

EXPOSURE CONTROL SYSTEM OF A CAMERA
HAVING AN INTERVAL MODE

This invention relates to an exposure control system for a camera having an interval photographing mode, and more particularly to an exposure control system to be used in this camera.

An exposure control system controls aperture, shutter speed and strobe emission based on luminance of an object, film sensitivity, and F number of a lens.

In particular, the exposure control system of a built-in strobe type camera is generally controlled such that the strobe emission or non-emission is automatically selected based on photometry data, and when in darkness the strobe is automatically emitted.

An exposure control system of this type is designed on a premise that a picture is taken by holding the camera by hand. Thus, the lowest limit of shutter speed is set to a level to avoid generation of camera shake, and when the exposure is not enough, the strobe is also emitted at such lowest limit of the shutter speed.

On the other hand, a camera having an interval mode is known and in general, interval photographing is performed in a state where the camera is fixed to a tripod. In this case, therefore, there is a reduced necessity to restrict the lower limit of the shutter speed.

However, as the conventional camera has the interval mode independent of the automatic exposure mode, exposure control particular to interval photographing was not performed.

According to the present invention there is provided an automatic exposure control system for a camera having a plurality of taking modes including an interval mode and a normal mode, said system comprising:-

- means for selecting between the plurality of taking modes;
- means for setting a threshold value of an exposure value;
- means for causing strobe emission as a function of said exposure value in relation to said threshold value; and
- changing means changing a setting of said threshold value in

response to the interval mode being selected by said selecting means, wherein said set threshold value in the interval mode is lower than when said normal mode is selected.

Conveniently, said plurality of taking modes includes a normal mode wherein when said normal mode is selected, said means for causing strobe emission causes a strobe emission in response to the exposure value being lower than another threshold value which is higher than said first mentioned threshold value.

In one case, said threshold value comprises an exposure value which in the normal mode is equal to 9.0 and said threshold value in the internal mode is equal to 6.0.

Conveniently, the system further comprises means for determining a shutter speed and an aperture value with reference to a detected exposure value E_v when said detected exposure value E_v is higher than said threshold value.

Preferably, the system further comprises means for resetting the aperture value with reference to distance measurement data and guide number of the strobe when said detected exposure value E_v is lower than said threshold value.

In one case, said resetting means uses said distance measurement data, said guide number of the strobe and a lowering of said guide number according to a lowering of a supply voltage as a parameter.

Thus, as the lower limit of the shutter speed determined by an exposure calculation is automatically lowered when the taking mode is set to an interval taking mode, a picture can be taken even in a relatively darker place without emitting the strobe.

An example of the invention is described in detail below with reference to the accompanying drawings, in which:-

Fig. 1 is a plan view of a camera.

5 Fig. 2 is a front view of the camera.

Fig. 3 is a rear view of the camera.

Fig. 4 is a block diagram of a control circuit.

Fig. 5 is a view for explaining the construction of a contact of a zoom switch.

10 Fig. 6 is a block diagram of a zoom motor system.

Fig. 7 is an expanded view of a code plate and a view showing the corresponding relation between the code plate and each code.

Fig. 8 is a view for explaining the mode setting.

15 Fig. 9 is a view for explaining segments displayed on an LCD.

Fig. 10 is a flowchart showing a RESET Program.

Figs. 11, 13, 14 and 15 are flow charts showing a MAIN Operation.

20 Fig. 12 is a flowchart showing a LOOP ESCAPE subroutine.

Fig. 16 is a flowchart showing a ZOOM INITIALIZATION subroutine.

Figs. 17 and 18 are flow charts showing a CODE CHECK 25 subroutine.

Fig. 19 is a flowchart showing a ZOOM REVERSE Operation.

Fig. 20 is a view for explaining the action of zooming.

30 Fig. 21 is a flowchart showing a ZOOM FORWARD Operation.

Fig. 22 is a flowchart showing a ZOOM TO TELE Operation.

Fig. 23 is a flowchart showing a ZOOM TO WIDE 35 Operation.

Fig. 24 is a flowchart showing a LOCK Operation.

Figs. 25 and 26 are flowcharts showing a MODE SETTING Operation.

Fig. 27 is a flowchart showing a MANUAL SHUTTER TIME OR INTERVAL TIME DISPLAYING Operation.

Fig. 28 is a flowchart showing a BLINK TIME DISPLAYING Operation.

Figs. 29 through 31 are flowcharts showing an AEF(AUDIO EXPOSURE and AUTO FOCUS) CONTROL Operation.

Fig. 32 is a flowchart showing an ALL(LENS LATCH) CALCULATION subroutine.

Fig. 33 is a flowchart showing an AE(AUDIO EXPOSURE CALCULATION) subroutine.

Fig. 34 is a flowchart showing a FM(FLASH MATIC CALCULATION) subroutine.

Fig. 35 is a flowchart showing a CHARGE Operation.

Fig. 36 is a flowchart showing a MANUAL SHUTTER TIME COUNT Operation.

Fig. 37 is a flowchart showing a WIND Operation.

Fig. 38 is a flowchart showing an INTERVAL CONTROL Operation.

In Figs. 1-38, an embodiment of a camera of the present invention is illustrated.

A camera body 1 has a stationary barrel 2 and a moving barrel 3, as shown in Fig. 1. As shown in Fig. 2, the front of the camera body 1 contains a distance measurement section 4, a finder window 5, a strobe 6, a photometric element, such as a CdS, and selftimer lamp 7. The back of the camera body 1, as shown in Fig. 3, contains a back cover 8, an LCD indicator 9, a first mode button A, a second mode button B, a clear button C, a zoom lever 10, a green lamp indicator (LED) D, a red lamp indicator (LED) E, a back cover release lever 11, a date display section 12 and a date switch 13.

When the back cover release lever 11 is moved from an upward stop position to a downward stop position, the back cover 8 opens. When the back cover 8 is opened, the back cover release lever 11 is in the downward stop position, while when the back cover 8 is closed, the back cover release lever 11 returns to its upward stop position.

A rewind button (not shown), is located on the bottom of the camera body 1.

The upper section of the camera body 1, as shown in Fig. 1, contains a lock lever 14, a shutter button 15 and a macro button 16. Lock lever 14 is slidable between an ON and OFF position.

Zoom lever 10 can be moved in a first (normal) direction, indicated by arrow r1 in Fig. 1 and a second (reverse) direction, indicated by arrow r2. The zoom lever 10 permits the camera lens to be moved between a wide extremity and a tele extremity. The zoom lever 10 is used to change both the manual shutter time and interval time, to be discussed below. The light projecting angle of the strobe 6 is changed according to the angle of view which is changed by zooming of the taking lens.

The camera contains a control circuit comprising a main CPU, to which a sub CPU is connected which performs shutter-related processing in association with a drive IC.

A single custom integrated circuit has been designed which contains the main CPU, sub CPU, drive IC, autofocus IC and other electronics.

The main CPU performs the following functions in response to input signals provided to the camera:

(1) Controls the zoom motor and a film motor via a motor drive circuit;

(2) Controls the illumination and blinking of the green lamp indicator D which provides distance measurement-related indication, the red lamp indicator E which provides a strobe-related indication, and the self timer lamp 7 which

provides a self timer-related indication;

(3) Controls the indication on the LCD 9; and

(4) Controls the charging of the strobe circuit.

Information is inputted to the main CPU by the
5 following:

(1) Lock switch LOCK, which is set to ON when the
lock lever 14 is set in its ON position;

(2) Photometry switch SWS, which is set to ON when
the shutter button 15 is depressed halfway;

10 (3) Release switch SWR, which is set to ON when the
shutter button 15 is fully depressed;

(4) MACRO switch MCRO, which is set to ON when the
macro button 16 is depressed;

(5) Zoom tele switch TELE, which is set to ON when
15 the zoom lever 10 is displaced from a center, neutral
position toward a tele side r2;

(6) Zoom wide switch WIDE, which is set to ON when
the zoom lever 10 is displaced from a center, neutral
position towards a wide side r1;

20 (7) Speed switch ZMHL, which is set to ON when the
angle of the zoom lever 10 is displaced a small amount from
the center, neutral position and is set to OFF when the zoom
lever 10 is displaced from the center, neutral position by a
large amount;

25 (8) Mode A switch MDA, mode B switch MDB and clear
switch MDC, which are set to ON when the mode buttons A, B,
C, respectively, are depressed;

(9) DX contact point, which reads a DX code printed
on a film patron(cartridge);

30 (10) Zoom code inputs ZC0, ZC1, and ZC2, which are
discussed in detail below;

(11) Back cover switch BACK, which is set to OFF
when the back cover release lever 11 is pressed down and set
to ON when the back cover 8 is closed and the lever returns
35 to its lock position; and

(12) Rewind switch REW, which is set to ON when the rewind button is pressed.

Three zoom-related switches TELE, WIDE and ZMHL are controlled by one zoom lever, the contact point layout being shown in Fig. 5. With these combinations, five conditions are inputted to the main CPU. The data is used for the zoom operation or mode setting. For example, when performing the zoom operation, the information for the normal or reverse speed is inputted to the main CPU.

10 The sub CPU controls the range finder, which comprises an infrared LED and a position sensor PSD via an autofocus IC. The sub CPU transfers the distance measurement data from the autofocus IC and photometry data (according to the CdS) to the main CPU.

15 The drive IC controls the shutter circuit according to commands from the sub CPU and outputs a trigger signal to the strobe circuit.

Referring to Fig. 6, the main CPU outputs commands for the normal or reverse rotation of the zoom motor via 20 four signal lines (MP1, MP2, MN1 and MN2) to the motor drive circuit.

A motor power control circuit, which supplies power to the motor drive circuit, switches between a high and low supply voltage according to the speed command input from the 25 main CPU via signal line MCNT. When MCNT is OFF, the battery voltage is supplied directly to the zoom motor drive circuit while, when MCNT is ON, the battery voltage is supplied after lowering the voltage to a specified value.

The details of these commands are shown in Table 1 30 below.

The zoom motor lets the focal length of the lens change to the tele extremity by shifting the moving barrel 3 in a direction so that it protrudes from the camera body via the cam ring when the normal rotation is executed. When the 35 reverse rotation is executed, it lets the focal length of

the taking lens change to the wide extremity by operating the moving barrel 3 in a reverse direction.

For this camera, the information which is indicative of the change in the focal length of the taking lens, changes by F_{min} (Full-Open Aperture F-number) according to the change of the lens in the wide extremity, tele extremity, macro position, or lock position, etc., is automatically detected and each kind of control is performed according to this information.

10 For this purpose, a code plate is attached on the surface of the cam ring of the lens and four brushes (ZC0, ZC1, ZC2, GND) contact the code plate. GND is a common terminal while the other three brushes are used for code detection.

15 Fig. 7 shows a diagram of the code plate and each code produced when terminals ZC0, ZC1 and ZC2 are in contact with a continuity portion (also known as "traces") of the code plate shown by the oblique lines in the figure, wherein a signal "0" indicates a portion of the conductive trace is removed, while a signal of "1" indicates a portion of the
20 conductive trace is not removed. In this description, a three-bit information code detected by the continuity relation between these terminals is known as a zoom code ZCODE.

25 A position code POS and division code DIV are defined according to the abovementioned zoom code so as to control zooming.

The position code POS is used to distinguish five conditions of the taking lens:- the position between the wide extremity and the lock position, the position of the
30 wide extremity or tele extremity in the zoom area, and the position between the tele extremity and the macro position. The division code DIV is used to identify the lens position by dividing the zoom range into fourteen areas.

In Fig. 7, the portion where POS equals "1 and 3" is
35 shown with a fixed width. POS equalling "1" is obtained when

the lens is set to the wide extremity, namely, only at the moment that ZC1 is set from 1 to 0 (from OFF to ON). Since the lens does not stop at the wide extremity, POS is switched from "0" to "2".

