Feb. 13, 1962 L. O. LUNDAHL 3,021,451

FLASHING DEVICE

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Fig. 1.

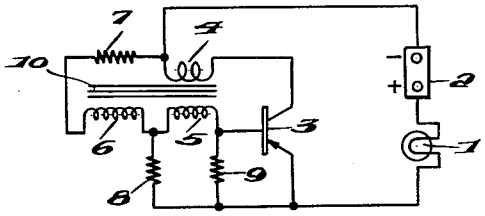


Fig. 2.

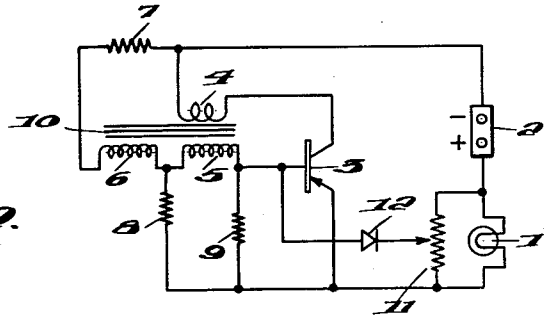
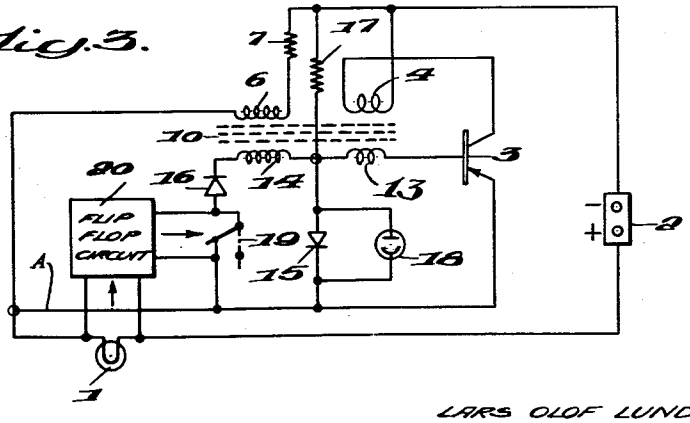


Fig. 3.



INVENTOR

LARS OLOF LUNDAHL,

BY Lawson and Taylor

ATTORNEYS

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FLASHING DEVICE

Lars Olof Lundahl, Lidingo, Sweden, assignor to Svenska Aktiebolaget Gasaccumulator, Lidingo, Sweden, a corporation of Sweden

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The present invention refers to a flashing device, i.e. an arrangement for producing pulses of current to be applied to a load. The load may be of any type and it will be assumed in the following description to consist of a lamp. In accordance with this assumption, the expression light interval will be used to denote the time interval during which a current pulse is applied to the load and the expression dark interval to denote the intervening intervals during which either no current is applied to the load or merely a current which is insignificant in comparison with the current during the light interval.

A flashing device may be said to form an oscillator operating at a low frequency. In order to achieve a sufficiently low frequency, it is required that the feed back circuit comprise either a large capacity or a large inductance. If the flashing device is constructed with a condenser in the feed back circuit, this condenser has to be of the order of 100μf. If it is desired to construct a flashing device of small dimensions, this requires the use of electrolytic condensers. However, electrolytic condensers in this application have certain disadvantages. This makes it desirable to develop a flashing device with an inductance in the feed back circuit.

In a flashing device having an inductance in the feed back circuit, the operation of the inductance resembles most nearly that of a high-inductance feed back transformer. At the same time it serves as a phase inverter, which makes it posisble to consturct a flashing device with only one transistor. The core of the inductor is preferably made entirely without any air gap so as to achieve the highest possible inductance. It is of advantage to proportion the arrangement in such a way that the core is periodically saturated. The moment at which the transition from light to dark interval occurs, or vice versa, will then be when the core reaches saturation. This is of advantage in that possible variations in the amplifying properties of the transistor do not affect the flash signal character.

In accordance with the present invention, the transformer windings are arranged in such a way that the iron core is magnetized in one direction during the light interval and in the opposite direction during the dark interval the magnetization of the iron core in either direction serving to control the duration of the said time intervals.

The invention will be described in the following with reference to the attached drawing, on which FIGS. 1 to 3 show various embodiments thereof.

