

[54] **SHUTTER OPERATING CIRCUIT
HAVING MEANS TO CLOSE SHUTTER
WHEN LIGHT IS INSUFFICIENT**

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[56] **References Cited**

UNITED STATES PATENTS

3,326,103 6/1967 Topaz.....95/10 CT

3,422,738 1/1969 Mori et al.95/10 CT
3,485,152 12/1969 Fuwa et al.250/212 X

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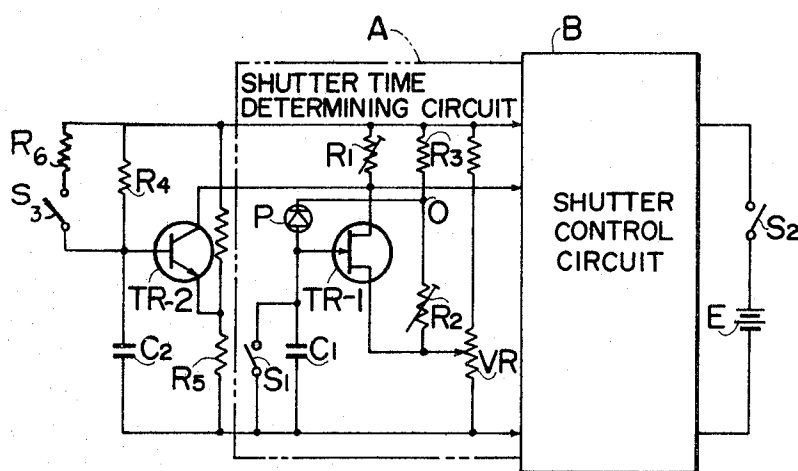
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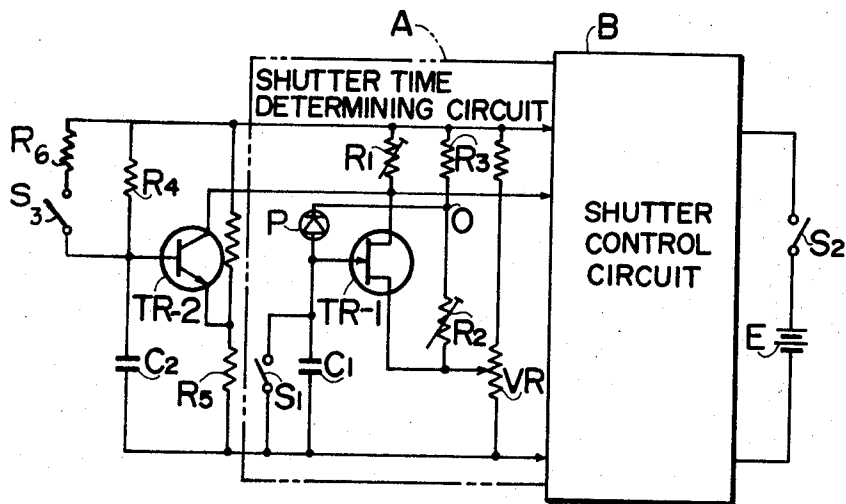
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ABSTRACT

In a shutter operating circuit comprising a shutter time determining circuit including a photo-electromotive element, and a high input impedance transistor; means to initiate the operation of the shutter time determining circuit; a shutter control circuit controlled by the shutter time determining circuit; and a source of supply connected to said two circuits, there are provided a series circuit connected across the source and including serially connected resistor and capacitor, and a switching transistor with its base electrode connected to the juncture between the resistor and the capacitor, the series circuit acting to trigger the switching transistor to operate the shutter control circuit when the shutter time determining circuit fails to operate after elapse of a predetermined interval after the operation of the initiating means.

4 Claims, 1 Drawing Figure





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SHUTTER OPERATING CIRCUIT HAVING MEANS TO CLOSE SHUTTER WHEN LIGHT IS INSUFFICIENT

BACKGROUND OF THE INVENTION

This invention relates to a shutter operating circuit for cameras, and more particularly to a shutter operating circuit employing a photo-electromotive element.

An electric shutter operating circuit functions to determine a proper shutter time in accordance with the brightness of an object to be photographed, but the prior shutter operating circuit is defective in that it operates to continuously maintain the shutter in the opened condition when the object is very dark. In the prior art shutter operating circuit utilizing a photoconductive element as means for determining the shutter time, for the purpose of eliminating this difficulty, a high resistance resistor is connected in parallel with the photoconductive element so as to establish a definite time constant by a capacitor and the resistance value of the resistor manifested thereby when the photoconductive element manifests an extremely high resistance whereby to close the shutter after it has been opened for a definite interval of time. Such idea has been disclosed in, for example, specifications of the U.S. Pat. Nos. 3,326,103 and 3,422,738.

When the photoconductive element or the time constant determining element is a passive element, the high resistance element connected in parallel therewith operates as desired whereas when the time constant determining element comprises a photo-electromotive element it is impossible to close the shutter with the prior shutter operating circuit utilizing a parallel connected high resistance element.

