EXPOSURE CONTROL CIRCUITRY COMPENSATED FOR TEMPERATURE AND VOLTAGE FLUCTUATIONS

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References Cited
UNITED STATES PATENTS
3,641,890 2/1972 Ono.............................. 95/10
3,698,302 10/1972 Sato............................ 95/10
3,712,194 1/1973 Yoshimura..................... 95/10

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ABSTRACT

In an electrical exposure control device for a single lens reflex camera in which the scene light of objects to be photographed which passes through the objective lens of the single lens reflex camera is received by light receiving elements the output thereof is detected by the compression circuit as a voltage proportional to the value of logarithm of the brightness of said light, said potential is stored in the storage means, the timing circuit is actuated, at the time of exposure, by the current anti-logarithmically converted from the stored voltage, and the activation circuit for terminating the exposure is included; there is disclosed that said device comprises a constant current generating circuit for preventing variation of current resulting from fluctuation of voltage in the power source, said voltage being impressed to the compression circuit; a circuit to which the current generated at the constant current generating circuit is fed, said circuit including photo-conductive elements and resistors, and generating a voltage proportional to a value of logarithm of illumination of light receiving surfaces; a compression circuit connected in series to the secondarily-mentioned circuit and including a bias voltage generating circuit depending upon a set value of film speed and a set value of diaphragm aperture, said compression circuit photographically calculating voltage of both circuits which is developed by output current of said constant current generating circuit and producing output voltage proportional to a value of logarithm of duration of exposure; a storage means for storing output voltage of said compression circuit through a switch prior to exposure; a timing circuit for producing an anti-logarithmically converted current from the stored voltage of said storage means simultaneously with the exposure, the thus produced current being impressed thereto; and an activation circuit being actuated by said timing circuit and terminating the exposure, said device being free from error which may be introduced due to a variation of characteristics of P-N functions in these circuits depending upon a variation of temperature, and part of these circuits being of an integrated circuit.

7 Claims, 13 Drawing Figures
**FIG. 3**

Combination adjustments of film speed and diaphragm aperture with respect to brightness of an object.

**FIG. 4**

Combination adjustments of film speed and diaphragm aperture with respect to exposure time and output voltage of compression circuit.
**FIG. 6(A)**

[Diagram of electrical circuit with components labeled]

**FIG. 6(B)**

Graph showing combined resistance in FIG. 6(A) vs. log LUX.

**FIG. 7**

Graph showing output voltage of compression circuit vs. log LUX.

**FIG. 8**

Graph showing temperature lower vs. temperature higher and brightness of an object.

**TABLE 1**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6</td>
<td>f: 5.6</td>
</tr>
<tr>
<td>ASA 100</td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td>Brightness</td>
</tr>
</tbody>
</table>

**Set Value of Film Speed and Diaphragm Aperture**

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As shown in the diagrams, the relationship between log LUX and brightness of an object is illustrated. The output voltage of the compression circuit varies with changes in temperature and brightness levels, as indicated by the graphs.
FIG. 9

Collector current of transistor Q2

TEMPERATURE TENDENCY TO LOWER

VOLTAGE ACROSS THE BASE AND Emitter of transistor Q2

FIG. 10

FIG. 11

Amplification factor of integrated transistor

-25° 0° 25° 50°
EXPOSURE CONTROL CIRCUITRY COMPENSATED FOR TEMPERATURE AND VOLTAGE FLUCTUATIONS

BACKGROUND OF THE INVENTION

The present invention relates to an electrical exposure control device for a single lens reflex camera and, more particularly, to an electrical exposure control device for a single lens reflex camera in which scene light entering an objective lens of a single lens reflex camera is received by light receiving elements so as to produce and store a value signal representative of the object brightness to be photographed. Exposure is controlled according to the stored signal as well as by a shutter speed manually set according to the brightness of the object to be photographed, the film speed, and the diaphragm aperture.

In the single lens reflex camera, it is well known that where the exposure is controlled by measurement of the scene light passing through the objective lens, the release operation causes the camera to be shifted from the viewing condition to the exposure condition. Also the reflex mirror is shifted from the viewing position to the exposure position. Therefore, the brightness of the object to be photographed, prior to causing the diaphragm aperture to enter a preset aperture setting, is detected as a voltage signal by a detection circuit, the detected voltage is stored by a storage means; a timing circuit is actuated by the stored voltage simultaneously with the start of exposure; and when the level detection circuit detects that the voltage level of the timing circuit has reached a predetermined level, the operating circuit for terminating exposure is actuated.

It is also known that the brightness of the object to be photographed which is detected by the detection circuit is logarithmically compressed; the logarithmically compressed voltage is stored in the storage means. Thereafter the stored voltage is anti-logarithmically converted. By such an arrangement, the capacity of the capacitor of the storage means can be lessened and the voltage of the power source can be lowered.

However, it is apparent that in the processes of logarithmical compression to the anti-logarithmical conversion, even a small error introduced in the logarithmically compressed stored voltage would result in a large error of the duration of exposure to be controlled, when the stored voltage is logarithmically extended. It will be also understood that an error in the exposure duration to be controlled, which is inversely proportional to the logarithmically extended storing voltage, becomes large, particularly when the brightness of the object to be photographed is high, in other words, when a fast shutter speed is controlled.

For reducing such an error to a minimum, the elimination of the error based upon fluctuation of the power source voltage must first be taken into consideration. For this purpose, the voltage compression circuit must be actuated by the output of the power source. Additionally, P-N junctions of transistors and diodes in either the constant current generating circuit, the compression circuit and the timing circuit are used for compensation. The P-N junction has a well-known characteristic which varies depending upon the temperature. Accordingly, consideration for compensation of error caused due to the temperature change of the P-N junctions of the respective semiconductor elements is required.

In the actual application of the exposure control according to the storage system in a single lens reflex camera, besides the value of brightness of the object to be photographed, values of film speed and diaphragm aperture are employed to control the exposure time. The diaphragm aperture, when the camera is in the viewing condition, is left fully open corresponding to the light projected through the objective lens, and is set to a preset value when the camera is changed into the exposure condition. Accordingly, the value of the diaphragm aperture is normally a preset value.

Either a value of film sensitivity or a preset value of the aperture changes such that the former is ASA 25, 50, 100 ... and the latter is 1.4, 2, 2.8, 4, etc., respectively, and these values must be fed as inputs to the compression circuit.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an electrical exposure control device for a single lens reflex camera, wherein, in a system for controlling an exposure in which a detected value of illumination of an object to be photographed is logarithmically compressed, that value is stored in a storage means prior to exposure, and at the time of exposure, the exposure is controlled according to the stored value, introduction of errors resulting from fluctuation of the power source voltage and temperature changes are prevented.

