June 6, 1944. N. I. HALL 2,350,888

SELECTING SYSTEM

Filed Nov. 21, 1941 2 Sheets-Sheet 1

FIG. 1

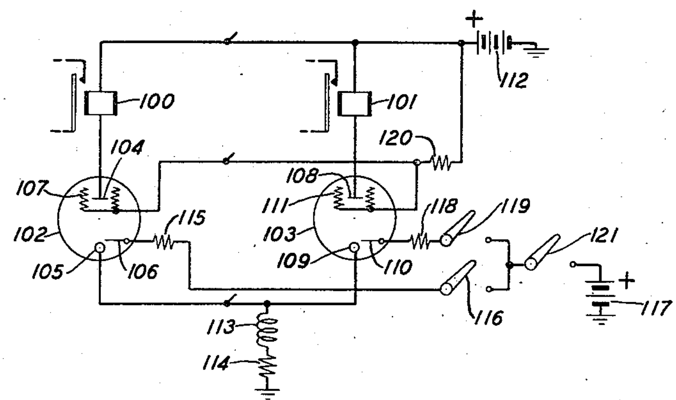

FIG. 2

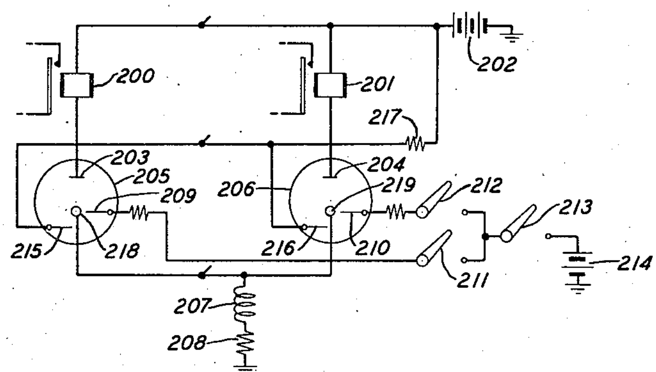

FIG. 3

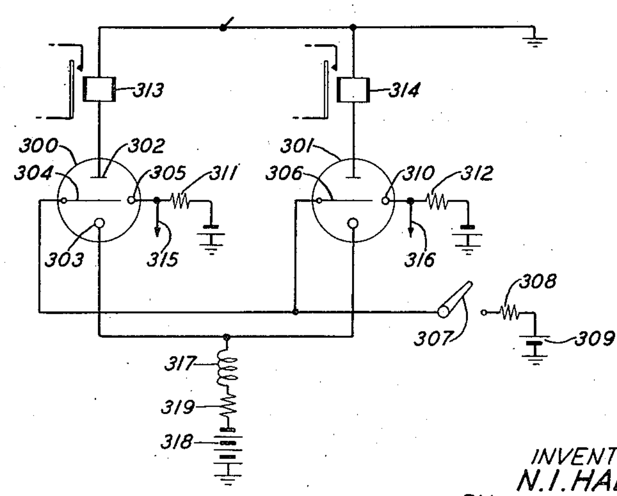

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FIG. 4

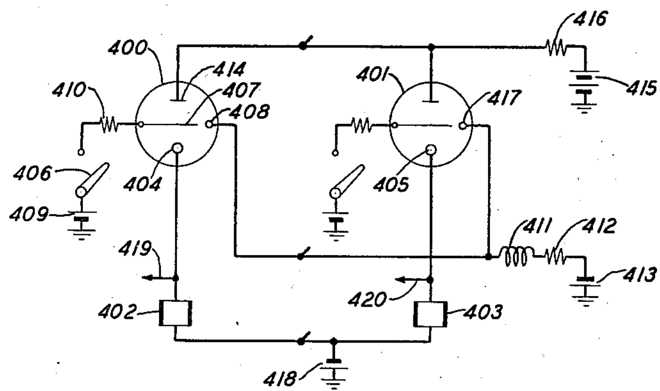
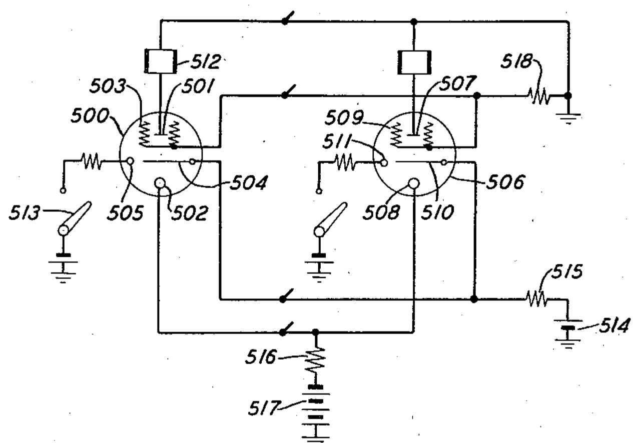


FIG. 5



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Patented June 6, 1944

2,350,888

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2,350,888

SELECTING SYSTEM

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Application November 21, 1941, Serial No. 419,879

5 Claims. (Cl. 315—294)

This invention relates to selecting systems and particularly to systems in whch selections are made automatically in a group of circuits, relays, or other electrical devices.

An object of the invention is to increase the certainty with which relays or other electrical devices of a group are rendered unselectable in response to the selection of one of them for use.

Another object of the invention is to improve the sensitivity of relays or other devices by utilizing discharge tubes in which ionization occurs in stages and to effect the selection of one of these relays and the exclusion of others after ionization of the corresponding tube has progressed through one or more of its stages.

Other objects of the invention are to simplify, to increase the speed of operation, and otherwise to improve selecting and controlling systems.

These objects are realized by means of a selecting and lock-out system in which a plurailty of lines, circuits, relays, or equivalent electrical devices, from which selection is to be made, are provided with a plurality of discharge tubes, one for each of the several circuits or devices, together with means for causing the ionization of the tubes at random; in which the initial starting voltage applied to any tube causes the tube to ionize in two or more successive stages, each stage involving a different pair of tube electrodes; and in which the current flowing through a common