Aug. 22, 1939. G. E. PRAY 2,170,157

ELECTRONIC SWITCH DEVICE

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FIG. 1

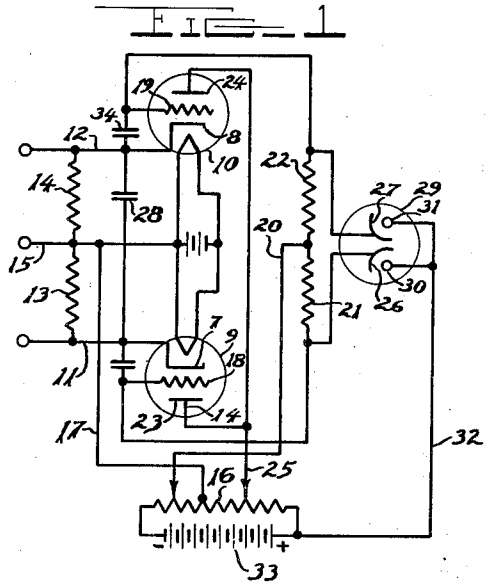


FIG. 2

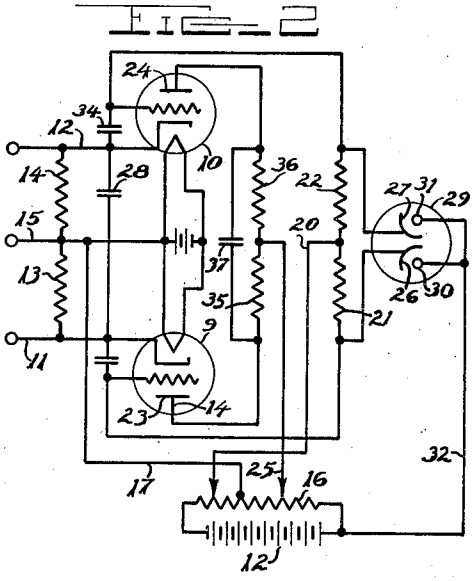
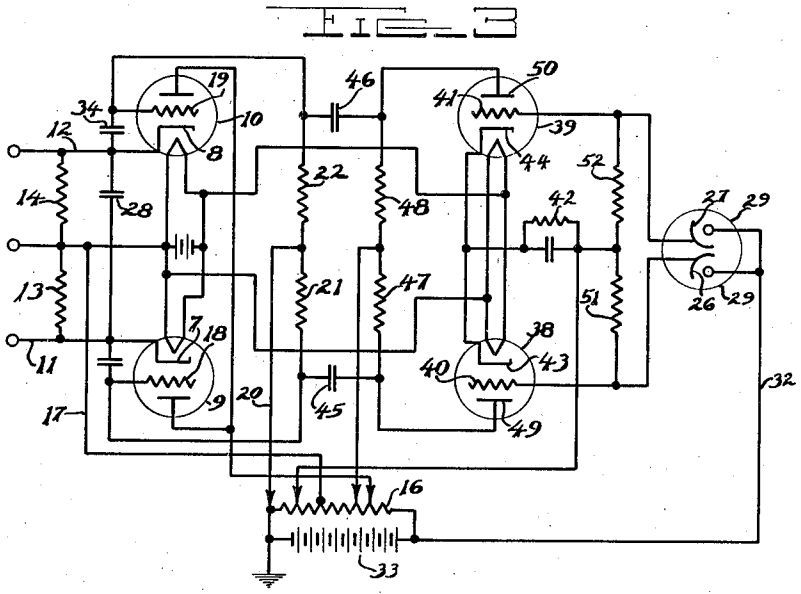


