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[56]

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[54] SOLID-STATE FLASHER

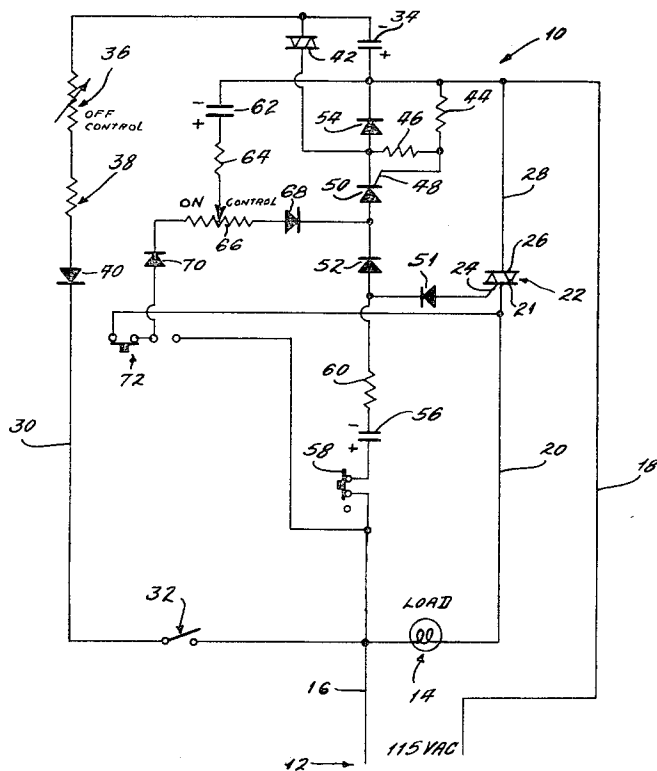
18 Claims, 1 Drawing Fig.

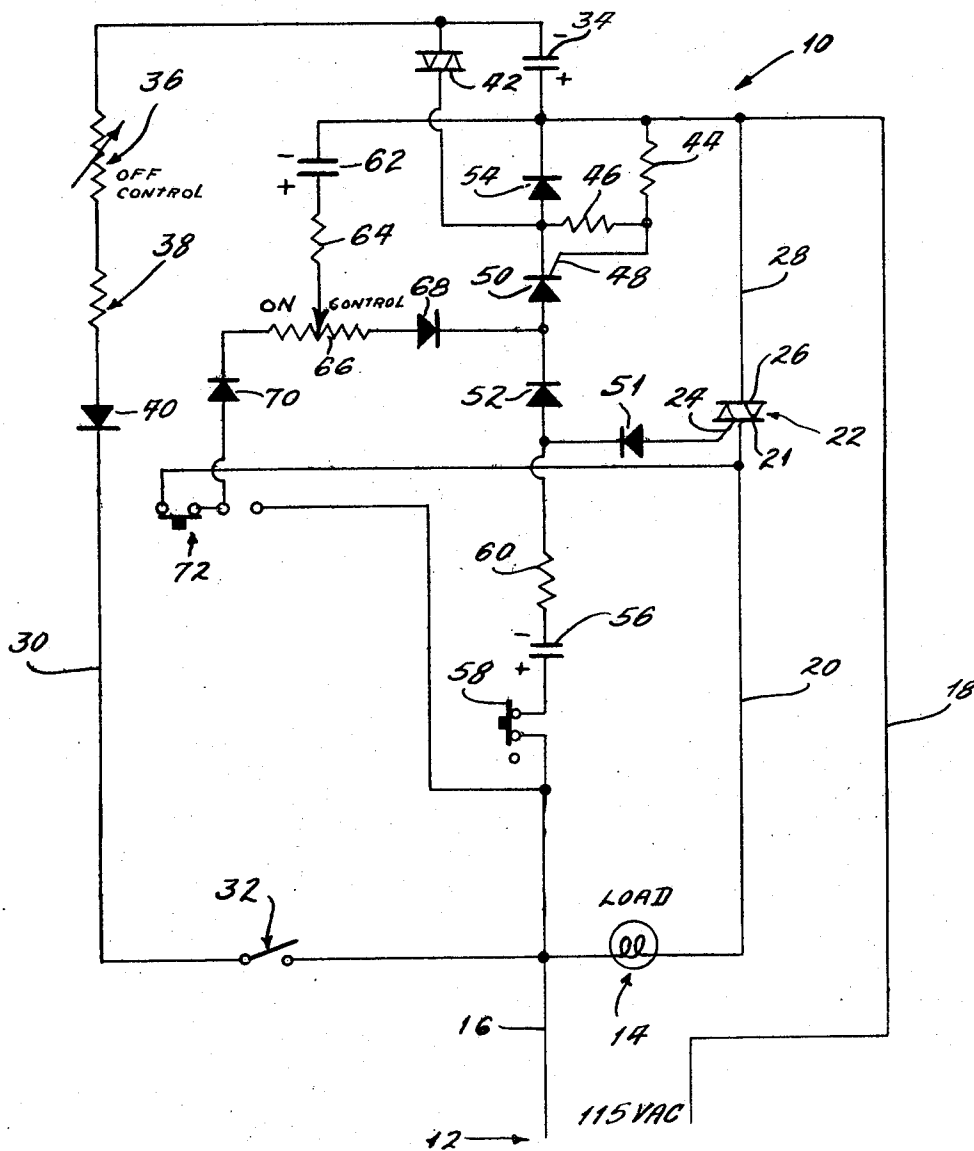
[52] U.S. Cl. **315/209 R**,
315/200 A, 315/225, 315/226, 340/81 R, 340/331,
340/340

