

April 12, 1955

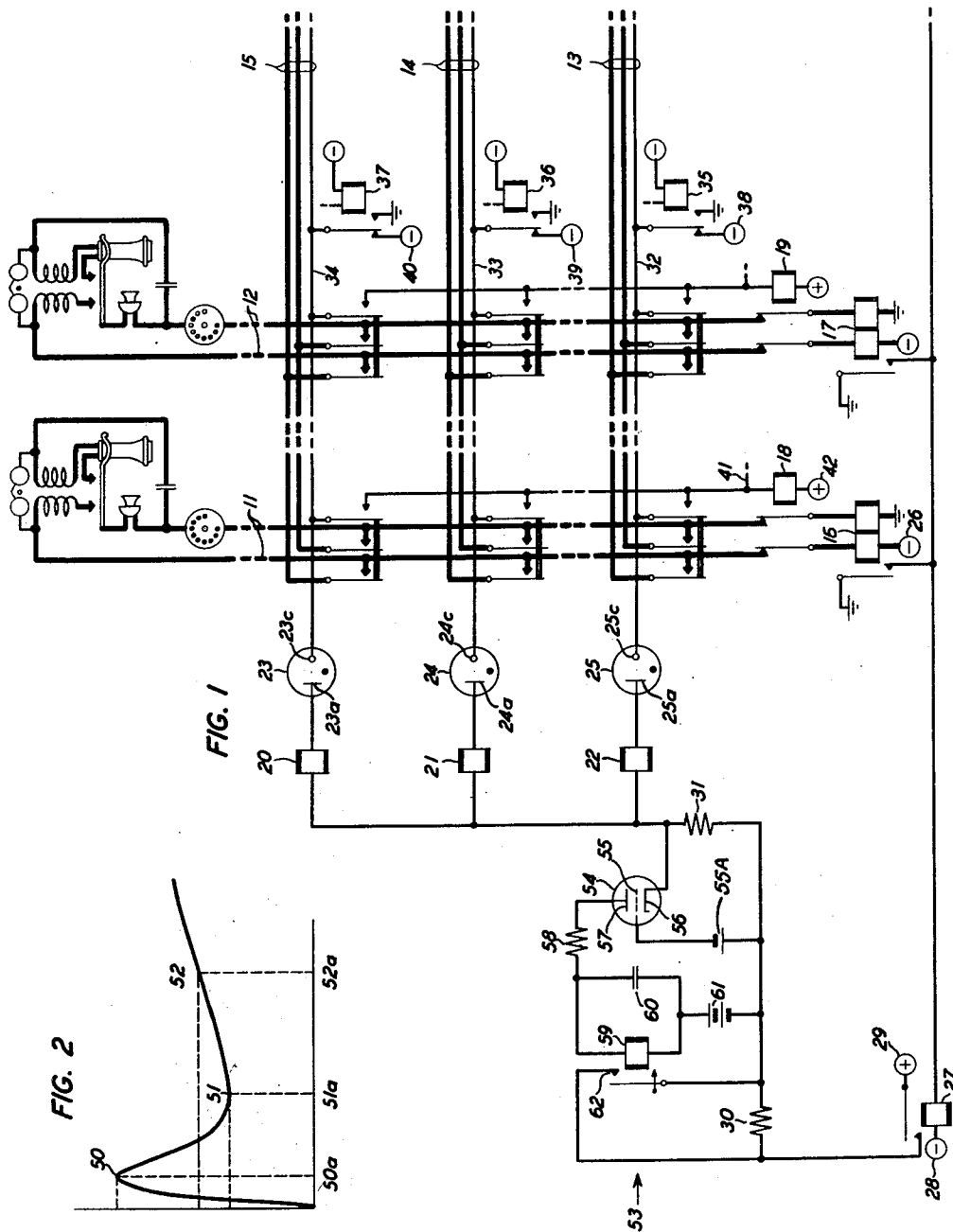
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2,706,221

