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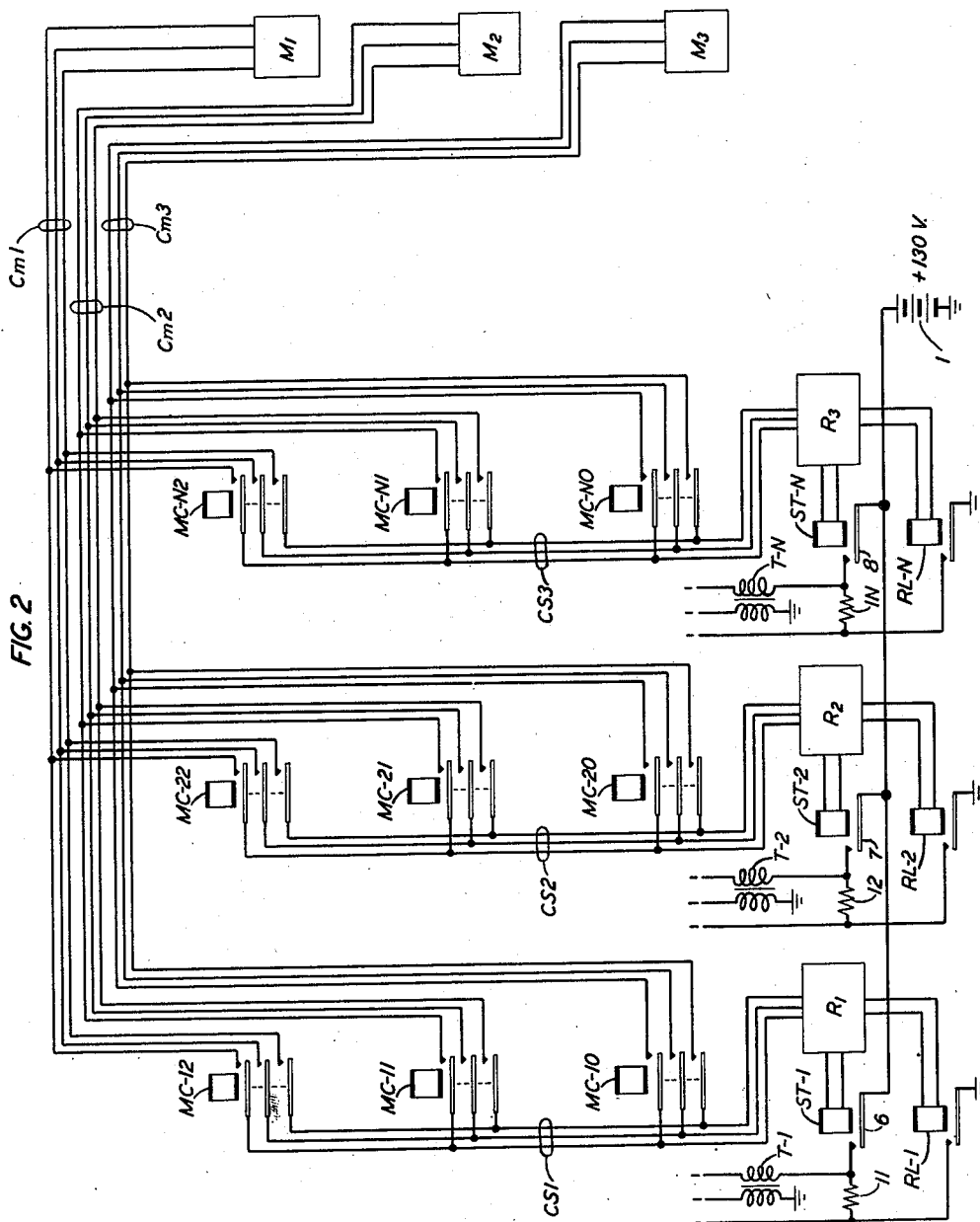
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COORDINATE SELECTING AND LOCK-OUT CIRCUIT

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COORDINATE SELECTING AND LOCK-OUT
CIRCUIT

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1

This invention relates generally to improvements of lock-out control circuits and more specifically it relates to improvements in lock-out control circuits employing cold-cathode gas tubes arranged in a coordinate fashion.

An object of the invention is to utilize time delay circuits to effectuate lock-out control.

