March 21, 1967 R. L. SEIDLER 3,310,708

LAMP CONTROL CIRCUIT

Filed Sept. 16, 1964 2 Sheets-Sheet 1

FIG. 1

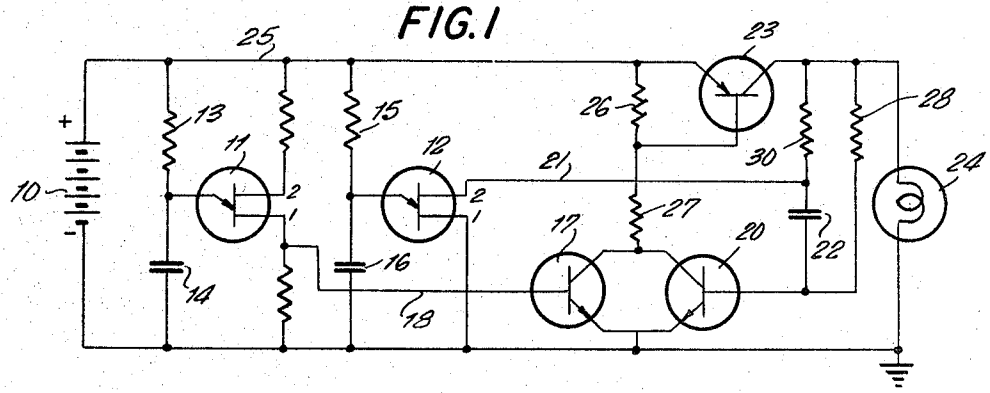


FIG. 2

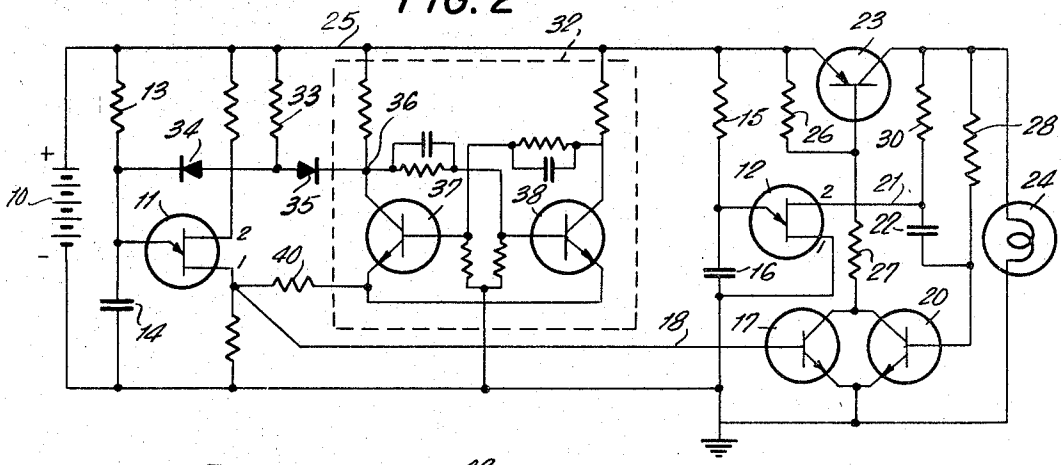


FIG. 3