Another object of the present invention is to provide an electrical exposure control device for a single lens reflex camera, in which, in an exposure control circuit of the type specified, and wherein a camera is provided with a curtain shutter consisting of two curtains, there is provided a delay circuit for compensating for exposure error resulting from an overlap between the trailing edge of the forward curtain and a leading edge of the rear curtain, which overlap exists when the curtain shutter is in a cocked position. A still further object of the present invention is to provide an electrical exposure control device for a single lens reflex camera, wherein the exposure control circuit is of a monolithic integrated circuit construction to provide miniaturization.

SUMMARY OF THE INVENTION

The foregoing objects of the present invention are obtained by a special design of a constant current generating circuit, which provides a source of current to the voltage compression circuit for determining a voltage in accordance with the object brightness; and a special design of the compression and exposure time control circuits. The constant current generating circuit uses semiconductor elements, such as transistors and diodes which are selected to have matching temperature characteristics. The semiconductor elements are connected to provide compensation for both the fluctuation of the battery power source and temperature changes. The voltage compression circuit includes compound photoconductive elements for producing a voltage proportional to the logarithm of the illumination on the light receiving surfaces of the compound photoconductive elements. A voltage bias circuit generates a voltage in accordance with the film speed and the diaphragm aperture setting. Both the logarithmic voltage and the voltage of the bias circuit are combined using the output of the constant current generating circuit to produce an output voltage representative of the
exposure time. That output voltage is stored and fed to a timing circuit wherein the logarithmically compressed signal is anti-logarithmically converted upon the initiation of exposure to actuate a circuit for terminating exposure. The voltage compression circuit and the timing circuit each include semiconductor elements selected and interconnected to compensate for errors resulting from temperature changes.

The circuit components are intended to be constructed as integrated circuits in order to provide miniaturized components for the exposure control circuits in a camera of the type specified herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram representation of an embodiment according to the present invention;

FIG. 2 is a graph showing a temperature characteristic of the output current of the constant current generating circuit shown in FIG. 1;

FIG. 3 is a graph showing the relationship of the output voltage proportional to the logarithm of brightness of an object to be photographed in the compression circuit of FIG. 1, in relation to respective set values of film speed and diaphragm aperture;

FIG. 4 is a graph showing the relation between the output voltage of the compression circuit and the logarithmic exposure time as a function of different film speed and diaphragm aperture settings;

FIGS. 5(A) and 5(B) are the electric circuit diagrams of an embodiment according to the present invention;

FIG. 6(A) is a partial circuit diagram showing an exemplary embodiment of a compound light receiving element for the compression circuit in the embodiment of FIGS. 5(A), 5(B);

FIG. 6(B) is a graph showing the relation between the logarithmic light value on receiving surfaces of the light receiving element of FIG. 6(A), and the value of combined resistance;

FIG. 7 is a graph showing the relation between the terminal voltage of a variable bias resistor Rs for setting values of film speed and diaphragm aperture and the values of diaphragm aperture and film sensitivity in the embodiment of FIGS. 5(A), 5(B);

FIG. 8 is a graph showing the relationships, for different temperatures, between an output voltage of the compression circuit and logarithmic light value of the light on the receiving surfaces of the light receiving elements;

FIG. 9 is a graph showing the relation between the base-emitter voltage of an input transistor of the timing circuit and the logarithmic collector current of the same transistor;

FIG. 10 illustrates a permissible range of automatic control as indicated by a meter circuit; and

FIG. 11 is a graph showing the relation between the amplification of an NPN transistor and a PNP transistor and the ambient temperature.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 constant current generating circuit I generates a stable output current even in the event of fluctuations in the supply voltage, while the output current thereof changes in proportion to an absolute temperature. The characteristics of the output current and the temperature are shown in FIG. 2. Constant current generating circuit I serves as a power source for meter circuit M and compression circuit P. Compression circuit P converts a quantitative change of incident light into a representative voltage signal. Generally, brightness of an object to be photographed and the aperture and film sensitivity settings, all of which are taken as inputs, change as, for example, 1 lux, 2, 4, ... lux in the value of brightness of the object to be photographed; 1, 4, 2, 8, 4 ... in the aperture settings, and 25, 50, 100 (ASA values) of film sensitivity, respectively. Accordingly, if such changing values are used, as they are, as outputs of measured light, the measured light outputs change accordingly. For example, suppose that the range of duration of exposure is limited from 1 to 1/1,000 second and the output voltage of the compression circuit P is 0.1 v per second. Then the output voltage is 100v for 1/1,000 second. Therefore, a large power source voltage is required and the employment of miniaturized circuitry is impossible. Consequently, the practical application of such values becomes impossible, or else requires bulky components, or produces inaccurate and unacceptable results.

In the circuitry according to the present invention, the abovementioned problems are overcome by using a compression circuit P so designed that an equal-differentially changing output of the measured light is obtained from the changing input data; the characteristic relationship thereof being shown in FIG. 3.

With respect to the storage means Me, in the single lens reflex camera, scene light of the object to be photographed passes through a photographing lens system, from which it is introduced to the finder system by a reflex mirror. Light receiving elements are disposed rearwardly from the reflex mirror so as to provide the light measurement. At the time of photographing, when the reflex mirror is rotated to block the path of light to the light receiving elements, the outputs thereof fluctuate to such an extent that the output voltage of the compression circuit does not represent a precise value. Therefore, in such a case, the duration of exposure cannot be controlled by the output of the compression circuit P. For the sake of eliminating such influences due to rotation of the reflex mirror or the like, there is provided a storage means Me, in which the output voltage of the compression circuit P is stored on a capacitor thereby using the output voltage of the compression circuit P during a period required to control the duration of exposure.

A timing circuit Tc, in case automatic exposure control is desired, controls the changing exposure times in accordance with the changing stored voltages of storage means Me, for example, by means of a transistor and capacitor timing circuitry; whereas, for manually set exposure control a circuit consisting of a fixed resistor and capacitor is actuated.

Level detection circuit D detects the level of output of the timing circuit Tc and generates an output signal when the timing circuit output reaches a predetermined level.

Delay circuit De may be added in the case where there is used a focal plane shutter having a forward curtain and a rear curtain which are overlapped to eliminate light leakage when the shutter is cocked. Delay circuit De is actuated to electrically adjust for an error in the duration of exposure resulting from the difference in the starting positions between the trailing edge of the forward curtain and the leading edge of the rear curtain. The delay circuit enables the adjustment between both curtains during assembly to be simplified.
Activation circuit A amplifies the output of either level detection circuit D or delay circuit De and controls the energization of an electromagnet to terminate exposure.

Finally, meter circuit M is actuated by the outputs of compression circuit P and constant current generating circuit I to indicate the duration of exposure at the time of photographing. The respective characteristics of storage means Me, timing circuit Tc, level detection circuit D, delay circuit De, and the activation circuit A are shown in FIG. 4.