Another object of the invention is the utilization of cold-cathode gas tubes for the purpose of maintaining lock-out for the desired period of time once it has occurred.

A further object of the invention is an arrangement whereby no two circuits of a first group of circuits ever become concurrently connected to the same circuit of a second group of circuits, or any two circuits of the second group of circuits ever become concurrently connected to the same circuit of said first group of circuits.

A fourth object of the invention is to prevent any two circuits of a first group of circuits from becoming simultaneously connected to the same circuit of a second group of circuits, and to prevent any two circuits of said second group of circuits from becoming simultaneously connected to said first group of circuits.

Reference is made to a copending application of E. Bruce, Serial No. 42,354, filed August 4, 1948. This prior disclosure utilizes gas tubes arranged in a coordinate fashion in a lock-out control circuit with the starting anodes connected in multiple in a vertical column and the main anodes and starting cathodes respectively connected in multiple in a horizontal row. For reasons of clarity the coordinate arrangement of the tubes will be regarded as being comprised of columns in the vertical direction and rows in the horizontal direction. A cold-cathode tetrode is used in the Bruce disclosure.

It is a characteristic of gas tubes connected in parallel with each other that only one of the tubes will ordinarily ionize if the circuit constants of each tube are the same. The certainty of only one tube ionizing is increased if an impedance common to all tubes in a row or column is included in the circuit in which the discharge is occurring. The Bruce application has such a common impedance to all tubes in a vertical column and another such impedance common to all the tubes in a horizontal row. Relays are used in connection with these lock-out control circuits to aid lock-out by opening the lock-out circuits in the starting space gap of all other tubes in the corresponding horizontal row. Relays, however, are susceptible to considerable wear and tear over the course of the years and

2

are subject to mechanical failure from dirt particles, etc. In addition relays have an operating time delay of three or more milliseconds, thus giving another tube in the same horizontal row some chance to ionize.

Applicant's invention avoids the above-mentioned relay problems inasmuch as no relays are used for such a purpose; instead of relays, gas tubes are utilized, one for each row. It is to be noted that these gas tubes are not the same ones that are arranged in coordinate fashion. The gas tubes operate in less than a millisecond and have a longer life in actual operation. Thus, a faster acting and more reliable lock-out control circuit is obtained.

In accordance with an exemplary embodiment of the invention four-element cold-cathode gas tubes are employed in a coordinate array, each of said four-element gas tubes having a control cathode, a control anode, a main cathode, and a main anode. Lock-out first takes place in a vertical column and subsequently occurs in the horizontal row. One three-electrode cold-cathode gas tube is associated with each horizontal row to provide lock-out in that row by lowering the voltage across the starting space path of the other tubes in that row.

Another feature of the present invention is the use of resistance-capacitance time circuits which gives the four-electrode gas tubes arranged in a coordinate fashion a preferred order of ionizing in any horizontal row.

A further feature of the invention is its adaptability as a connector circuit by which devices, such as registers may be connected to other devices, such as markers in such a manner that only one register will be connected to one marker. It is to be understood that groups of circuits other than registers and markers may be used in conjunction with this lock-out circuit.

The invention, its nature and objects, may be more fully understood from the following description of the drawings wherein:

Fig. 1 represents the arrangement of the four-electrode gas tubes in an exemplary embodiment of the invention and the associated three-electrode cold-cathode tubes; and

Fig. 2 illustrates how the lock-out circuit may be utilized in connecting senders to markers.

In an exemplary embodiment of the invention shown in Fig. 1 the ST- relays initiate operation of the lock-out circuit. Relays RL- deenergize the lock-out circuit after a particular switching operation. The transformers T- have a turn ratio of approximately one to three step-up with

a primary inductance of several henries. Resistances 11, 12 and 1N are about 5600 ohms and resistances 41, 42 and 4N are about 51,000 ohms. Resistances 51, 52 and 5N vary from 100,000 ohms to 1,000,000 ohms depending on what preferred order of ionizing of the tubes is desired. The capacitors 61, 62 and 6N are about .01-microfarad as are capacitors C₀, C₁ and C₂.

