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W. R. KOCH

2,275,016

CONTROL SYSTEM

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FIG. 1.

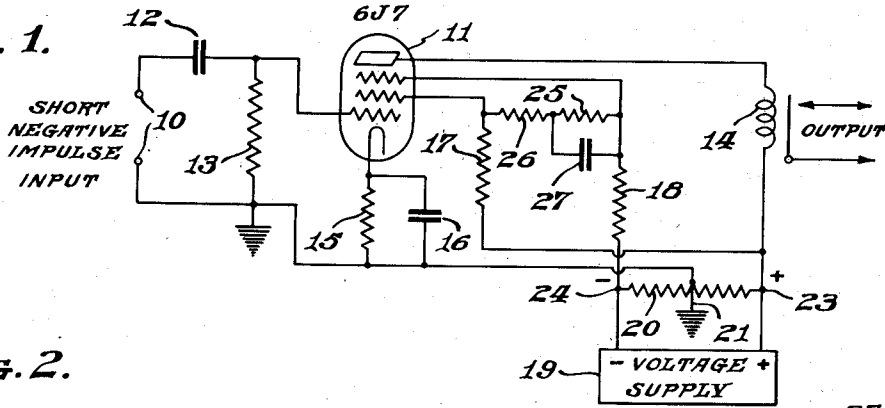


FIG. 2.

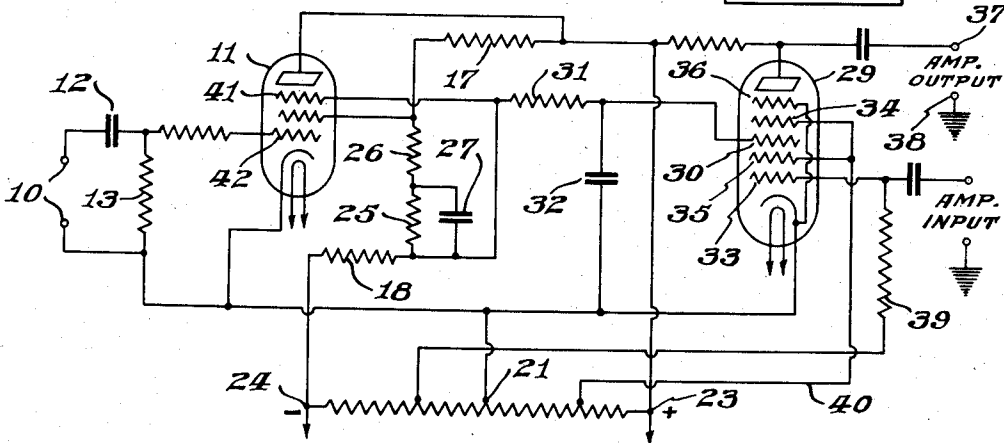


FIG. 4.

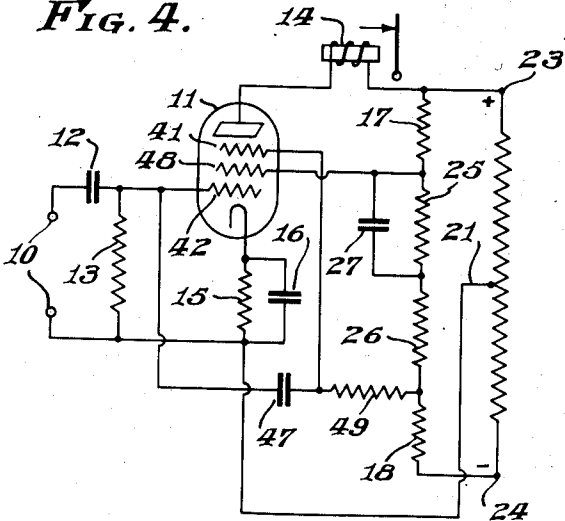
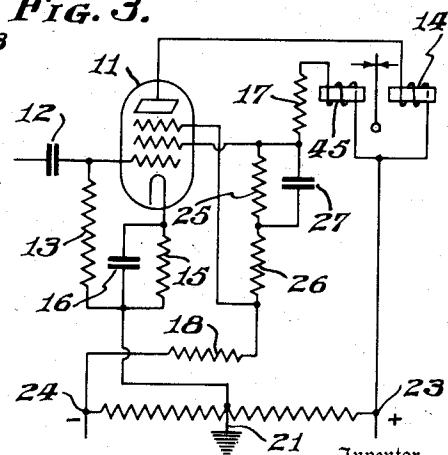


FIG. 3.



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[Signature]

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CONTROL SYSTEM

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8 Claims. (Cl. 250—27)

This invention relates to control systems such as are utilized to produce an effect which is dependent on the repetition or length of a control impulse, and has for its principal object the provision of an improved apparatus and method of operation whereby the use of floating batteries, gas tubes, insulated input transformers, and other expensive features, is avoided.

