

PATENT SPECIFICATION

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(54) ELECTRONIC EXPOSURE CONTROL DEVICE

(71) We, AGFA-GEVAERT AKTIENGESELLSCHAFT, a body corporate organised according to the Laws of Germany, of Leverkusen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an electronic exposure control device for use with cameras having electrical shutter operating means.

Previously proposed electronic exposure control devices include a trigger stage the input of which is connected to a timing circuit comprising a light-sensitive device and a capacitor.

It is an object of the invention to provide an exposure control device which operates more accurately, covers a greater range of brightness, and is less sensitive to variations in voltage.

According to the invention an electronic exposure control apparatus comprises a photo-electric cell, a pulse generator arranged to generate pulses at a frequency which is dependent on the intensity of light falling on the photo-electric cell, a pulse counter arranged to count the pulses and to provide a control signal when a preselected number of pulses have been counted, and a switching stage arranged to respond to the control signal and to provide, at an output port, a signal suitable for operating an electrically actuated camera shutter, an output terminal of the switching stage being connected to an input terminal of the pulse counter whereby, in operation, the pulse counter is stopped by the switching stage signal, the pulse generator consisting of a field effect transistor arranged to charge a capacitor at a rate dependent on the potential difference across the photo-electric cell and a threshold switch arranged to discharge the capacitor and to provide a pulse when the potential difference across the capacitor reaches the switch threshold level.

Thus, a pulse train, the frequency of which depends on the prevailing illumination, is produced by the generator. When a predetermined number of pulses has reached the counter an output signal is produced which may, for example, alter the state of a shutter control magnet. When the prevailing light is intense, the preselected number of pulses is reached quickly, whereas when the light is dim, a correspondingly longer time is required for this.

Advantageously, the pulse counter comprises a plurality of binary units and there is, preferably, provided means for preselecting the number of binary units to be activated before an output is given to take into account film sensitivity and/or camera diaphragm aperture. In this way, it is possible to allow for different film sensitivities or apertures without reducing the amount of light falling on the light responsive means.

Alternatively, there may be provided means for attenuating the light falling on the light responsive means in accordance with the camera diaphragm aperture and/or the film sensitivity.

Advantageously, the light responsive means together with a resistor forms a potential divider which is connected to the gate electrode of a field effect transistor, the main electrodes of which together with a capacitor determine the pulse frequency of the pulse generator. Preferably there is provided, in front of the light sensitive means, a correction filter to compensate for the relative spectral sensitivity of the light sensitive means.

The said number of pulses and the frequency range of the pulse generator for which the frequency is directly proportional to the brightness of the prevailing illumination are, preferably, so selected that the range of exposure times occurring during normal ambient lighting is matched to the possible range of exposure times determined by the apparatus. Thus it is arranged that the shortest and longest

exposure times occurring normally, lie within the range for which the apparatus operates approximately linearly.

5 The invention also provides a photographic apparatus comprising electronic exposure control apparatus as described above and a camera having electrical means for operating the shutter.

10 One form of electronic exposure control apparatus will now be described, by way of example, with reference to the accompanying drawing, which is a circuit diagram of the apparatus.

15 Referring now to the accompanying drawing, an on-off switch 2 is arranged to connect a battery 1 into the circuit and a further switch 3 is provided which is opened at the end of an exposure. A pulse generator generally indicated by the reference numeral 4 includes a silicon photoelectric cell 5, and a resistor 6 connected in series with the cell 5. The tapping between the cell and the resistor 6 is connected to the gate of a field effect transistor 7, the main electrode of which is connected to a capacitor 8. Connected between the capacitor 8 and the main electrode is the emitter of a transistor 9, the collector resistor of which is indicated by 10. The base of a further transistor 13 is connected between the resistor 10 and the transistor 9, the collector of the transistor 13 being connected to the base of the transistor 9 and the emitter being connected to a resistor 14.

