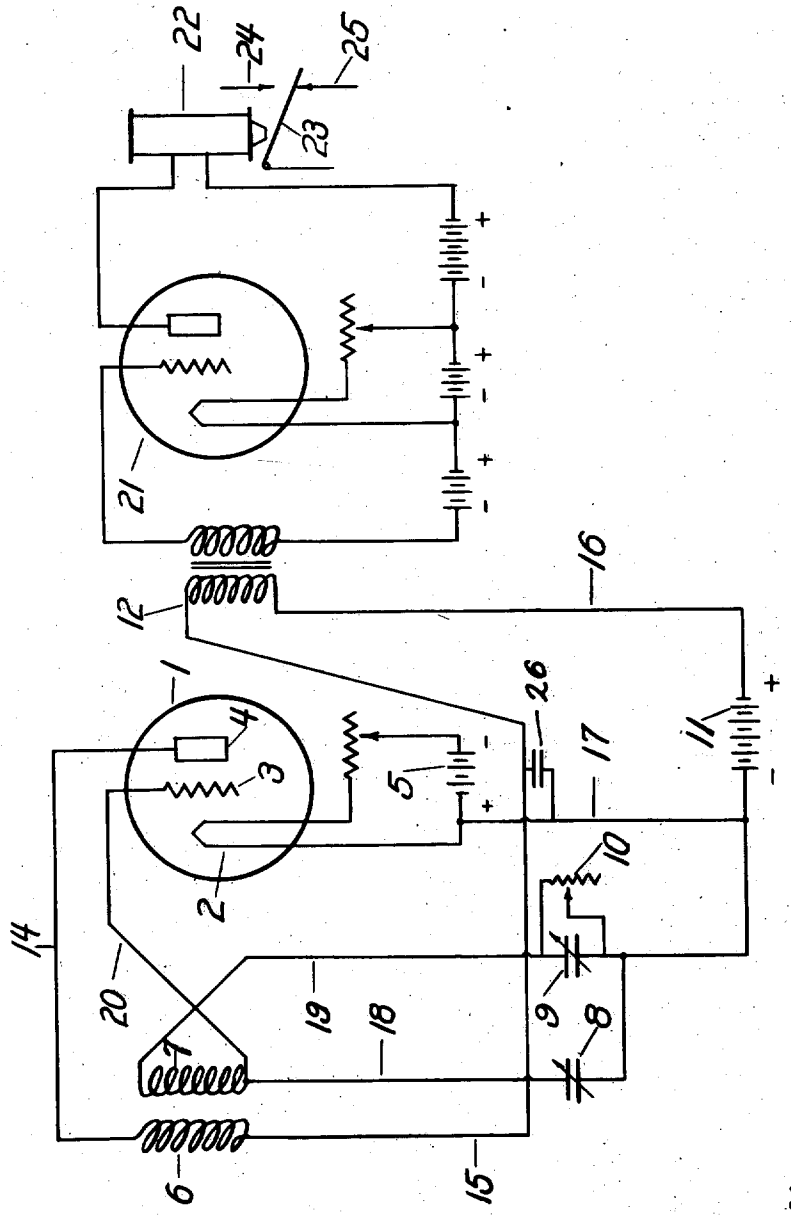
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VACUUM TUBE PERIODIC RELAY

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VACUUM TUBE PERIODIC RELAY

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This invention relates to thermionic control systems and more particularly to a device for cyclically opening and closing relay contacts at very low speeds.

Within limits, any desired period of opening and closing the relay can be obtained by a proper choice of the circuit parameters. Thus the system may be used in many adaptations, as for example the periodic switching on and off of electric signs, controlling the intermittent flashing of a beacon light or intermittently controlling the radiation from a radio beacon set.

The principal object of this invention is to provide a system for periodically opening and closing a set of relay contacts at any predetermined slow speed by means purely electrical without the advent of any moving mechanical parts.

Another object of this invention is to provide a system for periodically opening and closing a set of contacts that is both economical to construct and economical to operate. Other objects and advantages of this invention will appear from the detailed description and the drawing in which the single figure shows schematically a preferred embodiment of the invention.