Inductances L₀, L₁ and L₂ are 10 henries approximately and resistances R₀, R₁ and R₂ are 50,000 ohms. The tubes G- are of the well-known cold-cathode glow discharge type having an anode, cathode, starting anode and starting cathode. These tubes can be filled with argon or any other gas possessing lock-out characteristics. These four-electrode gas tubes, using the circuit connections for tube G-1 as typical, first have a discharge initiated between the starting cathode 102 and the starting anode 101. The first transfer takes place between the starting cathode and the main anode 100, the second and final transfer occurs in the gap between the main anode and the main cathode. This second transfer is caused by the voltage drop across inductance L₀ and resistance R₀ which places starting cathode 102 at a higher potential than main cathode 103. The gas tubes 31, 32 and 3N are cold-cathode tubes having three electrodes. Tubes suitable for the purpose are known and are in commercial use; a disclosure of such a tube is found in the United States patent application of Vance, Serial No. 715,934, filed December 13, 1946, now Patent No. 2,515,361, granted July 18, 1950, the disclosure of which, for the purpose of disclosing the tube used, is incorporated herein by reference. Each of the four electrode tubes has a time circuit in its starting anode circuit comprising a resistance such as 51 and a capacitor such as 61. The values of these resistances and capacitances can be adjusted to give any preferred order of ionizing if column or row preference is desired for a particular application. Battery supply 1 is 130 volts and battery supplies 71, 72 and 7N are 50 volts.

The operation of the circuit shown in Fig. 1 will now be described in detail.

The lock-out control circuit of Fig. 1 can be used to connect any one of a first group of circuits to any one of a second group of circuits with the feature that the same circuit of the first group is never connected to two circuits of the second group at the same time and also that two circuits of the first group are never connected to the same circuit of the second group at the same time. As exemplified in Fig. 1 it is immaterial which circuit of the second group is connected to a given circuit of the first group.

Let it be assumed, for example, that the ST-relays which initiate operation of the lock-out control circuit of Fig. 1 are energized by registers, not shown, each ST- relay being operated by an associated register when said register requires connection to a marker incident to completion of a telephone connection. Furthermore, let it be assumed the three MC- relays in each of the three tube columns actuate relay contacts for connecting the same marker to any register operating one of the ST- relays. For example operation of any one of relays MC-10, MC-20 and MC-NO actuates contacts for connecting the same marker to any one of the three registers which may operate one of the ST- relays. The circuit of Fig. 1 can, therefore, establish interconnection between three registers and three markers.

If the register operating relay ST-1 completes the winding circuit for ST-1, contact 6 is closed and direct-current potential source 1 applies a positive potential to the main anodes of gas tubes G-1, G-4 and G-7 through the primary of transformer T-1. As this potential does not exceed the main space path breakdown potentials for tubes G-1, G-4 and G-7, ionization does not occur at this time. This positive potential is also applied to conductor 21 through resistor 11. From conductor 21 there are three resistor-capacitor paths to ground, the mid-point of each resistor-capacitor combination being connected directly to the starter anode of gas tubes G-1, G-4 and G-7. The charging time constants for the three capacitor-resistor combinations have different values in accordance with any preferred order of row ionization. Let it be assumed the time constant for resistor 51 and capacitor 61 is shorter than that of the other resistor-capacitor combinations. Accordingly, capacitor 61 will acquire a starter space path breakdown potential before tubes G-4 and G-7 when contact 6 is made.

With the initiation of discharge in the starter anode 101-starter cathode 102 space path, the time rate of current change through inductance L₀ creates a potential drop across the terminals of said inductance whereby any circuit connections for applying an ionizing potential to the starter space paths of tubes G-2 and G-3 at this time, due to operation of relays ST-2 and/or ST-3, will be prevented from doing so by the lock-out characteristics of the common impedance L₀ in series with the plurality of parallel-connected gas tube G-1, G-2 and G-3 starter space paths. As inductance L₀ can only effectuate lock-out during a change of current flow, steady state lock-out with respect to tubes G-2 and G-3 is provided for by the resistor R₀-capacitor C₀ connection. Capacitor C₀ effectively shunts resistor R₀ during the initial transitory discharge period of the starter space path and by charging permits a potential drop across resistor R₀ after the discharge current has stabilized so that a transfer to the main cathode may occur.

