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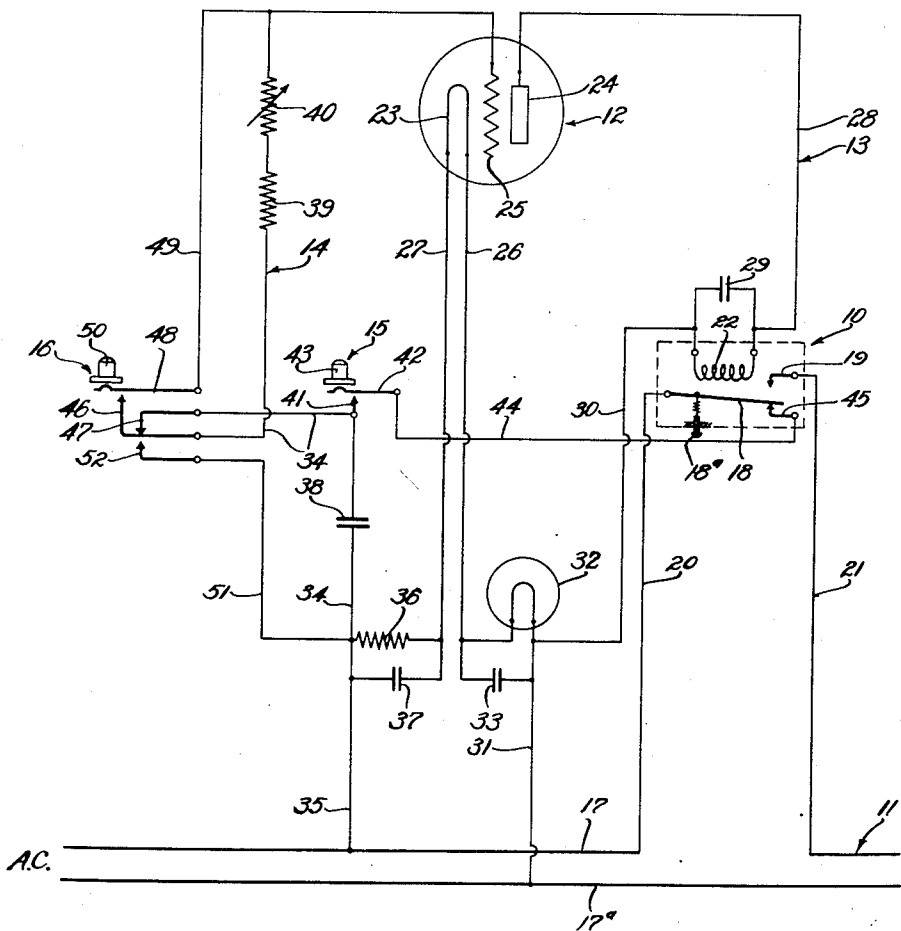
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ELECTRIC TIME DELAY DEVICE

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Fig. 1.



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ELECTRIC TIME DELAY DEVICE

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This invention relates to a time delay apparatus and relates more particularly to an electric time delay circuit or device. A general object of this invention is to provide a simple, inexpensive and dependable electric time delay device.

Time delay devices are employed where a unit or apparatus is to perform a given function for a given period. For example, in making photographic and X-ray exposures, the exposure time is often controlled by a time delay device. Various electrical time controls and time delay devices have been proposed but such devices are usually complicated and expensive. For example, they often contain rectifiers and a plurality of electron discharge devices or electric valves.

Another object of this invention is to provide a time delay device that is extremely simple, embodying only a single electric valve or electron discharge device, the single valve or discharge device operating both as circuit controller and a rectifier thus distinguishing the invention over prior time delay devices which require separate rectifiers.

Another object of this invention is to provide an electric time delay device that is regulable or variable to provide for the control or closing of the controlled circuit for a wide range of selected time periods.

Another object of this invention is to provide a time delay device that is affected to a minimum extent by variations in the frequency and potential of the power supply.

