

EXPOSURE CONTROL APPARATUS

The present invention relates to an exposure control apparatus for a camera associated with a strobe.

Conventionally, the charged voltage of a main capacitor in a strobe circuit is checked to see whether it reaches a predetermined level according to which flash permission or an indication thereof is given.

In the case of only one predetermined level being set, strobe flashing cannot be accurately controlled according to the present charged voltage.

On the other hand, in the case of a plurality of levels being set, arrangements become necessary to divide the charged voltage, to A/D convert and to check whether the charged voltage has reached each level.

Thus, the circuit size becomes large and the circuit becomes complicated resulting in increased costs.

Furthermore, as the amount of current which flows in present cameras has recently been increased because the performance of batteries used therein have been improved, there is a tendency that the charging time of a strobe is

shortened. Thus, the strobe can be frequently flashed and thereby the amount of heat generated due to charging also increases.

If the circuit is heated with the generated heat, paraffin which secures a winding of a boosting transformer may melt and thereby the circuit may be damaged. In addition, the winding itself or transistors may also be damaged by heat.

To prevent the circuits from being unduly heated, large capacity transistors or large capacity transformers can be effectively used. However, in small cameras such as lens shutter type ones, the circuits should be of compact form so it is preferable not to use large capacity transistors and transformers.

According to the present invention there is provided an exposure control apparatus comprising:-

detecting means for measuring the time width of a pulse the time width of the pulse being variable in relation to a charged voltage for application to a strobe; and

determination means for determining a said charged voltage on the basis of the measured time width of the pulse corresponding thereto and on the basis of a reference time width, the determination means determining a proper

exposure value according to the determined charged voltage;
wherein the reference time width comprises a measured
time width of a pulse corresponding to a reference voltage.

In a preferred embodiment, the reference time width
comprises an average of measured time widths of pulses
corresponding to the reference voltage.

Conveniently, a newly measured time width
corresponding to the reference voltage is added to form a
weighted average reference time width.

In one embodiment, in determining said proper exposure
value said determination means selects one of a plurality
of exposure correction values on the basis of said
determined charged voltage.

In a particular case, said determination means selects
one of a plurality of voltage bands according to said
determined charged voltage, each said voltage band being
allocated a said exposure correction value.

Preferably, said determination means selects one of
said voltage bands on the basis of whether the measured
time width is greater than one half said reference time
width plus a band dependent time constant.

Three exposure correction values may be provided.

It is preferred that said correction value is zero for a determined charged voltage equalling the maximum charged voltage for application to the strobe.

Conveniently, said correction value is related to the flash guide number.

The reference voltage may be a flash enable voltage for said strobe.

Reference is made to the following patent applications:-

Parent patent application number GB-A-2 230 663 from which the present application has been divided. This application concerns an apparatus for controlling a strobe whereby charging of the strobe is prohibited if a charge prohibit time has not elapsed after charging has been once completed, the charge prohibit time being changed according to the heat condition of said strobe.

Co-pending divisional patent application number
(Serial No. 2269676)
9317682.4, which concerns an apparatus for monitoring a charged voltage for application to a strobe wherein a pulse generating means generates a pulse having a time width

which is variable in relation to the charged voltage, and a detecting means measures the time width of the pulse to detect the charged voltage.

Examples of the present invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is an external top view of a camera, to which the apparatus embodying the present invention is applied;

Fig. 2 is a front view of the camera of Fig. 1;

Fig. 3 is a rear view of the camera of Fig. 1;

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

Fig. 5 is a circuit diagram of the strobe and the adjacent section;

Fig. 6 is a timing chart showing a voltage check processing; and

Fig. 7 is a chart showing the relation between

RLS pulse time periods and voltages.

Fig. 8 to Fig. 29 are flow charts showing functions of the camera which is equipped with an apparatus embodying the present invention.

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Fig. 8 is a flow chart showing a reset processing;

Figs. 9, 11, 12 and 13 are flow charts showing a main processing;

10 Fig. 10 is a flow chart showing a loop exit processing;

Fig. 14 is a flow chart showing a charge control processing (including a stop processing);

15 Fig. 15 is a flow chart showing a charge prohibiting processing;

Fig. 16 is a flow chart showing an RLS pulse time measurement processing;

Fig. 17 is a flow chart showing a time out check processing;

20 Fig. 18 is a flow chart showing a charge prohibition time processing;

Fig. 19 is a flow chart showing a lock processing;

25 Figs. 20, 21 and 22 are flow charts showing an AEAF control processing;

Fig. 23 is a flow chart showing a voltage check processing;

Fig. 24 is a flow chart showing an FM calculation processing;

5 Fig. 25 is a flow chart showing a release wait charging processing;

Fig. 26 is a flow chart showing a wind processing; and

10 Fig. 27 is a flow chart showing an interval control processing.

Illustrated in Figs. 1 through 3 is a camera which
15 employs an apparatus embodying the present invention.

The camera comprises, as shown in Fig. 1, a camera body 1 which has a stationary barrel 2 and a moving barrel 3. The front of the camera body 1 contains, as
20 shown in Fig. 2, a distance measurement section 4, a finder window 5, a strobe 6, a photometric element such as a CdS, and a self-timer lamp 7. The back of the camera body 1 contains, as shown in Fig. 3, a back cover 8, an LCD indicator 9, a first mode button A, a
25 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
5 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 the
10 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 contains, as shown in Fig. 1, a power or lock lever 14, a shutter
15 button 15 and a macro button 16. The power lever 14 is slidable between power-ON and power-OFF positions.

The zoom lever 10 can be moved in a first direction indicated by an arrow r1 in Fig. 1, and a second direction indicated by another arrow r2.

20 The movable lens barrel 3 is moved, upon operating the lock lever 14 and/or the macro button 16, among a lock position which is an accommodated state, a zoom area extending between a wide extremity where a focal length becomes 35 mm and a tele extremity where a focal
25 length becomes 70 mm; and a macro position for close-up

photograph. In the zoom area, the movable lens barrel 3 is moved, upon operating the zoom lever 10, between the wide extremity and the tele extremity.

Fig. 4 shows a control circuit configuration
5 employed in the camera described above.

This control circuit comprises a main CPU (Central Processing Unit) and a sub CPU which is connected to the main CPU via a drive IC (Integrated Circuit). The sub CPU executes shutter-related processings in
10 parallel with processings executed by the main CPU.

The main CPU performs the following functions in response to information inputted to the camera:

- (1) Control of a zoom motor and a film motor via motor drive circuits;
- 15 (2) Control of illumination and blinking of the green lamp indicator D which provides a 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
20 indication;
- (3) Control of indication on the LCD 9; and
- (4) Control of charging of a strobe circuit.