In the accompanying drawing blocks A and B show a conventional shutter operating circuit utilizing a photo-electromotive element. More particularly, A represents a shutter time determining circuit while block B a well known shutter control circuit. Since the construction of the shutter control circuit contained in block B is well known in the art, the detail thereof has been omitted from the drawing a source E is connected to the shutter operating circuit through a switch S_2 . The shutter time determining circuit A comprises a photo-electromotive element P which generates an electromotive force when it is irradiated with light and cooperates with a capacitor C_1 to form a serially connected time constant circuit. A switch S_1 connected in parallel with capacitor C_1 is arranged to be opened concurrently with the operation of a shutter release. There is provided a semiconductor element TR-1, a field effect transistor for example, having a high input impedance characteristic. The source electrode of the field effect transistor TR-1 is connected to the negative pole of the source E through a variable resistor VR whereas the drain electrode to the positive pole of the source through a variable resistor R_1 , a bleeder circuit comprising a resistor R_3 and a variable resistor R_2 is connected between the positive pole of the source E and the source electrode, and the junction between these resistors is connected to one side of the photo-electromotive element P. The gate electrode of the field effect transistor TR-1 is connected to the junction between the element P and capacitor C_1 . In the circuit constructed as above described, in order to eliminate the effect of the dark current upon the switching time it is necessary to decrease the negative bias impressed upon the photo-electromotive element P, for example a solar cell, thus decreasing the dark current. The presently available solar cell having a high signal-to-noise ratio has a very small output, moreover there is a limit for the signal-to-noise ratio and the internal resistance of the solar cell is very high, for example more than several thousand megohms. It is impossible to prevent permanent opening of the shutter even when a high resistance resistor is connected in parallel with the photo-electromotive element.

SUMMARY OF THE INVENTION

It is the principal object of this invention to obviate aforementioned defects.

More specific object of this invention is to provide a novel shutter operating circuit which can positively close the shutter of a camera even when the brightness of an object is not sufficiently high.

According to this invention, in a shutter operating circuit comprising a shutter time determining circuit including a photo-electromotive element and a high input impedance transistor; means to initiate the operation of the shutter time determining circuit; a shutter control circuit controlled by the shutter time determining circuit; and a source of supply connected to two circuits described above, there are provided a series circuit including a resistor and a capacitor which is connected across the source and a switching transistor with its base electrode connected to the juncture between the resistor and the capacitor, the series circuit acting to trigger the switching transistor to operate the shutter control circuit when the shutter time determining circuit fails to operate after elapse of a predetermined interval after the operation of the initiating means.

BRIEF DESCRIPTION OF THE DRAWING

The invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawing in which a single FIGURE shows a block diagram of one example of the shutter operating circuit embodying this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to this invention, a series circuit including a resistor R_4 and a capacitor C_2 is connected across E source through switch S_2 and the juncture between resistor R_4 and capacitor C_2 is connected to the base electrode a switching transistor TR-2. The emitter electrode of this transistor is connected to the negative pole of source E through a potentiometer resistor R_3 whereas the collector electrode of transistor TR-2 is connected to the drain electrode of the field effect transistor TR-1.

Resistor R_4 and capacitor C_2 comprises a time constant circuit that determines an instant at which switching transistor TR-2 becomes conductive, the time constant being determined by a preset interval between the opening of the shutter caused by a release button and an instant at which the shutter should be closed. The time constant is determined by the product of the resistance of resistor R_4 and the capacitance of capacitor C_2 .

In operation, switch S_2 is closed. Concurrently with the operation of the shutter release, short circuiting switch S_1 is opened. The output current from the photo-electromotive element P commences to charge capacitor C_1 . Where the light impinging upon the photo-electromotive element P is extremely weak so that the voltage across capacitor C_1 does not build up to a value sufficient to turn ON transistor TR-1, this transistor will not be rendered conductive by the capacitor voltage so that the shutter will be maintained in the opened state. However, according to this invention, capacitor C_2 is charged by source E through switch S_2 and resistor R_4 to a voltage sufficient to render conductive transistor TR-2 during the predetermined interval. As a result, transistor TR-2 controls the shutter control circuit B as if the field effect transistor TR-1 were rendered conductive, thus closing the shutter.

In accordance with another embodiment of this invention, the interval which is determined by the resistor R_4 and the capacitor C_2 can be made variable. An example of this construction is provided, as shown in the drawing by connecting another resistor R_4 through a switch S_3 across the resistor R_4 . When the switch S_3 is closed, the time constant obtained by the resultant resistance of the resistor parallel circuit and the capacitor C_2 becomes decreased and therefore said interval becomes short. Such a shutter operating circuit as this embodiment is useful for an automatic shutter camera for use with photoflash device.

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Thus, this invention provides a new and improved shutter control circuit which assures desired shutter opening period under adverse light conditions.

It will be clear that the invention is not limited to the particular embodiment illustrated and that many changes and modifications will occur to one skilled in the art within the true scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a shutter operating circuit comprising a shutter time determining circuit including a photo-electromotive element and a high input impedance transistor; means to initiate the operation of said shutter time determining circuit; a shutter control circuit controlled by said shutter time determining circuit; and a source of supply connected to said two circuits, the improvement which comprises a series circuit connected across said source and including serially connected a first resistor and capacitor and a switching transistor with its base electrode connected to the juncture between said resistor and capacitor, said series circuit acting to trigger said switching

transistor to operate said shutter control circuit when said shutter time determining circuit fails to operate after elapse of a predetermined interval after the operation of said initiating means.

2. The shutter operating circuit according to claim 1 wherein said photo-electromotive circuit is connected in series with a capacitor which is normally short circuit by a switch which is opened when a shutter release is operated so that when an object to be photographed has sufficient light, said photo-electromotive element charges said capacitor within a predetermined interval to trigger said high input impedance transistor.

3. The shutter operating circuit according to claim 1 wherein said first resistor is a variable resistor.

4. The shutter operating circuit according to claim 1 is further provided with the second resistor connectable across said first resistor of said series circuit and a switch adapted to connect said second resistor in parallel with said first resistor.

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