

June 21, 1938.

R. E. CONOVER

2,121,117

ELECTRONIC TIMER

Filed March 18, 1935

2 Sheets-Sheet 1

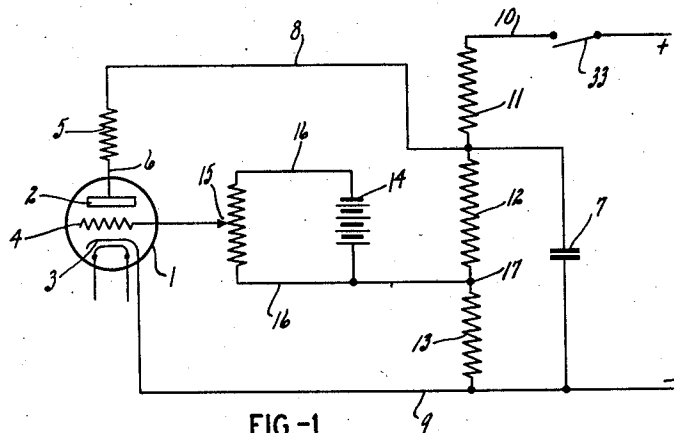


FIG-1

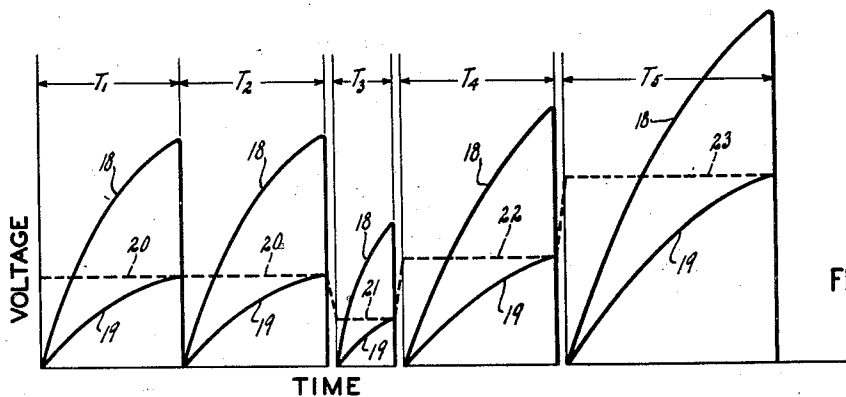


FIG-2

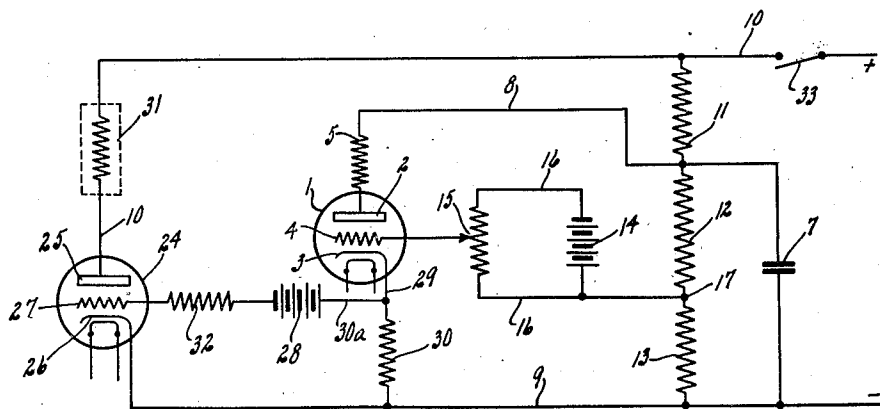


FIG-3

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2 Sheets-Sheet 2

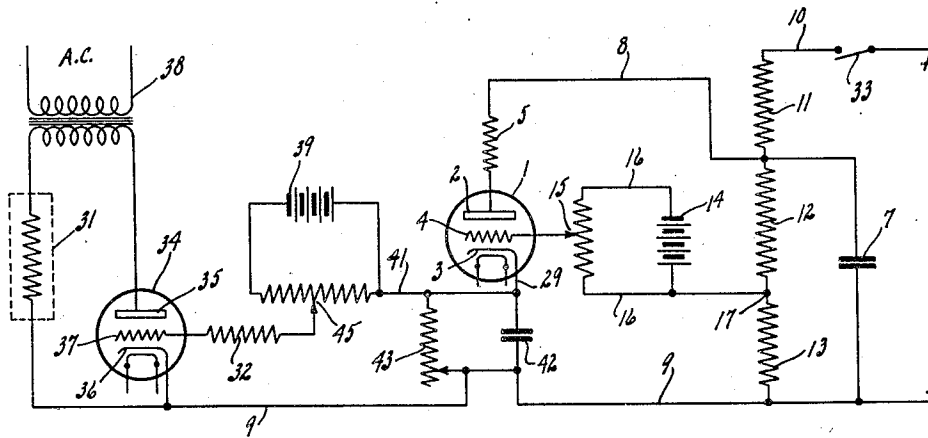


FIG-4

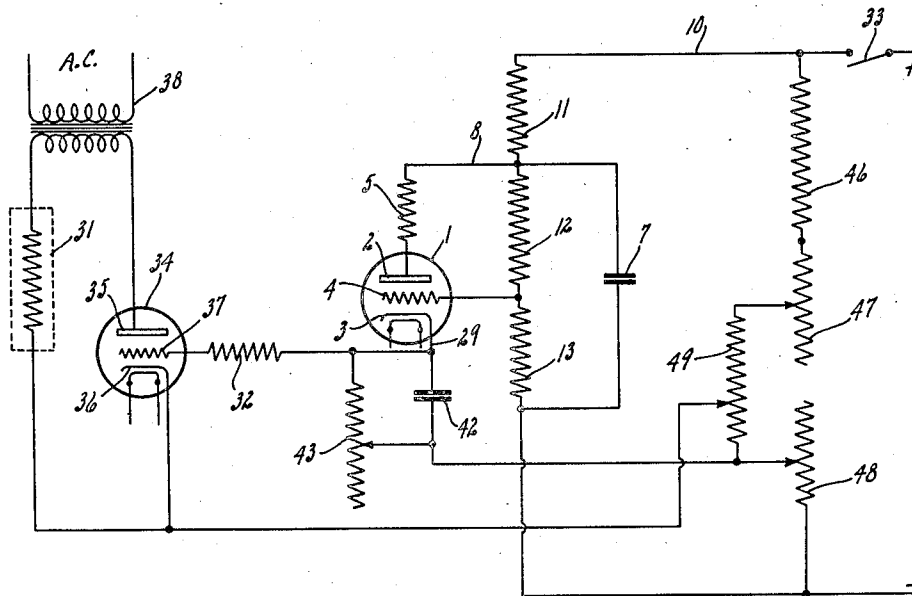


FIG-5

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UNITED STATES PATENT OFFICE

2,121,117

ELECTRONIC TIMER

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Application March 18, 1935, Serial No. 11,548

12 Claims. (Cl. 250—27)

My invention relates to electrical control circuits and more particularly to a control circuit having an ignition controlled discharge tube which discharges at predetermined periods of time to control a supply of current to a load, such as a relay, or another discharge tube, which, in turn, controls a load circuit.

In electrical control devices it is often desirable to control the supply of current to loads, such as relays, indicating devices, color selectors, automatic counters, safety gate operators, door openers, street lighting control, etc., in such a manner that current will be supplied to the load after a predetermined period of time, or it may be desirable to supply current to the load at intervals for a predetermined period of time. I have provided an improved circuit which is effective in initiating the supply of current to a load after a predetermined time or which is effective in supplying current to a load at intervals for a predetermined period of time.

It is therefore an object of my invention to provide an improved flasher circuit including an ignition controlled discharge tube which is discharged at predetermined intervals of time, or the discharge of which may be varied so that current will flow through the circuit at varied intervals of time. Another object of my invention is to provide an improved circuit which operates at predetermined intervals of time to control the supply of current to a load after a predetermined period of time. A further object of my invention is to provide an improved circuit which is effective in controlling the supply of current to loads at predetermined intervals.