Information is inputted to the camera by the followings:

- 25 (1) Lock switch LOCK, which is set to ON when the

power lever 14 is set in its power-OFF position;

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

(3) Release switch SWR, which is set to ON when
5 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 the zoom lever 10 is displaced from a center, neutral
10 position toward the 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 toward the wide side r1;

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

(8) 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
20 lever 11 returns to its lock position; and

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

On the other hand, the sub CPU controls a distance measuring unit which comprises an Infrared LED (Light
25 Emitting Diode) and a position sensor PSD via an

autofocus IC. The sub CPU sends to the main CPU distance measurement data based upon output of the autofocus IC as well as photometric data based upon output of the photometric element CdS.

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

Fig. 5 shows the detailed construction of the strobe circuit. In this figure, the main CPU and the
10 sub CPU are integrally illustrated as a CPU.

This circuit comprises a CPU, a regulator for stabilizing supply voltage to the CPU regardless of voltage change in a battery BATT due to charging and so on, a boosting circuit for raising battery voltage in
15 response to a charge enabling signal CHEN from the CPU to start charging a main capacitor C1, a trigger circuit for illuminating a Xe (xenon) lamp in response to a trigger signal TRG from the sub CPU, and a voltage detecting circuit for detecting charged voltage in the
20 main capacitor C1 in the form of RLS pulses in response to a voltage check signal CHCK from the CPU.

The boosting circuit comprises a boosting transformer, oscillating transistors Tr1 and Tr2, resistors R1, R2 and R3, a capacitor C2, and diodes D1
25 and D2. When the charge enabling signal CHEN becomes 1.

(low level output), it starts charging. When the signal becomes H (open), it stops charging.

The voltage detecting circuit comprises a Ne (neon) lamp, a switching transistor Tr3, an RLS pulse
5 generating transistor Tr4, resistors R4 through R8, and a capacitor C3. When the voltage check signal CHCK changes from H (high level output) to L (low level output), the voltage detecting circuit generates the RLS pulses in proportion to the voltage. The Ne lamp
10 is turned ON when a voltage exceeding 270 V is applied, and a voltage around 220 V is maintained, regardless of the current value, whilst the Ne lamp is turned ON. The hysteresis of the voltage required to enable turn ON and that required to hold an ON
15 state is used for generating the RLS pulses.

How voltage is detected is hereinafter explained by referring to Fig. 6.

When the voltage check signal CHCK becomes H, the transistor Tr3 is turned ON and the capacitor C3 is
20 discharged, and simultaneously the minus side of the Ne lamp is connected to the ground side through the resistor R4 and the transistor Tr3. At this time, if the charged voltage VF is 270 V or more, the Ne lamp is turned ON after a certain delay time has passed since the
25 signal CHCK became H, and current flows through the

Ne lamp, the resistor R4 and the transistor Tr3. Thus, the voltage of the resistor R4 on the Ne lamp side becomes $V_F - V_N$, where the ON-state holding voltage V_N for the Ne lamp is subtracted from the charged voltage V_F .

Then, when the signal CHCK is turned to 1, and thereby the transistor Tr3 is turned OFF, the current which flowed from the resistor R4 to the transistor Tr3 now flows from the resistor R4 to the capacitor C3 for the time being. Consequently, the capacitor C3 is charged and the transistor Tr4 is turned ON, and thus the line RLS becomes L.

As charging of the capacitor C3 progresses, the potential on the capacitor C3 side of the resistor R4 gradually increases, and the current becomes insufficient to hold the Ne lamp in its ON-state. Thus, the Ne lamp turns OFF and the current does not flow from the resistor R4 to the capacitor C3. Consequently, the transistor Tr4 is turned OFF and the line RLS becomes H.

The turn-OFF timing of the Ne lamp is correspondingly delayed as the charged voltage V_F increases. Thus, a time T (= the PLS pulse width) during which the line RLS is L, is determined by $(V_F - V_N)$.

Thus, by detecting the pulse width T, the charged voltage VF can be detected.

Fig. 7 shows an example of the relation between the charged voltage and the RLS pulse width.

5 When the charging voltage is 270 V or less, even if the transistor Tr3 is turned ON, the Ne lamp does not turn ON and thereby the line RLS remains H.

Next, functions of the mode buttons A and B are explained below.

10 The mode button A functions to set an exposure mode. As exposure modes, 6 modes are available, i.e., an auto mode (automatic strobe emission mode), a strobe ON mode (forced strobe emission mode), a strobe OFF mode (strobe emission forbidding mode), an exposure
15 compensation mode, a bulb mode and a bulb and strobe ON mode.

For the bulb mode or the bulb and strobe ON mode, 8 types of manual shutter time are available.

The mode button B functions to set a photographing
20 mode. As photographing modes, 6 modes are available, i.e., a one-frame photographing mode, a sequential photographing mode, a self-timer photographing mode, a double self-timer photographing mode, a multiple
25 photographing mode, and an interval photographing mode.

For the interval photographing mode, 16 types of interval period are available.

The initial value of the manual shutter time is bulb, and that of the interval period is 60 sec. They
5 are set by executing a MODE INITIALIZE subroutine or by turning ON the clear button C.

Next, the programs stored in the main CPU will now be described with reference to Figs. 8 through 27.

10 ((MAIN operation))

First, a MAIN operation and associated RESET operation will be described, with reference to Figs. 8 through 13. The MAIN operation executes the basic operation of the camera. Other functions are performed
15 by branching from or being controlled by the MAIN operation according to the various conditions.

When power is turned ON, reset of the main CPU is released and the RESET operation shown in Fig. 8 starts. The main CPU initializes the camera memory and
20 inputs switch data (steps RS1 and RS2) before performing a MODE INITIALIZATION subroutine in step RS3 and a ZOOM INITIALIZATION subroutine in step RS4. A series of instructions that comprise the MAIN operation shown in Fig. 9 are then executed. The MODE
25 INITIALIZATION subroutine resets various mode settings

to initial values to set the automatic strobe emission and one-frame photographing modes.

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

5 In steps M12 through M14, the photometry switch SWS, the release switch SWR, the wide switch WIDE, the tele switch TELE, the mode switch MDA, the mode switch MDB, the clear switch MDC and the macro switch MCRO are set to OFF and a switch judgement flag FSWOFF is set to
10 1. The flag FSWOFF is set to 0 if some of the aforementioned switches is turned ON.

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

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

When the rewind switch REW is judged to be ON
25 (step M110), the MODE INITIALIZING subroutine is

performed (step MI11), a LOOP ESCAPE subroutine, shown in Fig. 10, is then executed in step MI12. This subroutine comprises two steps, of which step L01 stops charging of the strobe circuit and step L02 turns OFF the red lamp charge indication, and is called every time the processing branches from the MAIN operation to another operation.

