July 12, 1932. J. D. LE VAN ET AL 1,867,225

TIMING DEVICE

Filed Jan. 2, 1930

Fig. 1

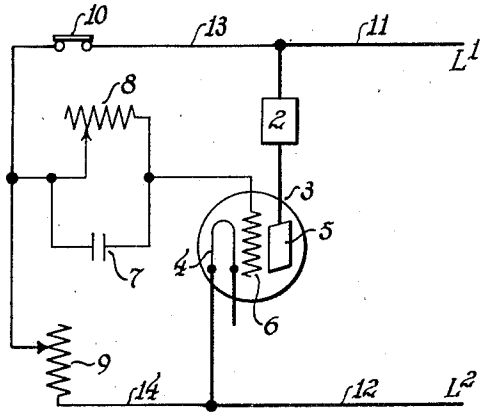
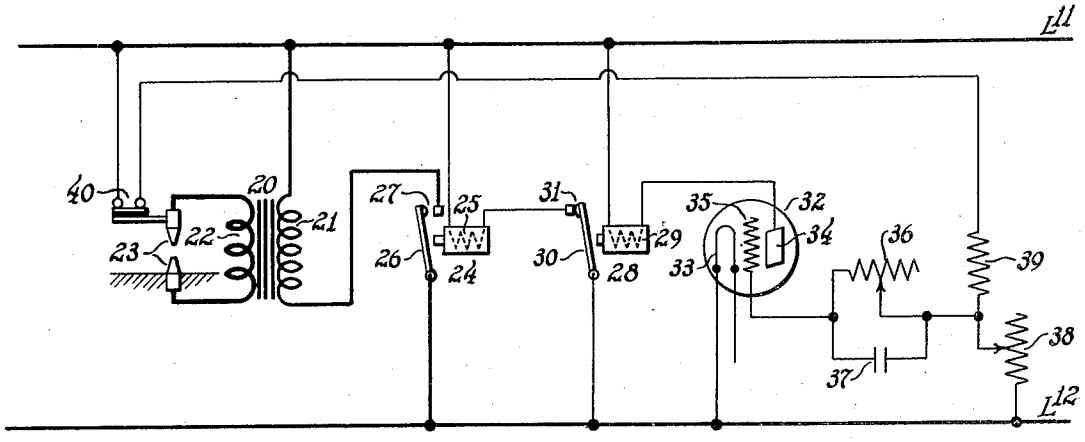


Fig. 2



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UNITED STATES PATENT OFFICE

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TIMING DEVICE

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The invention relates to the control of currents by means of electron tubes.

An object of the invention is to provide for the control of such tubes so as to pass therethrough a controlled current intermittently for an adjustable period of time.

Another object is to provide apparatus for commutating the current supplied to a translating device during an adjustable period.

Another object is to provide apparatus for accurately timing an interval during which current is supplied to a translating device.

Other objects will appear from the description and appended claims.

The accompanying drawing illustrates a mode of carrying out the invention.

Figure 1 is a diagram of the circuit arrangement illustrating the operation of the invention, while Fig. 2 is a diagram showing the application of the invention to an electric welder.

Hot cathode electron tubes of the grid type are conducting when the negative potential of the grid with respect to the cathode does not exceed a given value and the flow of current between the cathode and anode may be stopped or may be prevented from starting by the application to the grid of a higher negative potential. Current between the cathode and anode can only flow when the cathode is negative with respect to the anode, so that such tubes when employed in alternating current circuits act as rectifiers and pass only alternate half waves of the alternating current.

With high vacuum tubes the current from the cathode to the anode may be stopped by making the grid sufficiently negative with respect to the cathode, whether the voltage impressed upon the electrodes is direct or alternating current. That is to say, during the working half cycle when the cathode is negative the grid potential must not exceed a certain negative value or must be positive with respect to the cathode to permit a flow of current.

On the other hand, with gaseous tubes the flow of current between the cathode and anode cannot be stopped by a negative grid potential during the half cycle after it has once been started. To keep the tube from starting during any half cycle a sufficiently high negative potential must be impressed upon the grid during that half cycle.

The present invention is applicable to either a direct or alternating current power supply.

According to the present invention the grid is normally positive with respect to the cathode when the latter is negative so that current flows to the anode and means are provided whereby the positive potential of the grid is reduced or is changed to a negative potential for an adjustable period to keep the tube in the non-conducting condition during the desired period.

Fig. 1 will now be explained on the assumption that the power supply is direct current and the tube is a high vacuum tube, but as stated above the system is also operative with alternating current.

L^1—L^2 are the direct current power supply lines. 2 is a translating device, the current through which is to be regulated by means of the electron tube 3, having a cathode 4, an anode 5 and a grid 6. The cathode 4 may be heated by current from any suitable source in any well known manner. Connected to the grid is a condenser 7 which is shunted by an adjustable resistance 8. The condenser in turn is connected through a resistance 9 to the cathode 4 and line L^2 and under normal conditions through the normally closed switch 10 by wire 13 to the line L^1.

