" in step 29.

ZOOM FORWARD ROTATION (ZMFOW) Subroutine

Fig. 15 shows the flowchart of the ZOOM MOTOR FORWARD ROTATION subroutine, which is called in step 26 of the MAIN program. This subroutine describes the operation that occurs when the lock switch SWL is changed from ON to OFF, the macro switch SWM is changed from OFF to ON and then the macro switch SWM is set to OFF before the lens reaches the macro extremity.

When the ZOOM MOTOR FORWARD ROTATION subroutine is called, the focal length of the lens is indicated on the LCD display. In addition, the wide extremity flag F_{WIDE} is cleared and set to 0, while the zoom motor starts to rotate the lens in a forward direction (steps 180-182).

The CODE CHECK subroutine is performed and a determination is made as to whether the position code POS is less than or equal to "1_H" (steps 183 and 184). If the position code is equal to "0_H" or "1_H", the lens is in a position between the wide extremity of the zoom range and the lock position. To permit the motor in the forward rotation to pass the wide extremity or stop at the wide extremity, the wide extremity flag F_{WIDE} is set to 1 in step 185. Processing then loops back to step 183.

The camera of the present embodiment is designed so that backlash from the gear system is removed and the stop position of the lens in the wide extremity is set just after the position code POS switches from "1_H" to "2_H". For instance, the lens is not always positioned at the wide extremity of the focal length (i.e., 38 mm) even when the position code POS is set to "2_H". It cannot always be determined if the lens is in the wide extremity by only examining the position code POS. That is the reason for the setting of the wide extremity flag F_{WIDE}.

If the position code POS becomes greater than "1_H", according to the movement of the lens to the wide extremity, or the position code POS is already greater than "1_H" at the time that this subroutine is called, the macro switch SWM is

checked to determine if it has been set to ON (step 186).

When the macro switch SWM is ON, processing advances to step 187, so that the lens is moved to the macro extremity where the position code POS is "E_H". When the value of the position code obtained from the CODE CHECK subroutine called in step 187 is determined to be less than "C_H" (step 188), that is, the lens is in the zoom range, processing goes to step 189 to set the wide flag F_{WIDE} to 0, before looping back to step 186. Thus, as long as the position code is less than C_H, a loop comprising steps 186-189 is formed.

At some point, the position code will be greater than or equal to "C_H". When this occurs, the process breaks out of the loop and goes to step 190, which repeats the CODE CHK subroutine (steps 190 and 191) until the position code becomes equal to "E_H". When this occurs, the zoom motor brake is applied (step 192) and processing returns to the point just after from which this subroutine was called.

When the macro switch SWM is determined to be OFF (in step 186), or it is set to OFF while the lens is in the zoom range, the wide extremity flag F_{WIDE} is tested (step 193) to determine its status.

As noted above, the wide extremity flag F_{WIDE} has been set to 1 in step 185 and processing advances to step 186 just after the position code POS switched from "1_H" to "2_H", that is, the lens is in the wide extremity. In this case, the zoom motor is stopped in step 192, the lens being set to the wide extremity and the subroutine ends.

However, when the wide extremity flag F_{WIDE} is 0 in step 193, processing loops through steps 194 and 195 until the position code POS is switched in step 195 as detecting the result obtained from the CODE CHECK subroutine called in step 194. When the position code POS changes, as indicated by the code change flag F_{CHNG} being set to 1, the zoom motor brake is applied in step 192 and the subroutine ends.

There are twelve stop positions performed by this subroutine for the lens which are marked by circles in Fig.

26.

For example, when the lens is in the lock position and the lock switch is set to OFF so as to call this subroutine, the stop position is set to the point where the position code POS switches from "1_H" to "2_H", that is, the wide extremity. When the macro switch is changed from ON to OFF in the range of POS equals "7_H", the lens stops at the point where the position code POS switches from "7_H" to "8_H".

ZOOM WIDE (WIDE) Subroutine

Fig. 16 illustrates the flowchart of the ZOOM WIDE subroutine that is called by setting the zoom wide switch SWW to ON when the lens is in the zoom mode and does not reach the wide extremity. The operations to shift the focal length of the lens to the wide extremity are similar to the operations performed in the above-described ZOOM MOTOR REVERSE ROTATION subroutine. However, in the WIDE subroutine, the lens can stop at any desired position in its travel range.

When the WIDE subroutine is invoked, the focal length of the lens is indicated on the LCD display panel (step 200) and the zoom motor is caused to start rotating in the reverse direction (step 201). Thereafter, the CODE CHECK subroutine is executed and the status of the lock switch SWL, macro switch SWM, wide switch SWW and position code POS are checked. If either the lock switch SWL or the macro switch SWM is ON (steps 203 and 204), the zoom motor brake is applied and processing returns to the MAIN program. When both switches are OFF, the position code POS is checked to determine if it is equal to "1_H" in step 206, which indicates that the lens is in a stop prohibition area between the lock position and the zoom range. If the lens is in the stop prohibition area, the zoom motor is rotated forward (step 208) after having paused for a period of t_1 ms, as shown in Fig. 26. The subroutine waits until the position code POS switches from a value of "1_H" to "2_H" in steps 209 and 210. When the position code changes, as

indicated by the status of the code change flag F_{CHNG}, the wide extremity flag F_{WIDE} is set to 1 (step 211), the zoom motor brake is applied (step 212) and the subroutine ends. In this case, the lens is set to the wide extremity.

When the position code POS, tested in step 206, does not equal "1_H", the status of the wide switch SWW is checked in step 213. If the wide switch SWW is set to ON, processing loops back to step 202. Thus, in this case, a loop is formed involving steps 202-213 until the lens has reached the wide extremity.

When the wide switch is set to OFF, as determined in step 213, the indication prohibition flag F_{NODSP} is set to 1 (step 214) and a timer is started to count a period of t_2 ms (step 215). Then, the position code POS is obtained by executing the CODE CHK subroutine in step 216. If the time period has not reached t_2 ms (step 217), processing jumps back to step 216. When the time period t_2 ms is reached, the zoom motor is started to rotate in the forward direction (step 218) to move the lens to the tele range. In step 219, the t_1 ms timer is restarted and the CODE CHK subroutine is rerun. Then, the CODE CHK subroutine is executed and the timer is checked to see if the time period t_1 ms has been reached. If the time period has not been reached, processing jumps back to step 220 to re-execute the CODE CHK subroutine. When the time period t_1 ms has been reached, processing advances to step 222.

The time periods for the two timers are selected such that t_1 is less than t_2, as shown in Fig. 26. The time period t_1 corresponds to the time that is required to eliminate backlash of the mechanical system, while the time period t_2 corresponds to an arbitrary value that is larger than t_1. If the time period t_2 is shorter than t_1, the lens would stop at a point closer to the tele extremity than is desired.

In step 222, the indication prohibition flag F_{NODSP} is cleared and set to 0. The purpose of this flag setting was

explained in the ZOOM MOTOR REVERSE ROTATION subroutine. Then, the focal length of the lens is displayed on the LCD display panel, the zoom motor brake is applied and the subroutine returns to the MAIN program.

ZOOM TELE (TELE) Subroutine

Fig. 17 shows the flowchart of the TELE subroutine, which is called in step 38 of the MAIN program. This subroutine is called by setting the tele switch SWT to ON when the lens is in the zoom range and the position code POS is not equal to "C_H". The operation of activating the zoom motor so that it rotates in a forward direction to move the lens to the tele extremity is similar to the operation performed in the above-described ZOOM MOTOR FORWARD ROTATION subroutine. It is the same as the WIDE subroutine in that the lens can stop at any desired position in its travel range.