5 The lens is forbidden to stop in the area between the lock position and zoom area, as well as in the area between the zoom area and macro extremity, because when a terminal which is properly ON is detected as OFF, due to a bad contact between one brush and the code plate, the zoom
10 motor may possibly stop in the forbidden area. Therefore, the code plate and software are constructed so that the change from OFF to ON of the specified terminals is used when detecting these borders. If this configuration is used, stopping in the forbidden area can be avoided, even if a
15 brush floats because the terminal is OFF.

On the other hand, in the zoom area, fourteen divisions are used for the focal length of the lens, as mentioned above. In addition, terminal ZC2 is used to detect the tele extremity in the zoom area.

20 Thus, it is necessary to divide thirteen steps by two bits. In this example, the relative code configuration which is employed uses zoom codes ZCODE "4", "5", "6", or "7", respectively, to correspond to division codes DIV of "1H"- "EH".

25 When this configuration is used, it is impossible to uniquely specify a division code that corresponds to the focal length of the lens only by the use of the zoom code ZCODE. Therefore, the division code is fixed by successively rewriting the division code stored in memory as
30 changes in the zoom code from the end points are detected.

The function of the mode buttons A and B will now be explained. Mode button A is provided with the function of setting the exposure mode. The exposure mode includes an auto mode (automatic strobe emission mode), strobe ON mode
35 (forced strobe emission mode), strobe OFF mode (strobe

emission forbidding mode), exposure compensation mode, bulb mode, and bulb and strobe ON mode. In this specification, "bulb mode" includes "manual shutter mode".

In Fig. 8, the indication marks corresponding to each exposure mode are shown. In the auto mode, no indication is shown. MODE A is arranged to correspond to the exposure mode: "0" corresponds to auto, "1" corresponds to strobe ON, "2" corresponds to strobe OFF, "3" corresponds to the exposure correction, "4" corresponds to bulb, and "5" corresponds to bulb and strobe. When the mode button A is operated, the setting is changed.

The mode button B functions to select the taking mode. Six kinds of taking modes are available: one-frame photographing, continuous photographing, self timer, double self timer, multi-photographing, and interval photography. The indication marks corresponding to each taking mode are shown in Fig. 8. However, for one-frame photographing, no indication is shown. MODE B is arranged to correspond to the taking mode: "0" corresponds to one-frame photographing, "1" corresponds to continuous photographing, "2" corresponds to selftimer, "3" corresponds to double selftimer, "4" corresponds to multi-photographing and "5" corresponds to interval photography.

When mode button B is operated, the setting of MODE B is changed. The LCD indication is shown according to the contents of MODE A and B, the indication of the controls for photographing are shown according to these contents as well.

For the bulb or the bulb and strobe ON taking mode, the manual shutter times shown in Table 2 are available. Eight kinds of manual shutter speeds are available and a respective MODBLB value is provided for these eight kinds of manual shutter speeds.

"0" corresponds to bulb, while "1" to "7" correspond to each manual shutter speed from 1 to 60 sec. The contents of this MODBLB are changed in the mode setting flow mentioned below

by operating zoom lever 10 in the condition that mode button A is kept pressed after changing to the bulb or the bulb and strobe ON mode by pressing mode button A. It can also be changed by again pressing mode button A and operating zoom lever 10 when the manual shutter speed is not shown in the bulb or the bulb and strobe ON mode.

For the interval taking mode, the interval times shown in Table 3 are available. Sixteen interval times are permitted; a respective mode interval value MODINT is provided for each of the sixteen interval times. "0" to "15" correspond to each interval time from 10 seconds to 60 minutes. The contents of MODINT are changed by operating the zoom lever 10 whilst the mode button B is kept pressed after changing to the interval mode by pressing the mode button B. These can also be changed by pressing the mode button B and operating the zoom lever 10 when the interval time is not shown in the interval mode. The initial value of MODBLB is equal to "0" corresponding to bulb, while the initial value of MODINT is "5" corresponding to 60 seconds. These initial values are automatically set by setting the mode initialization or the clear button C to ON.

The details of the LCD indicator 9 are explained with reference to Fig. 9. The mode marks for mode button A and B are shown in each indication area according to each mode. As the meaning of many of the marks has already been explained, the remaining marks are described below.

Fig. 9 illustrates that the LCD indicator 9 contains a shutter button mark 17, a macro mark 18, a zoom lever mark 19, a battery mark 20, and a seven segment display section 21.

The unit mark "mm" is illuminated when the focal length of the zoom lens is displayed; the unit marks "M" or "S" are displayed when the manual shutter speed and interval time are displayed; and the unit mark "EX" is displayed when showing the frame number of the film.

Shutter button, mark 17 is shown when the shutter

button 15 is operable. Macro mark 18 is displayed when macro photography is possible, after having pressed the macro button 16 to make the taking lens move to the macro extremity. The macro mark blinks when it is necessary to switch to the zoom photographing position in response to a distance measurement. Zoom lever mark 19 is continuously illuminated or blinked when the zoom lever 10 is activated, while the battery mark 20 lights when the camera battery is discharged. The seven segment display section 21 indicates the frame number of the film, the focal length of the lens, the manual shutter speed or the interval time for taking pictures. With respect to the unit marks, "M" indicates minutes while "S" indicates seconds. "M" or "S" corresponds to the time set for the manual shutter speed or interval time.

The program stored in the main CPU will now be described with reference to Figs. 10 to 38. The letter "S" denoted on the Figs. are represented in the following text by the use of the word "step".

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TABLE 1

	MCNT	MP1	MP2	NN1	NN2
MOTOR HIGH SPEED NORMAL ROTATION		ON			ON
MOTOR LOW SPEED REVERSE ROTATION			ON	ON	
5 MOTOR HIGH SPEED NORMAL ROTATION	ON	ON			ON
MOTOR LOW SPEED REVERSE ROTATION	ON		ON	ON	
MOTOR BRAKE				ON	ON

TABLE 2

	MANUAL SHUTTER TIME	MODBLB
10	BULB	0
	1 SECOND	1
	2 SECONDS	2
	4 SECONDS	3
	8 SECONDS	4
15	15 SECONDS	5
	30 SECONDS	6
	60 SECONDS	7

TABLE 3

	INTERVAL TIME	MODINT
20	10 SECONDS	0
	20 SECONDS	1
	30 SECONDS	2
	40 SECONDS	3
	50 SECONDS	4
25	60 SECONDS	5
	2 MINUTES	6
	3 MINUTES	7
	4 MINUTES	8
	5 MINUTES	9
30	10 MINUTES	10
	20 MINUTES	11
	30 MINUTES	12
	40 MINUTES	13
	50 MINUTES	14
35	60 MINUTES	15

《RESET Program and MAIN Operation》

A RESET program and associated MAIN operation will be described first, with reference to Figs. 10 and 11. The MAIN operation describes the basic operation of the camera. Other functions are performed by branching from or being controlled from the MAIN operation according to various conditions.

When power is turned ON, the main CPU is reset and the processing shown in Fig. 10 starts. The main CPU initializes the camera memory and inputs switch data (steps RS1 and RS2) before performing a MODE INITIALIZATION subroutine in step RS3 and a ZOOM INITIALIZATION subroutine (shown in Fig. 16) in step RS4. Then, processing diverges to a series of instructions that comprise the MAIN operation, shown in Fig. 11. The MODE INITIALIZATION subroutine resets various mode settings to initial values to set the automatic strobe emission and one-frame taking mode.

In the MAIN operation, a 1-second timer, used for an indication hold, is cleared in step M11.

In steps M12 to M14, the photometry switch SWS, release switch SWR, wide switch WIDE, tele switch TELE, mode switch MDA, mode switch MDB, clear switch MDC and macro switch MCRO are set to OFF and switch judgment flag FSWOFF is set to 1.

In steps M15 to M18, when the photometry switch SWS, release switch SWR, wide switch WIDE and tele switch TELE are set to OFF and a forbidden photographing combination mode is not selected, the photometry switch effective flag FSWSEN is set to 1, when some of the switches are set to ON, or a forbidden combination mode is set, a value of 0 is set in flag FSWSEN.

In step M19, the status of each of the above-mentioned switches are inputted and processing is executed according to the inputted switch data.

When rewind switch REW is judged to be ON (step

MI10), the MODE INITIALIZATION subroutine is performed (step MI11). A LOOP ESCAPE subroutine, shown in Fig. 12, is then executed in step MI12. This subroutine comprises two steps, of which step L01 stops the charging of the strobe circuit and step L02 turns OFF the red lamp charge indication before
 5 other processing branches from the MAIN operation.

When the LOOP ESCAPE subroutine is completed, the MAIN operation diverges to a series of instructions that comprise a REWIND operation. When the REWIND operation has completed rewinding the film in the camera, a rewind
 10 complete flag FREWEND is set to 1 and processing is advanced by jumping to the beginning of the main operation.

When the back cover 8 is closed (turning ON back switch BACK), step MI14 is performed to determine whether the film has finished loading. This is performed by
 15 checking flag FLDEND. If the film has not finished loading, the flag is set to 0, and processing continues to step MI15, wherein the MODE INITIALIZATION subroutine is performed once more. Then, at step MI16, the LOOP ESCAPE subroutine is performed so as to diverge to a series of instructions that
 20 comprise a LOADING operation. When the LOADING operation has finished loading the film, flag FLDEND is set to 1 and processing goes to step MI19. Thus, the next time step MI13 is executed, the program will proceed to step MI19 because
 25 FLDEND will be set to 1.

When the back cover 8 is open, both FLDEND and FREWEND are reset to 0 (steps MI17 and MI18). In steps MI19 to MI24 (Fig. 13), a determination is made as to whether lock switch LOCK has been turned ON from its OFF position.
 30 That is, a test is made to see if the lock lever has been switched from the OFF position to the ON position. If the lens is not in the lock position, according to the lock position flag FLOCK, the display changes from indicating the film frame number to indicating the focal length of the lens
 35 (step MI21). Then, the LOOP ESCAPE subroutine (step MI22)

is executed, as described above. Thereafter, processing diverges to a series of instructions that comprise a ZOOM REVERSE Operation, shown in Fig. 19 and to be discussed below, so that the lens is pulled back to the lock position.

5 When the lens is already in the lock position and the REWIND operation has not finished (MI23), processing goes to step MI24 so as to execute the LOOP ESCAPE subroutine so that processing can diverge to a series of instructions that comprise a LOCK operation (Fig. 24). If the REWIND
10 operation has finished, processing is advanced by jumping to step MI56, shown in Fig. 15.

When the lock switch LOCK is in the OFF position and the lens is positioned between the lock position and the wide extremity (i.e., POS equals "0"), as determined by
15 steps MI19 and MI25, the focal length of the lens is indicated to the photographer (step MI26) for a period of one second (step MI27) by setting an indication hold flag FWAITD to 1. Thereafter, macro command flag FROMCRO is set to 0 (step MI28) and the LOOP ESCAPE subroutine is performed
20 (step MI29) so that processing can diverge to a series of instructions that comprise a ZOOM FORWARD operation, shown in Fig. 21. In this operation, the zoom lens is moved at a normal rotation speed towards the wide extremity. Processing then returns to the MAIN operation.

25 In step MI30, a determination is made as to whether the macro switch MCRO is ON. If it is ON, steps MI31-MI36 are performed so as to indicate the focal length of the zoom lens and set the indication hold flag FWAITD to 1. A test is then made to determine whether the zoom lens is in the
30 macro position by checking the condition of the macro position flag FMCRO (step MI33). If it is in the macro position, indication hold timer is cleared (step MI34) and restarted. Processing then advances to step MI55, shown in Fig. 15. If the lens is not in the macro position, the
35 macro command flag FRQMCRO is set to 1 and processing

diverges to the ZOOM FORWARD subroutine at a normal rotation speed so that the lens moves towards the macro extremity. After the ZOOM FORWARD subroutine has completed its execution, processing returns to the MAIN operation.

