

[54] APPARATUS FOR SYNCHRONIZING AN ELECTRONIC FLASH WITH A CAMERA

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[30] Foreign Application Priority Data

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[52] U.S. Cl. 354/34; 354/33; 354/50; 354/60 F

[58] Field of Search 354/27, 32, 33, 34, 354/35, 60 F, 50, 60 R

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[57] ABSTRACT

An apparatus for activating an electronic flash by operating an X contact when the first blind of a focal plane shutter has terminated its movement to fully open an exposure light path, irrespective of an exposure period establishing operation. Where an electronic focal plane shutter is combined with an auto-strobo, a photometric circuit within the electronic circuit is used to measure the radiation from the auto-strobo, and to control the amount of exposure to a proper value. Where a proper amount of exposure is available by natural light when the shutter is opened, a closing movement of the shutter is utilized to cause the trigger capacitor of the electronic flash to be discharged, thereby disabling the illumination of the electronic flash.

4 Claims, 10 Drawing Figures

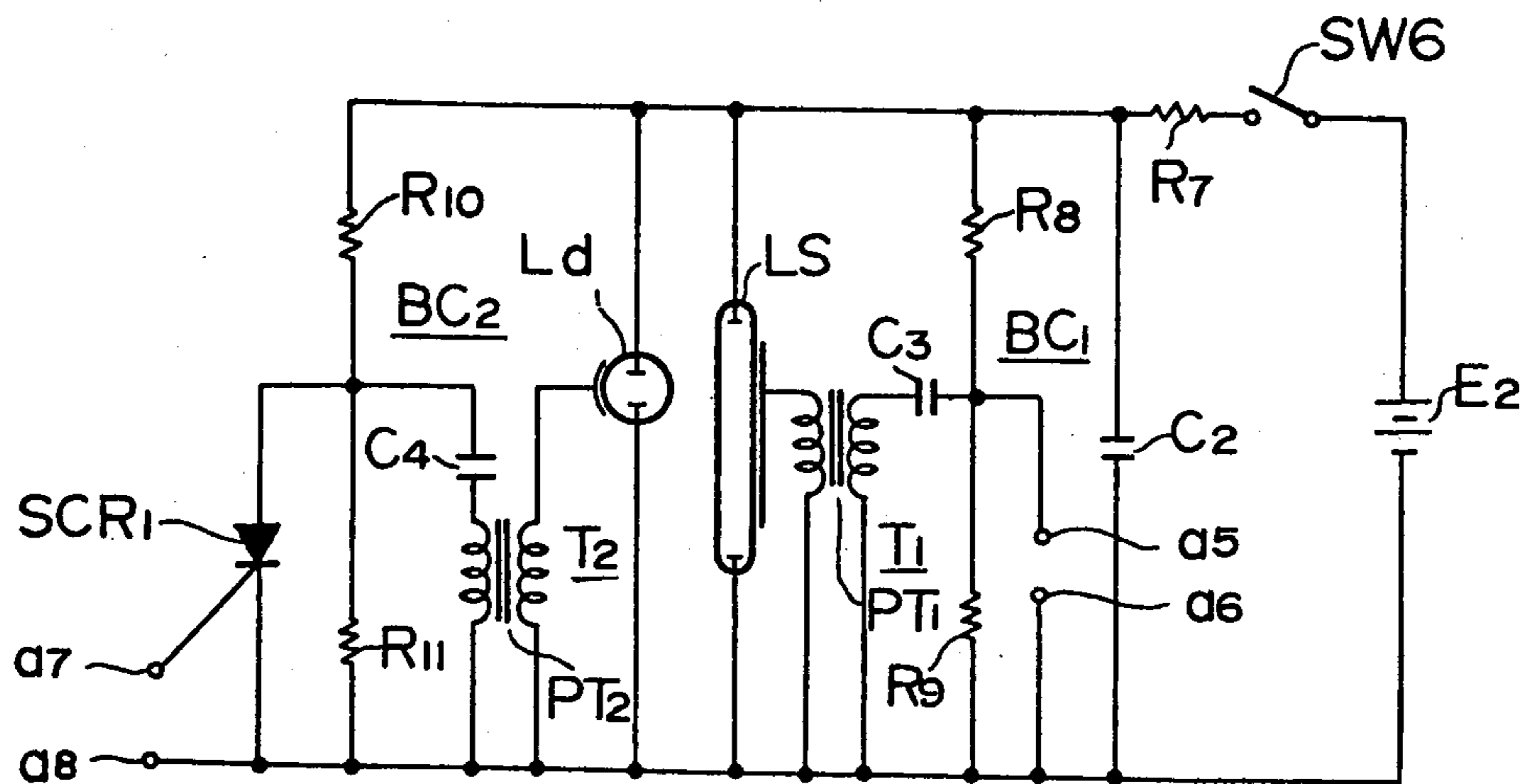


FIG. 1

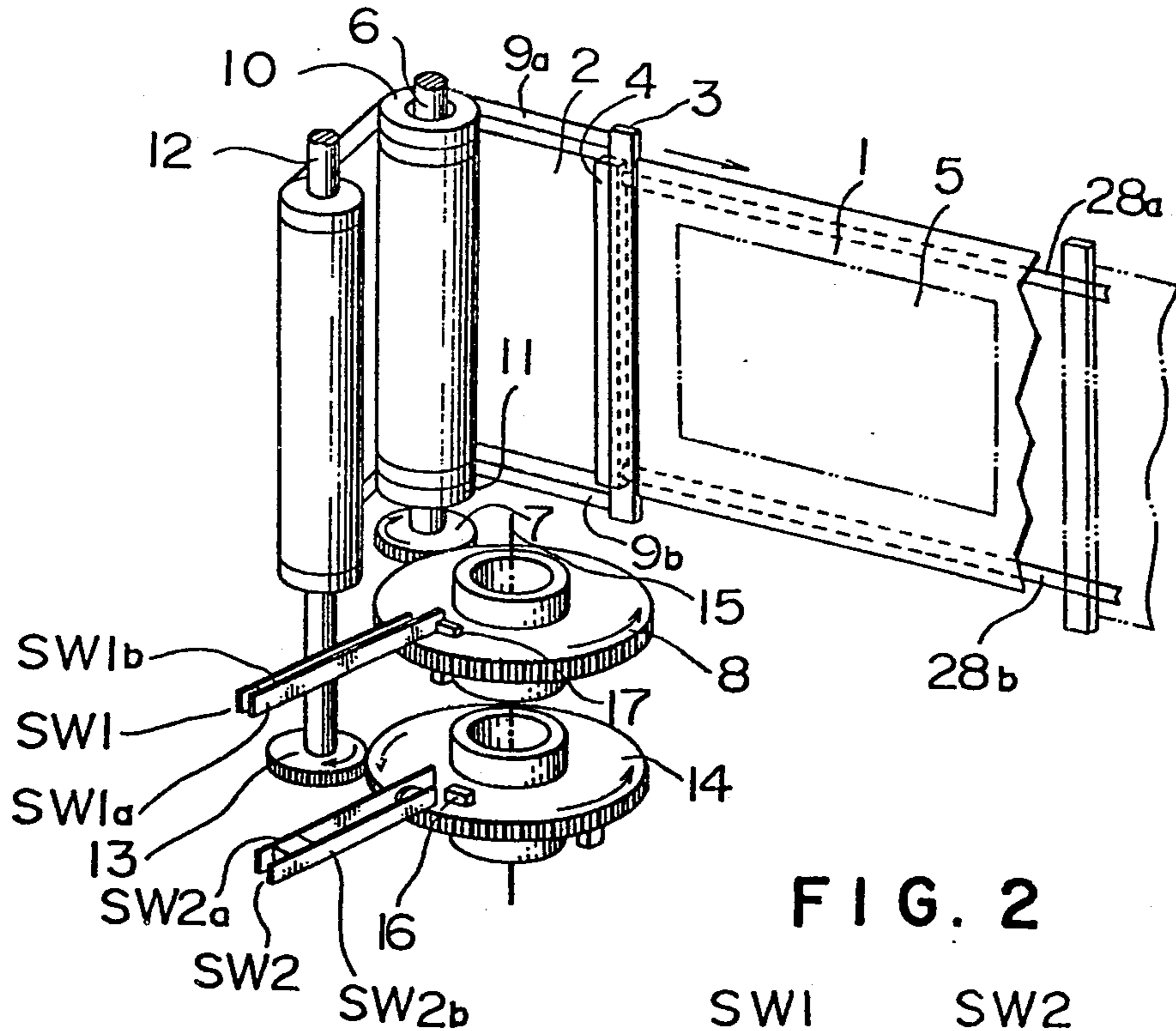


FIG. 2

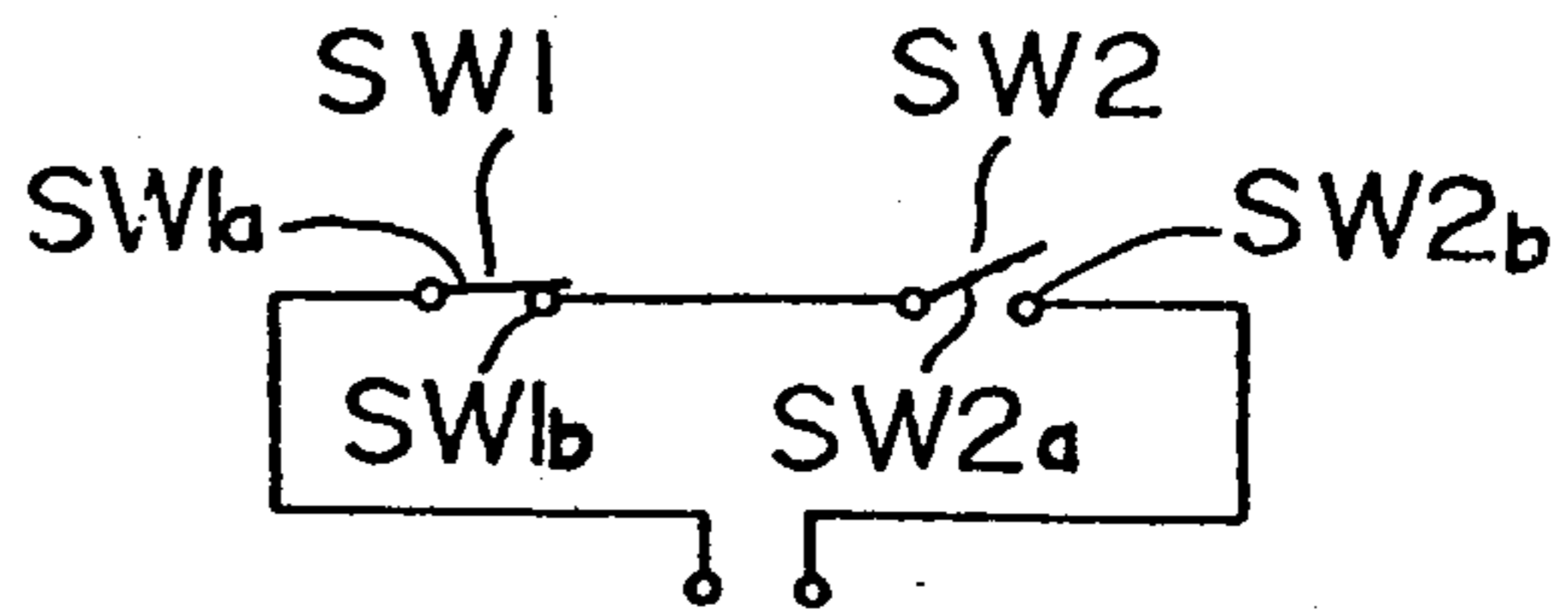


FIG. 3

	SW1	SW2
FOR EXPOSURE PERIOD GREATER THAN 1/60 SECOND		
FOR EXPOSURE PERIOD LESS THAN 1/60 SECOND		

FIG. 4

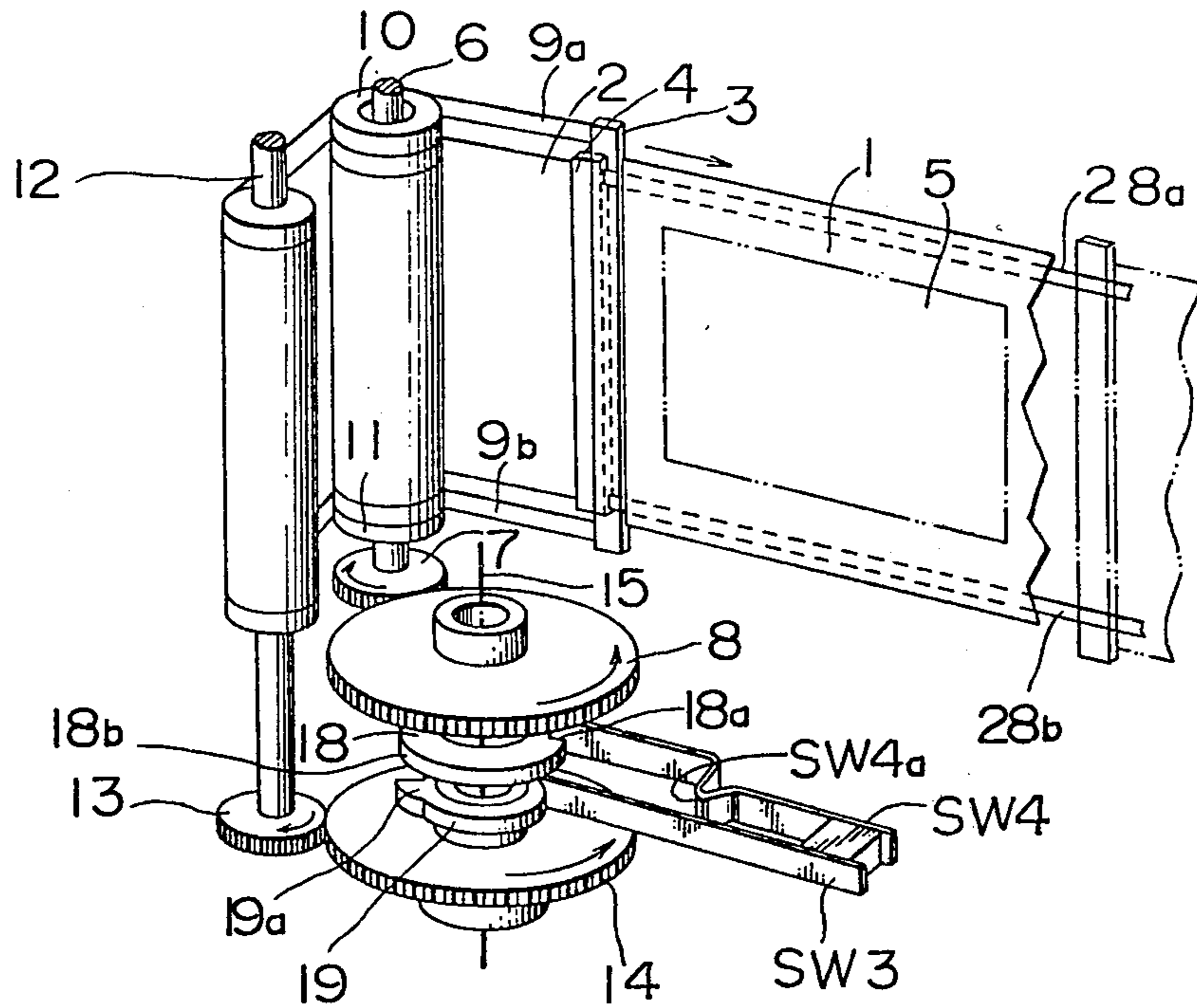