When the TELE subroutine is called, the focal length of the lens is indicated on the LCD display panel and the zoom motor starts to rotate in a forward direction (steps 230 and 231). The CODE CHK subroutine is called in step 232, and the status of the lock switch SWL, the macro switch SWM, the tele switch SWT and the position code POS are checked. If either the lock switch or the macro switch (steps 233 and 234) are ON, processing advances to step 235, which applies the zoom motor brake and returns to the point just after where the subroutine was called.

When the lock switch and the macro switch are both OFF, the position code POS is examined (in step 236) to determine whether it is greater than or equal to "C_H". If the position code is less than "C_H", the tele switch is checked to determine if it is still ON (step 237). When the position code POS is greater than or equal to "C_H", the test that is performed on the tele switch is skipped, because the lens has reached the tele extremity. Thus, processing jumps to step 238, so as to apply the zoom motor brake and return to the MAIN program.

However, if the position code is less than "C_H", meaning that the tele switch is OFF, processing loops back to step 232. The subroutine stays in the loop comprising steps 232-237 while the tele switch SWT is ON, until the lens reaches the tele extremity. When the tele switch SWT is set to OFF (step 237), as shown in Fig. 26, the zoom motor brake is applied (step 238) and control returns to the MAIN program.

BACKUP Operation

Fig. 18 illustrates the series of instructions that are executed to perform a BACKUP operation. This operation is performed by diverging from steps 6 and 57 of the MAIN program, as well as from an BAD CODE LOOP (BC LOOP) operation and the RESET operation. These instructions are performed to maintain data in the memory for a fixed period of time by powering the main CPU with electrical current supplied from the backup capacitor 320 when the battery 300 is removed or is depleted. When the camera goes into the BACKUP operation, all functions that require a large amount of electrical power are suspended so that the data in the memory can be retained for as long as possible.

When the BACKUP operation begins, all inputs with the exception of the lock switch SWL, macro switch SWM, battery switch SWB and film switch SWF are ignored in order to minimize electric power consumption. This is accomplished by switching the ports on the CPU 100 from an input mode to an output mode by a PORT INITIALIZATION subroutine in step 250. Thus, only information for the above-noted four switches will be detected.

In step 251, an indication of the frame to which the film is advanced is displayed on the LCD display panel. Then, the clock rate of the microprocessor is switched to a lower frequency (step 252). The operating speed of the camera is reduced to as to lower the power requirements of the camera circuitry. As is generally known, the faster an electrical component is operated, the more current that component

usually requires. For instance, when a microprocessor is operated at a 6 MHz clock rate, the microprocessor may draw 200 μA of current. If that same microprocessor is operated with a 8 MHz clock rate, the microprocessor will operate approximately 33 percent quicker than at the 6 MHz speed, but it may require 300 μA of current. Thus, one technique for reducing power consumption of an electrical circuit is to reduce its clock rate and this is accomplished by running the PORT INITIALIZATION subroutine.

Next, a timer is started (step 253). This timer is used to erase the film frame indication on the display panel and also to determine the memory setting of several switches. In step 254, the battery switch SWB is tested to determine whether it is set to ON. If the switch is set to OFF, the film indication on the LCD display panel starts to blink when the battery is removed (step 255). The film switch SWF is then checked in step 256 to determine if it is set to OFF. If this switch is ON, loading request flag F_{FDRQ} and loading end flag F_{LDEND} are cleared and set to 0 (step 257), the film frame indication on the display panel is erased (step 258) and processing proceeds to step 259.

If the film switch SWF is OFF, steps 257 and 258 are skipped, meaning that the processing goes from step 256 to step 259. At step 259, the timer is checked to determine whether a period of at least two minutes has passed since the timer was started. If less than two minutes has passed, processing jumps back to step 254. When the time period is greater than or equal to two minutes, processing goes to step 260, wherein it is determined if the timer flag F_{TM} is set to 1.

The timer flag F_{TM} is initially set to 0. When step 259 indicates that at least two minutes has passed since the timer was started, processing goes from step 259 to step 260. However, at this time, the timer flag will be equal to 0. Thus, step 261 is executed, which forces the timer flag F_{TM} to be set to 1. In step 262, the LCD display panel is

deactivated to conserve additional electrical power. Then, processing jumps back to step 254. The BACKUP operation stays in the loop of steps 254-260 until the battery switch SWB is set to ON.

If the timer test in step 259 indicates that less than two minutes has passed since the timer was started, steps 261 and 262 are skipped. Thus, when electrical power to the camera is removed, the LCD display panel will continue to indicate a display for a period of two minutes. After the two minute period, the display panel will be shut off.

When a battery is installed in the camera, as indicated by the battery switch being ON in step 254, processing comes out of the above-mentioned loop, the clock rate is switched back to its normal rate (step 263) and it is determined whether a time period of seventeen or more minutes have passed since the timer was set in step 264.

If less than seventeen minutes have passed, the timer flag F_{TM} is examined to determine whether it is set to 1 (step 265). If the flag is set to 1, power for the LCD display panel (which was turned OFF in step 262) is re-applied (step 266) and the timer flag F_{TM} is cleared and set to 0 in step 267. Thereafter, backup flag F_{BC} is set to 1 in step 268 and processing diverges to the BAD CODE LOOP (BC LOOP) operation to perform error processing.

When the timer flag F_{TM} is set to 0, steps 266 and 267 are skipped. Consequently, the LCD display panel is not reactivated. Instead, processing goes from step 265 to step 268.

When it is determined that more than seventeen minutes have passed since the timer was started, the timer flag F_{TM} is cleared and set to 0 in step 269 and processing diverges to the series of instructions that perform the RESET operation.

BAD CODE LOOP (BC LOOP) Operation

Fig. 19 shows the flow of the series of instructions that perform error processing. These instructions are

executed by diverging from the CODE CHECK subroutine or the BACKUP operation.

When the BC LOOP starts, data for the lock switch SWL and macro switch SWM are inputted and stored in memory (step 280). Then, the back up flag F_{BC} is tested to determine whether it is set to 1. That is, a determination is made as to whether the error operation is diverging from the BACKUP operation (step 281). When the backup flag is set to 1, it is reset to 0 in step 282. Afterward, the LCD display panel is switched to OFF (step 283) and processing diverges back to the MAIN program.

When the BC LOOP is executed after the CODE CHECK subroutine, the test performed in step 281 will be negative. Thus step 284 is processed, in which switch data is inputted. Based upon this input, the battery switch SWB is tested to determine if it is ON. When the battery is removed, processing goes to step 286, wherein the LCD display panel is shut down and processing advances to the BACKUP operation.

When the battery switch is determined to be ON, the tele switch SWT, wide switch SWW and photometry switch SWS are examined (step 287). If at least one of these switches is set to ON, processing advances to step 289.

Alternatively, if all three switches are OFF, step 288 is checked to determine whether the setting of lock and macro switches (SWL and SWM) are different from their values stored in the memory. If these switch settings differ from what was stored in the memory, processing advances to step 289.

In step 289, the voltage of the battery is checked. If the battery voltage is more than a predetermined value, the battery is considered as being good. Thus, the blinking of the LCD display panel becomes OFF (step 283) prior to diverging to the MAIN program. The MAIN program will then determine what information should be displayed on the LCD display panel.

When (1) the tele switch SWT, wide switch SWW and photometry switch SWS are all OFF and the setting of the lock switch SWL and macro switch SWM are the same as the values stored in the memory for the respective switches (steps 287 and 288), or (2) the battery is judged as being no good (step 289), the LCD display panel blinks ON in step 290. The setting of the lock switch SWL and macro switch SWM are stored in memory (step 291) and a 500 ms pause is introduced (step 292) prior to the BC LOOP jumping back to step 284, so as to loop through steps 284-292 until a good battery is placed in the camera.