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

When the back cover 8 is closed (turning ON the back switch BACK), step MI14 is performed to determine whether the film has finished loading. This is performed by checking the flag FLDEND. If the film has not finished loading (= the flag FLDEND is 0), the processing continues to step MI15, wherein the MODE INITIALIZATION subroutine is performed once more. Then, at step MI16, the LOOP ESCAPE subroutine is performed before diverging to a series of instructions that comprise a LOADING operation. When the LOADING operation is finished (= the flag FLDEND is 1), the processing goes

to step MI19.

Upon completion of loading, the flag FLDEND is set to 1 and the processing is advanced by jumping to the beginning of the MAIN operation.

5 When the back cover 8 is open, both FLDEND and FREWEND are reset to 0 (steps MI17 and MI18).

In steps MI19 through MI24 in Fig. 11, the processing to be executed when the lock switch LOCK is turned from OFF to ON is shown, that is when the power lever 14 is moved from the power-ON position to the power-OFF position. If the photographing lens is not in the lock position, the display changes from indicating the film frame number to indicating the focal length of the lens (step MI21). Then, the LOOP ESCAPE subroutine (step 15 MI22) is executed. Thereafter, processing diverges to a series of instructions that comprise a ZOOM REVERSE operation so that the lens is pulled back to the lock position. When the lens is already in the lock position and the REWIND operation has not finished, the processing goes to step MI24 so as to execute the LOOP 20 ESCAPE subroutine and processing diverges to a series of instructions that comprise a LOCK operation described later. If the REWIND operation has finished, the processing is advanced by jumping to "MID" of the 25 MAIN operation, shown in Fig. 13.

When the lock switch LOCK is OFF and it is discriminated step MI25 that the lens is in the lock position, the focal length is indicated on the display (step MI26) for a period of one second (step MI27) by
5 setting an indication hold flag FWAITED to 1.

Thereafter, a macro command flag FRQMCR is set to 0 (step MI28). Then, the LOOP ESCAPE subroutine (step MI29) is executed and the processing can diverge to a series of instructions that comprise a ZOOM FORWARD
10 operation. In this operation, when the macro request flag FRQMCRO is 0, the lens is moved from the lock position to the wide extremity, while, when this flag is set to 1, the lens is moved to the macro position.

In steps MI30 through MI36, if the macro switch
15 MCRO is ON, the focus length indication is displayed and the indication hold flag FWAITD is set to 1. Then, the test is made to determine whether the photographing lens is in the macro position (step MI33). If it is in the macro position, the indication hold timer is
20 cleared (step MI34) and restarted. The processing then advances by jumping to "MIC", shown in Fig. 13. If the lens is not in the macro position, the macro command flag FRQMCRO is set to 1, and the processing diverges to the ZOOM FORWARD operation via the LOOP ESCAPE
25 subroutine so that the lens moves towards the macro extremity.

In steps MI37 through MI43, when the tele switch TELE is ON, the focal length indication is displayed and the indication hold flag FWAITD is set to 1. When the lens is not in the tele extremity, it is

5 discriminated whether the lens is in the macro position or in the zoom area, upon completion of the LOOP ESCAPE subroutine. When the lens is in the zoom area, the processing diverges to a series of instructions that comprises a TELE SHIFT operation to move the lens to
10 the tele side. If it is in the macro position, the processing diverges to the ZOOM REVERSE operation to take back the lens to the tele extremity.

When the lens is already in the tele extremity, the display hold timer is cleared and the count of one
15 second is restarted.

In steps MI44 through MI50, when the wide switch WIDE is ON, the focal length indication is displayed and the indication hold flag FWAITD is set to 1. If the lens is in the wide extremity, the display hold
20 timer is cleared and restarted. When the lens is not in the tele extremity, it is discriminated whether the lens is in the macro position or in the zoom area, upon completion of the LOOP ESCAPE subroutine.

When the lens is in the zoom area, the processing
25 diverges to a series of instructions that comprises a

WIDE SHIFT operation to move the lens to the wide side. If it is in the macro position, the processing diverges to the ZOOM REVERSE operation to take back the lens to the tele extremity.

5 Thus, the photographing lens is set to the macro position, when the macro switch MACRO is ON. To retract the lens from the macro position to the zoom area, the zoom lever should be moved from its center, neutral position towards either direction.

10 In steps MI51 through MI54 in Fig. 12, in case it is necessary to shift the lens, that is, if the macro tele shift flag FMTSIFT is set to 1, the focal length of the lens is displayed and the indication hold flag FWAITD is set to 1. Thereafter, the processing
15 diverges to the ZOOM REVERSE operation to shift the lens to the tele extremity via the LOOP ESCAPE subroutine.

 With this lens, the
 distance limit for taking macro
20 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. If the shutter button is depressed under this condition, in
25 this embodiment, shutter release is locked and the lens

is shifted to the tele extremity from the macro position. The flag FMTSIFT is set in a LENS LATCH (LL) subroutine that is called by a series of instructions that comprise an AUTOMATIC EXPOSURE/AUTOMATIC FOCUS
5 (AEAF) CONTROL operation.

In step M155, the condition of the rewind complete flag FREWEND is checked. If the rewind operation has finished, "00 EX" is displayed on the LCD display (step M156). If the flag is 0, i.e., the rewind operation is
10 not finished, a MODE SETTING subroutine is performed (step M157).

After the switch judgement flag FSWOFF has been set in steps M12 through M14, the MODE SETTING subroutine is executed only when all switches are set
15 to OFF by the previous inputs. If some switches are set to ON, the procedure returns to the MAIN operation without changing any setting.

If there is a mode change in the MODE SETTING subroutine, a mode change flag FMDCHG is set to 1,
20 while if there is no change, it is set to 0.

When the processing returns from the MODE SETTING subroutine to the MAIN operation, the state of the flag FMDCHG is checked (step (M158)). If there is a mode change, the indication hold flag FWAITD is set to 1 in
25 step M159 before the processing jumps to the beginning

of the MAIN operation via the LOOP ESCAPE subroutine.

If there is no change, the photometry switch SWS and the photometry switch effective flag FSWSSEN are checked in steps MI61 and MI62. When the specified
5 conditions are satisfied, the focal length indication is displayed in steps MI63 through MI65 and the Indication hold flag FWAITD is cleared. The processing then diverges to the AEAFF CONTROL operation, via the LOOP ESCAPE operation, so as to execute the
10 shutter-related controls.

The AEAFF CONTROL operation is executed when the photometry switch SWS is 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
15 set. That is, the AEAFF CONTROL operation is performed only when the SWS is switched from OFF to ON. Therefore, if the zoom lever is operated, for instance, the MAIN operation continues without executing the AEAFF CONTROL operation.

20 In step MI66, a CHARGE CONTROL subroutine described later, which controls the strobe flash circuit, is called. Indication change is then executed in steps MI67 through MI71.

If holding of the display indication is requested, it
25 is checked whether 1 second has passed since the

Indication hold timer was cleared. Before 1 second has passed, the presently displayed indication continues.