My invention will be better understood by reference to the accompanying drawings in which:

Fig. 1 is an improved flasher circuit showing means for passing current through an ignition discharge tube at predetermined intervals of time.

Fig. 2 is a series of curves showing the relationship between condenser, resistor and grid voltages and the time intervals at which a discharge passes through the tube.

Fig. 3 is a circuit for supplying current to loads after a predetermined interval of time.

Fig. 4 is a circuit for supplying and disconnecting the supply of current to loads at predetermined intervals of time.

Fig. 5 is a modification of the circuit illustrated in Fig. 4.

As illustrated in Fig. 1 of the drawings, my improved flasher circuit comprises an ignition control discharge or grid glow tube 1 which is of the usual type and contains a vapor, such as

argon, helium, mercury, neon, or caesium. The discharge tube 1 is composed of an anode plate 2, a cathode 3 and a grid 4. A resistor 5 is connected to the conductor 6 leading from the plate to limit the current through the tube to a safe value upon discharge. A condenser 7 is connected in parallel with the anode-cathode circuit of the tube between the conductor 8, leading from the plate and the conductor 9 leading to the cathode.

Current is supplied to the circuit from any suitable direct current power supply having a comparatively high voltage. As illustrated in the drawings, the current passes through a resistor 11 which is connected to the conductor 8. Part of the current from the line flows through divided resistors 12 and 13 which are connected to conductors 8 and 9 in parallel with the condenser and the remainder is utilized in charging the condenser. Two resistors are provided so that the voltage across condenser 7 may be divided at a fixed ratio.

A source of grid potential, such as a battery 14, is connected in circuit with the potentiometer 15 by means of conductors 16 and to a point between the divided resistors 12 and 13. The grid is connected to the battery circuit at a predetermined point on the potentiometer 15 so that the desired amount of voltage may be supplied to the grid.

In accordance with my invention, the grid of the tube is arbitrarily made negative with respect to the cathode by means of the battery 14 and potentiometer 15. In this connection it will be particularly noted that the difference in potential between the grid and the cathode may be varied by means of the potentiometer 15.

The operation of my improved flasher circuit will now be apparent. Starting with the condenser 7 discharged, current from the line flows through resistor 11 to the conductor 8 and into the condenser 7. Since the sum of the resistors 12 and 13 is very large in comparison to resistor 11, the condenser cannot discharge itself through resistors 12 and 13 as fast as it receives a charge from the line through the resistor 11. The net result is that the voltage on the condenser builds up as indicated by curve 18, Fig. 2. Since resistors 12 and 13 constitute a voltage divider for the condenser voltage the potential across 13 rises along with the voltage across condenser 7. As the potential across resistor 13 rises, however, the net negative grid bias is slowly extinguished until the voltage across the resistor 13 equals the predetermined negative voltage between the grid

and the cathode. At this point, discharge occurs and the voltage across the resistor 13 and the condenser 7 drops to zero. The cycle is then repeated.

5 The time between cycles may be made constant or may be varied by varying the setting of the potentiometer 15. This is illustrated in Fig. 2 of the drawings in which the ordinal designates the voltage and the abscissa the time. As illustrated, the voltage across condenser 7 rises rapidly as indicated by the curve 18 and then gradually assumes a constant value. The voltage across resistor 13 rises in proportion with the condenser voltage as indicated by the curve 19 while the grid voltage, designated by the line 20, is constant. When the voltage across the resistor 13 becomes sufficient to neutralize the original negative bias between the grid and the cathode, discharge occurs and the condenser voltage drops to zero. As illustrated in Fig. 2 this occurs at the time designated T₁. The cycle is then repeated and if the negative potential of the grid with respect to the cathode is maintained at the same value, the discharge during the second cycle will occur in the same period of time as indicated by T₁ on the drawings. If the difference in potential between the grid and the cathode is set at a lower value, as indicated by the line 21, and the grid potential is made less negative with respect to the cathode 3 than in the previous example, the discharge will occur sooner as indicated at T₂. On the other hand, when the negative grid bias is increased, as indicated by the lines 22 and 23, the time of discharge will be increased as indicated at T₃ and T₄ of the drawings.