FIG. 5

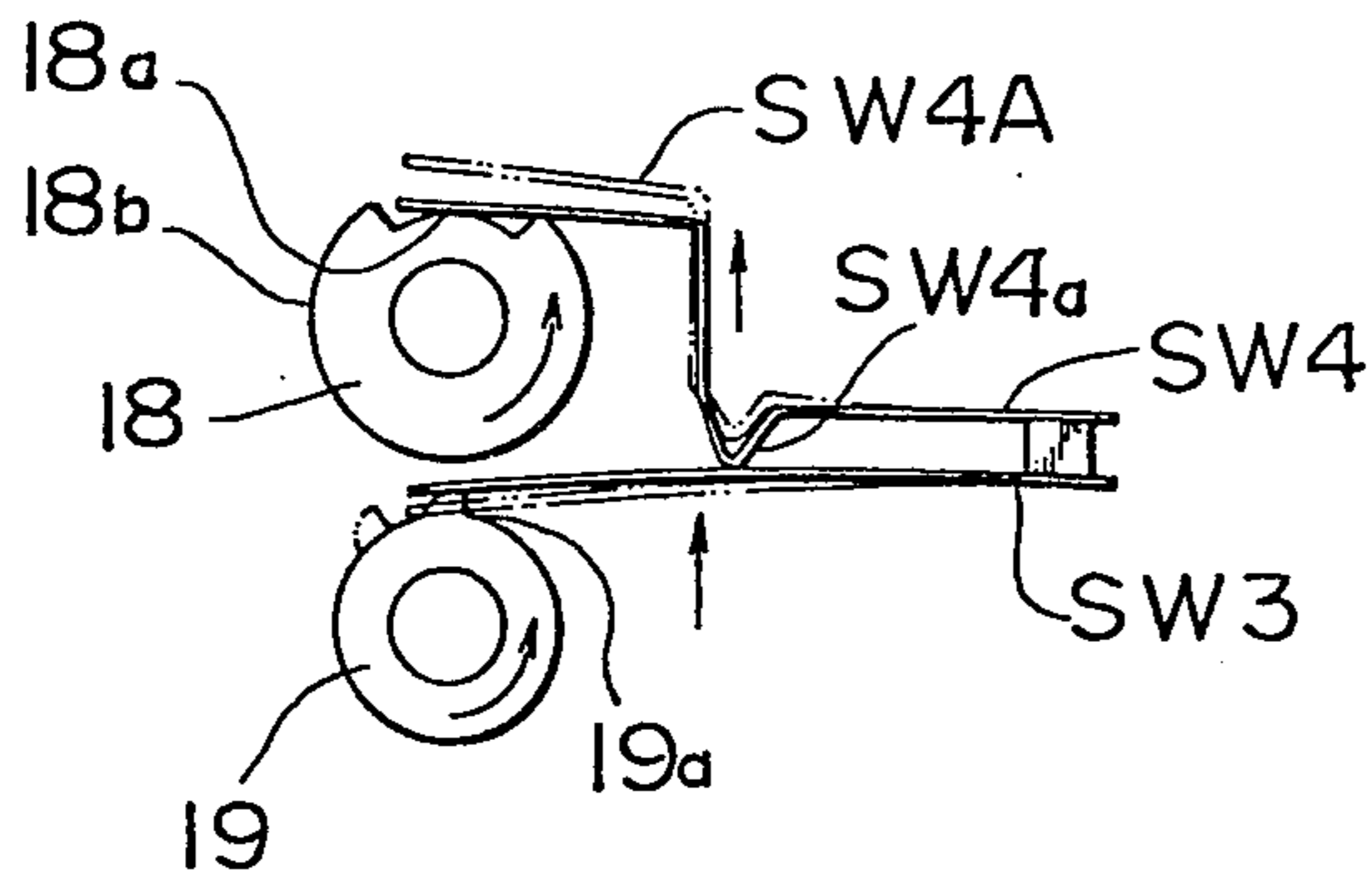


FIG. 6

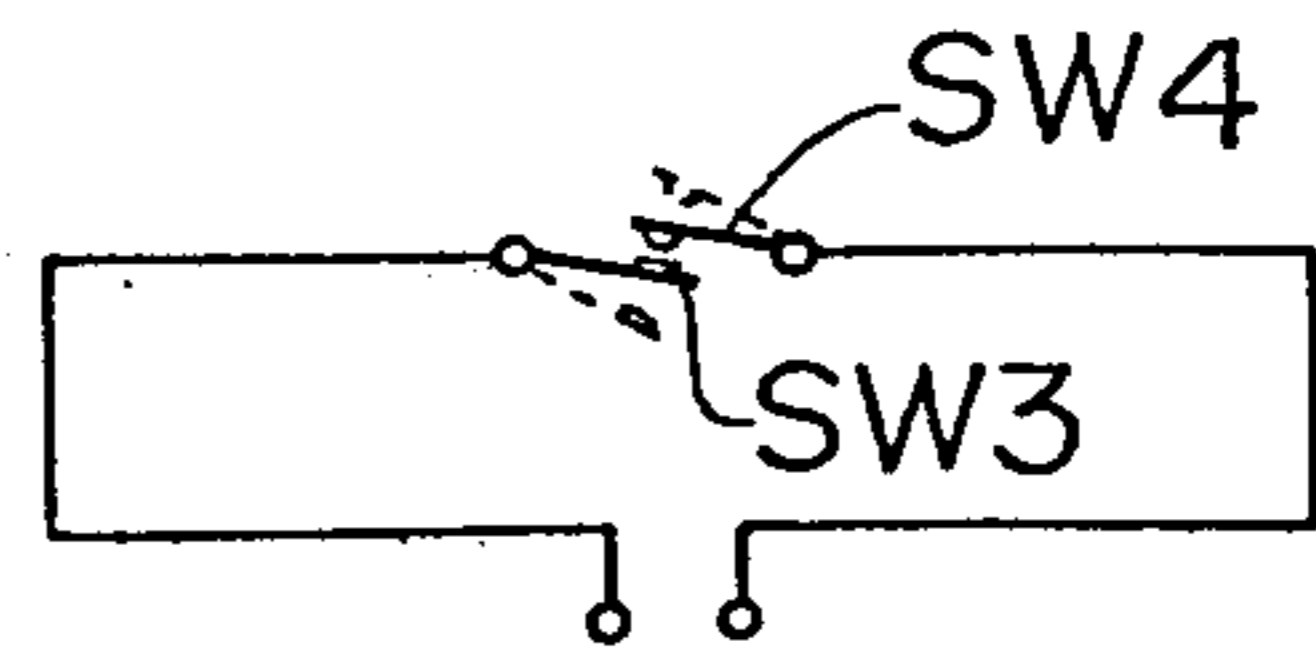


FIG. 7

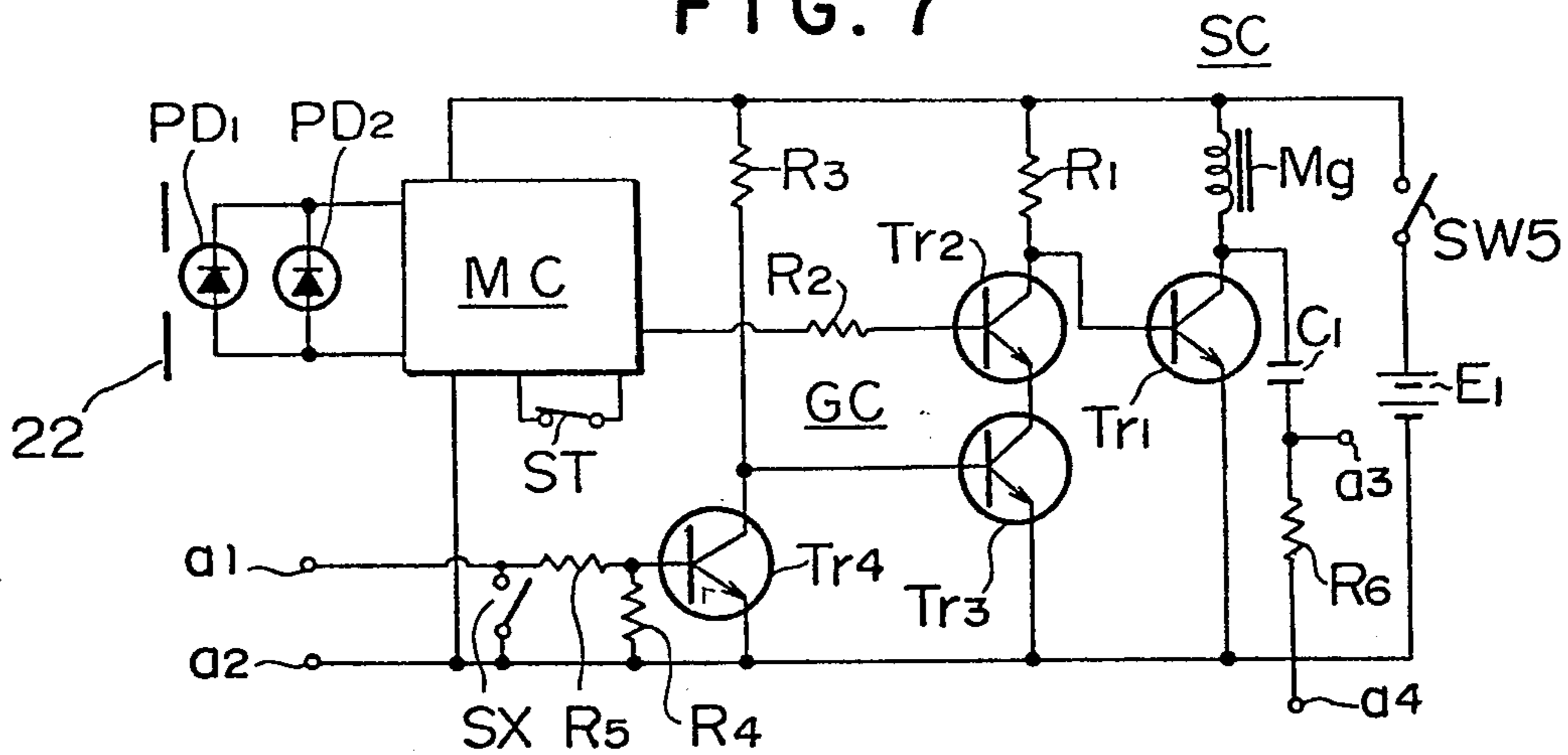


FIG. 8

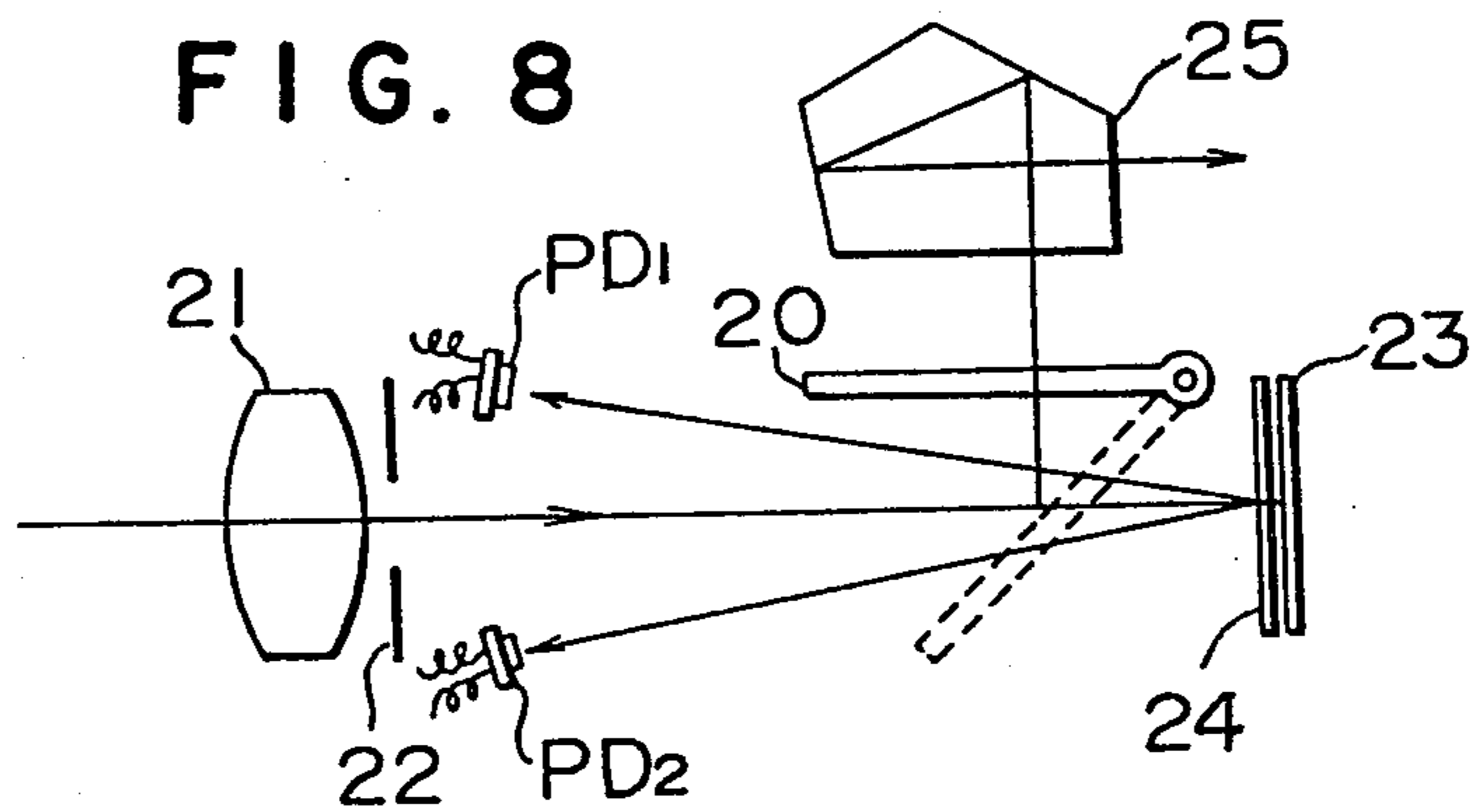


FIG. 9

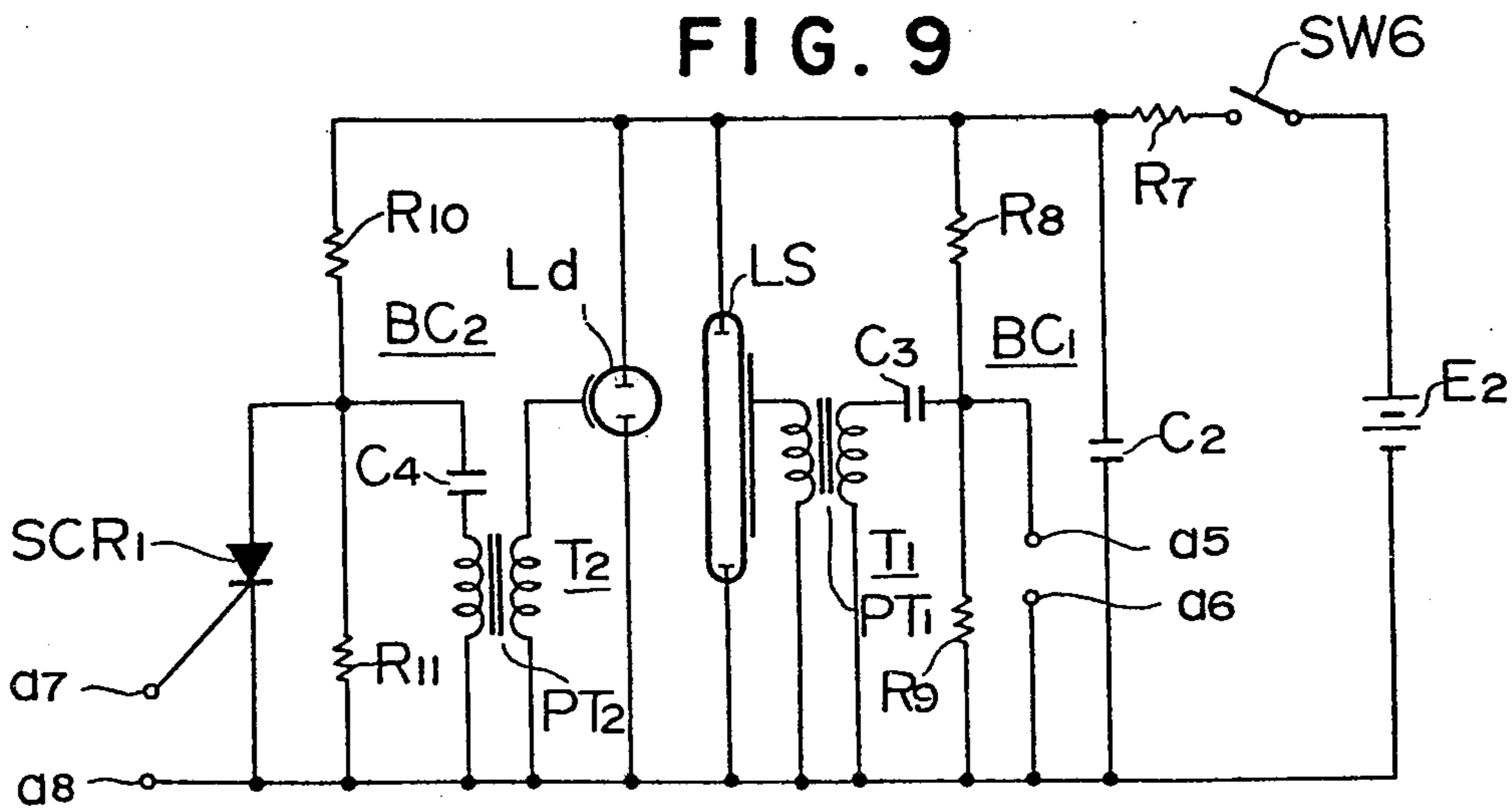
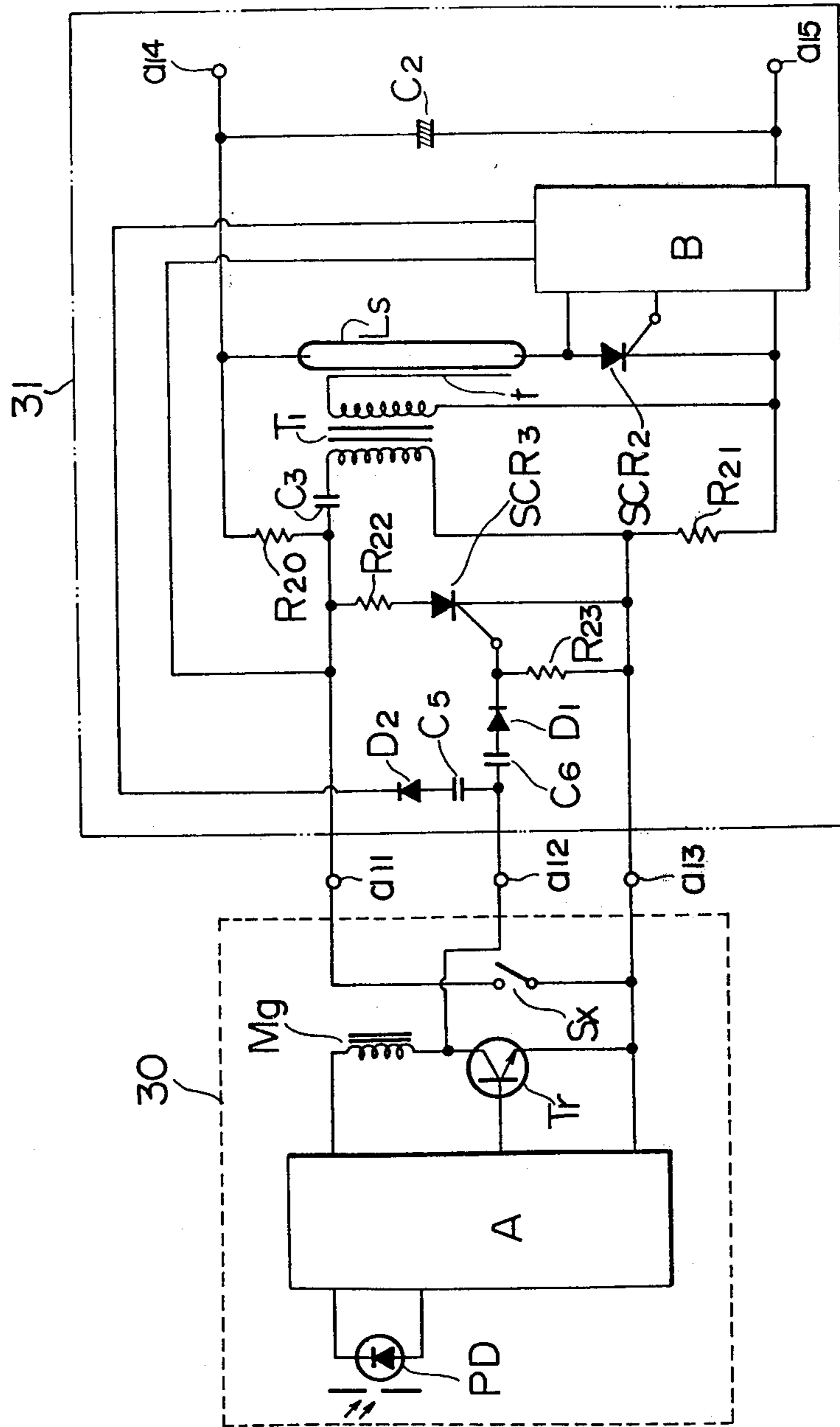


FIG. 10



APPARATUS FOR SYNCHRONIZING AN ELECTRONIC FLASH WITH A CAMERA

This is a division of application Ser. No. 504,856, filed Sept. 11, 1974, now U.S. Pat. No. 3,987,468.