In FIG. 1, reference number **1** designates the load, which in the present instance comprises a lamp. It is fed from a current source **2** via the flashing device, which is inserted in series with the lamp between the current source terminals. In the flashing device the transistor **3** operates with feed back via windings **4** and **5**, which are connected to the collector and base electrode, respectively of the transistor. The transformer further comprises a third winding **6**, which is inserted in series with resistors **7** and **8** and in series with the lamp **1** and the voltage source **2**. Finally, a resistor **9** is connected between the transistor base and the emitter. In the transformer, the winding **4**, through which the lamp current flows during the light intervals, comprise a few turns of heavy wire, whereas the winding **5** has a large number of turns. If sufficiently long light intervals or dark intervals are to be

obtained the voltage of a turn must be held at a low value. This is achieved during the light interval in that there occurs across the winding **4** a voltage of only a few tenths of a volt, the winding **5** being at this time short-circuited by the low output impedance of the transistor. During the dark interval, a sufficiently low voltage per turn is obtained through the arrangement of the resistors **8** and **9** in parallel with the winding **5**.

Since the transistor **3** has heavy feed back via the transformer, it can only have two stable conditions, namely one substantailly currentless condition, referred to in the following as the choking condition, and one fully conductive condition, in which the transistor voltage drop is insignificant. The latter condition will be referred to as bottoming.

The flashing device operates in the following manner. When the voltage source **2** is connected with the lamp **1** and the flashing device, current flows through the winding **6** and the resistors **7** and **8**. From the winding **6** there is then induced in the winding **5** a voltage of such direction that a positive blocking voltage is applied to the transistor base electrode. The transistor is then choked and the current applied to the load is below the value required for the lamp to be lighted. During this interval of time, a magnetic field is built up in the core **10** of the transformer until it is gradually saturated. The time that is required for saturation to be reached is then determined chiefly by the voltage per turn obtaining in the winding **5**. When the iron core is finally saturated, the voltage induced in the winding **5** drops so that the blocking voltage at the transistor base is removed. In its stead, the voltage drop across resistor **9** becomes operative and is applied via the winding **5** to the transistor base. The base then becomes negative with regard to the emitter, so that the transistor starts drawing current. This current flows from the transistor collector through the winding **4**, from which there is applied through the feed back to the winding **5** an additional voltage in the negative direction to the transistor base. The transistor therefore passes rapidly from the choking to the bottoming condition, which is equivalant to a transition from a dark to a light interval. During the light interval, the iron core **10** is magnetized in the opposite direction to that of the dark interval magnetization. When the core **10** has gradually reached saturation in this other direction, the additional negative voltage applied to the base disappears. This increases the resistance of the transistor, which causes the current through the winding **4** to decrease. Further, the winding **6** again becomes operative to induce in the winding **5** a voltage of such direction that a positive voltage is again applied to the transistor base. In this way, a rapid transition from light to dark interval is achieved. The process is then repeated periodically as has been described above.

An incandescent light source should be operated at constant voltage in order to yield the desired strength of light and be consumed at a constant rate. This is no problem where an accumulator serves as the current source. In dry batteries, however, a large difference in voltage occurs between new batteries and those that are partially consumed. This draw-back of dry batteries can be remedied in a flashing device according to the present invention if the device is provided with a voltage reference device which is connected so as to cause the application of a choking voltage to the transistor as soon as the lamp voltage tends to surpass a certain preadjusted value. The difference between battery voltage and lamp voltage is then taken up by the transistor and disappears in the form of heat. On the attached drawing, FIG. 2 shows a device operating in this manner. It is constructed substantially in the same way as the FIG. 1 arrangement, however, it comprises in addition thereto a potentiometer **11** connected in parallel with the lamp **1**. Further a refer-

ence diode **12** is connected between the potentiometer tap and the transistor base. The diode is connected in known manner so as to be subjected to a voltage in the blocking direction. The potentiometer tap therefore has a positive potential with regard to the transistor base. The tap is adjusted in such a position that, for a normal voltage across the lamp, the blocking voltage across the reference diode **12** is slightly below the value at which the reference diode starts conducting in the blocking direction. Thus, if the lamp voltage exceeds the normal value, a relatively heavy current is forced through the reference diode causing the desired choking of the transistor **3** and thereby protecting the lamp against dangerous overvoltages.

