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MONO-STABLE MULTIVIBRATOR

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Fig. 1.

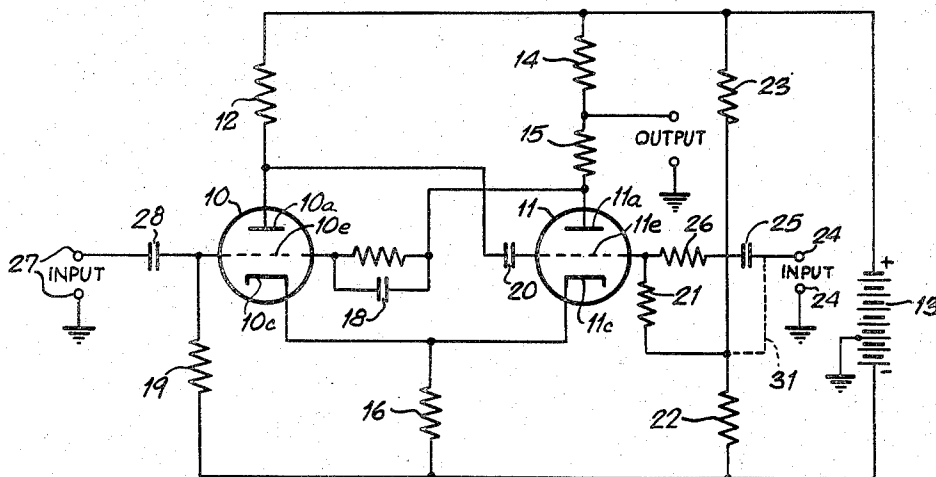
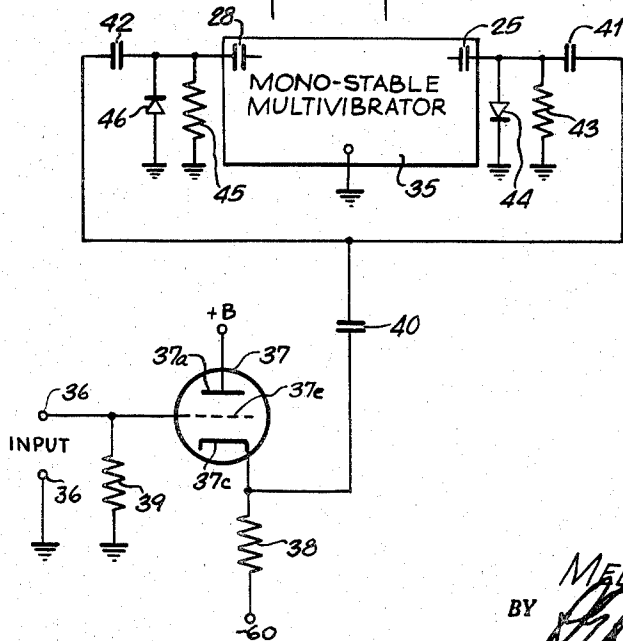


Fig. 2.



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MONO-STABLE MULTIVIBRATOR

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3 Claims. (Cl. 250—27)

This invention relates to electronic relaxation systems of the multivibrator type and, particularly, to the mono-stable form which is often called a "one-shot" multivibrator and is characterized by a normally stable operating condition but controllable temporarily to effect an unstable condition after which it automatically reverts within a predetermined short interval to its stable condition.

It is an object of the invention to provide a new and improved mono-stable multivibrator characterized by high stability and reliability of its operating characteristics.

It is a further object of the invention to provide an improved mono-stable multivibrator which may be controlled by the use of either or both positive or negative polarity changes of a control potential as desired in a particular application.

It is an additional object of the invention to provide a novel mono-stable multivibrator having a single control circuit which receives both positive-polarity and negative-polarity control potentials and in which either polarity is individually distinguished by the control circuit to provide a pre-selected desired control action of the multivibrator.

A mono-stable multivibrator embodying the invention includes a pair of discharge devices each having a conductance-control electrode and a load impedance, and having an impedance common to the input and output circuits of the devices for developing a common bias potential for both control electrodes. The load impedance of one of the devices is utilized for applying to the control electrode of the other the output of the one device including a steady-state bias potential of value normally rendering the other device non-conductive. A time-constant network applies an alternating current component output of the other device to the control electrode of the one device, and there is applied to the control electrode of the one device a steady-state bias potential of value rendering the one device normally conductive. With this arrangement, changes of control potential in one sense may be applied to the control electrode of one of the devices to change the state of conductance of that device, and changes of control potential in opposite sense may be applied to the control electrode of the other device likewise to change its state of conductance. The output potential of either device may be used for control purposes as desired.