My improved flasher circuit may be employed for various purposes, such as controlling relays, or may be utilized to control another ignition discharge tube. For example, in Fig. 3 of the drawings, a circuit is shown in which the flasher circuit controls the operation of another ignition control discharge or grid glow tube for supplying current to a load. The flasher circuit is similar to that disclosed in Fig. 1 and the parts have accordingly been designated by the same reference numerals. As illustrated, the second tube 24 is composed of an anode 25 connected to the conductor 10 and a cathode 26 connected to the conductor 9. The grid 27 is normally maintained negative with respect to the cathode 26 by means of a source of potential, such as a battery 28, and is connected to the conductor 29 leading from the cathode 3. A resistor 30 is connected in series with the conductor 29 between the point of connection of conductor 30a leading from battery 28 and the conductor 9.

The operation of the circuit for supplying current to the load 31 will now be apparent. When a discharge occurs in ignition tube 1, the voltage across resistor 30 is momentarily increased. This voltage, however, is of a different polarity and greater than the voltage of battery 28. The grid potential with respect to the cathode is thus made positive which causes a discharge in tube 24 causing current to flow to the load 31. As the plate is supplied by direct current voltage, current will continue to flow to the load after the grid potential has dropped back to a negative value. The load current can only be interrupted by opening the switch 33. It will thus be apparent that by my improved flasher circuit current may be supplied to the load after a predetermined interval of time and will continue to flow until the switch 33 is turned off.

The resistor 32 is connected in series with the battery to prevent excessive grid current after the discharge of the tube.

Figs. 4 and 5 of the drawings illustrate a circuit for supplying current to a load and disconnecting the supply of current at desired intervals. As shown in the drawings, the flasher circuit is designated by the same numerals as in Fig. 3. In this circuit the ignition control tube 34 is composed of an anode 35, a cathode 36 and a grid 37. The anode 35 is connected to a source of alternating current 38 and the grid is normally maintained negative with respect to its cathode by a source of potential, such as a battery 39, and potentiometer 45. In the arrangement of this circuit a conductor 41 leading from the positive side of the battery is connected to the conductor 29 leading from the cathode 3 and a condenser 42 is connected in series with conductor 29 which leads to conductor 9. A variable resistor 43 is connected to the conductor 41 in parallel with the condenser 42.

The use of a flasher circuit for supplying and disconnecting the supply of current to the load 31 will now be apparent. When tube 1 discharges, the condenser 42 charges and the potential across the condenser, being of opposite polarity to the battery 39, raises the potential of grid 37 with respect to cathode 36 to a positive value and the tube 34 discharges, thereby supplying current to the load 31. Condenser 42 then immediately commences to discharge through the resistor 43 which is of a comparatively high value. The charge in the condenser, however, is sufficient to maintain the voltage of grid 37 positive with respect to cathode 36 for the desired length of time. When the condenser discharges to such a point, however, that the potential across the resistor is less than the potential of battery 39 and potentiometer 45, the grid voltage becomes zero and then negative. Since the plate voltage in this case, however, is supplied by alternating current, when the grid becomes negative it regains control and the current to the load is disconnected.

The length of time which current is supplied to the load may be varied either by changing the value of the resistor 43 or by changing the negative grid voltage by means of the potentiometer 45. I find it advantageous to make both of these values variable. For instance, the resistor 43 may be a tapped resistor and the final adjustment may be made in potentiometer 45. It will be understood that the adjustment of both the load and flasher circuits is correlated so that the load is turned off before the next discharge occurs through tube 1.

Fig. 5 of the drawings discloses a modification of the circuit in Fig. 4. In this case a potential divider is placed across the high voltage supply line consisting of resistors 46, 47, 48 and 49. Resistor 47 is made variable so that the difference in potential across resistor 49 may be made constant irrespective of the setting of resistor 48.

