Sept. 17, 1929. I. W. GREEN 1,728,239

ARRANGEMENT FOR ESTABLISHING TIME INTERVALS

Filed July 1, 1926

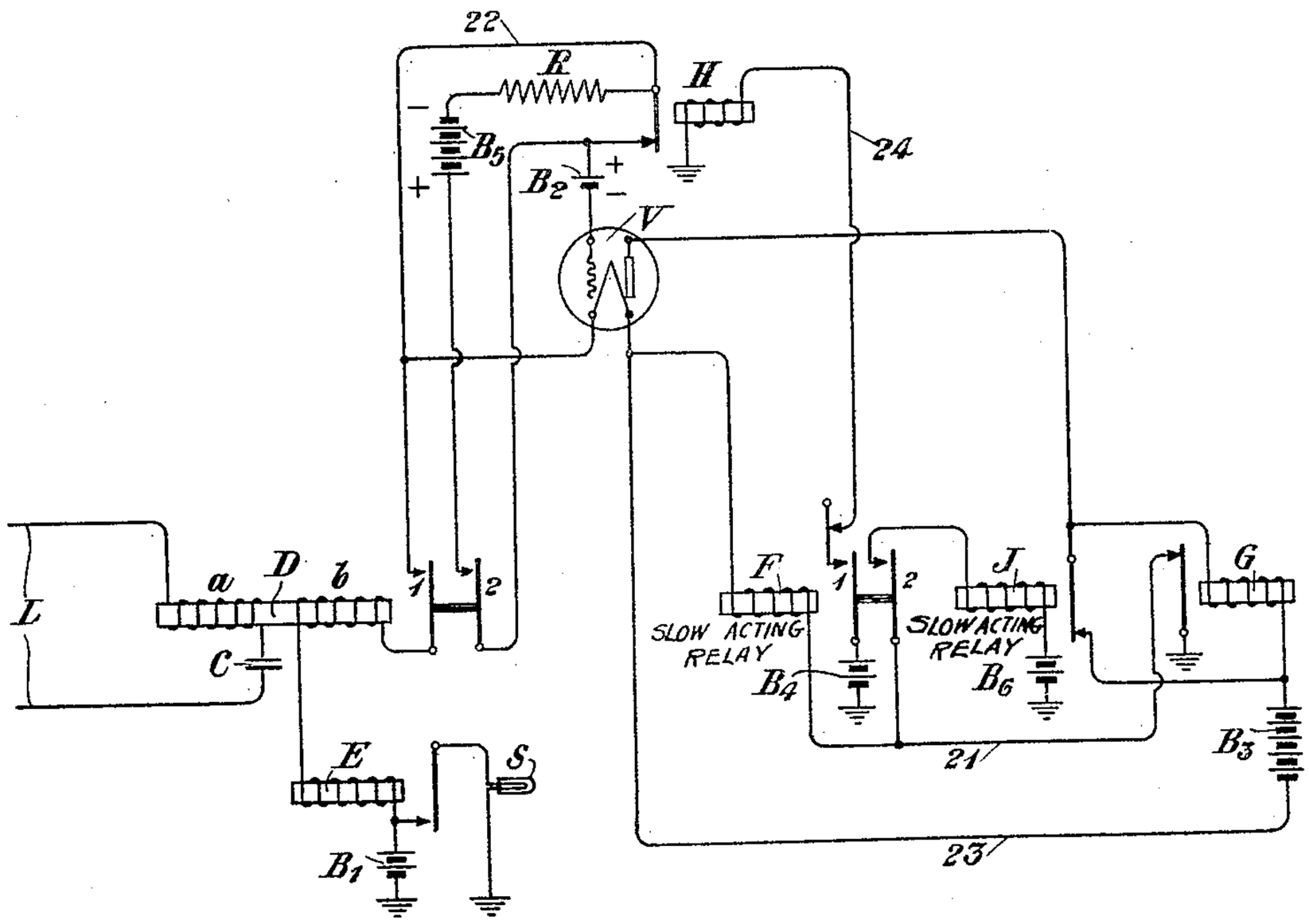

Fig. 1

Fig. 2

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Patented Sept. 17, 1929 1,728,239

UNITED STATES PATENT OFFICE

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ARRANGEMENT FOR ESTABLISHING TIME INTERVALS

Application filed July 1, 1926. Serial No. 119,973.