The relationships of the various parameters for the respective circuits are represented by the following formulas.

In the compression circuit P, \( V_p = K_1 + \log (L + K_2) \) \hspace{1cm} (1)

Wherein \( L \) is the brightness of the object to be photographed, \( K_1 \) is a constant, \( K_2 \) is a term which is determined depending upon a combination of the film sensitivity and aperture values, and \( V_p \) is the output of compression circuit P which is fed as an input to timing circuit Tc.

In timing circuit Tc, level detection circuit D, delay circuit De, and activation circuit A, the formula is:

\[ V_c = K_3 \log \left( \frac{1}{T + \alpha} \right) \] \hspace{1cm} (2)

wherein, \( K_3 \) is a constant, \( T \) is the exposure time, \( \alpha \) is the delay of delay circuit De, which is a value adjustable by the camera.

As is obvious from the above formulae, if the values of \( K_1, K_2 \) and \( K_3 \) are suitably determined, \( L = 1/P \) is obtained, and thus, the duration of exposure, \( T \), is automatically obtained as a function of the brightness of the object to be photographed.

Referring to FIGS. 5(A), 5(B) and constant current generating circuit I, the emitter current of transistor Q6 provides a constant current to light receiving elements Rc6s1, Rc6s2 and resistors R7, R8 of the compression circuit P; the emitter current of transistor Q11 provides a constant current to variable bias resistor Rs, the resistance of which varies depending upon the film speed and diaphragm aperture settings of compression circuit P; and the emitter current of transistor Q30 provides a constant current to meter circuit M.

Now with particular reference to FIG. 5(A), resistors R1 and R2 are connected in series with each other and are connected to the collector of NPN transistor Q1, while a terminal of resistor R1 is connected through switch S1 to the positive electrode of power source E. The emitter of NPN transistor Q1 is connected to the negative electrode of power source E. The base of transistor Q1 is connected to the junction of resistors R1, R2.

NPN transistor Q2, the base of which is connected to the collector of NPN transistor Q1, generates collector current proportional to the absolute temperature. The emitter of transistor Q2 is connected by resistor R3 to the negative electrode of power source E and the collector of transistor Q2 is connected to the emitter of NPN transistor Q3. The collector of NPN transistor Q3 is connected by resistor R4 and switch S1 to the positive electrode of power source E and also is connected to the emitter of PNP transistor Q4. The collector of PNP transistor Q4 is connected to the base of NPN transistor Q3 and to the base of NPN transistor Q7.

The collector of transistor Q7 is connected by switch S1 to the positive electrode of power source E and the emitter thereof is connected to the collector of transistor Q8. The base of transistor Q8 is connected to the base of NPN transistor Q2. The emitter of transistor Q8, which has a current characteristic equivalent to that of transistor Q2, is connected by resistor R5 to the negative electrode of power source E. The emitter of transistor Q7 is also connected through series connected diodes D1 and D2 to the base of PNP transistor Q4.

A circuit consisting of PNP transistor Q5 and PNP transistor Q6 is connected through resistor R6 and switch S1 to the positive electrode of power source E, and is connected in an equivalent manner as the circuit consisting of PNP transistor Q4 and NPN transistor Q3. The emitter of NPN transistor Q6 is connected to a circuit which produces an output voltage proportional to the logarithm of the brightness of the object to be photographed. In a similar manner, a circuit consisting of PNP transistor Q10 and NPN transistor Q11 is connected through resistor R12 and switch S1 to the positive electrode of power source E, and is connected in an equivalent manner as the circuit consisting of PNP transistor Q4 and NPN transistor Q3. The emitter of NPN transistor Q11 is connected to a circuit which produces a logarithmically compressed bias voltage depending upon the film speed and aperture settings.

Similarly, a circuit consisting of PNP transistor Q29 and NPN transistor Q30 is connected through resistor R39 and switch S1 to the positive electrode of power source E, and is connected in an equivalent manner as the circuit consisting of PNP transistor Q4 and NPN transistor Q3. The emitter of transistor Q30 is connected to meter circuit M. The bases of PNP transistors Q5, Q10, Q29 are all connected to the base of PNP transistor Q4.

Accordingly, if the voltage of power source E decreases, the operating current of transistor Q1 decreases, resulting in a decrease in the base-emitter voltage \( V_{be} \) of transistor Q1. However, the voltage across resistor R2 also decreases and therefore the collector potential of transistor Q2 is held stable against voltage fluctuation of power source E. This fact can be demonstrated by the following analysis. It is assumed that \( Tc \) is the absolute temperature, \( Is1 \) is the saturation current of transistor Q1 at temperature \( Te \), \( Is2 \) is the saturation current of transistor Q2 (the saturation current is determined for each transistor and varies depending upon temperature), then the following formula applies:

\[ (K_{Tel/q}) \ln(I1/I1) = R2I1 + (K_{Tel}/q) \ln (I2/Is2) + R3/2 \] \hspace{1cm} (3)

wherein, in order that the emitter current I2 of transistor Q2 is stable regardless of any fluctuation in the emitter current I1 of transistor Q1, \( a2/a1 = 0 \), and hence

\[ R2I1 = K_{Tel/q} \hspace{1cm} (R2/I1 = 26 \text{ mV if } Te = 300^\circ K) \] \hspace{1cm} (4)

and therefore, resistors R2, R3 must be set to satisfy the above formula.

Between the base-emitter of transistor Q1 and transistor Q2, a difference in the base-emitter voltage \( V_{be} \)
is produced either by providing a difference between emitter current \( I_1 \) and \( I_2 \), or by providing a difference between the areas of the emitter layers. The temperature coefficient of the base-emitter voltage \( V_{BE} \) is:

\[
V_{BE} = (KT/e) \ln \left( \frac{I_1}{I_1 B_1 - 1} \right)
\]

from which the following formula is obtained:

\[
dV_{BE}/dT = \frac{(V_{BE}/Te)}{-(KT/e) \cdot (dln(I_1)/dT)} < 0
\]

With increases in \( V_{BE} \), \( dV_{BE}/dT \) decreases. Accordingly, the difference in \( V_{BE} \) between transistors Q1 and Q2 varies as the temperature changes. In other words, the emitter current \( I_2 \) of the transistor Q2 is affected by temperature change. In the present invention, a difference of several 10 mV exists so as to set the collector current of transistor Q2 proportional to the absolute temperature. If a difference in \( V_{BE} \) is represented by the difference between emitter current \( I_1 \) and \( I_2 \) of transistors Q1 and Q2, and if transistors Q1 and Q2 have equal characteristics, and the amplification factors of which are sufficiently large, then, the following formulae apply:

\[
\frac{KT_1}{q} \ln \frac{I_1}{I_1 B_1 - I_1 R_2} = I_2
\]

(7)

\[
\frac{KT_2}{q} \ln \frac{I_2}{I_2' - I_1 R_2} = I_2'
\]

(8)

(wherin \( I_2' \) is the emitter current of transistor Q2 when the temperature is \( T_2 \)).

