Dec. 1, 1936. C. STANSBURY 2,062,616

ELECTRONIC TIMER

Filed July 5, 1934

Fig. 1

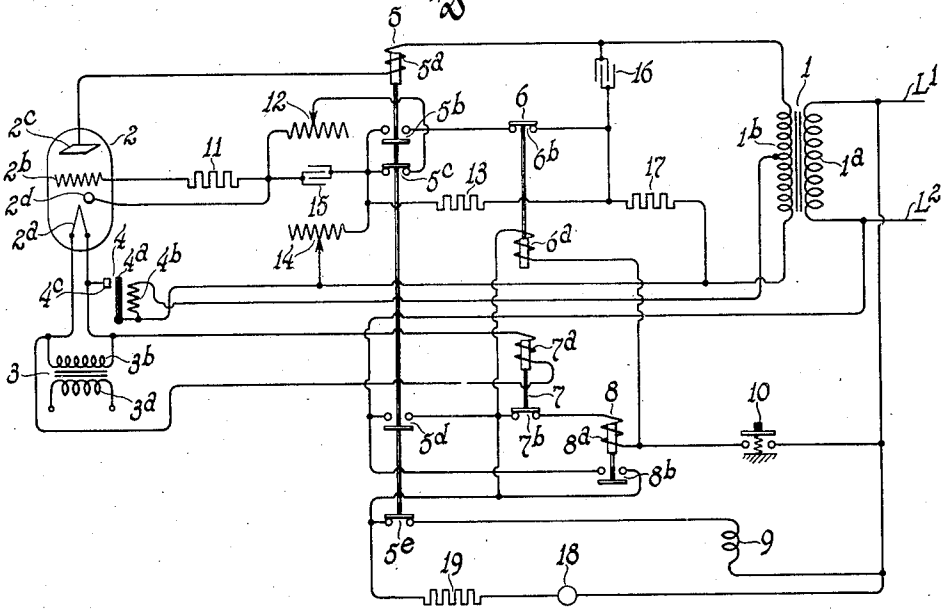
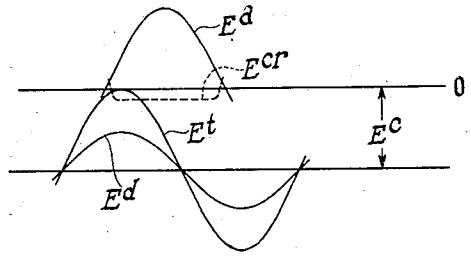


Fig. 2



Inventor
Carroll Stansbury
By Towle & Hubbard
Attorneys

Patented Dec. 1, 1936

2,062,616

UNITED STATES PATENT OFFICE

2,062,616

ELECTRONIC TIMER

Carroll Stansbury, Wauwatosa, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Application July 5, 1934, Serial No. 733,721

6 Claims. (Cl. 250—27)

This invention relates to electron tube timing devices. An object of the invention is to provide for greater accuracy of the period during which current is supplied to an electric translating device especially where the period is of short duration.

Another object is to provide a system in which the period of current supply is accurately adjustable.

Another object is to provide a system in which the application of plate voltage to the electronic tube is prevented until the tube has reached its operating temperature.

Another object is to provide a system comprising a gaseous electron tube through which current conduction when desired is initiated substantially at the beginning of the positive half cycle of the plate voltage.

Various other objects and advantages will hereinafter appear.

The system comprises a transformer 1, having a primary winding 1^a which is supplied with current from the terminals L^1 and L^2 of an alternating current circuit, and a secondary winding 1^b. Connected to the transformer secondary winding in a manner to be hereinafter described is a gaseous electron discharge tube 2 having a cathode 2^a, a grid 2^b, an anode 2^c and an auxiliary anode 2^d. The electron tube 2 is of the type disclosed in my Patent No. 1,940,029.