5 If the macro switch MCRO is in the OFF position, steps MI37-MI43 (Fig. 14) are performed to determine the setting of the tele switch TELE. When the tele switch TELE is ON, an indication of the focal length of the lens is displayed to the operator. When the lens is not in the tele
10 extremity where POS equals "3", a test is performed to determine if the lens is between the tele extremity and the macro extremity (i.e., POS equals "4") or the wide extremity (i.e., POS does not equal "4"). When the lens is in the position between the tele extremity and the wide extremity
15 in the zoom area, processing diverges to a series of steps that comprise a TELE SHIFT (ZOOM to TELE) operation, to be described below, to move the lens to the tele extremity. If the lens is in the position between the tele extremity and the macro extremity, processing diverges to the ZOOM REVERSE
20 operation so as to move the lens towards the tele extremity.

When the lens is already at the tele extremity (i.e., POS equals "3"), the display indication timer is cleared and the count of one second is started again.

In steps MI44-MI50, when the wide switch WIDE is ON,
25 the display is switched to indicate the focal length of the lens, the indication hold flag FWAITD is set to 1 and a test is performed to determine if the lens is at the wide extremity. If the lens is at the wide extremity, the display indication timer is cleared and restarted (in step MI48). If the lens
30 is not at the wide extremity, a test is made to determine whether the lens is in the wide extremity or the macro extremity (i.e., whether POS is equal to "4").

If the lens is not in the wide extremity, processing branches to a WIDE SHIFT (ZOOM to WIDE) Operation to move
35 the lens to the wide extremity. If it is in the macro

extremity, processing diverges to the ZOOM REVERSE operation to move the zoom lens to the tele extremity. When the wide switch WIDE is kept activated, even if the zoom lens reaches the tele extremity, processing diverges from the ZOOM
5 REVERSE operation to a series of instructions that comprise a WIDE operation so as to continuously move the lens.

Therefore, when the macro switch is ON, the zoom lens is set to the macro position and to retract the lens from the macro position to the zoom area, the zoom
10 lever should be moved from its center, neutral position towards either r1 or r2.

Steps MI51-MI54 are provided to test macro tele shift flag FMTSIFT to determine if it is necessary to shift the lens. If the flag is set to 1, the focal length of the
15 lens is displayed (step MI52) and the indication hold flag FWAITD is set to 1. Thereafter, processing diverges to the ZOOM REVERSE operation to shift the lens to the tele extremity.

In this embodiment of the
20 invention, the distance limit for taking macro photographs is approximately 1 meter (m). Thus, when the lens is in the macro position and the distance measurement indicates a distance greater than 1 m, it is impossible to take an infocus photograph when the shutter button is depressed.
25 However, by setting the release lock, the lens is controlled to be shifted to the tele extremity from the macro position.

The flag FMTSIFT is set in a LENS LATCH (LL) subroutine (shown in Fig. 32) that is called by a series of steps that comprise an AUTOMATIC EXPOSURE/AUTOMATIC FOCUS (AEAF)
30 CONTROL subroutine, shown in Fig. 29 and to be discussed below, that diverges from the main operation after step MI65 is performed.

In step MI55, the condition of a rewind complete flag FREWEND is examined. If the rewind operation has
35 finished, step MI56 is performed to display "00 EX" on the

LCD panel. If the rewind operation is not finished (as indicated by FREWEND being set to 0), a MODE SETTING subroutine is performed (step MI57).

5 After the switch judgment flag FSWOFF has been set in steps MI2-MI4, the MODE SETTING subroutine is executed only when all switches are set to OFF by the previous inputs.

If some switches are set to ON, the subroutine returns to the MAIN operation without changing any settings.

10 If there is a change in a mode setting, a mode change flag FMDCHG (step MI58) is set to 1, while if there is no change it is set to 0.

When processing returns to the MAIN operation, the condition of flag FMDCHG is examined (step MI58). If there is a mode change, the indication hold flag is set to 1 in 15 step MI59 before the program jumps to the beginning of the MAIN operation.

When there are no changes, photometry switch SWS and photometry switch effective flag FSWSEN are examined in steps MI61 and MI62. When the specified conditions are 20 satisfied, an indication of the focal length of the lens is displayed (steps MI63-MI65) and the indication hold flag is cleared. Processing then diverges to the ABAF CONTROL operation so as to control the camera shutter.

25 The ABAF CONTROL operation is executed when the photometry switch SWS is changed from OFF to ON, every switch data stored in each memory of the SWS, SWR, TELE and WIDE are OFF and the mode that allows a photograph to be taken is set. That is, the ABAF CONTROL operation is performed only when the SWS is switched from OFF to ON. 30 Therefore, if the zoom lever is operated, the MAIN operation continues without the ABAF CONTROL operation being performed.

In step MI66, a CHARGE CONTROL subroutine, which controls the strobe flash circuit, is called. This 35 subroutine causes an indication switch to be set in steps MI67-MI71. The presently shown indication is displayed for

a period of one second. When the holding of the display indication is not required, or one second has passed, the film frame number is redisplayed and the indication hold flag FWAITD is cleared. Thus, the indication of the film
 5 frame number is given preference over other indications, unless, the other data to be shown is only temporarily displayed.

After pausing for 125 ms at step MI72, a CHARGE PROHIBITING TIME subroutine is called. Processing then
 10 jumps to step MI2 (Fig. 11) to repeat the above outlined procedure.

Various subroutines and operations that are executed will now be discussed.

<ZOOM INITIALIZATION subroutine>

Fig. 16 illustrates the flowchart of the ZOOM
 15 INITIALIZATION subroutine that is called in step RS4 of the RESET program.

As mentioned above, the camera embodying the present invention uses a relative code for the zoom code. Accordingly, when the camera battery is removed and data in
 20 the memory is cancelled, the camera cannot identify the position of the lens. The ZOOM INITIALIZATION subroutine shifts the lens to the lock position in such a case.

First, a zoom code ZCODE is inputted in step ZI1, as determined by the terminal brushes that are contacting the
 25 code plate. A test is then performed to determine whether the lens is in the lock position (step ZI2). If the lens is not in the lock position, step ZI5 is performed to reversibly rotate the motor at a high speed. If the lens is
 30 in the lock position, steps ZI3 and ZI4 are performed to rotate the zoom motor in a forward direction for 100 ms before going to step ZI5 and performing the high speed motor reverse instruction to bring the lens to the lock position.

This subroutine results in the position code POS
 35 being set to "0", a lock position flag FLOCK being set to 1

and the macro position flag FMCRO being set to 0 before the subroutine returns to the point from which the subroutine was called.

<CODE CHECK subroutine>

5 Figs. 17 and 18 illustrate the CODE CHECK subroutine.

As mentioned above, a relative code is employed for determining the position of the zoom lens. However, it is impossible to specify one position code or division code which corresponds to the focal length of the
10 lens by only using the detected zoom code. Therefore, in the CODE CHECK subroutine, the position code POS and division code DIV, which are stored in memory, are successively rewritten while the zoom code is dynamically detected as it changes from the lock position (where ZCODE equals "2" and is an absolute
15 code).

When this subroutine begins, data is inputted with respect to the lock switch LOCK, macro switch MCRO, wide switch WIDE, tele switch TELE and speed switch ZMHL (step CK1). When the CODE CHECK subroutine is called by a ZOOM to
20 TELE subroutine or a ZOOM to WIDE subroutine, the inputted switch data is used after the processing of the subroutine is finished.

In steps CK2-CK5, when the position code POS shows that the lens is at the wide extremity (POS equals "1") or
25 the tele extremity (POS equals "3"), the position code POS is forcibly set to the codes that show the zoom area (POS equals "2") and the position between the tele extremity and macro position (POS equals "4"). Then, the zoom code ZCODE is inputted CK6. If there is no change in the value of the
30 zoom code, processing returns to the point in the MAIN operation from which this subroutine was called.

When there is a change in the value of the zoom code, the processing that is performed depends upon the rotation direction of the zoom motor. If the motor rotates normally,
35 processing advances from step CK8 to step CK9, while if the

motor rotates in a reverse direction, the processing advances to step CK25 (shown in Fig. 18). The following explanation pertains to the normal rotation case. The position code POS will be either "0, 2 or 4" after steps CK2-
5 CK5 are performed.

When the lens is between the wide extremity and the lock position (POS equals "0"), processing continues to step CK10, until brush terminal ZC1 is set to ON with respect to the code plate; that is, the lens is set to the wide
10 extremity. When ZC1 is ON, the position code POS is set to "1" and the division code DIV is set to "1H" (step CK11) and, if the zoom motor rotates normally, zoom code value ZCFOW, which will be used after the next change (change predictor in the normal rotation of the zoom code), is set to a value
15 of "4".

The change predictor is fixed, according to the table of Fig. 7. When the lens is in the zoom area (that is, the position code POS equals "2"), processing advances from step CK12 to step CK13 to determine whether the division
20 code DIV is smaller than "2H". If DIV is larger than "2H", a determination is made as to whether terminal ZC2 has changed.

The ZC2 terminal becomes 1 when the zoom lens is rotated to where the position code POS is equal to "2". That is, the ZC2 terminal is equal to 0 only when the zoom
25 lens approaches the CRITICAL TELE END or CRITICAL WIDE END, as shown Fig. 7. The ZC2 terminal is always equal to 1 when the zoom lens is in the zoom range. Therefore, by examining the status of the ZC2 terminal, it is possible to determine
30 whether the zoom lens is at the tele extremity without performing step CK13.

However, it could happen that ZC2 becomes 0 and ZC1 becomes 1 because of a structure error in the code plate. Therefore, a test is made in step CK13 so that the tele
35 extremity can be detected only by the signal of the ZC2

terminal, even if such an error occurs. When the tele extremity is detected, the position code POS is set to "3", while the division code DIV is set to "EH" and the LCD panel is changed to always indicate the

5 tele extremity focal length (i.e., 70 mm) and the CODE CHECK subroutine is exited (Steps CK15 and CK16).

If the tele extremity has not been reached, the terminal brush ZC2 is considered to be equal to 1 (step CK17) and step CK18 is performed to compare the zoom code ZCODE
10 with the change predictor ZCFOW. When they are the same, the division code DIV is up counted and a new change predictor is set in steps CK19 to CK22. If the indication keep flag (indication change permission flag) FKPLCD is set to 0, the subroutine performs the steps necessary to indicate the
15 focal length of the lens that corresponds to the new division code DIV and then the CODE CHECK subroutine is exited.

When steps CK9 and CK12 determine that POS is not equal to "0" or "2", it means that the lens is between the
20 tele extremity and macro extremity (POS equals "4"). Thus, an examination is made of brush terminal ZC0, in step CK23, to determine if it is equal to 0. If it is equal to 0, the macro position flag FMCRO is set to 1 in step CK24, macro command flag FRQMCRO is cleared (that is, set to 0) and the
25 CODE CHECK subroutine returns.

When the zoom motor rotates in the reverse direction, the CODE CHECK subroutine jumps from CK8 to step CK25 (shown in FIG. 18). Zoom code ZCODE being equal to "2" represents the absolute code, meaning that the lens is in
30 the lock position. In this case, step CK26 is executed to stop the rotation of the zoom motor. Then, POS is set to "0", while lock position flag FLOCK is set to 1. Thereafter, processing jumps to the start of the MAIN operation after CPU stack register processing has occurred (step CK28).

35 When the lens is in the position between the tele

extremity and the macro extremity (POS equals "4"), processing advances from step CK29 to step CK30. If terminal ZC1 is 1, control is returned to the point in the MAIN operation from which the CODE CHECK subroutine was
5 called.