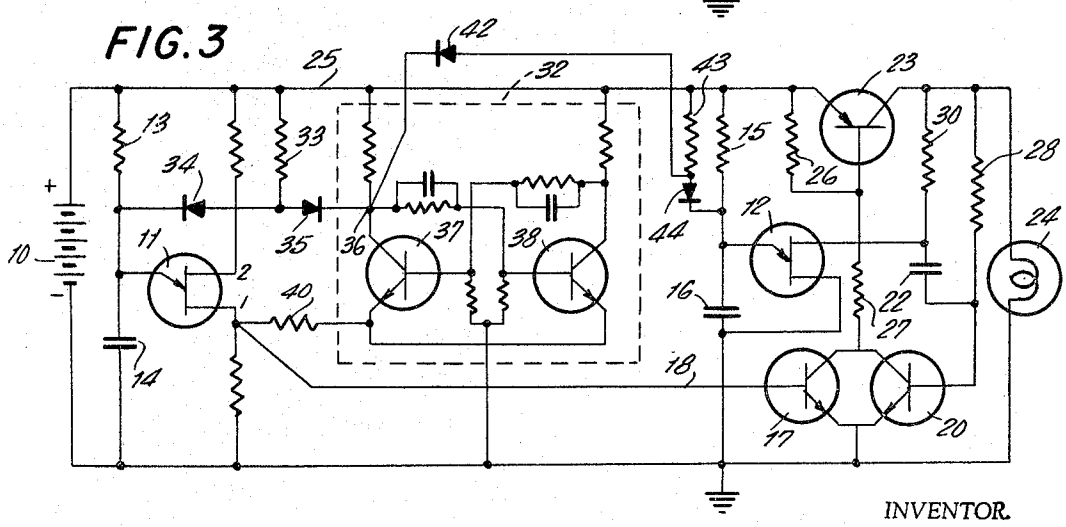


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FIG. 4

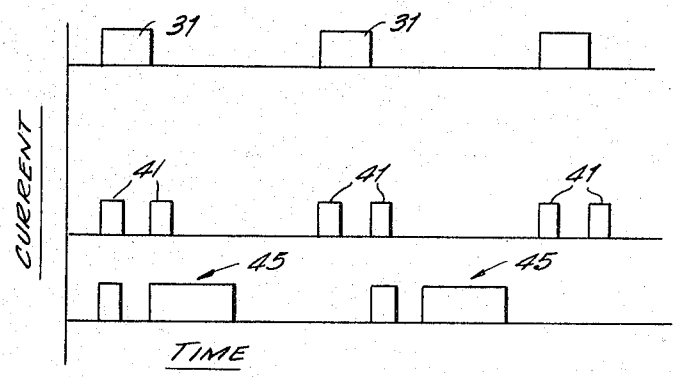



FIG. 5

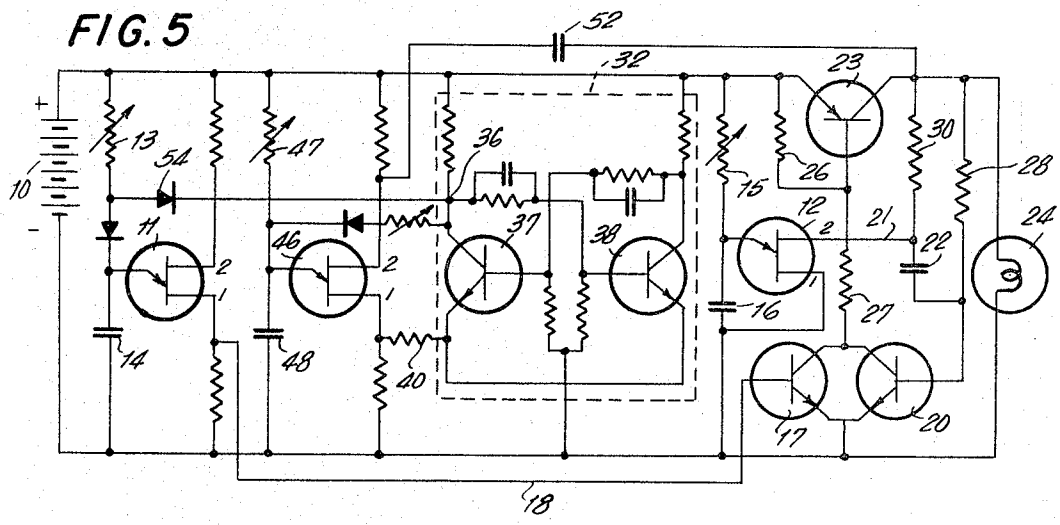
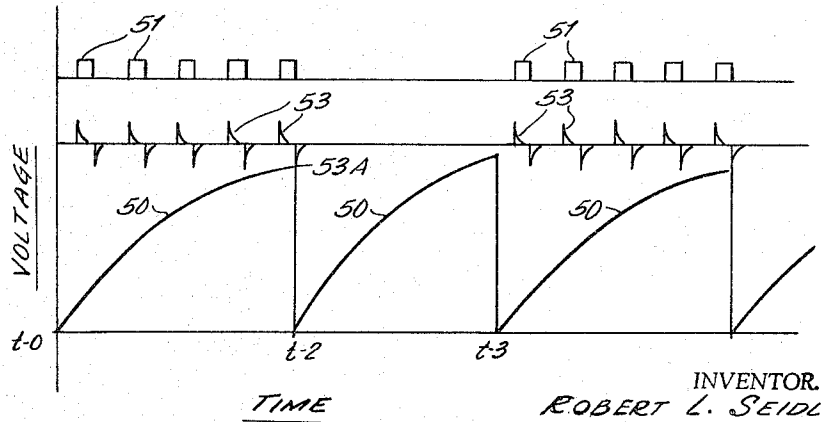