The apparatus functions in the following manner:

When the switch 10 is closed a current flows between the cathode 4 and the grid 6, the current flowing from line L^1 through wires 11 and 13, switch 10 and resistance 8 to grid 6 and hence over cathode 4 and wire 12 to line L^2, while another current branches off over resistance 9, wires 14 and 12 to line L^2. As long as grid 6 is positive current flows between the anode and cathode and through the translating device 2. The voltage drop over the resistance 8 is such as to accumulate a negative charge on the condenser plate which is connected to the grid.

If now the switch 10 be opened the cur-

rent flow to the grid from line L^1 will be stopped and the grid will become negative with respect to the cathode 4 due to the negative charge accumulated on the side of the condenser which is connected to said grid. This stops the flow of current between the main electrodes and through the translating device. The condenser will immediately begin to discharge through the resistance 8, thus reducing the negative potential on the grid 6 until, after a definite time interval, which is adjustable by adjusting the resistance 8, the grid potential has been reduced to zero, thus rendering the tube again conducting.

The switch 10 may now be closed again, whereupon the condenser 7 will be again charged and the described cycle repeated. It will thus be seen that by the opening of the switch 10 the current passing between the anode and cathode and thus through the translating device 2 may be interrupted for a definite and adjustable time interval.

Fig. 2 illustrates the application of the invention to an electric welding machine. In an electric welder it is desirable to apply a given current to the weld for a definite time, the time depending upon the character and thickness of the material which is to be welded, and other considerations, and the apparatus illustrated by Fig. 2 is designed to accurately regulate the time during which current is applied to the weld. In the drawing L^{11} and L^{12} are the alternating current power supply lines, furnishing power to a welding transformer 20 having a primary winding 21 and a secondary winding 22. The ends of the secondary winding are connected to the welding terminals 23 of a suitable type of welding machine. A magnet switch 24 having a magnet winding 25, an armature 26 and normally open contacts 27 controls the current supply to the winding 21.

The normally open magnet switch 24 is in turn controlled by a magnet switch 28 having a magnet winding 29, an armature 30 and normally closed contacts 31. The magnet winding 29 is in turn controlled by the electron tube 32 having a cathode 33, an anode 34 and a grid 35. In series with the grid is an adjustable resistance 36 which is paralleled by a condenser 37. The other side of the resistance 36 is connected to an adjustable resistance 38 which in turn is connected to the cathode 33. Resistance 36 is also connected through a resistance 39 to a normally closed switch 40, which is mechanically connected with the movable element of the jaws 23, so that when the jaws 23 open the switch 40 is closed and vice versa.

The apparatus operates in the following manner:

With an alternating current impressed upon the lines L^{11}—L^{12} and the jaws 23 of the welder open the switch 40 is closed so that a circuit is established from the line L^{12} over resistance 38, resistance 39 and switch 40 to line L^{11}. During the operating half cycle, that is, when the line L^{12} and the cathode 33 of the tube 32 are negative, current flows from the grid 35 to the cathode 33, thus making the tube 32 conducting as explained in connection with Fig. 1. Current therefore flows from the line L^{11} through the winding 29 of relay 28, the anode 34 to the cathode 33 back to line L^{12}. The energization of the magnet winding 29 attracts the armature 30, thus opening the contacts 31 so that no current can flow through the coil 25 of the magnet switch 24 and hence the armature 26 remains unattracted and contacts 27 remain open and no current flows through the primary winding 21 of the welder 20. If now the jaws 23 are closed on the material to be welded, the switch 40 is opened and the opening of such switch disconnects the resistance 39 and hence the grid 35 from the line L^{11}. The grid thereupon becomes negative due to the negative charge on the side of the condenser which is directly connected to the grid and thus makes the tube 32 non-conducting, resulting in deenergization of the switch 28 and closure of the contacts 31 which in turn causes energization of the coil 25 of magnet switch 24 and closure of contacts 27 so that now the transformer primary winding 21 is connected across the lines L^{11}—L^{12} and current is induced in the secondary winding 22 and supplied to the welding jaws 23 to bring about the desired weld.

The condenser 37 gradually discharges through the resistance 36, the time of discharge being adjustable through adjustment of the value of resistance 36. Ultimately when the potential of grid 35 has reached zero value, the tube again becomes conductive during the half cycle when the line L^{11} is positive, resulting in opening of switch contacts 31 and deenergization of the magnet switch 24 and opening of contacts 27 which interrupts the current in the transformer and terminates the flow of welding current through the jaws 23. The apparatus remains in this position until the jaws are again separated and the switch 40 closed and subsequently opened when the cycle is repeated.

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

1. In combination, a power supply, a translating device supplied thereby, an electron tube controlling the continuity of circuit thereof, and having a control electrode, means to impress upon said electrode a potential derived from said supply for rendering said tube conductive to effect completion of the circuit of said translating device and energy storing and discharging means associated with said electrode and having a transient effect thereon to cause said tube

to interrupt the circuit of said translating device for a given period of time.