In the drawing reference character 1 represents a thermionic tube having a cathode or filament 2, a control grid 3 and an anode or plate 4. The cathode 2 is shown connected so as to be energized by a battery or other appropriate source of potential 5. The control grid 3 is connected by means of the lead 20 to one end of a coil 7 constituting one of the windings of a transformer 6—7. The other end of the coil 7 is connected by means of lead 19 to one of the terminals of a condenser 9, the other terminal of which is connected through lead 17 to the cathode 2 of the tube. A resistance 10 is connected in shunt with the condenser 9. A condenser 8 is connected by means of leads 17 and 18 between the control grid 3 and the cathode 2. The plate or anode 4 of the thermionic tube 1 is connected by means of lead 14 to one end of the coil 6 of the transformer 6—7. The other end of the coil 6 is connected by means of lead 15 to one end of the primary winding of the iron cored audio frequency transformer 12. The other end of the primary winding of the transformer 12 is connected by means of the lead 16 to the positive terminal of a battery or other appropriate source of anode potential 11. The negative terminal of the source of potential 11 is connected by way of lead 17 to the cathode 2. The secondary winding of the transformer 12 is appropriately connected to the input electrodes of the amplifying thermionic tube 21 while the relay 22 is connected to be energized by current flow in said tube. Armature 23 controlled by the relay 22 is adapted to be connected to either contact 24 or 25 depending upon the energization of the relay 22.

The above description has dealt only with the actual circuit connections, the parameters of the circuit components will now be dealt with. With a vacuum tube of the type quite generally known as a 112 employed in the oscillator circuit (tube 1) with a potential of approximately 90 volts impressed at 11 and with winding 6 of the transformer 6—7 consisting of approximately 54 turns of No. 26 single covered silk wire wound into a coil 2½ inches in diameter and 2½ inches long closely coupled to coil 7 consisting of approximately 63 turns of No. 22 single covered silk wire wound into a coil 3 inches in diameter and 2½ inches long and with a condenser of .0005 microfarad connected at 8 and a condenser of 2 microfarads connected at 9 shunted by a resistance of 2 megohms at 10 the circuit will have a time constant of approximately seven seconds, that is, seven seconds will elapse between successive energizations or deenergizations of the relay 22. With a resistance of 1 megohm at 10 and with the other circuit parameters as above the time constant of the system will be approximately one second. Variation of the time constant of the system can also be obtained by varying the capacities of the condensers 8 and/or 9 or by varying them or either of them simultaneously with a variation of the resistance 10.

By varying the condensers 8 and 9 and omitting the resistance 10 very low speeds result, a time constant of over two minutes has been attained. This form of control is only efficient over a period of several hours. As the grid of the osc. tube becomes more and more highly charged the time constant gradually becomes greater.

Using the resistance 10 together with proper condensers at 8 and 9 the timing is highly efficient. A relay circuit built exactly as shown in the drawing should run indefinitely at the set time constant. A relay in operation continuously for over fifty hours showed absolutely no measurable change in time constant.

The exact theory of operation of the system is not definitely known although it is believed that the system functions as follows: With the energization of the cathode 2 a great swarm of electrons is drawn over to the anode 4 under the influence of the source of anode potential 11. This gives rise to a current surge in the coil 6 of transformer 6—7 and causes a potential to build up

across the coil 7. This potential quickly charges the condenser 8, which is of relatively small capacity, by way of leads 18 and 19 and the condenser 9 which is of relatively great capacity. Since coil 7 and condenser 8 constitute a tuned resonant circuit it is apparent that the potential of the control electrode 3 connected to one end of said coil is excited cyclically at a frequency determined by the L C constants of the circuit as a result of the initial surge of current in the coil 7. This cyclic variation of the potential of the control electrode of the tube causes the anode current to have a component which varies at that frequency. This varying anode current causes the oscillations to persist due to the transformer action at 6—7. However, as the oscillation persists the average value of the anode current decreases due to the accumulation of electrons on the control grid forcing its average potential more negative until ultimately the control grid becomes so highly charged that oscillations cease. Before oscillations can begin again the charge on the control grid 3 must leak off by way of the resistance 10. As this takes place the anode current gradually increases until the generation of oscillations starts again at which time the foregoing cycle is repeated.

The slow variation of the average current in the anode circuit causes a slow variation of the potential that is induced in the secondary of the transformer 12. Thus the value of the anode current through the relay 22 is slow to change and hence the relay 22 only energizes or deenergizes at such times as the average anode current of the tube 1 is increasing or decreasing depending upon the connection of transformer 12.