FIG. 6

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3,310,708

# LAMP CONTROL CIRCUIT

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This invention relates to a lamp control circuit which is operated by semi-conductor switching components and includes a control for lighting signal or illuminating lamps in any predetermined arrangement of short or long flashing during adjustable time intervals.

Many types of lamp control units have been made and used but nearly all these control systems have employed moving parts such as motors and relays, and nearly all prior art control circuits have contained electrical contacts which make and break electrical circuits and are therefore subject to pitting, sparking and short-circuiting. The present control circuit contains no moving parts and no electrical contacts. All switching operations and circuit variations are made by means of semi-conductor components such as transistors and silicon diodes and therefore have extremely long life and are not subject to the disadvantages met in the usual type of control circuit.

An object of the present invention is to provide an improved lamp circuit which avoids one or more of the disadvantages and limitations of prior art circuits.

Another object of the present invention is to turn the electrical power on and off at a predetermined rate to produce a flashing signal.

A further object of the present invention is to permit adjustment of the various control circuits so that the light flashes produced by the lamp may include long and short alternate light signals.

Still another object of the present invention is to provide a lamp control circuit which is small, compact, has no mechanical moving parts, and has an exceedingly long life.

A feature of the present invention includes one or more unijunction transistors connected as relaxation oscillators. These circuits produce electrical pulses of predetermined length and frequency and thereby control the lamp flashing rate.

The invention consists of the construction, combination and arrangement of parts, as herein illustrated, described and claimed.

In the accompanying drawings, forming a part hereof there are illustrated four forms of embodiment of the invention, in which drawings similar reference characters designate corresponding parts, and in which:

FIGURE 1 is a schematic diagram of connections of a simplified form of the control circuit which produces alternate short light flashes.

FIGURE 2 is a schematic diagram of connections of a control circuit which produces a succession of short flashes. The light flashes have the same duration but the time interval between flashes is varied.

FIGURE 3 is a schematic diagram similar to FIGURE 2, but having an additional coupling between a free running multivibrator and a unijunction transistor to produce a train of short-long flashes.

FIGURE 4 is a graph showing some of the pulses produced by the circuit shown in FIGURES 1, 2 and 3.

FIGURE 5 is a schematic diagram of connections similar to FIGURE 3 but employing three unijunction transistors for producing other arrangements of short flashes separated by different time intervals.

FIGURE 6 is a graph showing some of the pulses produced by the circuit shown in FIGURE 5.

Referring now to FIGURE 1, the circuit includes a battery **10** (or other source of direct current potential),



a first unijunction transistor **11**, and a second unijunction transistor **12**. The first transistor **11** is coupled to a relaxation circuit comprising a resistance **13** and a capacitor **14**. The second transistor **12** is coupled in a similar manner to resistance **15** and capacitor **16**. These circuits together with the supply circuits to bases **1** and **2**, create two relaxation oscillators, the first unijunction transistor circuit **11**, **13** and **14**, controlling the time between pulse starts and the second unijunction transistor circuit **12**, **15** and **16**, controlling the time duration of the pulses. Transistor **11** is coupled to a control transistor **17** by means of conductor **18** while transistor **12** is coupled to a second control transistor **20** by means of conductor **21** and capacitor **22**. Transistors **17** and **20** jointly control a series impedance in the form of a power transistor **23** by a connection between their collectors and the base of transistor **23**. Power transistor **23** is connected in series between the source of potential **10** and a load which in this case is a lamp **24**.