With the ionization of gas tube space path 101-102 a first transfer occurs which ionizes the space path between starting cathode 102 and anode 100. A second transfer occurs thereafter which ionizes the anode 100-cathode 103 space path. The time rate of current change through the primary of transformer T-1 due to successive ionization transfers involving anode 100, induces a potential in the secondary winding of said transformer which is applied through resistor 41 to the starter anode of tube 31. That potential, added to the potential of battery 71, ionizes the starter space path of tube 31. Subsequently, the ionization transfers to the main anode of tube 31 causing an immediate reduction in the potential of conductor 21 with respect to ground thereby preventing the potentials applied to the starter space paths of tubes G-4 and G-7 through conductor 21 from ionizing more than one tube in the row comprising tubes G-1, G-4 and G-7.

When current flow in tube G-1 due to ionization of space path 100-103 increases to a value sufficient to cause operation of relay MC-10, contacts closed by operation of relay MC-10, said contacts not shown in Fig. 1 but shown in Fig. 2, connect a marker not shown in Fig. 1

but shown in Fig. 2 to the register which caused operation of relay ST-1.

In general the connection and operation of each of the three rows is the same, as is the operation of the three columns, with the exception of any time delays introduced to give the tubes in a particular row or column a preferred order of operation.

Inductances L_1 and L_2 provide transient column lock-out for tube columns (G-4, G-5, G-6) and (G-7, G-8, G-9) respectively. Resistor-capacitor combinations R_1-C_1 and R_2-C_2 provide steady state column lock-out for their respective tube columns. Gas tubes 32 and 3N provide row lock-out for their associated rows in a manner identical to that of tube 31.

If a second register requiring connection to a marker causes relay ST-2 to actuate contact 7 at the same time contact 6 is made, tube G-2 will not ionize as column lock-out is effectuated by the potential drop across L_2 during transient current flow. During steady state current flow the potential drop across the R_2-C_2 shunt combination prevents ionization of more than one tube in that column at the same time. As a result of column lock-out no two registers can be connected to the same marker. If, however, tube G-2 were to ionize at the same time G-1 were ionized, operation of relays MC-10 and MC-20 would actuate contacts, not shown in Fig. 1, for connecting the one marker associated with that column to the two registers operating relays ST-1 and ST-2.

As tube G-2 is locked out, tube G-5 is completely ionized in a manner identical to the ionization of tube G-1. Tube G-5 is selected instead of tube G-8 due to the shorter time constant of the resistor-capacitor circuit connected to its starter anode as compared to that of tube G-8. Tube G-8 is subsequently locked out by operation of tube 32 in a manner identical to that of tube 31.

If a third register requiring connection to a third marker causes relay ST-N to actuate contact 8 at the same time contacts 6 and 7 are closed, tube G-9 will ionize as tubes G-3 and G-6 are locked out. Ionization of tube G-9 energizes relay MC-N2 thereby connecting the third marker to the third register. Operation of tube 3N has no lock-out effect on the row as tubes G-3 and G-6 are already locked out by the voltage drop across the impedance elements which are individual to the tube columns of tubes G-3 and G-6.

If contacts 6, 7 and 8 are simultaneously closed by energization of their respective relays the column and row lock-out arrangements will cooperate in such a manner that no two tubes in the same column or in the same row can be ionized at the same time, thereby preventing two registers from connection to the same marker at the same time or one register from connection to two markers at the same time.

When a register is finished with a marker it will momentarily operate relay RL- by connections not shown. This grounds the anode of the corresponding three-electrode tube, and also releases relay ST- by circuits not shown. The ground at RL- also furnishes a discharge path for surge voltages from T- or MC- elements.

The method of lock-out selection hereinbefore described in conjunction with Fig. 1 is especially adapted to the case where the number of inlets (i. e., registers) seeking connection to outlets

is large in comparison to the number of these outlets (i. e., markers).

In Fig. 2 the invention is applied to telephone circuits to connect registers to markers. It will be seen that each relay ST- is associated with a register and that each relay RL- is also associated with a register. The four-electrode tubes G- and the three-electrode tubes 31, 32, 3N, etc., and their operating circuits are not shown, for the most part, in Fig. 2 but it is to be understood that the array of tubes shown in Fig. 1 is associated with the circuit shown in Fig. 2. The relays MC- of Fig. 1, however, are shown in Fig. 2.

