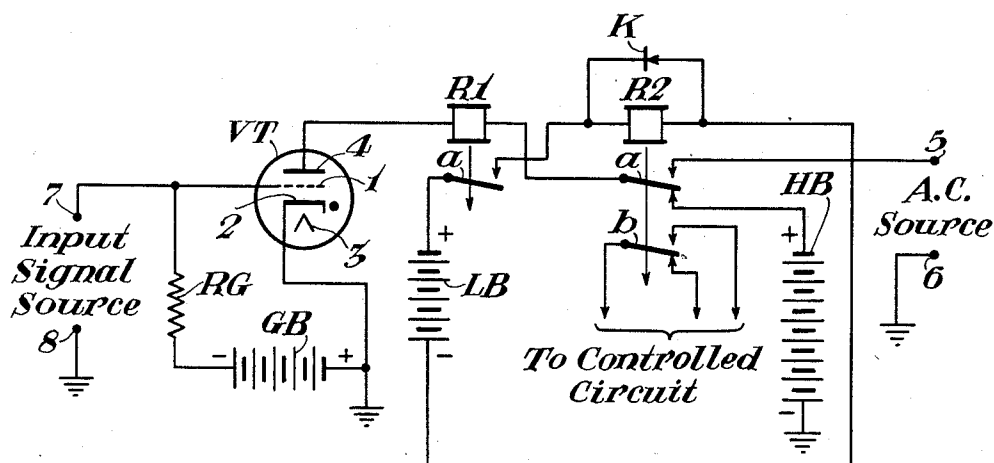


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ELECTRON TUBE CIRCUIT MEANS RESPONSIVE
TO A SIGNAL PULSE OF SHORT DURATION
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ELECTRON TUBE CIRCUIT MEANS RESPONSIVE TO A SIGNAL PULSE OF SHORT DURATION

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My invention relates to electron tube circuit means responsive to a signal pulse of short duration, and more particularly to electron tube circuit means for operating a signaling circuit for a predetermined minimum time interval in response to an input signal which may be a pulse of very short duration.

The circuit means disclosed in the present application is closely related to the improved circuit means disclosed in an application for Letters Patent of the United States Serial No. 155,254, filed on even date herewith for an Electron Tube Circuit Means Responsive to a Signal Pulse of Short Duration, which latter application is assigned to the same assignee as the present application.

It is well known that gas-filled electron discharge devices have the inherent property of becoming conductive or of being fired due to the ionization of the gas. In order to deionize the gas so as to stop the conduction of the device, it is necessary to reduce the positive anode potential of the device below a certain value for a short period of time. For example, in grid-controlled gas tubes such as thyatrons the control grid is capable of preventing the tube from firing; however, after the tube has fired it is necessary to reduce the positive anode potential in order to stop the conduction of the tube.

When the anode of a gas-filled electron discharge device is supplied with direct-current energy, the usual manner of deionizing the gas and stopping the conduction of the device is to remove the energy supplied to the anode.

It is a well known expedient to supply the anode of a gas-filled electron discharge device with alternating current; thus the device can fire only on the alternate half-cycles during which the anode potential is positive, and during the half-cycles when the anode is negative the gas deionizes thereby stopping the conduction of the device.

In certain applications it is desirable that a circuit means be provided for operating a signaling circuit for a predetermined minimum time interval in response to an input signal which may be a pulse of very short duration. Also, it is desirable that a circuit means be arranged to operate a signaling circuit in response to and during an input signal of an extended duration. Furthermore, the circuit means should be capable of recurrently responding to successive input signals. A use for such a circuit means is shown in the copending application Serial No. 105,144 for Vehicle Reporting Systems, filed July

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16, 1949, by Richard W. Treharne, Jr. In the above referred to application there is shown apparatus for detecting the passage of a vehicle such as a train by a certain point. The passing train causes the apparatus to produce a signal or pulse of very short duration such as approximately one millisecond if the train is traveling at a high rate of speed. However, if the train should stop at or be moving very slowly by the detection point, the apparatus produces a signal of extended duration.

It is an object of my invention to provide a circuit means for operating a signaling circuit for a predetermined minimum time interval in response to an input signal produced by the apparatus used in the above referred to Vehicle Reporting System.

It is also an object of my invention to provide an improved circuit means which includes an electron discharge device of the gas-filled variety and wherewith a signal of a predetermined duration is effected in response to a signaling impulse of very short duration.