impedance in response to the ionization in one of these stages in a particular tube alters the voltage applied to the remaining tubes sufficently to render them inoperative. More specifically these selecting tubes are provided with a multiplicity of electrodes, each tube having a main anode, a main cathode, and two or more auxiliary electrodes. If starting voltage is applied to the auxiliary electrodes of a plurality of these tubes simultaneously, initial ionization occurs in each tube, following which ionization transfers to the gap formed by one of the main electrodes and one of the auxiliary electrodes. The circuit for applying voltage to this gap includes a common impedance, and the current flowing therein as a result of the transfer of ionization in a particular tube lowers the voltage applied to the corresponding gaps of all other tubes to prevent the succesful transfer of ionization in any one of these other tubes. Hence one tube alone succeds in maintaining its transferred ionization, and this particular tube then proceeds to ionize its main gap, including the main anode and cathode, whereas the remaining tubes are rendered inoperative.

A feature of the invention is a selecting system of the kind above-described in which the initial ionization of the tube is transferred in two successive stages, both stages involving ionization gaps formed by different pairs of electrodes, and in which an exclusion or lock-out voltage is produced in each of these stages to render all except a particular one of the tubes inoperative.

These and other features of the invention will be described more fully in the following specification.

In the drawings accompanying the specification:

Fig. 1 illustrates an embodiment of the invention in which discharge tubes of the screen grid type are employed;

Fig. 2 illustrates a second embodiment in which the tubes are provided with auxiliary anodes;

Figs. 3 and 4 show alternatives in which the tubes are provided with separate starting gaps; and

Fig. 5 shows an embodiment in which the tubes are provided with screen grids and with separate starting gaps.