The operation of this circuit is the same as that disclosed in Fig. 4 with the exception that instead of utilizing a separate source of voltage to make the grid voltage negative with respect to its cathode, the conductors leading from the cathodes are returned to a point which is more positive than the conductors leading from the grids. For instance, the lead from cathode 3 is returned to the resistor 48 and the lead from cathode 36 is returned to resistor 49. Since the

cathode of each tube is thus made more positive than the respective grids, the potential of the grid with respect to the cathode will be negative under normal conditions. As the potential across resistor 13 rises, however, the negative grid bias will be overcome and a discharge will occur in tube 1. The discharge of tube 1 will change the potential of grid 37 with respect to the cathode 36 in the same manner as described in connection with Fig. 4 and the load will be turned on. After the condenser 42 discharges the grid will become negative and the current to the load will be turned off. It is apparent that the same method of obtaining the various potentials from a common source is applicable in the circuits illustrated in Figs. 1 and 3 of the drawings.

From the foregoing description it will be seen that I have provided an improved flasher circuit by means of which a discharge through the tube may be effected at predetermined intervals of time, which may be varied in accordance with the desired requirements.

It will also be apparent that I have provided an improved circuit by means of which current may be supplied to a load after a predetermined interval of time after the flasher circuit has been set in operation.

It will also be seen that my improved flasher circuit is effective for supplying and disconnecting current to a load at predetermined intervals of time which may be varied according to the desired requirements.

It will be understood that while I have designated the load diagrammatically in the drawings, the circuit may be employed for controlling any desired apparatus, such as relays, automatic scales, color selectors, automatic counters, safety gate operators, position indicators, door openers, street lighting controls, smoke detectors, etc.

To those skilled in the art many modifications and widely different embodiments and applications of my invention will suggest themselves without departing from the spirit and scope thereof. My disclosure and description are purely illustrative and are not in any sense limiting.

What I claim is:

1. An electrical control circuit comprising an ignition controlled discharge tube having an anode, a cathode and a grid, said tube being of a type in which an electric discharge may be started in response to a predetermined electrical condition of the grid and in which the magnitude of the discharge is independent of the electrical condition of the grid, a condenser connected in parallel with the anode-cathode circuit of said tube, a resistor divided into two portions connected in parallel with said condenser, means for normally maintaining the grid of said tube at a negative potential with respect to its cathode, means for charging said condenser and creating a difference of potential across one of said resistors which is less than the difference of potential across said condenser, and means responsive to the change of potential across the portion of the resistor having a lower potential than the condenser for changing the potential of the grid with respect to its cathode to such a value that the discharge occurs in the tube, thereby causing a discharge of the condenser through the tube and immediately restoring the negative potential of the grid with respect to its cathode.

2. An electrical control circuit comprising an ignition controlled discharge tube having an

anode, a cathode and a grid, said tube being of a type in which an electric discharge may be started in response to a predetermined electrical condition of the grid and in which the magnitude of the discharge is independent of the electrical condition of the grid, a condenser connected in parallel with the anode-cathode circuit of said tube, a resistor divided into two portions connected in parallel with said condenser, variable means for normally maintaining the grid of said tube at a negative potential with respect to its cathode, means for charging said condenser and creating a difference of potential across one of said resistors which is less than the difference of potential across said condenser, and means responsive to the change of potential across the portion of the resistor having a lower potential than the condenser for changing the potential of the grid with respect to its cathode to such a value that the discharge occurs in the tube, thereby causing a discharge of the condenser through the tube and immediately restoring the negative potential of the grid with respect to its cathode.

3. An electrical control circuit for supplying current to a load comprising a circuit including a discharge tube having an anode, a cathode and a grid, said tube being of a type in which an electric discharge may be started in response to a predetermined electrical condition of the grid and in which the magnitude of the discharge is independent of the electrical condition of the grid, a second discharge tube having an anode, a cathode and a grid, means for normally maintaining the grid of the first tube negative with respect to its cathode, a condenser in parallel with the anode-cathode circuit of the first tube and a resistor connected in parallel with said condenser, means for charging said condenser from a direct current source of power and creating a difference in potential between the anode and cathode of the second tube and across said resistor from the same source of power, means responsive to the rise in potential across said resistor for changing the grid potential of the first tube with respect to its cathode sufficiently to cause a discharge, and means responsive to the discharge of the first tube for causing an immediate discharge in the second tube, whereby direct current will be continuously supplied to the load through the second tube.