FIG. 3



INVENTOR

G. Emerson Pray

BY

Ramon K. Davis

ATTORNEY

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FIG. 4

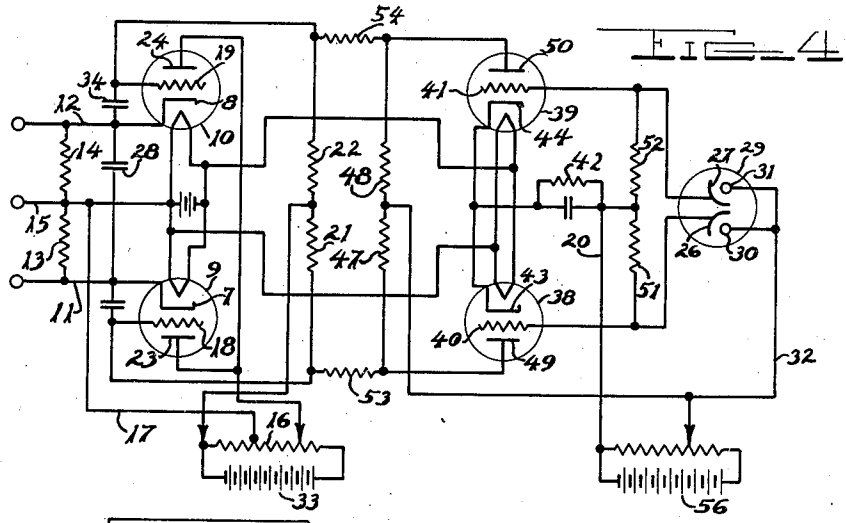


FIG. 5

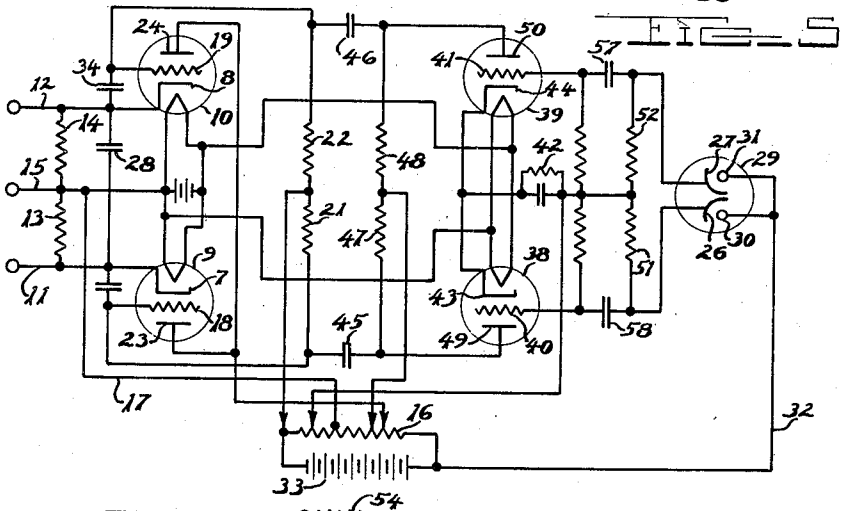
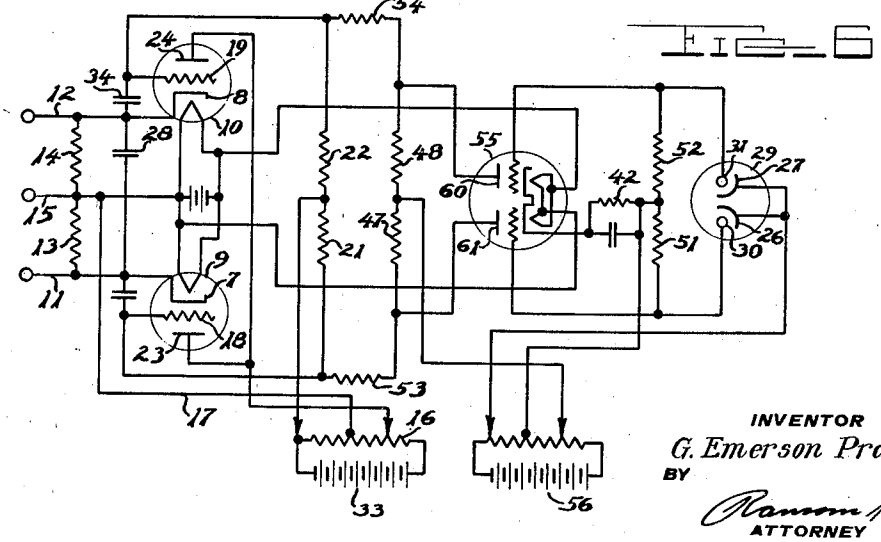