Another object of this invention is to provide an electric time delay circuit or device that embodies a manual control whereby the selected or given operating period may be terminated at any time at the will of the operator.

Another object of this invention is to provide an electric time delay device of the character just referred to in which the manual control may be manipulated to hold the controlled circuit closed as long as the operator desires, or to interrupt the timing period before its expiration.

A further object of this invention is to provide a time delay device of the character mentioned in which the operation of the means for closing or governing the controlled circuit is accompanied by disconnection of the manual starting switch so that the automatic time delay means is unaffected by continued or successive operations of the starting switch during the selected time delay period.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and

application of the invention, throughout which description reference is made to the accompanying drawing.

The drawing is a wiring diagram of the improved electric time delay device of the invention.

The improved time delay circuit or device of the present invention may be said to comprise, generally, a relay 10 for governing the circuit 11 to be controlled, an electric valve 12, two related circuits connected with the valve 12, one an energizing circuit 13 for the relay 10 and the other a control circuit 14 governing the energizing circuit 13, a manual starting switch 15 connected in the control circuit 14 and an auxiliary switch 16 connected in the control circuit operable to de-energize the relay 10 and operable to energize the relay 10 at the will of the operator.

The relay 10 is provided to control or complete the outside circuit or the controlled circuit 11. In accordance with the invention the relay 10 may be connected in one line 17 of a suitable A. C. power supply of, say, 110 v., in which case the controlled circuit 11 is a continuation of the supply circuit or power supply. The relay 10 may include a movable contact element 18 and a stationary contact 19 engageable by the element 18. A lead 20 extends from the power supply line 17 to the contact element 18 and a similar lead 21 connects the stationary contact 19 with the corresponding lead of the controlled circuit 11. The contact element 18 is normally held out of engagement with the contact 19 by spring means or by gravity. In the preferred form of the invention a manually adjustable spring means 18^a holds the contact element in its normal position. By adjusting the means 18^a the time delay period of operation of the device may be varied as will be apparent. The relay 10 further includes a winding or coil 22 for operating the contact element 18. The coil 22 is connected in the circuit 13, as will be hereinafter described, and is operable when energized to move the element 18 into cooperation with the contact 19 to complete the controlled circuit 11.

The electric valve 12 is in the nature of a vacuum or gaseous electron discharge tube. In the preferred arrangement illustrated the valve 12 includes a cathode 23, an anode 24, and a grid of control element 25 spaced between the cathode and anode. The cathode 23 may be directly or indirectly heated. In the case illustrated the cathode 23 is of the filament type and is directly heated having leads 26 and 27 extending to power supply means, as will be later described.

The circuit 13 is provided to control or en-

energize the relay 10. The relay energizing circuit 13 includes a lead 28 extending from the plate or anode 24 to the coil 22 of the relay 10. A suitable condenser 29 is preferably connected in parallel with the coil 22 to eliminate undesirable ripples or pulsations. The circuit 13 further includes a lead 30 extending from the winding or coil 22 to a power supply connected with the cathode lead 26. This power supply includes a power lead 31 extending from a line 17^a of the A. C. power source and connected with the lead 30. A resistance 32 in the form of a lamp is connected across the cathode lead 26 and the lead 31. The lamp 32 is preferably a carbon filament lamp to counteract or compensate for variations in the power potential by reason of its resistance characteristics. The potential drop across the terminals of resistance 32 as the result of the current flowing through it is the power supply for the circuit 13. A condenser 33 is connected between the leads 26 and 31 in parallel relation to the resistance 32 to give the potential applied to the circuit 13 the desired phase relation with respect to the phase of the potential of the power supply to circuit 14 as will be later described. The condenser 33 in addition to the functions to be later described, is related to the condenser 29 to minimize changes in the anode current due to changes in the power supply frequency.