The operation of this circuit is as follows: when the power is first applied to conductor **25**, capacitor **14** is slowly charged by current through resistor **13**. As soon as the voltage of the emitter of transistor **11** reaches the peak point voltage, the transistor fires and a positive pulse is sent over conductor **18** to the base of transistor **17** thereby reducing the emitter-collector voltage for a short time. This action increases the current through resistor **27** and the base of power transistor **23** permitting current to flow through its emitter-collector circuit to light lamp **24** and to send current through resistor **28** to the base of control transistor **20**. At the same time, current through resistor **30** charges up capacitor **22**, the base of transistor **20** is further biased, and the conductance of its emitter-collector is increased, drawing more current through resistor **27**, and the base of power transistor **23**. Transistor **20** remains in the conductive state and keeps power transistor **23** conductive. During this circuit condition the lamp **24** is lighted. Transistors **23** and **20**, together with their associated circuits, form a boot-strap amplifier.

As capacitor **22** charges up, base **2** of unijunction transistor **12** increases in potential. At the same time, the emitter of this transistor also increases in potential because of the slow charging of capacitor **16** through resistor **15**. Finally, transistor **12** fires and a negative pulse is sent from its base **2** to the base of control transistor **20** through capacitor **22** to turn off transistor **20**. When this happens, the current through the base of power transistor **23** is reduced because of reduced current through resistors **26** and **27**. Also, the reduction of current through the power transistor **23** reduces the potential of circuits **28** and **30–22**, so that the current through transistor **23** is finally reduced to zero. At this time control transistor **20** is held in its non-conducting condition by resistor **28** and lamp **24**. This condition is the same as the condition at the start of the cycle.

The cycle of lighting the lamp **24** and then turning it off again depends upon the time constant of circuit **13–14** and circuit **15–16**. The rate of charging capacitor **14** determines the time interval between the start of successive pulses and the rate of charge of capacitor **16** determines the *on* time interval. When transistor **11** fires, capacitor **14** is discharged. When this capacitor charges up against another cycle is started.

The result of the above described operation is indicated by the simple pulses **31** shown in FIGURE 4. Varying the time constants of the two unijunction circuits changes either the duration of the time the lamp is lighted or turned off.

The circuit shown in FIGURE 2 is the same as the circuit shown in FIGURE 1 except that a bistable multivibrator **32** has been added (shown within dotted lines).

Also, the frequency of oscillation of the first unijunction relaxation circuit is altered by means of a coupling circuit which includes a resistance 33 connected across resistor 13 but in series with a diode 34. The junction between resistor 33 and diode 34 is connected to one of the collectors in multi-vibrator circuit 32. Another diode rectifier 35 is connected in series with this conductor to prevent current flowing from junction 36 to the unijunction transistor 11 when transistor 37 is non-conducting. The multi-vibrator is triggered by a positive pulse from base 1 of unijunction transistor 11 through a limiting resistor 40 to the two emitters of transistors 37 and 38. Each time a pulse is applied, conductance is transferred from one transistor to the other.

The operation of the circuit shown in FIGURE 2 is as follows: let it be assumed that transistor 38 is conducting and transistor 37 is non-conducting. Point 36 is at a high potential and resistors 13 and 33 are in parallel, both sending current from conductor 25 to charge capacitor 14. The capacitor charges quickly and unijunction 11 fires, sending a positive pulse over conductor 18 to control transistor 17 and to make transistor 23 conductive so that lamp 24 is lighted. This action has been described in connection with FIGURE 1.

A positive pulse is also sent through resistor 40 to the multi-vibrator 32, triggering it and causing transistor 37 to become conductive. This lowers the potential of point 36 and draws current through resistor 33 and diode 35 to the collector electrode. The drop in potential of the lower end of resistor 33 reverse biases diode 34 and this diode cannot transfer current to the capacitor 14. The next pulse takes longer because the capacitor 14 charges at a slower rate. But when the next pulse does occur the same positive transfer pulses are sent, as before, to transistor 17 and to the multi-vibrator 32. As before, the first unijunction transistor 11 determines the time interval between the starts of each lighting pulse while the second unijunction transistor 12 determines the time duration of each pulse. In the circuit shown in FIGURE 2, the resultant wave form produced at the load terminals is represented by one of the series of pulses 41 shown in FIGURE 4.