RESET Operation

Fig. 20 illustrates the series of instructions that are executed when the RESET operation is performed. This operation is executed at the time of a reset-start or when processing diverges from the BACKUP operation. The RESET operation diverges from the BACKUP operation when more than seventeen minutes have passed since a battery was removed from the camera or a battery in the camera fails. The RESET operation is performed because the capacitor 330 is only intended to retain the contents of the memory for approximately seventeen minutes. After seventeen minutes, the data stored in the memory may be inaccurate or may not be reliably read back.

First, all memory locations and flags are cleared in step 300. Thus, the position code flag F_{POS} is also cleared so that the POSITION CODE INITIALIZATION subroutine is called when the MAIN program starts. Thereafter, power is applied to the LCD display panel and the PORT INITIALIZATION subroutine (discussed above) is called (steps 302 and 303). This subroutine sets all ports on the CPU 100 (except for the lock switch SWL, macro switch SWM, battery switch SWB and film switch SWF) to the output mode.

The status of the film switch SWF is inputted in step 305, and checked in step 308 to determine whether it is OFF. If the film switch is OFF, film loading becomes

possible. Therefore, the film load request flag F_{LDRQ} is set to 1 in step 309 and the RESET operation diverges to the BACKUP operation.

However, if the film switch is set to ON, the film load flag F_{LDRQ} is not set. That is, step 309 is skipped when the film switch SWF is OFF. Thereafter, processing diverges to the BACKUP operation.

FILM INDICATION Operation

The series of instructions to perform the FILM INDICATION operation are shown in Fig. 21. These instructions are executed by diverging from the MAIN program, the BACKUP operation, the LOAD operation and the LOCK operation.

At step 320, flag F_{LDRQ} is examined to determine whether the register has been set to 1. Flag F_{LDRQ} is set to 1 when the back cover of the camera is brought from an open position to a closed position, the film is not completely loaded and the film loading indicator has not been requested. When it has been set to 1, a film load request pattern L_d is created, in response to the loading request in display memory XA, and displayed on the liquid crystal display panel of the camera (steps 322 and 324), the flow operation is completed and control returns to the point just after where the FILM INDICATION operation diverged from.

However, if the film load indication flag F_{LDRQ} is set to 0, processing advances to step 326, where the film load end flag F_{LDEND} is checked. If the flag is set to 1, a FILM PATTERN ON subroutine (step 328) is called. This subroutine performs a film count F_C check. When F_C is not equal to "0", step 332 is executed to display on the LCD display panel the number of pictures that have been taken and to store the content of the film counter F_C in display memory XA, before returning to the point from which this operation diverged.

If F_{LDRQ} equals 0 (in step 320) and F_{LDEND} equals 0 (in

step 326), processing goes to step 334 to call a FILM PATTERN OFF subroutine. Information corresponding to the FILM PATTERN OFF is stored in the display memory XA (step 336) and the LCD display panel is turned off. The FILM INDICATION operation then returns to where it diverged from.

If the film count F_C check in step 330 is equal to "0", processing proceeds to step 336, which was described above, and then returns to the point from which the operation diverged.

LOAD Operation and WIND PULSE CHANGE Subroutine

The following discussion is directed to the LOAD operation and WIND PULSE CHANGE subroutine, which are interrelated. The flowchart diagram for the series of instructions that comprise the LOAD operation is illustrated in Fig. 22. This operation automatically winds the film that a user inserts into the camera to the correct location so as to permit the taking of a photograph. The operation is performed when there is a change in the setting of the lock switch SWL, the macro switch SWM and when the release switch is set from OFF to ON, assuming that the loading request flag F_{LDRQ} has been set to 1 in the MAIN program.

First, a wind pulse counter WPCNT is set to "18" in step 338. This count corresponds to the winding of four and one-half frames of the film. A WIND PULSE CHANGE subroutine (step 340) then takes place in accordance with the WIND PULSE CHANGE subroutine, a film advance (wind-up) motor starts a forward rotation in step 3401 (Fig. 23). Initialization flag F_{WPINT} and wind pulse off flag F_{WPOFF} are then set to 1 in step 3402.

In step 3403, a 1.5-second timer is set and started. The 1.5 second-timer is used to examine whether or not the film should be rewound. If it is determined that the wind pulse counter WPCNT is not equal to "0" in the WIND PULSE CHANGE subroutine (Fig. 23), to be described below, a return flag is set in step 3404, so that the forward rotation of the wind-up motor is brought to a stop in step 3405, even if

1.5 seconds or more have elapsed after the forward rotation of the wind-up motor or the increase in the wind pulse. Processing then returns to the LOAD operation. This example is for the initial film loading stage, in which the film normally advances within 1.5 seconds before the processing goes to step 3406. After switch data is inputted at step 3406, step 3407 examines whether a battery is in the camera. This test is made to determine whether the battery was removed during the advancing of the film. In such a case, processing diverges to the BACKUP operation after the forward rotation of the wind-up motor is brought to a stop in step 3408.

With a battery loaded in the camera, step 3409 is executed. This step checks to determine if the film switch SWF is OFF or ON. If the film switch SWF is ON, step 3410 is processed. This step sets flags F_{LDRQ}, F_{LDEND} and film counter F_C to "0", stops the forward rotation of the wind-up motor (step 3412) and then returns to the MAIN program. This operation is performed in case the back cover of the camera is opened during the film loading process (this process is known as a blank-shot film advancing operation).

If the back cover of the camera is kept closed, the film switch SWF remains OFF. Therefore, processing goes to step 3413, which determines if the wind pulse off flag (F_{WPOFF}) equals 1. Since flag F_{WPOFF} is initially 1, an affirmative answer is given to go to step 3414 to determine whether SWWP equals 0. SWWP equalling 0 corresponds to a low wind pulse W_P level. If the wind pulse W_P is not at a low level, processing returns to step 3404 to repeat the loop (comprising steps 3404, 3406, 3407, 3409, 3413 and 3414) until the wind pulse W_P becomes low. Thus, the wind pulse W_P is switched from a high level to a low level and step 3415 is executed to set the flag F_{WPOFF} to 0. Processing then returns to step 3404, eventually returning to step 3413. Since flag F_{WPOFF} will now be equal to 0, step 3416 will be executed to determine whether the flag

F_{WPINT} and SWWP have changed. Because flag F_{WPINT} has been established in step 3402 to equal 1 and SWWP has been changed from 1 to 0, an affirmative answer is given to the test in step 3416. Thus, processing goes to step 3417. Since the flag F_{WPINT} equals 1 in step 3417, processing goes to step 3418, where the flag F_{WPINT} is set to 0. After the flag F_{WPINT} has been set, the subroutine executes step 3419 to examine whether SWWP equals 1. If the wind pulse remains low, a negative result is obtained. Therefore, step 3404 is executed. Thus, processing loops through steps 3404, 3406, 3407, 3413 and 3416. When the flag F_{WPINT} has been changed from 1 to 0 (in step 3418), SWWP remains equal to 0 so that processing goes back to 3404. In the meantime, the wind pulse W_P is switched from a low level to a high level. This means that a change has taken place both in the flag F_{WPINT} and SWWP in step 3416. Therefore, step 3417 is processed. Since flag F_{WPINT} equals 0 in step 3417, processing goes to step 3420, wherein flag F_{WPINT} is set to 1. Then, step 3419 is executed, wherein since the wind pulse has switched from a low level to a high level and SWWP is set to 1, a FILM PATTERN BLINK INDICATION subroutine is performed in step 3421. The FILM PATTERN BLINK INDICATION subroutine illuminates the film pattern in the LCD display panel when the wind pulse is switched from a low level to a high level. This causes the liquid crystal display panel to show a display that corresponds to the actual advancing of the blank-shot film. After executing the subroutine in step 3421, "1" is subtracted from the wind pulse counter WPCNT (step 3422), so that the content of wind pulse counter WPCNT becomes equal to "17". Step 3423 then examines whether the wind pulse counter WPCNT equals "0". If the wind pulse counter WPCNT is not equal to "0", the WIND PULSE CHANGE subroutine returns to step 3403, where the processing mentioned earlier is repeated. That is, in the WIND PULSE CHANGE subroutine, the content of the wind pulse counter WPCNT is subtracted one by one upon every rise of the wind

pulse W_p. When the wind pulse counter WPCNT reaches "0", the forward rotation of the film advance motor is stopped (step 3424), a flag is set for the non-execution of a REWIND operation and the processing goes to step 342 of the LOADING operation.