This invention relates to arrangments for establishing a time interval, and particularly to such arrangements employing the physical characteristics of a vacuum tube therefor.

One of the objects of the invention is to provide arrangements for preventing the flow of current in a circuit during a fixed interval of time.

Another object of the invention is to provide a vacuum tube of suitable construction for automatically maintaining a signal at the subscriber's station of a telephone system for a fixed period of time after a ringing signal has been transmitted from the central office to the subscriber's station.

Other objects of the invention will appear in the detailed description to be given hereinafter.

A three-electrode vacuum tube consists essentially of a highly evacuated vessel, containing a themionic cathode, usually in the form of a filament, which can be heated by passing a current through it, an anode and a discharge controlling electrode which generally takes the form of a wire mesh or grid placed between the cathode and the anode. This third-electrode can, however, be of any form, since a controlling effect on the discharge can be obtained by so positioning any conductor with respect to the path of the discharge that potential variations applied to it will cause variations in the current flowing between the cathode and the anode.

It has been found in the three-electrode vacuum tube employed in the arrangement described hereinafter that when a high potential is applied to the grid of the vacuum tube, which makes the grid highly positive with respect to the filament, there is a temporary increase in the flow of current between the plate and the filament, and then a sudden decrease in this current to a value considerably below the normal value. This cessation or diminution of the electronic emission between the cathode and the anode may exist for a considerable period of time, for example, several minutes after the positive potential has been released from the grid of the vacuum tube. This interval of time may be adjusted by changing the potentials applied to the elements of the vacuum tube, and by changing the constants of the associated circuits. A vacuum tube exhibiting such features is shown in a copending application of H. A. Pidgeon, Serial No. 136,205, filed September 18, 1926, and such a tube will be more fully described hereinafter.

This invention may now be more fully understood from the description thereof hereinafter following when read in connection with the accompanying drawing, in which Figure 1 indicates schematically a circuit arrangement embodying the principles of this invention, and in which Fig. 2 represents a characteristic curve of the vacuum tube employed herein, given so as to aid in an understanding of its theory of operation.

Referring to Fig. 1, a three-electrode vacuum tube V is shown, of the type to which reference has been made, this tube consisting of a grid, a plate and a filament. The reference character S represents an indicator, such as a lamp, located at the subscriber's station which provides for the subscriber a visual means to observe for a fixed and predetermined time thereafter that a ringing signal has been transmitted to his station.

Ringing current applied to a telephone line L will energize the winding "*a*" of a relay D. This ringing current may be impressed upon the telephone line L at a central office (not shown), this ringing current flowing over the conductors of the telephone line L through the winding "*a*" of the relay D and through the condenser C. As the winding "*a*" of the relay D becomes energized, its armatures 1 and 2 are attracted, which armatures move synchronously, being connected by a bar of insulation. As the armature of the relay D closes its contact, current flows from a battery B_1 through the winding of a relay E, the winding "*b*" of the relay D, the armature 1 of the relay D, the filament of the vacuum tube V, the winding of a relay F, conductor 21, the armature of a relay G and ground. Thus, current

flows from the battery B_1 through the filament of the vacuum tube V, heating said filament to an electron emitting temperature. The grid of the vacuum tube V is brought to a suitable negative potential with respect to the filament thereof, the circuit interconnecting the grid and the filament, including a battery B_2, the armature of relay H and conductor 22. With the potential of battery B_2 applied to the grid of the vacuum tube V, normal current flows between the plate and filament of the vacuum tube V from a battery B_3, the circuit through which this current flows including the battery B_3, the armature of relay J, the plate and filament of the vacuum tube V and a conductor 23.

As soon as ringing current is applied to the telephone line L, the winding of relay E becomes energized, attracting its armature. Current then flows from the battery B_1 through the armature of the relay E and through the indicating device S, which indicating device is shown in this invention in the form of a lamp, merely for the purpose of illustration. The relay F is preferably a slow acting relay so that its winding does not become fully energized to attract its armatures until a predetermined period of time after the potential of the battery B_1 has been applied thereto, thereby allowing the filament of the vacuum tube V to reach its normal electron emitting temperature. After this predetermined period of time has elapsed, the armatures of relay F are attracted so that current flows from battery B_4 through the armature 1 of the relay F and its contact, conductor 24 and the winding of relay H.