The circuit shown in FIGURE 3 is the same as that shown in FIGURE 2, except that an additional coupling circuit has been added. This circuit is connected between point 36 and the emitter electrode of the unijunction transistor 12. It includes a diode 42, a resistor 43, and another diode 44. This circuit acts in the same manner as the circuit described above. It is obvious that resistors 43 and 15 are in parallel and, as long as no negative potential is applied to the anode of diode 44, capacitor 16 charges more quickly and produces a reduced time interval between pulses. When the potential of point 36 is reduced by conduction of transistor 37, the diode 44 becomes reverse biased and cannot conduct. Capacitor 16 is charged more slowly and therefore the time duration of the pulse is longer. A graph showing this type of pulse train 45 is shown in FIGURE 4. Unijunction transistor 11 again controls the triggering of the multi-vibrator 32 and the sequence of events is repeated.

The circuit shown in FIGURE 5 is similar to the circuit shown in FIGURE 2. The same load and boot-strap amplifier circuit is employed under control of unijunction transistor 12 which still determines the time duration of the lighting pulse. The bistable multi-vibrator 32 is the same as before and is triggered by a pulse received through resistor 40 from a unijunction transistor base. The unijunction transistor 11, coupled to the time constant circuit 13, 14, is the same as before and oscillates in the same manner to determine the start time of each pulse, the start pulses being transmitted over conductor 18 to the base of transistor 17 in the base circuit of transistor 23.

The circuit shown in FIGURE 5 differs from the circuit shown in FIGURE 2 by the addition of a unijunction transistor 46, with its emitter electrode connected to the time constant circuit comprising resistor 47 and capacitor 48. This oscillating circuit controls the triggering of the multi-vibrator circuit 32 by means of the tie between the common emitters of transistors 37, 38, and base 1, of the unijunction transistor 46. The rate of oscillation of this circuit is slower than the other relaxation oscillators and the voltage variations of the emitter electrode in component 46, are indicated by the curves 50 in FIGURE 6.

Unijunction 11 and its associated components oscillate in the manner described above and send pulses over conductor 18 to the output circuit. The result is a series of square topped pulses 51 (FIGURE 6) which light lamp 24. The duration of these pulses is controlled by the unijunction 12 and its associated circuitry. Each time a pulse 51 is transmitted to the load, the collector of power transistor 23 becomes more positive and each time the pulse is cut off it becomes more negative. A capacitor 52, connected between this collector and base 2 of unijunction transistor 46 applies a series of alternate positive and negative pulses 53 to the base as indicated in FIGURE 6.

The operation of this circuit is as follows: when the power supply 10 is first connected (at time $t-0$), current is supplied through resistors 13, 47, and 15, to charge capacitors 14, 48 and 16, respectively. As the voltage builds up on the capacitors, the unijunctions 11, 46, and 12 fire or conduct through their emitters at a rate controlled by the circuit values. Unijunctions 11 and 12 operate as described above in connection with FIGURE 1. During the first few cycles, unijunction 46 has no effect on the operation because its emitter circuit is non-conductive and the multi-vibrator is conductive on the right, retaining point 36 at a potential which is higher than the potential of the emitter of unijunction 11. The connection between point 36 and the emitter produces no action at this time because of diode 54. Also, the sharp pulses 53 applied through capacitor 52 produce no result except that the base 2 of unijunction 46 is varied slightly in potential.

After a series of pulses 51, as shown in FIGURE 6, capacitor 48 builds up enough positive voltage so that it is close to the firing potential. The negative pulses 53 applied to base 2 reduce the potential of the base so that unijunction transistor 46 fires more readily, and when these two potentials combine (as shown at point 53A) unijunction transistor 46 fires (at time $t-2$), discharging capacitor 48 and reducing the emitter potential to a low value. This action triggers the multi-vibrator and transfers conduction from transistor 38 to transistor 37 thereby reducing the potential of point 36 to a value which is lower than the peak point voltage of unijunction 11. This drop in potential is applied through diode 54 to the emitter and the unijunction circuit is de-energized. Since the unijunction transistor 11 cannot fire, there are no oscillations in this part of the circuit at this time.