Step 342 determines whether the REWIND subroutine should be performed. When step 3423 of the WIND PULSE CHANGE subroutine is executed, a negative answer is given regarding whether to proceed to step 344, while if processing goes through step 3404, an affirmative answer is given to go to steps 346 and 348. In steps 346 and 348, F_{LDEND} is set to 1 and F_{LDRQ} is set to 0 for the REWIND operation. In steps 344, 350 and 352, the film counter F_C is set to "1", F_{LDEND} is set to 1 and F_{LDRQ} is set to 0. Then, the FILM INDICATION operation (step 354), which was previously described, is performed.

REWIND Operation

Fig. 24 illustrates the flowchart of the REWIND operation which diverges from step 62 of the MAIN program and from the above-mentioned LOADING operation. This operation rewinds the film back into the patron when the last film frame has been exposed.

In step 360, the wind-up motor is started in a reverse rotation direction. Thereafter, step 362 is performed to determine whether the film loading detector switch SWF is off. This step functions to implement the stopping of the wind-up motor. When SWF is on, processing advances to step 364 to stop the reverse rotation of the wind-up motor, set F_C, F_{LDRQ} and F_{LDEND} to 0, and turn off the film case indication and film pattern that are shown on the LCD display panel. Then, the subroutine returns to the beginning of the MAIN program. If F_{LDRQ} and F_{LDEND} equal 0, processing goes to the MAIN program and runs until it reaches the FILM INDICATION subroutine. Now, since F_{LDRQ} equals 0 and F_{LDEND} equals 0, step 320 (of the FILM INDICATION subroutine) gives a negative answer and step 326

gives an affirmative answer. In step 334, a FILM PATTERN OFF subroutine is executed, and information corresponding to the film pattern off is stored in the display memory XA (step 336), with the film indication area on the liquid crystal panel turned blank.

When the film switch SWF (in the REWIND operation) is OFF, processing goes to step 366, where a wind pulse detection operation is performed. This step detects the change of the wind pulse from a LOW level to a HIGH level. Then, in step 368, a film pattern blink indication operation is executed. In the film pattern indication operation, the film pattern shown on the LCD display panel is turned-off at the time the wind pulse changes from a low level to a high level. Then, in step 370, a determination is made as to whether four wind pulse changes from LOW to HIGH have occurred, indicating that one frame of the film has been rewound.

If step 370 indicates that one film frame has not been rewound, steps 362-370 are repeated. Thus, an indication corresponding to the film being rewound appears on the LCD display panel. If one frame of the film has been rewound (as indicated by the test performed in step 370), step 372 is performed.

In step 372, the content of the film counter F_C is decreased by "1". Thereafter, the FILM INDICATION subroutine is called (in step 374) to indicate the frame number of the film on the LCD display panel. When the FILM INDICATION subroutine is completed, the REWIND operation jumps to step 362, looping through its instructions until SWF is turned ON.

LOCK Operation

Fig. 25 illustrates the flowchart of the LOCK operation which diverges from step 21 of the MAIN flow. This processing diverges when the lock switch is set to ON and the photographing lens is stored in the lock position.

In step 380, the port initializing operation is

performed and the mode of the ports on the CPU 100 is switched from the input mode to the output mode, so as to conserve battery power, as was previously explained. Then step 380A is executed to erase the mode indication and battery indication from the LCD display panel 32.

In step 381, the loading request flag F_{LDRQ} is checked to determine if it is set to 1. If this flag is set to 0, the loading end flag F_{LDEND} is checked to determine if it is set to 1 in step 382. If both test results are negative, power to the LCD panel is removed. When either the loading end flag F_{LDEND} or the loading request flag F_{LDRQ} are set to 1, the FILM INDICATION subroutine of step 384 is called.

In step 385, data for the lock switch SWL, battery switch SWB and film switch SWF are inputted and examined to determine if the data that was inputted have changed from the data that is stored in memory (step 386). When there is no change, processing goes to step 387, looping through steps 385-387 (with a pause of 125 ms in step 387) until there is a change between the settings in memory and the actual switch settings. When there is a change, power is reapplied to the LCD panel in step 388.

Based upon the switch data input from step 389, step 390 determines if the battery switch SWB is ON. If this switch is OFF, processing diverges to the above-mentioned BACKUP operation (step 391), while if it is ON, the condition of the lock switch SWL is checked (step 392).

If the lock switch is OFF, processing of the LOCK operation does not have to continue. Thus, step 392A is performed. This step switches the mode indication and the battery indication on the LCD display 32 to ON. Then, step 393 is performed to determine if there is a request for loading of the film. If there is a request, processing diverges to the LOAD operation (step 394), which was previously described. If step 393 indicates that there has been no request to load film, processing diverges back to the MAIN program.

If step 392 indicates that the lock switch SWL is set to ON, processing goes to steps 395 and 396. Step 395 tests whether F_{LDEND} is equal to 1, while step 396 tests whether F_{LDRQ} is equal to 1. If the tests performed in either step 395 or step 396 is affirmative, a test is made (in step 399) to determine whether the film load detector switch SWF is set to OFF. However, if steps 395 and 396 are both negative, processing proceeds to step 397.

Steps 397 and 399 check whether the film loading detector switch SWF has been turned OFF. If the film loading detector switch SWF is determined to be OFF in step 397, processing goes to step 398, wherein F_{LDRQ} is set to be equal to 1. Thereafter, the FILM INDICATION subroutine (step 402) is called. If the test performed in step 397 is negative or the test of step 399 is positive, processing goes to step 403. If step 399 results in a negative answer, F_{LDEND} and F_{LDRQ} are each set to 0 (steps 400 and 401) and the FILM INDICATION subroutine of step 402 is called. Thereafter, processing continues to step 403, where a check of F_{LDRQ} is made.

In step 403 and step 404, if it is judged that both the loading request flag F_{LDRQ} and the loading end flag F_{LDEND} are set to 0, power to the LCD display panel is removed in step 405.

In step 406, the switch data that were inputted in step 389 are stored in memory and the processing advances to step 387. If one of the above-mentioned flags is set to 1, step 405 is skipped. Thus, electrical power continues to be supplied to the LCD display panel.

Thus, in the LOCK operation, when the status of the lock switch SWL, battery switch SWB and film switch SWF does not change, processing stays in the loop of steps 386-387. When there is a change in the status of the film switch SWF, only one cycle of the loop of steps 388-406 is performed. When the status of the lock switch SWL and the battery switch SWB change, processing exits these loops to advance

to the next step in the routine.

DATA I/O Operation and MACRO TELE SHIFT (MT SIFT) Subroutine

Before describing the DATA I/O subroutine, illustrated in Fig. 27B, a description of the relationship of the distance measurement step, lens latch and focus position will be given. Reference for this discussion is made to Fig. 28.

