

**Dec. 19, 1950**

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ELECTRONIC TIMER

Filed July 9, 1945

**2,534,299**

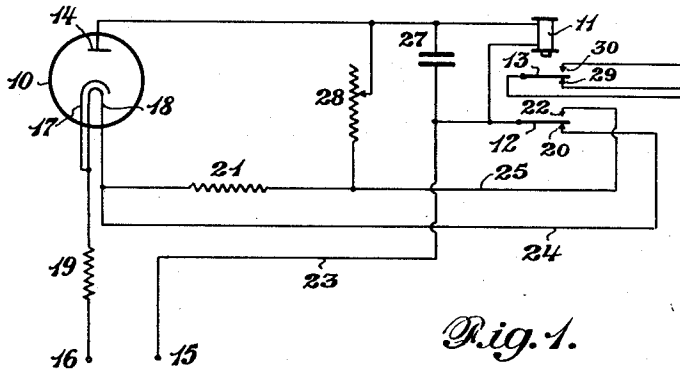
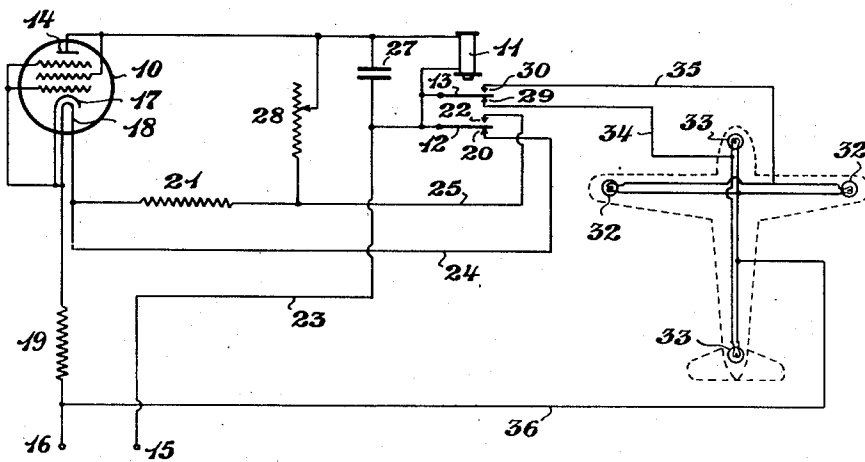


*Fig. 1.*



*Rig. 2.*

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## UNITED STATES PATENT OFFICE

2,534,299

## ELECTRONIC TIMER

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Application July 9, 1945; Serial No. 604,002

6 Claims. (Cl. 250-27)

(Granted under the act of March 3, 1883, as  
amended April 30, 1928; 370 O. G. 757)

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This invention relates to electronic timers of the type providing periodic switch actuation. The invention utilizes a thermionic tube adapted to periodically become conductive and substantially non-conductive at a rate determined primarily by the heating and cooling times for the cathode of the tube.

An object of the invention is to provide a simple, lightweight and inexpensive timing device which is adaptable to intermittent circuit control, such as a flashing signal control.

Timing devices known in the art are subject to various limitations and disadvantages. The system according to this invention uses negligible power, is capable of controlling relatively large loads, is light in weight, small, simple, and inexpensive, retains the original setting, may be readily adjusted to produce equal "on" and "off" periods or other conditions, and is operative on alternating or direct current of various voltages with little or no modification. The operation of this invention depends upon the periodic actuation of a relay in accordance with changes in conductance of a thermionic tube, the changes in conductance being initiated by changing the resistance in the heater circuit of the tube by the use of a switch comprising a part of the relay.

Further objects and advantages of the invention will be apparent from the following description when taken in conjunction with the drawings, of which:

Fig. 1 is a diagrammatic view of the preferred embodiment of a timer according to the invention; and

Fig. 2 is a diagrammatic view of a modification of the timer of the invention as applied to blinking running lights on an aircraft.

The timer of the invention shown in Fig. 1 comprises a thermionic diode tube 10 and a double-pole and double-throw relay including a solenoid actuating coil 11 and movable contacts 12 and 13. Anode 14 of diode tube 10 is connected through coil 11 to one power supply terminal 15, and cathode 17 is connected to the other power supply terminal 16 through a resistor 19. Power for these terminals may be alternating current, or it may be direct current. If direct current is used, terminal 16 should be negative and 15 should be positive in potential, causing a positive potential to be applied to anode 14. Heater filament 18 of the tube is connected at one end through current limiting resistor 19 to terminal 16, and at the other end to stationary contact 20 and through a resistor 21 to stationary contact 22. Movable contact 12 is in engagement with

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stationary contact 20 when the relay is in dropped out or deenergized position to provide current for the filament from terminal 15 through conductor 23; movable contact 12, stationary contact 20; conductor 24, filament 18; and resistor 19 to terminal 16. When the relay picks up or is energized, a substantially reduced current is provided through stationary contact 22, conductor 25, and resistor 21, the resistor serving to limit the current to a value less than normal rated heater filament current for the type of tube used. A condenser 27 is connected in parallel with solenoid coil 11, and a variable resistor 28 is connected from anode 14 to conductor 25 to act as a short-circuiting resistor across condenser 27 when the relay is picked up.