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[50] Field of Search 315/209,
225, 226, DIG. 7, 200 A; 340/81, 331, 340, 341;
367/249

ABSTRACT: A solid-state flasher circuit for controlling the flashing of electric signs, warning lights and other similar devices, said circuit having no movable parts or wear components. The subject circuit is a relatively versatile control which includes separate means adjustable to control the flasher on time, the flasher off time, the flashing frequency, whether the flasher is to be operated at full or half-wave power, it always initiates energizing of the flasher device under minimum power conditions, and it also includes means for operating as a time delay means.





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SOLID-STATE FLASHER

The subject invention relates generally to flasher circuits and associated devices including circuit means for controlling the energizing and deenergizing of a load circuit such as a lamp, a sign, a warning or delay device and so on. All known flashing devices have employed some kind of mechanical or electromechanical means such as electric motors and associated cam means or some form of relay means which operate to cause one or more sets of contact points to alternately open and close. The known devices usually also carry relatively substantial currents and as a result produce arcing and other circuit interruptions at their contact points causing the contacts to deteriorate and malfunction. Also, by including motor or relay means in the circuits of the known devices to open and close contacts and for other reasons creates maintenance problems and makes the known devices relatively expensive to construct and operate. The subject solid-state flasher circuit overcomes these and other disadvantages and shortcomings of the known devices, and has the further important advantages in that it has no moving or wear parts, no contacts to open and close, and it requires very little current to operate. Also the present circuit is much more flexible and versatile than known devices used for the same or similar purposes, and it can be made to be more compact and more economical to operate.

The present invention therefore discloses a relatively simple, inexpensive and maintenance-free yet very versatile control circuit particularly for controlling the energizing and deenergizing of a device such as a flashing device, which control circuit because of its versatility and low power requirements can be used for many different purposes including use with warning devices and the like.

It is therefore a principal object of the present invention to provide improved circuit means for operating a flashing device or the like.

Another object is to increase the flexibility, versatility and adjustability of flasher devices and of the control means therefor.

Another object is to provide improved means for varying the duration of a flasher's on and/or off periods.

Another object is to reduce or eliminate wear and deterioration in circuits used to control flashers and the like.

Another object is to provide a relatively compact and inexpensive circuit for controlling the operation of flasher and time delay devices.

Another object is to provide a relatively maintenance-free flasher control circuit.

Another object is to provide a flasher control circuit with means for adjusting the flashing frequency.

Another object is to provide a flasher circuit that is capable of handling widely varying load requirements.