FIG. 6



INVENTOR
G. Emerson Pray
BY
Ransom K. Davis
ATTORNEY

Patented Aug. 22, 1939 2,170,157

UNITED STATES PATENT OFFICE

2,170,157

ELECTRONIC SWITCH DEVICE

George Emerson Pray, Washington, D. C.

Application March 30, 1939, Serial No. 265,017
9 Claims. (Cl. 250—41.5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates to apparatus to shift back and forth between two points a potential for operating or controlling other apparatus, and in particular, it is an improvement on the electronic switch disclosed in my copending application, Serial No. 152,222, filed July 6, 1937.

The general object of this invention is to provide an improved type of electronic switch.

In the drawings:

Fig. 1 is a circuit diagram of an embodiment of the present invention utilizing two hot cathode gas triodes;

Fig. 2 is in general similar to Fig. 1 but adds certain features to the anode circuits of the tubes;

Fig. 3 adds to Fig. 1 means for amplifying the potential applied to the grids of the gas triodes;

Fig. 4 differs from Fig. 3 in that resistive coupling instead of capacitive coupling is used between the amplifiers and the gas triodes;

Fig. 5 differs from Fig. 3 in that the photo-electric means is capacitively coupled to the amplifiers;

Fig. 6 illustrates a twin triode amplifier in the circuit of Fig. 4.

It is frequently desirable that a potential for operating or controlling certain apparatus be shifted with great rapidity from one point to another. An example of such apparatus is shown in my co-pending application above referenced wherein the electronic switching means is energized in accordance with signal perforations in a tape and the apparatus keys a transmitting circuit in accordance with such perforations. It is to be understood that any desired means may be utilized with the present invention to effect alternate energization of the photo-electric units. In my said co-pending application, the electronic switching means is described as including cold cathode gas triodes, but such cathodes must be of considerable area to furnish adequate emission and therefore the present invention utilizes hot cathode gas triodes, which may be those commonly known as RCA type 885. However, when hot cathode gas triodes are used, it is necessary to provide a definite bias voltage between the grid and the cathode to make the grids negative with respect to the cooperating cathodes when the tubes are not in operation.

Referring now to Fig. 1, the cathodes 7 and 8 of gas-filled triodes 9 and 10 are connected to leads 11 and 12 between which the keying potential is to be switched. Resistors 13 and 14 are respectively connected between the leads 11 and 15 and 12 and 15, the lead 15 being connected to a point of suitable cathode biasing potential on voltage divider 16 through the conductor 17. Capacitor 28 is connected across both cathodes 7 and 8.

Grids 18 and 19 are connected to a point of suitable negative potential on voltage divider 16 through the common lead 20 and resistors 21 and 22, respectively, and anodes 23 and 24 are connected to a point of sufficiently high positive potential through the common lead 25. Cathodes 26 and 27 of a twin photo-electric cell 29 are respectively connected to the grid-connected terminals of resistors 21 and 22 and the respectively cooperating photo-cell anodes 30 and 31 are connected by lead 32 to the high potential terminal of voltage divider 16.

The operation of the above described apparatus is as follows:

When there is no current flowing in tubes 9 or 10, or photo-cell 29, there is no potential drop across resistors 13, 14, 21 and 22. Consequently, cathodes 7 and 8 are at the same potential as each other and as the common lead 17. Likewise, grids 18 and 19 are at the potential of lead 20 and are hence negatively biased with respect to cathodes 7 and 8. The grid bias required depends upon the anode potential applied, and where the latter is 90 volts the former may be 12 volts. Likewise, photo-cell anodes 30 and 31 may be operated with a potential of 90 volts. If photo-cell 29 is an RCA type 920 cell a light flux of 0.025 lumen falling upon cathode 27 will cause a current of about two micro-amperes to flow through resistor 22 and lead 20 through battery 33 to anode 31. A desirable value for resistor 22 is two megohms and when such value is used, the photo-cell current above mentioned will result in a positive potential of 4 volts at the grid-connected terminal of resistor 22 which will be applied to grid 19 and is sufficient to ignite the tube 10 and cause it to pass current. It is readily apparent that capacitor 34 will have been charged and that when the gas in tube 10 is ionized by the above mentioned charge in potential on grid 19, capacitor 34 will discharge through tube 10 and for very rapid operation, this capacitor should have a low value. Current through tube 10 passes through resistor 14 to lead 17 and thus charges capacitor 28 to a potential determined by the drop across resistor 14 which, with the values used in this circuit, is 74 volts since the drop through tube 10 is substantially 16 volts. Thus, a positive "marking" voltage is available on lead 12.

It is apparent from the foregoing that the potential on cathode 8 will now be 74 volts which is added to the negative 8 volts on grid 19 and

hence the cathode 8 is now 82 volts positive with respect to the cooperating grid. Interruption of the light falling on cathode 27 will result in no current passing through the photo-electric cell and hence the positive 4 volts developed by the photo-cell current and applied to grid 19 will be removed and the potential on cathode 8 with respect to grid 19 will rise to 86 volts. Anode current will continue to flow through tube 10, however, until the anode-cathode circuit is interrupted, which occurs when tube 9 is ignited and passes current. It will be seen that the drop across resistor 14 has negligible effect on the grid-cathode circuit of tube 9, since relatively little current flows through resistor 13 after capacitor 28 is charged. Therefore, grid 18 is biased at its normal potential of 12 volts and anode 23 has its normal 90 volts and the tube is ready for operation.

If now, a light flux of the value above stated falls upon cathode 26, a current of 2 microamperes will flow through resistor 21 and will reduce the potential on grid 18 to 12 volts and thus ignite tube 9 and cause it to pass current. The flow of current from tube 9 through resistor 13 is in opposition to the drop across resistor 14 and since discharge of capacitor 28 is delayed by resistors 13 and 14, the potential drop across resistor 13 due to current from tube 9 momentarily adds to the potential across capacitor 28 and doubles the drop across resistor 14, thereby raising the potential of cathode 8 to 148 volts. Since the potential on anode 24 is 90 volts, the net result is that cathode 8 is 58 volts positive with respect to anode 24, which is more than sufficient to stop the flow of current through tube 10. Capacitor 28 then discharges through resistors 13 and 14 and is charged in the opposite direction by the potential across resistor 13 and a "spacing" potential is available on lead 11. The same cycle of potential changes on the elements of tube 9 as was above described for tube 10 then takes place but tube 9 continues to pass current until light again falls upon cathode 27 and tube 10 is again ignited with consequent interruption of the flow of current through tube 9 in the same manner as in tube 10.

Fig. 2 discloses a circuit that is in general similar to that in Fig. 1, but here resistors 35 and 36 are respectively connected in the supply leads to anodes 23 and 24 and a capacitor 37 is connected across both resistors 35 and 36. It is apparent that flow of current through tube 10 in Fig. 2 will result in a potential drop across resistor 36 that will charge capacitor 37 through resistor 35 and will reduce the positive potential on anode 24 and hence will aid in the extinction of current flow through tube 10 when tube 9 is set into operation. Otherwise, the functioning of the circuit in Fig. 2 is the same as in Fig. 1. The values of resistors 35 and 36 and of capacitor 37 are interdependent with the values of resistors 13 and 14 and capacitor 28 respectively and, if desired, the "marking" and "spacing" potentials may be taken off across resistors 35 and 36 and capacitor 37.