When holding of the display indication is not requested, or 1 second has passed, the film frame number is re-displayed and the indication hold flag FWAITD is cleared.

Thus, the indication of the film frame number is given preference over other indications, unless the other data to be shown is only temporarily displayed.

10 After pausing for 125 ms in step M172, a CHARGE PROHIBIT TIME subroutine described later is called. The processing then jumps to step M12 of the MAIN operation.

In this camera, the start of strobe charging is delayed 15 for a charge prohibiting time which is set depending upon the frequency of strobe flashing, so as to prevent the strobe circuit from being over heated due to continuous use of strobe flashings. The CHARGE PROHIBIT TIME subroutine is to shorten the charge 20 prohibiting time.

The above is an explanation for the MAIN operation, and various subroutines and operations diverging therefrom will now be described.

25 ((CHARGE CONTROL subroutine))

The CHARGE CONTROL subroutine is called in the MAIN operation, a RELEASE-WAIT CHARGE subroutine or an INTERVAL CONTROL subroutine, the latter two being both described later. Referring to Fig. 14, this subroutine is principally
5 to execute the charge operation, and is periodically called in every 125 ms from any operation or subroutine.

In step CC1, it is determined whether the charge prohibiting time has elapsed by checking a prohibiting time completion flag FWTCMP. When the time has not elapsed
10 (FWTCMP = 0), in step CC2, a CHARGE PROHIBITING subroutine described later is executed. Then, in step CC3, it is discriminated whether charging is prohibited by checking a charge prohibiting time flag FWTSTR. If
15 charging is prohibited (FWTSTR = 1), the processing diverges to step CC7 and a CHARGE STOP operation is executed.

When the charge prohibiting time has elapsed and the prohibiting time completion flag FWTCMP is set to 1, or
20 when the prohibiting time elapsed in the CHARGE PROHIBITING subroutine and the charge prohibiting time flag FWTSTR is set to 0, the charge request flag FCHGRQ is checked in step CC5. If strobe charge is requested (FCHGRQ), the processing advances to step CC6. If not,
25 the processing advances to step CC4.

A prohibiting time reduction flag FCNTSTP is set to 0, in step CC4, so as to enable the charge prohibiting time to be shortened in a CHARGE PROHIBIT TIME subroutine. Then, in the CHARGE STOP operation, in steps CC7 through CC9, after charging and voltage checking are stopped and the red lamp is turned out, the processing returns back to the step from which it was called.

If charging is requested, it is judged, in step CC6, whether 8 seconds or more has passed after charging started by checking a time out flag FTOUT set in a TIME OUT CHECK subroutine described later. If 8 seconds or more (FTOUT = 1) have passed, a charge on flag FCHG, the prohibiting time completion flag FWTCMP and the charge request flag FCHGRQ are set to 0, in step CC10, the CHARGE STOP operation is performed.

If 8 seconds has not yet passed, in steps CC11 through CC15, the charge on flag FCHG is set to 1 so that the charging timer starts, and a voltage check signal is outputted while charging is prohibited. This is because the present voltage before charging starts is uncertain.

If charging is already being started, the processing diverges from step CC11 and a RLS PULSE TIME MEASUREMENT subroutine and the TIME OUT CHECK subroutine are executed in steps CC16 and CC17. By checking the

charge completion flag FCCMP which is set in both subroutines, it is judged whether charging is completed. This flag FCCMP is set to 1 when the charged voltage exceeds 330 V in the RLS PULSE TIME MEASUREMENT
5 subroutine. In the case that the voltage does not reach 330 V after 8 seconds have passed from the start of charging however, the flag FCCMP is set to 1 if the charged voltage exceeds 270 V.

When charging is completed (FCCMP =1), the CHARGE
10 STOP operation is executed via step CC10. If charging is not completed, the charge enable signal CHEN and the voltage check signal are outputted and the processing returns to the MAIN operation (steps CC19 through CC21).

15 Thus, before start of charging, steps CC12 through CC15 are executed once, and the charge check signal is outputted to check the present voltage.

Charging then starts, if the voltage does not reach 330 V in 125 ms via steps CC16 through CC21 the process returns.
20 During charging, steps CC16 through CC21 are repeatedly executed. At the time of completion of charging, steps CC7 through CC9 are executed.

((CHARGE PROHIBITING SUBROUTINE))

25 Fig. 15 shows a CHARGE PROHIBITING subroutine,

which is called in step CC2 of the CHARGE CONTROL subroutine.

This subroutine is called when the charge prohibiting time has not been completed, and a charge
5 prohibiting time TW and the value of the prohibiting time timer are compared so that strobe charging is postponed by the charge prohibiting time to prevent heating of the strobe circuit. The charge prohibiting time TW is determined according to a prohibiting time
10 data n which is set in the RLS PULSE TIME MEASUREMENT subroutine and the CHARGE PROHIBIT TIME subroutine.

If the prohibiting time timer has not yet started in step CS1 (FWTSTR=0), it is started and the prohibiting time flag and a prohibiting time reduction
15 flag are set to 1, in steps CS2 and CS3, so that charging is stopped in the CHARGE CONTROL subroutine of Fig. 14.

In steps CS4 through CS8, if the prohibiting time data n is larger than 50, a prohibiting time 10 sec.
20 setting flag FWT10S is set to 1 and the data n is forcedly set to 50 and the prohibiting time becomes 10 seconds. If the data n is larger than 7 and smaller than 50, the 10 sec. setting flag FWT10S is cleared and the processing returns to the MAIN operation.

25 If the data n is 7 or less, in steps CS9 through

CS11, the CHARGE PROHIBIT TIME subroutine is cancelled and the processing returns to the MAIN operation.

In the case that the CHARGE PROHIBITING subroutine is
5 executed after the CHARGE PROHIBIT TIME subroutine is started, the processing advances from step CS1 to CS12.

In steps CS12 through CS15, if the 10 sec. flag FWT10S is not set to 1, the prohibiting time TW is set
10 to $n \times 125$ ms, and it is checked whether the value in the prohibiting time timer exceeds the calculated prohibiting time TW in step CS14. If the 10 sec. flag FWT10S is set to 1, it is checked whether the value in the prohibiting time timer exceeds 10 seconds (step CS15).

15 Before the prohibiting time timer has counted past the prohibiting time TW or 10 sec., the processing directly returns to the MAIN operation. After the timer has counted the prohibiting time TW or 10 sec., the prohibiting time timer is reset and then the processing returns to the MAIN
20 operation, steps CS9 through CS11.

Thus, the prohibiting time is 0 ms if $n < 7$, $n \times 125$ ms if $7 \leq n < 50$, and 10 seconds if $n \geq 50$. As described later, 2 is added to n at every one charging cycle after charging and before flashing. While 1 is subtracted
25 from n at every 4-seconds. Accordingly, the charge prohibiting time can be

set correspondingly to the frequency of the strobe flashing.