TWO-STEP LOCKOUT SYSTEM

Filed May 22, 1952

2 Sheets-Sheet 1



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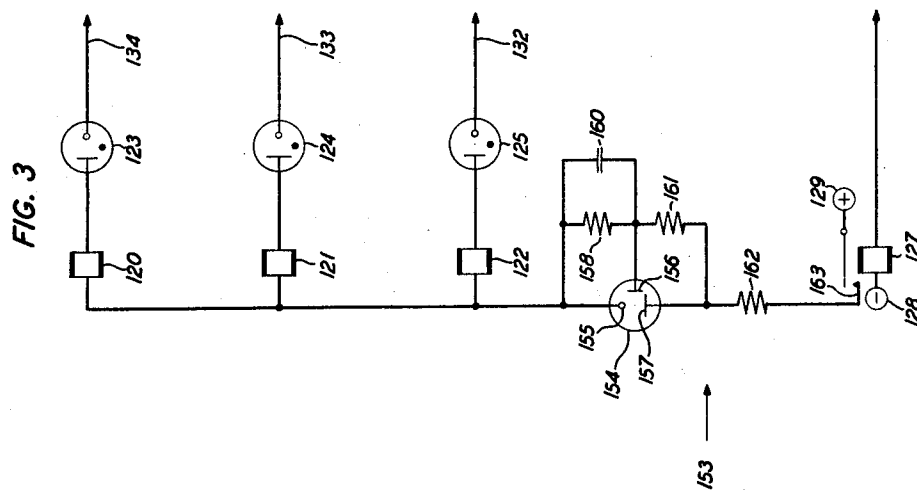
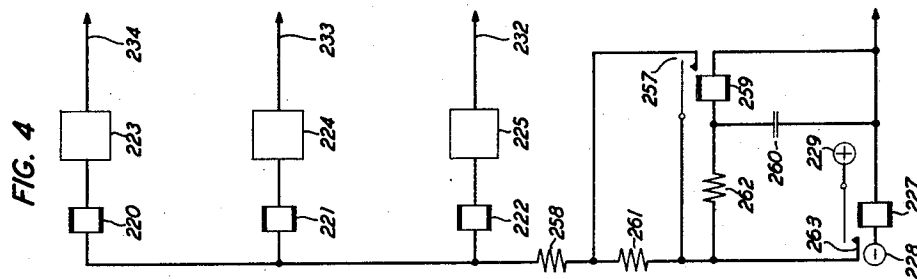
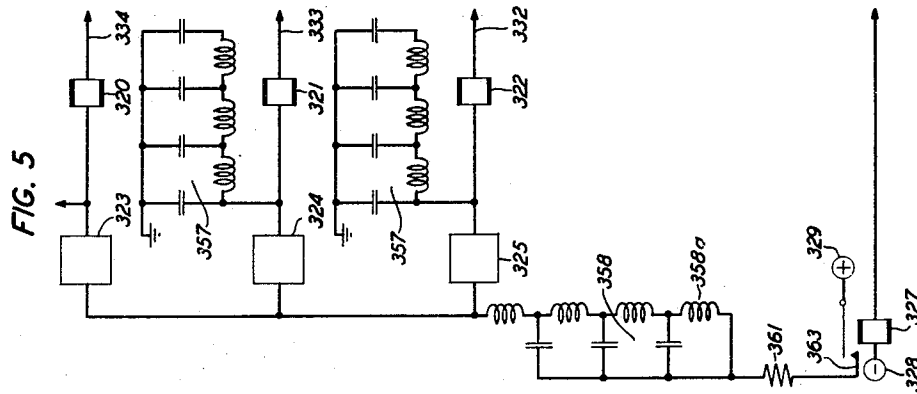
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2 Sheets-Sheet 2



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TWO-STEP LOCKOUT SYSTEM

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13 Claims. (Cl. 179—18)

My present invention relates to electronic lockout systems and more particularly to lockout systems utilizing circuit components having a negative slope over a limited range of their voltage current characteristics.

A lockout circuit is here defined as a circuit which under the influence of a number of external circuits provides an output indication corresponding to one and only one of these circuits at any time.