When the ZC1 terminal is 0, it means that the lens has entered the zoom area. As a result, the position code POS is set to "2", the division code DIV is set to "DH" and change predictor ZCREV is set to a value of "7" (step CK31).
10 Flag FKPLCD is then examined to determine if it is 1 or 0. If the flag is set to 0, the focal length of the lens is displayed (step CK33) on the LCD panel to show the new value (i.e., 65 mm). If the flag is equal to 1, the focal length indication step is skipped. Regardless of whether the focal
15 length of the lens is displayed or not, the next step is to return to the point from which the CODE CHECK subroutine was called.

If the position code POS is not equal to "4" in step CK29, processing is separated into the case where the
20 position code POS equals "2" and where the position code POS equals "0" (step CK34). When the lens is in the position between the wide extremity and the lock position (POS equals "0"), the subroutine returns to the point from which it was called.

25 When the lens is in the zoom area where the position code POS equals "2", a judgment is made (in step CK36) as to whether terminal ZC2 is ON (that is, having a value of 0) or OFF (that is, having a value of 1) and if the division code DIV was judged to be less than "BH". If the terminal ZC2 has a
30 value of 0, the position code POS is set to "0" by judging that the lens is in the position between the wide extremity and the lock position. On the other hand, if the indication change is permitted because flag FKPLCD is set to 0, the subroutine changes the focal length indication that is
35 displayed on the LCD panel, prior to exiting the CODE CHECK

subroutine. In steps CK40 and CK41, the ZC2 terminal is set to a value of 1 and the zoom code ZCODE is compared to the predictor ZCREV to determine if they are equal to each other.

5 When they are not the same, processing returns to the MAIN operation, while when they are equal to each other, steps CK42-CK45 are performed. In these steps, new change predictors ZCFOW and ZCREV are set by subtracting 1 from the division code DIV. Then, if the value of the indication
10 flag FKPLCD is 0 (in step CK44), the new focal length of the lens is displayed, prior to exiting from the CODE CHECK subroutine. If the value of the indication flag is 1, the focal length indication step is skipped.

As mentioned above, the setting for the lock
15 position, macro position, tele extremity and wide extremity is detected by the change from OFF (1) to ON (0) of the terminals ZC0, ZC1 and ZC2. With the above arrangement, detection errors due to bad contacts between the brushes and the code plate are prevented. Thus, the situation in which
20 the zoom motor stops in a forbidden position is avoided.

《ZOOM REVERSE Operation》

Fig. 19 shows the flowchart for the ZOOM REVERSE ROTATION operation that diverges from the MAIN operation at steps MI22, MI50 and MI54. This operation is executed to
25 shift the lens to the lock position and shift the lens from the macro position to the zoom area. When the lens stops within the zoom range, a normal rotation operation takes place to prevent backlash. When the MAIN operation diverges to this operation, it is first necessary (in steps ZR1 and
30 ZR2) to clear the macro tele shift flag FMTSIFT and the macro position flag FMCRO and set them to 0, prior to rotating the zoom motor in a reverse direction at a high rate of speed.

In step ZR3, the focal length of the lens is
35 prevented from being displayed by setting the indication

keep flag FKPLCD to 1. In steps ZR4 and ZR5, the CODE CHECK subroutine (Figs. 17 and 18) is called. Then, a test is performed to determine whether the value of the position code POS is greater than "2". If it is, meaning that the lens is positioned between the tele
 5 extremity and the macro extremity, the CODE CHECK subroutine is repeated.

When the position code is determined not to be greater than "2H", meaning that the lens is between the tele
 10 extremity and the zoom area or the lens has entered the zoom area, step ZR6 is performed to determine if the lock switch LOCK is ON or OFF. When the lock switch is ON, the indication keep flag FKPLCD is cleared in step ZR7. In step ZR8-ZR13, the zoom motor is rotated in a reverse direction
 15 until the lens reaches the lock position or the lock switch is set to OFF. When it reaches the lock position, the motor is stopped. The subroutine then jumps to the beginning of the MAIN operation. This movement is shown by character "a" in Fig. 20.

When the lock switch set to OFF before the lens
 20 moves to wide extremity (due to the reverse rotation of the zoom motor), the zoom motor is reversibly rotated for a period of 70 ms (ZR15) from when the lock switch was set to OFF. The zoom lens is then rotated in a forward direction
 25 at a high rate of speed for a period of 50 ms. If the lens is in the zoom area, it is stopped (as movement shown by character "b" in Fig. 20). If the lens is between the wide extremity and the lock position after the normal rotation, the motor is kept rotating to the wide extremity and is
 30 stopped after the lens is at the wide extremity (shown by character "c" in Fig. 20). In either case, processing jumps to the head of the MAIN operation after the focal length of the lens is displayed.

On the other hand, if the lock switch has been set
 35 to OFF beforehand, processing advances from step ZR6 to step

ZR24. If the wide switch is set to ON, processing advances to a series of steps that comprise a JPWIDE operation. This operation is essentially equivalent to a ZOOM to WIDE operation (shown in Fig. 23 and which will be discussed below) without the zoom motor initially being rotated in a reverse direction at a high speed. If the wide switch is set to OFF, steps ZR25-ZR30 are performed, wherein the zoom motor is rotated in the forward direction at a high rate of speed after a delay of 50 ms has passed from the time when the lens has entered the zoom area to set the lens to the tele extremity. Then, processing jumps to the MAIN operation (as shown by character "d" in Fig. 20).

In the ZOOM REVERSE subroutine, when the reverse rotation processing is switched over from terminal "STOPWD" for the wide movement processing, to remove backlash, the motor is rotated in the forward direction for 50 ms after the motor has stopped its reverse rotation. Therefore, if the focal length indication is not prevented from being displayed, the indication of the short focal length is changed just when the lens enters the division code DIV area of the wide extremity. Then, the indication of the focal length of the lens may be shown when the lens enters the division code DIV area of the tele extremity by reversing the rotation. Such indication changes may give the photographer the impression that the shifting of the lens has malfunctioned by shifting to the tele extremity, in spite of the fact that it is supposed to switch the focal length of the wide extremity.

Therefore, the indication keep flag FKPLCD is set to temporarily prevent the focal length changes from being displayed until the time when the zoom motor stops.

<ZOOM FORWARD Operation>

Fig. 21 is the flowchart showing the ZOOM FORWARD operation. This operation moves the lens from the lock position to the wide extremity or the zoom area to the macro

position.

When the ZOOM FORWARD operation begins, lock position flag FLOCK is cleared (step ZF1) and at step ZF2, the zoom motor is caused to rotate at a high speed. The lens is then checked to ensure that it is in a position between the wide extremity and the zoom area (step ZF3, ZF4).

If the macro command flag FRQMCRO (step ZF5) is set to 0, the motor is stopped and processing jumps to the MAIN operation. These steps move the lens from the lock position to the wide extremity when the lock lever is set to its OFF position, as shown by character "e" in Fig. 20.

When the macro command flag is set to 1, steps ZF7-ZF9 are performed, in which the operation waits until the lens passes the tele extremity in the zoom area. When the lock switch is set to ON, in step ZF10, the motor is stopped (as shown by character "f" in Fig. 20). Then, the operation returns to the MAIN operation. If the lens passes the tele extremity, steps ZF11-ZF13 are performed, in which the operation waits until the macro position flag FMCRO is set to 1, at which point the motor is stopped and processing returns to the MAIN operation. Steps ZF11-ZF13 are executed when the macro button 16 is pressed and the lock lever is in the OFF position (lock switch OFF).

According to the above discussion for the ZOOM REVERSE operation and ZOOM FORWARD operation, all lens operations by the main switch 14 or the macro button 16 are performed by the zoom motor operating at a high rate of speed.

<ZOOM TO TELE Operation>

Fig. 22 shows the flowchart of the ZOOM to TELE operation that diverges from step MI42 of the MAIN operation.

This operation is executed by setting the tele switch TELE to the ON position, with the lens set to the zoom area. It is common to the above-mentioned ZOOM FORWARD operation that the lens is moved by normally rotating the zoom motor. However,

this operation is different from the above-mentioned operation in that the zooming speed can be switched between a high speed and a low speed.

When this operation starts, the zoom motor is rotated in a forward direction at a high speed before the timer for switching the zoom motor speed is reset.

If the tele switch is set to ON, the lens does not reach the tele extremity (i.e., POS does not equal "3"). Thus, with the lock switch set to OFF, the motor is rotated at a high speed for 30 ms before the rotation speed is changed to the low speed (if applicable). Otherwise, it remains in the high rotation speed, based upon the setting of the speed switch.

In the zoom area, when the tele switch TELE is set to OFF, the operation is shown by the character "g" in Fig. 20. The operation when the lens reaches the tele extremity is shown by the character "h" in Fig. 20.

At some point the lock switch may be set to ON.

When this happens, the zoom motor is stopped in step ZT11, so that control returns to the MAIN operation.

《ZOOM TO WIDE Operation》

Fig. 23 shows the flowchart of the ZOOM to WIDE Operation that diverges from step MI50 of the MAIN operation.

This operation is known as a ZOOM to WIDE operation.

This operation is executed when the lens is in the zoom area and the wide switch WIDE is set to ON. It also happens in the above mentioned ZOOM REVERSE operation that the lens is moved in a storage direction.

When the WIDE MOVEMENT operation starts, the zoom motor is rotated in a reverse direction and the timer is reset. However, if this operation is called from step ZR24 of the ZOOM REVERSE operation, these two steps are not performed.

In steps ZW3-ZW10, if the wide switch is set to ON, and the lens does not enter the position between the wide

extremity and the lock position (that is, POS does not equal "0") and the lock switch is set to OFF, the zoom motor operates at a high speed for 30 ms before it starts to rotate in the reverse direction, switching from the high or
 5 low speed, based upon the setting of the speed switch.

When the wide switch WIDE is set to OFF, and the motor rotation speed is set to the high speed in step ZW11, the operation branches to step ZR14 of the ZOOM REVERSE operation to eliminate any possible backlash that may occur.
 10 (This movement is shown by character "i" in Fig. 20).

When the wide switch WIDE is set to OFF in the zoom area and the above-mentioned 70 ms normal rotation and 50 ms reverse rotation are finished, the lens comes out of the wide extremity, as shown by character "j" in Fig. 20 and the
 15 zoom motor stops rotating.

When the lens enters the lock position from the wide extremity after the motor is set to the high speed in step ZW12, the zoom motor is rotated in a reverse direction for a period of 50 ms (steps ZW13-ZW17). Next, the lens is set to
 20 the wide extremity and the motor is stopped (the movement shown by character "k" in Fig. 20), removing backlash, before the MAIN operation is re-entered.

When the lock switch is set to ON, step ZW18 is executed, which stops the zoom motor rotation prior to
 25 returning to the MAIN operation. In this case, the operation branches from the MAIN operation to the ZOOM REVERSE operation and the lens is shifted back to the lock position.

30 < LOCK Operation >

Fig. 24 shows the flowchart for the LOCK operation that is called in step MI24 of the MAIN operation. This operation is executed when the lens is stored in the lock position, after the lock switch is switched to ON.

35 When this operation begins, number indicator LCD is lit or extinguished, according to the condition of the

loading end flag FLDEND (steps LK1-LK4), which sets the initial mode.

A programming loop, comprising steps LK5-LK13, is repeated every 125 ms until the rewind switch REW is turned to ON, the back cover switch BACK is ON and the film is not fully loaded, or the lock switch is OFF.

In step LK13, the CHARGE PROHIBITING TIME subroutine is called. This is the same subroutine called in step M173 of the MAIN operation.

10 When the rewind switch REW is set to ON, processing diverges from step LK6 to the above-mentioned REWIND operation.

When the back cover is closed and the film is loaded, steps LK9 and LK10 are skipped, while when the back cover is open, the loading end flag is cleared (step LK9) and the indication of the frame number of the film is turned OFF. In the next loop, when the back cover is closed, processing diverges from step LK7 to the above-mentioned loading routine.