Distance measurement steps are represented in increments from 1 to 36. As indicated in Fig. 28, the distances for these steps are listed on the right side of the distance measurement steps. For example, distance measurement step "1" corresponds to 5 m - ∞ and distance measurement step "2" corresponds to 3.7 - 5 m. Also, as indicated in Fig. 28, in the zoom mode, lens latch steps are represented in steps of "1" and "3" to "19", corresponding to the distance measurement steps from "1" to "18" of the zoom lens 11. For example, for a distance measurement step of "1", the ideal focus position for a lens latch step of "1" is 9 m. The latch step of "1" allows one to take a photograph in an in-focus condition from a range of 5 m - ∞. For a distance measurement step of "2", corresponding to a latch step of "3", the ideal focus position is 4 m. At latch step "3", a photograph can be taken at an in-focus condition having a range of 3.7 m - 5 m.

The electronically controlled camera of the preferred embodiment is unable to take an in-focus photograph of a subject for distance measurement steps of "19" to "36" when the camera is in the zoom mode. In this situation, a release lock or short distance warning (to be mentioned below) is shown in the LCD panel 32. The user then switches from the zoom position SWZ to the macro position SWM, by manually operating the main switch 30, so that the camera is switched from the zoom mode to the macro mode.

In the macro mode, lens latch steps are set from "1" to "19", which corresponds to distance-measuring steps "16"-"36". As shown in Fig. 28, distance measurement steps "16"

and "17" correspond to lens latch step "1" in the macro mode. The ideal focus position of macro lens latch step "1" is 0.96 m. Macro lens latch step "1" allows one to take an in-focus photograph in the range of 0.94 m to 1 m. Distance measurement step "18" corresponds to macro lens latch step "2". The ideal focus position for macro lens latch step "2" is the same as that for lens latch step "19" in the zoom mode. This permits one to take an in-focus photograph in the range of 0.90 m to 0.94 m.

Distance measurement steps "16" to "18" overlap, as shown in Fig. 28, so that in-focus photographing is possible in both the zoom and macro modes at those steps. That is, the long distance side of the macro mode and the short distance side of the zoom mode are overlapped in the range from the boundary on the long distance side in the focus range in the macro mode (1 m) to the boundary on the short distance side in the focus range in the zoom mode (0.9 m). This avoids a situation wherein photographing cannot be performed in the macro mode because of fluctuations in distance measurements when photographing by manually operating the main switch 30 to switch to the macro mode in response to a warning that the taking of an in-focus photograph is impossible in the zoom mode.

Distance measurement step "36" corresponds to lens latch step "19" of the macro mode. In this case, only the short distance warning is given and the release lock is not performed.

In the macro mode, distance measurements from "1" to "15" correspond to lens latch steps "1" and "3"-"16", performing a MACRO-TELE SHIFT subroutine (MT SIFT subroutine), to be discussed below. For example, in the macro mode, when a distance measurement of "1" is obtained, the zoom lens 11 is operated to shift the lens from the macro extremity to the tele extremity in the zoom range to correspond to lens latch step "1". The ideal focal length

of lens latch step "1" is 9 m; a lens latch value of "1" permits an in-focus picture to be taken within a range of 5 m - ∞.

A description of the MACRO-TELE SHIFT Subroutine (MT SIFT), will now be given, together with an explanation of the DATA I/O operation. Reference is made to Figs. 27B and 29 for this discussion.

The first step performed in the DATA I/O subroutine (step 420), is the conversion of the DX code of the film loaded in the camera to an ISO SV sensitivity value. At step 422, the zoom code POS information of the zoom lens 11 is alpha-converted to yield an exposure operation for use in step 424. The resultant alpha value comprises an amount of variation in F_{min} (full-open aperture F-number) of the zoom lens positioned at the specified focal length position, with respect to the F_{min} of the zoom lens positioned at the wide extremity. At step 424, an exposure operation flag is set. In response to the completion of step 424, step 426 is executed to input distance measurement data from the CPU. Then, at step 428, a LENS LATCH (LL) subroutine is called.

After the LENS LATCH (LL) subroutine (see Fig. 30) is completed, step 430 of the DATA I/O subroutine of Fig. 27B is performed. In this step, photometry data information is input. Then, in step 432, an AUTO EXPOSURE CALCULATION AND FLASHMATIC CALCULATION (AEFM) subroutine is called. When the AEFM subroutine is completed, a test is performed to determine if the release lock flag R_{LOCK} is set to 1 (step 434). If the result of the test is YES, processing diverges to a RELEASE LOCK PROCESSING operation, at step 435, to be described below.

If the result of the release lock flag test of step 434 is negative, step 436 is performed to determine whether the macro tele shift flag MT SIFT is equal to a value of 1. If MT SIFT equals 1, a macro tele shift processing MT SIFT subroutine is performed (step 438). This subroutine, illustrated in Fig. 29, starts a reverse rotation of the

zoom motor 10 at step 4381. This permits the zoom lens to move towards the tele extremity. After this step has been completed, the position code POS is checked at step 4382 and, based upon the obtained code, a test is made at step 4383, as to whether the zoom lens is in the position where the position code POS equals "B_H". A loop between steps 4382 and 4383 occurs until the zoom lens is positioned such that the position code POS equals "B_H". When the zoom lens reaches the position where POS equals "B_H", the reverse rotation of the zoom motor 10 is stopped and a normal forward rotation of the zoom motor begins (step 4384). After step 4384 has been executed, the position code POS is checked (step 4386) to determine if the zoom lens is at the point where the code is equal to "C_H". A loop between steps 4385 and 4386 occurs until the position code POS equals C_H. When the zoom lens is set to the specified position of the tele extremity, a zoom motor brake (step 4387) is applied to stop the rotation of the zoom motor. This completes the MACRO TELE SHIFT (MT SIFT) subroutine. Processing control then returns to step 440 of the DATA I/O operation.

To summarize, the MACRO TELE SHIFT (MT SIFT) subroutine of Fig. 29 functions as a switching method for changing the zoom lens 11 from the macro extremity to the tele extremity when the distance measurement information indicates an unusable range in the macro mode.

After the main CPU executes the MACRO TELE SHIFT (MT SIFT) subroutine, it performs steps 440 and 442, so as to produce lens latch data (LL data) and exposure data (AE data). These two steps are also performed if the result from the test in step 436 is negative (i.e., MT SIFT flag does not equal 1).

At step 444, a test is performed to determine whether the release switch SWR is set to ON. If the release switch SWR is OFF, a test (in step 446) is made as to whether the photometry switch SWS is set to ON. If the photometry switch SWS is ON, step 448 is executed to decide if the lock

switch SWL is ON. If the lock switch SWL is OFF, the DATA I/O operation loops back to step 444, creating a release standby mode. That is, if the release switch SWR is OFF, the photometry switch SWS is ON and the zoom switch SWZ or the macro switch SWM is ON, a release standby mode exists wherein steps 444 to 448 are constantly performed.

If the result of the test in step 446 indicates that the photometry switch SWS is set to OFF, or the result of the test in step 448 indicates that the lock switch SWL is ON, the DATA I/O operation diverges back to the start of the MAIN program.

If the test made in step 444 indicates that the release switch SWR is set to ON, a step 450 is processed, wherein the computer program diverges to a RELEASE SEQUENCE operation, illustrated in Fig. 32 and discussed below.