A transformer 3 having a primary winding 3^a which may be connected to any desired source of alternating current has a secondary winding 3^b connected to the cathode 2^a to supply heating current thereto. A relay 4 consisting of a bimetallic strip 4^a, a heater resistor 4^b and a contact 4^c controls the application of plate voltage to the tube 2. The heater resistor 4^b is connected across part or all of the secondary winding 1^b to obtain heating current therefrom. The heater is mounted adjacent to the bimetallic strip 4^a and after a certain lapse of time it causes the strip to be deflected so as to make contact with the stationary contact 4^c. Connected between the plate 2^c and the winding 1^b is the coil 5^a of a relay 5 which has normally open contacts 5^b and 5^d and normally closed contacts 5^c and 5^e. When the tube is conducting a current flows from one terminal of the secondary winding 1^b through the bimetallic strip 4^a, contact 4^c, filament 2^a, plate 2^c, winding 5^a back to the other terminal of the winding 1^b and thus relay 5 is energized and commutates the aforementioned contacts. The system also contains a relay 6 having a winding 6^a and a normally closed contact 6^b, a relay 7 having winding 7^a and a normally closed contact 7^b, and a relay 8 having winding 8^a and a normally open contact 8^b. A normally open push button 10 is provided for the initiation of completion of the circuit to a translating device 9 which may be the magnet winding of a switch controlling the current supply to a consuming device or which may be the consuming device itself.

Connected to the grid 2^b is one terminal of a resistor 11, the other terminal of which is connected to the auxiliary anode 2^d and also to one terminal of a variable resistor 12, the other terminal of said latter resistor being connected to the normally closed contact 5^e. The other side of said contact is connected to one terminal of a resistor 13 and also to one terminal of a condenser 15, the other terminal of which is connected to the auxiliary anode 2^b. The first mentioned terminal of condenser 15 is also connected to one terminal of an adjustable resistor 14, the other terminal of which is connected to one terminal of the winding 1^b. The free terminal of the resistor 13 is connected to contact 6^b and also to the common terminal of a condenser 16 and a resistor 17, the free ends of which are respectively connected to the terminals of the winding 1^b. One terminal of the normally closed contacts 6^b is connected to one terminal of the normally open contact 5^b, the other terminal of the latter being connected to the common point of the resistors 14 and 13 and the condenser 15. The relay winding 7^a is connected across the secondary winding 3^b so that it receives current when the cathode is energized. One side of the normally open contact 5^d is connected to the line L^2, the other side being connected to the winding 6^a which, in turn, is connected in series with the push button 10 to the line L^1. One side of the normally closed contact 5^e is connected to the common terminal of the normally open contact 5^d and the coil 6^a, while the other side of said contact 5^e is connected in series with the translating device 9 to the line L^1. A resistor 19 in series with a neon lamp 18 is connected in shunt with the contact 5^e and the translating device 9. One side of the normally closed contact 7^b is connected to the common point of the contact 5^d and the coil 6^a, while the other side is connected through the coil 8^a to the common terminal of the push button 10 and the coil 6^a.

The system operates as follows:

If it is desired to supply power to the translating device 9 the lines L^1 and L^2 and the transformer winding 3^a are energized. Current is then supplied through winding 3^b to the cathode

2^a to heat the latter. At the same time current is supplied to the heating resistor 4^b and after a certain lapse of time the contact 4^c is closed. As the grid 2^b is at zero potential, current can flow from one terminal of the transformer winding 1^b through the bimetallic strip 4^a, contact 4^c, the cathode 2^a, anode 2^c through the relay coil 5^a, back to the winding 1^b, thus energizing relay 5.

When the relay 5 is energized, it closes its auxiliary contacts 5^b and 5^d. The closure of contacts 5^b permits the flow of electrons from the cathode 2^a to the grid 2^b and auxiliary anode 2^d during the positive half cycle of the alternating voltage which is impressed upon the resistor 17 by the transformer winding 1^b so that the condenser plate 15 which is in series with the grid is charged up to a negative potential with respect to the cathode corresponding to the peak value of the alternating current voltage drop across the resistor 17, the negative current flowing from one terminal of the winding 1^b through the thermal relay 4, cathode 2^a, anode 2^d, condenser 15, contacts 5^b and 6^b to the junction of the condenser 16 and the resistor 17. The function of the condenser 16 is to advance the phase of the voltage applied across the resistor 17 with reference to the anode voltage of the tube 2. Thus the condenser 15 is charged. If now the push button 10 is operated, the relay 8 is energized by current flowing from line L^1 through push button 10, relay coil 8^a, contact 7^b, contact 5^d to line L^2. Circuit is also completed from line L^1 over push button 10, relay coil 6^a, contact 5^d to line L^2, so that the normally closed contact 6^b is opened. This disconnects the condenser 15 from the resistor 17.