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 equivalent choices which are subject to a plurality of simultaneous demands. For example, in automatic telephone systems, and especially those of the crossbar type, there are numerous situations in which a plurality of demands may exist concurrently for an idle one of a group of lines, links, trunks, relays, magnets or other equivalent devices, whereas it is necessary to restrict the selection to a single one of these elements and to exclude all others either so long as the selected element is in use or temporarily until the necessary operations have been effected to permit the selection of a second one of the desired elements of the group. A better understanding of the problems which make this exclusive method of selection so desirable in systems of the crossbar type may be had from a study of the circuit operations involved in the patent to Carpenter, No. 2,235,803 of March 18, 1941, and in the patent to Busch et al. 2,224,251 of December 10, 1940. However, as above-noted, the invention is not limited to telephone systems but may be applied to other types of communication systems and to any other systems where it may be found useful.

The selecting system illustrated in Fig. 1 comprises a series of relays or magnets 100, 101, etc., each of which is associated with an individual discharge tube 102, 103, etc. Although only two relays and two associated tubes are illustrated, it will be understood that the series may contain as many as desired and that the controlling circuits are so arranged that attempts may be made to seize and operate the relays at random. Since the relays are subjected to random seizure, it follows that frequently attempts will be made to seize two or more relays simultaneously. Under such conditions the associated tubes serve to limit the selection to a single relay and to guard the remaining relays of the series against simultaneous operation.

The associated discharge tubes 102, 103 are provided with main anodes, main cathodes and starting electrodes and screen grid electrodes. For example, tube 102 has a main anode 104, a main cathode 105, a starting electrode 106 and a screen grid electrode 107. Similarly the tube 103 has a main anode 108, a main cathode 109, a starting electrode 110 and a screen grid electrode 111. The respective relays 100, 101, etc., are connected to the main anodes of the associated tubes and to the positive pole of anode battery 112. The main cathodes 105, 109 are connected directly in multiple to each other and thence through a common inductance element 113 and through a common resistor 114 to ground. The starting electrodes are connected through individual resistors to the contacts of switches or relays by means of which starting potential is applied at will to these electrodes. For instance, starting electrode 106 is connected through resistor 115 to the switch 116, which serves to connect the positive pole of battery 117 to the electrode. Similarly, starting electrode 110 is connected through resistor 118 to the individual switch 119. The screen grids 107, 111, etc., are all connected directly in multiple with each other and thence through a common resistor 120 to the positive pole of the anode battery 112.

A description of the selection system of Fig. 1 will now be given. Assume that all of the relays in the series are idle and that it is desired to select and operate the relay 100 to the exclusion of the others. To this end the common switch 121 is closed, followed by the closure of the individual switch 116. The closure of these switches establishes the following circuit for the starting gap 105—106: positive pole of battery 117, switch 121, switch 116, resistor 115, starting electrode 106, cathode 105, inductive impedance 113, resistor 114 to ground and thence to the negative pole of battery 117. The voltage of battery 117 is thus applied across the gap 105—106, and this gap ionizes. Since the voltage of the battery 112 is continuously applied across the gap formed by the main cathode 105 and the screen grid 107, the ionization of the control gap 105—106 immediately transfers to the gap formed by the cathode and the screen grid, and current now flows from the battery 112 through the resistor 120, screen grid 107, cathode 105, impedance element 113 and resistor 114 to ground. Thereupon the ionization within the tube immediately transfers to the main anode 104, and the main discharge circuit is now closed for the flow of current from the positive pole of battery 112 through the winding of relay 100, anode 104, cathode 105 and thence to ground. Relay 100 operates in this circuit and performs its related functions.