It is a further object of my invention to provide novel and improved circuits for deionizing an electron discharge device of the gas-filled variety.

Another object of my invention is the provision of circuit means for an electron discharge device of the gas-filled variety incorporating novel means to maintain a signal circuit operated when the tube is recurrently ionized and deionized in response to an input signal of some duration.

Other objects of my invention and features of novelty therein will be apparent from the following description taken in connection with the accompanying drawing.

In practicing my invention I provide a gas-filled electron discharge device such as a thyatron tube having an anode, a cathode, and a control electrode. The tube is provided with an anode circuit which includes in series the winding of a control or first relay and is normally supplied with energy from a direct-current source by a circuit including a back contact of a second relay, which second relay is energized over a front contact of the first relay. However, when the second relay is picked up the anode circuit is supplied with energy from an alternating current source by a circuit including a front contact of the second relay. The voltage of both the direct current source and of the alternating current source are preferably high enough to render the tube conductive. However, the con-

control electrode is normally biased in a negative direction to thereby render the anode circuit ineffective to fire the tube. The circuit operation is such that when a signal is applied to the control electrode which overcomes the bias of the control electrode, the tube is rendered conductive and the first relay picks up and thereby energizes the second relay over a front contact of the first relay. The second relay upon picking up transfers the anode circuit from the direct current source to the alternating current source. During the negative half-cycles of the alternating current the tube becomes deionized and thereby permits the control electrode to regain control of the conduction through the tube. Since the second relay is of the slow-release type it remains in the picked up position for a short period of time, for example, one second, after its energization has been removed. Thus, if the signal applied to the control electrode is a pulse of short duration the second relay is picked up for approximately one second, and if the signal is of extended duration the pulsating current through the first relay will cause the first relay to remain picked up and thereby retain the second relay picked up. Under either condition the second relay is picked up for at least approximately one second after which time the relays return to their normal position and may be operated again in a similar manner. It can readily be seen that the device which is to be operated by this circuit means can be governed over the contacts of the second relay.

I shall describe one form of circuit means for operating a signaling circuit for a predetermined minimum time interval in response to an input signal which may be a pulse of very short duration, which circuit means comprises a preferred embodiment of my invention and is adapted for use with a vehicle detection system. I shall then point out the novel features thereof in claims.

The accompanying drawing is a diagrammatic view showing a preferred form of electron tube circuits embodying my invention.

Referring to the drawing, the circuit means here shown includes as components a thyratron tube VT having a control electrode or grid 1, a cathode 2, a heater 3 and an anode 4; a first relay R1; a second relay R2; a rectifier K; a high voltage direct current source HB; a suitable source of alternating current energy, not shown, connected to terminals 5 and 6, which provides the proper voltage for operating this apparatus; a low voltage source of direct current LB for energizing relay R2; a resistor RG and a battery GB for applying a direct-current bias voltage between the grid 1 and cathode 2 of tube VT; and an input signal source, not shown, connected to terminals 7 and 8 for producing the input signal which causes the circuit to operate.

The apparatus is shown in its normal condition; that is, the input signal source is inactive, thyratron tube VT is non-conducting, and relays R1 and R2 are in their deenergized positions. The anode 4 of tube VT is connected to the positive terminal of the source of direct current HB by a circuit that may be traced from the anode, through the winding of relay R1, and over back contact a of relay R2 to the positive terminal of battery HB. The cathode 2 of tube VT is connected to the negative terminal of battery HB by a common ground connection as indicated on the drawing. In order to simplify the drawing, the circuit for supplying energy to the heater 3 of tube VT is not shown. The control electrode or

grid 1 of tube VT is biased negatively by a source of direct current that is applied over a circuit that may be traced from the grid, through resistor RG to the negative terminal of battery GB, and from the positive terminal of battery GB to the cathode 2 of tube VT. The parts are arranged and proportioned so that the negative potential applied to the grid 1 with respect to the cathode 2 sufficiently biases tube VT to thereby prevent the firing of, or conduction through tube VT even though the proper positive operating potential is applied to the anode 4 with respect to the cathode 2. It is to be understood that other well known means for biasing thyratron tubes may be used and that my invention is not limited to the method herein shown.