Prior to the opening of the contact 6^b the tube 2 was conducting during each positive half cycle in spite of the fact that a negative charge accumulated on the plate 15^a of the condenser 15. This charge in itself would have made the grid sufficiently negative to prevent the tube from conducting, but the alternating voltage drop across the resistor 17 reduces this negative voltage during each positive half cycle to a value which is less negative than the critical grid voltage so that the tube actually does conduct. Fig. 2 illustrates this condition. Assuming that the cathode potential be zero, then the voltage E^a is substantially the voltage impressed by the transformer winding 1^b upon the relay coil 5^a and the anode circuit of the tube. Prior to the starting of a timing period the potential across the condenser 15 which has been charged as aforedescribed is E^c and superimposed to this condenser potential in the grid circuit is an alternating voltage E^t. As this is the voltage which charges up the condenser 15, its peak value is substantially equal and opposite to the charge of the condenser 15. As a result the potential of the grid 2^b is reduced to approximately zero at substantially the beginning of the positive half cycle of the anode voltage on the tube so that the tube becomes conducting. After the contact 6^b has opened the alternating component of the potential of the condenser plate 15^b and thus that of plate 15^a relative to the potential of the cathode is determined by the ratio of the resistors 13 and 14 which are connected in parallel with the resistor 17. This potential is designated as E^d in Fig. 2. It is evident that as illustrated this grid voltage is not any more sufficiently high to make the tube conducting during the positive half cycle succeeding the opening of the contact 16. The interruption of current through the tube deenergizes the relay 5 and thus starts a timing period. In dropping back the relay closes a circuit for the condenser 15 through the discharge resistance 12 but the tube remains non-conducting until the condenser has discharged through said resistance 12 to an amount which will reduce the potential E^c and thus the negative potential of the grid 2^b so that the tube can again become conducting, that is, until the negative condenser voltage less the peak voltage of the drop through the resistor 14 is more positive than the critical voltage.

The phase shifting connection consisting of the condenser 16 and the resistor 17 makes it possible to advance the phase of the voltages E^d and/or E^t relative to the voltage E^a so that conduction starts substantially at the beginning of the positive half cycle instead of the middle of the positive half cycle as would be the case without any phase shifting connection. Thus a much more positive action of the relay 5 is obtained.

When the relay 5 is de-energized while the relay 8 is energized as aforedescribed, a circuit is completed for the translating device 9. Thus the translating circuit is supplied with current for a definite period of time immediately upon closure of the push button 10. By varying the resistor 12 the discharge rate of condenser 15 may be varied and thus the period during which current is supplied to the translating device.

The use of the supplemental anode 2^d greatly improves the accuracy of the timing circuit as it prevents the partial discharge of the condenser 15 through the arc between the cathode and anode of the tube 2. As disclosed in my aforementioned application, the auxiliary anode does not tend to discharge during the positive half cycle, because it is out of the path of the arc, in contrast to the location of the grid. Thus the loss of charge due to this phenomenon is made up by the auxiliary anode 2^d which during each positive half cycle recharges condenser plate 15^a to the initial potential as outlined heretofore. The resistor 11 is of such value as to further prevent a substantial loss of charge of the condenser 15 between succeeding charging half cycles.

The transformer 3 has preferably a wide variation of voltage between no load and full load so that upon burning out of the cathode 2^a the voltage on the secondary winding 3^b rises. By adjusting the relay winding 7^a so that it picks up and opens the contact 7^b upon attainment of said higher voltage, the equipment is protected against faulty operation upon the burning out of the cathode 2^a.

Instead of employing a tube with an auxiliary anode, as described, it is obvious that in its place a separate rectifier, having its anode connected to the circuit in place of 2^d and its cathode connected to the cathode 2^a may be employed with the same results as heretofore described.