Other objects and advantages of the invention will appear as the detailed description thereof proceeds in the light of the drawing forming a part of this application, and in which:

Fig. 1 is a circuit diagram representing a mono-stable multivibrator embodying the present invention in a particular form; and

Fig. 2 is a circuit diagram, partially schematic, embodying a modified form of the invention.

Referring more particularly to Fig. 1, the mono-stable multivibrator of the invention includes a pair of discharge devices 10, 11 which are shown as of the triode

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type and may, for example, be comprised of vacuum tubes each having a cathode 10c or 11c, a control electrode 10e or 11e, and an anode 10a or 11a. A load impedance 12, such as a resistor, couples the anode 10a of the device 10 to the positive terminal of a source of energizing potential 13. Similar series-connected load impedances 14, 15 couple the anode 11a of the device 11 to the potential source 13. A resistor 16 is provided in common to the cathodes of the devices 10 and 11, and thus is common to the input and output circuits of the devices, to develop from the space currents of the devices a common bias or operating potential for their control electrodes 10e and 11e.

A resistor 17 and shunt-connected condenser 18 couple the anode 11a of the device 11 to the control electrode 10e of the device 10 for applying the output of the former to the latter device. At the same time, the serially-connected load impedance 14, 15 of the device 11 and the resistor 17 form with a resistor 19, which is connected between the control electrode 10e and the negative terminal of the potential source 13, a resistive voltage divider across the source 13 which is effective to apply to the control electrode 10e a steady-state bias potential of value normally rendering the device 10 non-conductive. The anode 10a of the device 10 is coupled through a condenser 20 to the control electrode 11e of the device 11 to apply an alternating current component output of the device 10 to the latter control electrode. A resistor 21, which couples the control electrode 11e through a resistor 22 to the negative terminal of the potential source 13, comprises with the condenser 20 a series network having component values selected to integrate the output of the device 10. A resistor 23 is connected in series with the resistor 22 across the potential source 13 to form a voltage divider which applies through the resistor 21 to the control electrode 11e a steady-state bias potential of value rendering the device 11 normally fully conductive.

A first control circuit 24 may be coupled through a condenser 25 and a resistor 26 to the control electrode 11e of the device 11 by which to control the multivibrator circuit by changing the potential in a negative direction, or a second control circuit 27 may be coupled through a condenser 28 to the control electrode 10e by which to control the multivibrator by changing the potential in a positive direction.

Considering now the operation of the multivibrator just described, the multivibrator is normally stable in the condition of normal full conductivity of the device by virtue of the steady-state bias applied to its control electrode 11a through the resistor 21 from the voltage divider 22, 23. The device 10 at the same time is normally non-conductive by virtue of the bias applied to its control electrode 10e by the potential divider 14, 15 and 19. For representative component values and assuming the potential source 13 has a positive potential of 140 volts above ground and a negative potential of 60 volts below ground, the positive potential of the anode 11a of the device 11 has a value of approximately 60 volts and the control electrode potential of this device has with respect to ground a negative value at this time of approximately five volts. The cathodes 10c and 11c of the respective devices 10 and 11 also have a negative potential with respect to ground in the steady-state condition of the multivibrator of approximately five volts.

If it be now assumed that the control electrode 11e of the device 11 has its potential made more negative by a control potential applied to the control circuit 24, the device 11 becomes less conductive and the potential of its anode 11a accordingly becomes more positive, thus increasing in a positive direction the bias of the control electrode 10e of the device 10. If this change is suffi-

ciently large, the device 10 thereupon becomes conductive and the potential of anode 10a decreases. This decrease of potential is applied through the coupling condenser 20 to the control electrode 11e of the device 11 rendering the latter device even less conductive. This further increases the positive potential of its anode 11a, and thereby increases in a positive direction the bias of the control electrode 10e of the device 10. This action is cumulative or regenerative, and the device 11 is quickly rendered non-conductive and the device 10 fully conductive.