Another object is to provide a flasher circuit for controlling the operation of flashing devices used in advertising, warning and other applications.

Another object is to reduce the energy required to control a flasher device.

These and other objects and advantages of the present invention will become apparent after considering the following detailed specification which covers a preferred embodiment of a flasher control circuit in conjunction with the accompanying drawing which is a schematic electrical circuit diagram of a flasher control circuit constructed according to the present invention.

Referring to the drawing more particularly by reference numbers, number 10 refers generally to a flasher control circuit which for illustrative purposes is shown connected to an AC power source 12, such as a conventional 115 volt AC source, said circuit being constructed to operate or flash a load which is shown in the drawing as electric lamp 14.

The power from the source 12 is supplied to the circuit 10 on input leads 16 and 18. In the discussion which follows the voltages on the leads 16 and 18 will be considered at specific times during the cycles of the input source. For example, during alternate half-cycles the potential on the lead 18 will be

considered positive relative to the potential on lead 16 and vice versa.

The lamp 14 is connected between the input lead 16 and another lead 20 which has its opposite end connected to electrode 21 of a triac 22. The triac 22 also has a gate control electrode 24 and an anode electrode 26. The anode 26 is connected by another lead 28 to the input power lead 18. It can therefore be seen that whenever the triac 22 is turned on or gated by an appropriate signal being applied to the gate electrode 24, it will conduct and in so doing will establish a circuit for energizing the lamp 14 by effectively connecting the lamp across the source between the leads 16 and 18. When the triac 22 is not gated and not conducting, however, the lamp will be deenergized, except for another condition of the circuit which will be described later. The subject flasher circuit is designed to control the gating of the triac 22 in a desired manner, and in so doing to produce a desired flashing condition for the lamp 14 as will be explained.

When power is supplied to the flasher circuit 10 it will initially remain in a standby condition until power is supplied to another lead 30 which is connected to the input lead 16 by the closing of a switch 32. The switch 32 is an optional feature provided to enable the subject flasher circuit to be operated from a remote location. If the switch 32 is omitted, the lead 30 will then be permanently connected to the input lead 16, and the flasher circuit will be activated whenever the input leads 16 and 18 are connected to the input source. For the purposes of this description it will be assumed that the switch 32 is closed and that the leads 16 and 30 are therefore electrically the same.

When the flasher circuit 10 is activated by applying the AC source power from the source 12, a circuit is established for current to flow between the input leads 16 and 18, through a series circuit which includes a capacitor 34, a potentiometer 36, an optional resistor 38, and a diode 40 connected as shown. With this circuit, whenever the voltage on the input lead 18 is positive relative to voltage on the input lead 16, which occurs on alternate half-cycles of the input, a charge will accumulate on the capacitor 34 of the polarity shown and at a rate that depends on the time constant of the circuit just described. It is to be noted also that the capacitor 34 will only be able to be charged in the polarity shown during the half-cycles of the input when the voltage on the lead 16 is negative with respect to the voltage on the lead 18 due to the presence of the diode 40 which only permits conduction therethrough for this one polarity of the input voltage. When the voltage across the capacitor 34 builds to a predetermined voltage it will operate to fire a trigger diode 42 causing it to conduct. This in turn will cause current to flow through a circuit which includes the trigger diode 42 and resistors 44 and 46 which are in series therewith across the capacitor 34. In so doing, a voltage will develop across the resistor 46 which will be of such polarity that it places a positive voltage on gate electrode 48 of a silicon-controlled rectifier (SCR) 50 relative to the voltage on the cathode of the SCR 50. At this time, however, the SCR 50 will be prevented from going into a conducting condition by the reverse biasing across it, and this condition will continue to exist until the polarity of the voltage on the input reverses and the voltage on the lead 16 starts to go positive with respect to the voltage on the input lead 18. This takes place at the beginning of the next half-cycle of the input from the source 12.