BACKGROUND OF THE INVENTION

The invention relates to an apparatus for synchronizing an electronic flash with a camera including a focal plane shutter for the purpose of taking a picture under flashlight. When an electronic flash is used to take a picture under flashlight with a camera including a focal plane shutter the synchronizing contact must be changed to the X contact. Simultaneously the exposure period must be previously controlled so that a shutter speed or exposure period assumes a value at which a synchronized flashlight photographing is possible (which is referred to hereinafter as X-period), which is usually set to be greater than 1/125 to 1/60 second. Such value of the shutter speed corresponds to an exposure period which is defined from the termination of movement of the first blind of the shutter to fully open an exposure light path until the second blind moves to close the open exposure path. Such pre-establishing of the shutter speed is necessary because a focal plane shutter employs a slitwise exposure while an electronic flash represents a source of flashlight having a very short duration. If a picture is taken with a shutter speed established on the order of 1/250 second or the like, only one-half or one quarter of the scene to be photographed will be irradiated by the flashlight. This explains why the shutter speed must be established to an X-period. However, it often occurs that a photographer forgets to set the shutter speed to correspond to an X-period when taking a picture under flashlight, and becomes aware of this fact only after the exposed film is developed.

When using an electronic flash to take a picture under synchronized flashlight, it is known that the intensity of reflected light from an object being photographed varies as the distance between the camera and the object varies, thereby necessitating an adjustment of the diaphragm each time a picture is taken. To avoid such inconveniences, an adjusted flashlight emitter referred to as auto-strobo has been recently developed. This comprises a flash tube bypassed by a discharge tube in combination with a photometric circuit which is operative, upon illumination of the flash tube, to measure reflected light from an object being photographed and to cause a discharge of the discharge tube when the amount of light being measured reaches a proper amount of exposure, thus short-circuiting the flash tube to interrupt its operation and thus assuring a proper exposure. As is well known, an EE camera includes its own photometric circuit, which however is not used when the above mentioned auto-strobo is used to take a picture under flashlight.

Another difficulty occurs with the combination of the auto-strobo and an EE camera having an electronic focal plane shutter. The illumination of the strobo is controlled by the X contact which is closed by the operation of the shutter within the EE camera, which is in turn controlled by the EE circuit. Specifically, a release operation of the shutter causes the first blind of the shutter to move, and the X contact is closed when the photographic path becomes open. As the reflected light from an object being photographed reaches a proper amount of exposure, an electromagnet which

has been constraining the second blind of the shutter from moving is deenergized to permit movement of the second blind, thus terminating a photographing operation. The arrangement is such that if a given amount of exposure has been reached by natural light before the X contact is closed, an inhibit signal is applied to the strobo unit. However, depending on the relative timing of the inhibit signal generated and the closure of the X contact, the X contact may be closed to cause an illumination of the strobo unit. At this time, since the second blind of the shutter has already moved into the photographic path, vignetting is caused on the film surface by the presence of the second blind, thus resulting in a failure of synchronization.

SUMMARY OF THE INVENTION

It is a first object of the invention to provide an apparatus for synchronizing an electronic flash with a camera having a focal plane shutter capable of instantly providing an indication to a photographer, when taking a picture under synchronized flashlight, whether or not a shutter speed value within the X-period range has been established to cause a synchronized flashlight photographing, by merely recognizing the illumination or non-illumination of the electronic flash subsequent to the depression of a shutter button.

As a result, in accordance with the invention, if a shutter speed is established to a value which is on the higher speed side of the X-period, the circuit for causing an illumination of the electronic flash is prevented from being completed, so that if a photographer attempts to take a picture under flashlight without establishing the shutter speed to an X-period, no flash will be produced by the electronic flash, thus warning the photographer in a simple manner. In other words, the arrangement is such that the electronic flash can not be activated unless a shutter speed within the X-period range is established. Consequently, the photographer can be immediately informed whether or not a shutter speed within the X-period range is established, by merely taking notice of the illumination or non-illumination of the electronic flash, thus avoiding the inconvenience that the photographer may continue to take the pictures on the entire roll of film without knowing the failure of establishing an X-period, which he becomes away of only after developing the exposed film.

It is a second object of the invention to provide an apparatus for synchronizing an electronic flash with a camera having an electronic focal plane shutter, which permits the illumination from the electronic flash to be controlled by a photometric circuit contained within the shutter.

This permits a photometric circuit, which has usually been incorporated into an electronic flash as in the autostrobo, to be dispensed with, while assuring a proper amount of exposure under flashlight. Also the size of the electronic flash used can be minimized while at the same time improving the efficiency of use of the photometric circuit within the camera.

It is a third object of the invention to provide an apparatus for synchronizing an electronic flash with a camera having an electronic focal plane shutter in which the illumination of the electronic flash is prevented when a proper amount of exposure is reached by natural light before the electronic flash is to be illuminated while permitting the electronic flash to be illuminated in the event a given amount of exposure is not reached at the time when the X contact is to be closed.

In accordance with the invention, if a given amount of exposure is reached by natural light before the electronic flash is to be illuminated, a signal is derived from the electromagnet which controls the movement of the second blind of the shutter to discharge a trigger capacitor for the electronic flash before the X contact is closed, thus disabling the illumination of the electronic flash. In this manner, an asynchronous photographing is avoided.

It will be appreciated that the invention enables a satisfactory photographing operation under synchronized flashlight to be achieved while requiring of a photographer only the operations of coupling the electronic flash with the camera and depressing a release button to confirm the activation of flashlight. A synchronized photographing operation during daytime is also simplified.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the X contact associated with the electronic flash of a focal plane shutter which may be used in the apparatus according to the invention;

FIG. 2 is a wiring diagram showing the electrical connection of the X contact of FIG. 1;

FIG. 3 is a sequence diagram showing the closure of switches SW1 and SW2 which constitute together the X contact;

FIG. 4 is a perspective view showing another example of the X contact of a focal plane shutter which may be used in the apparatus according to the invention;

FIG. 5 is a plan view illustrating the operation of the X contact of FIG. 4;

FIG. 6 is a wiring diagram showing the electrical connection of the X contact of FIG. 4;

FIG. 7 is a circuit diagram of the photometric circuit and shutter control circuit of the electronic shutter contained within the camera associated with the apparatus of the invention;

FIG. 8 is a simplified schematic view of a camera having a TTL (through-the-lens) electronic shutter, illustrating the manner of incidence of light on a light receiving element contained in the photometric circuit of FIG. 7;

FIG. 9 is a circuit diagram of an exemplary adjusted strobo unit; and

FIG. 10 is a circuit diagram showing another embodiment of the invention for synchronizing an electronic shutter with a camera in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1, a focal plane shutter comprises a first blind 1 and a second blind 2. As is well known, a slit forming member 3 is fixed to the trailing edge of the first blind 1 and a slit forming member 4 is fixed to the forward edge of the second blind 2 to thereby form a slit which is moved across an exposure window 5 to permit an exposure. The trailing edge portion of the second blind 2 is fixedly mounted on a winding shaft 6 on which a gear 7 is fixedly mounted. The gear 7 meshes with a gear 8 of a larger diameter. The slit forming member 3 which is fixed to the trailing edge of the first blind 1 has a pair of traction strings 9a, 9b secured to its upper and lower end portions, which strings are passed around guide pulleys 10, 11, rotatably mounted on the winding shaft 6, and secured to a first blind winding shaft 12. A gear 13 is fixedly mounted on the winding

shaft 12, and meshes with a gear 14 of a larger diameter. The gears 8 and 14 having a larger diameter are rotatably mounted on an axle 15, and the arrangement is such that the gear 14 undergoes nearly one revolution in the direction indicated by an arrow as the slit forming member 3 traverses across the exposure window 5 when the first blind 1 moves, while the gear 8 undergoes nearly one revolution about the axle 15 in the direction indicated by an arrow as the slit forming member 4 traverses across the exposure window 5 in following relationship with respect to the member 3. These larger diameter gears 8 and 14 serve to wind the first and second blinds 1, 2 onto their respective winding shafts 6 and 12, respectively upon completion of taking a picture, by being integrally rotated through one revolution about the axle 15 in interlocked relationship with a film winding operation. When the both blinds 1 and 2 are wound, a shutter drive spring, not shown, is charged.