20 Lastly, when the lock switch LOCK is set to OFF, the operation sets charge start flag FCHGST and the indication hold flag FWAITD to 1 (steps LK14 and LK15) prior to returning to the MAIN operation.

As has been described above, if a subject to be photographed is too far away when the camera is set to the macro mode, a release lock is effected to prohibit photographing. As soon as the shutter button is released, the lens is shifted from the macro mode to the zoom mode, permitting a photograph to be taken without manually shifting the lens.

30 <MODE SETTING Operation>

Next, a mode setting operation will be described.

In step M155 shown in Fig. 15, when FREWEND is set to "0", it goes to the mode setting operation shown in Fig. 35 25A(step M157).

In the mode setting operation, a judging operation (step M01) for judging whether FSWOFF is set to "1" is carried out. When FSWOFF is set to "0" (when whichever switch is in its ON position), FMDCHG is set to "0" (step 5 M02), then it returns to the main flow and then goes to step M158. In step M158, it is judged whether FMDCHG is set to "0". Therefore, in mode setting, when any of the mode buttons A and B and the clear button C is continuously pushed, it returns to the main flow via step M01 and step 10 M02. Also, the mode set by any of the mode buttons (mode switches) A and B and the clear button (clear switch) C which is continuously pushed is maintained. In step M158, it is judged that FMDCHG is set to "0" and then processes from step M161 toward end step are continued.

15 In step M01, when FSWOFF is set to "1" (when all switches are in OFF position), it is judged whether the mode button A is in ON position (step M03). In step M03, when the mode button A is in OFF position, it is judged whether the mode button B is in ON position (step M04). In step 20 M04, when the mode button B is in OFF position, it is judged whether the clear button C is in ON position (step M05). In step M05, when the clear button C is in OFF position, the mode change flag FMDCHG is set to "0" (step M02), and then it returns to the main flow. Therefore, when all switches, 25 i.e., photometric switch SWS, release switch SWR, wide switch WIDE, tele switch TELE, mode switches MDA and MDB, clear switch MDC, and macro switch MCRO, are in OFF position, it goes through the processes of step M03~M05 and step M02 and then returns to step M158 of the main flow.

30 Suppose it is judged, in step M05, that the clear button C is in ON position. Then, the film number display process is carried out (step M06).

In step M07, the counter memory MODEA is set to "0".

Then, in step M08, the content of MODEB is set to "0" 35 and the identification flag FBB1INT0, the display lights-out

process via flag FBIHOLD, and the display blinking flag FZML01 are set to "0" (step M09). Then it goes to step M010. In step M010, MODBLB is set to "0". Then it goes to step M011 where MODINT is set to "5". Thereafter, the 5 mode mark is displayed (step M012). Then it goes to step M013 where FMDCHG is set to "1" and then it returns to step MI58 of the main flow. The identification flag FBBINT0 is adapted to identify whether the manual shutter time is being set or the interval time is being set. The display lights-out process via flag FBIHOLD is adapted to judge whether it should go via the display lights-out process.

Therefore, when the clear button C is turned ON, the display is changed to the film number display. Also, as the counter memory MODEA is set to "0", the exposure mode 15 becomes "auto". Furthermore, as the counter memory MODEB is set to "0", the taking mode becomes "one frame taking". In addition, as the counter memory MODBLB is set to "0", the manual shutter time becomes "bulb" and as the counter memory MODINT is set to "5", the interval time becomes 60 20 seconds. When the mode is auto and one frame taking, no mode mark is displayed.

Immediately after this clear button C is pushed, the flag FMDCHG is changed from "0" to "1". Therefore, in step MI58 of the main flow, it is judged that the flag 25 FMDCHG is "1". By this, the flag FWAITED is set to "1" (step MI59), and the loop escape process (step MI60) is carried out and then it returns to the top of the main flow (step MI1). If the clear button C is continuously kept in ON position thereafter (if the clear button C is being 30 pushed), it is judged that the flag FSWOFF is set to "0" when it goes again to the mode setting process of step MI57 (step M01). Then, the flag FMDCHG is set to "0" (step M02) and it returns to step MI58 of the main flow. This time it is judged, in step MI58, that the flag FMDCHG is set to "0" 35 and then processes after step MI61 are carried out. In the

mode initializing process, the processes of step M07~M013 are also carried out.

In step M04, when the mode switch B is in ON position (when the mode button B is pushed), it is judged whether the taking mode is interval (step M014). In step M014, it is judged as YES when the counter memory MODEB is set to "5" and then it is judged whether the interval time is being displayed (step M015). When the display is not displaying the interval time, it jumps to step M021 and the flag FBB1INT0 is set to "0". In step M015, when the interval time is being displayed, or in step M014, when the mode is not interval, the content obtained by adding "1" to the preceding content of the counter memory MODEB is treated as the content this time. For example, if the preceding content of the counter memory MODEB was "2", the content of this time becomes "3" (step M016). And then the process of step M017 is carried out.

Therefore, if the mode button B is turned on when the taking mode is not interval or if the mode button B is turned on when the interval time is being displayed, the taking mode is changed.

In step M017, it is judged whether the content of the counter memory MODEB is "6" or more. This judgment of step M017 is made for changing the content of the counter memory MODEB to "0" when the content of the counter memory MODEB is "6" or more. The reason is that the taking mode corresponds to "0"~"5" of the content of the counter memory MODEB and there is no taking mode corresponding to "6" or more. That is, if the content of MODEB is "6" or more, it is judged as YES and then it goes to step M018. In step M018, the number display process is carried out, and then it goes to step M019. In step M019, the content of the counter memory MODEB is set to "0". Thereafter, the process of step M012 is carried out. Therefore, the processes of step M017~M019 mean that the taking mode is

changed to one frame taking.

In step M017, if the content of the counter memory MODEB is "5" or less, it is judged whether the mode is interval (step M020). In step M020, if it is judged that the mode is not interval, the processes of step M012 and M013 are carried out and then it returns to step M158. Therefore, the processes of M017, M020, M012 and M013 mean that the taking mode mark is changed within a range from the continuous taking mode to the multiple taking mode.

10 In step M020, if the taking mode is judged as interval, the identification flag FBB1INT0 is set to "0" (step M021). Then, it goes to step M022. In step M022, the manual shutter or interval time display process shown in Fig. 27 is carried out. In the manual shutter or interval
15 time display (see Fig. 27), first, in step B11, it is judged whether the flag FBB1INT0 is set to "0". When the mode button B is in ON position and the interval time is being set, as the flag FBB1INT0 is set to "0", the interval time is displayed (step B12) and then it goes to step M023. If
20 the mode button B is turned on when the taking mode is interval (when it is judged as YES in step M014) and the display is not displaying the interval time (when something else is being displayed), as it goes via step M014, M015, M021 and M022, the interval time is likewise displayed.

25 In step M023, the mode mark display process is carried out and the interval mark is displayed on the display, and the display blinking flag FZML01 is set to "0". Then a 0.5 second timer is started in order to perform the display blinking process (step M025). Then it goes to
30 step M034 shown in Fig. 26A. In step M034, it is judged whether the flag FBB1INT0 is set to "0". As the flag FBB1INT0 is set to "0" here, it goes to step M036. Before describing this step M036, there will be described a case where the mode button A is turned on (a case where the mode
35 button A is pushed).

When the mode button A is in ON position in step M03, it is judged whether the exposure mode is bulb or bulb & stroboscope ON (step M026). In step M026, when the exposure mode is bulb or bulb stroboscope ON, it is judged whether the display is displaying the manual shutter time (step M027). When the display is not displaying the manual shutter time in step M027, it jumps to step M033 and the flag FBB1INT0 is set to "1". When the display is displaying the manual shutter time in step M027, or when the exposure mode is not bulb or bulb stroboscope ON, the content of the counter memory MODEA is obtained by adding "1" to the preceding content of the counter memory MODEA so as to be treated as the current content of the counter memory MODEA. For example, when the content of the counter memory MODEA is "5", the current content of the counter memory becomes "6" (step M028).

Then it goes to step M029. By this, if the mode button A is turned on when the exposure mode is not bulb or bulb stroboscope ON, or when the display is displaying the manual shutter time, the exposure mode is changed.

In step M029, it is judged whether the content of the counter memory MODEA is "6" or more. This judgment of step M029 is made for changing the content of the counter memory to "0" when the content of the counter memory MODEA is "6" or more. The reason is that the taking mode corresponds to "0"~"5" of the content of the counter memory MODEA and there is no taking mode corresponding to "6" or more. That is, if the content of MODEA is "6" or more in step M029, it is judged as YES and the number display process is carried out (step M030) and then it goes to step M031.

In step M031, the content of the counter memory MODEA is set to "0". Then it goes to step M012. Therefore, the processes of step M029~M031 mean that the exposure mode is changed to auto. When the content of the

counter memory MODEA is "5" or less in step M029, it is judged whether the exposure mode is bulb or bulb stroboscope ON (step M032). When the exposure mode is not bulb or bulb & stroboscope ON in step M032, the processes of step M012 and M013 are carried out and then it returns to step M158. Therefore, the processes of step M029, M032, M012 and M013 mean that the exposure mode is changed within a range from the stroboscope ON to the exposure correction.

In step M032, when the exposure mode is bulb or bulb & stroboscope ON, the flag FBB1INT0 is set to "1" (step M033) and thereafter the manual shutter or interval time display shown in Fig. 27 is carried out in step M022. In the manual shutter or interval time display (step B1), it is judged whether the flag FBB1INT0 is "0" in step B11. When the mode button A is in the ON position and the manual shutter time is set, as the flag FBB1INT0 is set to "1", the manual shutter time is displayed (step B13) and then it returns to step M023. If the mode button A is turned ON when the exposure mode is bulb or bulb & stroboscope ON and the manual shutter time is not being displayed, as it goes via step M026, M027, M033 and M022, the manual shutter time is likewise displayed. Then, the mode mark process is carried out in step M023, and in step M024, the display blinking flag FZML01 is set to "0", 0.5 second timer is started (step M025) and then it goes to step M034 shown in Fig. 26A.

Next, processes after step M034 will be described.

Suppose that the mode button A is turned ON and the flag FBB1INT0 is set to "0" here. Then, it is judged that the flag FBB1INT0 is set to "1" in step M034 and it goes to step M035. In step M035, it is judged whether the mode button A is in the ON position. When the mode button A is in the OFF position, the blinking of the manual shutter time display is canceled (step M037). Then, the flag FMDCHG is set to "1" (step M039) and it goes to step M158 of the main flow. In step M158, as the flag FMDCHG is set to "1", the

display is continuously displaying the one second manual shutter time (see step M159, M167 and M166). Then the mode button B is turned on and when the flag FBB1INT0 is set to "0", it goes to step M036. When the mode button B is in the OFF position in step M036, the blinking of the interval time display is canceled (step M040) and then it goes to step M039. The flag FMDCHG is set to "1" in step M039 and then the process of step M158 of the main flow is carried out.

In step M158, as the flag FMDCHG is set to "1", it goes to step M159. By this, the display keeps displaying the one second interval time (see step M158, M167 and M166).

The blinking of the manual shutter time display and the blinking of the interval time will be described hereinafter.

When the mode button A is in the ON position in step M035, or when the mode button B is in the ON position in step

M036, the charging stop process is carried out (step M042).

This charging stop process is made in order to avoid the continuation of charging when it goes into the processes after step M042 during the charging. After the process of step M042 is carried out, it is judged whether the tele switch TELE is in the ON position (step M043). When the tele switch TELE is in ON position, it is judged whether the flag FBB1INT0 is set to "1" (step M056). When the tele switch TELE is in OFF position, it is judged whether the wide switch WIDE is in ON position (step M044).