The circuit 14 is the control circuit and is connected with the grid or control element 25 of the valve 12 to govern the circuit 13 through the medium of the valve. The circuit 14 includes a lead 34 extending from the control element 25 to a power supply associated with the cathode lead 27. This power supply includes a lead 35 extending from the power supply line 17 and connected with the lead 34. A resistance 36 is connected between the leads 27 and 34 and a condenser 37 is connected in parallel with the resistance 36. The potential drop across the terminals of resistance 36 is the power supply for the circuit 14. The condenser 37 affects the phase relation of the potential applied to the circuit 14 with respect to the phase of the potential of the power supply line 17—17^a to give the circuit 14 the correct phase relation. It will be observed that the resistances 32 and 36 are connected in series in the cathode leads 26 and 27. The cathode or filament 23 is heated by the current from the power supply leads 17 and 17^a flowing through resistance 36 or condenser 37 or both, and resistance 32 or condenser 33, or both. It will be observed that the condensers 33 and 37 installed as described, permit the employment of resistances 32 and 36 of a higher value so that the current flow is to a large extent through the condensers 33 and 37 and there is a minimum heat loss in the resistances.

The control circuit 14 includes a time control element in the form of a condenser 38. The condenser 38 may or may not be a variable condenser. The condenser 38 is adapted to build up a charge or potential equal to the potential of the power supply for the circuit 14. The control circuit 14 further includes a fixed resistance 39 and a variable resistance 40. The resistances 39 and 40 are connected in series in the lead 34. Either the variable resistance 40 or the condenser 38 may be the time period control means, that is, either one or both of these elements may be manually adjusted to vary the period during which the controlled circuit 11 is completed at a given operation of the device. It will be seen that the control circuit 14 associated with the element 25 of the valve 12 embodies the timing condenser 38 and the

variable resistance 40 for changing the setting or timing of the device.

The starting switch 15 is adapted to be closed or actuated by the operator to initiate the operation of the device. In accordance with the invention the switch 15 is associated with the circuit 14 and is operable to short out or cause a rapid discharge of the condenser 38. The switch 15 may be varied to suit different uses and installations of the device. As illustrated in the drawing, the switch 15 includes a stationary contact 41 connected in the lead 34 and a movable contact 42 operated by a key 43. A lead 44 extends from the movable contact 42 to a stationary contact 45 at the relay 10. The contact 45 is normally engaged by the movable element 18 of the relay 10. When the key 43 of the switch 15 is depressed current flows through the switch 15, the lead 44, the contact 45, the element 18 and the lead 20 connected with the power line 17, thus rapidly discharging the condenser 38. As will be later described, the discharge of the condenser 38 is accompanied by actuation of the relay 10 so that the element 18 is disengaged from the contact 45 immediately following closing of the switch 15. Accordingly, the maintenance of the switch 15 in a closed condition or the repeated closing of the switch 15 while the relay 10 is energized, has no effect on the circuits 13 and 14.

The switch 16 is manually operable to cause deenergization of the relay 10 when the latter is energized by reason of the action of the time delay means, and is operable to maintain the relay 10 energized at any time and for any period, so long as the operator holds the switch closed. The switch 16 includes a movable contact 46 and a stationary contact 47, both connected in the lead 34 between the condenser 38 and the resistance 39 and 40. The movable contact 46 normally engages the stationary contact 47 to complete the circuit through the lead 34. The switch 16 further includes a second movable contact 48 connected with a tap lead 49. The lead 49 is connected with the lead 34 at a point between the valve 12 and the pair of resistances 39 and 40. A manually operable key 50 is provided to depress the contact 48. When the contact 48 is depressed to its first position in cooperation with the contact 46 the resistances 39 and 40 are shunted out. The consequences are that a high potential is impressed on the control element 25, producing de-energization of the relay 10. An understanding of this depends upon a full understanding of the timing operation, to be later described. The timing period is determined principally by the magnitudes of the condenser 38 and the total of resistances 39 and 40. Shunting out resistances 39 and 40 by operation of the key 50 effectively reduces the timing period to a very short one, resulting in practically instantaneous de-energization of relay 10.