((RLS PULSE TIME MEASUREMENT subroutine))

Fig. 16 shows the RLS PULSE TIME MEASUREMENT
5 subroutine called in step CC16 of the CHARGE CONTROL
subroutine. This subroutine is executed to detect the
voltage of the strobe main capacitor as a pulse time
obtained by voltage - time conversion.

In steps RL1 through RL4, the voltage check
10 signal is set to L, and it is checked whether the RLS
becomes L before a 2 ms timer times up.

As described above, the RLS becomes L only when
the charged voltage exceeds 270 V and thereby the Ne
lamp turns ON. Therefore, the charged voltage is
15 discriminated to be 270 V or less, if the line RLS remains H
for more than 2 ms, and a charged voltage 270 V flag FCH270
and a charged voltage 280 V flag FCH280 are both cleared,
i.e., set to 0, in step RL5, and then a value DGV is set to
0/4 before returning to the MAIN operation.

20 The strobe capacitor is fully charged at 330 V,
and the guide number is determined based upon the light
quantity of a flashing at this full-charge voltage.

However, even if the strobe capacitor
is not fully charged, the strobe is prepared to flash
25 correspondingly, at the charged voltage. Accordingly,

the guide number must be corrected in accordance with the charged voltage to obtain a proper exposure. DGV is a parameter which represents the correcting amount of the guide number corresponding to the charged voltage.

- 5 The parameter is set to $2/4$ at 315 V or more, $1/4$ at 285 V to 315 V, and $0/4$ at 285 V or less.

In the case that the RLS becomes L before the 2 ms timer times up, i.e., in the case that the charged voltage exceeds 270 V, the time that elapses until the RLS becomes H
10 is measured by an RLS pulse time timer to set the pulse time T, in steps RL7 through RL9.

When the charged voltage exceeds 270 V and the RLS pulse appears for the first time after charging started, steps RL11 through RL14 are executed once to
15 correct the measurement reference time T1 according to the measured RLS pulse time T. In the case that 500 ms has elapsed after charging started, T1 is determined based upon the average value T1AV of past T1's stored in the RAM. Then, T1 which is newly determined is set as the
20 new average value T1AV, and 2 is added to the prohibiting time data n.

When the RLS becomes L before 500 ms has elapsed since the charging time timer starts, it is assumed that
the capacitor was already charged at 270 V or more
25 before charging started, and the value of T1AV is set

as T1 without correcting T1. Hence, in this case, it is assumed that the charging time is short and that the temperature rise in the transformer is small.

Accordingly, no value is added to the prohibiting time
5 data n.

The charged voltage VF and the RLS pulse time have a relation as shown in Fig. 7 for a design. However, the value may deviate product by product. So, by averaging the values of the first RLS pulses
10 which substantially correspond to the charged voltage 270 V at every charging time and by considering it in evaluating the pulse time, the above deviations in the products are corrected.

In steps RL15 and RL16, the charging voltage 280 V
15 flag FCH280 is cleared, DGV is set to 0/4 Ev and the charging voltage 270 V flag FCH270 is set to 1.

When the RLS PULSE TIME MEASUREMENT subroutine is executed a second time or later after the charged voltage exceeds 270 V, in steps RL17 through RL25, the
20 latest RLS pulse time T is compared with a voltage corresponding time to discriminate the charged voltage.

The voltage corresponding time is designed to be 330 V at $T1/2 + 800 \mu s$; 285 V at $T1/2 + 500 \mu s$; and 280 V at $T1/2 + 400 \mu s$. Fig. 7 shows an example where
25 T1 is $600 \mu s$.

If the voltage exceeds 330 V, the charge completion flag FCCMP is set to 1 and DGV is set according to the voltage. In any case, if the charged voltage exceeds 280 V, the charged voltage flags are all set
5 to 1 and then the processing returns to the MAIN operation.

If the voltage is 280 V or less, the processing returns to the MAIN operation via steps RL15 and RL16.

10 ((TIME OUT CHECK subroutine))

Fig. 17 shows the TIME OUT CHECK subroutine executed in step CC17 of the CHARGE CONTROL subroutine. This subroutine is executed to determine the upper limit of the charging time according to the counted time of
15 the charging time timer which is started in step CC12 of the CHARGE CONTROL subroutine.

This subroutine comprises steps T01 through T09. If charging is being executed after the charging time timer counts 6 seconds, the time up flag FCHTUP is
20 set to 1.

When 8 seconds elapse, if the charging voltage has reached 270 V, the charge completion flag FCCMP is set to 1. Otherwise, the time out flag FTOUT is set to 1 and the processing returns to the
25 MAIN operation. When the time out flag is set to 1,

charging is stopped in the CHARGE CONTROL subroutine.

((CHARGE PROHIBIT TIME subroutine))

Fig. 18 shows the CHARGE PROHIBIT TIME
5 subroutine executed in step MI73 of the MAIN operation
and in a LOCK operation described later. This
subroutine serves to decrement the prohibiting time
data n being set, if the strobe is not used. With this
subroutine, the prohibiting time TW is shortened.
10 If it is indicated by a prohibiting time reduction
prohibit flag FCNTSTP that the reduction of the
prohibiting time is not allowed namely, when the charge
prohibiting time is being counted or in the case that the
charge prohibiting time is already set to be 0, the
15 processing returns to the MAIN operation from step TC1
without executing any step.

When the reduction is not prohibited, the flag
FCNTSTP is cleared. If the prohibiting time data n is
0 (step TC4), in step TC5, the prohibiting time reduction
20 prohibiting flag FCNTSTP is set to 1 and then the processing
returns to the MAIN OPERATION. From the next call, the
decrement in n is not executed.

If the prohibiting time data n is not 0, in steps
TC6 through TC12, the 4 sec. timer is used and n is
25 decremented by 1 at every 4 seconds passing through the
subroutine.

In other words, the prohibiting time data n is not decremented only when n becomes 0.

((LOCK operation))

5 Fig. 19 shows the flow of the LOCK operation which diverges from step M124 of the MAIN operation. This operation is executed when the photographing lens is stored in the lock position after the lock switch is turned ON.

10 When this operation starts, the frame number indication on the LCD indication display is turned ON or OFF according to the state of a loading end flag FLDEND in steps LK1 through LK4 to set the initial mode.

15 The loop of steps LK5 through LK13 is repeated in 125 ms on condition that the rewind switch REW is OFF, the back cover switch BACK is OFF or the loading is finished even if the back cover switch BACK is ON, and the lock switch LOCK is ON.

20 In step LK13, the CHARGE PROHIBIT TIME subroutine is executed like step M173 of the MAIN operation.

In the case that the rewind switch is turned ON, the processing diverges from LK6 to a REWIND operation.

In the case that the back cover is closed and loading is completed, steps LK9 and LK10 are skipped to form a loop.
25 When the back cover is open, the loading end flag

is cleared and the frame number indication is turned OFF.
In the next loop, when the back cover is closed, the
processing diverges from step LK8 to a LOADING operation.