4. A time relay for delaying the supply of current to a load for a predetermined period of time after application of supply voltage, comprising a circuit including a discharge tube having an anode, a cathode and a grid, said tube being of a type in which an electric discharge may be started in response to a predetermined electrical condition of the grid and in which the magnitude of the discharge is independent of the electrical condition of the grid, means for normally maintaining the grid of the tube negative with respect to its cathode, a condenser in parallel with the anode-cathode circuit of the tube and having a resistor connected in parallel therewith, means for charging said condenser and creating a difference in potential between the anode and cathode of said tube from a direct current source of power, means responsive to the rise of potential across said condenser and parallel resistor for changing the grid potential of the tube in the positive direction sufficiently to cause discharge of the tube, a second discharge tube which functions as a line switch to supply current to a load from a direct current source of power, and means

responsive to the discharge of the first tube for causing immediate discharge of the second tube, whereby current will be continuously supplied to the load through the second tube.

5 5. A time relay for delaying the supply of current to a load for a predetermined period of time after application of the supply voltage, comprising a circuit including a discharge tube having an anode, a cathode and a grid, said tube being
10 of a type in which an electric discharge may be started in response to a predetermined electrical condition of the grid and in which the magnitude of the discharge is independent of the electrical condition of the grid, means for normally
15 maintaining the grid of the tube negative with respect to its cathode, a condenser in parallel with the anode-cathode circuit of the tube having a resistor connected in parallel therewith, means for charging said condenser and creating
20 a difference in potential between the anode and cathode of said tube from a direct current source of power, means responsive to the rise of potential across said condenser and parallel resistor for changing the grid potential of the tube in the
25 positive direction sufficiently to cause discharge of the tube, a second discharge tube which functions as a line switch to supply current to a load from the source of power common to the first tube, and means responsive to the discharge of
30 the first tube for causing immediate discharge of the second tube, whereby current will be continuously supplied to the load through the second tube.

35 6. In combination, a flasher circuit including a discharge tube having an anode, a cathode and a grid, and means for normally maintaining the grid of said tube negative with respect to its cathode, a second discharge tube having an anode, a cathode and a grid, a load in series with
40 the second discharge tube, means associated with the cathode of the first tube and the grid of the second tube for normally maintaining the grid of the second tube negative with respect to its cathode, a source of direct current voltage connected
45 to the anode of both tubes, means responsive to the supply of direct current voltage to the tubes for causing a discharge of the first tube in a predetermined time after current is supplied thereto, and means responsive to the discharge of the first
50 tube for temporarily changing the grid bias of the second tube, whereby current from a direct current source of power is supplied to the load through the second discharge tube.

7. In combination, a flasher circuit including a
55 discharge tube having an anode, a cathode and a grid, a direct current source of power connected to said circuit, and means responsive to the supply of current for causing repeated discharges of said tube at predetermined intervals
60 after current is supplied thereto, a second discharge tube having an anode, a cathode and a grid, a load in series with the second discharge tube, means for supplying current from an alternating current source of power to the second
65 tube, means associated with the cathode of the first tube for normally maintaining the grid of the second tube negative with respect to its cathode, and means responsive to the discharge of the first tube for changing the grid potential of
70 the second tube in a positive direction sufficiently to permit discharge for a predetermined portion of the time between the discharges of the first tube, thus permitting current to be supplied to a load for predetermined intervals between the dis-
75 charges of the first tube.

8. In combination, a flasher circuit including a discharge tube having an anode, a cathode and a grid, and a condenser in parallel with the anode-cathode circuit of the tube, a second discharge tube controllable by the first tube having
5 an anode, a cathode and a grid, a load in series with the second tube, means for normally maintaining the grids of both tubes negative to the respective cathodes, a resistor common to the discharge circuit of the first tube and the grid-cathode circuit of the second tube, means for
10 supplying voltage from a single direct current source of power to charge the condenser in series with the first tube and to create a difference of potential between the anode and cathode of the second tube, means responsive to the charge of
15 said condenser for changing the grid bias of the first tube in a positive direction sufficiently to cause discharge of the first tube, means responsive to the discharge of the first tube for creating a difference of potential across said resistor, and
20 means responsive to the rise of potential across said resistor for instantly changing the grid bias of the second tube in a positive direction sufficiently to cause discharge of the second tube, whereby a direct current flows continuously from the single source of supply to the load through
25 the second tube.