When the wide switch WIDE is in OFF position in step M044, the time display blinking process shown in Fig. 28 is carried out (step M044'). In the time display blinking process, it is judged whether the 0.5 second timer is timed up in step TD1. In step TD1, when the 0.5 second timer is not timed up, it returns to M0B and the processes after step M034 are carried out. When the mode button A or the mode button B is kept pushed, it comes back again to step TD1 via step M043, M044, and M044'. When the 0.5 second timer is timed up in step TD1, the 0.5 second timer is started

again in step TD2. Then, it is judged whether the flag FZML01 is set to "0" (step TD3).

At first, as the flag FZML01 is set to "0" in step M024, the flag FZML01 is set to "1" (it goes to step TD4) and then it goes to step TD5. It is judged whether the flag FBIHOLD is set to "0" in step TD5. At first, as the flag FBIHOLD is set to "0", the display does not display the time (step TD6), and it returns again to step TD1 where the display keeps displaying no time until the 0.5 second timer is timed up. When the 0.5 second timer is timed up, it goes to step TD2 to start the 0.5 second timer again, and it goes to step TD3 where it is judged whether the flag FZML01 is set to "0". As the flag FZML01 is now set to "1" when it goes via step TD4, step TD5 and TD6, it goes to step TD7 this time. In step TD7, the flag FZML01 is set to "0" and then it goes to step TD8. In step TD8, the display displays the manual shutter or interval time. Therefore, when the mode button A or the mode button B is kept being pushed, the manual shutter or interval time is blinked at the cycle of 1Hz.

In step M044, when the wide switch WIDE is in ON position, it goes to step M045. Therefore, the time display blinking process is not carried out, and the display does not display the blinking of the manual shutter or interval time. In step M045, it is judged whether the flag FBB1INT0 is set to "1". When the flag FBB1INT0 is set to "1" in step M045, a value obtained by deducting "1" from the preceding content of the counter memory MODBLB is treated as the current content of the counter memory MODBLB (step M046). For example, when the preceding content of the counter memory MODBLB was "6", the content this time of the counter memory MODBLB becomes "5", and a limiting process of this counter memory MODBLB min. is carried out (step M047). The limiting process of this counter memory MODBLBmin is a process for setting the content of the

counter memory MODBLB to "0" when the MODBLB is less than "0". The reason is that there is no manual shutter time corresponding to those less than "0".

After the process of this step M047 is carried out, the manual shutter or interval time display process shown in Fig. 27 is carried out in step M048, and after the manual shutter or interval time display process is finished, the 300ms timer is started (step M049). It is then judged whether the wide switch WIDE is in ON position (step M050). When the wide switch WIDE is in OFF position in step M050, the flag FBHOLD is set to "1" (step M051) and the processes after step M034 are carried out. When the wide switch WIDE is in ON position in step M050, it is judged whether the speed switch-over switch ZMHL is in ON position (step M052).

By this, it is judged whether the switching of the display of the manual shutter time or interval setting time is changed step by step or the same is changed continuously.

That is, when the zoom lever is in a state corresponding to the direction where the zoom lens is moved toward the wide position at a high speed by the zoom lens lever (when the zoom lever is largely moved from the center position), it is judged whether the 300ms timer is timed up (step M053).

This loop of step M050, step M052 and step M053 is repeated until the 300ms timer is timed up. When the 300ms timer is timed up in step M053, it goes to MOD where the processes of step M044~M053 are repeated. By this, the content of the counter memory MODBLB is subtracted every 300ms. That is, the manual shutter time or interval time is continuously changed.

When the zoom lever is in a state corresponding to the direction where the zoom lens is moved toward the wide position at a low speed by the zoom lever (when the zoom lever is moved a little from the center position), the loop of step M050 and M052 is repeated until the wide switch is turned off in step M050. Therefore, although the content

of the counter memory MODBLB is changed immediately after the wide switch WIDE is brought to ON position from OFF position, the content of the counter memory MODBLB is not changed thereafter. Therefore, if the zoom lever 10 is lightly operated to repeat on and off of the wide switch WIDE while keep pushing the mode button A or mode button B, the manual shutter time is changed step by step.

In step M045, when the flag FBBINT0 is set to "0", the content of the counter memory MODINT obtained by deducting "1" from the preceding content of the counter memory MODINT is treated as the current content (step M054). Then, the limit process of the MODINTmin is carried out in step M055. This limit process of MODINTmin is a process for setting the content of the counter memory MODINT to "0" when the content of the counter memory MODINT is "0" or less. The reason is that there is no interval time corresponding to "0" or less, and the processes of step M048~M053 are continuously carried out. Regarding the deduction process of the interval time, as it is carried out in the same manner as the deduction process of the manual shutter time, the detail thereof will be omitted.

When the mode button A or the mode button B is kept pushed to change the manual shutter time or interval time and the wide switch WIDE is turned off, the flag FBIHOLD is set to "1" (step M051) and as long as the mode button A or the mode button B is turned off, the processes of step M043, M044 and M044' are continued and it reaches the time display blinking process, and as it is judged that the flag FBIHOLD is set to "1" in step TD5, it goes to step TD9. Therefore, immediately after a desired manual shutter or interval time is finally obtained, the finally obtained manual shutter time or interval time is kept displaying on the display for a predetermined time. That is, the display does not display the blinking of the manual shutter or interval time immediately. If the mode

button A or the mode button B is kept pushed thereafter, the display displays the blinking of the manual shutter time or the interval time. In step TD9, the flag FBIHOLD is set to "0".

5 In step M043, when the tele switch TELE is in the ON position, it goes to step M056. When the flag FBB1INT0 is set to "1", an adding process is carried out such that the value obtained by adding "1" to the preceding content of the counter memory MODBLB is treated as the current content
10 of the counter memory (step M057). After the limit setting process of the MODBLBmax is carried out (step M058), it goes to the manual shutter or interval time display to display the manual shutter or interval time, and thereafter, it goes to step M060 to start the 300ms timer
15 and then it goes to step M061 to judge whether the tele switch TELE is in ON position. When the tele switch TELE is in ON position in step M061, it goes to step M063 to judge whether the velocity switch-over switch ZMHL is in ON position. When the zoom lever is in a state corresponding
20 to the direction where the zoom lens is moved toward the tele position at a low speed by the zoom lever (when the zoom lever is moved a little from the center position), the loop of step M061 and step M063 is repeated. When the zoom
25 lever is in a state corresponding to the direction where the zoom lens is moved toward the tele position at a high speed by the zoom lever, it goes to step M064 to judge whether the 300ms timer is timed up. The processes of step M061~M064 are repeated until the 300ms timer is timed up. When the
30 300ms timer is timed up in step M064, the loop after step M043 and M056 is repeated via MOC. As the process when the tele switch TELE is in ON position is the same to the process when the wide switch WIDE is in ON position only except that the manual shutter or interval time is subjected
35 to a reduction process when the wide switch WIDE is in ON

position but the same is subjected to an addition process when the tele switch TELE is in ON position, the detailed description thereof will be omitted.

《AEAF(AUTO EXPOSURE AND AUTO FOCUS) CONTROL Operation》

- 5 Figs. 29 to 31 show the flowchart for the AEAF CONTROL Operation that diverges from the MAIN Operation at step M165.

This operation is executed when the photometric switch SWS changes from OFF to ON, and a combination of the modes is correct. Also, this operation is executed from a terminal of AEAF CONTROL 2 after the operation temporarily diverges a CHARGE operation during this operation, from terminal of AEAF CONTROL 3 after winding in continuous photographing mode.

- 15 In steps AF1 to AF3, when the operation diverges from a midway of AEAF CONTROL Operation to CHARGE operation and then returns again to this operation, as the photometry operation and the distance measurement operation are already finished as will be described hereinafter, AEAF jump flag FAEAF is represented by 1 in order to jump these operations and the flag for else is represented by 0.

When the operation diverges from the MAIN Operation, the operation checks the state of the auto release flag FAUTOREL in the steps AF4 and AF5, and if the auto release flag FAUTOREL is 0, the focal length is displayed. This flag is set to 1 at the time when the second shooting downward in interval mode or the second shooting in double self mode are executed. In these cases, the photographing is automatically executed even if the photometric switch SWS and the release switch SWR are in OFF position.

The voltage checking operation in the step AF6 is a procedure for measuring the charged voltage of a strobe condenser. When the voltage is 270V or more, 270V charged flag FFCN270 is represented by 1, and DGV is set by dividing the voltage into three stages with reference to 315V and

285V. The strobe condenser is full charge at voltage 330V, and the guide number of the strobe is determined in accordance with a full charge condition. On the other hand, this camera is controlled such that the strobe is omitted
 5 with 270V or more even if the condenser is not fully charged.

Therefore, when the voltage does not reach 315V, it is necessary to catch the lowering of the guide number because otherwise the exposure becomes under. DGV is a parameter indicating the lowering of the guide number due to a
 10 fall of the strobe charged voltage. DGV is set to 0/4 at 315V or more, 1/4 at 285V~315V and 2/4 at 285V or less.

In step AF7, the charge request flag FCHGRQ which is established through FM calculation as will be described hereinafter is set to 0.

15 Step AF8, AF9 are performed to determine conditions of the FAUTOREL flag and FAEAF flag. When both FAUTOREL flag and FAEAF flag are 0, steps AF10 and AF11 are executed.

This condition means not an interval mode or a second shooting of double self timer mode, and AEAF CONTROL
 20 Operation is diverged from the MAIN Operation or the WIND operation. In step AF10, the distance measurement data is input from the sub CPU, and the LENS LATCH (LL) CALCULATION subroutine (see Fig. 32) is executed (step AF11). The LL CALCULATION subroutine is an operation which determines a
 25 moving amount of the taking lens to focus the taking lens according to the distance measurement data.

When at least one of these flags is 1, steps AF10, AF11 are skipped. This condition means an interval mode or a second shooting of the double self timer mode.

30 In this condition, LL data which were obtained in the preceding LL CALCULATION subroutine are directly used. Therefore when the interval photographing is executed, the state of focus is the same as the first shooting. When the interval photographing is executed, the photographer is
 35 usually away from the camera. For example, when a slightly

moving object is taken, if the distance measurement is performed every time the photographing operation is performed, it becomes out-focus when the object is moved away from the center of the screen. The reason is that the
 5 auto-focus is executed by measuring a distance to the object positioned in the center of the screen.

In step AF12~ AF16, all procedures relating to photometry are carried out excepting a case where the routine comes back to AEAF operation from a temporarily
 10 diverged CHARGE operation. In step AF13, the DX code of the film that is set into the camera is input and converted to sensitivity information Sv.

Then the division code DIV is alpha-converted in step AF14 for use in an FM (FLASHMATIC) CALCULATION subroutine
 15 below, wherein the alpha value comprises an amount of variation in Full-Open Aperture F-number of the zoom lens positioned at the specified focal length position, with respect to the Full-Open Aperture F-number of the zoom lens positioned at the WIDE extremity.

20 In step AF15, photometry data is obtained from sub CPU, while in step AF16, an AE (AUTO EXPOSURE) CALCULATION subroutine (see Fig. 33) is called and AE data is calculated.

In Step AF17, FM(FLASHMATIC) CALCULATION subroutine shown in Fig. 34 is called and the FM data is set. When
 25 the routine comes back to this operation from the temporarily diverted CHARGE operation, AE CALCULATION subroutine is skipped. However, as there is a possibility that DGV is changed due to charging, the FM CALCULATION is executed again.

30 After the FM CALCULATION subroutine exits, step AF18 is executed to decide the state of the release lock with reference to the FRLOCK flag. If flag FRLOCK is set to 1, steps AF19-21 is executed. The release lock is set in such cases as that the lens is located in the zoom area and the
 35 object is too near and that the lens is located in a macro-

position and the object is too far. In these cases, as it is difficult to obtain a well-focused photograph, the green lamp is blinked to give a warning to that effect in step AF19~AF21. After the photometric switch SWS turns OFF, the red lamp and the green lamp are made OFF to move the processing to MAIN Operation.