LENS LATCH (LL) Subroutine

In the LL subroutine, shown in Fig. 30, distance measurement information (AF data) is converted to a distance measurement step (AF step) in step 4281. The distance measurement step is restricted to a minimum value AF_{min} of 1 and a maximum value AF_{max} of 36. Thereafter, step 4282 is performed, wherein a determination is made as to whether the macro switch SWM is turned ON. When the macro switch SWM is not ON, the LL subroutine concludes that zoom switch SWM is ON and performs step 4283. In step 4283, the subroutine decides if the distance measurement step is less than or equal to "18". If an affirmative answer is obtained, an in-focus photograph can be taken in the zoom mode. Accordingly, step 4284 is executed to perform the necessary processing to provisionally set the distance measurement step value as the lens latch step LL. The software routine then continues to step 4285, where a determination is made as to whether the lens latch step LL is less than or equal to "1". When LL is less than or equal to "1", the LL subroutine is terminated and processing returns to the DATA I/O flow operation. When LL is greater than "1", the lens

latch step LL is increased by "1" (in step 4286). The processing returns to the DATA I/O operation. Therefore, for example, when the distance measurement step equals "2", a lens latch step of "3" is set. As previously discussed and shown in Fig. 28, each distance measurement step "1 to 18" corresponds to a respective lens latch step of "1, 3 to 19".

When the distance measurement step (AF step) is equal to or greater than "19" in step 4283, step 4287 is executed so as to set a macro mark blink flag MCMFL to 1, which causes a macro mark that is displayed on the LCD display panel to blink. In addition, a release lock flag R_{LOCK} is set to 1. Step 4287 is performed because when the distance measurement step is in the range of "19 to 36" while the camera is in the zoom mode, it is impossible to take an in-focus picture. Thus, it is necessary to make the macro mark blink as a warning aid to the user of the camera to turn ON the macro switch SWM, and set the release lock, so as to prevent the taking of an out-of-focus photograph. The LL subroutine then proceeds to step 4293, which will discussed below.

When the macro switch SWM is ON in step 4282, the LL subroutine proceeds to step 4288, to determine whether the distance measurement step is greater than or equal to "16". If it is determined that it is greater than or equal to "16", step 4289 is performed, wherein "16" is subtracted from the distance measurement step. Then, step 4290 is performed, wherein the minimum value of lens latch step LL_{min} is set to "1". This step prevents LL_{min} from being set to "0" when a lens latch step corresponding to a distance measurement step of "16" occurs.

After executing step 4290, the software subroutine proceeds to step 4291 to decide whether LL is greater than or equal to "19". If LL is greater than or equal to "19", LL is set equal to "19" in step 4293. In addition, a green lamp flag GLAMPFL is set to 1 so as to cause the green lamp

Gd, located on the back of the camera body 1, to blink. The blinking green lamp alerts the photographer that the subject is too close to the camera for a satisfactory picture. The LL subroutine is then completed and processing returns to the DATA I/O operation. In the macro mode, processing to set the flag for the release lock is not performed so that photographing is possible, even if a subject is too close.

If the distance measurement step is less than "16" in step 4288, step 4292 is performed to set macro tele shift flag MT SIFT to 1. Then, steps 4284 to 4286 are performed in the manner described above for these steps. That is, the distance measurement step is provisionally set to the lens latch step LL and a test is made at step 4285 to determine if LL is less than or equal to "1". If LL is less than or equal to "1", the LL subroutine is terminated and processing returns to the DATA I/O subroutine. When the lens latch step LL is greater than "1", LL is incremented by "1" at step 4286, the LL operation subroutine is terminated, and processing of the DATA I/O operation continues. Therefore, for example, when the distance measurement step equals "2", a lens latch step of "3" is set. Thus, lens latch steps from "1" and "3"-"16" will correspond to each value of the distance measurement step "1-15", as shown in Fig. 28.

RELEASE LOCK PROCESSING Subroutine

The RELEASE LOCK PROCESSING subroutine is illustrated in Fig. 31. In this subroutine, a determination is made as to whether the battery switch SWB is ON (step 4351), and if it is, step 4532 is executed to determine whether the photometry switch SWS is ON. An affirmative determination results in a test being made (at step 4353) as to whether the lock position SWL is ON. If the lock position SWL is OFF, the subroutine loops back to step 4531. Therefore, if the battery switch SWB is ON, the photometry switch SWS is ON and the lock switch SWL is OFF, the RELEASE LOCK PROCESSING subroutine performs a continuous loop between steps 4351 and 4353, until one of these three conditions

changes. That is, the loop is terminated by either setting the battery switch SWB to OFF, setting the photometry switch to OFF, or by setting the lock switch SWL to ON.

When the battery switch SWB is turned OFF, processing diverges to the BACKUP operation, shown in Fig. 18 and discussed above. When the photometry switch SWS is set to OFF, or the lock switch is set to ON, processing returns to the MAIN program.

RELEASE SEQUENCE Operation

Fig. 32 illustrates the set of instructions that comprise the RELEASE SEQUENCE operation. This operation diverges from step 450 of the DATA I/O operation, discussed above.

In the RELEASE SEQUENCE operation, an exposure control is obtained in step 4501, which includes activating the shutter of the camera. Step 4502 is then executed to determine whether the macro tele shift flag MT SIFT is set to 1. If MT SIFT equals 1, step 4503 is executed to decide if the macro switch SWM is ON.

If the macro switch SWM is ON, step 4504 is performed, which executes a TELE MACRO SHIFT (TM SIFT) subroutine. The TM SIFT subroutine is the reverse of the MT SIFT subroutine explained in connection with Figs. 27B and 29; hence, a further explanation of the specific operation of the TM SIFT subroutine is not given. When the macro switch SWM is ON, the TM SIFT subroutine operates to return the zoom lens 11 to the macro position, after a photograph has been taken in the zoom position. When the TELE MACRO SHIFT subroutine TM SIFT is completed, processing diverges to a WIND operation (step 4505), to advance the film. The WIND operation is shown in Fig. 33 and is discussed below.

If the macro tele shift flag MT SIFT test that was performed in step 4502 is not equal to 1, the test for determining whether the macro switch SWM is ON (step 4503) and the TM SIFT subroutine (step 4504) are not performed. Rather, the RELEASE SEQUENCE operation jumps to step 4505 to

diverge to the WIND operation.

WIND Operation

The WIND operation is shown in Fig. 33. In the WIND operation, the wind pulse counter WPCNT is set to be equal to "4" (step 45051). A count of "4" corresponds to one film frame in the preferred embodiment of the invention. In step 45052, a check is made to see if F_{LDEND} is equal to 1. Since loading is not finished when F_{LDEND} equals 0, processing exits the WIND operation and returns to the start of the MAIN program. If F_{LDEND} equals 1, the FILM INDICATION subroutine, shown in Fig. 21 is called. The number of pictures taken before the winding operation is indicated (step 45053), and the WIND PULSE CHANGE subroutine (shown in Fig. 23) is called in step 45054. After the execution of the WIND PULSE CHANGE subroutine to advance the film by one frame, a determination is made at step 45055 as to whether a REWIND operation should take place. If the determination is affirmative, processing diverges to the REWIND operation shown in Fig. 24. If no rewind operation is to be performed, processing goes to step 45056 where the film counter F_C is increased by "1". Processing then returns to the start of the MAIN program. Thus, the LCD display panel increments its display by one, showing that another picture has been taken (i.e., the display changes, for instance, from showing the number "1" to showing the number "2").

Operation of the Strobe Unit

The operation of the strobe unit will be explained with reference to Figs. 34-37. Fig. 34 represents the MAIN program of the camera embodying the present invention, as depicted in Figs. 9 and 10 above. Fig. 34 has been condensed so as to emphasize the instructions that are related to the operation of the strobe 22. Instruction steps that correspond to instructions illustrated in the flowchart of Figs. 9 and 10 have been assigned the same step number in Fig. 34 to more easily explain how the steps

pertaining to the operation of the strobe are interfaced with the MAIN program shown in Figs. 9 and 10. However, it is to be understood that the camera embodying the present invention has only one MAIN program which contains all the relevant instructions for the operation of the camera.