When the trigger diode 42 is fired, it will conduct and continue conducting to maintain the voltage developed across the resistor 46 until the polarity of the line voltage reverses at which time the SCR 50 will also conduct. This is accomplished in the circuit by the resistor 44 which is in series with the resistor 46, the combination providing a relatively slow discharge path across the capacitor 34. The resistors 44 and 46 also form a voltage divider circuit which limits the gate voltage that can be applied to the gate electrode 48 of the SCR 50. With this circuit arrangement therefore, the SCR 50 can only be switched from its nonconducting to its conducting

condition at a time when the polarity of the input is reversing and at a time when a positive voltage is being applied to its gate electrode 48. In other words, it is not possible for the SCR 50 to go into a conducting condition at any time except at a time when the line voltage goes through a zero voltage condition. This kind of switching or gating is sometimes referred to as "zero-voltage switching." When the SCR 50 is triggered it immediately triggers the triac 22 as will be explained. Zero-voltage switching is important to the present device because it eliminates the possibility of radio frequency interference, and it prolongs the life of lamp 14 which may be an incandescent lamp or other device to be switched because under zero-voltage switching the lamp or other device is always energized initially at a time when the input source voltage is at or near 0 volts.

When the SCR 50 conducts, another circuit is established for current to flow through the lamp 14 on an alternate path which includes the lamp 14, the triac electrodes 21 and 24, there being relatively little impedance between these electrodes in a triac, and then back to the input lead 18 through diodes 51 and 52, the SCR 50, and through another diode 54. This means that the load current for operating the lamp 14 will be able to flow through the triac 22 during the half-cycles of time that the voltage on the input lead 16 is positive with respect to the voltage on the input lead 18 following gating of the SCR 50. Furthermore, since triacs are latching-type devices the conducting condition thereof, once it is established will continue in effect during the rest of the same half-cycle when the voltage on lead 16 is positive with respect to the voltage on lead 18. It is also to be noted that triacs, being latching devices, will remain in the condition they have at the beginning of each half-cycle and until the end of that half-cycle, and will then cease to conduct if they are conducting unless they are regated. This is the nature of triacs.

Also, during the same half-cycle when the input lead 16 is positive with respect to input lead 18, another capacitor 56 will charge in the polarity shown through a circuit which includes series-connected switch 58, when closed, resistor 60 the diode 52, the SCR 50 and the diode 54. The capacitor 56 and the resistor 60 are included in the circuit to provide means for regating the triac 22 at the end of the half-cycle when input lead 16 goes negative so that the lamp will continue to be energized. The means for regating the triac 22 include a closed circuit formed by the capacitor 56, the resistor 60, the lamp 14, the triac electrodes 21 and 24 and the diode 51. When the polarity across the input leads 16 and 18 reverses at the end of the half-cycle when the lead 16 was the more positive that is, when the lead 16 goes negative with respect to the lead 18, the charge on the capacitor 56 will flow through the switch 58, the lamp 14, the triac electrodes 21 and 24, the diode 51, and the resistor 60, and in so doing will regate the triac 22 thereby maintaining the lamp 14 in its energized condition. This occurs at the beginning of the half-cycle following the half-cycle in which the triac 22 is triggered by the triggering of the SCR 50 as explained above.

At the beginning of this same half-cycle when the input lead 18 goes positive with respect to the input lead 16, and with the triac regated and conducting, the capacitor 56 as aforesaid will have discharged and will commence recharging, but this time in the opposite polarity from the polarity shown on the drawing. The circuit for recharging the capacitor 56 in this opposite direction is through the low resistance of the triac 22 and the circuit formed by the gate electrode 24, the diode 51, the resistor 60 and the switch 58. The charge produced on the capacitor 56 at this time will be dissipated after the beginning of the next half-cycle. However, this condition will not be able to regate the triac 22 because it is of the wrong polarity to pass through the diode 51, and therefore has no effect on the operation. Furthermore, what charge there is on the capacitor 56 will be rapidly dissipated through a circuit which includes the elements 60, 52, 50 and 54 after the polarity reversal.

The purpose of the capacitor 56, the associated resistor 60 and the circuitry associated therewith is therefore to provide

means to cause the triac 22 to conduct on the half-cycles following the half-cycles in which the triac is triggered by the SCR 50.