The switch 16 further includes a contact 52 connected to the resistance 36 by a lead 51. The contact 52 is engageable by the movable contact 46 when the switch 16 is moved to its second position. When the movable contact 48 is depressed sufficiently to bring the movable contact 46 into engagement with the contact 52 the condenser 38 and the resistances 39 and 40 of the circuit 14 are shunted out to reduce the potential on the element 25 and causes an increase in the potential in the circuit 13 which increased potential in the circuit 13 operates the relay 10. As will be understood from a later explanation, the potential applied to the element 25 is greater than the poten-

tial of the power supply by the potential of the charge in the condenser 38. Thus, when the condenser 38 is removed from the circuit together with the resistances 39 and 40 by a full operation of the switch 16, the potential on the element 25 is reduced. It will be seen that the switch 16 may be manually operated to the first position following the actuation of the switch 15 to de-energize the relay 10 and thus terminate the time control period, and may be manually held in a fully closed position or second position to hold the relay 10 actuated so that the controlled circuit 11 may be completed at any time for as long as desired.

The phase relation of the potential impressed on the circuit 14 is opposite to that imposed on the circuit 13 by its power supply. During the half cycles when the potential in the circuit 14 is positive with respect to the cathode 23 current flows through the control circuit 14 and its condenser 38 and resistances 39 and 40. These half-cycles may be termed the negative half-cycles. The rate of this current is determined by the potential of the power supply to circuit 14, the potential of the charge in condenser 38, the aggregate resistance of resistances 39 and 40 and the resistance of the interelectrode space between the cathode 23 and the control element 25. Also affecting this current is the electrostatic induction into the element 25 by the other elements such as 24. Disregarding the inductive action, and assuming no discharging circuit for the potential in the condenser 38, after successive negative half cycles, the ultimate potential of the charge in the condenser 38 (when fully charged) equals the peak negative potential of the power supply for the circuit 14. At any time the potential applied to the circuit 14 is the vector sum of the potentials of the charge in condenser 38 and the power supply of circuit 14. For a fully charged condenser 38, the vector sum ranges from zero to twice the peak potential of the power supply of circuit 14, with an average value equal to the condenser charge. Obviously, with a discharged condenser, the vector sum is only the potential of the power supply of circuit 14 alone, with values ranging from the negative to positive peak potentials of the power supply, and an average of zero.

The potential applied to the element 25 with respect to the cathode 23 is approximately equal to the vector sum of the charge potential of the condenser 38 and the power supply for the circuit 14 only when the sum indicates by the direction of the vector that the control element 25 is negative with respect to the cathode 23, from which no current flows and there is no drop in the potential in resistances 39 and 40. Current of this polarity or direction cannot flow, and there is no discharge circuit for the condenser 38, as was assumed above, by virtue of the nature of the valve 12. No current flows through the relay circuit 13 during the said negative half-cycles because the potential on the anode 24 is negative relative to the cathode 23. Current flows through the relay circuit 13 during the positive half-cycles with a magnitude determined by the value of its power supply, the value of the space impedance in the valve 12, and the general circuit resistance including the relay coil 22, etc. It will be seen that when the potential of the charge in the condenser 38 reaches a maximum the potential on the control element 25 is maximum and negative relative to the cathode 23 so that the anode current and the current in the circuit 13 is at a

minimum. This minimum normal potential of the circuit 13 is insufficient to operate the relay 10 and the relay is normally dropped or open, as illustrated. The impedance of the anode space in the valve 12 is determined by the normal potential on the control element 25.