35 A voltage which depends on the brightness of the prevailing illumination is applied to the gate of the field effect transistor 7. Consequently the resistance between the main electrodes of the field effect transistor 7 corresponds to the prevailing illumination. The main electrodes together with the capacitor 8 determine the frequency of the pulse generator 4. The capacitor 8 is charged via the main electrodes of the field effect transistor 7. If the potential at the emitter of the transistor 9 is smaller than the potential at the base of the transistor 9, the transistor 9 becomes conductive and there is, therefore, at the resistor 10, a voltage which decreases and causes the driving of the transistor 13. The driving process of the transistor 9 is accelerated by this. Thereupon the capacitor 8 is discharged via the resistor 10 and the collector-emitter of the transistor 9. If the potential at the emitter of the transistor 9 is more positive than the potential at its base, the transistor 9 is blocked, so that the transistor 13 is also blocked. The capacitor 8 now begins to charge again. A pulse series dependent on the prevailing light is thus produced.

Between the emitter of the transistor 13 and the resistor 14 is a connection to a binary counter 15, which has a predetermined number of binary elements. The output of the binary counter 15 is connected to a switching stage 16, to the output of which is connected a shutter control magnet 17. A feedback branch 18 leads from the switching stage 16 to a separate input of the binary counter 15. By means of the feedback branch 18, after driving the switching stage 16, a stop pulse is supplied to the input of the binary counter 15 which can thus no longer be influenced by further pulses. A starting switch indicated by 19, which is in the form of a rest contact, holds all the counting elements of the binary counter 15 in a zero position when in the closed state. When the switch 19 is opened, the counting process is started.

If the camera-user closes the operating switch 2, the circuit arrangement is connected to the battery 1. The result is that the pulse generator 4 begins to oscillate. Since the starting switch 19 is still closed, the pulses have no effect on the counter 15. After actuating a trigger, which is not illustrated, the starting switch 19 is opened by a shutter closure member and switches on the binary counter 15 ready for operation. The individual binary elements are influenced one after the other by the pulses from the pulses generator 4. After a predetermined number of pulses there appears at the output of the binary counter 15 a switching pulse which transfers the switching stage 16 out of its previously conductive state into the blocked state. Consequently the shutter control magnet 17 which was energized, is de-energized. In a manner not illustrated a shutter closing member is released by means of the shutter control magnet 17 to cover the lens aperture. After transferring the switching stage 16 into its blocked state, a stop pulse is supplied via the feedback branch 18 to the binary counter 15, so that the latter is no longer influenced by further pulses. A light attenuating device arranged in front of the silicon photoelectric cell 5 is indicated by 21. By means of the light attenuator means 21 the preselected aperture stop, for example, may be taken into account.

WHAT WE CLAIM IS:—

1. An electronic exposure control apparatus comprising a photo-electric cell, a pulse generator arranged to generate pulses at a frequency which is dependent on the intensity of light falling on the photo-electric cell, a pulse counter arranged to count the pulses and to provide a control signal when a preselected number of pulses



exposure times occurring normally, lie within the range for which the apparatus operates approximately linearly.

5 The invention also provides a photographic apparatus comprising electronic exposure control apparatus as described above and a camera having electrical means for operating the shutter.

10 One form of electronic exposure control apparatus will now be described, by way of example, with reference to the accompanying drawing, which is a circuit diagram of the apparatus.

15 Referring now to the accompanying drawing, an on-off switch 2 is arranged to connect a battery 1 into the circuit and a further switch 3 is provided which is opened at the end of an exposure. A pulse generator generally indicated by the reference numeral 4 includes a silicon photoelectric cell 5, and a resistor 6 connected in series with the cell 5. The tapping between the cell and the resistor 6 is connected to the gate of a field effect transistor 7, the main electrode of which is connected to a capacitor 8. Connected between the capacitor 8 and the main electrode is the emitter of a transistor 9, the collector resistor of which is indicated by 10. The base of a further transistor 13 is connected between the resistor 10 and the transistor 9, the collector of the transistor 13 being connected to the base of the transistor 9 and the emitter being connected to a resistor 14.

20 A voltage which depends on the brightness of the prevailing illumination is applied to the gate of the field effect transistor 7. Consequently the resistance between the main electrodes of the field effect transistor 7 corresponds to the prevailing illumination. The main electrodes together with the capacitor 8 determine the frequency of the pulse generator 4. The capacitor 8 is charged via the main electrodes of the field effect transistor 7. If the potential at the emitter of the transistor 9 is smaller than the potential at the base of the transistor 9, the transistor 9 becomes conductive and there is, therefore, at the resistor 10, a voltage which decreases and causes the driving of the transistor 13. The driving process of the transistor 9 is accelerated by this. Thereupon the capacitor 8 is discharged via the resistor 10 and the collector-emitter of the transistor 9. If the potential at the emitter of the transistor 9 is more positive than the potential at its base, the transistor 9 is blocked, so that the transistor 13 is also blocked. The capacitor 8 now begins to charge again. A pulse series dependent on the prevailing light is thus produced.