In the case that the lock switch LOCK is set to OFF,
5 the processing sets the charge request flag FCHGRQ and the
indication hold flag FWAITD to 1, respectively.
In steps LK14 and LK15, then jumps to the MAIN
operation.

When the processing returns to the MAIN operation
10 from the LOCK operation, the main capacitor has usually
been discharged. Thus, by executing a charging request,
an operator need not wait for charge completion if
strobe flashing is necessary at a first shutter-release
after power is ON.

15

((AEAF CONTROL operation))

Referring to Figs. 20 through 22, the AEAF CONTROL
operation for controlling the shutter is described, this
operation diverges from step M165 of the MAIN operation.

20

As described earlier, this operation is executed
when the photometry switch SWS is turned from OFF to ON
and the mode combination is proper. In addition, after the
AEAF CONTROL operation once diverges to the RELEASE
WAIT CHARGE operation or after the WIND operation

25 is performed in the continuous photographing

mode, the AEAF CONTROL is executed from the AEAF control 2 terminal and at the AEAF control 3 terminal, respectively.

In steps AF1 through AF3, a photometric distance measurement jump flag FAEAF is set depending on from
5 what processing the AEAF CONTROL operation takes place. When the operation is returned from the RELEASE WAIT CHARGE operation diverged from the AEAF control operation, since the photometric measurement and distance
10 later, FAEAF is set to 1 so as to jump such processings. In other cases, the flag FAEAF is set to 0.

When the AEAF CONTROL operation diverges from the MAIN operation, in steps AF4 and AF5, if an auto release flag FAUTOREL is set to 0, the focal length is
15 indicated. This flag is set to 1 in the interval mode or in taking a second shot in the double self mode, as described later. In these cases, even if the photometric switch SWS and the release switch SWR are
20 turned OFF, the photographing is automatically executed.

In step AF6, a VOLTAGE CHECK subroutine described later is executed and the charged voltage of the strobe main capacitor is measured.

In step AF7, the charging request flag FCHGRQ
25 which is set in an FM calculation described later is

set to 0.

Steps AF8 through AF11, do not take place from the interval mode or the second shot of the double self mode, but from the MAIN operation or the WIND operation. The photometric data is inputted from the sub CPU to execute LL (lens latch) calculation.

In other cases, the former LL data is used.

Thus, in performing interval photographing and the like, the same focus as the first shot takes place.

10 In performing interval photographing, since the user is normally away from the camera, it is necessary to prevent the focus point from being moved when the subject is moved from the distance measurement area at the center of the screen.

15 The LL calculation serves to determine the amount of lens movement for focusing the subject according to the result of the distance measurement. In the LL calculation, when the lens is in the zoom area and the subject is at a near distance, the green lamp blink flag is set to 1 so as to generate an alarm to the user and the release lock flag FRLOCK is set to 1. When the lens is in the macro position and the subject is at a far distance, besides the above two flags, the macro tele shift flag FMTSIFT is set to 1.

25 In steps AF12 through AF16, except when the AEAF

CONTROL operation takes place again after once
diverging to the RELEASE WAIT CHARGE subroutine, the
photometric-related processings are executed. That is,
in step AF13, the DX code is inputted, which is converted
5 into an Sv value used to calculate an ISO sensitivity of
the film. In step AF14, the compensation amount α
(alpha) of the open F number is obtained from the focal
length of the lens. With such data and the photometric
data being inputted from the sub CPU in step AF15, the
10 AE (automatic exposure) calculation is executed and the
AE data is obtained in step AF16.

In step AF17, an FM (flashmatic) calculation shown
in Fig. 24 is called and the FM data is set. When the
AEAF control operation takes place again after the
15 RELEASE WAIT CHARGE operation has diverged therefrom, the AE
calculation is skipped. However, since the value DGV may
change due to charging, the FM calculation is executed
again.

In step AF18, it is checked whether the release
20 lock has been discriminated during the LL calculation in
step AF11 according to the state of the release lock flag
FRLOCK In step AF18. The release lock is
discriminated when the lens is in the zoom area and the
subject is too close to the lens or when the lens is in
25 the macro position and the subject is too far from the

lens. In these cases, since photographs are out of focus, in steps AF19 through AF21, the green lamp blinks to alarm to the user. The processing waits until the photometric switch SWS is released. After
5 that, the processing turn OFF the red and green lamps and then jumps to the MAIN operation.

In steps AF22 through AF24, when the charged voltage of the strobe capacitor is lower than a predetermined value and the charging request takes
10 place, in the event that the interval mode does not take place, or in the event that the first shot is photographed in the interval mode, the processing diverges to the RELEASE WAIT CHARGE operation shown in Fig. 25. In other words, in the second or later shots
15 In the interval mode, even if the charged voltage is lower than the predetermined value, the strobe is flashed and the following release sequence is executed.

In the interval mode, as shown in Fig. 27, the CHARGE CONTROL operation is executed on every shot.
20 If the charged voltage does not reach the predetermined value with this operation, even if charging is again executed, there is only a small possibility in increase of the voltage.

In steps AF25 through AF27, each data being
25 set is outputted to the sub CPU.

In the automatic photograph mode, the lamp indication, photometric measurement, and judgment of the release switch are skipped and the processing jumps to AFA shown in Fig. 21. In steps AF29 and 5 AF30, when the strobe is flashed according to FM data, the red lamp is turned ON and the processing is advanced to AFB shown in Fig. 21.

In steps AF31 through AF33, the green lamp is turned ON or blinks according to the green lamp blink 10 flag FGLMPFL which is set in the LL calculation. The turn-on and blinking of the green lamp represent the photograph permission and the alarm, respectively.

In steps AF34 and AF35, when the photometric switch SWS is turned ON, the processing waits until the 15 release switch SWR is turned ON. When the shutter button is released, in step AF34a, the red and green lamps are turned OFF and the processing is jumps to the MAIN operation.

In steps AF36 through AF43, when the first shot is 20 taken in the interval photographing mode, the 3 sec timer is started. When the first shot is taken in the self timer mode or double self timer mode, the 10 sec timer is started. When the second or later shot is taken, since the interval timer has been started, the 25 processing is advanced to a time up wait processing

comprising steps AF44 and later. When the mode is in neither the interval mode nor the self mode, the processing jumps to AFC shown in Fig. 22.

Steps AF44 through AF54 are a loop for waiting
5 until the interval timer, the 10 sec timer, the 5 sec timer, and the 3 sec timer time up. When each timer times up or when the mode button is depressed, the processing exits from this loop. In these cases, in steps AF55 and AF56, the red and green lamps and the
10 self timer lamp are turned OFF, the automatic photographing flag is cleared, the present mode is initialized, and the processing jumps to the MAIN operation.

