

MULTI-PROGRAM SHUTTER

This invention relates to motor driven multi-
5 program shutters.

In general, when a lens having a relatively long focal length is used, or when the picture of a moving object is taken, a high speed program is needed, whereas, when a lens having a relatively short focal
10 length is used, or when the depth of field is desired to be relatively deep, a low speed program is needed. A typical conventional multi-program shutter having high and low speed programs is arranged such that the rotational speed of a motor is controlled (see Japanese
15 Patent Application No. 61-2796 (1986)).

In such a multi-program shutter, a stepping motor which is reversible and less costly is used, and to switch the rotational speed of the stepping motor from one to the other, it is general practice to change only
20 the ON period of pulses. However, this practice suffers from the following disadvantages. As shown in Figure 7, if driving conditions in which the relationship between the rotational angle of the rotor of the stepping motor and pulses is linear when the shutter speed is high and the ON period of the pulses alone is
25 changed when the shutter speed is low, then, the relationship between the rotor rotational angle and the pulses is dis-ordered as shown by the broken line. This is because the balance between the output of the
30 stepping motor and the load thereon is destroyed. This dis-order causes the change of sector aperture diameter with respect to the elapsed time to become non-uniform, as shown by the broken line in Figure 6, so that it is impossible to effect precise exposure control. If,

conversely, motor driving conditions which are optimal when the shutter speed is low are set, the rotor of the stepping motor cannot follow up the pulses when the shutter speed is high, resulting in the shutter failing to operate normally.

The present invention aims at overcoming the above described disadvantages and to provide a multi-program shutter which is so designed that the motor operates smoothly in accordance with each program thereby to enable precise exposure control.

According to the present invention, there is provided a multi-program shutter having at least two programs, said shutter comprising: a motor for opening and closing sectors of the shutter; selecting means for selecting one of said programs; and a control circuit for controlling said motor under predetermined driving conditions at least on the basis of an output from the selecting means, said driving conditions including a pulse duration and predetermined voltage or current corresponding to each program.

In the preferred embodiment the motor is a stepping motor.

The shutter may have at least a high speed program and a low speed program where shutter speed is made relatively fast and slow respectively.

Preferably the control circuit is arranged to control the motor at least on the basis of an output from the selecting means and information concerning the brightness of a subject to be photographed.

The selecting means may be a manually operable switch.

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

5 Figure 1 is a plan view of one embodiment of a multi-program shutter according to the present invention;

Figure 2 is a sectional view of the shutter shown in Figure 1;

10 Figure 3 is a plan view of a known stepping motor used in a multi-program shutter according to the present invention;

Figure 4 is a sectional view of the motor shown in Figure 3;

15 Figure 5 is a program chart illustrating programs for determining a shutter speed and an aperture value in a multi-program shutter according to the present invention;

20 Figure 6 is a chart showing changes in sector aperture diameter in the case of fast and slow shutter speeds; and

Figure 7 is a chart showing movement of the rotor of a stepping motor in the case of fast and slow shutter speeds.

25 Figures 1 and 2 show one embodiment of a multi-program shutter according to the present invention. A base plate 1 has a lens positioning plate 2 secured thereto. A sector chamber 3 is defined between the base plate 1 and the lens positioning plate 2. Two sectors 4
30 are pivotally provided in the sector chamber 3, the sectors 4 pivoting symmetrically about pins 5 to determine a lens aperture. A sector driving lever 6 is pivotally supported on the base plate 1 to a shaft 7 which is built therein. The lever 6 is engaged through

a groove portion 6a formed at one end thereof with a pin 9a of a sector driving wheel 9 which is pivotally provided on the shaft 7. The lever 6 is also engaged with the sectors 4 through a sector pin 10 which is provided in the side thereof which is closer to the base plate 1. The sector driving wheel 9 is pivotally supported by the shaft 7 in such a manner that it is, when in a stationary state, held at a reference position by means of stopper portions 9b formed on the outer periphery thereof and a spring 8 which biases the sector driving wheel 9 so as to turn counter-clockwise. The sector driving wheel 9 is connected to a toothed portion 9c formed at one end thereof to a driving shaft 13a (Figure 4) of a stepping motor 12 through a gear train.