To operate the device to complete the outside or controlled circuit 11 for a given selected time the operator closes the switch 15. It is to be understood that the variable resistance 40 may be set to provide for the completion of the controlled circuit 11 for any selected period. Closing of the switch 15 causes the condenser 38 to rapidly discharge, there being a current flow through the switch 15, the lead 44, the element 18 and the lead 20. The negative potential impressed on the element 25 of the valve 12 during the positive half cycles is thus reduced allowing the potential in the anode circuit 13 to rise to a high value. This sudden increase in the potential in the circuit 13 operates the relay 10 and the relay in turn completes the controlled circuit 11. Simultaneously with the operation of the relay 10 the element 18 moves out of engagement with the contact 45 to remove the short circuit from the condenser 38 so that the condenser 38 may begin to recharge. The time required for the condenser 38 to regain its normal maximum charge is determined principally by the size of the condenser and the value of the resistances 39 and 40. The other factors determining the time necessary for the condenser 38 to recharge are the potential of the power supply for the circuit 14 and the impedance of the valve circuit between the cathode 23 and the control element 25. The relay 10 remains operated as the charge gradually builds up in the condenser 38. However, the potential in the relay circuit 13 slowly diminishes as the charge in the condenser 38 increases. When the charge or potential of the condenser 38 reaches a given value the anode current is diminished to a value that allows the relay element 18 to drop or return by the action of the means 18^a to its normal open condition. This, of course, opens the controlled circuit 11 and terminates the time delay operation of the device.

From the above it will be seen that the selected period of time delay action of the device is determined by the constants of the related circuits 13 and 14 including the resistance 40 and the condenser 38, either one or both of which may be variable to be set to change or vary the time delay period, as desired. If it is desired to open the controlled circuit 11 before the completion of the selected time delay period of operation of the device the switch 16 is operated to its first position to short-circuit the resistances 39 and 40 so that the condenser 38 receives its full charge rapidly to effect the restoration of the relay 10. The manual control switch 16 may be operated to its second position at any time to complete the circuit 11 and may be held in the second position to keep the circuit 11 closed as long as desired.

The following is a further explanation of the relationship and action of the elements of the device. The condenser 33 is connected in multiple with the resistance 32 by connecting one terminal of the condenser 33 to the lead 31 and the other terminal of the condenser to the lead 26. The phase relation of the potential drop across the resistance 32, which potential is applied to the circuit 13, is shifted with respect to the phase of the A. C. supply potential in accordance with the relative values of the resistance 32 and the con-

denser 33. The condenser 37 is connected in multiple with the resistance 36 by connecting one of its terminals to the lead 35 and the other to the lead 27. The phase relation of the potential drop across the resistance 36, which potential is applied to the circuit 14, is shifted with respect to the phase of the A. C. supply potential in accordance with the relative values of the resistance 36 and the condenser 37. Thus the relative values of the resistances 32 and 36 and of the condensers 33 and 37 determine the phase relations of the potentials applied to the circuits 13 and 14.

The phase relations of the potentials appearing at the elements 24 and 25 with respect to the cathode 23 of the valve 12, are the results of the phase relations of potentials applied to circuits 13 and 14, respectively, together with the effects of the circuit elements such as the relay coil 22, the condenser 29, the resistances 39 and 40 and the inter-electrode capacitances of the valve 12. If the relations of phases appearing at the valve elements 24 and 25 are opposite, the potential of the element 24 is maximum and negative during the negative half-cycles when the potential on the element 25 is maximum and positive. The space charge in the vicinity of the element 25 produced by the potential on the element 24 has a definite effect upon the impedance of the valve circuit between the cathode 23 and the control element 25, as described above, and therefore, has an effect upon the rate of charge of the condenser 38.

The condenser 33 has the effect of causing the potential in the circuit 13 to lag, thereby delaying the peak negative potential of the element 24 during the negative half cycles when the condenser 38 is receiving its charge. The effect is an acceleration of the charge rate.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims:

Having described my invention, I claim:

1. In an electrical timing device, an electron discharge device having a cathode, an anode and a control element, a source of alternating potential for the cathode, a circuit from said source to the anode, a relay connected in said circuit to be controlled by the anode current, a circuit from said source to the control element, means associated with the power source and affecting the phase relation of the potentials applied to said circuits so that the potentials imposed on the anode and control element are in opposite phase relations with respect to the cathode during some part of the cycle, a condenser in the last named circuit adapted to build up sufficient potential in the said last named circuit and control element to normally maintain the potential in the first named circuit so low that the relay is idle, means for momentarily discharging the condenser to cause operation of the relay, and means operated by the relay reestablishing the condenser in its charging relation so that the relay may remain operated for the period required for the condenser to build up its normal charge.