9. In combination, a flasher circuit including
30 a discharge tube having an anode, a cathode and a grid, a condenser in parallel with the anode-cathode circuit of said discharge tube, a resistor in parallel with said condenser, and means for normally maintaining the grid of said tube negative with respect to its cathode, a second discharge tube controllable by the first discharge
35 tube, a load in series with the second discharge tube, a source of potential connected to the cathode of the first tube and the grid of the second tube for normally maintaining the grid of the second discharge tube negative with respect to
40 its cathode, a second resistor common to the discharge circuit of the first tube and the grid-cathode circuit of the second tube, means for applying voltage from a direct current source of power to the condenser in parallel with the first
45 tube and to the anode of the second tube, the resistor in parallel with said condenser being associated with the grid of the first tube in such a manner that an increase in potential across
50 said resistor changes the grid bias of the first tube in a positive direction sufficiently to cause discharge of the first tube in a predetermined period of time, thereby creating a temporary difference of potential across the second resistor, and means responsive to the rise in potential
55 across the second resistor for instantly changing the grid bias of the second tube in a positive direction sufficiently to cause discharge of the second tube, whereby current flows to a load
60 through the second tube.

10. In combination, a flasher circuit including an ignition controlled discharge tube having an anode, a cathode and a grid, a condenser in parallel with the anode-cathode circuit of said tube,
65 means for normally maintaining the grid of said tube negative with respect to said cathode, a direct current source of power connected to the circuit for charging said condenser, means responsive to the discharge of said condenser for
70 changing the grid bias of said tube in a positive direction sufficiently to cause discharge of said tube, means responsive to the discharge of said tube for charging a second condenser connected to the cathode of said tube, and means
75

for permitting discharge of the second condenser, a second ignition controlled discharge tube having an anode, a cathode and a grid, means for supplying current from an alternating current source of power to the anode of the second tube, means for normally maintaining the grid of the second tube negative with respect to its cathode, and a connection between the cathode of the first tube and the grid of the second tube whereby the charging of the second condenser changes the grid bias of the second tube in a sufficiently positive direction for a predetermined period of time to permit discharge of the second tube.

11. In combination, a flasher circuit including an ignition controlled discharge tube, a source of direct current connected to said circuit, means associated with the circuit and responsive to the supply of current for automatically causing repeated discharges of said tube at predetermined intervals after current is supplied thereto, and a condenser in series with the cathode of said tube which is charged during the discharge of said tube, a resistor in parallel with said condenser through which the condenser is discharged, a second discharge tube having an anode, a grid and a cathode, a load in series with the second discharge tube, means for supplying current from an alternating source of power to the second tube, means for normally maintaining the grid of the second tube negative with respect to its cathode, and means whereby the discharge of the condenser in the flasher circuit maintains the grid of the second tube in

a positive direction sufficiently to cause discharge of the second tube for a predetermined portion of the time between the discharges of the first tube, thus permitting current to be supplied to the load for predetermined intervals between the discharges of the first tube.

12. In combination, a flasher circuit including an ignition controlled discharge tube, a source of direct current connected to said circuit, and means associated with the circuit responsive to the supply of current for automatically causing repeated discharges of said tube at predetermined intervals after current is supplied thereto, a second discharge tube having an anode, a cathode and a grid, means for supplying current from an alternating current source of power to the second tube, means for normally maintaining the grid of the second discharge tube negative with respect to its cathode, a condenser in series with the first tube having a resistor in parallel therewith, said condenser and resistor being associated with the grid of the second tube in such a manner that upon discharge of the first tube the grid bias of the second tube is changed in a positive direction to a sufficient value to allow current to flow through the second tube for a predetermined period of time, the capacitance of said condenser and the resistance of said resistor being of such a value that the grid bias of the second tube will be restored to its normal negative value before recurrence of the discharge of the first tube.

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