Suppose that the following relationship is substituted in formulas 7 and 8:

\[
I_{s1}' = I_{s2}' = I_2' = (T_2/T_1) I_2
\]

(9)

(wherein \( I_{s1} = I_{s2} \)), then, the formula:

\[
ln I_1 - ln I_2 + \left[ T_2/(T_2 - T_1) \right] ln T_2/T_1 = (q/KT_1) R_3 I_2
\]

(10)

is obtained.

In the above formulae, \( T_1 \) and \( T_2 \) are determined by the required temperature range, and the emitter current \( I_2 \) of transistor Q2 is known since it is a required current, as well. Then by assigning a stabilizing value to resistor R3, the value of emitter current \( I_1 \) of transistor Q1 is obtained.

It should be noted that with respect to transistors Q3, Q4, Q5, Q6, Q10, Q11, Q29 and Q30, should an integrated circuit be used, the amplification factor of PNP transistors is greatly lowered to such an extent that it is impossible to use PNP transistor alone, and therefore, in the present invention, PNP transistors and NPN transistors are employed in combination, to thereby increase the amplification factor. As is apparent from FIG. 5(A), the approximate emitter currents of transistors Q6, Q11 and Q30 are obtained from the following formulae, respectively:

\[
I_6 = (R_4/R_6) I_2; I_{11} = (R_4/R_{12}) I_2; I_{30} = (R_4/R_{38}) I_2
\]

(11)

Because the emitter current \( I_2 \) of transistor Q2 remains stable with respect to voltage fluctuation of power source E, and is proportional to the absolute temperature, output currents, \( I_6, I_{11} \) and \( I_{30} \) are also stable with respect to voltage fluctuations of power source E and are also proportional to the absolute temperature. A circuit consisting of transistors Q7, Q8, diodes D1, D2 and resistor R5 generates the base current of the aforesaid PNP-NPN transistor combination circuits. In that circuit the base current flows to diodes D1, D2, while the current fed to transistor Q7 and the current of transistor Q8 have a constant current characteristic equivalent to the current characteristic of transistor Q2. In the event that the amplification factors of the PNP transistors are extremely low, the characteristics of emitter currents \( I_6, I_{11} \) or \( I_{30} \) are not affected, even if the base current is large.

With continuing reference to FIG. 5(A), compression circuit P is a circuit for converting analogically-changing input photographic data, such as the brightness of the object to be photographed, and aperture and film sensitivity settings and the like, into an arithmetically-changing output voltage.

Two photoconductive elements \( R_{c1} \) and \( R_{c2} \) are combined into a so-called composite photoconductive element, and each photoconductive element, as seen in FIG. 6(A), consists of a photoconductive element \( cdsh \) of high sensitivity and a photoconductive element \( cdsl \) of low sensitivity, and are connected in parallel with each other. High sensitivity photoconductive element \( cdsh \) is connected in series to resistor \( r_1 \) and resistor \( r_2 \) is connected in series with the parallel circuit. The logarithm of the combined resistance of the aforesaid resistors is linear over a wide range relative to the logarithm of the scene light, as is clearly shown in FIG. 6(B).

Two photoconductive elements, one of which is shown in FIG. 6(A), are employed in the circuit of FIG. 5(A), in which the high sensitivity photoconductive elements (on the side of low resistance) are connected with each other through variable resistor \( R_9 \) and in parallel with which the low sensitivity photoconductive elements (on the side of high resistance) are directly connected with each other, and variable resistor \( R_9' \) is connected as shown in FIG. 5(A). The two compound photoconductive elements are mounted in a finder light path system (for example, at a front edge and a rear edge surface of a roof-shaped reflex pentagonal prism). By adjusting the resistances of variable resistors \( R_9 \) and \( R_9' \), the output voltage varies arithmetically in relation to the analogically-changing value of brightness of the object to be photographed which is referred to as the CLC effect.

Resistors \( R_7, R_8 \) connected in series with each other are connected in parallel with the above described compound photoconductive circuit. Resistors \( R_7, R_8 \) and the photoconductive circuit are connected to the collector of transistor \( Q_9 \), the base of which is connected to the junction of resistors \( R_7 \) and \( R_8 \). Transistor \( Q_9 \) provides temperature compensation for the base-emitter voltage of transistor \( Q_{12} \).
Resistor R10 and thermistor Rth are connected to the emitter of transistor Q9. Since emitter current I6 of transistor Q6, or, in other words, the operating current of transistor Q9, varies in proportion to the absolute temperature, the base-emitter voltage of transistor Q9 also changes in accordance with the temperature change, contrary to the case where the emitter current I6 of transistor Q6 is constant. If emitter current I6 decreases as the temperature falls, the variation of the base-emitter voltage is less than the case where emitter current I6 is constant. That difference is compensated by resistors R10 and Rth. This compensation is represented by the following formula:

\[
\Delta VBE = (KT/2q) \ln I6 - (KT/2q) \ln [I6 \cdot (T2/T1)]
\]

(12)

wherein, if the variation of temperature is 50°C, the difference is approximately 4 mV, which is compensated.

Variable resistor Rs is a means for feeding data such as the values of aperture and film sensitivity. The voltage produced across Rs is 16 Rs = 16 × (nr), wherein, n is the number of set levels and r is a value of resistance per 1 electron volt (eV). By setting n according to the values of aperture and film sensitivity, the voltage produced across resistor Rs has the variation as shown in Fig. 7. Now, the sum of outputs Vp of the compression circuit P (the voltage between the positive side of resistor R9' and the negative electrode of power source E) are represented by the formula:

\[
Vp = VBE_{oa} + (R_s + R')/11 + [R_s + R' + (R7 - R9') - R8 Rcds][R7 + R8 + Rcde + R9'] I6
\]

(13)

wherein, R' is the combined resistance of resistors R10, Rth and R11; Rcde is a combined resistance of resistors Rcde1, Rcde2 and R9. These are shown in Fig. 8 for a typical example, in which Rs and Rcde, that is to say, the values of aperture, film sensitivity and brightness of the object to be photographed are shown as a function of the temperature. As is apparent from that graph, so far as the output voltage characteristic is concerned, since the emitter current I11 or I6 is stable in relation to the voltage of power source E, the output voltage is stabilized. Meanwhile, in relation to the temperature, the output voltage is shifted parallel, because the base-emitter voltage VBEoa of transistor Q9 increases as the ambient temperature falls, and since emitter currents I11 and I6 are proportional to the absolute temperature, the gradient of output voltage Vp becomes less.

