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Ackermann

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[54] **CONTROL SYSTEM FOR TERMINATING THE DISCHARGE OF A FLASH LAMP**

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[58] **Field of Search** ..... 315/151, 159, 241 P, 315/241 R

[56] **References Cited**

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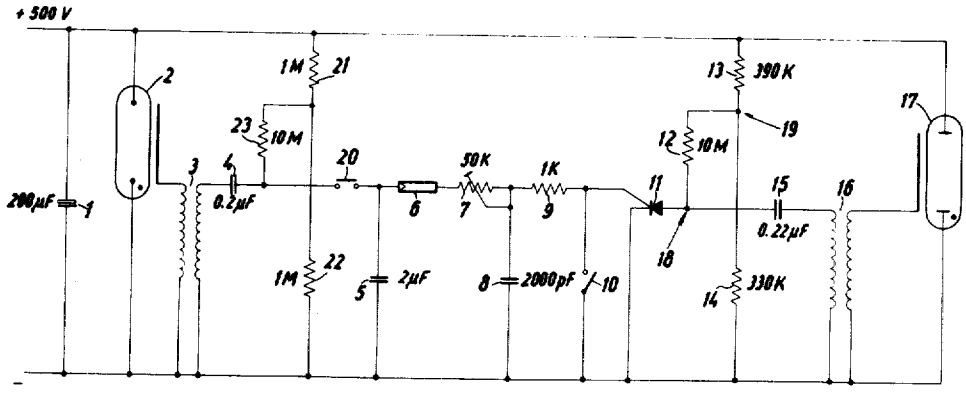
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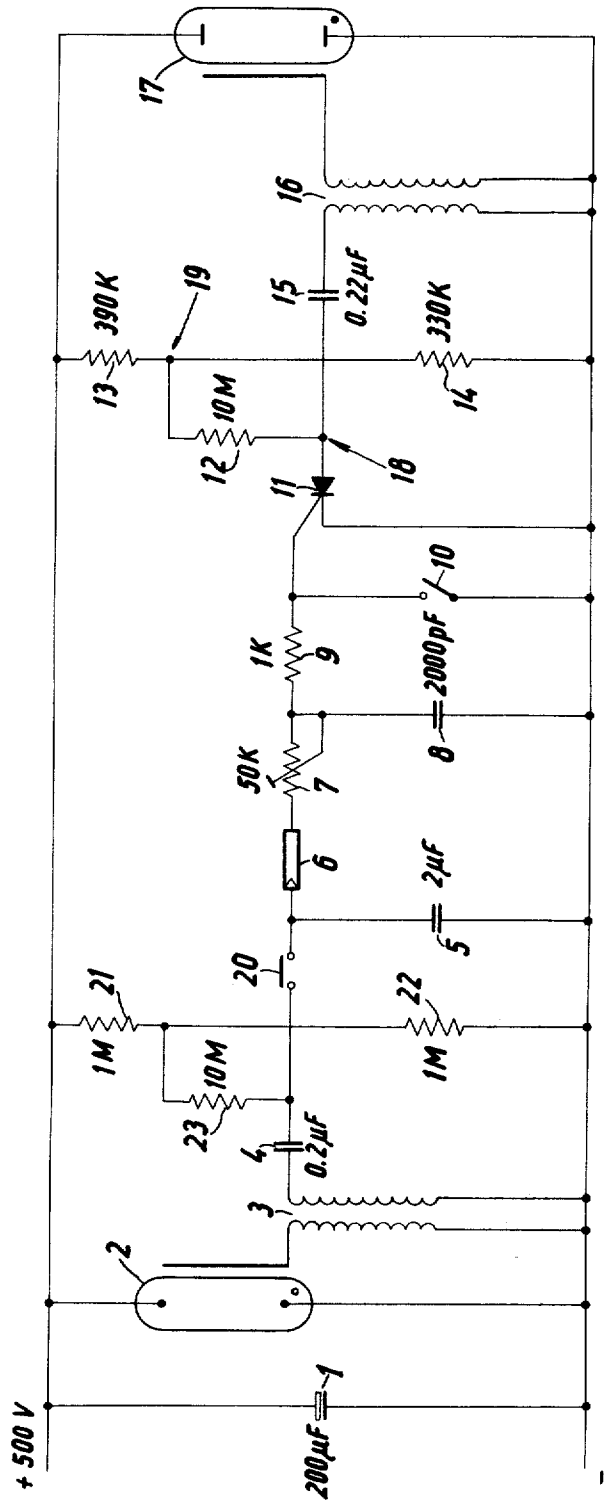
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[57] **ABSTRACT**

