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"N" STABLE MULTIVIBRATOR

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FIG. 1

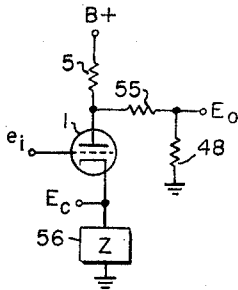


FIG. 2

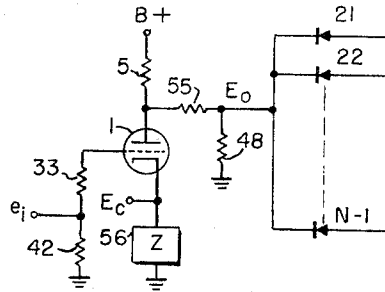
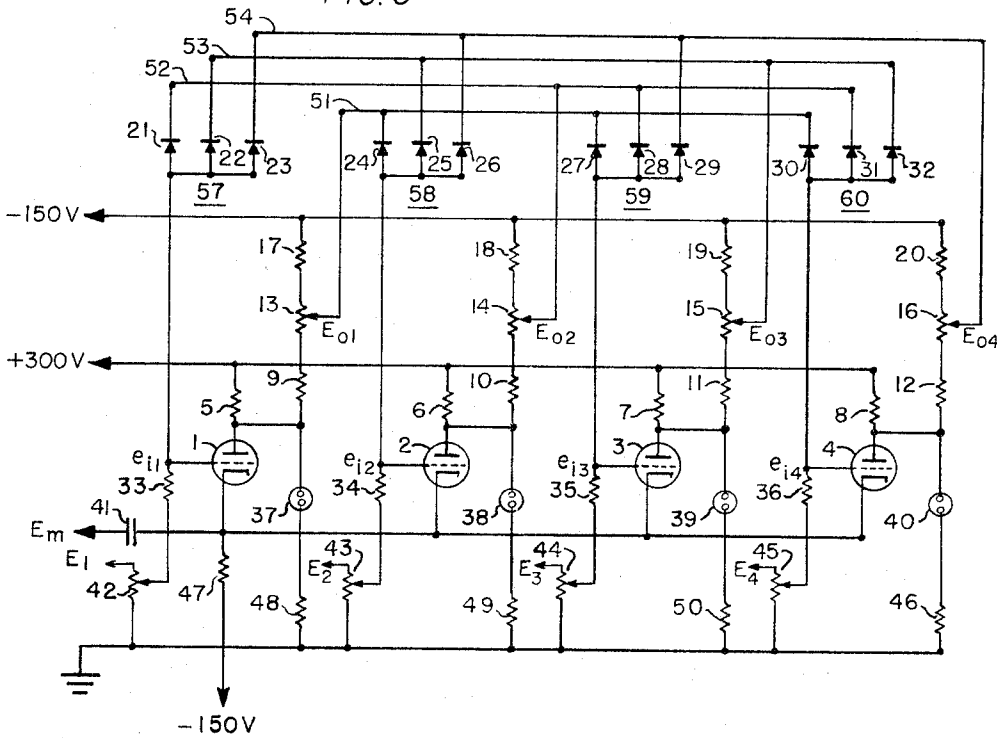


FIG. 3



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"N" STABLE MULTIVIBRATOR

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This invention relates to a multivibrator circuit and more particularly to a multivibrator circuit that has a plurality of stable states.

The invention relates specifically to a multivibrator circuit having more than two stages. The stages are connected together in such a manner that the addition of "N" active elements provides "N" stable states. These states correspond to the condition of any one of the active elements being turned "on" while the remaining active elements are "off." The stable states are exclusive because the stage that is turned "on" provides a potential that holds the remaining stage "off." Thus, at no time can more than one stage be turned "on."

Several different types of multi-stable multivibrator circuits are known; however, generally speaking the number of stable stages is limited in the prior art devices and the stable states are not exclusive when more than two states are provided.

Therefore, an object of my invention is to provide a multivibrator circuit having more than two stable states.

Another object of my invention is to provide a multivibrator circuit that has as many stable states as there are active elements.

Another object of my invention is to provide a multivibrator circuit that has "N" stable states.

A still further object of my invention is to provide a multivibrator circuit that has "N" exclusive stable states.

These and other objects of the invention will become readily apparent by referring to the following specification and accompanying drawing in which like parts in the various figures have like numerals and in which:

FIG. 1 shows the basic circuitry of a single tube stage of a bistable multivibrator.

FIG. 2 shows the basic circuitry of a single stage of my invention.

FIG. 3 shows a multi-stable multivibrator circuit in accordance with my invention.

FIG. 1 which shows a single tube stage of a basic multivibrator is included in this application only to illustrate how the well known multivibrator is modified to arrive at my invention; however, a brief discussion of this circuit may be helpful. The combination of resistors 55 and 48 forms the basic D.C. coupling between stages. The output voltage E_o is adjusted to be approximately equal to the common stage voltage E_c developed across the coupling impedance Z . A complete bistable multivibrator is formed by taking a second tube stage essentially identical to FIG. 1 and interconnecting the two stages in a well known manner.

As was stated above, a single stage of my "N" stable multivibrator is made by modifying the circuit of FIG. 1. These modifications, as shown in FIG. 2, include the addition of resistors 33 and 42 and the addition of a coupling network comprising diodes 21 through $N-1$ (where N is the total number of tube stages in the final circuit). If the input signal is applied directly to the grid of tube 1

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rather than through resistor 33, only one resistor connected between grid and ground is necessary. My "N" stable multivibrator is arrived at by interconnecting, in the manner shown in FIG. 3, "N" tube stages essentially identical to the tube stage of FIG. 2.

The multivibrator shown in FIG. 3 has four identical tube stages, and therefore, it has four stable states. Each stage has a triode, input and output circuits, and a diode coupling network. The cathodes of triodes 1 through 4 are coupled to a negative 150 volt potential through common resistor 47. Input signals E_1 through E_4 are applied to the control grids of triodes 1 through 4 respectively. When one of the triodes is conducting, diode networks 57 through 60 operate to hold the remaining tubes cut-off. The diode networks each consist of three or ($N-1$) diodes (where "N" is the number of tube stages). The anodes of the diodes in each network are connected to the control grid of the associated triode. For example, the anodes of diodes 21, 22, and 23 in network 57 are connected to the grid of triode 1 and the anodes of diodes 30, 31 and 32 in network 60 are connected to the grid of triode 4. The plate of each triode is coupled through a variable and fixed resistor to the cathode of one diode in each network except the diode network that has the anodes of its diodes connected to the grid of the same tube. Thus, the plate of triode 1 is coupled through fixed resistor 9 and variable resistor 13 to the cathodes of diodes 24, 27, and 30 in networks 58 through 60 respectively. However, the plate of triode 1 is not coupled to any of the diodes in network 57; since, the anodes of these diodes are connected to the grid of this tube. A B+ potential of 300 volts is coupled to the plates of triodes 1 through 4 via resistors 5 through 8 respectively. A negative potential of 150 volts is applied to the output networks of all the triodes. The various fixed potentials are so adjusted that the output voltage E_o of a given tube is greater than its grid voltage e_1 when the tube is cut-off and less than its grid voltage when it is conducting. Neon lamps 37 through 40 give a visual indication of which stage is turned "on."

The circuit shown in FIG. 3 has two modes of operation. It is operated in one mode when the input signals are above the level required to change states and is operated in the mode when the input signals are below the level required to change states.

With no input signals applied, all the tube stages start to conduct the moment the fixed potentials are applied; and an unstable balanced condition exists. As soon as a random noise pulse from shot noise in the tubes, or from slight differences in the tube characteristics disturbs this balanced condition one tube starts to draw more current than the others. This slight unbalance cause the one favored tube to increase the bias of the others, tending to cut them "off." This action continues until the favored tube is held full "on" while the other tubes are held full "off."

The operation just described is obtained by means of a D.-C. feedback path and applies not only to my "N stable" multivibrator but also to all bistable devices. Diode networks 57 through 60 provide the D.-C. feedback path in my circuit. The diode networks provide a path for applying a negative bias to the tubes that are to be cut-off. This can be seen by assuming that one of the tubes, say triode 2, is the favored tube. When triode 2 is conducting, diodes 21, 28, and 31 will be biased in the for-

ward direction, and the grids of triodes 1, 3, and 4 will be driven more negative. As the grids of these triodes are driven more negative their plates become more positive. The increased potential on the plates of triodes 1, 3, and 4 back biases diodes 24, 25, and 26. Eventually triode 2 will be full "on" and the bias on triodes 1, 3, and 4 will be sufficiently negative to hold these tubes "off." When triodes 1, 3, and 4 are "off," the potential on the cathodes of diodes 24, 25, and 26 will be positive; therefore, these diodes will be back biased and the grid of triode 2 will be held more positive than its cathode. Since the grid of triode 2 is held more positive than its cathode, triode 2 will remain "on" until it is turned "off" by an input signal or signals.

The circuit of FIG. 3 is now ready to receive input pulses in its first mode of operation. In this mode of operation at least one of the input signals E_1 - E_4 must be of sufficient amplitude to cause a change of state or else nothing will happen. Of course, no change will take place, if the one pulse that is above the threshold required to cause a change of state is applied to the favored tube. The assumption was made earlier that triode 2 is the favored tube; therefore, it will be assumed that triode 1 is the only tube that receives a pulse whose amplitude is above the threshold level. Under these conditions, triode 1 will begin to draw current and the series of events described above in reference to the favored tube, will again take place; however, in this case triode 1 is turned "on" and held "on" while triodes 2, 3, and 4 are held "off."

If all the input pulses E_1 - E_4 are above the threshold value and not in time coincidence, the tubes will be turned "on" in sequence. The sequence will be determined by the time relationship of the input pulses. The tube receiving its pulse first will be turned "on" first.

If the input pulses E_1 - E_4 are above the threshold value and in time coincidence, the operation depends upon whether or not the pulses are of equal amplitude. When the time coincident pulses are of equal amplitude, no change of state takes place. The favored tube remains "on." When the pulses are not of equal amplitude, the tube receiving the largest pulse will be turned "on."

In the second mode of operation, the input pulses E_1 - E_4 are all below the threshold level required to cause a change of state. Before any input pulses are applied to the grids of the triodes, a measure pulse E_m is applied to the cathodes of all the tubes. This measure pulse turns all the tubes "off." At the end of the measure pulse, the triode having the largest input pulse applied to its grid is turned "on." The fact that the circuit operates in this manner when a measure pulse is applied to the cathodes of the triodes is apparent if the operation when no input pulses are applied is recalled. At the end of the measure pulse all the tubes begin to conduct and an unsteady balanced condition exists. The input signals to the grids disturb this balance. The tube receiving the largest signal on its grid will draw more current than the other tubes and eventually all the other tubes will be cut-off.

From the above discussion it is apparent that my circuit when operated in its second mode compares the input signals and selects the one having the largest amplitude. My invention can also be used as a pulse amplitude comparator when operated in its first mode; however, in this case all the input signals to the grids must be coincident in time. It will, of course, be apparent to those skilled in the art that my invention can be used for purposes other than amplitude comparison. It will also be apparent to those skilled in the art that various omissions, substitutions and changes in form can be made to the embodiment shown and described without departing from the scope of the invention. For example, transistors can be substituted for the triodes shown without changing the basic circuit configuration. There-

fore, it is my intention to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. An "N" stable multivibrator comprising: "N" electron tube stages, each stage having a triode electron tube, a diode network, input circuit means, and output circuit means; means to connect the cathodes of all said triode electron tubes to a common point; means to apply separate input signals to the input circuit of each of said triodes; and means to couple the output circuit of each said electron tube to all but one of said diode networks.