The input signal source, not shown, which produces the input signal that causes the circuit to operate is connected to terminals 7 and 8 which are respectively shown connected to the grid 1 of tube VT and, connected to the cathode 2 by means of the common ground connections as indicated.

It is well known in the art that with a thyratron tube, even though a large positive potential is applied to the anode with respect to the cathode if the potential with respect to the cathode applied to the control electrode or grid is more negative than a certain value, depending upon the magnitude of the anode potential, the tube is considered to be non-conductive by virtue of the fact that the gas therein is not ionized. However, when the potential applied to the grid is less negative than this certain value the tube is said to be fired or rendered conductive in that ionization of the gas therein takes place.

From the foregoing, it will be seen that when the input signal source is made active and the input signal supplied from the source has a positive polarity and is of sufficient magnitude to overcome the negative grid bias voltage applied to tube VT, the tube will be fired or become conductive. As a result of tube VT becoming conductive a current, hereinafter referred to as the anode current, flows through a circuit that may be traced from the positive terminal of battery HB, over back contact a of relay R2, through the winding of relay R1, through the tube VT from the anode 4 to the cathode 2, and thence to the negative terminal of battery HB by means of the common ground connections. The parts are arranged and proportioned so that the anode current which flows through the winding of relay R1 energizes the relay causing it to pick up its contacts.

When relay R1 is picked up, current will flow through a circuit that may be traced from the positive terminal of the low voltage battery LB, over front contact a of relay R1, and through the winding of relay R2 to the negative terminal of battery LB. The parts are arranged and proportioned so that the current which flows through the winding of relay R2 energizes the relay causing it to pick up its contacts. Rectifier K is connected across the terminals of the winding of relay R2 to make the relay slow in releasing. It is to be understood that my invention is not limited to the use of a rectifier for snubbing the relay R2, but that any well known expedient for making a relay slow in releasing its contacts may be used such as copper ferrules on the magnetic core of the relay, a resistor or capacitor connected across the winding of the relay.

When relay R2 picks up its contacts, the previously traced circuit established over its back

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contact *a* is opened and thus the anode current supplied by battery HB is interrupted. Due to the opening of this circuit the potential applied to the anode 4 of tube VT with respect to the cathode 2 is reduced to zero thereby causing the gas within tube VT to become deionized. Relay R1 is made to be slightly slow in releasing, therefore current will continue to flow through the winding of relay R2 from the low voltage battery LB by means of the previously traced circuit during the period of time that relay R2 is picking up its contacts. However, when relay R2 picks up its contacts thereby closing front contact *a*, a circuit is completed that may be traced from terminal 5 of the alternating current source, over front contact *a* of relay R2, through the winding of relay R1 to the anode 4 of tube VT and from the cathode 2 to terminal 6 of the alternating current source by means of their common ground connections.

When the anode 4 of tube VT is supplied with alternating current energy, there is conduction through the tube during the alternate half-cycles that the potential applied to the anode 4 is positive with respect to the cathode 2 provided that the input signal supplied from the input signal source overcomes the negative grid bias voltage applied to tube VT. Also during the alternate half-cycles that the potential applied to the anode 4 is negative with respect to the cathode 2, the gas within the tube VT becomes deionized and there is no conduction through the tube. Thus, only during alternate half-cycles of the alternating current energy current flows through the winding of relays R1, but since relay R1 is made to be slightly slow in releasing, its contacts remain in the picked up position during the brief intervals in which there is no current flowing through the winding. So, as long as the input signal supplied from the input signal source overcomes the negative grid bias voltage applied to the tube VT, the contacts of relay R1 and R2 remain in their picked up position, but when the input signal does not overcome the negative grid bias voltage applied to tube VT, the conduction through tube VT ceases and after a very brief interval of time relay R1 releases its contact. When relay R1 opens its contact the circuit supplying energy to the winding of relay R2 over contact *a* of relay R1 is opened. Although energization is removed from the winding of relay R2, the contacts of relay R2 remain in the picked up position for approximately one second depending upon the slow release characteristics of the relay. Thus, if the input signal which initiated the circuit operation described above is of extended duration, relay R2 picks up its contacts and remains picked up during the time the input signal is applied in addition to approximately one second immediately following the removal of the input signal depending upon the slow release characteristics of the relay.

When relay R2 releases its contacts, the apparatus is returned to its normal condition ready to be reactuated.