In connection with the storage means Me, as shown in Figs. 5(A) and 5(B), wherein output voltage Vp of the compression circuit P is stored, output voltage Vp is cut off by means of switch S2 when the mirror is turned. Thus, output voltage Vp is stored for the period required to control the duration of exposure and is fed as an input to timing circuit Tc, and the change of output voltage Vp for a duration of exposure requires a nominal value of capacity. In this invention, the duration of storage produces a negligible error of the duration of exposure.

Timing circuit Tc, as shown in Fig. 5(B), is composed of transistor Q12 controlled by switch S4 being opened in conjunction with the shutter release and according to an input from the storage means which stores the output Vp of the compression circuit P. Transistor Q12 and capacitor C2 are connected so as to produce an output at the collector of transistor Q12, whereby the duration of exposure is automatically controlled by setting the values of aperture and film sensitivity. Variable resistor RT and capacitor C3 are connected in series with each other to produce an output at their junction, so that a desired duration of exposure is manually controlled by change-over switches AM1 and AM2.

Assuming a reference voltage VT of the level detection circuit D between the base of transistor Q14 and the positive electrode of power source E, the duration of exposure T' is obtained by the following formula. In case of a manual control, as is well known, the formula is:

\[
T' = C3RT \ln \left( \frac{1}{1 - VT/E} \right)
\]

(14)

For automatic control, if the collector current of transistor Q12 is IcQ12, and if R35 = 0, the duration of exposure T' is:

\[
T' = \frac{2VT}{C2IcQ12}
\]

(15)

As is well known for manual control, T' is stable either for a variation in the power source E voltage or for changes in temperature, and therefore, further elaboration is not necessary. However, in the case of automatic control T' is a function of the voltage variations of power source E and the changes in ambient temperature. In relation to fluctuations of power source E voltage in formula 15, VT is given by the formula

\[
VT = \frac{R15}{(R15 + R16 + R13)} \cdot E
\]

(16)

Accordingly, the duration of exposure T' is not subject to variation in the event of fluctuation of voltage in the power source E, and it is sufficient to vary IcQ12 at a fixed rate. That is to say, it is enough to vary the base potential of transistor Q12.

In case resistor R13 and capacitor C1 are connected as shown in Fig. 5(B), ICQ12 changes from I1 to I2, when the voltage of power source E varies from E1 to E2, the amount of fluctuation VBEQ12 of the base-emitter voltage VBEQ12 of transistor Q12 is obtained as follows in the generic formula of transistor:

\[
VBEQ12 = \frac{(KT/eq) \ln (I1/Is) - (KT/eq) \ln (I2/Is)}{KT/eq} \ln I1/I2
\]

(17)

and, suppose that the duration of exposure T' is constant,

\[
I1 = \frac{(C2/T') \cdot [R15/(R15 + R16)] \cdot E1}{I2} = \frac{(C2/T') \cdot [R15/(R15 + R16)] \cdot E2}{I2}
\]

(18)

accordingly, formula 16 becomes:

\[
VBEQ12 = \frac{(KT/eq) \ln E1/E2}{1 - E1 - E2}
\]

(19)

wherein, if E = E1 - E2, the following formula is obtained:
\[
\frac{(R_{13}+R_{15}+R_{16})}{(R_{13})} = -(1/E) \cdot \frac{(KT/q)}{E} \ln \left\{ \frac{(E-\Delta E)}{E} \right\}
\]

(wherein \(\Delta E\) is the amount of fluctuation of voltage in the power source, and the value of resistance of the resistor \(R_{13}\) is set so as to satisfy formula 16.) For example, if \(E_{1} = 6V\), and \(E_{2} = 2V\), the voltage across resistor \(R_{13}\) is approximately 60 mV. As a result, a substantially perfect voltage is compensated for that fluctuation of voltage in the power source \(E\), which takes place when the electromagnet \(M_{G}\), which requires a large current, is rendered conductive.

In the event of a temperature change, in order to maintain the value of duration of exposure \(T\) free from fluctuation, collector current \(I_{CQ12}\) of transistor \(Q12\) must be kept stable. In general, the base-emitter voltage of a transistor is represented by

\[
V_{BEQ12} = (KT/q) \ln (I_{CQ12}/I_{S})
\]

and its characteristic is shown in FIG. 9. As is apparent from FIG. 9, there is a parallel shift in the characteristic and a variation in its gradient, as the temperature changes. The gradient varies in proportion to the absolute temperature, as is understood from the foregoing formula. Accordingly, so far as the duration of exposure \(T\) is concerned, compensation is made so as to offset these two functions of the base-emitter voltage \(V_{BEQ12}\) of transistor \(Q12\).

In view of the formula representing the output voltage \(V_{P}\) of the compression circuit \(P\), if a transistor having a characteristic equivalent to those of transistors \(Q9\) and \(Q12\) is employed, the variation of the base-emitter voltage \(V_{BEQ9}\) of transistor \(Q9\) compensates for the parallel shift variation in the base-emitter voltage \(V_{BEQ12}\) of transistor \(Q12\). The gradient component, which varies in proportion to the absolute temperature, is compensated by the emitter currents \(I_{E1}\) and \(I_{E6}\), which are proportional to the absolute temperature.

Particularly, in case of a short duration of exposure, the voltage on capacitor \(C1\) is slightly discharged through transistor \(Q12\) and resistor \(R_{13}\). If the base current of transistor \(Q12\) is \(ib_{Q12}\), the potential at the base of transistor \(Q12\) is lowered by the value \(ib_{Q12} \times R_{13}\). Therefore, this change in potential is added to the potential at the base of transistor \(Q12\) and is related to the duration of exposure. For example, 1.1 mV for \(1/1,000S = 1 mV\); 2.1 mV for \(1/500S = 2 mV\); 4.1 mV for \(1/250S = 4 mV\).

To compensate for this, if variable resistor \(R_{35}\) is incorporated between transistor \(Q12\) and capacitor \(C2\) as shown in FIG. 5(B), then,

\[
VT = (1/C2) \cdot I_{CQ12} + I_{CQ12} \cdot R_{35} \text{ becomes } T' = \frac{(I_{CQ12}/C_{Q12}) - (R_{35})}{(2C_{VQ12}I_{CQ12}) - (2C_{R35})}
\]

It will be apparent from the above formulae that a fixed value of seconds equivalent to delay elements \(C_{R35}\) can be deducted. For example, if 1.1 mV is to be equivalent to 1 mS, and if \(C2 = 1 \mu F\), the value of \(R_{35}\) is 100 \(\Omega\).