The width of the slit defined between the slit forming members 3 and 4 is determined by the relative timing of movement of the second blind 2 with respect to that of the first blind 1, which is in turn established in accordance with a preset exposure period.

As mentioned previously, the gear 14 undergoes nearly one revolution as the slit forming member 3 traverses across the exposure window 5, and the gear 8 undergoes one revolution as the slit forming member 4 traverses across the exposure window 5 to close an exposure light path. Thus it will be seen that the exposure path which passes through the exposure window 5 remains fully open after one revolution of the gear 14 and before the gear 8 initiates its rotation. A satisfactory synchronization is assured for taking a picture under flashlight if the flashlight is activated under the open condition of the exposure window.

In accordance with the invention, the synchronizing contact or X contact comprises a first switch which is closed when the exposure light path is fully open as a result of movement of the first blind 1, and a second switch which is opened as the second blind 2 initiates its movement in order to close the open exposure light path. Specifically, a tab 16 is disposed on the gear 14, and a movable contact SW2a of a normally open switch SW2 is located in the path of travel of the tab 16 which operates as a switch control member. Similarly, a tab 17 which operates as a switch control member is disposed on the gear 8, and a movable contact SW1a of a normally open switch SW1 is located within the path of travel of the tab 17. When the second blind 2 is wound by a film winding operation, the tab 17 bears against the movable contact SW1a to move it into contact with a fixed contact SW1b, thus closing the normally open switch SW1. As shown in FIG. 2, the switches SW1 and SW2 are connected in series to constitute the X contact for an electronic flash.

With the X contact as constructed in this manner, when the shutter is charged in interlocked relationship with the winding of a film, the gears 8 and 14 rotate clockwise about the axle 15 through nearly one revolution, whereby the tab 17 on the gear 8 bears against the movable contact SW1a to close the switch SW1 while the tab 16 on the gear 14 remains at a position close to but spaced from the movable contact SW2a. When a shutter speed is established to a value within the X-period range, the first blind 1 will move in the direction indicated by an arrow upon shutter release, thereby fully opening the exposure window 5. When the exposure path is fully open, gear 14 will have rotated about

the axle 15 through one revolution, whereby the tab 16 bears against the movable engagement SW2a to move it into contact with a fixed contact SW2b, thus closing the switch SW2. Since the switch SW1 is already closed, the closure of the switch SW2 results in a closure of the X contact, thus illuminating the electronic flash to permit a photographing under synchronized flashlight. Upon lapse of an established exposure period, the second blind 2 commences its movement, whereby the gear 8 rotates counter-clockwise about the axle 15, thus opening the switch SW1. The opening of the switch SW1 occurs immediately before the slit forming member 4 associated with the second blind 2 moves into the open exposure path. When the switch SW1 is opened, the X contact remains open even though the switch SW2 may be closed. It will be appreciated that the X contact comprising both switches SW1 and SW2 is closed only when a shutter speed or an exposure period within the X-period is established. Stated differently, if an exposure period greater than the X-period is established, it is assured that the both switches SW1 and SW2 will be closed as shown in FIG. 3 when the exposure path is fully open. The illumination of the electronic flash under this condition ensures a completely synchronized flashlight photographing. In FIG. 1, characters 28a and 28b represent traction strings associated with the second blind 2.

While in the above described embodiment, the switches SW1 and SW2 which together constitute the X contact are opened and closed by gears which undergo a rotation through nearly one revolution in interlocked relationship with the running of the first and second blinds, it should be obvious that these switches may be directly operated by the first and second blinds 1 and 2, respectively. The only requirement is that the switch SW2 is closed when the first blind 1 has completed its movement to fully open the exposure light path while the other switch SW1 is opened immediately before the second blind 2 which has started running moves into the open exposure light path.

FIGS. 4 to 6 show another embodiment of the X contact, and corresponding parts are designated by like reference characters as used in FIG. 1. In the embodiment shown in FIG. 4, the synchronizing contact or X contact comprises a pair of movable contacts, one of which is displaced into contact with the other in interlocked relationship with the movement of the first blind 1 as it runs to fully open the exposure light path, thereby closing the contact to cause an illumination of the electronic flash. Subsequently, when the second blind 2 initiates its movement in order to close the fully open exposure light path, the other movable contact is moved away from said one movable contact in interlocked relationship with the movement of the second blind 2, immediately before the second blind moves into the open exposure path, thus opening the previously closed contact.

Specifically, the X contact comprises a pair of independently movable blade contacts SW3 and SW4, both of which are formed of a resilient material. These blade contacts are disposed in opposing relationship with each other, and a bend SW4a formed in the movable blade contact SW4 and a mating portion of the movable blade contact SW3 form a cooperating pair of electrical contacts. The movable blade contact SW4 is resiliently biased toward the movable blade contact SW3, while the latter is resiliently biased to move away from the other movable blade contact SW4. Both movable blade

contacts SW3 and SW4 have their free ends extending adjacent to the axle 15 mentioned before. The movable blade contact SW4 is adapted to be displaced by a cam 18 which operates as a switch control member and is integrally mounted on the gear 8 while the movable blade contact SW3 is adapted to be displaced by a projection on a disc 19 which operates as a switch control member and is integrally mounted on the gear 14. The disc 19 is fixedly mounted on the boss of the gear 14, and rotates through nearly one revolution as the gear 14 rotates through nearly one revolution in the direction indicated by an arrow, with its projection 19a bearing against the movable blade contact SW3 to cause it to move toward the other movable blade contact SW4, thus closing the pair of electrical contacts mentioned above. The cam 18 is fixedly mounted on the boss of the gear 8 and comprises a planar cam having a portion of reduced diameter 18a, and in the charged position of the shutter, the free end of the movable blade contact SW4 bears against the portion of reduced diameter 18a of the cam 18, but as the gear 8 commences its rotation through one revolution, the remaining portion of the cam, shown at 18b, displaces the movable blade contact SW4, whereby the electrical engagement between the movable blades SW3 and SW4 is interrupted.

In operation, it is initially assumed that a shutter speed is established to define an exposure period which is within the X-period. Upon shutter release, the first blind 1 moves, and by the time it has fully opened the exposure light path, the gear 14 has undergone nearly one revolution, so that the projection 19a displaces the movable blade contact SW3 as shown in FIGS. 5 and 6 into engagement with the blade contact SW4. Thus, the X contact is closed, and the electronic flash is activated under the fully open condition of the exposure light path, permitting a photographing operation under synchronized flashlight. Subsequently, when the established exposure period has elapsed, movement of the second blind 2 initiated. As it begins to move, the movable blade contact SW4 which has been in abutment against the portion of reduced diameter of 18a will be engaged by the remainder 18b of the cam 18 as it rotates together with the gear 8, whereby the blade contact SW4 will be displaced to a position SW4A shown in FIG. 5 in chain lines. This displacement moves the movable blade contact SW4 away from the other movable blade contact SW3, whereby the electrical contact therebetween is interrupted to open the X contact. It will be appreciated that the X contact will be closed only when an exposure period greater than the X-period is established in the similar manner as in the previous embodiment.

While in the above embodiment, the pair of movable blade contacts SW3 and SW4 which together constitute the X contact have been displaced by cam 18 and disc 19 having projection 19a and which are mounted on the gears 8 and 14, respectively, it should be understood that they may be directly moved by the first and second blinds 1 and 2, respectively. This may be achieved, for example, by utilizing the slit forming member 3 of the first blind 1 to urge one of the movable blade contacts SW3 into contact with the other movable blade contact engagement SW4 when this member has completed its movement and by utilizing the movement of the second blind 2 to move the movable blade contact SW4 away from the movable blade contact SW3 to open the X contact when the second blind 2 has initiated its movement. The only requirement is that one of the movable

blade contacts, SW3, is moved into contact with the other movable blade contact SW4 when the first blind 1 has completed its running to fully open the exposure light path and the movable blade contact SW4 is moved away from the movable blade contact SW3 when the second blind 2 has initiated its movement to move into the open exposure light path.

