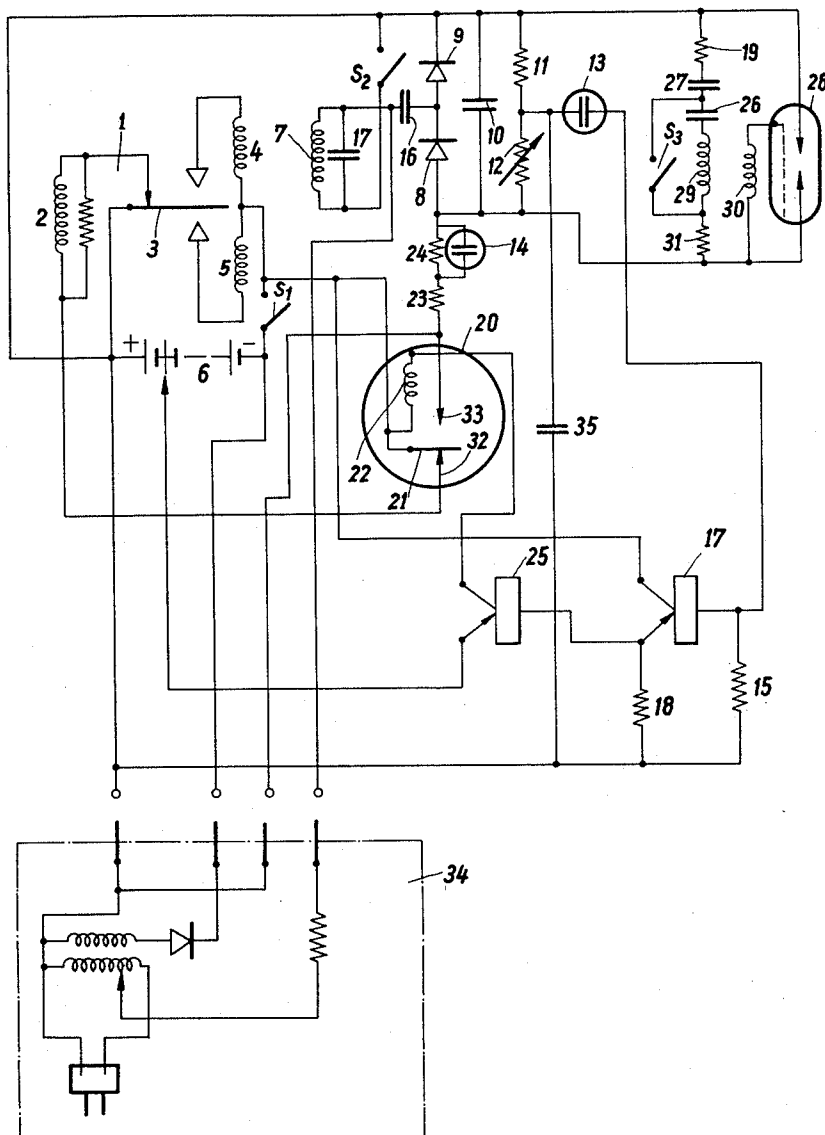


Nov. 28, 1961

P. KAPTEYN
CIRCUIT ARRANGEMENT FOR ELECTRONIC FLASH
UNITS WITH ECONOMIZING OPERATION
Filed July 20, 1959

3,011,094



Inventor:

Paul Kapteyn

1

2

3,011,094 CIRCUIT ARRANGEMENT FOR ELECTRONIC FLASH UNITS WITH ECONOMIZING OPERATION

Paul Kapteyn, Am Pfarracker 15, Berlin-Lichterfelde-Ost, Germany

Filed July 20, 1959, Ser. No. 828,423

Claims priority, application Germany July 22, 1958
6 Claims. (Cl. 315—183)

The object of the invention is a circuit arrangement for electronic flash units with the special aim of saving electricity by means of a low consumption circuit.

One advantage of such arrangements is that, owing to the properties of the circuit used, the unit can be operated with approximately always the same light energy provided time is given for the gas discharge lamp to light up, this serving as an indication that the storage condenser is fully charged. In comparison, with the flash units used up to now, the voltage of the storage condenser generally rose quite considerably after the first lighting up of the gas discharge lamp when new dry batteries or newly charged accumulators were used, since the voltage reached on the storage condenser was dependent on the discharge state of the batteries and in order to have full use of the batteries, it was necessary to make do with an excess voltage during the start of the battery discharge.