An important additional feature of the present circuit is provided by having the switch 58 in its open condition. When the switch 58 is open, the half-cycles following each of the half-cycles in which the triac is triggered by SCR 50 would be omitted and the lamp 14 would not be energized during these half-cycles. This means that the switch 58 can be used to select between full-wave and half-wave conduction of the triac 22 and the lamp 14. For example, when the switch 58 is open the triac 22 will operate only in half-wave conduction cycles, and when the switch 58 is closed it will operate in full wave conduction cycles. With this feature, the life of the lamp 14 can be substantially extended because it can be made to flash at half instead of at full power. This is an advantage in those situations where full brightness is not required.

It is usually also desired to energize the lamp or other load for more than one full cycle of line current at a time, and the present circuit includes means which make this possible. The means for accomplishing this as will be explained, include means that cause the SCR 50 to remain in conducting condition for periods of as long duration as desired. This is accomplished by holding circuit means which include another capacitor 62, another resistor 64, a potentiometer 66, diodes 68 and 70, and a three-position selection switch 72. When the voltage on the input lead 16 is positive with respect to voltage on the input lead 18, and in the interval before the lamp 14 is energized by the triggering of the SCR 50 and the triac 22, a relatively small current will flow through the lamp 14, the lead 20, the switch 71 when closed in its left-hand position as shown, the diode 70, the left part of the potentiometer 66, the resistor 64, and the capacitor 62, which at this time will be charged to the polarity shown. Thereafter, when the SCR 50 conducts as aforesaid, it will be maintained in its conducting condition due to the holding current supplied thereto by the capacitor 62. This holding current is supplied to the SCR 50 through the resistor 64, the right-hand portion of the potentiometer 66 and through the diode 68. During the time the SCR 50 is held conducting, the triac 22 is also conducting thereby causing the lamp 14 to remain energized. However, when the lamp is energized, the capacitor 62 will not longer be receiving charging current through the circuit just described since at this time the lead 20 is at the same potential as the lead 18. The capacitor 62 will therefore be discharged through the same circuit just described which includes the diode 54, the SCR 50, the diode 68, the right part of the potentiometer 66 and the resistor 64, and when discharged will no longer be able to supply holding current for the SCR 50, so that the SCR 50 will then stop conducting as soon as the end of that particular half-cycle of operation is reached.

The time constant of the discharge circuit for the capacitor 62 is controlled by the setting of the potentiometer 66, and the potentiometer 66 therefore acts as the "on time" control for the flasher circuit 10. This means that the lamp 14 will remain energized for a time period that is determined by the setting of the potentiometer 66. Thereafter, at a still later time, the lamp 14 will again be reenergized during a cycle when the capacitor 34 is recharged through the potentiometer 36 as discussed above. This means that the setting of the variable resistor 36 provides the means for controlling the "off time" of the lamp 14, and the setting of the potentiometer 66 controls the "on time" of the lamp 14. It can therefore be seen that in the left setting position of the switch 72 which is the position described above, the circuit 10 operates as an on/off flasher circuit. Other variations in the operation of the circuit 10 are obtained by setting of the switch 72 in its other two operating positions.

In the middle operating position of the switch 72, which is the position in which neither side of the switch is closed, the charging circuit to the capacitor 62 is open so that it cannot supply any holding current for the SCR 50 to maintain it in its conducting condition. In this switch position therefore, the

lamp 14 will be energized only for exactly one full cycle each time it is energized. This position of the switch 72 can be used in any application requiring full wave or half-wave pulses.

In the third or right operating position of the switch 72, the capacitor 62 is continuously charged during the time when the voltage on the input lead 16 is positive with respect to the input lead 18 through a circuit from lead 18 which includes the switch 72, the diode 70, the left portion of the potentiometer 66, and the resistor 64. Thus, in the right position of the switch 72, one the SCR 50 conducts, it will remain conducting until power is removed from the circuit. In the right position of the switch 72 therefore, the subject circuit operates as a time delay relay, and in this condition when power is first applied, the lamp will remain deenergized for a period of time entirely determined by the setting of the "off time" control 36. After this delay time, the lamp or other load will be energized, and will stay energized until the power is removed. Delay relays of this general type have many possible applications in the electronics industry.