Heretofore in the prior art lockout circuits utilizing circuit components having a negative resistance characteristic have been utilized, as for example, lockout circuits utilizing gaseous diodes. It is well known in the art that when a breakdown potential is applied through a series resistor to a plurality of gaseous diodes connected in parallel, only one of them will usually conduct. The diode having the lowest breakdown potential will usually ionize first with an accompanying reduction of potential to its ionizing sustaining potential. The reduction of potential across the parallel circuitry of the gaseous diodes prevents the subsequent breakdown or firing of any of the other gaseous tubes. Unwanted concurrent ionization, however, of two or more gas tubes and the operation of their associated output loads occasionally occur in this type of lockout circuit. Though various means have been suggested for overcoming this difficulty and decreasing the probability of the occurrence of lockout failure, it is believed that no absolutely failure-proof means have been suggested. For example, an inductor or varistor, in addition to or in lieu of the common series resistor has been connected in series with the parallel circuitry of the gas tubes to increase the time of transition through the negative resistance portion of the tube characteristics and multielectrode selecting tubes have also been suggested where the initial starting voltage causes the tubes to ionize in two or more successive stages. Only one of the tubes usually succeeds in transferring the ionization to its main electrodes while the other tubes are rendered inoperative by the ensuing lowering of the voltage. All of the means, however, as suggested in the prior art necessitate dissimilar tube characteristics for satisfactory operation and thus only reduce the probability of lockout failure.

The present invention overcomes the difficulties existing in the prior art by providing for a novel, two-stage, lockout system. A potential is supplied through a resistance to a plurality of negative resistance devices connected in parallel where each device has associated therewith in series an individual output load apparatus. The current restricted by the resistance is insufficient to operate the output load apparatus if one or more devices discharge. The initiation of discharge in one or more of the devices causes the operation of a delay circuit which after a finite interval of time allows the current to rise to a value sufficient to operate the output load apparatus. If two or more devices discharge simultaneously an unstable condition necessarily occurs in the restricted current range which seeks a stable system where only one tube remains conductive. The maximum time for the stabilization of the system where only one tube conducts is less than the predetermined delay time for the operation of the delay circuit.

It is then an object of the present invention to provide for a novel lockout system that is absolutely failure-proof.

Another object of the present invention is the provision of a novel random negative resistance device

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lockout system that operates successfully even when the characteristics of the negative resistance devices are identical.

Still another object of the present invention is the provision of a novel two-stage, lockout system utilizing gas tubes where an unstable condition necessarily occurs when two or more tubes fire simultaneously and where the associated output load apparatus operates after all but one of the tubes are extinguished.

Further objects and advantages will become apparent in consideration of the following description taken in conjunction with the figures wherein:

Fig. 1 is a circuit diagram illustrating a switching system incorporating the novel features of the present invention in which a detector delay circuit is utilized;

Fig. 2 is a voltage current characteristic of a typical negative resistance device utilized in the present invention;

Fig. 3 is a circuit diagram illustrating a second embodiment of the present invention in which a gaseous triode delay circuit is utilized;

Fig. 4 is a circuit diagram illustrating a third embodiment of the present invention in which the delay circuit is directly operated; and

Fig. 5 is a circuit diagram illustrating a fourth embodiment of the present invention in which delay lines are utilized.

This invention is applicable to a wide variety of uses and to numerous kinds of systems. More specifically it is particularly useful wherever it is desirable to make a single exclusive random selection from a plurality of simultaneous demands. Although the invention is not limited in its application to any specific type of switching system, it is illustrated herein in connection with a system for extending the subscriber's line of a telephone system to groups of links, trunks or other circuits. It is assumed that the subscribers' lines appear on primary line switches of the well-known crossbar type and that these primary switches have access through links and secondary line switches to groups of trunk relays.

Referring now to Fig. 1 the subscribers' lines 11, 12, etc., appear in vertical rows and the outgoing trunks appear in the horizontal rows 13, 14, 15, etc. Individual line relays 16, 17, etc., and switch hold magnets 18, 19, etc., represent the subscribers' lines, and select magnets 20, 21, 22, etc., represent the outgoing circuits. Each outgoing circuit is also represented by a gaseous tube 23, 24, 25, etc. The anodes 23a, 24a, 25a, etc. of the tubes 23, 24, 25, etc., are connected together through the select magnets 20, 21, 22, etc. respectively.