Additional stationary contacts 29 and 30 are shown adapted to be engaged by movable contact 13 to control an external circuit.

In operation when power is applied to terminals 15 and 16, substantially rated current flows through filament 18, the current being limited by resistor 19 to the rated value. Of course, if substantially rated filament voltage is applied to terminals 15 and 16, resistor 19 may be omitted. As the cathode 17 is heated by the filament to emissive temperature, tube 10 becomes conductive causing a current to flow from terminal 15 through coil 11 to anode 14. As the conductance becomes higher, the current increases until the relay picks up. If the power supplied is alternating current, it will be rectified by the action of the tube; consequently, only unidirectional current will flow through coil 11, whether a direct or alternating current source is provided. Condenser 27 will become charged to the potential appearing across coil 11 as the current increases. When the relay picks up, engaging movable contact 12 with stationary contact 22, the filament connections are changed by the insertion of an additional filament current limiting resistor 21 which reduces the filament current to a value insufficient to maintain the cathode at emissive temperature. As the cathode cools, the conductance of the tube is decreased until, after a period of time, the current through the tube decreases to a value insufficient to maintain the picked-up condition of the relay. The condenser discharges through the relay coil as the current through the tube decreases to maintain the relay picked-up until the tube current is considerably less than hold-in current for the relay. Variable resistor 28 may be provided to adjust the discharge time of the condenser 27; a low resistance value for resistor 28 causing more rapid drop-out of the

relay. The inclusion of resistor 28 is not essential to the proper operation of the invention, however, merely furnishing a convenient and novel control device for the timer.

The choice of a tube to use in the timer will depend primarily on the time constant desired and to a lesser extent on the voltage, the current requirements of the relay coil, cost, ruggedness required, and whether alternating or direct current power is supplied. It has been found as to the time constant that a period for the "on"- "off" cycle as low as one-eighth of a second will result from the use of a filamentary cathode tube of the type designed primarily for battery operation in which the mass of the filament is very small and the filament may be quickly heated and cooled, whereas a tube with a separate, relatively heavy cathode of the type requiring 117 volt alternating or direct current as a filament supply may give a time cycle of 4 or 5 seconds or more. By properly selecting the value of resistor 19, substantially any type of thermionic tube with a filament acting as a heater for a thermionic emissive surface, and with an anode, may be successfully utilized, and a different time cycle may be obtained by using a different type of tube. The capacity of condenser 27 will also effect the time constant to an important extent.

Fig. 2 discloses a modified arrangement of the device described as applied to the control of blinking aircraft running lights. A tube 10 is shown of a type provided with a control grid, a suppressor grid and a screen grid, the control and suppressor grids being connected to the cathode 17, and the screen grid being connected to the anode 14 in a well known manner to cause the tube to act as a diode. The circuit is substantially the equivalent of that shown in Fig. 1, except that additional connections are shown from stationary contacts 29 and 30, respectively, to the fore-and-aft and wing tip running lights of an airplane, being so arranged that when relay contact 13 is dropped out into engagement with contact 29 current is provided from power terminal 15 through conductor 23, movable contact 13, stationary contact 29, and conductor 34 to the fore-and-aft lights 32 and thence through conductor 36 to power terminal 16, whereas when the relay picks up movable contact 13 into engagement with stationary contact 30 current is provided through conductor 35 to the wing tip lights 32 and thence to conductor 36 and terminal 16. As previously explained, the relay picks up and drops-out at a constant rate while the timer is operative, which in this case will cause first the fore-and-aft lights to come "on," then go "off" as the wing lights come "on," the cycles continuing indefinitely at the constant rate determined by the timer of the invention.

If it is desired to increase the anode-cathode potential of the tube in either Fig. 1 or Fig. 2, the potential drop in resistor 19 may be eliminated by connecting cathode 17 directly to power terminal 16 instead of to the filament end of resistor 19. Alternatively, resistor 19 may be omitted by connecting the filament and cathode directly to terminal 16 and inserting a suitable filament current limiting resistor in series in conductor 24 or in series between conductor 23 and movable relay contact 12.