A pin 11 is adapted to engage with either one or the other of the portions 9b of the sector driving wheel 9 thereby to limit the range within which the sector driving wheel 9 can rotate.

Referring next to Figures 3 and 4, which show one embodiment of the stepping motor 12, a quadri-pole rotor 13 is made of permanent magnets and is rotatably attached to upper and lower plates 14, 15 with one end of the driving shaft 13a projecting from the lower plate 15, so that the sector driving wheel 9 is driven through a pinion 16 which is secured to the projecting end of the driving shaft 13a. Stators 17, 18 each made of a U-shaped magnetic material have two leg portions. Each of the stators 17, 18 has an exciting coil L1, L2 wound on one leg portion thereof, and each stator has two magnetic pole portions 17a, 17b and 18a, 18b, provided at its distal end in such a manner that the two magnetic pole portions are in 90° relation to each other with respect to the central axis of the rotor 13. The stators 17, 18 are positioned by means of guide pins 19

so that one magnetic pole portion 17b of the stator 17 and one magnetic pole portion 18b of the stator 18 are in 45° relation to each other with respect to the central axis of the rotor 13. Thus, the stepping motor 12 is arranged so that the rotor 13 can be rotated both forwardly and reversely through steps each set at 90° .

Referring back to Figure 1, a control circuit 22 is connected to the stepping motor 12 through a driver circuit 21 to which is connected a constant voltage circuit 20. To the control circuit 22 are connected the constant voltage circuit 20 and a selector switch 23 capable of selecting either one of a high speed program and a low speed program. The driver circuit 21 amplifies signals output from the control circuit 22 and feeds the amplified signals to the exciting coils L1 and L2 of the stepping motor. The constant voltage circuit 20 is capable of controlling two different kinds of supply voltage, i.e. high and low voltages. The circuit 20 selects either one of the two voltages in accordance with a signal output from the control circuit 22 and outputs the selected voltage to the driver circuit 21. In the control circuit 22 are previously set driving conditions for the stepping motor, i.e. the number of pulses, pulse duration and applied voltage, so that an optimal relationship between the shutter speed and the aperture value can be obtained from subject brightness information delivered from a photometric section (not shown) and information concerning whether the selector switch 23 is open or closed on the basis of two, i.e. high and low speed, programs shown in Figure 5. Among the motor driving conditions, pulse duration and applied voltage are selected on the basis of the selector switch information. If it is assumed that, for example, when the selector switch 23 is open, the high

speed program is selected, a pre-set short pulse duration and high applied voltage are selected when the switch 23 is open, whereas, when the selector switch 23 is closed, a pre-set long pulse duration and low applied voltage are selected. It should be noted that stepping motors have general characteristics that, as the applied voltage is raised, the response is improved and as the applied voltage is lowered, the response deteriorates. Therefore, the applied voltage and the pulse duration are set so that the relationship between the rotor of the stepping motor and the pulses is linear in the case of both high and low shutter speeds, as shown in Figure 7. As a result, the change of sector aperture diameter with respect to elapsed time becomes linear, as shown in Figure 6.

Figure 5 is a program chart showing the programs of a multi-program shutter according to the present invention, in which the ordinate represents aperture value (F-number), the abscissa represents the shutter speed (T), and the oblique axis represents E_v value. The high speed program is a program according to which the shutter speed is set at relatively high values and which is therefore suitably selected when a tele-photo lens is used or when the picture of a moving subject is taken, whereas the low speed program is a program according to which the shutter speed is set by relatively low values and which is therefore suitably selected when a wide angle lens is used or when the depth of field is desired to be relatively deep.

The operation of the multi-program shutter arranged as described above will next be described.