2. In combination, a power supply, a translating device, an electron tube controlling the continuity of circuit thereof and having a control electrode, an impedance and a parallel resistance connected in series with said control electrode, a second impedance in series with said first impedance and connected to an electrode of said tube, a switch for connecting said last mentioned impedance across the power supply and to interrupt such connection for varying the potential impressed upon the control electrode and the first impedance, and to control the conductivity of the tube in accordance with a transient voltage resulting from such variation.

3. In combination, a translating device, an electron tube controlling the continuity of circuit thereof and having a control electrode, an impedance and a parallel resistance connected in series with said control electrode, means to impress a potential upon said resistance and said control electrode to render the tube conductive to effect completion of the circuit of said translating device, said means being operative thereafter to alter said potential and to affect the potential of said grid by a transient voltage resulting from such alteration to interrupt the continuity of circuit of said translating device for a given time interval.

4. In combination, a power supply, a translating device and an electron tube having a control electrode, said translating device and said tube being connected in circuit with said power supply, two adjustable resistances connected in series between one side of the power supply and the control electrode, a condenser in parallel with one of said resistances and a switch connected between the other resistance and the other side of the power supply and adapted to vary the potential impressed upon said resistances, to thereby produce a transient potential on the control electrode for affecting the conductivity of the tube.

5. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination a power supply, a pair of relatively movable welding jaws receiving energy from said supply, an electromagnetic switch for controlling the supply of current to said jaws, an electromagnetic relay for controlling said switch, the windings of said switch and said relay being adapted to receive power from said supply, an electron tube in circuit with the winding of said relay, a resistance and a parallel condenser connected with a control electrode of said tube, a second resistance connected in series between the condenser and one side of said power supply and a switch mechanically connected to said jaws and movable with the latter, adapted to normally connect the condenser end of said second resistance to the other side of the power supply and to disconnect it therefrom when the jaws are moved towards each other.

6. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination a power supply, a transformer having a primary winding, receiving energy from said supply and a secondary winding, a pair of relatively movable welding jaws receiving energy from said secondary winding, an electromagnetic switch for controlling the supply of current to said primary winding, an electromagnetic relay for controlling said switch, the windings of said switch and said relay being adapted to receive power from said supply, an electron tube in circuit with the winding of said relay, a resistance and a parallel condenser connected with a control electrode of said tube, a second resistance connected in series between the condenser and one side of said power supply and a switch mechanically connected to said jaws and movable with the latter, adapted to normally connect the condenser end of said second resistance to the other side of the power supply and to disconnect it therefrom when the jaws are moved towards each other.

7. In an electric welding system adapted to supply to the material to be welded current for an adjustable time, in combination, a power supply, a pair of welding jaws receiving energy from said supply, an electron tube controlling the continuity of circuit thereof and having a control electrode, means to impress upon said electrode a potential for varying the conductivity of said tube to effect commutation of circuit to said jaws and energy storing and discharging means associated with said electrode and having a transient effect thereon to cause said tube to effect completion of the circuit to said jaws for a given period of time.

8. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination, a power supply, a pair of welding jaws receiving energy from said supply, an electron tube controlling the continuity of circuit thereof and having a control electrode, means to impress upon said electrode a potential rendering said tube conducting to effect interruption of circuit to said jaws, and energy storing and discharging means associated with said electrode and having a transient effect thereon to cause said tube to effect completion of the circuit to said jaws for a given period of time.

9. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination, a power supply, a pair of welding jaws receiving energy from said supply, an electron tube controlling the continuity of circuit

thereof and having a control electrode, an impedance and a parallel resistance connected in series with said control electrode, a second impedance in series with said first impedance and connected to an electrode of said tube, a switch for connecting said last mentioned impedance across the power supply and to interrupt said connection for varying the potential impressed upon the control electrode and the first impedance and to control the conductivity of the tube in accordance with a transient voltage resulting from such variation.

10. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination, a power supply, a pair of welding jaws receiving energy from said supply, an electron tube controlling the continuity of circuit thereof and having a control electrode, an impedance and a parallel resistance connected in series with said control electrode, means to impress a potential upon said resistance and said control electrode to render the tube conducting to effect completion of said circuit, said means being operative thereafter to alter said potential and to affect the potential of said grid by a transient voltage resulting from such alteration to complete the circuit to said jaws for a given time interval.

11. In an electric welding system adapted to supply current to the material to be welded for an adjustable time, in combination, a power supply, a pair of jaws receiving energy from said supply and an electron tube having a control electrode, said jaws and said tube being connected in circuit with said power supply, two adjustable resistances connected in series between one side of the power supply and the control electrode, a condenser in parallel with one of said resistances and a switch connected between the other resistance and the other side of the power supply and adapted to vary the potential impressed upon said resistances to thereby produce a transient potential on the control electrode for affecting the conductivity of the tube.

In witness whereof, we have hereunto subscribed our names.

JAMES D. LE VAN.
CARROLL STANSBURY.