What I claim as new and desire to secure by Letters Patent is:

1. A gaseous electron discharge tube having a cathode, an anode, an auxiliary anode and a control electrode, means to impress an alternating potential on said cathode and anode, an energy storage circuit connected to said cathode and control electrode and adapted to impress upon said control electrode a unidirectional potential derived from said auxiliary anode to render said tube non-conducting during the positive half cycle of said alternating potential, and means to superimpose upon said unidirectional potential an alternating potential whose maximum amplitude coincides substantially with the beginning of the positive half cycle of the first named al-

ternating potential to render the tube conducting during said half cycle.

2. In combination with a translating device to be supplied with energy from a source for a given period, a gaseous electron discharge tube having a cathode, an anode, an auxiliary anode and a control electrode, means to connect said cathode and anode to said source and to impress an alternating potential thereupon, an adjustable electrostatic energy storage discharge circuit connected to said cathode and control electrode and adapted to impress upon said control electrode a unidirectional potential derived from said auxiliary anode to render said tube non-conducting during the positive half cycle of said alternating potential and to supply energy to said device during said given period, and means to superimpose upon said unidirectional potential an adjustable alternating potential, leading said first-mentioned alternating potential by substantially 90 degrees and adapted to render the tube conducting during said half cycle and to prevent current supply to said device.

3. In combination with a translating device to be supplied with energy from a source for a given period, a gaseous electron discharge tube having a cathode, an anode, an auxiliary anode and a control electrode, means to connect said cathode and anode to said source and to impress an alternating potential thereupon, an adjustable electrostatic energy storage discharge circuit connected to said electrodes and adapted to impress upon said control electrode a unidirectional potential derived from said auxiliary anode to render said tube non-conducting during the positive half cycle of said alternating potential and to supply energy to said device during said given period, and means to superimpose upon said unidirectional potential an adjustable alternating potential, leading said first-mentioned alternating potential by substantially 90 degrees and adapted to render the tube conducting during said half cycle and to prevent current supply to said device, and means having a time function to delay the connection of said first mentioned alternating potential to said tube for a given interval.

4. In combination, an alternating current source, a gaseous electron discharge tube having a cathode, an anode and a control grid, means to connect said cathode and anode in circuit with said source, a condenser connected to said grid, means to charge said condenser and impress a unidirectional potential upon said grid to maintain said tube non-conducting, means to superimpose upon said unidirectional potential an adjustable alternating potential leading the potential of said source by substantially 90°, the maximum amplitude of said last mentioned alternating potential being of a magnitude to render the tube conducting, means to reduce said alternating potential to render the tube non-conducting and adjustable means responsive to stoppage of current flow in said tube to very said unidirectional potential to again render the tube conducting and to restore said unidirectional and superimposed potentials.

5. In combination with a translating device to be supplied with energy for a given period, an alternating current source, a gaseous electron discharge tube having a cathode, an anode and a control grid and adapted to control the energy supply to said translating device, means to connect said cathode and anode in circuit with said source and said translating device, a condenser connected to said grid, means to charge said condenser and to impress a unidirectional potential upon said grid to maintain said tube non-conducting, means to superimpose upon said unidirectional potential an adjustable alternating potential leading the potential of said source by substantially 90°, the maximum amplitude of said superimposed potential being of a magnitude to render the tube conducting which effects stoppage of current supply to said translating device, means to reduce said superimposed alternating potential to render the tube non-conducting and to supply energy to said translating device and adjustable means responsive to the stoppage of current flow in said tube to vary said unidirectional potential to again render the tube conducting and to restore said unidirectional and superimposed potentials.

6. In combination with a translating device to be supplied with energy for a given period, an alternating current source, a gaseous electron discharge tube having a cathode, an anode and a control grid and adapted to control the energy supply to said translating device, means to connect said cathode and anode in circuit with said source and said translating device, a condenser connected to said grid, means to charge said condenser and to impress a unidirectional potential upon said grid to maintain said tube non-conducting, means to superimpose upon said unidirectional potential an adjustable alternating potential leading the potential of said source by substantially 90°, the maximum amplitude of said superimposed potential being of a magnitude to render the tube conducting which effects stoppage of current supply to said translating device, means to reduce said superimposed alternating potential to render the tube non-conducting for a given period and to supply energy to said translating device and adjustable means responsive to the stoppage of current flow in said tube to vary said unidirectional potential to again render the tube conducting and to restore said unidirectional and superimposed potentials.

CARROLL STANSBURY.