An arrangement for controlling the flash duration in photographic cameras. A light-sensitive element within the apparatus responds to light originating from the source for flash bulbs and reflected by the object or scene to be photographed. The flash bulb is ignited by an ignition circuit which also generates the operating voltage for the light-sensitive device. Through the application of a discharge tube which has a considerably lower internal resistance, when ignited, than the flash bulb, the latter becomes extinguished when the *quantity of* light reflected by the object or scene and impinging upon the light-sensitive device, is [of] a predetermined [magnitude] *quantity*.

13 Claims, 1 Drawing Figure





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By: [illegible]

CONTROL SYSTEM FOR TERMINATING THE DISCHARGE OF A FLASH LAMP

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The present invention resides in an electronic flash apparatus for photographic applications which includes a light meter fed from a DC operating voltage supply. The electronic control circuitry containing the light meter extinguishes the flash bulb used in conjunction with the flash apparatus as soon as the scene to be photographed has reflected a predetermined amount of light onto the light-sensitive element of the light meter.

Heretofore, an electronic flash apparatus has been available for the purpose of omitting the requirement to set the diaphragm of a photographic camera prior to each exposure because of the different distances between the flash apparatus and the scene to be photographed. The flash apparatus serves under these conditions the purpose of illuminating the scene to be photographed. With such electronic flash apparatus, the flash bulb becomes automatically extinguished when the scene to be photographed is sufficiently illuminated. In this manner, the object or scene being photographed is correctly illuminated in view of the condition that the duration of the flash is controlled through the amount of light reflected by the scene upon a light sensitive element.

The light meter includes, for this purpose, an integrating arrangement which integrates the electrical current derived from the light-sensitive element and actuates in response thereto, a control arrangement, as soon as the integrated current attains a predetermined value. The conventional means for integration is in the form of a capacitor which integrates the current derived from the light-sensitive element. The capacitor becomes charged, and when the voltage across the capacitor attains a predetermined value, the control arrangement becomes actuated and the flash bulb becomes thereby extinguished. It is known in the art that for the purpose of extinguishing the flash bulb, a discharge tube is used in parallel with the flash bulb. The discharge tube has a considerably lower internal resistance than the flash bulb when it is ignited. The discharge tube becomes thus ignited through the control arrangement or circuitry when the capacitor has attained a predetermined voltage level. The lower internal resistance of the ignited discharge tube causes the discharge of the storage capacitor which provides electrical energy for the flash bulb, and as a result the flash bulb becomes extinguished.

An electronic arrangement provided with such a control circuit, however, has the disadvantage that the photographic process or operation can be interfered with through the prevailing ambient light, as well as through the photographic flash resulting from another camera in the neighboring vicinity. The ambient light causes current to be generated through the light-sensitive element before actuation of the flash apparatus, and this current is applied to the capacitor which performs its integrating function. As a result, the capacitor possesses unpredictable initial voltage prior to initiation of the flash. In view of this condition, the time interval during which the predetermined voltage across the capacitor is attained, is no longer well defined. Furthermore, a remote flash from another apparatus in the vicinity, can actuate the control arrangement or circuitry of the flash apparatus under consideration, at an undesired instant of time. The result of such action is that the storage capacitor becomes thereby discharged.

In order to avoid interference through the ambient light, it has been previously proposed to omit the integrating capacitor and to provide a single and sole photoresistor of predetermined characteristics. With such an arrangement, however, interference resulting from remote flashes can still not be avoided.

It is also known in the art, to connect the light meter into the circuit first at the beginning of the flash through a switch or shutter mechanism. With such design, disturbances or interferences can be avoided from either the ambient light or remote flashes. Such design, however, requires rather careful and meticalous mechanical construction which is considerably complex and thereby costly to manufacture. At the same time, such mechanism and design does not operate reliably.