The armature of relay H is attracted because of the flow of current through the winding thereof from battery B_4, relay H remaining energized merely momentarily by virtue of the "make" before "break" feature of the contacts associated with the armature of relay F. Another battery B_5 is temporarily connected in series relationship with battery B_2 between the grid and the filament of the vacuum tube V, thus momentarily rendering the grid highly positive with respect to the filament. The circuit interconnecting the grid and filament of the vacuum tube V during this momentary period includes battery B_2, armature 2 of the relay D, battery B_5, a resistance R and conductor 22. A temporary increase in a flow of current from the battery B_3 through the plate circuit of the vacuum tube V then takes place. This increase in the flow of current lasts only for a very short period of time and thereafter drops considerably below the normal plate current value, the current in the plate circuit, the current in the plate circuit gradually building up to its normal value, a fixed and predetermined period of time after the highly positive potential of the vacuum tube V has been removed from the grid. This fixed and predetermined period of time may be, by example, several minutes. Moreover, this period of time may be varied by changing the potentials applied to the elements of the vacuum tube V, or by changing the constants of the various circuits associated therewith.

Upon the closure of armature 2 of the relay F because of the flow of current of definite magnitude from the battery B_1 through the winding thereof, a circuit including the winding of relay J becomes closed. This latter circuit includes battery B_6, the winding of relay J, armature 2 of relay F, conductor 21, the armature of relay G and ground. Inasmuch as relay J, as employed herein, is a slow acting relay, it is a predetermined period of time after the potential of the battery B_6 has been applied to the winding thereof that normal current may flow therethrough, this period of time being the time required for the current in the plate circuit to reach its minimum value. The armature of relay J is then attracted so that the potential for the plate of the vacuum tube V may be supplied by battery B_3 through the winding of relay G. When the current in the plate circuit of the vacuum tube V is at its minimum value, the energization of the relay G is insufficient to attract its armature. Yet, after the normal current in the plate circuit has been built up (which may be several minutes later), the energization of relay G will become sufficient to attract its armature so that the general ground connection provided by said armature is broken, thereby deenergizing the winding "b" of the relay D and the windings of relays E, F and J. The circuit arrangement is then ready for its next operation. Thus, the embodiment of the invention shown in Fig. 1 is employed to operate a visual signal S at a substation for a fixed and predetermined period of time after ringing current has been applied to the telephone line of the substation.

The explanation of the operation of the vacuum tube of this invention to produce what is believed to be a blocking or paralyzing effect will be described in connection with Fig. 2. When a potential is applied to the grid of the vacuum tube which makes the grid highly positive with respect to the filament, a flow of electrons is established from the filament to the grid. Due to the bombardment of the grid by these electrons, at a high velocity, the contact potential between the filament and the grid is changed so that when the positive potential is removed from the grid the effective potential of the grid is more negative than it was before the positive potential was impresesd thereon. Thus the current flowing in the

output circuit is reduced to a value considerably below its normal value. This may, if preferred, be considered the result of a shift in the contact potential between the grid and the filament, and will be better understood from the following description in connection with the characteristic plate current-grid voltage curve of the vacuum tube.

The grid of this vacuum tube is normally maintained at a suitable negative potential *oc* to give a corresponding plate current *od*. When a potential is applied to the grid which makes the grid highly positive with respect to the filament, the potential of the grid is in effect momentarily raised to a value, such as *oe*, giving the plate current *og*. However, this effectively increased grid potential causes a flow of electrons from the filament to the grid, which produces a change in the contact potential between the filament and the grid, making the grid more negative. Consequently the net effective grid potential is reduced by an amount such as *he*, so that the grid potential assumes a value corresponding to *oh*, giving a plate current of *oj*. When the high potential is removed from the grid the effective grid potential becomes *ok*, thus rendering the potential of the grid with respect to the filament lower than its original value *oc* by an amount *ck*, which is equal to *he*. This results in a drop in the plate current to the value *om* shortly after the positive potential has been removed from the grid.