The resistor 12 in the anode circuit of the device 10 is selected to have a value which is small in comparison with the sum of resistors 14 and 15. The resulting large space current of the device 10 increases the positive potential developed across the cathode resistor 16 by approximately 20 volts. This value of bias is sufficiently large that the device 11 is unable to become conductive even after the control potential is removed from the control circuit 24 and the control electrode 11e has returned to its initial value. The condenser 25 starts its discharge at this time from its initial negative voltage of approximately five volts, which was the value of the bias on the control electrode 11e during the steady-state condition of the multivibrator, toward the positive 20 volt bias to which the cathodes 10c and 11c of the devices 10 and 11 have been raised by the cathode current of the device 10 as earlier explained. As the condenser 25 and its associated control electrode 11e approach the control electrode cut-off bias of approximately 12 volts of the device 11, the latter again becomes conductive and the positive potential of its anode 11a drops. This drop in potential is applied through the resistor 17 and condenser 18 to the control electrode 10e of the device 10 to render the latter less conductive and thereby increase the positive potential of its anode 10a. The latter increase of potential is applied in turn through the condenser 20 to the control electrode 11e further to increase the conductivity of the device 11. This action again is cumulative in a regenerative manner to cause the device 11 to be very rapidly driven into its fully conductive state with the condenser 25 being discharged almost instantaneously to a negative potential of approximately five volts. At the same time, the device 10 is very rapidly driven to its normal non-conductive state. The multivibrator thereupon completes a cycle of operation from its stable condition to its unstable condition and automatically back to its stable condition. The rapidity with which the multivibrator returns to its stable condition, after being placed in its unstable condition, is dependent primarily upon the time-constant of the condenser 25 and impedance of the control-potential source which is coupled to the control circuit 24.

It will be apparent from the foregoing described operation of the multivibrator circuit that it may likewise be changed to its unstable condition by application of a positive control potential through its control circuit 27. This increases in a positive direction the bias of the control electrode 10e of the device 10 to render the latter conductive. The operation of the multivibrator is then essentially the same as that earlier described and will not be repeated.

As pointed out above, the condenser 25 serves both as a coupling condenser for control potentials applied to the control circuit 24 and as the timing condenser establishing the time interval required for the multivibrator to return to its stable condition after it has been placed in its stable condition. Where only the one control circuit 27 is used by which to control the multivibrator by potentials changing in a positive direction, the multivibrator circuit is modified by connecting one terminal of the condenser 25 to the juncture of the resistors 21 and 22 as indicated by the broken line 31.

Fig. 2 is a circuit diagram representing a modified form of the invention, circuit elements of Fig. 2 which correspond with those of Fig. 1 being designated by similar reference numerals. The Fig. 1 multivibrator

is here shown as a unit 35, and a single control circuit 36 is used to control its operation by either positive or negative control potentials applied to the latter circuit. The control circuit 36 is coupled to the control electrode 37e of a discharge device 37 which may be of the triode type as shown and includes a cathode 37c which is connected through a cathode resistor 38 to ground. The anode 37a of the device is coupled to a source of anode potential, indicated as +B, and its control electrode 37e is connected to ground through a resistor 39, thus completing the connections of the device 37 as a cathode follower type of repeater stage. The resistor 38 of the stage is coupled through a condenser 40 to two condensers 41 and 42 which in turn are coupled to respective condensers 25 and 28 of the multivibrator 35. Connecting the juncture of the condensers 41 and 25 to ground is a resistor 43 and a shunt-connected unidirectional conductive device 44 which may be a thermionic diode rectifier or a germanium or copper-oxide form of diode rectifier. Similarly connecting the juncture of the condensers 42 and 28 to ground is a resistor 45 and similar unidirectional conductive device 46. The devices 44 and 46 are so poled that potentials increasing in the positive direction or increasing positive potentials applied from the cathode follower 37 render the device 44 conductive but not the device 46, whereas applied potentials decreasing in the positive direction or potentials of increasing negative polarity render the device 46 conductive but not the device 44. Thus, positive or negative pulses of potentials applied to the single control circuit 36 are translated by the cathode follower amplifier 37 to the control circuits 24 and 27 of the multivibrator 35. The positive pulses are applied to the control circuit 27 to operate the multivibrator to its unstable condition as earlier described, whereas the positive pulses are not applied to the control circuit 24 since they are shunted around this control circuit by rendering the device 44 conductive. On the other hand, negative pulses applied to the control circuit 36 render the device 46 conductive and accordingly are shunted around the control circuit 27, but they are not shunted by the device 44 and are thus applied to the multivibrator control circuit 24 likewise to operate the multivibrator to its unstable condition.