During the time current is flowing in the main anode-cathode circuit in the tube 102, the voltage drop across the common elements 113 and 114, due to this current flow, applies a positive potential to the cathode 109 and to the cathodes of the unoperated tubes in the series. This positive potential on the cathodes of these tubes reduces below the ionizing value the voltage across their control gaps to prevent the subsequent operation of any one of these tubes in response to the closure of the individual switches. Therefore, relay 100 remains operated, and it is impossible to operate any one of the remaining relays until the guarding potential is removed from the cathodes of the associated tubes. Following the operation of the selected relay 100 the switches 116 and 121 or the switch 116 alone may be opened to remove the starting potential from the electrodes. When it is desired to restore the relay 100, the anode-cathode discharge circuit is opened in any conventional manner to permit the deionization of the main discharge gap of the tube 102.

Assume next that an attempt is made to seize and operate relays 100 and 101 simultaneously. That is to say, switch 121 is first closed and then switches 116 and 119 are closed at substantially the same time. In response to the closure of these switches, starting potential is applied to electrodes 106 and 110, and the control gaps of both tubes 102 and 103 are ionized at the same time. Although the switches 116 and 119 may be closed substantially at the same time, the speed with which the discharge tubes ionize their control gaps and transfer their ionizations is so great that one or the other of any pair of tubes undergoing simultaneous seizure will in all probability transfer its ionization from the main cathode to the screen grid somewhat in advance of the other tube. Assume, therefore, that while the tubes 102 and 103 ionize their control gaps concurrently, the transfer of ionization from the main cathode to the screen grid in the tube 102 precedes the corresponding transfer in the tube 103. The instant the transfer takes place current flows from the battery 112, common resistor 120, across the gap from screen grid 107 to cathode 105 through the common inductance 113 and resistance 114. This flow of current in the inductance 113 sets up a relatively high potential which, in addition to the drop across resistor 114, is immediately applied to the cathode 109. Also the current flowing in resistor 120 lowers the positive potential on screen 111. Thus the simultaneous reduction of the negative potential of cathode 109 and the positive potential of screen grid 111 lowers the voltage between the cathode 109 and the screen grid 111 below the ionizing value. Therefore, the ionization fails to transfer from the cathode 109 to the screen grid 111, and the tube 103 remains inoperative. As above explained, the ionization in the selected tube 102 continues its transfer to the main anode 104, and the desired relay 100 is operated. Similarly if three or more tubes are undergoing simultaneous attempts at seizure, the first one to transfer its ionization from the main cathode to the screen grid will cause an induced voltage in the common impedance 113 which will lower the potential of the cathodes of the remaining tubes to prevent any one of them from transferring its ionization.

It will be noted that the blocking or lock-out potential produced in the common impedance element 113 is applied directly to the cathodes of all tubes which are to be prevented from operating. This is achieved by connecting the cathodes of all tubes directly in multiple with each other free from all individual resistances.

The selecting system of Fig. 2 is similar to that of Fig. 1, except that the screen grids are replaced by starting anodes. The relays 200, 201, etc., are connected between the positive pole of battery 202 and the main anodes 203, 204 of the respective tubes 205, 206. The main cathodes of the tubes are connected through common impedance 207 and common resistor 208 to ground; and the starting electrodes 209, 210 are connected through individual resistances and switches 211, 212 and 213 to the positive pole of battery 214. The auxiliary anodes 215, 216, which replace the screen grids of Fig. 1, are connected directly in multiple with each other and thence through the common resistor 217 to the positive pole of battery 202.