When the input signal which initiates the circuit operation is a pulse of very short duration, the circuit operation will be as described above except that when relay R2 picks up its contacts thereby opening the circuit established over its back contact *a* and causing the gas within tube VT to become deionized, the tube will not become conductive during the time the alternating current energy is supplied to its anode 4 because the negative bias potential applied to its control elec-

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trode on grid 1 in the absence of a suitable input signal prevents the tube VT from firing or becoming conductive. Thus, when relay R2 picks up its contacts, relay R1 releases its contacts thereby removing energization from the winding of relay R2 as previously described; however, the contacts of relay R2 remain picked up for approximately one second thereafter depending upon the slow release characteristics of the relay. When relay R2 releases its contacts, the apparatus is again returned to its normal condition ready to be re-actuated.

From the foregoing it will be seen that I have provided circuit means for operating the contacts of relay R2 for a period of at least approximately one second from an input signal which may be a pulse of very short duration. Circuits which are to be governed by the presence or absence of an input signal may be controlled by contact *b* of relay R2 as shown on the drawing. It is to be understood, however, that the arrangement of the contacts of relay R2 for controlling particular circuits is not limited to that shown on the drawing but that other contact arrangements may be provided if desired.

Although my invention is especially suited for use in connection with vehicle detection systems, it is to be understood that my invention is not limited to such use, but that it may be used in other applications where a short input signal or pulse is to be used for operating another circuit for a considerable longer period of time.

Although I have herein shown and described only one form of apparatus embodying my invention, it is to be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a source of direct current, a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, a second relay which is slow in operating from its energized to its deenergized position, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its deenergized position for connecting said circuit to said direct current source, means governed by said second relay in its energized position for connecting said circuit to said alternating current source, and a source of bias voltage connected across said control electrode and cathode to render the control electrode negative in potential with respect to the cathode, said source of bias voltage being so proportioned to normally render said direct current source and said alternating current source ineffective to fire said discharge device.

2. In combination, a source of direct current, a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, a second relay of a type that is slow in operating from its energized to its deenergized position, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its deenergized position for connecting

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said circuit to said direct current source, means governed by said second relay in its energized position for connecting said circuit to said alternating current source, and a source of input signal voltage connected across said control electrode and cathode, said source of input signal voltage being effective at times to render said direct current source and said alternating current source effective to fire said discharge device.

3. In combination, a source of direct current, a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said relay, a second relay, means governed by said second relay in its deenergized position for supplying energy to said circuit from said direct current source, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its energized position for supplying energy to said circuit from said alternating current source, a source of bias voltage connected across said control electrode and cathode and so proportioned to normally render said direct current source and said alternating current source ineffective to fire said discharge device, and a source of input signal voltage across said control electrode and cathode, said source of input signal voltage being effective at times to render said direct current source and said alternating current source effective to fire said discharge device.

4. In combination, a source of direct current, a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said relay, said first relay having a contact operable from a first to a second position when its winding is energized, a second relay having a winding and provided with a contact closed in a first position when its winding is deenergized and closed in a second position when its winding is energized, means including said contact of the first relay in its second position for energizing said second relay, means including said contact of the second relay in its first position for supplying direct current to said circuit from said direct current source, means including said contact of the second relay in its second position for supplying alternating current to said circuit from said alternating current source, a source of bias voltage connected across said control electrode and cathode and so proportioned to normally render said direct current source and said alternating current source ineffective to fire said discharge device, and a source of input signal voltage connected across said control electrode and cathode, said source of input signal voltage being effective at times to render said direct current source and said alternating current source effective to fire said discharge device.

5. In combination, a source of direct current, a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, said first relay having a contact operable from a first to a second position when its winding is energized, a second relay having a winding and provided with a contact closed in a first position when its winding is deenergized, said second relay being of the type that is slow in operating its contact from its

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second to its first position, means including said contact of the first relay in its second position for energizing said second relay, means including said contact of the second relay in its first position for supplying direct current to said circuit from said direct current source, means including said contact of the second relay in its second position for supplying alternating current to said circuit from said alternating current source, a source of bias voltage connected across said control electrode and cathode and so proportioned to normally render said direct current source and said alternating current source ineffective to fire said discharge device, and a source of input signal voltage connected across said control electrode and cathode, said source of input signal voltage being effective at times to render said direct current source and said alternating current source effective to fire said discharge device.