Level detection circuit \(D\) in FIG. 5(B) is so composed that the voltage divided by resistors \(R_{15}\), \(R_{16}\) or a variable resistor \(R_{22}\), is fed to one terminal of the input of level detection circuit \(D\), so that voltage serves as a reference voltage (which is the above voltage \(VT\)). The other terminal of the input is connected to the output terminal of timing circuit \(Tc\), and voltage of capacitors \(C2\) and \(C3\) is compared to that reference voltage. In FIG. 5(B), transistors \(Q13\) and \(Q14\) form a known type of differential amplification circuit, in which transistor \(Q16\) serves as a constant current supply source. A circuit consisting of transistor \(Q17\) and resistors \(R_{17}\), \(R_{18}\) is identical in composition with the circuit consisting of transistor \(Q1\) and resistors \(R_{1},R_{2}\) in the constant current generating circuit \(I\). Since the collector current of transistor \(Q1\) is stable in relation to fluctuations of voltage in the power source, the collector current of transistor \(Q12\) is extremely stable in relation to fluctuations of voltage in the power source. As for temperature changes, should the base of transistor \(Q16\) be connected directly to the collector of transistor \(Q17\), it follows that the collector current of transistor \(Q16\) is subject to variation, and therefore, a buffer circuit consisting of diodes \(D3\), \(D4\) and resistors \(R_{19},R_{20}\) are provided to stabilize the collector current. By means of this circuit, transistors \(Q13\) and \(Q14\) are stably actuated to produce the stable output at the collector of transistor \(Q22\) which is an output of level detection circuit \(D\).

Delay circuit \(Dc\), as shown in FIG. 5(B), is used in the case wherein the circuitry of the present invention is applied to a camera having a focal plane shutter, and a fixed time delay must be added to the time established by timing circuit \(Tc\), because of the difference in the starting positions between the forward curtain and the rear curtain, as explained above. In delay circuit \(Dc\), variable resistor \(R_{28}\) and capacitor \(C4\) are connected in series with each other. Capacitor \(C4\) is connected to transistor \(Q23\) to render it conductive or non-conductive according to the output of level detection circuit \(D\), whereby capacitor \(C4\) is effectively short-circuited or in an opened condition. With the aid of the charging characteristic of capacitor \(C4\) and variable resistor \(R_{28}\), a fixed rate of time lag is provided. In the circuit, the junction between resistor \(R_{28}\) and capacitor \(C4\) serves as an output point.

Activation circuit \(A\) detects the variation of voltage in the output delay circuit \(Dc\), and amplifies it to actuate electromagnet \(Mg\). In FIG. 5(B), the voltage of power source \(E\) is divided by diodes \(D5\), \(D6\) and resistors \(R_{29},R_{30}\), to produce a reference voltage at the junction of resistors \(R_{29}\) and \(R_{30}\). The reference voltage and variation of output voltage at the output of delay circuit \(Dc\) are compared and detected by transistor \(Q24\), and amplified by transistors \(Q25\), \(Q26\) and \(Q27\). In this circuit, diodes \(D5\) and \(D6\) are employed to compensate in the event of fluctuation of voltage in the power source \(E\) and for temperature changes. In this case, the formulae are:

\[
(1/C4) \cdot i_{R28dt} = V_{BEQ24} + (E-V_{D5}-V_{D6}) \times \frac{R_{30}}{(R_{29}+R_{30})}
\]

which becomes

\[
t = \frac{C4R28 \ln (E)}{E - V_{BEQ24} - \frac{R_{30}}{R_{29}+R_{30}} \times (E-V_{D5}-V_{D6})}
\]

wherein, if \(V_{D5} = V_{D6} = V_{BEQ24}, R_{29} = R_{30}, \) then \(t = C4R28 \ln 2\). Thus, a stabilized fixed rate of time lag is obtained. In the camera provided with a focal plane...
shutter, the electromagnet Mg actuates armatures associated with the retention and release of the rear curtain. Resistor R31 connected in series with electromagnet Mg adjusts the current flow to electromagnet Mg to set the most suitable value. Diodes D7, D8 and D9 are arranged for the purpose of preventing transistor Q27 from being affected due to the counter-electromotive force of electromagnet Mg. Capacitor C5 is connected in parallel with electromagnet Mg and resistor R31, and compensates for the variation between intervals of actuation of the armatures by electromagnet Mg. This enhances the accuracy of the circuit performance especially when a short duration of exposure is controlled. Both resistors R32 and transistor Q32, the collector of which is connected to one terminal of the input side of level detection circuit D, are provided for preventing oscillations caused by the following reason.

A power source in a camera is subject to restriction in size because of the dimensions of the camera, and therefore, dry cells employed therein must be extremely small. In that case, should the large quantity of current (for example 30mA) be fed to the electromagnet Mg, it would cause a voltage drop of the dry cells. Further, when the electromagnet is rendered non-conductive, the load on the dry cells drastically decreases, as a result of which the voltage thereof instantaneously rises slightly, and thereafter, is returned to the original condition. Accordingly, in timing circuit Tc and level detection circuit D, assuming that the instantaneously rising voltage in the supply source is ΔE, the base voltage of transistor Q14 changes to ΔE [R15/(R15+R16+R13)], while the base of the transistor Q13 of the differential amplification circuit does not follow the variation of voltage in the power source E, because of capacitors C2 and C3 connected thereto. Consequently, the base voltage of transistor Q13 varies by ΔE and the repetitive variation of the base voltage causes the circuit to oscillate.

Meter circuit M, as shown in FIG. 5(A), actuates meter Met by the output of compression circuit P. Meter Met indicates a set value of duration of exposure as shown in FIG. 10, and provides a warning, when a set value of duration of exposure which is determined by a combination of the values of aperture, film sensitivity and brightness of the object to be photographed, exceeds a permissible range. In FIG. 5(A), inputs to meter circuit M are fed to the base of transistor Q31, and if the potential thereof varies, the emitter potential of transistor Q31, is represented by the following formula:

\[ VEQ30 = Vp + VBEQ31 + I30R36 \]  

(23)

Accordingly, the emitter potential varies in a manner similar to the output potential Vp of compression circuit P. The emitter potential of transistor Q34 is represented by the following formula:

\[ Vp + VBEQ31 + I30R36 - VBEQ33 - VBEQ34 \]  

(24)

Accordingly, the variation of the emitter potential of transistor Q34 is equivalent to that of the output voltage Vp of compression circuit P. The output voltage Vp of this circuit is left unchanged in the event of fluctuation of voltage in the power source, and emitter current I30 of transistor Q30 is maintained stable, thereby ensuring accurate meter indication. Also, with respect to variations of ambient temperature, an offset to the temperature change is made in the sum of the base-emitter voltage VBEQ9 of transistor Q8 and voltage VBEQ31 of transistor Q31 and in the sum of the base-emitter voltage VBEQ33 of transistor Q33 and voltage VBEQ34 of transistor Q34. The emitter current I30 of transistor Q30 varies in proportion to the absolute temperature. The temperature coefficient thereof is approximately 3,300 PPM/°C, while the temperature coefficient of the internal resistance of meter Met is approximately 3,800 PPM/°C, because its coils are made of a copper wire. Hence, these temperature coefficients offset one another to ensure the stable and precise indication of meter Met. Furthermore, variable resistor R37 connected in series with meter Met to the emitter of transistor Q34 is employed for adjusting the gradient characteristic of meter Met.