When a subscriber picks up his receiver he initiates a sequence of events, as is hereinafter described, which results in a connection of the subscriber to one of the outgoing trunks 13, 14, 15, etc. The lifting of the receiver corresponding to the subscriber's line 11, for example, closes a circuit through the lines 11, the line relay 16, and the battery 26. The energization of the relay 16 closes a circuit from ground through the armature of the relay 16, the relay 27, to the negative battery 28. The energization of the relay 27 closes a circuit supplying a positive battery 29, through the armature of relay 27, the resistances 30 and 31 and relays 20, 21, 22, etc., to the anodes 23a, 24a, 25a, etc., of the gas diodes 23, 24, 25, etc. The resistors 30 and 31 are connected between the back contact of the relay 27 and the parallel circuitry, described above, of the relays 20, 21, 22, etc. and the tubes 23, 24, 25, etc. The cathodes 23c, 24c, 25c, etc., of the tubes 23, 24, 25, etc., are connected respectively through the conductors 34, 33, 32, etc., and the armatures of relays 37, 36, 35, etc. hereinafter described, to negative batteries 40, 39, 38, etc. In this manner a voltage is placed across the tubes 23, 24, 25, etc. which is equal to the sum of the positive voltage 29 and one of the negative voltages 38, 39, 40, etc. The sum voltage is approximately equal to the breakdown potential for the tubes 23, 24, 25, etc. and one or more than one of the tubes 23, 24, 25, etc. fire initially. Only one of the tubes 23, 24, 25, etc. remains fired and passes sufficient

current, as is hereinafter described in reference to Fig. 2 to operate its respective select magnets 20, 21, etc. The operation of select magnet 22, for example, in response to the continued ionization of tube 25 prepares the horizontal row of cross-bars, which appear in outgoing circuit 13, for further operation. Thereafter, in any suitable manner a circuit is closed over conductor 41 for the operation of hold magnet 18 connected through a positive battery 42 to ground. The operation of hold magnet 18 closes the said cross-bar contacts and establishes a circuit from the subscriber's phone through line 11 to the outgoing circuit 13. Simultaneous with the establishment of a circuit to the outgoing line 13, the relay 35, which is under the control of the supervisory relay (not shown) operates to place ground potential upon the cathode 25c of tube 25 and also provides a holding circuit to ground for hold magnet 18. The removal of the negative potential from the cathode 25c, does not reduce the potential across the tube 25 to a value below its sustaining potential and thus the tube 25 remains conducting until the deenergization of the relay 27. When the hold magnet 18 is energized it opens the line 11 to deenergize relay 16 which in turn causes the relay 27 to deenergize. Deenergization of relay 27 opens the circuit from positive battery 29 to the anodes 23a, 24a, 25a, etc., extinguishing tube 25 and deenergizing select magnet 22.

If the subscriber upon line 12 should attempt to place a call during the continuation of the call along lines 11, tube 25 would not be affected. Relay 27 would be operated from ground on the armature of line relay 17 in the manner described above with respect to line relay 16. Relay 35 remains energized throughout the duration of the call from the subscriber of line 11 and therefore keeps the cathode 25c at ground potential. The potential across tube 25 due to the battery 29 alone is below the breakdown potential and thus does not cause ionization, upon its reapplication thereto. The remaining tubes 23, 24, etc., however have their cathodes negatively biased and thus are able to ionize upon the application of potential due to battery 29.

When the subscriber of line 11 hangs up his receiver the supervisory relay (not shown) operates to deenergize relay 35 which in turn opens the holding circuit for relay 18. The relay 18 is deenergized due to the balancing of batteries 42 and 38 where the reconnection of battery 38 also readies the tube 25 for another subscriber. The use of the supervisory relay referred to above and its mode of operation are well known in the art as, for example, in patent to E. H. Clark 1,844,147, dated February 9, 1932.

As briefly described above, only one of the tubes 23, 24, 25, etc., will operate its respective select relay 20, 21, 22, etc. in response to the lifting of the subscriber's receiver. Referring now to Fig. 2 which is a typical voltage current characteristic of one of the gaseous diodes 23, 24, 25, etc., 50 is the maximum voltage or the breakdown voltage and occurs at approximately 10^{-8} amperes. The characteristic has a negative slope between the maximum voltage 50 and point 51 where the slope passes through zero to become positive again. It is evident therefore that for any value of current between the currents 50a and 51a the tubes 23, 24, 25, etc. will present a characteristic of decreased voltage with increase of current, usually called a negative resistance effect. When a subscriber lifts his receiver, a voltage equal to the sum of the positive potential from battery 29, in Fig. 1 and the negative potential from one of the batteries 38, 39, 40, etc. is applied across each of the tubes 23, 24, 25, etc. unless as described above any of the respective output lines 13, 14, 15, etc. is being used. If an output line 13, 14, 15, etc. is busy, its respective tube 25, 24, 23, etc. receives a potential equal only to that supplied by the battery 29 and so cannot fire. If the tubes 23, 24, 25, etc. receiving the sum voltage, have different breakdown voltages, one of them will break down, or ionize, first and have accompanied therewith a rapid reduction in voltage to the sustaining voltage. The resistances 30 and 31 described above restrict the total current through one or more of the tubes 23, 24, 25, etc. to a value less than 52a in Fig. 2 which corresponds to a voltage of 52. The select relays 20, 21, 22, etc., require for operation currents in excess of 52a and thus do not

operate immediately due to the firing of the tubes 23, 24, 25, etc. The select relays 20, 21, 22, etc. are operated in response to the action of the delay circuit, hereinafter described, and generally designated by the numeral 53 in Fig. 1.

When, however, the tubes 23, 24, 25, etc. have substantially identical characteristics a plurality of them will fire upon the application of the sum voltage as described above. When, for example, tubes 23 and 24 fire simultaneously a conductive loop is established from battery 40 to line 34, tube 23, select relay 20, select relay 21, tube 24, line 33 and thence to battery 39. The resistances of the relays 20 and 21 are such that the sum of the positive resistance in the loop is less than the absolute value of the sum of the negative resistances due to the two tubes 23 and 24. When the positive resistance of a loop is less than the negative resistance, the loop becomes unstable and current in one tube will increase and in the other decrease until a stable equilibrium condition is reached, with one tube at high current and the other extinguished. The sum resistance will remain negative and the loop will remain unstable until one of the tubes 23 or 24 extinguishes. Even if one of the tubes 23 or 24 starts to pass current greater than 51a, shown in Fig. 2 and thus making its resistance positive, the positive resistance is of such a small value as not to succeed in counteracting the increased negative resistance of the other tube as it swings downward towards a value of current equal to 50a. The sum of the currents through all the tubes 23, 24, 25, etc. and in this case through tubes 23 and 24 is limited, as described above, by the resistances 30 and 31 so that both tubes 23 and 24 cannot both pass a current greater than 51a. As one of the tubes passes more current, the other tube passes less current with instability continuing to exist until one of the tubes swings below the current 50a, thus achieving a high positive resistance and simultaneously becoming extinguished. When more than two of the tubes 23, 24, 25, etc. break down, a plurality of unstable loops are initiated. The instability persists as tube after tube extinguishes until only one tube remains fired. This system is an essentially failure-proof system, for as long as the negative resistances in the loops exceed the positive resistance, no more than one tube can remain ionized. The resistance of the select relays 20, 21, 22, etc. together with the other circuit resistances in the loop are so chosen as to cause this condition of instability whenever two or more tubes fire. The currents are so restricted by the circuit parameters as to have a current through resistors 30 and 31 greater than the number of tubes 23, 24, 25, etc. times the value of current 50a and less than twice the current 51a. The minimum current is necessary to allow all the tubes 23, 24, 25, etc. to fire and the maximum current is necessary to insure the instability when only two of the tubes 23, 24, 25, etc. are initially fired. If more than two of the tubes 23, 24, 25, etc. fire the loops are more unstable as when only two fire as less current flows therethrough and thus the negative resistance of each of the tubes 23, 24, 25, etc. is greater.

The fact that the minimum current depends upon the value of 50a and the number of tubes 23, 24, 25, etc. whereas the maximum current is only dependent upon the value of 51a places a definite restriction on the maximum number of tubes having a certain characteristic that can be fired simultaneously. Since, however, 50a is approximately 10^{-8} amperes and 51a is approximately 10^{-3} amperes this factor is not of serious consequence.

The lockout features as described above, operate when all the tubes 23, 24, 25, etc. have identical voltage ampere characteristics. Any initial disturbance will upset the balanced instability to cause one tube to conduct more and one tube to conduct less which culminates in selecting only one of the tubes 23, 24, 25, etc.

The time from the initial occurrence of ionization to the extinguishing of all of the tubes 23, 24, 25, etc., except one, is called the severance time. The severance time for a given circuit containing a plurality of given tubes and circuit elements is of definite maximum duration. Thus a definite maximum time after applying a potential across the tubes 23, 24, 25, etc., a maximum time equal to the statistical time lag for ion-

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ization to start, plus the severance time, only one of the tubes 23, 24, 25, etc. will remain fired.