In step AF18, when flag FRLOCK is set to 0, a determination is made as to whether processing is diverged for CHARGE Operation. In step AF22-AF24, when the charge voltage of the strobe condenser does not reach a predetermined value and therefore a charge is demanded, the routine is diverged to the CHARGE Operation of Fig. 35 under the conditions that the mode is not interval mode or even if the mode is the interval mode, the photographing operation is for the first shooting. That is, in the second shooting downward of the interval photographing, even when the charge voltage does not reach the predetermined value, the strobe is emitted by only the charged voltage and the following release sequence is executed.

In INTERVAL CONTROL Operation, as is shown in Fig. 38, a charge control is effected every time one shooting is made. The reason is that when the charge voltage does not reach the predetermined voltage in this control operation, the voltage is not be increased even if the charge control is executed again.

In steps AF25-AF27, the lens latch (LL) data is output to the sub CPU, automatic exposure (AE) data for the shutter control is supplied to the sub CPU and flashmatic (FM) data to be used for the strobe emission timing is provided to the sub CPU.

When flag FAUTOREL is set to 1 (automatic taking mode), judgment of lamp indication and status of the photometric switch and release switch are skipped, and processing jumps to a terminal AFA in Fig. 30. When flag FAUTOREL is set to 0 (normal taking mode), in the case the

strobe is emitted based on FM data in steps AF29 and AF30, the red lamp is lit up and the process is moved to a terminal AFB of Fig. 30.

Afterwards, step AF31 is performed to determine whether the green lamp indicator should blink or be continuously turned on with reference to flag FGLMPFL which is set in the LL CALCULATION subroutine. If flag FGLMPFL is set to 0, the green lamp indicator is continuously turned on (step AF32). Otherwise, the green lamp D blinks (step AF33).

The lighting of the green lamp means allowance of photographing, while the blinking thereof means a warning.

In steps AF34 and AF35, the release switch SWR is waited to be turned ON under the condition that the photometric switch SWS is kept in an ON position, and when the SWS is turned OFF, that is, when the finger is removed from the shutter button, the red lamp and green lamp are switched off in step AF43a and the control operation is returned to the MAIN Operation. When the release switch SWR is turned ON, the control operation is moved to step AF36.

In steps AF36~AF43, three second timer is started when the first shooting of the interval photographing is made. Similarly, ten second timer is started when the first shooting is made in self timer mode, or double self timer mode, and five second timer is started when the second shooting is made in double self timer mode. In the case of the second shooting downward of the interval photographing, as the timer is operated in accordance with the content of MODEB as mentioned above, it directly goes to the time count operation of step AF44 downward. When the mode is neither the interval mode nor the self timer mode, it jumps to a terminal AFC of Fig. 31.

Steps AF44~AF54 constitute a loop for waiting the above-mentioned timer to be timed up. Besides the time-up, the operation can escape from the loop by means of

operation of a mode button. In this case, the red, green lamp and the self timer lamp are switched off in steps AF55 and AF56 and the auto release flag FAUTOREL is cleared. After calling the MODE INITIALIZATION operation of Fig. 25 (step 5 AF56), it jumps to the MAIN Operation. In the second shooting downward of the interval mode, the remaining time of the timer is displayed.

Also, when the remaining time of the timer becomes three seconds or less, the self timer lamp is blinked at 4Hz.

10 When time is up, in the case of self timer, it directly goes to the terminal AFC of Fig. 31 and in the case of double self timer, it goes to the terminal AFC of Fig. 31 after the flag FAUTOREL is inverted in AF59. In the case of double self timer, the flag FAUTOREL is set from 0 to 1 when the first shooting is
15 made and returned from 1 to 0 when the second shooting is made and then automatic photographing is released.

In the case of interval mode, the interval time established in steps AF60~AF64 is set in the timer, and the maximum value of the number of taking frames is set to 40
20 frames when the first shooting is made and the auto release flag FAUTOREL is set to 1 in order to automatically execute the second shooting downward. When the second shooting downward is made, the remaining time display is set to "0" and then it goes to the terminal AFC of Fig. 31. The
25 procedure of step AF64 is made in order to avoid that the display returns to numerical figures other than 0 owing to time up.

In steps AF65~AF67, the lamps are all put off before the exposure is executed and the shutter start signal
30 is output to a sub CPU. In steps AF68 and AF69, date exposure is prohibited when multiple photographing is effected.

If the mode is not the bulb mode, the operation is diverged from step AF70 and the input of a shutter operation
35 finish signal from the sub CPU is confirmed in step AF71,

and then it goes to the WIND Operation of Fig. 37.

When the mode is the bulb mode, the input of the shutter start signal from the sub CPU is confirmed in step AF72 and it is judged whether the photographing is the bulb exposure photographing or the manual shutter photographing in step AF37. If it is the bulb exposure photographing, it is waited in steps AF74 and AF75 that the finger is removed from the shutter button and both photometric switch SWS and release switch SWR are turned OFF and then, a shutter close signal is output in step AF76. If it is the manual shutter, the MANUAL SHUTTER TIME COUNT subroutine of Fig. 36 is called in step AF77 and a shutter operation end signal is output after the counting operation is finished.

《LL(LENS LATCH) CALCULATION subroutine》

Fig. 32 shows a flowchart of the LL CALCULATION subroutine that is called from AEAFF CONTROL Operation at step AF11.

In the LL CALCULATION subroutine, AF data (distance-measurement-information) is converted to the distance measurement step in step LL1 with reference to TABLE 4. Then, a limit processing, which limits the range for the distance measurement step between "1 and 20" is performed. In step LL2, flag FGLMPFL, which judges if the green lamp indicator D should blink, is set to 0. Flag FMTSIFT, which is the flag to judge if the taking lens should be shifted from the macro extremity to the tele extremity, is set to 0.

When flag FGLMPFL equals 1, the green lamp indicator D blinks. Flag FRLOCK equalling 1 means to apply the release lock. Having flag FMTSIFT equal to 1 means the operation of the lens should shift from the macro extremity to the tele extremity.

Then, step LL3 is executed to set a temporary lens latch LL value equal to the distance measurement step value so that the number of the lens latch steps corresponding to the distance measurement steps can be obtained.

In step LL4, a determination is made as to whether the distance measurement step equals "1". When the distance measurement equals "1", step LL5 is performed to determine if the macro switch MCRO is ON. When the distance measurement step is equal to "1" and macro switch is ON, flags FRLOCK, FGLMPFL and FMTSIFT are set to 1 (steps LL6-LL8) before the LL CALCULATION subroutine exits and returns to step AF12 of the AEAFC CONTROL Operation. In this condition, the release lock is applied, even if the shutter button is pressed. When photometric switch SWS is ON by pressing the shutter button 15, the lens is shifted from the macro extremity to the tele extremity. Then, processing returns to the AEAFC CONTROL Operation.

When the distance measurement step is not equal "1" or macro switch MCRO is OFF even if the distance measurement step is equal "1", step LL9 is performed to determine whether the distance measurement step is more than "19".

In step LL9, when the distance measurement step is less than "19", the subroutine exits and returns to the AEAFC CONTROL Operation. In either the macro mode or the zoom mode, when the distance measurement step is more than "2" and less than "19", the processing returns to the AEAFC CONTROL Operation. Therefore, when the distance measurement step is "1" and the zoom mode is set, the release lock is not applied.

When the distance measurement step is more than "19", steps LL10 and LL11 are executed to set flag FGLMPFL to 1 and the lens latch (LL) step to "18". Because only eighteen steps (from "1" to "18") are provided with the lens latch steps. Step LL12 is performed to determine whether the macro switch MCRO is ON. If the result of the test is affirmative, the subroutine quits and processing returns to the point in the AEAFC CONTROL Operation from which the LL CALCULATION subroutine was called. This is because it is desirable to permit a photograph to be taken, even when a

subject is too close for an in-focus picture. However, as flag FGLMPFL has been set to 1, the green lamp indicator D will blink to alert the photographer of this condition.

If the macro switch MCRO is OFF (step LL12), a test is
 5 made of the distance measurement step to determine if it is greater than "20" (step LL13). If it is less than "20", processing returns to the ABAF CONTROL Operation. Hence, when the distance measurement step is "19" in the zoom mode, the green lamp indicator D blinks to warn the operator to
 10 switch to the macro mode. However, photographing can be performed by pressing shutter button 15.

In step LL14, when the distance measurement step is more than "20", flag FRLOCK is set to 1 before processing returns to the ABAF CONTROL Operation. When the distance
 15 measurement step is more than "20", an in-focus photograph cannot be obtained, even if the photograph is taken in the zoom mode. Therefore, the camera is programmed to prevent the taking of such a picture, even if the shutter button is pressed. Accordingly, when the subroutine executes steps
 20 LL13 and LL14, the release lock is applied, and the green lamp indicator D blinks. When the LL CALCULATION subroutine is completed, processing returns to the ABAF CONTROL subroutine to perform step AFG.

In the normal photographing mode (zoom mode) though
 25 release lock is applied, the operator can take a picture if the macro switch is set to ON. However, in the macro mode, if the release lock will be applied, the operator can not take a picture in any way. It is desirable to permit a photograph to be taken under the above condition if the operator wishes to photograph.
 30 Therefore, when the macro switch MCRO is set to ON, release lock is not applied even when a subject is too close for an in-focus picture.

TABLE 4

5 STEP	CHANGING DISTANCE		ZOOM		MACRO	
	ZOOM	MACRO	LENS LATCH	FOCUS POINT	LENS LATCH	FOCUS POINT
1			1	10.00m	ROCK	WARNING
	6.00m	1.00m				
2			2	5.10m	2	0.97m
10	4.50m	0.94m				
3			3		3	
16			16		16	
	1.12m	0.64m				
15			17	1.09m	17	0.63m
17	1.06m	0.62m				
18			18	1.03m	18	0.61m
	1.00m	0.60m				
19			18	1.03m	18	0.61m
20	0.90m	0.58m		(WARNING)		(WARNING)
20			LOCK		18	0.61m
	0.50m	0.40m				(WARNING)

《AE (AUTO EXPOSURE) CALCULATION subroutine》

Fig. 33 shows AE CALCULATION subroutine called in 25 step AF16 of ABAF CONTROL Operation.

This operation is a procedure for establishing an AE data to be output to the sub CPU.

In steps AE1~AE4, the exposure mode shown in Fig. 8 is determined. If it is an establishment including a 30 bulb, the bulb is established to AE data in step AE5 and then it returns to ABAF CONTROL Operation.

If it is a mode other than the bulb mode, the upper limit and the lower limit of the photometry value are limited in steps AE6 and AE7 and in steps AE8~AE10, when 35 the photometry value Bv is equal to the lower value limit,

the photometry value lower limit flag FBVMIN is set to 1 and if not equal, it is set to zero.

In step AE11, the exposure value Evs is calculated from a film sensitivity information Sv, a photometry data Bv, and a correction value α of Full-Open Aperture F-number according to the change of the focal length from the WIDE extremity.

In steps AE12 and AE13, when in exposure correction mode, correction is made in order to obtain a bright exposure by deducting 1.5 from the calculated exposure value Evs.

As described in the foregoing, as the interval photographing is usually effected in the state where the camera is fixed to a tripod, etc., there is no fear of hand shake even if a slower shutter than that of a normal taking mode is effective.

Therefore, in steps AE14~AE17, the lower limit exposure value Evsmin is set to 6.0 when the exposure mode is other than auto mode, or when the exposure mode is auto and the taking mode is the interval. Similarly, the value Evsmin is set to 9.0 when the exposure mode is auto and the taking mode is other than the interval mode.

