July 14, 1959 J. W. CROWNOVER ET AL 2,895,081

INTERRUPTED FLASH GENERATOR

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FIG. 1.

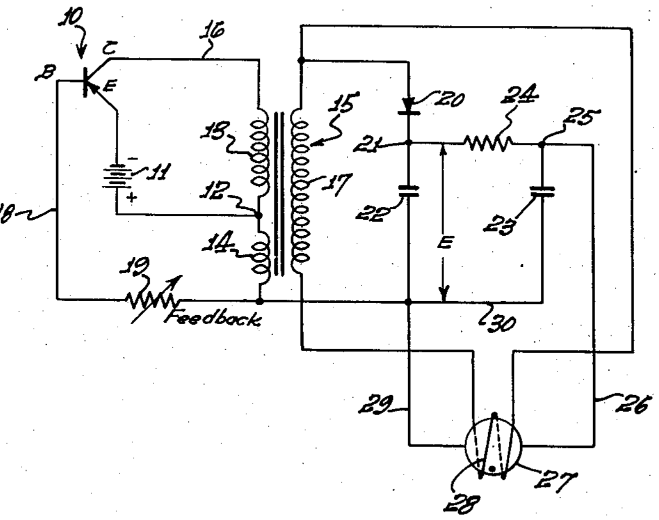
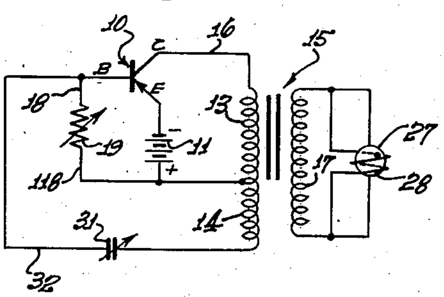


FIG. 2.



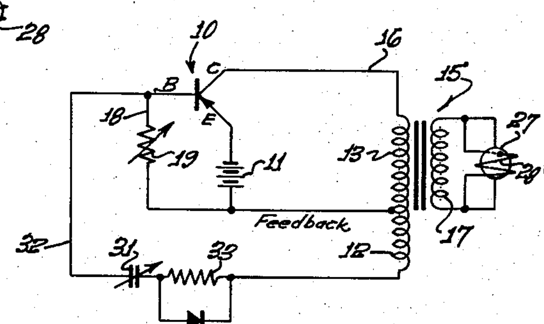


FIG. 3.

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INTERRUPTED FLASH GENERATOR

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6 Claims. (Cl. 315—206)

This invention relates generally to interrupted flash generators in which means are provided for generating and emitting interrupted flashes of light, and more particularly the invention has to do with a novel and improved interrupted flash generator characterized in its operation as providing extended flash duration for sharply increased visibility, the components of the generator including no moving parts such as switches or relays normally subject to wear and deterioration. The invention is primarily directed to improving what are known in the art as barricade flashers, useful at night in and around open areas of construction activity as warning or signal devices.

At the present time barricade flashers normally incorporate means for generating single interrupted electrical pulses passed to a tube or bulb in which each pulse causes or controls the emission of a very short flash of light. Such flashers typically incorporate a voltage source for energizing the primary winding of a transformer, a switch connected in the circuit between the voltage source and the transformer primary and actuated by a mechanical interrupter, and a bulb or tube connected with the transformer secondary. One disadvantage with this type apparatus concerns the mechanical nature of the interrupter for the switch, and the switch itself, the movable interrupter being subject to possible malfunction in operation, and the electrical contacts of the switch oftentimes undergoing rather rapid deterioration as a result of electrical arcing.

A more serious objection with such a flasher concerns its limited ability to produce a desirably visible flash of light. Efforts have been made in the past to improve the brightness or visibility of the single flashes produced by such generators, typical approaches to the problem taking the form of increasing the step-up ratio of the transformer windings in order to increase the voltage at the tube or bulb, and/or increasing the voltage of the source and thereby driving the system near the performance limitations of the bulb. It has been found, however, that such expedients produce only nominally improved visibility of the flash, and it is clearly undesirable to materially increase the voltage of the source since this entails the use of a heavier battery enlarging the size of the flasher and resulting in more rapid deterioration of the switch contacts by reason of increased arcing.

The present invention marks a new approach to the problem of increasing the visibility of interrupted flashes by reason of applicants' concept of extending the duration of each flash so that the eye of the observer may integrate or absorb more light, resulting in greatly improved flash visibility. Extension of flashing time is achieved by generating and passing interrupted groups of voltage oscillations through the bulb, instead of relying upon one brief electrical pulse to produce the flash, all without increasing the weight or bulkiness of the flasher, by utilizing a transistor for generating voltage oscillations, the transistor being capable of energization

by relatively low voltage. Also provided is a novel electrical circuit operating to step-up the oscillating voltage output of the transistor oscillator for transmission to the tube or bulb, the circuit including capacitance for alternately storing and discharging electrical charge flowing in the circuit so as to control the transmission of groups of relatively high voltage oscillations to the tube, thereby eliminating any need for switching devices.

The electrical system accomplishes transmission of groups of relatively high voltage oscillations to the tube for short time intervals during which the tube is caused to emit light, and after each such interval the action of the capacitance in the circuit causes brief interruption of voltage oscillation transmission to the tube, during which interruption period no light is emitted. The major advantage of this system lies in the relatively extended period of the light flash resulting from not merely one surge of electricity through the tube but several such surges or oscillations, so that the eye may distinguish the flash much more readily.

The invention also contemplates the use of resistance in the circuit interconnected with the capacitance to control the timing of periodic transmission of the relatively high voltage oscillations to the tube, with the resistor or the capacitor or both being variable if desired for adjusting flash duration and interruption so as to relatively shorten or lengthen them with respect to one another.

Other features and objects of the invention as well as the details of an illustrative embodiment, will be more fully understood from the following description of the drawings, in which:

Fig. 1 is a showing of one form of the flash generator circuit;

Fig. 2 is a showing of another form of the flash generator circuit;

Fig. 3 is a slightly modified showing of the circuit in Fig. 2.

Referring first to Fig. 1, the transistor oscillator, which preferably though not necessarily comprises a junction transistor, is shown at **10** to include an emitter, collector and base respectively connected with the three leads at the transistor and designated by the letters E, C and B. A low voltage source **11**, which may typically comprise a 6-volt battery, is connected with the emitter through lead E in energizing relation with the transistor, the negative terminal of the battery being connected at **12** between the two primary windings **13** and **14** of an iron core transformer **15**, the latter being employed in view of audio frequency operation of the circuit.

Line **16** transmits the oscillating voltage output of the transistor appearing at its collector to the primary winding **13** of the transformer, the secondary winding **17** of which steps up the voltage to a relatively high value, typically around two thousand volts R.M.S. The oscillator circuit is completed by the feed-back coupling **18** connecting the second primary winding **14** of the transformer with the transistor base, a suitable variable resistor **19** being connected in series with the coupling to vary the exciting voltage applied to the oscillator.

Voltage produced across secondary **17** is led through a rectifier **20** at the input **21** of a pi filter network including a pair of capacitors **22** and **23** connected in parallel on opposite sides of resistor **24** which is in series between the input **21** and output **25** of the filter network. Finally, line **26** connects the filter output with gas tube **27**, from which voltage is returned to the transformer secondary completing the circuit through the gas tube. The latter may comprise any suitable light emitting tube and typically may consist of a neon tube in which neon gas is ionized at a sufficiently high voltage to pass current, causing the tube to glow. In order that increased ionization of gas within the tube may be effected, causing greater visible intensity of the glow, the tube may be closely externally surrounded by one or more wire loops which may be suitably connected into the circuit and preferably across the secondary 17 for transmitting alternating current through the loop or loops 28 inducing a varying electromagnetic field within the tube.

In operation, the transistor 10 produces an oscillating voltage output as a result of the feed-back coupling from the transformer primary to the transistor base. The stepped-up voltage appearing at the secondary is rectified and impressed on the pi filter network as a result of which the amplitudes of the voltage pulses are substantially reduced and electrical charge steadily collects on the capacitor 23 until the voltage across that capacitor has been increased to the ionization potential of the tube 27. At that time, the tube becomes conductive, with the result that high voltage oscillations pass through the tube and around the circuit comprising the capacitor 23, line 26, tube 27, and lines 29 and 30 back to the capacitor. When the voltage across the capacitor 23 has dropped below the cut-out potential of the tube, it ceases to conduct and remains non-conducting until the potential across the capacitor 23 has again increased to the ionization potential of the tube. It is, of course, understood that the values of capacitance, resistance, and transformer inductance in the circuit may be proportioned in accordance with experiment or analysis to provide suitable flash duration and interruption periods between flashes.

The modified circuit shown in Fig. 2 also includes a transistor 10 energized by a suitable low-voltage source 11, the voltage output of the transistor being transmitted through line 16 to the primary winding 13 of the transformer 15. Feed-back coupling 118 is provided between the transformer primary winding and the transistor base, a suitable variable resistor 19 being connected in series with coupling 118.

The circuit is considerably simplified by the provision of a blocking capacitor 31 in series with line 32 connected between the transformer primary winding 14 and the transistor base input, this capacitor preferably being variable for adjusting the blocking potential applied to the transistor output voltage oscillations. For example, the capacitor 31 may normally be chosen so that its capacitive reactance may be substantially equal to or greater than the inductive reactance of the transformer primary winding, giving a tuned relationship maximizing current flowage to the capacitor during voltage oscillation through the primary.