The low frequency circuit associated with unijunction 46 slowly builds up the potential of capacitor 48 and it fires (at time $t-3$), triggering the multi-vibrator and transferring conductance from transistor 37 to transistor 38. The potential of point 36 now rises and the first oscillating circuit associated with unijunction 11 is again energized and it oscillates, producing pulses 51. The voltage pulses through capacitor 52 are provided so that unijunction 46 fires at the end of one of the pulses 51, thereby keeping the two circuits in synchronism.

It is obvious that the four circuits, as described and shown, may be combined to produce other trains of light flashes. It is also obvious that the frequency of the light flashes and the time intervals between flashes may be varied over a wide range of values by varying the resistor and capacitor values used in association with the unijunction components.

Having thus fully described the invention, what is

claimed as new and desired to be secured by Letters Patent of the United States, is:

1. A flasher circuit for supplying controlled electrical current pulses to a lamp comprising, a source of direct current power, a first unijunction transistor relaxation oscillator circuit which includes an emitter electrode connected to a first time constant circuit bridged across the source of power, a lamp for producing light flashes, a power transistor including emitter, collector, and base electrodes for applying current pulses to the lamp, said power transistor having its emitter-collector electrodes connected in series between the lamp and said source of power, a transistor amplifier having an output circuit coupled to the base of the power transistor and having a boot-strap circuit for maintaining the power transistor in either a conductive or a non-conductive condition, circuit coupling means between the first unijunction transistor and an input circuit in said transistor amplifier for applying a control pulse thereto and making the collector emitter electrode circuit of the power transistor conductive whenever the first unijunction transistor is fired; a bistable multi-vibrator circuit coupled to the first unijunction transistor, said multi-vibrator circuit including two transistors, each having an emitter, a collector, and a base electrode, said unijunction transistor coupled to the emitter so that conductance is transferred from one transistor to the other whenever the unijunction transistor fires, and circuit means coupled between one of said collectors and the time constant circuit of the first unijunction transistor for changing the frequency of oscillation each time the multi-vibrator conductance is transferred; a second unijuncion transistor relaxation oscillator circuit which includes an emitter electrode connected to a second time constant circuit bridged across the source of power and a base 2 electrode coupled to the collector electrode of the power transistor for starting the generation of a pulse in the second oscillator circuit when the power transistor is made conductive, and capacity coupling means between the second unijunction oscillator and the transistor amplifier for applying a pulse thereto for making the collector-emitter electrode circuit of the power transistor non-conductive when the second unijunction transistor fires.

2. A flasher circuit as claimed in claim 1 wherein said first time constant circuit includes a resistor and capacitor connected in series across the source of power and wherein the emitter of the first unijunction transistor is connected to the junction of the resistor and the capacitor.

3. A flasher circuit as claimed in claim 2 wherein a resistor 33 and a diode rectifier are connected in series across the resistor in the first time constant circuit and wherein one of said collectors in the multi-vibrator circuit is coupled to the junction of the resistor 33 and the diode rectifier.

4. A flasher circuit as claimed in claim 3 wherein said second time constant circuit includes a resistor and a capacitor connected in series and bridged across the source of power and wherein the emitter of the second unijunction transistor is connected to the junction of the resistor and the capacitor.