This excess voltage has already been avoided to a considerable extent by arranging for the lighting up of the gas discharge lamp to operate a relay which switches off the source of current and so prevents the storage condenser being charged to the excess voltage point.

The object of the present invention is a circuit arrangement which leads to an increase in the accuracy of this effect so that it is possible to operate with particularly exactly determined luminosity which is important for colour photography. Tests have shown that the miniature gas discharge signal lamps on sale and generally used as an indication device for the completed discharge in the electronic flash units change their ignition voltage with the presence of photo-electrons during exposure. For this reason, it is best either to provide this gas discharge lamp with a cover on the bulb impervious to light or with a cover of high light absorbent material or to fit it in a darkened position inside the flash unit.

It is also possible to use special tubes with an especially high service life constancy instead of the gas discharge lamp for the control circuit whose glow discharge is often not clearly visible from outside.

Thus, in accordance with the present invention, an additional incandescent or gas discharge lamp is provided as an indication of flash readiness in the above-mentioned circuit arrangement for electronic flash units with economizing operation. This is switched on via relay activation only when the desired charging voltage of the storage condenser is reached. According to a further feature of the invention, the same relay as is used for the control circuit can be employed and is provided with one rest contact and one make contact for this purpose. Here, the flash readiness is indicated, e.g., by a miniature gas discharge lamp which is switched off in the "rest position" of the relay armature and accordingly put out of operation for the period of charging.

Further, it has been shown that the internal resistance of the supply battery, e.g. the dry cells or nickel-cadmium accumulators, has a damaging effect on the operation of the relay. In the previous circuit arrangements of the applicant, the ignition of the gas discharge lamp effects a decrease in the relay current after a sufficient condenser voltage has been attained so that the contact drops. This means that the interrupter current is switched off and

that, on release from this load, the battery voltage rises and thereby the transistor currents and the relay current too. This in turn prevents the relay armature from falling properly and the relay begins to "flutter" which is disadvantageous for the service life of the contacts.

In accordance with the invention, it is aimed at avoiding this effect by causing the switching to effect an intensification of the relay current on ignition of the gas discharge lamp. The relay is, therefore, formed as a "closed circuit relay" and accordingly, on intensification of the relay current, switches off the interrupter circuit. The rise in the battery voltage resulting from the removal of the load from the battery now intensifies the switching-off effect (the relay current becomes higher) so that there is no "flutter" but an exact switching on and off of the battery current via the relay.

A further method of avoiding "relay flutter" owing to the internal resistance of the supply battery is to connect a condenser in parallel to the series connection of the gas discharge lamp and base series resistance (13 and 15 in the diagram). In this way, slow relaxation oscillations occur with ignited gas discharge lamp and this also results in an exact switching of the relay current. A suitable value for this switching arrangement is a condenser of, say, 0.5 μ f.

An improvement of the circuit arrangement of the applicant used up to now is also to be found in the reduction of the influence of the supply voltage. If the base of the first of the two amplifier transistors is connected to the collector via the base resistance (e.g. 15 in the circuit arrangement shown in the attached diagram), its voltage changes according to the battery voltage in comparison with the emitter. However, if it is connected to its emitter via the resistance 15, in accordance with the attached diagram, the voltage which chiefly determines the height of the collector current remains practically the same between the base and the emitter, independent of the height of the voltage between emitter and collector. Accordingly, the circuit arrangement of the present invention supplies—almost independent of the discharge state of the supply battery—a continuously constant voltage on the storage condenser.

A regular disadvantage of all transistor amplifiers is the dependence to a certain extent of the operational data on the temperature. In the circuit arrangement used up to now by the applicant, the "collector residual current" which rises heavily with the temperature results in the production of such a large relay constant current from a certain temperature onwards that the armature of the relay remains closed even when the gas discharge lamp strikes. However, with the present invention, a low condenser voltage with a relative low temperature rise is sufficient to cause the relay to switch off the interrupter, i.e. with increasing temperature, the condenser voltage falls somewhat and vice versa.

It is the aim of the invention to avoid these errors too by means of one or more or all of the following measures:

(1) The base of the second transistor is positively biased by approx. 1 volt compared to its emitter (cf. appended diagram). This means that the residual current of the first transistor can have quite a considerable value without the base of the second transistor becoming negative compared to its emitter. Accordingly, so long as this is so, there is no flow of the collector current of the second transistor.