When the exposure mode is auto mode, if the exposure value Evs is smaller than the exposure lower limit value Evsmin in step AE18~AE21, or the photometric value is limited at its lowest limit, the automatic strobe emission flag FAUTOSTB is set to 1 so as to emit the strobe light.

Accordingly, if it is not established to be the interval mode, the lower limit of the shutter speed is lowered automatically and the chance for emitting the strobe becomes small.

In steps AE22~AE24, the upper and lower limits of the exposure value Evs are limited and the same is returned to ABAF CONTROL Operation by serving the same as AE data.

35 <FM (FLASHMATIC) CALCULATION Subroutine>

Fig. 34 shows FM CALCULATION subroutine called in step AF17 of AEAFF CONTROL Operation.

This operation is to decide the emission or non emission of the strobe and the aperture value Avs when the strobe is emitted.

In steps FM1~FM5, the exposure mode returns the FM data to the AEAFF CONTROL Operation as "strobe no emission" when in strobe OFF mode, exposure compensation mode, and bulb mode, or when in auto mode and the flag FAUTOSTB is set to 0 in the AE CALCULATION subroutine.

In other cases than the above, the aperture value Avs is found from the distance measurement data and the reference guide number in step FM6 and then the aperture value Avs is corrected in view of the information of charged voltage DGV in step FM7. The reason is that as the guide number is established with reference to the full charge time of the strobe condenser, unless the guide number is lowered when the exposure is low, the exposure becomes under.

In step FM8, the aperture value Avs is added with a film sensitivity information Sv and in steps FM9 and FM10, the changing amount ZGDV caused by zooming of the strobe itself is added when it is in the zoom area. The reason is that a light projecting angle of the strobe is changed according to the angle of view which is changed by zooming of the taking lens.

Furthermore, in FM11, the changing amount α of the Full-open Aperture F-number based on the focal length of the lens is deducted from the aperture value Avs.

In steps FM12~FM14, the upper limit and the lower limit of the aperture value Avs are limited and the charge request flag FCHGRQ is set to 1 based on the result of the voltage check operation called in step AF6 of the AEAFF CONTROL Operation when the voltage of the strobe condenser is 270V or less and then returned (steps FM15, FM16).

《CHARGE OPERATION》

Fig. 35 shows the charging operation diverged from stops AF23 and AF24 of the AEAFF CONTROL Operation.

Steps CH1~CH9 are a loop for repeatedly executing the charging control of step CH6 at a cycle of 125ms. The operation can escape from the loop when it is determined to be time-up or to be charged voltage of 280V or more from the charge time up flag FCHTUP and 280V charged flag FCH280 erected during the charge control operation in step CH6.

10 In the case of an automatic photographing in an interval mode, etc., it can escape to step CH10 by turning on a selected one of the mode switches (mode button A, mode button B and clear button C), and when the mode is not an automatic photographing, it can be escaped when the
15 finger is removed from the shutter button.

Even when the charged voltage does not reach 280V within a predetermined time and it becomes time-up, it can escape from the charging operation. In the case of such an escape, the red and green lamps are switched off in steps CH10 -
20 CH12 and a charging stop operation is effected. After releasing the automatic photographing, it jumps to the MAIN Operation.

When the charged voltage reaches 280V before it is timed up, it goes to steps CH14~CH16 via step CH13 where
25 the red lamp is lighted when the mode is not the automatic photographing mode so as to indicate that preparation for emission is over, and after the charge request flag FCHGRQ is cleared, processing jumps to the AEAFF control 2. When it enters to the AEAFF control 2 from this operation, as
30 described above, the photometry, distance measurement, etc. are omitted and calculation is effected using the preceding data.

The voltage checking at the time when the charging is underway is effected with reference to 280V and the
35 voltage checking after the charging operation is effected is with

reference to 270V. The reason is that a voltage drop due to the stop of the charging operation, noise, etc. is taken into consideration.

《MANUAL SHUTTER TIME COUNT subroutine》

5 Fig. 36 shows the MANUAL SHUTTER TIME COUNT subroutine called in step AF77 of the AEAF CONTROL Operation.

When the manual shutter is established, the shutter speed can be changed in accordance with the correlation of Table 2. At this time, as the aperture is controlled in
10 such a manner as to be fully opened, the exposure is decided by the shutter speed and the Full-open Aperture F-number.

However, the established shutter speed is decided with reference to the Full-open Aperture F-number when the taking lens is set to the WIDE extremity, and when the focal
15 length of the lens is changed, the same exposure cannot be obtained at the same shutter speed.

In view of the above, therefore, in this camera, the shutter speed, which has been established with reference to the WIDE extremity is controlled such that the shutter
20 speed is established again in accordance with the focal length of the lens in order to obtain the same exposure.

The correlation of the re-establishment is as shown in Fig. 5. In the Table, α denotes the changing amount of the Full-open Aperture F-number, and D1 denotes the content
25 $n(1\sim 7)$ of the MODBLB, and D2 denotes the display on the LCD panel.

TABLE 5

			UNIT : SECOND						
			WIDE ←	α			→ TELE/MACRO		
D1	D2		1/4	2/4	3/4	4/4	5/4	6/4	7/4
5	1	1	1	1.25	1.5	1.75	2	2.25	2.5
	2	2	2	2.5	3	3.5	4	4.5	5
	3	4	4	5	6	7	8	9	10
	4	8	8	10	12	14	16	18	20
	5	15	16	20	24	28	32	36	40
10	6	30	32	40	48	56	64	72	80
	7	60	64	80	96	112	128	144	160

The shutter speed shown in Table 5 is decided in accordance with the following relation.

$$\text{shutter speed} = 0.25 \times 2(n-1) \times (4\alpha + 3)$$

15 and the flowchart of Fig. 36 counts this shutter speed.

In Fig. 36, steps MS1~MS5 are a procedure for finding $2(n-1)$ and putting the same into T_n , and a product of T_n found by this and $T\alpha$ found in step MS6 is found in 20 step MS7, and this value is set in the counter MTCNT.

Steps MS8~MS10 are a loop for deducting the value of the counter MTCNT at a cycle of 250ms. By counting until it becomes MTCNT=0, the shutter speed decided by the above relation can be counted.

25 In this way, as the shutter speed is re-established such that the exposure value becomes constant even if the focal length is changed, it is not necessary to establish the shutter speed every time the focal length is changed.

<WIND OPERATION>

30 Fig. 37 shows a wind operation to which it goes after AEAFF CONTROL Operation is finished.

The wind operation is a procedure for winding the film by one frame after the photographing operation is finished. When it enters into the WIND operation, the 35 frame number is displayed on the LCD panel excluding the

interval mode in steps WD1 and WD2. In the case of a multiple photographing operation, the operation is diverged from step WD3 to step WD4 where the taking mode is returned to one frame taking mode, and then it jumps to the MAIN
5 Operation. That is, the multiple photographing operation is cleared for each shooting.

When the taking mode is other than the multiple photographing mode, one frame is wound in step WD5. If the winding operation is not finished within a predetermined
10 time, it is diverged from step WD6 to step WD7 where the auto release flag FAUTOREL is cleared and then it goes to the REWIND operation as described above.

When the winding operation is finished, the frame number counter is counted up in step WD8, and the new number is
15 displayed in steps WD9 and WD10 when the mode is not the interval mode. In this way, the frame number is not displayed when the mode is the interval mode because a remaining time available until releasing operation is displayed during the interval photographing operation as
20 will be described hereinafter.

In steps WD11 - WD15, a diverging destination after the winding operation is decided in accordance with the established photographing mode.

When in a continuous photographing mode, if the
25 shutter button is kept pushed, it jumps to AEAF control 3 of Fig. 29 to continue the sequence of exposure and if the shutter button is not being pushed, it jumps to the MAIN Operation.

Next, when in double self mode, it jumps again to
30 the AEAF control at the time point when the first shooting is finished, and it jumps to the MAIN Operation when the second shooting is finished.

When in interval mode, it jumps to INTERVAL CONTROL Operation of Fig. 38, and it jumps to the MAIN Operation
35 when in any other mode, that is, when in the frame shooting mode

or self timer mode.

< INTERVAL CONTROL Operation >

Fig. 38 shows INTERVAL CONTROL Operation to which it moves from step WD15 of the above-mentioned WIDE
5 Operation. This operation is a procedure for waiting while counting the time till the second shooting downward when the photographing mode is set in INTERVAL mode. When in any mode other than INTERVAL, the operation is usually looped within MAIN Operation. When in INTERVAL mode, however, it
10 is looped between AEAFC CONTROL Operation and INTERVAL CONTROL Operation without going through the MAIN Operation.

When it enters into this operation, both charge request FCHGRQ and charge request memory flag FCHGRQM are cleared in step IN1.

15 In steps IN2 and IN3, it deducts the INTERVAL number and determines whether the same becomes 0. The initial value of this counting is 40 as set in step AF62 of AEAFC CONTROL Operation. When the 40 frames taking is finished, it executes the charge stop operation and the auto release flag
20 FAUTOREL is cleared in step IN4~IN6, and after the MODE INITIALIZING Operation of Fig. 25 is called, it jumps to the MAIN Operation.

When the count number is not 0 frame, it loops steps IN7~IN21 at a cycle of 125ms and waits for the next
25 photographing operation. In the meantime, when either the mode switch or the clear switch is turned on, it initializes the mode and jumps to the MAIN Operation.

When in this loop, the deduction display of the timer is normally performed. However, when the photometric
30 switch SWS is turned on, the frame number is displayed, and when the wide switch of the zoom is turned on, the focal length is displayed.

When the remaining time becomes 16 seconds or less, both FCHGRQ and FCHGRQM are set to 1 in step IN18. This
35 timer is set and started in step AF60 of AEAFC CONTROL

Operation.

In CHARGE CONTROL operation in step IN20, the charging operation is effected when FCHGRQ is 1 and skipped when it is 0. This flag is cleared when the charging operation is finished.

Therefore, when it circles around the loop of step IN17~IN20, the charging operation is forcefully started in the first loop. When a sufficient charge is detected here, the charging operation is stopped and the CHARGE CONTROL Operation is skipped from the next loop.

When the remaining time becomes less than 4 seconds, it diverges from step IN19 and the charging operation is stopped and the remaining time of the timer is displayed in steps IN22 and IN23, and then it jumps to ABAF CONTROL Operation of Fig. 29 and waits for the time-up in steps AF44~AF54 of this procedure.

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CLAIMS

1. An automatic exposure control system for a camera having a plurality of taking modes including an interval mode and a normal mode, said system comprising:-

means for selecting between the plurality of taking modes;

means for setting a threshold value of an exposure value;

means for causing strobe emission as a function of said exposure value in relation to said threshold value; and

changing means changing a setting of said threshold value in response to the interval mode being selected by said selecting means, wherein said set threshold value in the interval mode is lower than when said normal mode is selected.

2. A system as claimed in claim 1 wherein said plurality of taking modes includes a normal mode wherein when said normal mode is selected, said means for causing strobe emission causes a strobe emission in response to the exposure value being lower than another threshold value which is higher than said first mentioned threshold value.

3. A system as claimed in claim 2 wherein said threshold value comprises an exposure value which in the normal mode is equal to 9.0 and said threshold value in the internal mode is equal to 6.0.

4. A system as claimed in any preceding claim further comprising means for determining a shutter speed and an aperture value with reference to a detected exposure value E_v when said detected exposure value E_v is higher than said threshold value.

5. A system as claimed in claim 4 further comprising means for resetting the aperture value with reference to distance measurement data and guide number of the strobe when said detected exposure value E_v is lower than said threshold value.

6. A system as claimed in claim 5 wherein said resetting means uses



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said distance measurement data, said guide number of the strobe and a lowering of said guide number according to a lowering of a supply voltage as a parameter.

7. An automatic exposure control system for a camera having a plurality of taking modes including an interval mode, substantially as herein described with reference to the accompanying drawings.