At the second or later shot in the interval mode,
15 the remaining time of the interval timer is displayed.

When the remaining time of the interval timer, the 3 sec timer, the 5 sec timer, or the 10 sec timer becomes 3 sec. or less, the self timer lamp is blinked at 4 Hz.

20 When the timer times up, in the self timer mode, the processing directly advances to AFC shown in Fig. 22. In the double self mode, the processing advances to AFC after the auto release flag FAUTOREL is reversed in step AF59. In the double self mode, at the first
25 shot, the flag is changed from 0 to 1. At the second

shot, the flag is changed to 0 and the automatic photographing mode is canceled.

In the interval mode, the interval timer is started at the interval time which is set in steps AF60 through AF64. At the first shot, the maximum value of the number of photographing frames is set to 40. In addition, to automatically take the second or later shot, the auto release flag FAUTOREL is set to 1. When the second or later shot is taken, the remaining interval time indication on the LCD display is set to 0s and the processing advances to AFC shown in Fig. 22. Step AF64 is executed to prevent the indication from being returned to a value other than 0 because the timer times up.

In steps AF65 through AF67 shown in Fig. 22, before the exposure operation is started, each lamp is turned OFF and the shutter start signal is outputted to the sub CPU. In steps AF68 and AF69, in the overlap photographing mode, date imprinting operation is prohibited.

In other than the bulb mode, the processing diverges from step AF70 to step AF71 where it is confirmed that the shutter operation completion signal is inputted from the sub CPU. After that, the processing advances to the WIND operation shown in Fig.

26.

In the bulb mode, in step AF72, it is confirmed that the shutter release signal is inputted from the sub CPU. In step AF73, it is checked whether the mode
5 is the conventional bulb mode or the manual shutter mode. If it is the bulb mode, in steps AF74 and AF75, the processing waits until the shutter button is released. In step AF76, the shutter close signal is outputted. If it is the manual shutter mode, in step
10 AF77, the manual shutter time is counted and after the counting is completed, the shutter close signal is outputted.

((VOLTAGE CHECK subroutine))

15 Fig. 23 shows a VOLTAGE CHECK subroutine which is called in step AF6 of the AEAF CONTROL operation.

In steps VC1 through VC4, after the voltage check signal CHCK is set to H, the processing waits for 50 ms so that the Ne lamp turns ON. Then the RLS PULSE
20 TIME MEASUREMENT subroutine described above is executed and the signal CHCK is set to L.

In steps VC5 through VC7, if the charged voltage is 270 V or more, and the camera is operated in the double self mode or the interval mode, the prohibiting
25 time reduction prohibiting flag FCNTSTP is cleared. In

other cases, the processing advances to step VC8.
Thus, in the double self mode and the interval mode,
the prohibiting time is not shortened.

Thereafter, in step VC8, both the charge on flag
5 FCHG and the charge completion flag FCHCMP are cleared,
and the processing returns to the AEF CONTROL
operation.

The charge request flag CHGRQ is set to 1. In a
later described FM calculation subroutine, by the
10 charged voltage 270 V flag FCHG270 set to 1 in the
VOLTAGE CHECK subroutine. Thereby, the processing
diverges to the RELEASE WAIT CHARGE subroutine.

((FM calculation))

15 Fig. 24 shows the FM calculation called in step
AF17 of the AEF CONTROL operation.

This operation serves to determine whether to
flash the strobe and to determine the aperture number
Avs at the time when the strobe flashes.

20 In steps FM1 through FM5, in the case of the strobe
OFF mode, the exposure compensation mode and the bulb
mode, or in the case that non-flash is determined in the AE
calculation in the auto mode, the FM data is set to
no-flash and the processing returns to the AEF
25 CONTROL operation.

In other cases, in step FM6, an aperture value A_{vs} is obtained from the distance measurement data (AF step) and the reference guide number. In step FM7, the charging voltage information DGV is added and the aperture value A_{vs} is corrected. The above guide number is set according to the full charge state of the strobe capacitor. Therefore, unless decrease of the guide number at a low voltage is considered, under exposure takes place.

10 In step FM8, the film sensitivity S_v is added to the aperture value A_{vs} . In steps FM9 and FM10, in the zoom area, the change amount ZDGV of the guide number caused by zooming of the strobe itself is added.

In step FM11, the change amount Δ (alpha) of the release F number is subtracted from the aperture value A_{vs} .

In steps FM12 through FM14, the upper and lower limits of the aperture value A_{vs} are restricted. When the voltage of the strobe capacitor is 270 V or less according to the result of the VOLTAGE CHECK subroutine called in step AF6 of the AEAF CONTROL, the charging request flag FCHGRQ is set to 1 and the processing returns to the MAIN operation.

25 ((RELEASE WAIT CHARGE operation))

Fig. 25 shows the RELEASE WAIT CHARGE operation which diverges from steps AF23 and AF24 of the AEAFF CONTROL operation.

Steps CH11 through CH19 are a loop for repeatedly
5 executing charging in step CH16 every 125 ms. When it is judged that the charging time is completed or that the charged voltage exceeds 280 V according to the time up flag FCHTUP and the 280 V charge flag FCH280, the processing exits from the RELEASE WAIT CHARGE
10 operation.

In automatic photographing such as the interval mode, by turning ON one of the mode switches (the mode button A, the mode button B or the clear button C), the processing exits to step CH10. In other than automatic
15 photographing, when the user takes their finger off the shutter button 15, the processing exits from the RELEASE WAIT CHARGE operation.

Also, if the charged voltage does not reach 280 V in 6 seconds and the time is up, the processing exits
20 from the RELEASE WAIT CHARGE operation. When the processing exits from the RELEASE WAIT CHARGE operation, in steps CH10 through CH12, the red and green lamps are turned OFF, the CHARGE STOP operation is executed, automatic photographing is canceled, and
25 the processing jumps to the MAIN operation.

When the charged voltage reaches 280 V before the time is up, the processing advances to CH14 - CH16 via the CHARGE STOP operation in step CH13. In other than automatic photographing, the red lamp is turned ON to
5 inform the user that the strobe is ready to flash. In addition, the charging request flag FCHGRQ is cleared and the processing jumps to the AEAF control 2 shown in Fig. 20. When the processing advances from the RELEASE WAIT CHARGE operation to the AEAF CONTROL
10 operation, the photometric measurement operation, the distance measurement operation and so forth are omitted and the calculation is executed using the former data. During charging, the voltage is checked in comparison to 280 V. After charging, the voltage is checked in
15 comparison to 270 V, because the voltage drop and noise due to the charge stop are considered.

In the CHARGE CONTROL subroutine executed in the MAIN operation, charging is completed when the charged voltage reaches 330 V or the time up in 8 sec. is
20 monitored. However, in the RELEASE WAIT CHARGE operation, since the user waits until charging is completed while pressing the photometric switch SWS, charging is completed when the voltage reaches 280 V and the time is monitored for 6 sec. Thus, since the
25 charging request flag FCHGRQ is not cleared in step

CC10 of the CHARGE CONTROL subroutine, the flag is cleared in step CH16.