2. In an electrical timing device, an electron discharge device having a cathode, an anode and a control element, a source of A. C. potential for the said discharge device, a relay connected in the anode circuit to be controlled by the anode current, a control circuit from the control element, means for shifting the phase relation of the po-

tential of one of said circuits relative to the phase of the A. C. supply potential so that the potentials imposed on the anode and control element are in opposite phase relations with respect to the cathode during at least a part of the cycle, a condenser in the control circuit adapted to build up sufficient potential in the control circuit and control element to normally maintain the potential in the anode circuit so low that the relay is idle, a lead for shorting out the condenser, a switch for momentarily closing the circuit through said lead to discharge the condenser, and means operated by the relay for opening the circuit through said lead whereby the relay may be operated for the period required for the condenser to build up its normal charge whereby the switch is ineffective while the relay is operative.

3. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means for supplying the control electrode and the anode with alternating potentials in such a manner that the phase relations of the control electrode and the anode are opposite with respect to the cathode during at least a portion of the cycle, a condenser in the control circuit adapted to normally have a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, means for momentarily discharging the condenser to cause operation of the relay, and means operated by the relay reestablishing the condenser in its charging relation so that the relay is operated for the period required for the condenser to regain its normal charge.

4. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an A. C. power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials of opposite phase relations with respect to the cathode during at least a portion of the cycle, a condenser in the control circuit normally having a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, a variable resistance in the control circuit, manually operated means for momentarily discharging the condenser to cause operation of the relay, and means operated by the relay reestablishing the condenser in its charging relation so that the period of operation of the relay is determined by the period required for the condenser to regain its normal charge.

5. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source, a heating circuit from said source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials of opposite phase relations relative to the cathode during at least a portion of the cycle, said means including sets of multiple related condensers and resistances connected in series in the power source between the terminals of the cathode and the points of connection of the said cir-

cuits with the opposite sides of the power source, a condenser in the control circuit normally having a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, means for momentarily discharging the condenser to cause operation of the relay, and means operated upon actuation of the relay reestablishing the condenser in its charging relation in the control circuit so that the relay may remain operated for the period required for the condenser to regain its normal charge.

6. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials of opposite phase relations with respect to the cathode during a portion of the cycle, a condenser in the control circuit adapted to normally have a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, switch means for momentarily discharging the condenser to allow the relay to be operated, switch means operated by the relay reestablishing the condenser in its charging relation in the control circuit so that the relay remains operated for the period required for the condenser to regain its normal charge, and a resistance in the control circuit variable to change the time required for the condenser to build up its normal charge.

7. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials of opposite phase relations with respect to the cathode during a portion of the cycle, a condenser in the control circuit adapted to normally have a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, means for momentarily discharging the condenser to allow the relay to be operated, switch means operated by the relay reestablishing the condenser in its charging relation in the control circuit so that the relay remains operated for the period required for the condenser to regain its normal charge, a resistance in the control circuit variable to change the time required for the condenser to build up its normal charge, and means for shunting out the resistance to rapidly recharge the condenser to restore the relay.

8. In an electrical timing device, an electron discharge device having a cathode, an anode and a control element, a source of A. C. potential for the discharge device, a circuit from said source to the anode, a relay connected in said circuit to be controlled by the anode current, a circuit from said source to the control element, means for shifting the phase relation of the potential of one of said circuits relative to the phase of the potential of the power source so that the potentials imposed on the anode and control element are in opposite phase relations with respect to the cathode during a portion of the cycle, a condenser in the last named circuit adapted to build up suf-

ficient potential in the said last named circuit and control element to normally maintain the potential in the first named circuit so low that the relay is idle, means for adjusting the relay to change the potential required to maintain the relay in the operated condition, means for momentarily discharging the condenser so that the relay is operated, and means operated by the relay reestablishing the condenser in its charging relation so that the operating period of the relay is determined by the period required for the condenser to build up its normal charge.

9. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials of opposite phase relations with respect to the cathode during at least a portion of the cycle, said means including a carbon filament resistance element in the anode circuit to compensate for variations in the voltage of said source, a condenser in the control circuit adapted to normally have a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, means for shorting the condenser to cause operation of the relay by the anode circuit, and means operated by the relay reestablishing the condenser in its charging relation in the control circuit so that the time period the relay may remain operated is determined by the period required for the condenser to retain its normal charge.

10. An electrical time delay device comprising an electron discharge device having a cathode, an anode and a control electrode, an alternating current power source for the cathode, a circuit from the anode, a control circuit from the control electrode, a relay operable by the anode circuit, means associating the anode circuit and the control circuit with the power source so that the control electrode and the anode are supplied with alternating potentials which are of opposite phase relations with respect to the cathode during at least a portion of the cycle, said means including a condenser in series with the cathode to minimize anode current changes due to power source frequency variations, a condenser in the control circuit adapted to normally have a charge of such potential that the potential in the anode circuit is insufficient to operate the relay, means for discharging the last named condenser to cause operation of the relay by the anode circuit, and means operated by the relay reestablishing the condenser in its charging relation in the control circuit so that the time period the relay may remain operated is determined by the period required for the said last named condenser to regain its normal charge.

11. In a device of the character described, an electron discharge device having a cathode, an anode and a control element between the cathode and anode, a source of A. C. potential for the said device, a relay operated by the anode circuit, a condenser in the circuit of said control element, means for shifting the phase relation of the alternating potential of one of said circuits with respect to the alternating potential of the other of said circuits so that the potentials imposed on the anode and control element are opposite in their phase relations with respect to the cathode dur-

ing a part of the cycle whereby the potential of the charge in the condenser and the potential of the control circuit are normally sufficient to maintain the potential in the anode circuit at a low value where the relay is idle, means for discharging the condenser so that the relay is operated by the anode circuit potential, and means operated upon actuation of the relay reconditioning the condenser for charging by the potential of the anode circuit whereby the period of operation of the relay is determined by the period required to recharge the condenser to its normal state.

12. In a device of the character described, an electron discharge device having a cathode, an anode and a control element between the cathode and anode, a source of A. C. potential for the said device, a relay operated by the anode circuit, a condenser in the circuit of said control element, means for shifting the phase relation of the alternating potential of one of said circuits with respect to the alternating potential of the other of said circuits so that the potentials imposed on the anode and control element are opposite in their phase relations with respect to the cathode during a part of the cycle whereby the potential of the charge in the condenser and the potential of the control circuit are normally sufficient to maintain the potential in the anode circuit at a low value where the relay is idle, said means including a condenser and resistance of related values connected in multiple in one of said circuits, means for discharging the first mentioned condenser so that the relay is operated by the anode current, and means operated by the relay reestablishing the said first mentioned condenser

in its charging condition so that the period which the relay remains operated is dependent upon the period required to recharge the said first mentioned condenser.

13. In a device of the character described, an electron discharge device having a cathode, an anode and a control element between the cathode and anode, a source of A. C. potential for the said device, a relay operated by the anode circuit, a condenser in the circuit of said control element, means for shifting the phase relation of the alternating potential of one of said circuits with respect to the alternating potential of the other of said circuits so that the potentials imposed on the anode and control element are opposite in their phase relations with respect to the cathode during a part of the cycle whereby the potential of the charge in the condenser and the potential of the control circuit are normally sufficient to maintain the potential in the anode circuit at a low value where the relay is idle, said means including resistances connected in series with said circuits, and condensers connected in multiple with the resistances, the phase relation of the potential drops across the resistances being shifted relative to the phase of the said source, means for discharging the first mentioned condenser so that the relay is operated by the anode current, and means operated by the relay reestablishing the said first mentioned condenser in its charging condition so that the period which the relay remains operated is dependent upon the period required to recharge the said first mentioned condenser.

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