In the FIG. 3 embodiment of the invention, the flashing device may be controlled by a photocell and it is also possible to control the flashing device in such a way that the desired flash signal character, for instance a double flash, is obtained. In this embodiment the feed back circuit corresponding to the winding **5** is divided into two portions. The one portion **13** comprises fewer turns of heavier wire and the other portion **14** has a greater number of turns. The portion **13** causes feed back during the light interval, whereas the portion **14** yields sufficient choking voltage during the dark interval. As is apparent from the figure, one end of the winding **13** is connected to the transistor base, whereas the junction of windings **13** and **14** is connected through a rectifier **15** to the transistor emitter. The other end of the winding **14** is also connected through a rectifier **16** with the transistor emitter. The conductive directions of the rectifiers are chosen in such a way that a circuit for the current induced in the winding **14** can be closed through the rectifiers **15** and **16**.

When the arrangement is switched on and also during the dark interval, a voltage is induced in the same way as in the arrangements already described from the winding **6** to the winding **14**. This voltage acts through the circuit just referred to comprising the rectifiers **15** and **16** and makes the junction between the windings **13** and **14** more positive than the transistor emitter. Via the winding **13**, this voltage is applied to the transistor base to hold the transistor in the choking condition. This choking voltage disappears upon saturation of the core **10**. A circuit comprising the rectifier **16**, the winding **14** and an additional resistor **17** then becomes operative and causes the junction between the windings **13** and **14** to assume a negative potential relative to the transistor emitter. This causes the transition to the light interval in the same manner as has already been described. The circuit referred to and comprising the rectifier **16**, the winding **14** and the resistor **17** as well as the circuit comprising the winding **6** and the resistor **7** are closed through the lamp **1** and the current source **2**.

To enable actuation of the flashing device by the obtaining lighting conditions, the rectifier **15** in the FIG. 3 embodiment is connected in parallel with a photocell **18**. As long as this photocell does not receive light, it has no noticeable effect on the operation of the flashing device. If however, light strikes the photocell **18**, a voltage is produced over it of such polarity as to make the transistor base positive with regard to the emitter. This keeps the flashing device choked off until the ambient light has gone down to such a value that there is no longer any choking voltage produced by the photocell **18**. A desired flash signal character can be obtained in the FIG. 3 arrangement by the connection in series with the rectifier **16** of a member which applies across it a voltage depending in suitable manner upon the voltage across the lamp **1**, for instance in response to the braking action of a switch **19**. The said member may comprise, for instance, a known type of flip-flop circuit **20**, which is controlled by the voltage across the lamp **1** in such a way that every second lighting of the lamp produces a voltage in the output circuit of the flip-flop, whereas the intervening lightings of the lamp produce no such voltage. The said voltage in the output circuit has such a polarity that the result produced by its appearance in the output circuit of the member **20** is a shortening of the dark interval. In this way a flat signal character of double flash type is obtained.

For the case wherein the windings are placed on a closed core with two legs, it is suitable to place the windings **4** and **13** on one leg and the windings **6** and **14** on the other leg. Owing to the leakage inductance, the windings **6** and **14** on the other leg will then not delay the transition to the light interval. It would otherwise be possible for the flashing device at twilight to draw an unnecessarily heavy current in its inoperative condition for the case that the flashing device is controlled by the photocell **19**.

In the embodiments of the invention described, it was assumed that the core was driven to saturation in each direction. However, the arrangement is operative even if the core is not periodically saturated under the assumption that the arrangement is dimensioned in such a way that a transition from light to dark interval or vice versa is obtained as soon as the transistor current has reached a predetermined value. In this case, however, the operation of the flashing device will be more sensitive to the momentary conditions of the transistor, which may bring about less stable operation.

I claim:

1. A flashing device comprising a series loop for an oscillator circuit connected to include a lamp, a source of current, and a first winding of said oscillator circuit, a transistor connected by a feedback winding to one end of the first winding, and by a blocking winding to the other end of the first winding, a core for said first, feedback and blocking windings in which a magnetic field is built up therein to saturation for effecting periodically the energization and de-energization of said transistor to effect corresponding energization and deenergization of said lamp, and a voltage reference circuit connected to be responsive to the voltage across said lamp and including a diode circuit connecting a portion of said voltage across said lamp to the connection of said blocking winding to said transistor for limiting the voltage applied to said lamp.

2. A flashing device as claimed in claim 1 wherein said voltage reference circuit is a potentiometer connected in parallel with said lamp, and said diode is connected between the base of the transistor and the movable contact of said potentiometer.

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