(2) The resistance in the emitter circuit of the first transistor should be of a very low value so that the residual current of the first transistor does not bring about too large a drop in the voltage. A suitable value is approx. 200 to 1000 ohms, preferably approx. 500 ohms.

(3) The resistance between base and emitter of the

first transistor should be of a very small value since in this case "the residual current" will also be smaller. A suitable value is of the range 5000 to 50,000 ohms, preferably approx. 15,000 ohms.

A further special advantage lies in the use of thermally unstable resistances (so-called "hot conductors") for the elements 11, 15 and 18 (cf. attached diagram). These resistances lower their resistance even with small rises in temperature to $\frac{1}{2}$ or $\frac{1}{3}$ of their resistance value at 20°. If, for example, the resistance 18 considerably decreases in value, the amplification of the first transistor falls so that the relay switches off the interrupter at a somewhat higher condenser voltage. A further effect of the decrease in resistance value at increased temperature lies in the fact that the collector residual current decreases with the decrease in the resistance value between base and emitter and this also has a favourable effect on the dependence of the switching on temperature and on the maximum possible operational temperature without lowering the sensitivity of the arrangement at the normal temperature of +20°. On replacement of the resistance 11 (cf. diagram) by a thermally unstable resistance, the voltage on the gas discharge lamp 13 falls with the increasing temperature. Accordingly, this strikes at a higher condenser voltage and this also compensates for the temperature change of the first transistor.

It is possible to avoid too great a change in temperature of these resistances by simply connecting a thermally stable resistance in parallel or series to one of the thermally unstable resistances.

As regards the arrangement of the ignition circuit, use of an additional condenser (in attached diagram, e.g., condenser 27) is important. This effects a voltage division so that the maximum permissible voltage of approx. 300 volts required by the manufacturers of photographic shutters is not exceeded on the synchronous contact without any additional current consumption occurring due to an ohmic voltage divider which would otherwise have to be used.

An example of the circuit arrangement in accordance with the invention is shown in the given diagram. 1 is the interrupter with the winding 2 and the interrupter contact spring marked 3. On switching on the switch S_1 which is mechanically coupled to switch S_2 to give like operation, the battery circuit from the battery 6 runs by means of the interrupter alternatively to the coils 4 and 5 which in turn are inductively coupled to the coil 7. The currents in coil 7 charge the storage condenser 10 via a voltage doubling circuit by means of the rectifiers 8 and 9. Here condenser 16 operates as voltage doubling condenser whilst condenser 17 serves to extinguish the sparks on the contacts of the interrupter. The actual ignition device for the flash lamp 28 is fitted to the storage condenser 10 and consists of the resistance 19, ignition condenser 26 with the series condenser 27, Tesla transformer 29, 30, series resistance 31 and the flash lamp 28. When the necessary charging voltage is reached on the storage condenser 10 and therefore on the ignition condenser as well, as shown by the lighting of the gas discharge lamp 13 or the signal lamp 14, then on closing the switch S_3 in the Tesla transformer 29, 30, an impulse of current is released resulting in the discharge of the flash lamp 28 and so the flash light.

The circuit of the signal gas discharge lamp 13 is connected to the storage condenser 10 by means of the voltage divider 11, 12. If there is sufficient voltage to strike the flash lamp 28 on the condenser 10, then the gas discharge lamp 13 strikes and so the base of the connected amplifier transistor 17 is given an increasing negative voltage, likewise the base of the transistor 25. Accordingly, an intensified current now flows into the transistor circuits and thus through the winding 22 of the switching relay 20 too. The relay armature 21 which, when in the rest position of the relay, provides for the excitation of the coil 2 of the interrupter 1 by means of the battery 6

via the contact 32 is detached and connected to the make contact 33. This means that the interrupter 1 is switched off and the "economical operation" starts. In this phase, the gas discharge signal lamp 14 is switched on at the same time via the resistance 23 and the parallel resistance 24 in the transistor circuit. This signal lamp 14 represents the additional gas discharge lamp used in the invention and shows that the unit is ready for operation since, as already explained in the general section of the description, the gas discharge lamp 13 does not always show a visible light for the purpose of high accuracy of the ignition voltage.

If the flash is now released by pressure on the switch S_3 , the voltage on the storage condenser 10 falls, the transistor circuits are blocked owing to the base bias voltage becoming more positive and the armature 21 of the switching relay 20 falls back into the rest position. The interrupter circuit begins to operate again and recharges the condenser 10. The whole cycle can recommence.