When the MAIN program (as depicted in Figs. 9 and 10) is started, the input conditions of the tele switch SWT, wide switch SWW, release switch SWR, photometric switch SWS and lock switch SWL are read and their conditions are stored in a memory (step 1, which is also shown in Fig. 34). When the main switch 30 is moved to the ZOOM position (or MACRO position) from the LOCK position, processing is transferred from the LOCK operation (described above and shown in Fig. 25) back to the MAIN program that is shown in Fig. 34. At this time, charging flag FCHGST is set to 1, while charging flags FCHGRQ and FCHGDSP are set to 0 before pausing for a period of 125 ms (step 50) before jumping back to step 3. At step 3, the input conditions of switches are re-read. The MAIN program calls the zoom subroutines (which were discussed above) to move the zoom lens to a location that matches the switch settings and then returns to the MAIN program, wherein the zoom subroutines are carried out once more. This time, when the positions of the main switch and the zoom lens match, processing goes to step 47.

At step 47, the input condition of the photometric switch SWS stored in memory and the input condition of photometric switch SWS that was read at step 3 are compared. When there are no differences, processing goes to step 550, which checks whether flag FCHGST equals 1. As noted above, when processing is transferred to the MAIN program, the value 1 is set for flag FCHGST. Therefore, processing goes to step 556 to determine whether the strobe capacitor charging is completed. As the strobe capacitor has not yet been charged, processing is transferred to step 558 to determine whether the strobe capacitor is being charged. If

the strobe capacitor is not being charged, processing goes to step 560 to start charging the strobe capacitor (steps 560 and 562).

At step 554, the charging flag FCHGDSP is checked to determine if it is set to 1. When this flag has been set to 1, the red lamp indicator Rd will blink (step 564) and processing is transferred to step 50 for the 125 ms pause before jumping to step 3. When flag FCHGDSP is set to 0 in step 554, processing proceeds to step 50 without causing the red lamp indicator Rd to blink. . When there are no variations in the input conditions of the tele switch SWT, wide switch SWW, release switch SWR, photometric switch SWS and lock switch SWL, the strobe capacitor is charged in the loop 3 to 550, 556, 558, 560, 554, 50 and 3.

If the charging of the battery is not completed within 15 seconds, step 556 will direct processing to step 558. This will stop the charging of the strobe capacitor and turn off the red lamp indicator Rd. Eventually, the routine will loop back to step S3.

When the charging of the strobe capacitor is completed, processing proceeds from step 556 to step 568. The charging of the strobe capacitor is stopped and the red lamp indicator Rd is turned OFF at step 568. Processing then continues to step 570, wherein flags FCHGST, FCHGRQ and FCHGDSP are each reset to 0. After the charging of the strobe capacitor is completed, the processing of steps 3 to 50 is repeatedly carried out.

At this time, if the shutter button is depressed and the photometric switch SWS is ON, step 47 will judge that there is a change in the photometric switch SWS setting. Thus, processing goes to step 48 to determine whether the photometric switch SWS is ON. If the photometric switch SWS is OFF, processing goes back to step 550. When it is ON, the red lamp indicator Rd is turned off (step 572), the charging of the strobe capacitor is stopped (step 574), and processing diverges to a series of instructions that

constitute a STROBE AUTOMATIC EXPOSURE/AUTOMATIC FOCUS (SAEAF) operation.

In the SAEAF operation, illustrated in Fig. 35, distance finding data Dv, photometric data Bv and ISO data Sv are inputted (step 576). At step 578, an exposure value Ev is calculated by adding the photometric data Bv and the ISO data Sv. Also, a FLASHMATIC (FM) operation is executed using the exposure value Ev, distance finding data Dv and ISO data Sv. Thus, when it is necessary to use the strobe to obtain a properly illuminated photograph, flag FFLASH will be set to 1, while when the strobe is not required, flag FFLASH will be set to 0.

At step 580, a test is made to determine whether flag F FLASH equals 1 meaning that the strobe is required. If the use of the strobe flash is not necessary, processing diverges to a RELEASE PROCESSING operation, to be discussed below. When step 580 determines that the strobe flash is necessary, processing goes to step 582 to determine whether the strobe capacitor charging operation is completed. That is, a test is made to determine whether the use of the strobe flash is possible. If it is possible to use the strobe, processing diverges to the RELEASE PROCESSING operation, after the red lamp indicator Rd is turned ON (step 584). The continuous illumination of the red lamp indicator Rd informs the photographer that the strobe will flash when the shutter release button is depressed. If it is not possible to fire the strobe, i.e., the strobe capacitor is not fully charged, processing diverges to a series of instructions that constitute a CHARGE operation, after setting flag FCHGRQ to 1 (step 586). The CHARGE operation is illustrated in Fig. 36.

When processing diverges to the CHARGE operation, a charging timer is started at step 587 and charging is permitted at step 588. Thereafter, step 589 checks whether the strobe capacitor charging is completed. When it is completed, processing goes to step 590, wherein flag FCHGRQ

is set to 0, the charging of the strobe capacitor is inhibited and the red lamp indicator Rd is turned OFF (step 591). Processing then diverges back to the SAEAF operation, which was previously described.

When the charging of the strobe capacitor is not completed, processing goes to step 592 to determine whether the photometric switch SWS is ON. If the photometric switch SWS is OFF, processing goes to step 593 to set flag FCHGDSP to 1. The charging of the strobe capacitor is then inhibited and the red lamp indicator Rd is turned OFF (step 594). Processing then returns to the MAIN program listing of Fig. 34.

When processing returns to the MAIN program, it goes to step 564 to enable the blinking of the red lamp indicator Rd, because flag FCHGDSP was set to 1 at step 593. Afterwards, processing returns to step S3, after the 125 ms wait in step 50. Until the strobe capacitor is completely charged, the red lamp indicator Rd will blink, while processing goes through the loop comprising steps 3, 47, 550, 552, 556, 558, 566, 554, 564, 50 and 3. After the strobe capacitor charging operation is completed, the red lamp indicator Rd is turned off (step 568) and flags FCHGDSP, FCHGRQ and FCHGST are each set to 0 (step 570). Processing then goes to step 50.

If the shutter button is depressed and the photometric switch is set to ON when the strobe flash is needed but not ready to flash, the strobe capacitor will start charging. The red lamp indicator Rd will also start to blink while the capacitor is being charged.

If the photometric switch SWS is ON at step 592 in the CHARGE operation, processing goes to step 595 to check whether the lock switch SWL is ON. If it is, processing goes to step 593 so as to inhibit the charging of the strobe capacitor and turn off the red lamp indicator Rd (step 594), before returning to the MAIN program. If the main switch 30 is not in the LOCK position, processing goes to step 596,

wherein a check is made to determine whether the charge time exceeds 15 seconds. If the charge time exceeds 15 seconds, processing goes to step 597. If it does not exceed 15 seconds, processing goes to step 598.

At step 598, processing is suspended for 125 ms before the red lamp indicator Rd is activated to start blinking (step 599). When the photometric switch SWS is ON (meaning that a photographer intends to take a photograph), the red lamp indicator Rd blinks to inform the photographer that the strobe capacitor is being charged.

When the photometric switch SWS is set to OFF, processing is routed through steps 592, 593 and 594. In other words, the strobe capacitor is fully charged and the red lamp indicator Rd is turned OFF. Processing then diverges back to the MAIN program.

As long as the photometric switch SWS is ON, a program loop occurs between steps 589 and 599, so as to charge the strobe capacitor for a maximum of 15 seconds, or until the charging operation is complete, whichever comes first. This means that the strobe capacitor is charged via the instructions of the CHARGE operation while the shutter button is being depressed. On the other hand, when the shutter button is released, the charging of the strobe capacitor is carried out in response to the instructions of the MAIN program.

If the strobe capacitor charging is not completed within 15 seconds at step 596 of the CHARGE operation, processing goes to step 597 to set flag FCHGRQ to 0, turn off the red lamp indicator Rd and inhibit the charging of the strobe capacitor (step 597A) before diverging back to the MAIN program.