Referring to FIGS. 7 and 8, a control of the illumination of an adjusted strobo or auto-strobo by means of a photometric circuit contained within an electronic focal plane shutter, in particular an electronic focal plane shutter of TTL (through-the-lens) type, will now be described. Initially describing the arrangement on the side of a single lens reflex camera having an electronic focal plane shutter of TTL type which is not adapted to store a photometric value, FIG. 7 shows a photometric circuit MC which does not store a photometric value, a gate circuit GC and a shutter control circuit SC, connected in parallel with each other and connected through a power switch SW5 with a first d.c. power supply E1, the power switch being closed immediately in response to the initiation of a shutter release operation. The photometric circuit MC is conventional in that it comprises light receiving elements PD1 and PD2 such as photodiodes for receiving reflected light from an object being photographed (not shown), an integrator circuit and a switching circuit. The photometric operation is initiated by an opening of a trigger switch ST which is opened in synchronism with the opening movement of the shutter or the start of movement of the first blind of a focal plane shutter which is initiated in response to a shutter release operation with a time delay after the closure of the power switch SW5. The light receiving elements PD1 and PD2 of the photometric circuit MC are adapted to receive light incident upon a film 23 and the first blind 24 of the focal plane shutter having the same reflectivity as the film 23 as reflected therefrom, the light being incident on the film 23 through an objective 21 and a diaphragm 22 when a movable reflecting mirror 20 moves up in response to a shutter release operation as shown in FIG. 8. A pentaprism 25 is disposed for conducting light incident onto and reflected by the reflecting mirror 20 to a finder window, not shown, when the mirror 20 is set within the light path as shown by dotted lines.

The shutter control circuit SC comprises a first NPN transistor *Tr1*, the collector of which is connected in series with an electromagnet *Mg*. The electromagnet *Mg* locks the second blind of the focal plane shutter against movement when it is energized, and permits the second blind to move when it is deenergized. The transistor *Tr1* is shunted by a differentiator circuit comprising a capacitor C1 and a resistor R6 connected in series, the resistor R6 being connected across a pair of terminals *a3* and *a4* which are adapted to apply a shutter closing signal to an electronic flash. The gate circuit GC comprises a pair of NPN transistors *Tr2* and *Tr3* connected in series, with a resistor R1 connected to the collector of the transistor *Tr2* and to the power switch SW5, and an NPN transistor *Tr4* which has its collector connected through a resistor R3 with the power switch SW5. The base of the transistor *Tr3* is connected with the collector of the transistor *Tr4*. One input terminal, that is, the base of the transistor *Tr2* is connected through a resistor R2 with the output terminal of the photometric circuit MC, and the other input terminal or the base of the transistor *Tr4* is connected through a resistor R5 with a terminal *a1*. Another terminal *a2* is

connected with the emitter of the transistor *Tr4*, and the base and the emitter of the transistor *Tr4* are interconnected by a resistor R4. An inhibit signal from the electronic flash is applied across these terminals. The output terminal of the gate circuit GC, or the collector of the transistor *Tr2*, is connected to a control signal input for the shutter control circuit SC, that is, the base of the transistor *Tr1*. A synchronizing contact or X contact SX which is closed when the first blind of the focal plane shutter has moved to fully open the exposure light path is connected across the terminals *a1* and *a2*.

Referring to FIG. 9, the arrangement on the side of an adjusted strobo unit will be described. As shown, a second d.c. power supply E2 has its positive terminal connected through a power switch SW6 and a resistor R7 with one plate of a main capacitor C2, the other plate of which is connected directly with the negative terminal of the power supply E2. The capacitor C2 is shunted by a parallel combination of a flash discharge tube *Ls* and a bypass discharge tube *Ld* which are associated with trigger circuits T1 and T2, respectively. The first trigger circuit T1 comprises a voltage divider BC1 comprising a pair of resistors R8 and R9 connected in series across the flash discharge tube *Ls*, with the resistor R9 being shunted by a series circuit comprising a trigger capacitor C3 and the primary winding of a first pulse transformer PT1. The secondary winding of the first pulse transformer PT1 is connected across a trigger electrode associated with the flash discharge tube *Ls* and one of the main electrodes thereof. The resistor R9 has its opposite ends connected to a pair of terminals *a5* and *a6*, across which the X contact SX is connected as a start switch. Thus, an inhibit signal is applied from the terminals *a5*, *a6* to the base-emitter path of the transistor *Tr4* in the gate circuit GC.

The second trigger circuit T2 comprises a voltage divider BC2 comprising a series connection of resistors R10 and R11 in shunt with the discharge tube *Ld*, with the resistor R11 being shunted by a series circuit comprising a capacitor C4 and the primary winding of a second pulse transformer PT2. The secondary winding of the second pulse transformer PT2 is connected across an auxiliary electrode and one of the main electrodes of the discharge tube *Ld*. The resistor R11 is also shunted by a start switch which comprises a three terminal thyristor SCR1, which has its gate connected with a terminal *a7* and its cathode connected with a terminal *a8*. The pair of terminals *a7* and *a8* are connected with the pair of terminals *a3* and *a4* in the shutter control circuit SC, whereby a shutter closing signal from the circuit SC may be applied to the gate of the thyristor SCR1 as an illumination interrupt signal.

With the above arrangement, an electronic flash is loaded on the camera and its terminals *a5* and *a6* connected with the terminals *a1* and *a2* of the camera. Also the terminals *a7* and *a8* are connected with the terminals *a3* and *a4*. By closing the power switch SW6 of the electronic flash, the main capacitor C2 can be charged to a sufficient level to cause an illumination of the flash discharge tube *Ls*, and the capacitors C3 and C4 can also be charged. Thereupon, the terminal voltage across the resistor R9 will be applied as an inhibit signal across the base and emitter of the transistor *Tr4* through the mating terminals *a5-a1* and *a6-a2*.

When the shutter of the camera is released under this condition, the power switch SW5 will be closed together with the initiation of the release operation, whereby the transistor *Tr4* having an inhibit signal ap-

plied to its base will be turned on to prevent conduction of the transistors *Tr3* and *Tr2*, which ultimately results in a conduction of the transistor *Tr1*. As a consequence, the electromagnet *Mg* will be energized, locking the second blind against movement. Subsequently, the reflecting mirror 20 will move up, followed by the initiation of movement of the first blind of the focal plane shutter, and the trigger switch *ST* will be opened in synchronism therewith, initiating the operation of the photometric circuit *MC*. When the first blind has run through its complete stroke or when the exposure light path is fully open, the X contact *SX* will be closed to turn off the transistor *Tr4*, whereby the resistor *R9* in the trigger *T1* is short-circuited, thus enabling the charge on the trigger capacitor *C3* to be instantaneously discharged through the primary winding of the pulse transformer *PT1*. Thereupon, a high tension pulse will be induced across the secondary winding of the pulse transformer *PT1* to trigger the flash discharge tube *Ls* into conduction, which therefore emits a flash. The flash from the tube *Ls* irradiates an object being photographed. Light reflected from the object being photographed impinges through the objective 21 and diaphragm 22 of the camera onto the film 23, thus allowing an exposure thereof, and is also reflected by the film 23 to impinge upon the light receiving elements *PD1* and *PD2* of the photometric circuit *MC* which is then operating.

When a photometric value reaches a proper amount of exposure, the photometric circuit *MC* produces a shutter closing signal, which is applied to the base of the second transistor *Tr2* for turning *Tr2* on. Since the transistor *Tr4* is already turned off thereby conditioning the transistor *Tr3* to be ready to be turned on, the shutter closing signal permits the both transistors *Tr2* and *Tr3* to conduct simultaneously, thus rendering the first transistor *Tr1* non-conductive. As a result, a pulse signal is developed across the terminals *a3* and *a4* of the differentiator circuit, and is applied through terminals *a7* and *a8* to the gate-cathode path of the thyristor *SCR1* to cause its conduction. The conduction of the thyristor *SCR1* causes the capacitor *C4* of the trigger circuit *T2* to discharge in an impulse manner through the thyristor and the primary winding of the second pulse transformer *PT2*, so that high tension pulse is induced across the secondary winding of this transformer to be applied to the discharge tube *Ld* to initiate conduction. Thereupon, the flash discharge tube *Ls* becomes short-circuited by the discharge tube *Ld*, whereafter the discharge current from the capacitor *C2* will be bypassed by the discharge tube *Ld*, thus interrupting the illumination of the flash discharge tube *Ls*. Simultaneously, the turning off of the transistor *Tr1* deenergizes the electromagnet *Mg*, whereby the second blind is released to move, thus closing the shutter to terminate a photographing operation. Therefore, it will be seen that the illumination of the electronic flash is controlled by a shutter closing signal derived from the photometric circuit *MC* of a camera, and that a complete synchronization is assured since the electronic flash can be activated in the fully open condition of the shutter.

When a flashlight photographing by means of an electronic flash is attempted to take a picture of a man under counter-light, bright illumination, inconveniences may be caused such that the electronic flash fails to operate or a synchronized flashlight photographing is prevented if an arrangement is such that the photometric circuit *MC* supplies a shutter closing signal directly

to the shutter control circuit *SC*, since in this instance the photometric circuit *MC* may produce a shutter closing signal before the shutter is fully open or the first blind has completed its movement, to thereby permit a movement of second blind before the electronic flash is activated because the latter is adapted to be activated under the fully open condition of the shutter.

However, in accordance with the invention, the shutter closing signal produced by the photometric circuit *MC* is supplied to the shutter control circuit *SC* through the gate circuit *GC*, which passes the closing signal to the shutter control circuit *SC* only when the X contact *SX* is closed, so that even if the photometric circuit *MC* produced a shutter closing signal before the shutter is fully open, a closing movement of the shutter is not initiated and the illumination interrupt signal will not be supplied to the electronic flash until after the shutter becomes fully open to permit an activation of the electronic flash. Thus, a satisfactory synchronized photographing is assured as mentioned before even when a picture is taken of a man under counter-light, bright illumination.