The condenser 35 shown by a dotted line is a condenser which, in accordance with the invention, is to be connected in parallel to the gas discharge lamp 13 and the base resistance 15 in order to overcome the "relay flutter" arising from the internal resistance of the supply battery 6 in the manner already described in the general description above.

For the rest, the following measures in the circuit arrangement shown serve to overcome the dependence of the transistors on temperature, as already mentioned above. The base of the transistor 25 has a low positive bias voltage compared to its emitter (approx. +1 volt). Further, the resistance 18 in the emitter circuit of the transistor 17 has a very low value, e.g. approx. 500 ohms and the resistance 15 between the base and the emitter of the transistor 17 is relatively small, e.g. approx. 15,000 ohms. The various measures can be used together or separately in a circuit arrangement for electronic flash units in order to compensate for the dependence of the transistors on the temperature.

The additional use of the so-called "hot conductors" is also a means for compensating for the temperature variation of the transistors and the importance of this measure was already explained in detail in the general section of the description in connection with the parts 11, 15 and 18.

In the circuit example shown, the mains supply section is designated 34. In accordance with the invention, this enables the electronic flash unit to be operated from the mains as well and the accumulator can be charged. In this case, the switches S_1 and S_2 are open.

What I claim is:

1. A circuit arrangement for electronic photoflash units comprising in combination an interrupter system, a storage condenser connected to said interrupter system for charging, an energizing potential source, means for connecting this energizing source to said interrupter system, a flash lamp circuit connected to said storage condenser, a gas discharge lamp connected between said storage condenser and said potential source for controlling the energy consumption of said source, a transistor amplifier circuit, and a switching relay, said gas discharge tube, said transistor, and said switching relay being connected together as to be adapted to operate said relay through said amplifier circuit via said gas discharge tube for switching off said interrupter system as soon as said gas discharge lamp has become conductive dependent on the charging potential of said storage condenser for energy economizing purpose, a base resistance connected in series with said gas discharge lamp between the base of the first transistor of said transistor amplifier circuit and the plus-pole of said energizing potential source, and a special condenser for overcoming disturbing effects in the circuit of said switching relay connected in parallel to the series connection of said gas discharge lamp and said base resistance.

5

2. A circuit arrangement for electronic photoflash units comprising in combination an interrupter system, a storage condenser connected to said interrupter system for charging, an energizing potential source, means for connecting this energizing source to said interrupter system, a flash lamp circuit connected to said storage condenser, a gas discharge lamp connected between said storage condenser and said potential source for controlling the energy consumption of said source, a transistor amplifier circuit, and a switching relay, said gas discharge tube, said transistor, and said switching relay being connected together as to be adapted to operate said relay through said amplifier circuit via said gas discharge tube for switching off said interrupter system as soon as said gas discharge lamp has become conductive dependent on the charging potential of said storage condenser for energy economizing purpose, a base resistance connected in series with said gas discharge lamp between the base of the first transistor of said transistor amplifier circuit and the plus-pole of said energizing potential source, and a special condenser for overcoming disturbing effects in the circuit of said switching relay connected in parallel to the series connection of said gas discharge lamp and said base resistance, said gas discharge lamp being connected between a potential divider lying in parallel to said storage condenser and the first transistor of said transistor amplifier.

3. A circuit arrangement as claimed in claim 1, wherein an ohmic resistance is connected between the emitter of

6

the first transistor of said transistor amplifier circuit and said base resistance of said transistor.

4. A circuit arrangement as claimed in claim 1, wherein said special condenser connected in parallel to the series connection of said gas discharge lamp and said base resistance being dimensioned to 0.5 μ f.

5. A circuit arrangement as claimed in claim 1, wherein an ohmic resistance is connected between the emitter of the first transistor of said transistor amplifier circuit and said base resistance of said transistor, said ohmic resistance being so dimensioned as to provide on the base of the second transistor connected to the first transistor of said amplifying circuit an additional positive bias voltage of nearly 1 volt compared to its emitter.

6. A circuit arrangement as claimed in claim 1, wherein said base resistance connected in series with said gas discharge lamp between the base of the first transistor of said transistor amplifier circuit and the plus-pole of said energizing potential source being dimensioned to amount to nearly 5000 to 50,000 ohms.

References Cited in the file of this patent

UNITED STATES PATENTS

2,763,813	McKinney et al.	Sept. 18, 1956
2,901,671	Most	Aug. 25, 1959

FOREIGN PATENTS

953,991	Germany	Dec. 13, 1956
---------	---------------	---------------