Between the emitter of the transistor 13 and the resistor 14 is a connection to a binary counter 15, which has a predetermined number of binary elements. The output of the binary counter 15 is connected to a switching stage 16, to the output of which is connected a shutter control magnet 17. A feedback branch 18 leads from the switching stage 16 to a separate input of the binary counter 15. By means of the feedback branch 18, after driving the switching stage 16, a stop pulse is supplied to the input of the binary counter 15 which can thus no longer be influenced by further pulses. A starting switch indicated by 19, which is in the form of a rest contact, holds all the counting elements of the binary counter 15 in a zero position when in the closed state. When the switch 19 is opened, the counting process is started.

25 If the camera-user closes the operating switch 2, the circuit arrangement is connected to the battery 1. The result is that the pulse generator 4 begins to oscillate. Since the starting switch 19 is still closed, the pulses have no effect on the counter 15. After actuating a trigger, which is not illustrated, the starting switch 19 is opened by a shutter closure member and switches on the binary counter 15 ready for operation. The individual binary elements are influenced one after the other by the pulses from the pulses generator 4. After a predetermined number of pulses there appears at the output of the binary counter 15 a switching pulse which transfers the switching stage 16 out of its previously conductive state into the blocked state. Consequently the shutter control magnet 17 which was energized, is de-energized. In a manner not illustrated a shutter closing member is released by means of the shutter control magnet 17 to cover the lens aperture. After transferring the switching stage 16 into its blocked state, a stop pulse is supplied via the feedback branch 18 to the binary counter 15, so that the latter is no longer influenced by further pulses. A light attenuating device arranged in front of the silicon photoelectric cell 5 is indicated by 21. By means of the light attenuator means 21 the preselected aperture stop, for example, may be taken into account.

WHAT WE CLAIM IS:—

1. An electronic exposure control apparatus comprising a photo-electric cell, a pulse generator arranged to generate pulses at a frequency which is dependent on the intensity of light falling on the photo-electric cell, a pulse counter arranged to count the pulses and to provide a control signal when a preselected number of pulses

- have been counted, and a switching state arrange to respond to the control signal and to provide, at an output port, a signal suitable for operating an electrically actuated camera shutting, an output terminal of the switching stage being connected to an input terminal of the pulse counter whereby, in operation, the pulse counter is stopped by the switching stage, the pulse generator consisting of a field effect transistor arranged to charge a capacitor at a rate dependent on the potential difference across the photo-electric cell and a threshold switch arranged to discharge the capacitor and to provide a pulse when the potential difference across the capacitor reaches the switch threshold level.
2. An electronic exposure control apparatus as claimed in claim 1, wherein there is provided means for attenuating the light falling on the photo-electric cell.
3. An electronic exposure control apparatus as claimed in claim 1 or claim 2, wherein there is provided a correction filter arranged to intercept light falling on the photo-electric cell, to compensate for the relative sensitivity of the photo-electric cell.
4. An electronic exposure control apparatus as claimed in any one of claims 1 to 3, wherein the pulse counter comprises a plurality of binary units.
5. An electronic exposure control apparatus as claimed in claim 4, wherein the number of operative binary units is variable.
6. An electronic exposure control apparatus as claimed in any one of claims 1 to 5, wherein the threshold switch includes a PNP-NPN transistor pair having a threshold voltage level set by a potential divider.
7. Apparatus as claimed in any one of claims 1 to 6, wherein the said number of pulses and the frequency range of the pulse generator for which the frequency is directly proportional to the brightness of the prevailing illumination are so selected that the range of exposure times occurring during normal ambient lighting is matched to the range of exposure times determined by the apparatus.
8. Electronic exposure control apparatus substantially as hereinbefore described, with reference to and as shown in the accompanying drawing.
9. Photographic apparatus comprising electronic exposure control apparatus as claimed in any one of claims 1 to 8 and a camera including electrical means for operating the shutter.
10. Apparatus as claimed in claim 9, wherein the means for operating the shutter includes an electro-magnet.

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