The operation of the delay circuit 53 to operate one of the select relays 20, 21, 22, etc. requires a time slightly in excess of the severance time. The delay circuit 53 consists of a triode vacuum tube 54, where the grid 55 is negatively biased by the battery 55a, connected to the common junction of the relays 20, 21, 22, etc. through the resistor 31. The grid 55 is therefore connected to the junction between the resistance 31 and the resistance 30. The cathode 56 is connected to the common junction of the relays 20, 21, 22, etc. and the plate 57 is connected through the resistance 58, parallel circuit of relay 59 and capacitor 60, and battery 61 to the resistor 31. The tube 55 is normally non-conducting due to the negative bias but begins to conduct the instant that ionization commences in one or more of the tubes 23, 24, 25, etc. The slow-operate relay 59 is additionally delayed by the resistance 58 and capacitor 60 combination and operates to close its contacts at 62 to short the resistance 30. The shorting of the resistance 30 shifts the load line and allows an increased current to flow through the fired tubes 23, 24, 25, etc. The time for the operation of the delay circuit 53 from the commencement of ionization to the shorting of the resistance 30 is greater than the severance time. By shorting the resistance 30 in this manner after successful lockout has been achieved sufficient current is caused to flow to actuate one of the select relays 20, 21, 22, etc. The select relays 20, 21, 22, etc. operate only when a current greater than 52a, Fig. 2, flows there-through. This condition can only be achieved by shorting the resistance 30 no matter how many of the tubes 23, 24, 25, etc. fire initially. A maximum output power is thus available, limited only by the current carrying capacity of the tubes 23, 24, 25, etc. The maximum available voltage is the difference between the breakdown voltage 50 and the sustaining voltage 51. Thus failure-proof lockout is achieved supplying a maximum output power to a random selected path or branch.

A modification of the present invention is shown in Fig. 3 where only the lockout or left portion is shown. The conductors 134, 133, 132, etc. are similar to the conductors 34, 33, 32, etc. and the tubes 123, 124, 125, etc. are similar to the tubes 23, 24, 25, etc. described above in reference to Fig. 1. The circuit operates generally in the same manner as the circuitry of Fig. 1. The junction of the select relays 120, 121, 122, etc. similar to select relays 20, 21, 22, etc. in Fig. 1 is connected to the cathode 155 of the gas triode 154. The cathode 155 is also connected through the parallel circuit of resistance 158 and capacitor 160 to the starting anode 156. The starting anode is also connected to a resistor 161. The main anode 157 is connected to the junction of resistor 161 and a resistor 162 which is in turn connected through the contacts 163 of relay 127, and positive battery 129 to ground. The relay 127 is similar to relay 27 of Fig. 1 and is connected through negative battery 128 to ground. The relay 127 is operated in response to the energization of a relay (not shown) similar to relays 16, 17, etc. in Fig. 1. The firing of the triode 154 is delayed by means of the resistance 158 and capacitor 160 network and initial conduction through the delay circuit 153 proceeds through the resistance 158 and capacitor 160 network, to resistance 161, resistance 162, contacts 163, which are closed, battery 129 to ground. Initially, a high voltage drop exists across the resistance 161, which is thereafter reduced to essentially the main gap sustaining voltage after the tube 154 has fired and the ionization transferred across the main gap. The time required from the initial ionization of one of the tubes 123, 124, 125, etc., to the ionization of the main gap of the triode 154 is greater than the severance time for establishing lockout. Only one of the tubes 123, 124, 125, etc., remains conducting when the resistance of the delay circuit 153 is reduced by the reduction thereacross to the potential required for sustaining ionization. The initial resistance of the delay circuit 153 and resistance 162 restrains the current through the tubes 123, 124, 125, etc. to the value insufficient to operate the select relays 120, 121, 122 and where instability exists as described above in reference to Figs. 1 and 2 if two or more of the tubes 123, 124, 125, etc. fire. Thus, failure-proof lockout

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is achieved supplying a maximum output power to a random selected path or branch.