A series of markers are designated M_1, M_2, M_3 , etc. and each marker has associated therewith a set of conductors, C_{m1}, C_{m2}, C_{m3} , etc. In the telephone art the number of leads by which a register requires to be connected to a marker is known for each type of telephone system but may vary somewhat dependent upon the type of system. This variance may be quite considerable. The exact number is not of primary consequence to this invention which is capable of associating a register with a marker by any number of conductive leads within reasonable limits, for example, any number between 1 and 100. It will be seen that such a system of conductors designated C_{s1} extends from each register R_1 and a similar system C_{s2} extends from a similar register R_2 , etc. These conductors all terminate on sets of armatures of the relays MC-. It will be seen that each marker has extended therefrom a corresponding set of conductors, C_{m1}, C_{m2}, C_{m3} , etc., and that when any one relay MC- associated with any particular marker is closed, this set of conductors is extended through to the marker. Thus, the conductors C_{m1} extend from the marker M_1 , for example, to the upper row of front contacts of relays MC-, the conductors C_{m2} extend from marker M_2 to the second row of front contacts, etc. By extending the array that there may be any reasonable number of senders and any reasonable number of markers. The number of registers required for a given number of markers will be determined by the time necessary for a subscriber to dial in information to the register. Since the holding or operating time of a marker is from a few tenths of a second to a half second and the holding or operating time of a register is from ten to fifteen seconds, the number of registers will be large compared to the number of markers. From the description of Fig. 1, it is apparent that it is possible for any register to become connected to any marker, the only limitation to such possibility being determined by resistance capacitance time delay circuits associated individually with each four-electrode gas tube.

After the register has spilled its stored information to the marker, the register operates relay RL- which places ground on the anodes of the associated three-electrode gas tube as hereinbefore described and extinguishes said tube. Also as described prior relay ST- is released and that portion of the lock-out circuit is again ready for use.

In a broad aspect the invention is not limited to interconnection of registers with markers. It could equally well be employed in analogous manner for the interconnection over a suitable number of conductors from any one of a series of units with any one of a series of other units so that each connection during its existence is unique. A specific example of another such use

would be connecting senders to markers. The necessity for separate sequencing or allotting circuits or their equivalents is avoided. In other words, the elements of one series such as registers R₁, R₂, R₃, etc. may close their respective contacts calling for connection with an element of another series of devices such as the markers M₁, M₂, M₃, etc. in any order, within the limitations imposed by the resistance-capacitance time delay circuits, and at any time. It is observed that the relays MC- are indicated as multicontact relays. If the number of conductors required to be extended is too great, a plurality of relays MC- may be arranged with their windings in series or multiple to perform the desired function or each relay MC- may control one or more other relays whereby the desired number of conductors may be extended.

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

What is claimed is:

1. The combination comprising a matrix of gas discharge tubes connected into rows and columns, each of said tubes including a main space path and a control space path, the control space paths of the tubes in each column being connected in parallel, the main space paths of the tubes in each row being connected in parallel, lock-out means connected to said control space paths whereby not more than one tube in each column can be in an ionized state at the same time, a plurality of time delay networks each individually connected to the control space paths of different tubes, a plurality of lock-out tubes one for each tube row, each of said lock-out tubes comprising a main space path and a control space path, a plurality of impedance elements each separately connected in a power supply circuit common to the control space paths of the tubes of one row, a plurality of transformers each for coupling the main space paths of the tubes in a different row to the control space path of the associated lock-out tube whereby ionization of any one main space path of the tubes in a row initiates a discharge in the control space path of the associated lock-out tube, and the main space paths of each of said lock-out tubes being connected to the control space paths of the tubes in the associated row through the time delay networks connected to the tubes in that row whereby ionization of said main space path brings the potentials across said control space paths to a value less than breakdown by creating an increased voltage drop across the impedance element for that row.

2. In a matrix of gaseous discharge tubes connected into rows and columns for interconnecting any one of a first group of circuits, devices or terminals to any one of a second group of circuits, devices or terminals wherein a complete discharge in only one tube in the same column and the same row at the same time is necessary for the establishment of such an interconnection, said tubes having an ionization initiating space path therein, the improvement which comprises a lock-out tube for each row having at least a main space path and a control space path, a plurality of time delay networks each individually connected to different ionization initiating space paths, a plurality of impedance elements each individually connected in a power

supply circuit common to all the ionization initiating space paths of the tubes in one row, a transformer having a primary winding connected in series with a power supply conductor individual to the tubes in a row and a secondary winding connected to the control space path of the lock-out tube for that row whereby a current flow in said secondary winding initiates a discharge in said control space path, and the main space path for said lock-out tube being connected in parallel through the associated time delay networks with said ionization initiating space paths for all the tubes in said row whereby an increased voltage drop across the impedance element common to that row prevents more than one tube in that row from attaining complete ionization.