Gas tube 27 is connected directly across the secondary winding 17 of the transformer with the result that the maximum voltage developed at the secondary winding 17 is applied directly to the tube. In operation, the transistor oscillator produces voltage oscillations applied to the transformer primary winding, the voltage being increased according to the step-up ratio of the transformer to peak values above the ionization potential of the gas tube. Accordingly, oscillating flow of current through the tube causes it to emit a flash of light continuing during the time that the tube remains conductive and ordinarily encompassing several current and voltage oscillations. During this time electrical charge builds up on the capacitor 31 until the voltage across the capacitor applied to the transistor input is sufficient to block and prevent further oscillation thereof, at which time the transistor ceases to produce an oscillating voltage output so that no voltage or current is transmitted to the tube 27 and no light is emitted therefrom. Subsequently, the charge on the capacitor 31 flows around the circuit including primary winding 14, line 118, resistor 19 and line 32 back to the capacitor, with the result that the voltage at the capacitor which is applied to the transistor input is steadily and continuously reduced. When this voltage has decreased sufficiently, the oscillator becomes unblocked and commences once again to oscillate so that the tube again emits light.

To aid ionization of the gas in tube 27, a wire loop 28 extending about the tube is connected across the secondary winding 17 of the transformer, inducing an alternating electromagnetic field within the gas when voltage is transmitted to the tube. Actual tests show that the apparent brightness of the glow or flash of light emitted by the tube is considerably increased by connecting the wire loop about the tube.

By varying the capacitance and/or resistance of the capacitor 31 and resistor 19 respectively, the time duration of the flash of light emitted by the tube and the time elapsing between successive flashes may be varied in any desired manner, giving for example relatively long or short flashes of light separated by relatively long or short time intervals.

The circuit shown in Fig. 3 is substantially the same as that shown in Fig. 2, with the exception that an additional resistor 33 is inserted in series with the capacitor, with a current rectifier 34 bypassing the resistor. During the period of oscillation of the transistor, charge flows through the resistor 33 to collect at a slower rate on the capacitor 31 thereby extending the oscillation time of the transistor, and likewise extending the duration of the flash of light emitted by the gas tube. After the potential across the capacitor has increased sufficiently to block further oscillation of the transistor, such oscillation ceases and the capacitor discharges through the resistor 19 relatively more quickly since current flowing from the capacitor bypasses the resistor 33 through the rectifier 34. As a result, the time interval elapsing before the transistor again commences to oscillate is substantially reduced in relation to the time interval during which the transistor oscillates, producing relative long flashes of light from the tube 27 separated by short interruptions.

It will be seen that the circuits described in connection with Figs. 2 and 3 are somewhat more advantageous than the circuit of Fig. 1 for several reasons, including decreased energy loss as a whole, since there are no I^2R losses in the circuits of Figs. 2 and 3 such as exist in the resistor 24 in Fig. 1. Furthermore, outdoor temperature changes such as would exist at construction areas would not affect the timing of light flashers and interruptions of the Figs. 2 and 3 circuits, whereas such temperature changes might have some effect on flash and interruption timing in Fig. 1. This is due primarily to the fact that the timing of the flash emitted by tube 27 in Fig. 1 is affected by the temperature sensitive ionization potential of the tube inasmuch as the voltage across capacitor 23 remains continuously applied to the tube, whereas in the circuits of 2 and 3 voltage is applied to the tube 27 only during the oscillation period of the transistor.

We claim:

1. For combination with a relatively high voltage responsive light emitter tube containing an ionizable gas, a single transistor having base, collector and emitter electrodes, a direct current source of relatively low voltage having two terminals of opposite polarity one of which is connected in energizing relation with the transistor emitter electrode, and electrical circuit means interconnecting the transistor with the tube, said means including a voltage step-up transformer for increasing the voltage output of the transistor for transmission to the tube, feedback coupling from the transformer to the transistor for causing transistor oscillation and capacitance and resistance connected into the circuit means so as to cause periodic storage and discharge of electrical charge flowing in said circuit means in controlling relation with periodic transmission of relatively high voltage oscillations sufficient to alternately establish and cut off current flow through the tube, said transformer having an iron core and secondary inductance winding across which said tube is connected, said transformer including primary inductance winding having two end terminals electrically connected respectively with said base and collector elec-

trodes and a fixed intermediate tap connected with the other terminal of said low voltage source, said resistance being connected in series between said transformer primary winding intermediate tap and said transistor base electrode, and all of said capacitance being connected in series between said base electrode and said transformer primary winding end terminal.

2. The invention as defined in claim 1 in which said capacitance includes a variable capacitor for varying the oscillation frequency of said voltage output.

3. The invention as defined in claim 1 in which said resistance comprises a variable resistance for varying the voltage interruption period.

4. The invention as defined in claim 1 including a resistor connected in series with said capacitor for extending the oscillation period of electrical current through the transformer primary winding.

5. The invention as defined in claim 4 including a rectifier connected across said resistor for by-passing current around the resistor during discharge of the capacitor.

6. The invention as defined in claim 1 in which said circuit includes inductive coupling with the gas tube for increasing ionization of the gas contained therein.

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