If an electronic flash is not loaded on the camera, no inhibit signal will be fed from the electronic flash to the terminals *a1* and *a2*, so that the transistor *Tr4* normally remains off while the transistor *Tr3* normally remains on. In other words, a signal from the photometric circuit *MC* is passed through the gate circuit *GC* to the shutter control circuit *SC* any time, thus assuring a proper operation of the camera.

While the above embodiment deals with a single lens reflex camera of TTL type incorporating a photometric circuit which does not store a photometric value, a conventional bladed shutter employs a photometric circuit of the type which stores a photometric value, so that the invention can be equally applied to such cameras.

In this manner, in accordance with the invention, the photometric circuit of the camera can be used to provide a control of the illumination of a flash tube within an electronic flash, thus eliminating the need for a photometric circuit in the electronic flash while permitting the same effect to be achieved as that of a flashlight photographing using an adjusted strobo. Thus, a flashlight photographing operation with a proper amount of exposure is facilitated, and consequently the electronic flash used may be a compact and inexpensive one. In addition, the utilization of the photometric circuit of the camera is maximized.

The invention also provides an arrangement in which an electronic flash is prevented from emitting light when a given amount of exposure is reached by natural light before the illumination of the electronic flash should take place and in which the electronic flash is activated only when a given amount of exposure is not reached when the X contact is to be closed. Referring to FIG. 10, an electrical circuit shown within a box 30 indicated in broken lines represents an electronic shutter circuit provided on the part of an EE camera while an electrical circuit shown within a box 31 indicated in chain lines represents the principal part of an auto-strobo of a series controlled type. Both electrical circuits are electrically connected together through connection terminals *a11*, *a12* and *a13*. The electronic shutter includes a light receiving element *PD* which comprises a photoelectric transducer element such as a photodiode, phototransistor, silicon photocell or the like having a rapid response to a natural light (continuous

light) as well as a flash from the strobo unit. The electronic shutter includes a block A of a conventional design and having its last stage formed by the series circuit comprising an electromagnet *Mg* for permitting the movement of the second blind and a switching transistor *Tr*. As before, the electromagnet *Mg* is energized by the conduction of the transistor *Tr* when the first blind initiates its movement upon shutter release, thereby constraining the second blind of the shutter from movement. When a proper amount of exposure is reached, the block A operates to turn off the transistor *Tr*, thereby deenergizing the solenoid to permit the second blind to move. The transistor *Tr* has its emitter connected with the connection terminal *a13* and its collector connected with the connection terminal *a12*, while the X contact SX is connected between the connection terminals *a11* and *a13*.

The main electrical circuit of the strobo unit comprises a main capacitor C2 connected across a pair of power supply terminals *a14*, *a15*; a series circuit comprising a flash discharge tube *Ls* and a thyristor SCR2 which are connected across the capacitor C2 through a conduction control circuit B for the thyristor SCR2; another series circuit connected across the first mentioned series circuit and comprising a resistor R20, a trigger capacitor C3, the primary winding of a triggering pulse transformer T1 and a resistor R21; a further series circuit comprising a current limiting resistor R22 and a thyristor SCR3 connected in series across the pair of connection terminals *a11* and *a13*; an additional series circuit comprising a capacitor C6, diode D1 and resistor R23 connected across the pair of connection terminals *a12* and *a13*; and a connection circuit including a capacitor C5 and diode D2 in series between the connection terminal *a12* and the conduction control circuit B. The secondary coil of the triggering transformer T1 has its one end connected with a trigger electrode *t* and its other end connected with a cathode of the thyristor SCR2. The gate of the thyristor SCR2 is supplied with a firing voltage from the conduction control circuit B while the gate of the thyristor SCR3 is supplied with a firing voltage from the junction between the diode D1 and the resistors R23. The junction between the resistor R20 and the trigger capacitor C3 is connected with the connection terminal *a11*, which is also connected to the conduction control circuit B.

When an electronic flash is coupled with the electronic shutter, the light from the flash discharge tube *Ls* as reflected from an object being photographed is received by the element PD within the electronic shutter for processing within the electronic shutter circuit, and when a proper amount of the exposure has been reached, the electromagnet *Mg* is deenergized to permit the second blind of the shutter to start moving. Since the mechanical operation of the shutter blind is slower in operation than the time interval during which the electronic flash is activated, it is impossible to rely on the closing movement of the second blind alone in order to control the light from the electronic flash. In view of this, a release signal indicative of the deenergization of the electromagnet *Mg* is derived to be passed through a path including the capacitor C5 and diode D2 to be applied to the conduction control circuit B so as to interrupt the conduction of the thyristor SCR2, thus terminating the illumination of the flash discharge tube *Ls*. In this manner, a proper amount of exposure is assured.

In operation, if a given amount of exposure is reached by natural light before the strobo unit is to be activated, the block A produces a signal which permits the second blind to move immediately after the movement of the first blind, whereby the transistor *Tr* is turned off to deenergize the electromagnet *Mg*. This release signal is derived at the connection terminal *a12* and applied through the capacitor C6 and diode D1 to the gate of the thyristor SCR3 as a firing voltage, thus rendering this thyristor conductive. The conduction of the thyristor SCR3 causes the trigger capacitor C3 to be discharged through the current limiting resistor R22. Consequently, even if the X contact SX is closed subsequently by the operation of the first blind, any voltage applied to the trigger electrode *t* will be insufficient to cause an illumination of the discharge tube *Ls*. If a release signal is obtained from the electromagnet *Mg* subsequent to the closure of the X contact SX, the charge on the trigger capacitor C3 will be discharged through the triggering transformer T1, and at the same time the thyristor SCR2 will be turned on, thereby initiating the illumination of the flash discharge tube *Ls*. However, this illumination will be immediately interrupted since simultaneously with the release signal from the electromagnet *Mg*, this signal will operate the control circuit B through the capacitor C5 and diode D2 to turn off the thyristor SCR2 in the manner mentioned previously.

In this manner, the invention assures a satisfactory synchronized flashlight photographing in any instance, including a synchronized photographing during daytime.

What is claimed is:

1. An apparatus for synchronizing an electronic flash with a camera having a focal plane shutter provided with first and second blinds, said apparatus comprising:
 - a normally disabled photometric circuit having a switch means for enabling said circuit to initiate a photometric operation in synchronism with initiation of an opening movement of the shutter first blind to subsequently produce a shutter closing signal at a time delay controlled by the amount of time required for the photometric value to reach a given amount of exposure;
 - a shutter control circuit having a control input, said shutter control circuit preventing the remaining blind from running to thereby keep the shutter open in the absence of a shutter control signal at said control input and for enabling the remaining blind to run and thereby close the shutter when a shutter closing signal is applied to said control input;
 - an electronic flash unit including means for initiating illumination thereof as soon as the first blind has completed running;
 - gate means for enabling the shutter closing signal to be coupled to the shutter control circuit only when the shutter first blind has moved to its fully open position;
 - means for interrupting the illumination of the electronic flash unit when the shutter closing signal is supplied from the photometric circuit as a result of photometry thereby a light reflected from an object being photographed, due to either natural light or flash light from the electronic flash unit or both.
2. An apparatus according to claim 1 in which the shutter control circuit comprises a series circuit including a transistor and an electromagnet, said electromagnet being effective in its energized condition to lock the

second blind of the focal plane shutter against movement, the deenergization of the electromagnet permitting the second blind to move.

3. An apparatus for synchronizing an electronic flash with a camera having a focal plane shutter provided with first and second blinds, the apparatus comprising:

a photometric circuit having switch means for initiating operation of the photometric in synchronism with initiation of an opening movement of the first blind of the shutter to produce a shutter closing signal at a time when a photometric value reaches a given amount of exposure;

a shutter control circuit for closing the remaining blind of the shutter in response to said shutter closing signal derived from the photometric circuit;

an electronic flash unit activated for flash illumination by second switch means operated in synchronism with the completion of the opening movement of the shutter first blind which occurs at the time that the exposure light path is fully open;

means for interrupting the flash illumination of the electronic flash unit responsive to the shutter closing signal which occurs when the photometric circuit determines that reflected light from an object being photographed, which object is irradiated either by natural light or flash illumination from

the electronic flash unit or both, reaches the given amount of exposure;

said electronic flash unit including an energy storing capacitor discharged by said switch means when said light path is fully open and means coupled across said energy storing capacitor for developing an inhibit signal when the flash unit is in an inactivated state;

a gate circuit interposed between the photometric circuit and the shutter control circuit for inhibiting the coupling of the shutter closing signal from the photometric circuit to the shutter control circuit in response to said inhibit signal, said inhibit signal being interrupted by closure of said switch means which occurs in synchronism with the initiation of the flash illumination of the electronic flash unit.

4. An apparatus according to claim 3 in which the gate circuit comprises a first series circuit including a first resistor and a first transistor, and a second series circuit including a second resistor and second and third transistors, the output from the photometric circuit being applied to the base of the second transistor through a third resistor, the output of the first transistor being applied to the base of the third transistor, the inhibit signal from the auto-strobo being applied across the base and emitter of the first transistor.

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