The RELEASE PROCESSING subroutine is illustrated in Fig. 37. In this subroutine, a determination is made in step 610, as to whether the release switch SWR is ON. When it is not ON, processing continues at step 612, which determines whether the photometric switch SWS is ON. If the

photometric switch SWS is not ON, the red lamp indicator Rd is turned OFF at step 614 and processing returns to the MAIN program. However, if the photometric switch SWS is ON, processing goes to step 616, wherein a determination is made as to whether the lock switch SWL is ON. If the lock switch is not ON, the subroutine loops back to step 610. Therefore, if the release switch SWR is OFF, the photometry switch SWS is ON and the lock switch SWL is OFF, the RELEASE PROCESSING subroutine performs a continuous loop between steps 610 and 616, until one of these three conditions change. That is, the loop is terminated by either setting the release switch SWR to ON, setting the photometry switch SWS to OFF, or by turning the lock switch SWL to ON.

When the photometric switch SWS is set to OFF, or the lock switch SWL is ON, processing returns to the MAIN program.

When the release switch SWR is ON, the red lamp indicator Rd is turned OFF (step 618) and the shutter is released (step 620). Strobe 22 is then checked (in step 622) to determine whether it is ready to flash. If the strobe 22 is ready to flash (that is, FlagFFLASH equals 1), processing proceeds to step 624, to set flags FCHGRQ to 1 and FCHGDSP to 0, so as to request charging of the battery for the next picture. In this sequence, because the photographer is not waiting to take a photo, flag FCHGDSP will be set to 0 and the red lamp indicator Rd will not light. Processing then goes to 626. If the strobe 22 is not ready to flash, processing goes from step 622 to step 626.

At step 626, it is determined if film is loaded in the camera. If film is loaded, processing goes to step 628 to execute the WIND subroutine to advance the film and then return to the MAIN program. If film is not loaded, the WIND subroutine is skipped and control returns to the MAIN program.

The operation of the charging of the strobe

provides the photographer with a clear indication as to the status of the charging process. This indication is shown to the photographer only when he attempts to take a photograph. When the photographer does not attempt to take a photograph, no charging status indication is shown, even if the charging of the flash is actually under way.

* C L M S *

CLAIMS

1. A position detecting apparatus for detecting a current position of a member movable relative to a reference position, the apparatus comprising:-

a code information carrier having a plurality of codes, each code representing one or more positions of said movable member relative to said reference position and said codes representing a code change pattern of said code information carrier;

a code identifying device operatively associated with said code information carrier for movement relative thereto and for identifying said codes;

detecting means for detecting a code change when said code has changed to a code expected in accordance with said code change pattern;

counting means for counting the number of occurrences of code changes; and

means for determining a position value of said movable member as a function of said number of occurrences of code changes.

2. A position detecting apparatus as claimed in claim 1 wherein for at least a major proportion of said codes, each said code represents two or more positions of said movable member relative to said reference position.

3. A position detecting apparatus as claimed in claim 1 or 2 wherein at least one of said codes is an absolute code representing a position of said movable member having a predetermined positional relation with said reference position.

4. A position detecting apparatus as claimed in claim 3 wherein at least two of said codes are absolute codes and the apparatus further includes means for inhibiting said moveable member from being stopped at the position represented by one

or more but not all said absolute codes.

5. A position detecting apparatus as claimed in claim 3 or 4 wherein the codes not being absolute codes have at least one boundary, and wherein a said absolute code is located proximate said one boundary.

6. A position detecting apparatus as claimed in any one of claims 3 to 5 wherein the codes not being absolute codes are provided as a lengthwise extending series having a first end and a second end, and wherein a said absolute code is located proximate each end of said series.

7. A position detecting apparatus as claimed in any one of claims 3 to 6 wherein said position determining means determines the position of said movable member as a function of said number of occurrences of code changes relative to a said absolute code.

8. A position detecting apparatus as claimed in any one of claims 3 to 7 further comprising a memory for storing positional information; means for determining whether said positional information is lost from said memory; and means for moving said movable member to said absolute code position when memory is lost.

9. A position detecting apparatus as claimed in claim 8 further comprising means for providing a warning indication in the case that said information is lost from memory.

10. A position detecting apparatus as claimed in claim 8 or 9 further comprising a power source including a removable battery, and wherein said means for determining whether said information stored in memory is lost comprises means for determining whether a predetermined time has elapsed after removal of said battery.

11. A position detecting apparatus as claimed in any one of claims 3 to 10 further comprising means for determining, if said changed value is not indicative of one of said at least one absolute codes, thereby defining an error, whether said error is a result of a malfunction of said code identifying device.

12. A position detecting apparatus as claimed in any preceding claims wherein said detecting means temporarily stores an estimated code value and determines a code change if a current code value that has changed during movement of said movable member coincides with said estimated code value.

13. A position detecting apparatus as claimed in any preceding claim further comprising:-
(i) means for determining whether said current code value coincides with an actual position of said movable member with respect to said reference position;

(ii) means for indicating said actual position of said movable member with respect to said reference position; and

(iii) means for inhibiting said means for indicating said actual position of said movable member if said current code value does not coincide with said actual position of said movable member with respect to said reference position.

14. A position detecting apparatus as claimed in any preceding claim wherein said position determining means further comprises assigning means responsive to detection of a code change by said detecting means to assign a value of a position code, which position code is indicative of respective predetermined positions of said movable member with respect to said reference position.

15. A position detecting apparatus as claimed in any preceding claim further comprising control means actuable by

an activation signal to control movement of said movable member to a predetermined initial position, said control means comprising:-

(i) means for temporarily storing a position value of the movable member according to the present code;

(ii) means for causing said movable member to move to an evaluated position for said initial position evaluated according to the stored position value;

(iii) means for temporarily storing the detected position value corresponding to said evaluated position for said initial position;

(iv) means for determining whether said temporarily stored detected position value corresponding to said evaluated position for said initial position agrees with the actual initial position value and controlling said movable member to move to said actual initial position when agreement is not determined.

16. A position detecting apparatus as claimed in claim 15 and as dependent on claim 8 wherein said activation signal is produced in response to at least part of said positional information being absent from memory.

17. A position detecting apparatus as claimed in any preceding claim wherein said code identifying device further comprises means for repeatedly identifying code information and the apparatus further comprises means for verifying the identification of code information by comparing said code information repeatedly identified a plurality of times until said information identified coincides a predetermined plurality of times.

18. A position detecting apparatus as claimed in any

preceding claim wherein said code identifying device comprises a pick-up member in slidable contact with said code information carrier.

19. A position detecting apparatus for detecting a current position of a member movable relative to a reference position substantially as herein described with reference to the accompanying drawings.

20. A power zoom unit for a camera including a position detecting apparatus as claimed in any preceding claim, the unit comprising:-

a zoom lens provided in an assembly for permitting focal length variation of said zoom lens;

a zoom motor;

a cam ring having said code information carrier and operatively connecting said zoom lens and said zoom motor to effect a variation in the focal length of said zoom lens assembly by changing the position of said zoom lens with respect to said reference position and wherein said detecting means comprises a plurality of brushes adapted to be fixedly mounted with respect to the body of the camera in sliding conductive contact with said code information carrier for generating a position code related to the position of said zoom lens,

switches for operating said zoom motor for driving said zoom lens in a predetermined manner;

means for controlling said zoom motor in response to said zoom code and as a function of the state of each of said switches for operating said zoom motor.

21. A power zoom unit as claimed in claim 20 and including means for converting said position code to respective focal lengths of said zoom lens; and means for incrementally indicating focal lengths of said zoom lens in response to incremental changes being counted by said means for counting changes in position codes.