5. A flasher circuit for supplying controlled electrical current to a lamp comprising, a source of direct current power, a first unijunction relaxation oscillator circuit which includes an emitter electrode connected to a time constant circuit bridged across the source of power, a lamp for producing light flashes, a power transistor including emitter, collector, and base electrodes for applying current pulses to the lamp, said power transistor having its emitter-collector electrodes connected in series between the lamp and said source of power, a transistor amplifier having an output circuit coupled to the base of the power transistor and having a boot-strap circuit for maintaining the power transistor in either a conductive or a non-conductive condition, circuit coupling means between the first unijunction transistor and an input circuit in said transistor amplifier for applying a control pulse thereto and making the collector-emitter electrode circuit of the power transistor conductive whenever the first unijunction transsistor is fired, a second unijunction transistor relaxation oscillator circuit which includes an emitter electrode connected to a second time constant circuit bridged across the source of power and a base 2 electrode coupled to the collector electrode of the power transistor for starting the generation of a pulse in the second oscillator circuit when the power transistor is made conductive, a bistable multivibrator circuit coupled to the first unijunction transistor, said multi-vibrator circuit including two transistors, only one of which is conductive at any time, said unijunction transistor adapted to shift conductance from one multi-vibrator transistor to the other whenever the unijunction transistor fires, circuit means coupled between one of said multi-vibrator transistors and said second time constant circuit for altering its time characteristic whenever conductance is shifted from one of said multi-vibrator transistors to the other, and coupling means between the second unijunction oscillator and the transistor amplifier for applying a pulse thereto for making the collector-emitter electrode circuit of the power transistor non-conductive when the second unijunction transistor fires.

6. A flasher circuit as claimed in claim 5 wherein said multi-vibrator transistors each include emitter, collector, and base electrodes, and wherein said first unijunction transistor is coupled to both emitters for transferring conductance by the application of a voltage pulse.

7. A flasher circuit as claimed in claim 6 wherein said second time constant circuit includes a resistor and a capacitor connected in series across the source of power and wherein the emitter of the second unijunction is connected to the junction of the resistor and the capacitor.

8. A flasher circuit as claimed in claim 7 wherein a resistor 43 and a diode are connected in series across the resistor in the second time constant circuit and wherein one of said collectors in the multi-vibrator circuit is coupled to the junction of the resistor 33 and the diode.

9. A flasher circuit for suppling controlled electrical current pulses to a lamp comprising:

a source of direct current power,

a first unijunction transistor relaxation oscillator circuit connected to the source of power,

a lamp for producing light flashes in accordance with a predetermined sequence,

a power transistor including emitter, collector, and base electrode for supplying current to the lamp in said sequence, said power transistor having its emitter-collector electrodes connected in series between the lamp and the source of power,

a boot-strap amplifier coupled to the base and collector electrodes of the power transistor for maintaining the power transistor in either a conductive or a non-conductive condition,

circuit coupling means between the first unijunction transistor and the boot-strap amplifier for triggering it and making the collector-emitter circuit conductive whenever the first unijunction transistor is fired,

a second unijunction transistor relaxation oscillator circuit connected to the source of power,

coupling means between the second unijunction oscillator and the boot-strap amplifier for triggering the amplifier and making the collector-emitter electrode circuit of the power transistor non-conductive whenever the second transistor fires,

a third unijunction transistor relaxation oscillator circuit connected to the source of power,

a bistable multi-vibrator circuit including two transistors, each having an emitter, a collector, and a base electrode,

coupling means between the third unijunction transistor and the multi-vibrator circuit for triggering it and

changing conductance from one of its transistors to the other whenever the third unijunction transistor fires,

circuit means coupled between one of the collectors in the bistable multi-vibrator and a time constant circuit connected to the first unijunction transistor for changing the time interval between pulses each time the multi-vibrator conductance is transferred,

and coupling means between one of the collectors in the bistable multi-vibrator and a time constant circuit connected to the third unijunction transistor for changing the time interval between pulses each time the multi-vibrator conductance is transferred.

**10.** A flasher circuit as claimed in claim **9** wherein all three of the unijunction transistor oscillators include time constant circuits comprising a resistor and a capacitor and wherein an emitter in each of the unijunction transistors is connected to the junction of the resistor and capacitor.

**11.** A flasher circuit as claimed in claim **10** wherein an additional coupling circuit is connected between the collector of the power transistor and said third unijunction transistor, said coupling circuit including a series capacitor for applying a series of negative pulses to the third unijunction transistor to assist in the timing of the firing of the third unijunction transistor circuit.



**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,972,706 | 2/1961 | Malm | 315—200 |
| 3,113,293 | 12/1963 | Breese | 315—200 |
| 3,150,307 | 9/1964 | Kaeding | 318—345 |

OTHER REFERENCES

Solid State Products, Inc., Applications and Circuit Design Notes, bulletin D410–01, July 1959, pp. 3 and 4.

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