Thus there has been shown and described a novel control circuit for controlling the operation of any device which is to be operated or energized intermittently or on some desired time schedule to produce a desired condition, such as to produce a particularly flashing condition or to produce a time delay for some purpose. Such devices have many possible uses and applications including being used to flash electric signs, control warning devices including traffic control and similar devices, produce a desired time delay action, and for many other uses and applications as well. It will be apparent to those skilled in the art, however, that many changes, modifications, variations and other uses and applications of the subject control are possible and can be made without departing from the spirit and scope of the invention. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow.

What is claimed is:

1. A control circuit for controlling the energizing of a device such as a flasher device comprising a flasher device to be controlled, means including an alternating input power source and a control element connected in series with the flasher device, said control element having a gate electrode energizable to control the conducting condition thereof, means for controlling the conducting condition of said control element to control the energizing of said flasher device, said control means including charge storage means, means including a voltage divider discharge path connected across the charge storage means, and means including a gated rectifier device having a control electrode connected to a predetermined point in which voltage divider discharge path, the control electrode of said gated rectifier device being gated to enable the rectifier device to be able to go into a conducting condition whenever the charge on the charge storage means is being dissipated, and means including said gated rectifier device enabling a gating pulse to be applied to the gate electrode of said control element to cause said control element to go into a conducting condition to energize the flasher device whenever the rectifier device goes into a conducting condition.

2. The circuit of claim 1 wherein the gate pulse applied to the gate electrode is applied at a time when the polarity of the alternating power input is reversing.

3. Means for controlling the alternate energizing and deenergizing of a device comprising a source of alternating input voltages which reverses polarity on alternating half-cycles, a device to be energized and deenergized alternately by said source, the improvement comprising a control member connected in a series circuit with said device across said source, said control member having a control element therefor, circuit means connected to said control element to control the conducting condition of the control member such that when the control member is conducting the device is energized and when the control member is not conducting the

device is deenergized, said circuit means including first charge storage means connected to store charge during half-cycles of one polarity of the input source, means responsive to the accumulation of a predetermined charge on said first charge storage means including means for establishing a circuit condition which will enable the control member to go from a nonconducting to a conducting condition the next time there is a reversal of the polarity of the input source, said circuit means including second charge storage means connected to store charge during the half-cycles of the other polarity of the input source, means connecting said second charge storage means to the control element of said control member whereby the charge stored on said second charge storage means operates to maintain the control member in a conducting condition during the half-cycle of operation following the half-cycle in which the control member goes to a conducting condition.

4. The means defined in claim 3 wherein said circuit means include means adjustable to control the time required to charge the first charge storage means to said predetermined charge.

5. The means defined in claim 3 including means to deactivate the second charge storage means.

6. The means defined in claim 3 including third charge storage means, means operable to cause charge to store on said third charge storage means during said other half-cycles of the input source, and other circuit means including means to control the rate of discharge of the charge stored on said third charge storage means, said other circuit means having an operative connection to the control element of the control member to control the time duration that the control member remains in a conducting condition.

7. A circuit for controlling alternate on and off cycles of a device comprising a device to be controlled, switching means connected in series with said device across an alternating current input source, said switching means including a first solid-state member having a control element excitable to control the conducting condition thereof, and circuit means connected to the control element to control the conducting conditions of said member, said circuit means including a second solid-state member having a control element, and means including charge storage means and associated voltage divider means, means connecting said charge storage means to the alternating current input source whereby charge is stored thereon during selected half-cycles of the input source depending on the polarity of the input source, the occurrence of a predetermined charge on the charge storage means operating through the voltage divider circuit to condition the second solid-state member so that said member will conduct the next time the polarity of the input source reverses, and other means connected to the control element of said switching means including the said second solid-state member when in its conducting condition enabling said switching means to go from its nonconducting to its conducting condition to energize the device being controlled.