6. In combination, a source of direct current, a source of alternating current, a first relay, a second relay, a thyratron tube having an anode, a cathode, and a control electrode; a first anode circuit connected across said anode and cathode and including said direct current source, a back contact of said second relay and a winding of said first relay; a second anode circuit connected across said anode and cathode and including said alternating current source, a front contact of said second relay and said winding of said first relay; another circuit including a front contact of said first relay, a winding of said second relay and a power source for energizing said second relay; said direct current source and said alternating current source having voltages sufficient to fire said tube, a source of bias voltage, said bias voltage source being connected across said control electrode and cathode to render the control electrode negative in potential with respect to the cathode, said bias voltage source being of a voltage sufficient to render said direct current source and said alternating current source ineffective to fire said tube, and means including an input signal source connected across said control electrode and cathode and effective at times to counteract said bias voltage source.

7. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, a second relay of a type that is slow in operating from its energized to its deenergized position, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its deenergized position for connecting said circuit to said first pair of terminals, means governed by said second relay in its energized position for connecting said circuit to said second pair of terminals, and a source of bias voltage connected across said control electrode and cathode to render the control electrode negative in potential with respect to the cathode, said source of bias voltage being so proportioned that when said terminals are connected to said source of current said source will normally be ineffective to fire said discharge device.

8. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current,

a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, a second relay of a type that is slow in operating from its energized to its deenergized position, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its deenergized position for connecting said circuit to said first pair of terminals, means governed by said second relay in its energized position for connecting said circuit to said second pair of terminals, and a source of input signal voltage connected across said control electrode and cathode, said source of input signal voltage being effective at times when said direct current source and said alternating current source are connected to said terminals to fire said discharge device.

9. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, a second relay, means governed by said second relay in its deenergized position for connecting said circuit to said first pair of terminals, means governed by said first relay for energizing the winding of said second relay when said first relay is energized, means governed by said second relay in its energized position for connecting said circuit to said second pair of terminals, a third pair of terminals adapted to be connected to a source of input signal voltage and connected across said control electrode and cathode, and a fourth pair of terminals adapted to be connected to a source of bias voltage and connected across said control electrode and cathode.

10. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said first relay, said first relay having a contact operable from a first to a second position when its winding is energized, a second relay having a winding and provided with a contact closed in a first position when its winding is deenergized and closed in a second position when its winding is energized, means including said contact of the first relay in its second position for energizing said second relay, means including said contact of the second relay in its first position for connecting said circuit to said first pair of terminals, means including said contact of the second relay in its second position for connecting said circuit to said second pair of terminals, a third pair of terminals adapted to be connected to a source of input signal voltage and connected across said control electrode and cathode, and a fourth pair of terminals adapted to be connected to a source

of bias voltage and connected across said control electrode and cathode.

11. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current, a gas-filled electron discharge device having an anode, a cathode, and a control electrode; a first relay, a circuit connected across said anode and cathode and including a winding of said relay, said first relay having a contact operable from a first to a second position when its winding is energized, a second relay having a winding and provided with a contact closed in a first position when its winding is deenergized and closed in a second position when its winding is energized, said second relay being of a type that is slow in operating its contact from its second to its first position, means including said contact of the first relay in its second position for energizing said second relay, means including said contact of the second relay in its first position for connecting said circuit to said first pair of terminals, means including said contact of the second relay in its second position for connecting said circuit to said second pair of terminals, a third pair of terminals adapted to be connected to a source of input signal voltage and connected across said control electrode and cathode, and a fourth pair of terminals adapted to be connected to a source of bias voltage and connected across said control electrode and cathode.

12. In combination, a first pair of terminals adapted to be connected to a source of direct current, a second pair of terminals adapted to be connected to a source of alternating current, a first relay, a second relay, a thyratron tube having an anode, a cathode, and a control electrode; a first anode circuit connected across said anode and cathode and including said first pair of terminals, a back contact of said second relay and a winding of said first relay; a second anode circuit connected across said anode and cathode and including said second pair of terminals, a front contact of said second relay and said winding of said first relay; another circuit including a front contact of said first relay, a winding of said second relay and a pair of terminals adapted to be connected to a source of power for energizing said second relay, a pair of terminals adapted to be connected to a source of input signals, and connected across said control electrode and cathode, and a pair of terminals adapted to be connected to a source of bias voltage and connected across said control electrode and cathode.

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