The timer is particularly adapted to aircraft applications because of the light weight, the sturdiness, ease of adjustment, and small power requirements of the device, and because the time periods remain substantially constant

through atmospheric temperature or pressure changes. Ordinary dirt and moisture will not affect the operation of the timer. The device is also adaptable to the control of blinking signal lights at sea or ashore or to the control of an electrical circuit for many other types of signaling or other apparatus where it is desired to alternately "make" and "break" one or more circuits at a constant rate. The timer may replace motor-driven cam-operated switches and similar equipment at a saving in cost, weight and simplicity, and with more reliable and accurate operation.

It is immaterial to the practice of this invention whether the cathode of the tube comprises a separate sleeve surrounding the filament or constitutes the electron emissive surface of the filament itself. Thus, the cathode shown as element 17 in Fig. 1 may be a sleeve type indirectly heated cathode connected externally to one terminal of filament 18 or the element 17 may be the surface of the filament and form a part thereof. It is to be noted that wherever the term "cathode" is used in the appended claims, the term is intended to cover either type of thermionic emissive surface, either an indirectly heated sleeve or the directly heated filament surface.

While we have shown a particular embodiment of our invention, it will be understood, of course, that we do not wish to be limited thereto, since many modifications may be made, and we, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An electronic timer comprising a thermionic tube having an anode and a cathode with a heating filament, a relay connected to the anode and responsive to changes in the conductance of the tube, a two contact switch operated by the relay, each contact being included in a separate circuit including the filament, one circuit including a resistance, and a condenser connected in parallel with the relay, and the condenser and relay in parallel being connected in series with that one of the filament heating circuits closed by the corresponding switch contact, the said relay switch circuits alternately increasing and decreasing the conductance of the tube by respectively heating and cooling the cathode, and the condenser causing the operation of the relay to lag behind changes in the conductance of the tube.

2. An electronic timer comprising a thermionic tube having an anode, a cathode, and a heating filament for the cathode, a relay connected to the anode and responsive to changes in conductance of the tube, switch means operated by the relay and including electrical circuits opened and closed thereby, one circuit including a resistance in circuit with the heating filament, another of said circuits including only the filament, the two circuits being alternately closed and opened for alternately increasing and decreasing the conductance of the tube by respectively heating and cooling the cathode, a condenser connected in parallel with the relay for causing a lag in the relay operation, and a variable resistance connected in the said resistance circuit and to the

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anode connection of the relay for adjusting the discharge time of the condenser to vary the lag thereof.

3. In an electronic timer, a thermionic tube having an anode and a cathode, a relay connected to said anode and responsive to changes in the conductance of said tube, a source of energy for heating said cathode, a circuit including a resistor connectable between said source and said cathode for supplying energy from said source to said cathode, and switch means actuated by said relay for connecting said circuit between said source and said cathode.

4. In an electronic timer, a thermionic tube having an anode and a cathode, a relay connected to said anode and responsive to changes in the conductance of said tube, a source of energy for heating said cathode, a pair of circuits connectable between said source and said cathode for supplying energy from said source to said cathode, one of said circuits including a resistor, and switch means automatically operable upon energization of said relay for connecting said one circuit between said source and said cathode, and upon deenergization of said relay for connecting the other of said circuits between said source and said cathode, whereby the conductance of said tube is alternately increased and decreased to thereby alternately actuate and deactuate said relay.

5. In an electronic timer, a thermionic tube having an anode and a cathode, electromagnetic means connected to said anode and responsive to changes in the conductance of said tube, a source of energy for heating said cathode, a first circuit connected between said source and said cathode for supplying a predetermined amount of energy to said cathode, a second circuit including a resistor connectable between said source and said cathode for supplying a smaller amount of energy to said cathode, said smaller amount being insufficient to maintain said cathode at emissive temperature, and switch means responsive to the energization of said electromagnetic means for

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simultaneously breaking said first circuit and completing said second circuit.

6. In an electronic timer, a thermionic tube having an anode circuit and a cathode, electromagnetic means connected in said anode circuit and responsive to the current flow therein, a source of energy for heating said cathode, first circuit means connectable between said source and said cathode for supplying to said cathode an amount of energy sufficient to maintain a current flow in said anode circuit which will energize said electromagnetic means, second circuit means connectable between said source and said cathode for supplying to said cathode a smaller amount of energy than the first-named amount, said smaller amount being insufficient to maintain the current flow in said anode circuit necessary to energize said electromagnetic means, and switch means responsive to energization of said electromagnetic means for simultaneously connecting said second circuit means and maintaining said first circuit means disconnected, said switch means being operable to connect said first circuit means and to maintain said second circuit means disconnected when said electromagnetic means is deenergized.

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