8. The circuit defined in claim 7 including second charge storage means operatively connected to be charged by the input source, and means for discharging a charge stored thereon, said discharging means including a discharge circuit connected through the second solid-state member, said discharge circuit conditioning said second solid-state member so that it will go from a conducting to a nonconducting condition.

9. A solid-state flasher circuit for controlling energizing and deenergizing of a flasher device comprising a flasher device, a source of alternating current, a controllable member connected in series with the flasher device across the alternating current source, said controllable member having a control electrode, the improvement comprising circuit means connected to the control electrode of the controllable member to produce signals thereon that control the conducting condition of the controllable member and the energizing and deenergizing of the flasher device, said circuit means including a first circuit portion connected across the the alternating current

source and including charge storage means and impedance and rectifier means connected in series with the charge storage means to control the rate and polarity of charge storage on the charge means, means including a voltage divider discharge path connected across the charge storage means, and a gated rectifier having a control electrode connected to a point in the voltage divider discharge path, said gated rectifier conditioning the circuit means so that the controllable member can go from a nonconducting to a conducting condition under control of a polarity reversal of the source, and other means included in the circuit means to maintain the controllable member in a conducting condition for a determinable time period.

10. The solid-state flasher circuit defined in claim 9 including means adjustable to control the time duration that the controllable member is in a conducting condition.

11. The solid-state flasher circuit defined in claim 9 including means adjustable to control the time duration that the controllable member is in a nonconducting condition.

12. The solid-state flasher circuit defined in claim 9 wherein said controllable member is a triac.

13. The solid-state flasher circuit defined in claim 9 wherein said voltage divider discharge circuit includes a trigger diode.

14. The solid-state flasher circuit defined in claim 9 wherein said circuit means includes a second circuit portion including second charge storage means, means to cause a charge of predetermined polarity to be stored on said second charge storage means from said alternating current source on alternate half-cycles of the source, and means for dissipating the charge on said second charge storage means, said charge-dissipating means including the control electrode of the controllable member.

15. The solid-state flasher circuit defined in claim 9 including means for controlling the length of time that the gated rectifier conditions the circuit means so that the controllable member can go from its nonconducting to its conducting condition said last-named control means including means adjustable to control the time durations that the flasher device remains energized.

16. Means for controlling the energizing and deenergizing of a device comprising a source of input voltage having alternating half-cycles of opposite polarity, a controllable element capable of being in a conducting or nonconducting condition connected in series with the device to be energized and deenergized across the input source, said controllable element having a gate electrode, and means connected to the gate electrode for applying signals thereto to control the conducting condition of the element and of the device to be energized and deenergized, said means connected to the gate electrode including first means operable in response to a predetermined first circuit condition to enable a signal to be applied to the gate electrode to cause said controllable element to go from a nonconducting to a conducting condition, said last-named means including first charge storage means and means to adjust a first circuit time constant to vary the charging rate of said first charge storage means, and second means responsive to a predetermined second circuit condition to maintain the controllable element in conducting condition for a determinable time period, said second means including second charge storage means and means to adjust a second circuit time constant to vary the charging rate of said second charge storage means.

17. The means defined in claim 16 including switch means connected into the circuit of the second charge storage means, said switch means being movable between a first position in which the device to be energized is operated on half-wave energy from the source, and a second position in which the device to be energized is operated on full wave energy from the source.

18. The means defined in claim 16 including switch means connected into the circuit with the second charge storage means, said switch means being movable between a first position in which the second means operate every time the device is energized to maintain the device energized for one full cycle of the input source, a second position in which the device is maintained energized for a predetermined time interval each time it is energized, and a third position in which the device after once being energized remains energized.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,631,318 Dated December 28, 1971

Inventor(s) Bobby Gene Hubbard

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 52, "a flasher circuit" should be "improved means"; line 53, "waring" should be "warning".

Column 4, line 31, "71" should be "72"; line 42, "not" should be "no".

Column 5, line 7, "18" should be "16"; line 9, "one" should be "once"; line 24, "particularly" should be "particular"; line 65, "voltages" should be "voltage".

Signed and sealed this 6th day of June 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents