Dec. 2, 1930. F. FIRESTONE 1,783,234

ELECTRICAL APPARATUS

Filed June 6, 1927

Fig. 1.

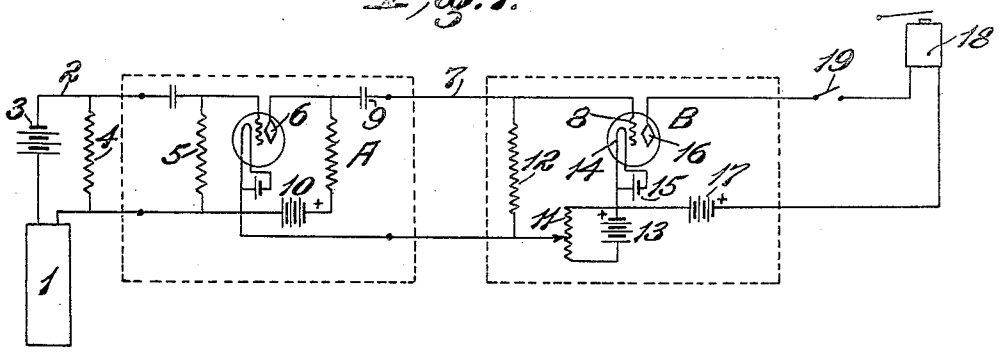


Fig. 2.

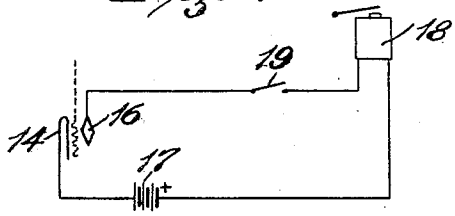


Fig. 3.

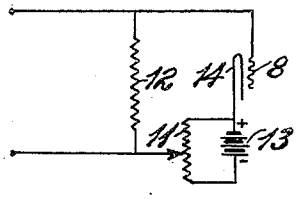


Fig. 4.

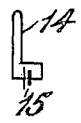
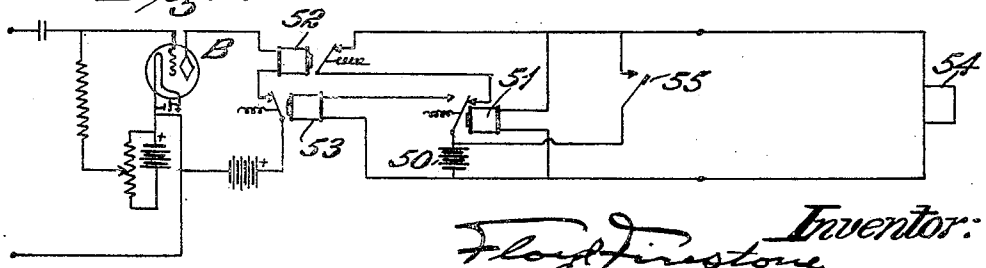


Fig. 5.



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UNITED STATES PATENT OFFICE

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ELECTRICAL APPARATUS

Application filed June 6, 1927. Serial No. 196,828.

This application is a continuation in part of my application Serial No. 44,955 filed July 20, 1925.

My invention relates to a hook-up of electrical apparatus and has for its principal object to devise a hook-up by means of which an electro-magnet or similar device will be made responsive to a single pulse of electricity or to a current change of momentary duration. Another object is to devise a hook-up by means of which an electrical current whose normal intensity is insufficient to operate an electric device in its circuit, will be increased in intensity sufficiently to operate said device as the effect of a momentary change in the potential of a controlling element.

In the accompanying drawing which forms part of this specification,

Fig. 1 is a diagrammatic view of the hook-up of an electrical apparatus conforming to my invention,

Fig. 2 is a diagrammatic view of the plate circuit of the gas content electron tube,

Fig. 3 is a diagrammatic view of the grid circuit of said tube; and

Fig. 4 is a diagrammatic view of the filament circuit of said tube.

Fig. 5 illustrates a modification whereby the plate circuit is automatically broken.

In the system illustrated in the accompanying drawing there is a photoelectric, selenium or other light sensitive cell 1 in an electrical circuit 2 that contains an electric battery 3 and a resistance 4. The input of a vacuum tube amplifier A of well known type is shunted across resistance 5. The plate 6 of the amplifier tube is electrically connected by wires 7 with the grid 8 of a gas content electron tube B through a condenser 9; and the opposite side of the amplifier plate battery 10 is connected to a potentiometer 11, the output terminals of said amplifier being shunted across a resistance 12 interposed between said condenser 9 and said potentiometer 11. Said potentiometer is connected to the negative pole of a battery 13 whose positive pole is electrically connected to the filament 14 of said gas content electron tube B. The grid circuit of said gas content electron tube therefore, (see Fig. 3) contains the resistance 12, the potentiometer 11 and the battery 13. The filament circuit of said gas content electron tube (see Fig. 4) comprises the filament 14 and an ordinary A battery 15. The plate circuit of said gas content electron tube (see Fig. 2) comprises the plate 16 thereof, a battery 17 to whose positive side said plate is electrically connected through an electromagnet or other suitable electrical device 18 and a switch 19 which is normally closed, and the filament 14 of said gas content electron tube which is connected to the negative side of said battery.

The function of the filament battery 15 is the usual function of heating the filament and causing an emission of electrons therefrom. The main function of the battery 13 is to create a negative potential or bias on the grid of the electron tube. The principal function of the plate battery 17 is to maintain a positive potential with respect to the filament 14 on the plate 16. If an electron passes from the filament 14 toward the plate 16 at a sufficiently high velocity it may strike a molecule of the gas contained in the tube and cause said molecule to be ionized, that is, broken up into a negative charge which proceeds to the plate 16, and a positive charge which returns toward the filament 14. If the grid 8 is held at a sufficiently large negative potential, very few electrons will pass from the filament 14 to the plate 16 with sufficient velocity to ionize the gas in their path. Therefore, the plate current (which is composed mainly of these electrons) will be very small. Under these conditions, most of the electrons which leave the filament 14 will return to it. If, however, the negative potential on the grid 8 should be decreased, that is, made more positive, an increasing number of electrons will travel from the filament 14 to the plate 16, and an increasing number of gas molecules will be ionized. When a certain critical value of the potential of the grid 8 is reached, a sufficient number of positive ions will be formed so that as they return to the filament and reach the space between the filament 14 and the grid 8, the field of their positive charges will counteract, near the filament 14, the field of the negative charge on the grid 8, and consequently a large num-

ber of electrons will be permitted to leave the filament and travel across to the plate 16. This, in turn, produces a larger number of positive ions which return to the filament so that finally practically all of the electrons emitted by the filament 14 travel to the plate 16. If the grid is now made more positive than this critical value at which the ionization became unstable very little change in the plate current will take place. If the grid is now made more negative than the critical value, the ionization will still persist since the large number of positive ions between the filament and grid has practically eliminated the effect of the grid. The original un-ionized condition may be restored by opening the plate circuit.

In operation, the grid potential is normally held at a value at which the ionization does not take place. Any source of electromotive force, as, for instance, a vacuum tube amplifier, may be arranged to vary this grid potential. If at any time the grid potential should cross the critical value, then ionization will immediately start and the increase in place current will be sufficient to operate the electromagnet 18 or a similar device. Now, even though the grid potential may return to its original value, the current through the magnet 18 will still persist until the switch 19 is opened.

An additional refinement of my invention is shown in Figure 5. If the ionization in the tube is permitted to persist for a period of several hours, the bombardment of the filament by the positive ions of the gas which return to it will finally destroy it. To prevent this, a series of relays is arranged to hold the circuit in the operated condition after once the ionization has started and immediately cut off the plate current in the tube so that the ionization lasts but a fraction of a second. While this may be accomplished in a variety of ways, the circuit of Figure 5 is typical. The device to be operated 54 corresponding to the electromagnet 18 of Figure 1 receives its current, not from the gas content tube, but from the battery 50 which is controlled by relays 51 and 52. The relays are shown in the condition in which they would be when the circuit is ready to be operated and there is no ionization in the tube. If, now, due to a certain input electromotive force, the gas content tube becomes ionized, the increased plate current will operate the relay 52, thus breaking the circuit through the battery 50 and the device to be operated 54. This same action cuts off the current from relay 51, thus permitting its armature to connect the battery 50 to relay 53. Relay 53 breaks the plate circuit of the tube B and stops the ionization; relay 52, at the same time, is de-energized, permitting its contacts to close. However, the current from the battery 50 cannot now pass through the device 54 because the circuit is broken in relay 51, the battery 50 still being connected to relay 53. Thus, the device remains in the operated condition. When it is desired to re-set the circuit to its original condition, switch 55 may be momentarily closed and then opened. The closing of the switch 55 energizes the magnets of relay 51, thus returning the device 54 to its original condition and also permitting the magnets of relay 51 to receive their current from battery 50 through the relay contacts after the switch 55 is opened.

It is noted that in the hook-up illustrated in Figure 5, the out-put of the amplifier is connected to the negative side of the plate battery of the gas electron tube instead of being connected to the potentiometer, as in Figure 1. In other respects, the hook-up of the two figures is substantially the same.