In the operation last described, positive pulses applied to the control circuit 36 produce a positive shift of potential across the cathode-follower load resistor 38, and this positive increased potential is differentiated as it is applied to the control circuit 27 of the multivibrator. In similar fashion, the negative pulses applied to the control circuit 36 are differentiated in being applied to the control circuit 24 of the multivibrator. The use of a cathode follower is desirable in this arrangement, since it constitutes a low-impedance driving source capable of charging either condenser 41 or 42, depending upon which of the devices 44 or 46 is rendered conductive, in addition to effecting the required change of potential at the other of the control circuits 24 or 27 as required to effect operation of the multivibrator to its unstable state. It will be apparent from this that any other equivalent low-impedance driving source may be used in place of the cathode follower stage 37.

While not intending to limit the invention, the following component values are illustrative as suitable for use in the Figs. 1 and 2 embodiments of the invention.

Tubes 10, 11 and 37 -----	Type 5965.
Resistor 12 -----	5100 ohms.
Resistor 14 -----	15,000 ohms.
Resistor 15 -----	5100 ohms.
Resistor 16 -----	10,000 ohms.
Resistor 17 -----	300,000 ohms.
Resistor 19 -----	220,000 ohms.
Resistor 21 -----	1.8 megohms.
Resistor 22 -----	100,000 ohms.

Resistor 23	82,000 ohms.
Resistor 26	100 ohms.
Resistor 38	10,000 ohms.
Resistor 39	0.5 megohms.
Resistor 43	100,000 ohms.
Resistor 45	100,000 ohms.
Condenser 18	15 micromicrofarads.
Condenser 20	15 micromicrofarads.
Condenser 25	50 micromicrofarads to 0.02 microfarad (timing condenser).
Condenser 28	50 micromicrofarads.
Condenser 40	100 micromicrofarads.
Condenser 41	22 micromicrofarads.
Condenser 42	22 micromicrofarads.
Devices 44 and 46	Type 1N34.

What is claimed is:

1. A mono-stable multivibrator comprising a first discharge device, a second discharge device, each of said devices having at least a plate, conductance-control electrode, and cathode, a source of energizing potential, a load impedance for said first discharge device to said source, a load impedance for said second device to said source, said last-mentioned impedance being of a value less than said first mentioned impedance, a common impedance connecting the cathodes of both said devices to said source, means for applying to the conductance-control electrode of said first discharge device a steady-state bias potential from said source of a value rendering said first discharge device normally conductive independent of the conductivity of either device, means including said source and said load impedance of said first discharge device for rendering said second discharge device normally non-conductive when said first discharge device is conductive, means for applying only the change of potential at the plate of said second discharge device to the conductance-control electrode of said first discharge device, means for applying a switching pulse to at least one of said control electrodes to initiate a switching cycle of said multivibrator, whereby said first device is additionally biased off by rise of its cathode to a higher potential, said steady-state bias means for the control electrode of said first device being adapted to draw said latter control electrode toward a potential higher than said higher cathode potential, timing circuit means to delay the rise of potential of the control electrode of said first device for a predetermined time, and at least one output circuit coupled

to an individual load impedance of one of said discharge devices.

2. A mono-stable multivibrator in accordance with claim 1 in which said first device responds to one sense of input-circuit potential change from a first predetermined value to become non-conductive and said second device responds to an opposite sense of input-circuit potential change from a second predetermined value to become conductive, an input circuit to said first discharge device, an input circuit to said second discharge device, a common control circuit coupled to each of said control electrode input circuits and adapted to receive and transmit potential changes in either of said senses, and means included in said input circuits for permitting substantially only potential changes in said one sense from said first predetermined value to be applied by said control circuit to said first device and substantially only potential changes in said other sense from said second predetermined value to be applied by said control circuit to said second device.

3. In combination with a mono-stable multivibrator circuit comprising a pair of devices having conductance-control input circuits, and adapted to respond to a pulse of only one sense applied to one of said input circuits or to a pulse only of the opposite sense applied to the other of said input circuits to initiate a complete cycle of operation of the multivibrator, two pulse transmitting circuit means connected, respectively, to said input circuits, one of said pulse transmitting means being adapted to pass only pulses of the sense which is effective at the input circuit to which it is connected to trigger said multivibrator circuit, the other one of said pulse transmitting means being adapted to pass only pulses of the opposite sense, and a common pulse generating means capable of generating pulses of either sense coupled to each of said pulse transmitting circuit means.

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