2. A multistable multivibrator circuit comprising: first, second, third and fourth triode electron tubes; means to apply separate input signals to each of said electron tubes; a first, second and third diode; means to couple the anodes of said first, second and third diode to the grid of said first triode; a fourth, fifth, and sixth diode; means to couple the anodes of said fourth, fifth and sixth diodes to the grid of said second triode; seventh, eighth and ninth diodes; means to couple the anodes of said seventh, eighth and ninth diodes to the grid of said third triode; tenth, eleventh and twelfth diodes; means to couple the anodes of said tenth, eleventh and twelfth diodes to the grid of said fourth triode; means to couple the anode of said first triode to the cathodes of said fourth, seventh and tenth diodes; means to couple the anode of said second triode to the cathodes of said first, eighth and eleventh diodes; means to couple the anode of said third triode to the cathodes of said second, fifth and twelfth diodes; means to couple the anode of said fourth triode to the cathodes of said third, sixth and ninth diodes; and means to connect the cathodes of all said triodes to a common point.

3. An "N" exclusive stable state multivibrator comprising: "N" electron tubes each having a cathode, a grid, and an anode; means to connect the cathodes of all said electron tubes to a common point; means to apply separate input signals to the grids of all said electron tubes; "N" diode networks each having $(N-1)$ diodes; and means to couple the grids of each said electron tubes through said diodes to the anodes of all the other said electron tubes.

4. An "N" exclusive stable state multivibrator comprising: "N" electron tubes each having a cathode, a grid and an anode; means to connect the cathodes of all said electron tubes to a common point; means to apply separate input signals to the grids of all said electron tubes; "N" diode networks each having $(N-1)$ diodes; means including said diode networks for coupling the grid of each said electron tube to the anodes of all the other said electron tubes; and means to simultaneously apply a measure pulse to the cathodes of all said electron tubes.

5. A multivibrator circuit having "N" exclusive stable states comprising: "N" identical tube stages; each said tube stage having a triode electron tube, an input circuit, an output circuit, and $(N-1)$ diodes; means to couple the anodes of said $(N-1)$ diodes of each stage to the input circuit of that stage; means to couple the input circuit of each stage to the grid of the triode of that stage; means to connect the cathodes of the triodes of all said stages to a common point; means to apply separate input signals to the input circuit of each of said stages; and feedback means including said $(N-1)$ diodes of all said stages for coupling the output circuit of each said stage to the input circuit of all the other of said stages.

6. A multivibrator circuit as described in claim 5 wherein a measure pulse is applied to said common point.

7. An "N" stable multivibrator comprising: "N" triode electron tubes; means to couple the cathodes of all said triodes to a common point; means to apply separate input signals to each grid of all said triodes; and feedback means for coupling the output of each of said triodes to the grids of all the other triodes, said feedback means including "N" diode networks each having $(N-1)$ diodes.

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8. An "N" stable multivibrator comprising "N" amplifying devices each having an input electrode, an output electrode and a third electrode; means to connect said third electrode of all said amplifying devices to a common point; means to apply separate input signals to said input electrodes of all said amplifying devices; "N"-diode networks each having (N-1) diodes; and means including said diode networks for coupling the input electrode of each said amplifying device to the output electrodes of all the other of said amplifying devices.

9. An "N" stable multivibrator as described in claim 8 wherein a measure pulse is applied to said common point.

10. An "N" stable multivibrator as described in claim 8 wherein said amplifying devices are transistors.

11. An "N" stable multivibrator as described in claim 15

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10 wherein a measure pulse is applied to said common point.

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