((WIND OPERATION))

5 Fig. 26 shows the WIND operation which is called after the AEAF CONTROL is completed.

The WIND operation serves to wind one frame of the film whenever photographing takes place.

10 In the WIND operation, in steps WD1 and WD2, the frame number is indicated on the LCD display except in the interval mode. In the overlap photographing mode, the processing branches from step WD3 to step WD4 to return to the frame photographing mode, and the processing jumps to the MAIN operation. In other
15 words, the overlap photographing mode is cleared whenever one frame is photographed.

In other than the overlap photographing mode, in step WD5, one frame is wound. When the WIND operation is not completed in a predetermined time, the
20 processing branches from step WD6 to step WD7 where the automatic photographing operation flag is cleared and the processing executes the REWIND operation and jumps to the MAIN operation.

When the WIND operation is completed, in step WD8,
25 the frame counter is counted up. In steps WD9 and

WD10, if other than the interval mode, the new frame number is indicated. In the interval mode, the frame number is not indicated because the remaining time to next photographing is decrementally indicated as described later.

In steps WD11 through WD15, the destination of diverging is determined according to the photographing mode set.

In the continuous photographing mode, while the shutter button is being depressed, the processing jumps to the AEAF control 3 shown in Fig. 20 and the exposure sequence is continued. When the button is released, the processing jumps to the MAIN operation.

In the double self mode, when the first shot is taken, the processing jumps to the AEAF CONTROL operation. When the second shot is taken, the processing jumps to the MAIN operation.

In the interval mode, the processing jumps to the INTERVAL CONTROL operation shown in Fig. 27. In other modes, i.e., in the frame photographing mode or the self timer mode, the processing jumps to the MAIN operation.

((INTERVAL CONTROL operation))

Fig. 27 shows the INTERVAL CONTROL operation

which diverges from step WD15 of the WIND operation described above. This operation serves to wait while measuring the time for taking second or later shots, when the photographing operation mode is set to the
5 Interval mode. In other than the interval mode, this operation is executed in a loop of the MAIN operation. However, in the interval mode, the operation is executed while looping between the AEAFF CONTROL operation and the INTERVAL CONTROL operation without
10 returning to the MAIN operation.

In the INTERVAL CONTROL operation, in step IN1, both the charging request flag FCHGRQ and the charging request memory flag FCHGRQM are cleared.

In steps IN2 and IN3, the interval frame count
15 number is decremented and it is checked whether it becomes 0. The initial value of the counting number is 40 frames which is set in step AF62 of the AEAFF CONTROL operation. When the 40 frames have been photographed, in steps IN4 through IN6, the CHARGE STOP operation is
20 executed, the automatic photographing flag is cleared, the MODE INITIALIZE subroutine is executed, and the processing jumps to the MAIN operation.

When the frame count number is not 0, steps IN7 through IN21 are looped every 125 ms and the processing
25 waits until the next frame is photographed. During

this period, when one of mode switches or the clear switch is turned ON, the mode is initialized and the processing jumps to the MAIN operation.

5 In this loop, normally the timer decrement indication takes place. However, when the photometric switch is turned ON, the frame number is indicated. When the zoom tele/wide switch is turned ON, the focal length is indicated.

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

15 In the CHARGE CONTROL operation in step IN20, when FCHGRQ is set to 1, charging is executed. When the flag is set to 0, charging is skipped.

20 Thus, in the loop of steps IN17 through IN20, charging is forced to start. When it is judged that the strobe capacitor is fully charged, charging is stopped. In the next loop, the CHARGE CONTROL operation is skipped.

25 When the remaining time becomes 4 sec. or less, the processing diverges from step IN19. In steps IN22 and IN23, charging is stopped and the remaining time in the timer is indicated. The processing jumps to the AEAF CONTROL operation shown in Fig. 27 and waits until

the time is up in steps AF44 and AF54.

As described above,

when the strobe circuit is heated due to frequent chargings, by prohibiting the charging
5 for a predetermined time, it is possible to prevent the circuit from being over heated and the circuit parts from being damaged.

In addition, since the charge prohibit time is increased and decreased according to the frequency of
10 strobe flashings, in the event that the circuit is not going to be over heated, charging can be immediately executed just after the strobe is flashed, thereby reducing time lost for the user.

Furthermore, the charged voltage of the
15 strobe main capacitor can be detected on a fine level with a relatively simple structure. Thus, exposure control and the like can be accomplished according to the flashing condition corresponding to the charged voltage.

20 By arranging that a pulse is output only when the charged voltage exceeds a predetermined reference value, a misjudgment can be reduced in measuring the pulse time.

By arranging that charging time and charge
25 limit voltage can be selected according to the

operation mode of the camera, it becomes possible for the user to select the charged voltage or the charge waiting time according to the situation.

By arranging that the exposure can be corrected according to a change of the charged voltage, even if the charged voltage of the strobe main capacitor is insufficient, it is possible to prevent under exposure due to weak strobe flashing.

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CLAIMS

1. An exposure control apparatus comprising:-
detecting means for measuring the time width of a pulse the time width of the pulse being variable in relation to a charged voltage for application to a strobe;
and
determination means for determining a said charged voltage on the basis of the measured time width of the pulse corresponding thereto and on the basis of a reference time width, the determination means determining a proper exposure value according to the determined charged voltage;
wherein the reference time width comprises a measured time width of a pulse corresponding to a reference voltage.
2. Apparatus according to claim 1 wherein the reference time width comprises an average of measured time widths of pulses corresponding to the reference voltage.
3. Apparatus according to claim 2 wherein a newly measured time width corresponding to the reference voltage is added to form a weighted average reference time width.
4. Apparatus according to any preceding claim wherein in determining said proper exposure value said determination means selects one of a plurality of exposure correction values on the basis of said determined charged voltage.



5. Apparatus according to claim 4 wherein said determination means selects one of a plurality of voltage bands according to said determined charged voltage, each said voltage band being allocated a said exposure correction value.
6. Apparatus according to claim 5 wherein said determination means selects one of said voltage bands on the basis of whether the measured time width is greater than one half said reference time width plus a band dependent time constant.
7. Apparatus according to any one of claims 4 to 6 wherein three exposure correction values are provided.
8. Apparatus according to any one of claims 4 to 7 wherein said correction value is zero for a determined charged voltage equalling the maximum charged voltage for application to the strobe.
9. Apparatus according to any one of claims 4 to 8 wherein said correction value is related to the flash guide number.
10. Apparatus according to any one preceding claim wherein said reference voltage is a flash enable voltage for said strobe.



11. An exposure control apparatus as claimed in claim 1 and substantially as herein described with reference to the accompanying drawings.