To select one of the relays in Fig. 2, one or more of the corresponding starting switches are closed to cause the ionization of the starting gaps formed by the starting electrodes 209, 210 and the main cathodes 218, 219. Immediately following the ionization of the control gap of any tube the ionization transfers from the main cathode to the auxiliary anode, and the first tube to transfer its ionization sets up voltages across the impedance 207 and resistor 217 which apply potentials to the cathodes and to the auxiliary anodes respectively of the remaining tubes to prevent a second one from transferring its ionization. If, for example, the tube 205 is the first one to transfer its ionization from the main cathode 218 to the auxiliary anode 215, current immediately flows from the positive pole of battery 202 through the common resistor 217, auxiliary anode 215, cathode 218, impedance 207 and resistance 208 to ground. The voltage induced by the impedance 207 and also by resistance 208 is applied to the cathode 219 and to the cathodes of all other tubes in the series and the drop across resistor 217 is applied to the axiliary anodes to prevent any other tube from transferring its ionization from the control gap to the gap formed by the main cathode and the auxiliary anode. Thereafter the preferred tube 205 transfers its ionization from the main cathode 218 to the anode 203, and current now flows in the main discharge gap including the relay 200. Relay 200 operates and performs its required functions.

In Fig. 3 the tubes 300, 301 have starting gaps separate from the main anodes and cathodes. For example, the tube 300 has a main anode 302, a main cathode 303, and a starting gap formed by the starting anode 304 and the starting cathode 305. The starting anodes 304, 306 of all tubes are connected directly in multiple and thence through the common switch 307 and common resistor 308 to the positive pole of battery 309. The starting cathodes 305, 310 are connected through individual resistors 311, 312 to the negative pole of battery.

When it is desired to select an idle one of the relays 313, 314 associated with the tubes 300, 301, the switch 307 is closed to apply starting potential to the starting anodes 304, 306, etc., of all tubes in the series. The starting cathodes of all tubes corresponding to busy relays will have ground potential applied thereto over conductors 315, 316, etc., whereas the starting cathodes corresponding to idle relays will be connected only to the negative pole of battery. Hence the starting gaps of all tubes corresponding to idle relays ionize, and the gaps of the remaining tubes remain deionized. As soon as the starting gaps have ionized, ionization transfers from the starting anodes to the main cathodes, and the first tube to transfer its ionization sets up a voltage across the common impedance 317 and a voltage across the common resistor 308 which locks out the other tubes. If, for example, it is assumed that the tube 300 first transfers its ionization from the starting anode 304 to the main cathode 303, the remaining tubes are excluded, and the ionization of tube 300 immediately transfers again to the main anode 302. Current now flows in the main discharge circuit from the grounded or positive pole of battery 318 through the common winding of relay 313, anode 302, cathode 303, inductance 317, resistor 319 to the negative pole of battery 318.

In Fig. 4 the tubes 400, 401, etc., are provided with separate starting gaps as in Fig. 3, but in this case the work relays 402, 403 are included in circuit with the main cathodes 404, 405. When it is desired to select one of the work relays, such as the relay 402, the individual switch 406 is closed to apply starting potential to the starting anode 407. The starting or control gap 407—408 is ionized over a circuit traceable from the positive pole of battery 409, switch 406, resistor 410, starting anode 407, starting cathode 408, inductance 411, resistor 412 to the negative pole of battery 413. As soon as the starting gap 407—408 ionize, ionization transfers from the starting cathode 408 to the main anode 414. This transferred ionization causes the flow of current from the positive pole of battery 415, common resistor 416, anode 414, starting cathode 408, inductance 411, resistor 412 to the negative pole of battery 413. The voltage set up by the impedance 411 is applied to the starting cathode 417 of tube 401 and to the starting cathodes of all other tubes and the drop across resistor 416 is applied to the main anodes to prevent any one of these tubes from transferring its ionization from the starting cathode to the main anode thereof. Following the transfer of ionization from the starting cathode 408 to the main anode 414, the main discharge gap of the tube ionizes, and current now flows in the main discharge circuit from battery 415, resistor 416, anode 414, cathode 404, relay 402 to the negative pole of battery 418. If it is desired to render any one of the work relays inoperative, ground potential may be applied to the corresponding conductor 419, 420. The presence of ground potential on one of these conductors prevents the transfer of ionization to the main cathode of the tube. It will be understood that this busy ground may be applied without operating the work relay by the simple expedient of opening the circuit to the relay before the ground is applied.