A further feature of the invention is the use of a single electron discharge device to produce a control effect heretofore realized only from the use of a plurality of electron discharge devices. The achievement of this improved result involves utilization of the negative transconductance existing between the suppressor grid voltage and screen grid current of an electron discharge device of the pentode type. The improved control system may obviously be utilized to exercise a control which is selective as to alternate control impulses or as to the length of successive impulses. One of the illustrated uses is that of initiating operation of an amplifier in response to one impulse and interrupting such operation in response to the next successive control impulse. Many other applications of the invention are readily recognizable.

The invention will be better understood from the following description considered in connection with the accompanying drawing, and its scope is indicated by the appended claims.

Referring to the drawing,

Figure 1 illustrates a control system adapted to operate a controlled device in response to alternate control impulses,

Figure 2 illustrates one application of this system to the control of a signal amplifier,

Figure 3 illustrates a modification of the system of Fig. 1, and

Figure 4 illustrates a system wherein the length of the control impulse is the determining factor in the resulting control effect.

The system of Fig. 1 includes input terminals 10, which are coupled to the input or control grid circuit of an electron discharge device 11 through a capacitor 12 and a resistor 13. The device 11 is of the pentode type and is provided with an output circuit which includes a relay winding 14 and a cathode return lead resistor 15 which is common to the input and output circuits of the device 11 and is shunted by a capacitor 16. The device 11 is also provided with a screen grid circuit which includes a resistor 17, and with a suppressor grid circuit which includes a resistor 18. Power for the operation of the device 11 is derived from a source 19, which is shunted by a

resistor 20 provided with a grounded terminal 21 which is connected through the resistor 15 to the cathode of the device 11, with a positive terminal 23 which is connected through the relay coil 14 to the plate or anode of the device 11 and is connected through the resistor 17 to the screen grid of this device and with a negative terminal 24 which is connected to the suppressor grid of the device 11 through the resistor 18.

Interposed between the screen and suppressor grid leads of the device 11 is a resistor 25—26, the section 25 of which is shunted by a capacitor 27. This capacitor is the very heart of the system, for the reason that the condition of its charge determines whether the plate or screen grid current will be large after the application of a negative control impulse to the control grid of the device 11.

Thus, if the circuit and applied voltages are adjusted so that the voltage of the screen grid would normally be +100 volts and the resistors 25—26 and 18 are of such values that the voltage of the suppressor grid would be -20 volts, (1) a small additional negative voltage applied to the suppressor grid will tend to turn back more electrons and thereby increase the screen grid current, thus making the screen grid more negative and, through the coupling afforded by resistors 25—26 and capacitor 27, making the suppressor grid still more negative and, through the accumulative action, reducing the plate current to a small value, or (2) a small additional voltage applied to the suppressor grid to make it less negative will tend to allow more electrons to pass through to the plate, thereby decreasing the screen grid current, thus making the screen grid and, in turn, the suppressor grids more positive and, through the accumulative effect, increasing the plate current to a large value. No intermediate stopping point is possible, and the plate current of the tube must assume one of the two values. The function of the capacitor 27 is to control this action in accordance with the condition of the circuit just prior to the application of the control impulse, or furnish a memory, so that after the application of an impulse, the plate current will be of a different value than prior to the impulse. This action is secured as follows.

When the plate current is large and the screen grid current is small, the suppressor grid potential approaches that of the cathode, the potential drop of the resistor 17 is low, the potential drop from the screen grid to the negative terminal 24 is therefore large, and the capacitor 27 is charged with its suppressor grid terminal negative.

When a short negative impulse is applied to the control grid under these conditions, the plate and screen grid currents are momentarily interrupted. As the impulse subsides, the current of the screen grid circuit increases, thus increasing the drop through the resistor 17, the capacitor 27 delays change in the potential drop of the resistor section 25, the potential drop in resistor 18 will therefore be small, making the suppressor grid more negative, and the plate current will become small. During the interval before the application of the next impulse, the charge of the capacitor 27 is reduced because of the lower voltage drop in the resistor 25 across which it is connected.

After the application of a short negative impulse to the control grid under these conditions, the suppressor grid will become less negative because the capacitor 27 will tend to keep the voltage drop in resistor 25 small, thus making the drop in resistor 18 large, the plate current will become large, and the screen grid current will become small. The capacitor 27 will be charged during the interval before the next impulse is applied to the control electrode, thus completing the repetition of the cycle set forth in the second paragraph above. There are thus delivered, at the output terminals of the system, impulses of a frequency which is one-half that of the control impulses. It is not necessary that the impulses be applied at any particular rate or with any regularity, but they must be of short duration and not too frequent to permit the change in charge in capacitor 27.