In accordance with the present invention, on the other hand, an arrangement is provided in which the ambient light as well as remote flashes are taken into account through a very simple and reliable manner. The present invention provides that the operating DC voltage is realized through the ignition of the flash bulb by an ignition current from an ignition circuit for the flash bulb. The arrangement in accordance with the present invention is based on electrical structure rather than mechanical parts, and thereby the control circuitry is principally switched on only during the flash. In this manner, interferences from remote flashes and ambient light cannot be incurred.

The flash bulb of an electronic flash apparatus becomes ignited through the application of an ignition capacitor operating in conjunction with an ignition transformer. The ignition capacitor is connected to the primary winding of the ignition transformer, and when a synchronizing [shutter] *trigger* cable becomes switchingly actuated, the ignition capacitor discharges and thereby produces a high voltage ignition pulse in the secondary winding of the ignition transformer. This high voltage pulse is applied to the flash bulb.

In carrying out the concept of the present invention, the primary winding of the ignition transformer can form a closed series circuit with the ignition capacitor and with a charging capacitor, when igniting the flash bulb. The voltage across the charging capacitor results from [charging] *discharging* of the ignition capacitor and serves as the DC operating voltage for the light meter.

When the electronic flash apparatus is switched on, one electrode of the ignition capacitor is connected to a voltage divider associated with the flash bulb. The other electrode of the ignition capacitor leads to ground potential, by way of the primary winding of the ignition transformer. The ignition capacitor becomes thus charged to a corresponding voltage.

When the synchronizing shutter cable is actuated so that it forms a closed circuit through it, the charging capacitor becomes switched to the ignition capacitor. One electrode of this charging capacitor is connected to ground potential. With this arrangement the primary

inding of the ignition transformer forms a closed se-
ies circuit with the ignition capacitor and with the
harging capacitor. The ignition capacitor, thereby,
ansfers a portion of its charge to the charging capaci-
or, by way of the primary winding of the ignition trans-
ormer. When, in accordance with the further provision
f the present invention, the capacitance of the charg-
ng capacitor is large compared to that of hte ignition
apacitor, the largest proportion of the charge of the
nition capacitor becomes transferred to the charging
apacitor. As a result, the equalizing current flows from
ne charged ignition capacitor to the uncharged capaci-
or by way of the primary winding of the ignition trans-
ormer. Through this current flow through the ignition
ansformer, the flash bulb becomes ignited.

The voltage resulting across the charging capacitor
hrough rapid charging of the latter to its maximum
alue, remains first constant near this maximum level,
nd forms the DC operating voltage for the light meter.

In a further embodiment of the present invention, the
ght meter can contain a series circuit to which the DC
perating voltage is applied and which includes a light
ensitive element in the form of a photoresistor, an
djustable charging resistor, and an integrating capaci-
or.

The adjustable charging resistor must be set in accor-
lance with the sensitivity or speed of the film being
sed. This setting remains as the only setting to be
arried out by the photographer. The setting can re-
nain for as long as the same film material is used. After
he flash bulb becomes ignited, the current produced
y the photoresistor becomes integrated by the capaci-
or. This current through the photoresistor is a function
f the brightness or illuminating intensity and the dis-
ance of the flash bulb from the scene or object to be
lluminated. The integrating capacitor attains a prede-
ermined voltage after a predetermined time interval
uitable for illuminating the film.

In accordance with a further embodiment of the
resent invention, the voltage of the integrating capaci-
or can be applied, through a protective resistor, to the
athode-control electrode path of a controlled silicon
iode or thyristor. This controlled silicon diode or sili-
on rectifier ignites a discharge tube when controlled
o that it is in the conducting state. This discharge tube
ies in parallel with the flash bulb, in the conventional
nanner. The internal resistance of the discharge tube,
when ignited, has a considerably lower value than the
nternal resistance of a flash bulb.

Through the large current due to the ignition of the
ischarge tube by the thyristor, the storage capacitor
which feeds the flash bulb becomes discharged at an
arlier instant of time than if it were to be discharged
nly through the flash bulb itself. As a result, the flash
bulb becomes extinguished at the correct instant of
time determined by the illumination required for the
specific film being used in the camera.

Another specific feature of the present invention
resides in the manner in which the thyristor and the
discharge tube are interconnected.

SUMMARY OF THE INVENTION

An electronic flash arrangement for photographic cameras in which the flash bulb becomes extinguished after ignition when light reflected from the object to be photographed has attained a predetermined magnitude. A light measuring circuit responds to light originating from the flash bulb and reflected by the object to

be photographed. The flash bulb is ignited through an ignition circuit which also generates a DC operating voltage for the light measuring device. Once the flash bulb becomes ignited, light is reflected by the object and impinges upon the light measuring device. When the reflected light impinging on the light measuring device has thus attained a predetermined level, the flash bulb becomes extinguished, and as a result the correct amount of illumination is applied for the photographic operation.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

An electrical schematic diagram of the electronic flash arrangement showing the operating components and their interconnections, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, a storage capacitor **1** of approximately 200 μf becomes charged to approximately 500 volts during several seconds after the electronic flash apparatus is switched on through electrical elements, not shown. This storage capacitor **1** provides the electrical energy for a flash bulb **2.**

When the electronic flash circuit, of the present invention, is switched on, one electrode or terminal of the capacitor **4** leads to the junction of resistors **21** and **22,** by way of resistor **23.** Resistors **21** and **22** form a voltage divider connected across the 500 volt supply which is also applied across the flash bulb **2.** Thus, the voltage divider composed of resistors **21** and **22** is connected in parallel with the terminals of the flash bulb **2.** Whereas one terminal of the resistor **21** is connected to the +500 volt potential line, the resistor **22** terminates at ground potential. The capacitor **4** functions in the circuit as an ignition capacitor. The primary winding of an ignition transformer **3** has one terminal connected to the opposite terminal of the ignition capacitor **4,** so that in this other or opposite terminal of the ignition transformer **4** leads to ground potential through the primary winding of the ignition transformer **3.** The ignition transformer serves further to ignite the flash bulb, and as a result of connecting the primary winding of the transformer **3** to the capacitor **4,** in this manner, the ignition capacitor becomes charged to a voltage established by the voltage divider consisting of resistors **21** and **22.**

The switch **20** shown in the drawing represents the shutter synchronizing and actuating cable of the camera. This cable is between the flash apparatus and the photographic camera. When this synchronizing cable **20** is actuated, a short circuit is established across the terminals, denoted in the drawing as associated with the switch **20,** and a series circuit is formed through the primary winding of the ignition transformer **3,** the ignition capacitor **4,** and a charging capacitor **5.** As a result of this closed series circuit, the ignition capacitor **4** transfers charge to the charging capacitor **5,** so that in the final state both capacitors have the identical volt-

age applied across them. The current flowing from the ignition capacitor **4** to the charging capacitor **5** for the purpose of equalizing their charge voltages, flows also through the primary winding of the ignition transformer **3**. As a result of this current flow through the primary winding, a high voltage pulse is generated in the secondary winding of the transformer, and the flash bulb **2** becomes ignited.

Assuming for example, that the ignition capacitor **4** has a capacitance of 0.2 μf, then the voltage prevailing across the capacitor **5**, when the circuit is switched on, is 1/11 of 250 volts, or approximately 23 volts. This voltage which remains first constant forms the operating DC voltage for a light meter which contains the series circuit comprised of a photoresistor **6**, a variable or adjustable resistor **7**, and an integrating capacitor **8**.

The photoresistor is a light-sensitive element and varies its resistance as a function of the illumination intensity. For larger illuminating intensities the resistance decreases and permits a larger current to flow from the charging capacitor **5** to the capacitor **8**. The latter integrates the individual current elements to the extent that the voltage on the capacitor **8** thereby increases. When illumination of larger magnitudes is applied to the photoresistor **6**, the capacitor **8** attains more rapidly a predetermined voltage level *herein referred to as terminating signal*, than it does when the illumination intensity is of lower magnitudes. The adjustable resistor **7** must be set, as already indicated, in accordance with the sensitivity of the film material being used.

A control silicon diode **11** in the form of a thyristor receives its anode potential by way of a large resistor **12** which may be of the order of approximately 10 megohms. The resistor **12** is connected to the tap or junction **19** of a voltage divider comprised of resistors **13** and **14**. This voltage divider is connected across the voltage supply of 500 volts for the flash bulb **2**. The control or starting electrode of the thyristor is connected with the integrating capacitor **8**, by way of a protective resistor **9**. The cathode of this thyristor, on the other hand, is connected to ground potential. The anode-cathode path of the thyristor is not conducting when the voltage between the control electrode and the cathode is below a predetermined value. As long as the thyristor is nonconducting, the ignition capacitor **15** for a discharge tube **17**, also remains charged. The ignition capacitor **15** is connected to the junction **18** leading to the anode of the thyristor, and leading also to the tap **19** of the voltage divider of resistors **13** and **14**, by way of the large resistor **12**. The other terminal of the capacitor **15** leads to ground potential by way of the primary winding of an ignition transformer **16**.

When ignition of the flash bulb **2** is initiated through the short circuiting cable switch **20**, the voltage across the charging capacitor **5** becomes available as a DC operating voltage. The integrating capacitor **8** thus acquires a voltage sufficient to fire the thyristor **11**, *this voltage being herein referred to as a terminating signal*, as a result of the current flow from the charging capacitor **5** and through the photoresistor **6**. When the thyristor is thus fired and the anode-cathode path of the thyristor is conducting, the ignition capacitor **15** for the discharge tube **17**, discharges through the thyristor. As a result of this discharge, a current pulse is realized in the primary winding of the ignition transformer **16**. The discharge tube **17** becomes ignited through the secondary winding of this transformer **16**. This discharge tube **17**, when ignited has a considerably lower resistance than the flash bulb **2**, and therefore the latter is extinguished when the discharge tube becomes ignited. As a result of such action, the object or scene to be photographed is no longer illuminated. The discharge tube **17** is mounted within the interior of the electronic flash apparatus, and is covered against the exterior environment.

After the flash bulb **2** is extinguished through the discharge tube **17**, a small residual voltage prevails across the storage capacitor **1** and also at the tap or junction **19** of the voltage divider comprised of resistors **13** and **14**. In order that the voltage at the anode of the thyristor **11**, and thereby the junction **18**, acquires a small value for the purpose of again turning off the thyristor, a large ohmic value is selected for the resistor **12**. Thus, this resistor is selected so that it has a value of the order of 10 megohms. The integrating capacitor **8** [charges] *discharges*, after control of the thyristor **11** has been exercised, through the protective resistor **9** and the cathode-control electrode path towards ground potential.

Through closing of a switch **10**, the electronic control arrangement for [automotic] *automatic* extinguishing of the flash bulb **2**, may be made inoperative.

The component values indicated in the circuit diagram of the drawing, have been designated only for the purpose of illustrating the basis for the selection of the components. It is quite possible to provide, in cases, different values for these components.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in electronic flash apparatus for cameras, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

I claim:

[1. An electronic flash arrangement for photographic cameras comprising, in combination, flash bulb means; ignition means connected to said flash bulb means for igniting said flash bulb means; light measuring means for responding to light from said flash bulb means and reflected by the object to be photographed; said ignition means connected to the light measuring means in a way as to deliver a D.C. operating voltage for the light measuring means, so that said D.C. operating voltage prevails only after the ignition of the flash bulb means, said flash bulb means becoming extinguished after ignition when the light reflected by said object and impinging upon said light measuring means is of a predetermined magnitude.]

2. The electronic flash arrangement [for photographic cameras] as defined in claim [1] *12* wherein said ignition means comprises an ignition transformer connected to said flash [bulb] means; [and] *an* ignition capacitor connected to said ignition transformer means; and a charging capacitor connected in series with said ignition capacitor and said ignition transformer means when said flash bulb means is ignited, the voltage across the charging capacitor resulting from [charging] *discharge of* said ignition capacitor and being said *D.C.* operating voltage for

perating said light measuring means.