Various other negative resistance devices may be used without departing from the spirit of the invention as, for example, transistors, thermistors, saturable cores, etc. When the negative resistance device does not have a statistical time lag as, for example, thermistors, it is possible to operate a slow-operate relay directly from the supply voltage as shown in Fig. 4. The thermistors 223, 224, 225, etc. are connected to conductors 234, 233, 232, etc. which are similar to conductors 34, 33, 32, etc. of Fig. 1 and conductors 134, 133, 132, etc. of Fig. 3. Each thermistor 223, 224, 225, etc. is connected to a select switch 220, 221, 222, etc. which is similar to the select switches 20, 21, 22, etc. and 120, 121, 122, etc. of Figs. 1 and 3, respectively. The junction of the select relays 220, 221, 222, etc. is connected through the resistances 258 and 261, contacts 263, and battery 229 to ground. The resistor 261 is paralleled by the contacts 257 of slow-operating relay 259. The relay 259 is connected through the resistor 262 essentially across voltage supply. The relay 259 is connected through relay 227 and negative battery 228 to ground and resistor 262 is connected through contacts 263 of relay 227 and positive battery 229 to ground. When the relay 227 is operated, contacts 263 close supplying a positive potential to the thermistors 223, 224, 225, etc. and initiating the operation of the relay 259 delayed by the resistance 262 and capacitor 260 connected across the relay 259. Lockout is accomplished in a manner similar to that described above in reference to Figs. 1 and 3 and then relay 259 closes its contacts 257 and shorts the resistance 261 allowing the current to rise through one of the thermistors 223, 224, 225, etc. This failure-proof lockout is accomplished supplying a maximum output power to the random selected path or branch. Due to the fact that the thermistor commences functioning immediately the operation of the relay 259 can be initiated immediately upon the operation of relay 227 instead of starting as does relay 59 in Fig. 1 after the statistical time delay for ionization of the tubes 23, 24, 25, etc.

Another modification of the present invention is shown in Fig. 5 which is particularly suited for high speed devices as vacuum tubes and transistors. The circuit components 320 through 325, 332 through 334 and 327 through 329 are similar to the circuit components 20 through 25, 32 through 34 and 27 through 29 described above in reference to Fig. 1. A delay line 358 whose input is placed in series with the contacts 363 and battery 329 has a high characteristic impedance. Another delay line 357 has an input connected to the lower terminals of the negative resistance devices 323, 324, 325, etc. and has a low characteristic impedance. The far end 358A of delay line 358 is short-circuited so that it offers high impedance to the flow of current for a given length of time, equal to twice the line's delay time, and thereafter presents a low impedance. The delay line 357 has its ends open-circuited so that it provides low impedance for the devices 323, 324, 325, etc. for a given time, and thereafter a high impedance. If the two delay lines 358 and 357 are equal in delay time the net effect is that the delay time 358 keeps the current through the devices 323, 324, 325, etc. in their negative resistance region for the given time and the other line 357 provides low resistance in the loop for the same time interval so that the instability does not depend upon the resistance of the select relays 320, 321, 322, etc. In this manner lockout is achieved even if the relays 320, 321, 322, etc. are high impedance devices.

Various other modifications are possible without departing from the spirit of the invention as, for example, having a saturable core, pre-excited to restrict the currents and insure instability of the delay circuit.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A lockout system comprising a parallel circuit having a plurality of branches; a resistor connected in series with said parallel circuit; a delayed action shorting circuit connected to said resistor; and an input circuit connected to said parallel circuit, each of said plurality of

branches having a negative resistance device and positive resistance components, the operation of said input circuit causing said parallel circuit to be unstable upon the breakdown of a plurality of said negative resistance devices, said delayed action shorting circuit being responsive to the breakdown of said negative resistance device to short a part of said series connected resistor after the stabilization of said parallel circuit with only one of said branches being active.

2. A lockout system comprising energizing means; a plurality of randomly selectable parallel circuits connected to said energizing means, each of said parallel circuits having a negative resistance device and positive resistance components; and a delayed action device connected to said plurality of parallel circuits and responsive to the energization of said negative resistance device for delaying the rise of current through the selected of said parallel circuits so that the total effective resistance of each of said parallel circuits is negative.

3. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said parallel circuits having a similar negative resistance device and positive resistance components; means for applying a potential to all of and causing the conduction of at least one of said devices, the conduction of a plurality of said devices forming at least one conductive loop; and a delayed action device connected to said plurality of parallel circuits for delaying the rise of current through said loops so that the total resistance in each of said loops is negative.