In my co-pending application, I have disclosed my invention as applied to the detecting of flaws in rollers for roller bearings and the automatic assorting of good and defective rollers. Obviously, however, the electric hook-up hereinbefore described is capable of numerous applications where it is desired to make a persistent response to a single pulse of electricity or to a merely momentary condition of an electrical circuit. Likewise, I do not wish to be limited to the details described, for instance the amplifier might be replaced with any other suitable unit having out-put terminals suitable for cooperating with the in-put terminals of the trip relay circuit.

What I claim is:

1. The combination of a gas content electron tube having a filament, a control grid and a plate, a substantially steady source of electrical energy of such strength and so connected to said plate as to normally maintain a substantially steady plate potential large enough to produce ionization of the gas in the tube above a certain grid potential, a source of grid potential large enough to normally overcome the tendency of the gas in the tube to ionize, means for applying electromotive force to the grid, and a device in the plate circuit irresponsive to the normal current therein but responsive to the current therein during such ionization.

2. The combination with an electrical amplifier of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a substantially steady source of electrical energy of such strength and so connected to said plate as to normally maintain a substantially steady plate potential large enough to produce ionization of the gas in the tube above a certain grid potential, a source of grid potential large enough to normally overcome the tendency of the gas in the tube to ionize, means for applying to said grid the output of electromotive force from the amplifier to permit ionization of the gas and a device in the plate circuit irresponsive

to the normal current therein but responsive to the current therein during ionization.

3. The combination with an electrical amplifier of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a substantially steady source of electrical energy of such strength and so connected to said plate as to normally maintain a substantially steady plate potential large enough to produce ionization of the gas in the tube above a certain grid potential, a source of electrical energy in the grid circuit large enough to normally overcome the tendency of the gas in the tube to ionize, means for applying to the grid the output of electromotive force of the amplifier and a device in the plate circuit irresponsive to the normal current therein but responsive to the current therein during ionization.

4. The combination of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a substantially steady source of electrical energy of such strength and so connected to said plate as to normally maintain a substantially steady plate potential large enough to produce ionization over a certain range of grid potentials, a source of grid biasing potential of suitable value to normally prevent ionization of the gas in the tube, means for applying an operating electromotive force to the grid, and a device in the plate circuit responsive to the change in the plate current due to such ionization.

5. The combination with an electrical amplifier of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a substantially steady source of electrical energy of such strength and so connected to said plate as to normally maintain a substantially steady plate potential large enough to produce ionization of the gas in the tube over a certain range of grid potentials, a source of grid biasing potential of suitable value to normally prevent ionization of the gas in the tube, means for applying to said grid the output of electromotive force from the amplifier to cause ionization of the gas, and a device in the plate circuit responsive to the change of plate current due to such ionization.

6. The combination of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a source of plate potential large enough to produce ionization over a certain range of grid potentials, a source of grid biasing potential of suitable value to normally prevent ionization of the gas in the tube, means for applying an operating electromotive force to the grid, a device in the plate circuit responsive to the change in plate current due to such ionization, and means responsive to said device for breaking the plate circuit.

7. The combination of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a source of plate potential large enough to produce ionization over a certain range of grid potentials, a source of grid biasing potential of suitable value to normally prevent ionization of the gas in the tube, means for applying an operating electromotive force to the grid, and an electromagnet in said plate circuit responsive to the change in the plate current due to such ionization, and a normally closed circuit containing a source of electrical energy and an electromagnet, each of said electromagnets having its armature in and normally closing the circuit of the other.

8. The combination of a gas content electron tube having a filament, a control grid and a plate, a source of plate potential large enough to produce ionization of the gas in the tube above a certain grid potential, a source of grid potential large enough to normally overcome the tendency of the gas in the tube to ionize, means for applying electromotive force to the grid, and a device in the plate circuit irresponsive to the normal current therein but responsive to the current therein during such ionization and a device in the plate circuit for opening and closing the same.

9. The combination with an electrical amplifier of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a source of plate potential large enough to produce ionization of the gas in the tube above a certain grid potential, a source of grid potential large enough to normally overcome the tendency of the gas in the tube to ionize, means for applying to said grid the output of electromotive force from the amplifier to permit ionization of the gas and a device in the plate circuit irresponsive to the normal current therein but responsive to the current therein during ionization, and means for restoring said tube to un-ionized condition.

10. The combination of a gas content electron tube having a filament, a control grid and a plate, circuits therefor, a source of plate potential large enough to produce ionization over a certain range of grid potentials, a source of grid biasing potential of suitable value to normally prevent ionization of the gas in the tube, means for applying an operating electromotive force to the grid, and a device in the plate circuit responsive to the change in the plate current due to such ionization and a device in the plate circuit for opening the circuit thereof.

Signed at Detroit, Michigan, this 4th day of June, 1927.

FLOYD FIRESTONE.