Since the emitter current I30 of transistor Q30, as set forth, varies in proportion to the absolute temperature, the operating current of transistor Q31 also shows an equivalent variation.

In detail, the base-emitter voltage VBEQ31 of transistor Q31 varies in like manner to that of the base-emitter voltage VBEQ9 of transistor Q9 of the compression circuit, to cause a slight error of meter Met. Although the error is small to such extent that no special compensation is normally required, there is provided in the present invention, for compensation purposes, resistor R38 interposed between the output of the compression circuit and transistor Q31. Generally, in an integrated circuit, the amplification factor of an NPN transistor decreases by approximately 30 percent with every 50°C decrease of temperature, while that of a PNP transistor decreases approximately by 50 percent. Accordingly, if transistors Q31 and Q32 in meter circuit M are in an integrated circuit, the amplification factor thereof decreases approximately by a total of 65 percent. In detail, the base current of transistor Q31 increases with a decrease in temperature, and then, the voltage across resistor R38 varies with a change in temperature. Accordingly, if the voltage variation across resistor R38 is set to be equivalent to the variation of the base-emitter voltage VBEQ31 of transistor Q31, the indication error of meter Met can be minimized to a negligible extent. In case transistors Q31 and Q32 are normal transistors, the decrease in the amplification factor of either an NPN or a PNP transistor is approximately 30%, and therefore, the resistance of resistor R38 must be set accordingly.

In the constant current generating circuit, it is obvious that a variation of resistance in resistor R6 causes a variation in emitter current I6 of transistor Q6. In the compression circuit P, the variation in the characteristics of two composite photoconductive elements Rcds1 and Rcds2 is adjusted by variable resistors R9 and R9', so that the gradient variation of the set values of the brightness of the object to be photographed correspond with the characteristic of input transistor Q12 of the timing circuit. Therefore, in order to change the collector current ICQ12 of transistor Q12 in terms of sets of 2, in view of the generic formula for a transistor the value per level must be:

\[ VBEQ12 = (KTelq) \ln 2 \]  

(25)
The value is approximately 17.8 mv at 25°C. Accordingly, the resistance of resistor R6 must be adjusted so as to set the value of emitter current I6 of transistor Q6 correspondingly.

It is also apparent that a variation in resistance of resistor R12 will cause a variation in the emitter current I11 of transistor Q11. The emitter currents I6 and I11 are combined and fed to variable resistor Rs, by means of which data relating to the values of aperture and film sensitivity are set. Resistor Rs, generally, is not uniform but irregular from a manufacturing standpoint. In the present invention, the variation in the gradient component is adjustable by adjusting the emitter current I11 of transistor Q11. In the event that the output voltage changes due to a variation of resistor Rs, resistor Rs is adjusted so that the gradient component corresponds with the characteristic of the base-emitter voltage VBEQ12 of the input transistor of timing circuit Tc.

Changing the resistance value of variable resistor R11 will shift the characteristic of output voltage Vp of compression circuit P parallel to the characteristic curves shown in FIG. 3. Resistor R11 is employed primarily to adjust the variation in the base-emitter voltage VBEQ9 of transistor Q9 and voltage VBEQ12 of transistor Q12. For example, a voltage variation of approximately ±2mv is encountered in the case where these transistors are in an integrated circuit. Also the capacity variation of capacitor C2 is also properly adjusted by resistor R11.

It is also obvious that if the resistance of resistor R39 varies, then the emitter current of transistor Q30 changes. And the change of emitter current I30 causes a variation in the emitter potential of transistor Q33 in the meter circuit, namely, a variation in the emitter potential of transistor Q34. Since this means a variation in the current to meter Met, the zero point of meter Met is made adjustable by adjustment of the resistance of resistor R39.

Variable resistor R22 of level detection circuit D is provided for setting the reference voltage thereof which is required for manually setting the duration of exposure. By adjusting resistor R22, a variation in the delay provided by capacitor C3 and resistor RT can be compensated.

Resistor R14 of timing circuit Tc discharges capacitor C2 or C3. Resistor R14 serves to maintain capacitors C2 and C3 from being affected by heat resulting from the drastic discharge thereof. Normally, the impression of an operating voltage of 3 V per volt will stabilize capacitors C2 and C3.

Change-over switches A-M(1), A-M(2) and A-M(3) serve to switch detection circuit D from manual control to automatic control, and vice versa. These switches are actuated substantially simultaneously.

Where the circuit is used for manually controlling the duration of exposure, the respective contacts of change-over switches A-M(1-3) contact the M switch terminals in FIG. 5(B). Variable resistor RT is set to a required resistance value, and simultaneously with the release of the shutter, switch S5 is closed to thereby actuate timing circuit Tc, level detection circuit D, delay circuit D3 and activation circuit A shown in FIGS. 5(A), 5(B). Then, normally closed switch S3 is opened and when switch S4 is closed simultaneously with the start of exposure, delay capacitor C3 is charged through variable resistor RT until its voltage becomes equivalent to the reference voltage set by variable resistor R22, whereby level detection circuit D is actuated to render electromagnet Mg non-conductive through delay circuit Dc and activation circuit A.

Where the duration of exposure is automatically controlled, in FIGS. 5(A) and (B), the contacts of change-over switches A-M(1-3) contact the A switch terminals, and sliding terminal b of variable resistor RT is moved to point a. And then, variable resistor Rs is adjusted to set a value of film sensitivity and normally open switch S1 is closed to thereby actuate meter circuit M, constant current generating circuit I, compression circuit P, and storage means Me. And, a value of aperture is set with the aid of variable resistor Rs so as to allow meter Met to indicate a desired value of duration of exposure. By this time, switch S2 has been closed to impress on capacitor C1 the potential equivalent to that of output voltage Vp of compression circuit P.

Thereafter, simultaneously with the start of shutter release, switch S2 is opened, before the value of illumination on the light receiving surfaces of light receiving elements RCDs1, RCDs2 is subject to fluctuation due to rotation of the mirror, whereby the voltage representing aperture, film sensitivity and brightness of the object to be photographed are stored by capacitor C1. As the shutter release operation progresses, opened switch S5 is closed to actuate timing circuit Tc, level detection circuit D, delay circuit Dc and activation circuit A. Briefly, electromagnet Mg is rendered operative. Thereafter, closed switch S3 is opened, while opened switch S4 is closed simultaneously with the start of exposure, whereby capacitor C2 starts charging through transistor Q12. The charged voltage is impressed onto the base of transistor Q13 of level detection circuit D. When the voltage becomes equivalent to the reference voltage, the value of which is set by resistors R15, R16 and R13 and which is impressed on the base of transistor Q12, level detection circuit D is actuated to energize electromagnet Mg through delay circuit Dc and activation circuit A, thereby terminating the exposure.