When it is found desirable to do so, the voltages derived from the photo-cell 29 may be amplified as depicted in Fig. 3. Here, the triode amplifiers 38 and 39 have their grids 40 and 41 connected to the resistors 51 and 52 in place of the gas triode grids in the preceding figures. A grid-biasing resistor 42 is provided between cathodes 43 and 44 and the respective grids 40 and 41 and the tubes 38 and 39 normally pass a small current. It is apparent that capacitors 45 and 46 will be charged from battery 33 through the resistors 21, 47 and 22, 48 respectively and that such charges hold the grids 18 and 19 at potentials to limit the flow of current through tubes 9 and 10. However, when light falls upon cathode 27 of photo-cell 29 the current through resistor 52 results in a positive voltage that raises the potential on grid 41 sufficiently to increase the current through tube 39 and also gives rise to a negative potential that is applied to grid 40 and reduces, or completely stops, the flow of current through tube 38. The potential of capacitor 45 is thus decreased by the drop across resistor 48 and the bias on grid 19 is sufficiently reduced to permit tube 10 to pass current. The operation of tube 10 then follows the cycle above set forth and continues until interrupted by the flow of current through tube 9 due to excitation of cathode 26 of photo-cell 29 and the resulting flow of current through tube 38.

Fig. 4 discloses a circuit that is like that in Fig. 3 except that the anodes 49 and 50 of tubes 38 and 39 are coupled to grids 18 and 19 of tubes 9 and 10 by resistors 53 and 54, respectively, instead of capacitively.

Fig. 5 includes the further modification that photo-cell 29 is capacitively coupled to grids 40 and 41 of tubes 38 and 39 by capacitors 56 and 57.

Fig. 6 modifies Fig. 4 by substituting a twin triode 55 for the amplifier tubes 38 and 39 and by connecting anodes 30 and 31 of photo-cell 29 to the control of grids of the amplifiers instead of connecting the cathode 26 and 27 thereto. Here tube 55 is biased for flow of current through both sets of electrodes so the drop across the resistors 47 and 48 biases grids 18 and 20 to keep tubes 9 and 10 inoperative. When light falls on cathode 27, current passes between anode 31 and cathode 27, the resulting drop across resistor 52 reducing the flow of current to anode 60 so the bias on grid 19, due to the drop across resistor 48, is reduced sufficiently that tube 10 ignites. Cessation of light flux to cathode 27 allows the current to anode 60 to resume its initial value but tube 10 continues to pass current until light falls on cathode 26 and reduces the current to anode 61, when tube 9 is ignited and tube 10 is extinguished, as above described. In Figs. 4 and 6 an additional battery 56 is used to avoid continuous flow of current through coupling resistors 53 and 54.

The invention herein described and claimed may be used and/or manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. Electronic switch apparatus, comprising two gas triodes each having a grid, a hot cathode and an anode; a capacitor connected between the grid and the cathode in each tube, a switching voltage capacitor connected between said cathodes, two resistors whereof one terminal of each is connected to a respective cathode and the other terminals of both are connected to a common point, a source of potential, means connecting said common point to a point on said source to bias said cathodes, means connecting said anodes to a point of more positive potential on said source, two high resistors each having one terminal connected to a respective grid and the other terminal connected to a point of said source of more negative potential than the point of connection of said cathodes to said source, two sets of cooperating pho-

toelectric anodes and cathodes, means connecting both photoelectric anodes to a point of high positive potential on said source and means connecting each of the photoelectric cathodes to the grid-connected terminal of a respective one of said high resistors.

2. Electronic switch apparatus, comprising two gas triodes each having a grid, a hot cathode and an anode; a capacitor connected between the grid and the cathode in each tube, a switching voltage capacitor connected between said cathodes, two resistors whereof one terminal of each is connected to a respective cathode and the other terminals of both are connected to a common point, a source of potential, means connecting said common point to a point on said source to bias said cathodes, two anode resistors each connected at one terminal to a respective one of said anodes and at the other terminal to a common point on said source of more positive potential than the point of connection of said cathodes to said source, capacitance connected across both said anode resistors, two high resistors each having one terminal connected to a respective grid and the other terminal connected to a point on said source of more negative potential than the point of connection of said cathodes to said source, two sets of cooperating photoelectric anodes and cathodes, means connecting both photoelectric anodes to a point of high positive potential on said source and means connecting each of the photoelectric cathodes to the grid-connected terminal of a respective one of said high resistors.