In Fig. 5 the tubes are provided both with screen grids and with separate control gaps. Two successive transfers are made between the ionization of the control gap and the ionization of the main gap, and the lock-out feature is applied to both of these transfer operations. For example, tube 500 is provided with a main anode 501, a main cathode 502, a screen grid 503 and a separate control gap formed by the starting anode 504 and a starting cathode 505. Similarly, the tube 506 is provided with a main anode 507, a main cathode 508, a screen grid 509 and with a separate control gap comprising the starting anode 510 and the starting cathode 511.

When it is desired to select the relay 512 to the exclusion of other relays, the individual switch 513 is closed to apply starting voltage to the control gap 504, 505. This gap ionizes, and ionization immediately transfers from the starting anode 504 to the main cathode 502. Current now flows from positive pole of battery 514 through common resistor 515, starting anode 504, cathode 502 through the common resistor 516 to the negative pole of battery 517. The voltage drop produced across the common resistors 515 and 516 lowers the voltage across the corresponding gap of any other tube, such as tube 506. Any other tube, therefore, which has its control gap ionized simultaneously with the control gap of tube 500 and which does not transfer its ionization to the gap formed by the starting anode and the main cathode prior to the transfer by the tube 500, is locked out and prevented from establishing an ionization across the gap of the starting anode and main cathode. Immediately following the first transfer in the tube 500 a second transfer of ionization takes place between the main cathode 502 and the screen grid 503. As soon as this gap ionizes, current flows from the positive or grounded pole of battery 517, common resistor 518, screen grid 503, cathode 502, resistor 516 to the negative pole of battery 517. Current flowing in the common resistors 516 and 518 lowers the voltage across the gaps formed by the screen grid and the main cathode of all other tubes to prevent the transfer of ionization in any tube which may already have achieved ionization between its start anode and main cathode. Thus the tube 500 succeeds in locking out any other tubes in the second stage of ionization which may not have been successfully locked out in the first stage of ionization transfer. Immediately thereafter the final transfer takes place in the tube 500 between the main anode and cathode, and current now flows from the grounded pole of battery 517 through the winding of relay 512, anode 501, cathode 502, resistor 516 to the negative pole of battery 517. Relay 512 operates, and the voltage drop across the common resistor 516 prevents any other tube from ionizing its main discharge gap. Thereafter the switch 513 may be opened to deionize the control gap 504—505. The relay 512 may be released by opening the common anode supply circuit in any suitable manner.

While the space discharge tubes illustrated herein may be of any suitable type, such as those filled with different gases, it has been found that better results are obtained in the systems disclosed when tubes filled with argon are employed.

What is claimed is:

1. In combination, a plurality of discharge tubes, each having main electrodes forming a main discharge gap and a plurality of auxiliary electrodes, circuit means for applying at random a starting potential to one of the auxiliary electrodes of one or more of said tubes to start the ionization of said tubes, an auxiliary discharge circuit common to all of said tubes and including an auxiliary gap of each tube formed by one of the main electrodes and one of the auxiliary electrodes, means for causing the transfer of ionization of any particular one of said tubes to the auxiliary gap thereof and the consequent flow of current in said auxiliary discharge circuit, and a common impedance element for producing a voltage drop in response to the flow of current in said auxiliary discharge circuit, said voltage drop being applied to the auxiliary gaps of said tubes to render inoperative all tubes except said particular tube.