The grid of the vacuum tube remains substantially at potential *ok* with respect to the filament for some time and then slowly drifts back to its original value *oc*, as is shown by the curve in which grid voltage is plotted against time. The effect of the shift on the contact potential may be due either to the peculiar characteristic of the alloy core of the filament or to the characteristic of such a core when covered with a thick shaggy coating of thermionically active material. Yet, a more complete explanation of the cause for the shift in the contact potential is not deemed necessary to an understanding of the invention.

While this invention has been shown in one particular embodiment merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. An arrangement for establishing a cessation of current flow in an electrical circuit for a predetermined time interval, comprising a vacuum tube of the three-electrode type, means whereby the grid is momentarily made highly positive with respect to the filament, and means for releasing said highly positive potential from said grid, the filament being unable to assume its normal electronic emission to the plate until a predetermined interval of time has elapsed after the highly positive potential has been removed from the grid.

2. The method of establishing an interval of time which consists in impressing a highly positive potential on the grid of a three-electrode discharge tube, and releasing said potential when the interval of time is to begin so that the normal conductivity between the plate and the filament is greatly altered during said interval of time.

3. The method of preventing a flow of current in an electrical circuit which consists in impressing a highly positive potential on the grid in the input circuit of a three-electrode vacuum tube, the output circuit of which is associated with the circuit to be affected, and releasing the highly positive potential from the grid so that the flow of current in said electrical circuit cannot take place until a predetermined interval of time has elapsed to permit the filament to resume its normal state of electronic emission.

4. The method of substantially altering the normal flow of current in the output circuit of a three-electrode vacuum tube which consists in impressing a highly positive potential on the grid in the input circuit of said tube, and releasing the grid from the effect of the highly positive potential so that the flow of current in the output circuit is substantially altered during the predetermined interval required for the filament to resume its normal electronic emission to the plate.

5. In a system for establishing a time interval, in combination, a line, a ringer, an electrical discharge tube having input and output circuits, a source of high potential, a signaling device, means associated with said line for connecting said source of high potential to the grid in the input circuit so as to make the grid highly positive with respect to the filament when a ringing signal is being transmitted over said line to the said ringer, and means to operatively connect said signaling device during the interval of time required for the filament to reach the normal state of electronic emission to the plate after said source of high potential has been removed from the grid.

6. In a ringing system, in combination, a line having a ringer associated therewith, a discharge tube having a grid, plate and filament, an indicator, means for impressing a potential on the grid of said tube so as to make said grid highly positive with respect to said filament, and circuit means operatively associated with the plate circuit of said tube to operate said indicator during the time that ringing current is being trans-

mitted and during the interval of time thereafter in which the normal state of electronic emission of the filament to the plate is impaired.

7. The method of establishing a time interval which consists in making the grid of an electrical discharge tube highly positive with respect to the filament, operating an indicator during the time that said grid is highly positive, and keeping said indicator in operation during the interval of time that it takes the filament to reach its normal state of electronic emission after the potential is removed from the grid of said tube.

8. The method of producing a time interval in the flow of current through an electrical circuit with which a three-element vacuum tube is associated, which consists in rendering the grid electrode normally negative with respect to the filament so that there may be a normal state of electronic emission between said filament and the plate electrode, and changing the potential so as to render the grid electrode highly positive with respect to the filament in order to prevent the normal electronic emission between the filament and the plate electrode, whereby the normal flow of current through the electrical circuit associated with the vacuum tube may be greatly decreased during a predetermined interval of time.

9. The combination of a vacuum tube system having plate, filament and grid electrodes, a transmission circuit connected to said plate and filament electrodes, means to render the grid electrode normally negative with respect to the filament electrode, and means to release the grid electrode from its normal negative potential with respect to the filament electrode and to render said grid electrode highly positive with respect to said filament electrode, whereby the normal electronic emission between the plate and filament electrodes is greatly diminished, causing a cessation in the flow of current through said transmission circuit.

In testimony whereof, I have signed my name to this specification this 29th day of June, 1926.

IRVING W. GREEN.