3. Electronic switch apparatus, comprising two gas triodes each having a grid, a hot cathode and an anode; a capacitor connected between the grid and the cathode in each tube, a switching voltage capacitor connected between said cathodes, two resistors whereof one terminal of each is connected to a respective cathode and the other terminals of both are connected to a common point, a source of potential, means connecting said common point to a point on said source to bias said cathodes, two anode resistors each connected at one terminal to a respective one of said anodes and at the other terminal to a common point on said source of more positive potential than the point of connection of said cathodes to said source, two vacuum tubes each having a cathode, a grid and an anode, two anode resistors each respectively connected at one terminal to an anode of a said vacuum tube and at the other terminal to a common point on said source of more positive potential than the connection of the cathodes of said vacuum tubes to said source, a capacitive coupling between each vacuum tube anode and the grid of a respective triode, two resistors each respectively at one terminal to the grid of a said vacuum tube and at the other terminal to a common point on said source somewhat less negative than the connection of said triode grids to said source, self-biasing means connected between the cathodes and grids of said vacuum tubes, two sets of photoelectric anodes and cathodes whereof each cathode is connected to the grid of a respective vacuum tube and both anodes are connected to a point of high positive potential on said source.

4. Electronic switch apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; two sets of selectively energizable photoelectric anodes and cathodes, resistive means connected across said grids and said photoelectric cathodes whereby passage of current through a photoelectric anode and cathode raises the potential on a said grid to cause a triode to pass current and current supply means operatively connected to said triodes and said photoelectric elements.

5. Electronic switch apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; resistive means and capacitive means in parallel with each other and in series with each said anode, two sets of selectively energizable photoelectric anodes and cathodes, resistive means connected across said grids and said photoelectric cathodes whereby passage of current through a photoelectric anode and cathode raises the potential on a said grid to cause a triode to pass current and current supply means operatively connected to said triodes and said photoelectric elements.

6. Electronic switch apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; two amplifier tubes each having an anode, a grid and a cathode, a resistor in the supply to each said amplifier anode, capacitive means coupling each said amplifier anode to the grid of a respective triode, two sets of selectively energizable photoelectric anodes and cathodes, resistive means connected across the grids of said amplifier tubes and said photoelectric cathodes whereby potential due to passage of current through a said photoelectric anode and cathode changes the potential on a said amplifier grid and by the resulting flow of current through the amplifier ignites one of said triodes, and current supply means operatively connected to all said tubes.

7. Electronic switch apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; two sets of photoelectric means for producing electric current, means connected to each set to derive a positive potential from the current therefrom, and means to apply each such positive potential to a respective triode grid to ignite such triode, and current supply means operatively connected to all said tubes.

8. Electronic switching apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; two sets of photoelectric means for pro-

ducing electric current, means connected to each set to derive a positive potential from the current therefrom, means to amplify said positive potential, means to apply each such amplified positive potential to the grid of a respective triode to ignite such triode, and current supply means operatively connected to all said tubes.

9. Electronic switch apparatus, comprising two gas triodes each having an anode, a hot cathode and a grid and normally biased to pass no current; resistive means and capacitive means connected in parallel between said cathodes to develop a potential difference when either of said tubes is passing current and to stop the flow of current through one said tube when the other is ignited; two electron discharge units each including an anode, a grid and a cathode, all biased to pass current; a source of current, means connecting said discharge unit cathodes to said source, a respective resistor in series between each discharge unit anode and said source, means to apply to said triode grids the potential drop due to current through said respective resistors; two sets of photoelectric anodes and cathodes, two resistors each connected at one terminal to a photoelectric anode and to a discharge unit grid and at the other terminal to a common connection to said source, and means connecting said photoelectric cathodes to a common point on said supply less positive than the connection of said photoelectric anodes thereto.

GEORGE E. PRAY.