2. In combination, a plurality of discharge tubes, each having main electrodes forming a main discharge gap and a plurality of auxiliary electrodes, circuit means for applying at random a starting potential to one of the auxiliary electrodes of each of a plurality of said tubes to start the ionization thereof, an auxiliary discharge circuit having a common branch for all of said tubes and an individual branch for each tube including an auxiliary gap of such tube formed by one of the main electrodes and one of said auxiliary electrodes, potential means for causing the initial ionization of any particular one of said tubes to transfer to the auxiliary gap thereof and the consequent flow of current in the main branch of said discharge circuit, a common impedance element in the main branch of said circuit for producing a voltage drop in response to the flow of current in said auxiliary circuit, said voltage drop being applied to the auxiliary gaps of said tubes to prevent the transfer of ionization of all tubes except said particular tube, a main discharge circuit for each of said tubes including the main electrodes thereof, and means responsive to the ionization of the auxiliary gap of said particular tube for causing the transfer of said ionization to the main gap of said tube and the consequent flow of current in the circuit of said main gap.

3. In combination, a plurality of discharge tubes, each having a main anode and a main cathode forming a main discharge gap and having auxiliary electrodes, circuit means for applying a starting voltage to the gaps formed by two of the electrodes of each of a plurality of said tubes for starting the initial ionization of said tubes simultaneously, a discharge circuit including a common branch, individual branches connecting said common branch in multiple to one of the main electrodes of each of said tubes, and individual branches connecting said common branch in multiple to one of the auxiliary electrodes of each of said tubes, the multipled main electrodes and the multipled auxiliary electrodes forming auxiliary discharge gaps, potential means responsive to the initial ionization of any particular one of said tubes for causing the ionization of the auxiliary discharge gap of said tube, a common impedance element in the main branch of said discharge circuit for producing a voltage drop in response to the ionization of the auxiliary gap of said particular tube, said voltage drop serving to render inoperative all tubes except said particular tube, a main discharge circuit for each tube including the main discharge gap thereof, and means responsive to the ionization of the auxiliary discharge gap of said particular tube for causing the ionization of the main gap of said tube.

4. In combination, a plurality of discharge tubes, each having two main electrodes forming a main discharge gap and having a plurality of auxiliary electrodes, circuit means for applying potential to one of the auxiliary electrodes of said tubes to cause the initial ionization of a plurality of said tubes simultaneously, a first auxiliary discharge circuit including a first auxiliary discharge gap of each of said tubes formed by one of the main electrodes and one of the auxiliary electrodes, a second auxiliary discharge circuit including a second auxiliary discharge gap of each of said tubes formed by one of said main electrodes and another of said auxiliary electrodes, means responsive to the initial ionization of a

particular one of said tubes for causing the transfer of ionization in successive steps first to said first auxiliary gap and then to said second auxiliary gap of said particular tube, the ionization of each auxiliary gap causing the flow of current in the corresponding auxiliary discharge circuit, an impedance element common to both auxiliary discharge circuits, said impedance element serving to produce a voltage in response to the flow of current in the first auxiliary circuit to prevent the transfer of ionization to the first auxiliary discharge gap of all tubes except said particular tube, said impedance element serving to produce a voltage in response to the flow of current in said second auxiliary discharge circuit to prevent transfer of ionization to the second auxiliary gap of all tubes except said particular tube, a main discharge circuit for each of said tubes including the main discharge gap thereof, and means for causing the transfer of ionization from the second auxiliary discharge gap of said particular tube to the main discharge gap thereof.

5. In combination, a plurality of discharge tubes, each having a main anode and a main cathode forming a main discharge gap, each having a starting anode forming with the main cathode an initial ionization gap, each having an auxiliary electrode forming with the main cathode an auxiliary discharge gap, circuit means for applying at random starting voltages to the initial ionization gaps of more than one of said tubes to start the ionization thereof, an auxiliary discharge circuit common to all of said tubes and including the auxiliary gap of each tube, voltage means for causing the transfer of the initial ionization of any particular one of said tubes to the auxiliary discharge gap thereof and the consequent flow of current in said auxiliary discharge circuit, and a common impedance element for producing a voltage drop in response to the flow of current in said auxiliary discharge circuit, said voltage drop being applied to the auxiliary gaps of said tubes to render all tubes inoperative except said particular tube.

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