3. The electronic flash arrangement [for photoraphic cameras] as defined in claim [2] *14* herein the capacitance of said charging capacitor is ırge compared to the capacitance of said ignition capacitor.

4. The electronic flash arrangement [for photoraphic cameras] as defined in claim 3 wherein the apacitance of said charging capacitor is ten times as ırge as the capacitance of said ignition capacitor.

5. The electronic flash arrangement [for photoraphic cameras] as defined in claim [1] *12* herein said light measuring means includes the series onnection of a light sensitive element, an adjustable esistor, and an integrating capacitor.

6. The electronic flash arrangement [for photoraphic cameras] as defined in claim 5 wherein said ght sensitive element is a photoresistor.

7. The electronic flash arrangement [for photoraphic cameras] as defined in claim 5 including con-olled silicon rectifying means with cathode-control lectrode path connected to said integrating capacitor ieans, discharge tube means *connected in* parallel with aid flash bulb means and ignited by said controlled ectifier means, the internal resistance of said discharge ıbe means being substantially smaller when ignited ıan the resistance of said flash bulb means.

8. The electronic flash arrangement [for photoraphic cameras] as defined in claim 7 including proective resistor means between said integrating capaci-or means and said [controlled] *control* electrode-athode path of said controlled rectifier means.

9. The electronic flash arrangement [for photoraphic cameras] as defined in claim 7 including an gnition transformer connected to said discharge tube ieans for igniting the same; ignition capacitor means onnected between said ignition transformer means nd said controlled rectifier means; and voltage divider ieans connected to said ignition capacitor means and aid controlled rectifier means.

10. The electronic flash arrangement [for photoraphic cameras] as defined in claim 9 including resis-or means connected between said voltage divider ieans and the junction of said ignition capacitor means nd said controlled rectifier means.

11. The electronic flash arrangement [for photoraphic cameras] as defined in claim 10 wherein said esistor means has a resistance value [substantially f] *in* the order of megohms.

12. An electronic flash arrangement for a photographic rocess, comprising in combination, flash generating ieans for generating a flash; ignition means connected o said flash generating means for igniting said flash enerating means upon external activation, thereby inititing said flash, said external activation creating a current flow in said ignition means, said ignition means further comprising means for furnishing a D.C. voltage only after the start of said current flow; light measuring means operative only after application of an operating voltage thereto, for responding to light during an exposure and furnishing a terminating signal when said light has reached a predetermined light quantity; means connecting said ignition means to said light measuring means in such a manner that said D.C. voltage constitutes said operating voltage; and means connected to said light measuring means for terminating said flash upon receipt of said terminating signal.

13. An electronic flash arrangement for a photographic process, comprising in combination, flash generating means for generating a flash; ignition means connected to said flash generating means for igniting said flash generating means upon external activation, thereby initiating said flash, said external activation creating a current flow in said ignition means, said ignition means further comprising means for creating a D.C. voltage only after the start of said current flow; light measuring means operative only after application of an operating voltage thereto, for responding to light during an exposure and furnishing a terminating signal when said light has reached a predetermined light quantity; means connecting said ignition means to said light measuring means in such a manner that said D.C. voltage constitutes said operating voltage; and means connected to said light measuring means for terminating said flash upon receipt of said terminating signal.

14. An electronic flash arrangement for photographic process, comprising, in combination, flash generating means for generating a flash; ignition means connected to said flash generating means for igniting said flash generating means upon external activation, thereby initiating said flash, said ignition means comprising an ignition transformer connected to said flash generating means, an ignition capacitor connected to said ignition transformer and a charging capacitor connected to said ignition capacitor in response to said external activation in such a manner that a D.C. voltage is created across said charging capacitor resulting from discharge of said ignition capacitor; light measuring means operative only after application of an operating voltage thereto, for responding to light during an exposure and furnishing a terminating signal when said light has reached a predetermined light quantity; means for connecting said ignition means to said light measuring means in such a manner that said D.C. voltage across said charging capacitor constitutes said operating voltage; and means connected to said light measuring means and said flash generating means for terminating said flash upon receipt of said terminating signal.

* * * * *