The control impulse responsive system of Fig. 2 is similar to that of Fig. 1, as indicated by the corresponding reference numerals, but is shown in this modification as utilized to control the operation of an amplifier 29, which may be of the pentagrid type and includes a third or control grid 30 coupled through a resistor 31 and a capacitor 32 to the junction of the capacitor 27 with the resistors 18 and 25. This amplifier also includes a signal input grid 33, screen grids 34, 35, a suppressor grid 36, and amplified signal output terminals 37-38. Bias potential is applied to the grid 33 through a resistor 39, and potential is applied to the screen 34-35 through a lead 40. The resistor 31 and capacitor 32 function to filter from the amplifier control voltage the control impulse voltage so that it does not appear in the amplifier output circuit.

With these connections, the amplifier is inoperative when the potential of the suppressor grid 41 of the control device 11 is highly negative, and is operative when the potential of this grid is less negative. As explained in connection with Fig. 1, these results are produced by the application of successive negative impulses to the control grid 42 of the device 11, the suppressor grid voltage being more negative when the screen grid current is large than when the plate current is large, and vice versa.

The system of Fig. 3 is similar to that of Fig. 1 in most respects, but differs therefrom in that it includes a two-winding relay, the additional winding 45 being connected in the screen grid circuit for operating the relay armature in a direction opposite to that in which it is operated by the winding 14. This, of course, avoids the necessity of a bias spring for the armature of the relay and makes the relay action more sensitive and positive.

The system of Fig. 4 is responsive to the length of the control impulse applied to the control grid

of the device 11, the plate current of the device 11 being large after a short control impulse and small after a long control impulse. This result is accomplished by the addition of a small capacitor 47 connected between the suppressor and control grids, and resistor 49 between the suppressor grid and the junction of resistors 18 and 26.

With the connections of Fig. 4, the added capacitor 47 will have little effect when a long impulse is applied to the control grid. In this case, the plate and screen grid currents are interrupted, a large potential drop is produced in the resistor sections connected between the negative terminal 24 and the screen grid 48, and the capacitor 27 is charged to a high voltage with its lower terminal negative. After the control impulse is terminated, current starts through the plate and screen grid circuits, the potential drop between the positive terminal 23 and the screen grid 48 increases, the capacitor 27 keeps the drop of the resistor section 25 nearly constant, and the potential drop between the terminal 24 and the lower side of the capacitor 27 decreases. This tends to make the suppressor grid 41 more negative, the screen grid current increases, the potential drop of the resistor 17 increases still further, the suppressor grid becomes more negative, and the plate current is reduced to a low value.

When a short impulse is applied to the control grid 42, however, there is transferred through the capacitor 47 a voltage which predominates over the voltage applied to the suppressor grid as a result of the above described effect of the screen grid current. Thus, when the control grid is becoming less negative as the control impulse decreases in value, the suppressor grid also becomes less negative, tending to make the plate current large and the screen grid current small. This change in screen grid current is in such a direction as to make the suppressor grid more positive because of the small potential drop in the resistor 17. The plate current is thus increased to a large value in response to the application of a short impulse to the control electrode of the device 11. In conjunction with a relay such as that shown in Fig. 3, the system of Fig. 4 may obviously be utilized to selectively operate a controlled device in accordance with the length of the control impulse to which it is subjected. The illustrated embodiments of the invention are, of course, susceptible of uses other than those described, as will be readily recognized without further detailed explanation.

I claim as my invention:

1. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, and means including a controlling capacitor responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit.

2. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals,

with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, means responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit, and an amplifier device provided with one control grid maintained at a voltage dependent on the voltage of said suppressor grid and with another control grid which is subjected to the signal to be amplified.

3. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, means responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit, and relay means provided with a plurality of operating coils one of which is responsive to the current of said output circuit and the other of which is responsive to the current of said screen grid circuit.

4. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, means responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit, and means for causing the current of said output circuit to be small when the input circuit control impulse is of relatively long duration and to be large when said impulse is of relatively short duration.

5. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals, with an output circuit connected with the anode

electrode and with screen and suppressor grid circuits, means for energizing said electrodes, means responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit, and means responsive to the duration of said control impulses for predetermining which of said circuits is selected.

6. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with a control grid circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, means responsive to the relation between the suppressor voltage and screen grid current of said device for causing current to be transmitted selectively through said output circuit or through said screen grid circuit, and means including a capacitor connected between said suppressor grid and input circuits for predetermining which of said circuits is selected.

7. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with an input circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, and means including a resistor and a capacitor shunting a portion thereof connected between said suppressor and screen grid circuits for causing only alternate control impulses to be effective in said output circuit.

8. The combination of control impulse supply terminals, an electron discharge device having a cathode, anode, control grid, screen grid and suppressor grid electrodes provided with an input circuit connected to said terminals, with an output circuit connected with the anode electrode and with screen and suppressor grid circuits, means for energizing said electrodes, and a resistance-capacity network including a controlling capacitor connected between said screen and suppressor grid circuits for causing current to be transmitted selectively through said output circuit or through said screen grid circuit.

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