For the purpose of simplicity the drawing shows the source of cathode and anode potentials as being batteries and the thermionic tubes shown are simple triodes; however it is to be clearly understood that alternating current may be used to energize the cathodes of the tubes and that any desired source of direct current may be used to supply the anode potential. Other tubes than the ones disclosed may be used as for example heater type tubes and/or tubes with screening grids and the like, also impedance coupling of appropriate type may be used in lieu of the transformer 12. When the source of potential 11 and the primary of the transformer 12 are lacking in sufficient distributed capacity to make the system function properly a by-pass condenser should be connected as shown at 26 between leads 15 and 17.

The novel features and the operation of this device will be apparent from the foregoing description. While the device has been shown and the structure described in detail, it is obvious that this is not to be considered limited to the exact form disclosed and that changes may be made therein within the scope of what is claimed without departing from the spirit of the invention.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

1. A system for producing a relatively low frequency variation of the average current in the primary winding of a transformer comprising a thermionic tube having a cathode, an anode and a control electrode, a source of potential connected so as to energize said cathode, a source of anode potential, an inductance coil, means connecting said source of anode potential, the primary winding of said transformer and the inductance coil in series between the cathode and the anode of said tube, a second inductance coil closely coupled to said first mentioned inductance coil, a condenser of relatively small capacity, a condenser of relatively large capacity shunted by a resistance of relatively large size, means connecting the condenser of relatively small capacity between the control electrode and the cathode of said tube, means connecting one of the ends of said second inductance coil to the control electrode, and means connecting the other end of said second inductance coil to the cathode of said tube, said last means including the condenser of relatively large capacity shunted by said resistance of relatively large size, whereby the potentials induced in the secondary of said transformer are of relatively low frequency.

2. A system for producing a relatively low frequency variation of the average current in the primary winding of a transformer comprising a thermionic tube having a cathode, an anode and a control electrode, a source of potential connected so as to energize said cathode, a source of anode potential, an inductance coil, means connecting said source of anode potential the primary winding of said transformer and the inductance coil in series beween the cathode and the anode of said tube, a second inductance coil closely coupled to said first mentioned inductance coil, a condenser of relatively small capacity, a condenser of relatively large capacity shunted by a resistance of relatively large size, means connecting the condenser of relatively small capacity between the control electrode and the cathode of said tube, means connecting one of the ends of said second inductance coil to the control electrode, and means connecting the other end of said second inductance coil to the cathode of said tube, said last means including the condenser of relatively large capacity shunted by said resistance of relatively large size, and means for selectively adjusting the sizes of the said condensers and the resistance value of said resistance connected in shunt with one of said condensers whereby the potentials induced in the secondary of said transformer may be varied as to frequency.

3. An electron tube system for cyclically energizing a relay at a very slow rate comprising a three element tube having an oscillatory circuit included between the cathode and one of the other elements thereof, a second circuit closely coupled to said oscillatory circuit included between the cathode and the remaining element thereof, a condenser of relatively large capacity shunted by a variable resistance of relatively large size connected between the control electrode and the cathode thereof, an impedance included in the anode circuit, and means for utilizing the slow variation in the average value of the current in said impedance for controlling the energization and deenergization of said relay.

4. An electron tube system for cyclically energizing a relay at a very slow rate comprising a three element tube having an oscillatory circuit included between the cathode and one of the other elements thereof, a second circuit closely coupled to said oscillatory circuit included between the cathode and the remaining element thereof, a condenser of relatively large capacity shunted by a variable resistance of relatively large size connected between the control electrode and the cathode thereof, an audio frequency transformer, means connecting the primary winding of said transformer in the anode circuit of said tube, an audio frequency amplifier having its input circuit connected to the secondary of said transformer and a relay included in the output circuit of said amplifier.

5. An electron tube system for cyclically energizing a relay at a very slow rate comprising a three element tube having an oscillatory circuit included between the cathode and one of the other elements thereof, a second circuit closely coupled to said oscillatory circuit included between the cathode and the remaining element thereof, a condenser of relatively large capacity shunted by a variable resistance of relatively large size connected between the control electrode and the cathode thereof, an audio frequency transformer, means connecting the primary winding of said transformer in the anode circuit of said tube, an audio frequency amplifier having its input circuit connected to the secondary of said transformer and a relay included in the output circuit of said amplifier whereby the current in said relay changes as the average value of the anode current in said three element tube changes.

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