In the foregoing description, although variable resistor R22, fixed resistors R15, R16 and capacitors C2, C3 are operated by change-over switches A-M(1) and A-M(2), it will be understood that one of the two, viz. the switch A-M(1), may be omitted because capacitors C2 and C3 are operable by a single switch. In case the circuitry of the present invention is applied to a single lens reflex camera, it is recommended that meter circuit M, constant current generating circuit I, compression circuit P, storage means Me and timing circuit Tc, are mounted around the pentaprism, and to mount level detection circuit D, delay circuit De and activation circuit C in the camera body. Such an arrangement of the circuitry in the camera allows the finder system to be mounted in various ways. And the provision of switch system A-M(1), A-M(2) and A-M(3) facilitates the above arrangement.

As will be understood from the foregoing description, the power consumption is greatly reduced, because of the provision of switch S5, by which the current is fed, only during exposure, to electromagnet Mg, which has the largest current consumption in the circuit. Additionally, since the conventional circuit is of the differential type, disadvantages have been encountered in that a large quantity of current must be fed to actuate the meter. Therefore, in the event of a decrease in the
resistance of the photoconductive elements and the resistor which sets values of aperture and film sensitivity, the current will increase. For example, if the brightness of the object to be photographed is high, a current of several mA must be supplied depending upon the aperture setting. This may decrease the life of the power source.

On the contrary, according to the present invention, data such as the values of current flow to meter Met, the brightness of the object to be photographed, aperture and film sensitivity settings are obtained through the constant current generating circuit, and whatever the combination thereof may be, the current consumption is decreased. It is advantageous that with a current of several ten μA to 100 μA, the circuit is actuated with the current consumption substantially equivalent to that of an conventional actionmeter.

In the foregoing description, the resistors and transistors of constant current generating circuit I, transistor Q9 of compression circuit P, transistor Q12 of timing circuit Tc are respectively constructed in a monolithic integrated circuit. It is possible, however, to form a circuit equivalent to the circuit of the present invention by conventional circuit construction techniques or by mixed integrated circuits, and in that case, the transistors are replaceable by transistors of a counter type, for example, a PNP transistor may replace an NPN transistor, and vice-versa.

What is claimed is:

1. An electrical exposure control device for a single lens reflex camera, comprising:
   a power source having positive and negative terminals;
   a constant current generating circuit for generating current proportional to absolute temperature and including:
   a resistance consisting of a first resistor, one terminal of which is connected to said positive terminal, and a second resistor connected in series to said first resistor,
   a first NPN transistor having a collector connected to said second resistor, an emitter connected to said negative terminal, and a base connected to the junction of said first and second resistors,
   a second NPN transistor having a base connected to the collector of said first NPN transistor and an emitter connected through a third fixed resistor to said negative terminal,
   a first transistor circuit consisting of a PNP transistor having an emitter connected through a fourth resistor to said positive terminal, and a third PNP transistor having a base connected to a collector of said PNP transistor, a collector connected to the emitter of said PNP transistor and an emitter connected to the collector of said second NPN transistor,
   a second transistor circuit having a circuit connection equivalent to said first transistor circuit and consisting of a PNP transistor having a base connected to the base of the PNP transistor of said first transistor circuit and an emitter connected through a fifth resistor to said positive terminal, and an NPN transistor;
   a compression circuit including light receiving elements connected to an emitter of the NPN transistor of said second transistor circuit and which produces a potential proportional to the logarithm of light on the receiving surfaces of said light receiving elements;
   means for storing an output of said light receiving elements;
   a timing circuit including a fourth compression circuit having a base for receiving the voltage of said compression circuit at the time of exposure.

2. An electrical exposure control device for a single lens reflex camera as in claim 1, further comprising:
   a third transistor circuit in said constant current generating circuit and connected equivalently to said first transistor circuit, and consisting of
   a PNP transistor having a base connected to the base of the PNP transistor of said first transistor circuit and an emitter connected through a sixth resistor to said positive terminal, and
   an NPN transistor;
   a fifth NPN transistor in said compression circuit for producing a voltage proportional to the logarithm of illumination on the light receiving surfaces of said light receiving elements, said fifth NPN transistor having a similar temperature characteristic to that of said fourth NPN transistor;
   a variable resistor having one terminal connected to an emitter of said fifth NPN transistor and connected to the emitter of the NPN transistor of the third transistor circuit of said constant current generating circuit and another terminal is connected to said negative terminal, and the resistance of said variable resistor varying in accordance with the diaphragm aperture and film speed settings.

3. An electrical exposure control device for a single lens reflex camera as in claim 1, wherein said timing circuit includes a first capacitor connected to the collector of said fourth NPN transistor, and a second capacitor in parallel with said fourth NPN transistor and said first capacitor, said second capacitor and said series connected first capacitor and said fourth NPN transistor being selectively connected through a first change-over switch to a second variable resistor the resistance of which varies according to the diaphragm aperture and film speed settings.

4. An electrical exposure control device for a single lens reflex camera as in claim 3, further comprising:
   a second change-over switch for establishing either automatic exposure control or manual exposure control;
   a level detection circuit connected through said second change-over switch to one terminal of either of said first capacitor or said second capacitor for detecting the voltage of either of said first and second capacitors, to thereby generate a signal when said voltage reaches a predetermined level; and
   an electromagnet for terminating exposure and actuated by said level detection circuit.

5. An electrical exposure control device for a single lens reflex camera as in claim 4, wherein said means for storing includes a capacitor for storing the output voltage of said compression circuit and a fixed resistor connected to said capacitor and said negative terminal to thereby compensate for a voltage drop of said power source which results from the current flow to said electromagnet.

6. An electrical exposure control device for a single lens reflex camera as in claim 5, further comprising a delay circuit connected between an output terminal of
said level detection circuit and an input terminal of said operating circuit to compensate for the time interval representing the overlap between a trailing edge of a first curtain and a leading edge of a second curtain at the cocked position thereof.

7. An electrical exposure control device for a single lens reflex camera as in claim 3, further comprising: a fourth transistor circuit connected equivalently to said first transistor circuit in said constant current generating circuit and consisting of a PNP transistor having a base connected to the base of the PNP transistor of said first transistor circuit and an emitter connected through a resistor to said positive terminal, and an NPN transistor; and a meter circuit to which the output voltage of said compression circuit is fed and to which the emitter current of said NPN transistor of said fourth transistor circuit is fed.

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