It is assumed that, since a lens having a relatively long focal length is used, the high speed program which involves less effect of camera shake is

selected by the selector switch 23. When, in this state, a release button (not shown) is actuated, a power supply switch (not shown) is turned ON and information concerning the brightness of the subject to be photographed and information concerning whether the selector switch 23 is open or closed are input to the control circuit 22. The control circuit 22 selects the high speed program shown in Figure 5 on the basis of the selector switch information, and also determines an optimal applied voltage and pulse duration for the stepping motor 12. The control circuit 22 further determines on the basis of the brightness information a number of pulses for the stepping motor 12 on condition that the relationship between the aperture value and the shutter speed is coincident with the high speed program, and outputs a predetermined number of pulses to both the constant voltage circuit 20 and the driver circuit 21. The constant voltage circuit 20 outputs the high supply voltage to the driver circuit 21 in response to the signal output from the control circuit 22. The driver circuit 21 outputs to the stepping motor 12 a high applied voltage, a short pulse duration and a predetermined number of pulses on the basis of the outputs from the control circuit 22 and the constant voltage circuit 20. The output of the driver circuit 21 is supplied to the exciting coils L1 and L2 of the stepping motor 12, and the stators 17, 18 are thereby excited, causing the rotor 13 to rotate forwardly and reversely through an angle corresponding to the predetermined number of pulses under the above described driving conditions. The rotation of the rotor 13 is transmitted to the sector driving wheel 9, through the pinion 16 against the load of the spring 8. The pivotal motion of the sector driving wheel 9 is transmitted to the sectors 4

through the lever 6, thereby effecting a sector opening operation in the case of high or fast shutter speed as shown in Figure 7.

On the other hand, when the low speed program is
5 selected by the selector switch 23, the low speed program shown in Figure 5 is selected, and stepping motor driving conditions are determined on the basis of various kinds of information to effect a sector opening operation in the case of low or slow shutter speed as
10 shown in Figure 7.

Although in the foregoing embodiment two, i.e. high and low speed, programs are used, it is possible to readily carry out the present invention in the case where the number of programs exceeds two by increasing
15 the number of selector switch means and setting appropriate pulse durations, applied voltages, etc. for each of the programs.

Although in the above described embodiment a stepping motor is employed, it is possible to employ any
20 type of motor whose forward and reverse rotation can be controlled.

Further, although in the described embodiment the selector switch is actuated manually to select an optimal program, the present invention is not
25 necessarily limited thereto. For example, in a camera provided with a plurality of lenses having different focal lengths, such as a tele-photo lens and a wide angle lens, if a selector switch is arranged so as to be actuated in response to the operation of a lens
30 selecting means, it is possible to select automatically a high speed program when the tele-photo lens is used, and a low speed program when the wide angle lens is used.

As has been described above, according to the

present invention, the voltage or current supplied to the motor is changed in accordance with the selected program. Accordingly, it is possible to activate the motor smoothly in each program and hence make uniform
5 change of the aperture diameter with respect to elapsed time. Therefore it is possible to effect high precision exposure control and also realise high precision of synchronisation with flash at an optimal aperture diameter corresponding to the subject distance when
10 flash photography is carried out.

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C L A I M S

1. A multi-program shutter having at least two programs, said shutter comprising: a motor for opening and closing sectors of the shutter; selecting means for selecting one of said programs; and a control circuit
5 for controlling said motor under predetermined driving conditions at least on the basis of an output from the selecting means, said driving conditions including a pulse duration and predetermined voltage or current corresponding to each program.
- 10 2. A shutter as claimed in claim 1 in which the motor is a stepping motor.
3. A shutter as claimed in claim 1 or 2 having at least a high speed program and a low speed program where shutter speed is made relatively fast and slow
15 respectively.
4. A shutter as claimed in any preceding claim in which the control circuit is arranged to control the motor at least on the basis of an output from the selecting means and information concerning the bright-
20 ness of a subject to be photographed.
5. A shutter as claimed in any preceding claim in which the selecting means is a manually operable switch.
6. A multi-program shutter substantially as herein described with reference to and as shown in the
25 accompanying drawings.