4. In combination, a plurality of selectable circuits; discharge devices individual respectively to said circuits; means for applying a potential to all of and discharging at least one of said devices; a resistor connected in series with said plurality of selectable circuits; and a delay shorting circuit connected to said resistor and said selectable circuits comprising a detector circuit, and a slow-acting relay circuit, said detector circuit operating upon the initiation of discharge in said discharge devices to energize said slow-acting relay circuit, said slow-acting relay circuit shorting part of said series-connected resistor after the severance time of said selectable circuits.

5. In combination, a plurality of selectable circuits; discharge devices individual respectively to said circuits; means for applying a potential to all of and discharging at least one of said devices; a resistor connected in series with said plurality of selectable circuits; and a slow-acting relay circuit connected across part of said resistor energized by said potential applying means, said slow-acting relay circuit shorting part of said series-connected resistor after a period of time equal to the sum of the statistical time delay of said discharge devices and the severance time of said selectable circuits.

6. In combination, a plurality of selectable circuits; a thermistor individual respectively to each of said circuits; a resistor connected in series with said plurality of selectable circuits; means for applying potential to all of and causing the conduction of at least one of said thermistors; and a delay shorting circuit connected to said resistor energized by said means and shorting part of said resistor an interval of time greater than the severance time of said selectable circuits after said means applies potential to said thermistors.

7. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said circuits including a gaseous tube having a similar voltage ampere characteristic; means for applying a potential to said tubes, the discharging of a plurality of said tubes causing said selectable circuits to form at least one unstable loop; and a delay circuit energized by said discharged tubes for restricting the current through said loop to maintain the instability of said loop until all but one of said tubes extinguish.

8. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said circuits including a gaseous tube having a similar voltage ampere characteristic; means for applying a potential to said tubes, the ionization of a plurality of said tubes causing

said selectable circuits to form at least one unstable loop; and a delay circuit for restricting the current through said loop to maintain the instability of said loop until all but one of said tubes extinguish, said delay circuit being connected in series with said selectable parallel circuits and comprising a triode gas tube having a main gap; a starting gap; and a resistor connected across said main gap, part of said resistor being connected across said starting gap, the sum of the statistical time delay and transfer time of said triode tube being greater than the severance time of said loops.

9. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said circuits including a gaseous tube having a similar voltage ampere characteristic; means for applying a potential to said tubes, the ionization of a plurality of said tubes causing said selectable circuits to form at least one unstable loop; and a delay circuit for restricting the current through said loop to maintain the instability of said loop until all but one of said tubes extinguish, said delay circuit comprising an initially high impedance delay line connected in series with said selectable circuits, and a plurality of initially low impedance delay lines interconnecting said gas tubes, the delay time of said initially high impedance delay line and said plurality of initially low impedance delay lines being greater than the severance time of said loops.

10. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said circuits including a gaseous tube having a similar voltage ampere characteristic and output load device; means for applying a potential to said tubes, the ionization of a plurality of said tubes causing said selectable circuits to form at least one unstable loop; and a delay circuit for restricting the current through said loop until all but one of said tubes extinguish, said delay circuit comprising an initially high impedance delay line connected in series with said selectable circuits, and a plurality of initially low impedance delay lines each connected between said gas tube and the respective of said output load devices and ground so that the instability of said loops is independent of said output load devices, the delay time of said initially high impedance delay line and said plurality of initially low impedance delay lines being greater than the severance time of said loops.

11. A lockout system comprising a plurality of randomly selectable parallel circuits, each of said circuits including a gaseous tube having a similar voltage ampere characteristic and output load device; means for applying a potential to said tubes, the discharging of a plurality of said tubes causing said selectable circuits to form at least one unstable loop; and a delay circuit for restricting the current through said loop to maintain the instability of said loop until all but one of said tubes extinguish, the instability of said loops being independent of said output load devices.

12. A lockout system comprising a plurality of selectable circuits; means for maintaining said selectable circuits unstable upon the selection of a plurality of said selectable circuits; and delay means for maintaining selected only one of said selectable circuits by delaying the rise in current through the selected of said selectable circuits until equilibrium is reached.

13. A lockout system comprising a plurality of selectable circuits; means for supplying relatively small currents through said selectable circuits; means for stabilizing said selectable circuits at said relatively small current upon the selection of a plurality of selectable circuits; delay means for maintaining selected only one of said selectable circuits by delaying the rise in current through the selected of said selectable circuits until equilibrium is reached; and means for supplying a relatively high current through said maintained selected circuit.

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