3. In a coordinate row and column array of gaseous discharge tubes for connecting only one of a first group of circuits, devices or terminals to only one of a second group of circuits, devices or terminals wherein a discharge in only one tube in the same column and only one tube in the same row at the same time is necessary for the establishment of such a connection, the improvement which comprises an auxiliary tube individually connected to each row, said auxiliary tube having at least a main space path and means for initiating a discharge therein, a plurality of time delay networks each individually connected to discharge control electrodes of different tubes in the rows, an impedance element for each row through which current is supplied to initiate ionization between the discharge control electrodes of the tubes of the associated row, coupling means individually connected to each row, said coupling means being responsive to current flow in a power supply conductor which is common to the tubes in the associated row only, each of said coupling means being connected to the discharge initiating means for the auxiliary tube of the associated row whereby current flow in said power supply conductor initiates a discharge in said auxiliary tube, and the main space path of the auxiliary tube for each row being connected in parallel through the associated time delay networks to the discharge control electrodes for all of the tubes in the associated row whereby an increased potential drop across the impedance element for that row prevents more than one tube of that row from completely ionizing.

4. The combination comprising a plurality of gaseous discharge gaps connected in parallel wherein each gap has discharge initiating means individually associated therewith, said discharge initiating means being connected in parallel, a time delay network connected to each of said discharge initiating means, an impedance element connected in the power supply circuit for said discharge initiating means, a lock-out tube having at least a main space path and a control space path, a transformer having a primary winding connected in series with a common power circuit for said parallel connected gaseous discharge gaps and a secondary winding connected to the control space path of said lock-out tube whereby a discharge in one of said parallel connected gaps induces a potential in said secondary winding for applying a breakdown potential to said control space path, and the main space path of said lock-out tube being connected in parallel with all of said parallel connected discharge initiating means through said time delay networks whereby an increased

potential drop across said impedance element prevents more than one of said gaseous discharge gaps from being ionized at the same time.

5 5. The combination comprising a plurality of gas tubes, each having at least a main space path and a starter space path, said main space paths being connected in parallel, each of said starter space paths being individually shunted by a capacitor, each of said starter space path-capacitor subcombinations being connected to a power supply source through a series resistor individual to only one of said subcombinations, a lock-out tube having at least a main space path and a starter space path, an impedance element connected in a common power supply circuit for said gas tube starter space paths and said lock-out tube main space path, the starter space path of said lock-out tube being connected to a power supply circuit for said parallel connected main space paths whereby current flow in said power supply circuit applies a breakdown potential to said starter space path, and all of said series resistor-capacitor-starter space path subcombinations being shunted by the main space path of said lock-out tube whereby initiation of a discharge in two or more of said gas tubes at the same time is prevented by an increased voltage drop across said impedance element in response to the ionization of said lock-out tube main space path.

6. The combination comprising a matrix of gas tubes connected into rows and columns, each of said tubes comprising a main discharge gap and a starter discharge gap, means for preventing two tubes in the same column from conducting at the same time, a resistor-capacitor time delay network connected to the starter discharge gap of each of said tubes so as to specify the order of main discharge gap conduction for said tubes, a lock-out tube individual to each row, said lock-out tube comprising a main discharge gap and a starter discharge gap, the starter discharge gap of each of said lock-out tubes being inductively coupled to a power supply conductor individual to the main discharge gaps of the tubes in the row to which said lock-out tube is individual whereby current flow in said conductor applies a breakdown potential to said lock-out tube, and a resistor connected in series with a power supply conductor individual to the starter discharge gaps of the tubes in one row

and the main discharge gap of the associated lock-out tube whereby the voltage drop across said last-mentioned resistor due to conduction in the main discharge gap of the lock-out tube prevents more than one gas tube in the corresponding row from ionizing.

7. In combination, a plurality of parallel connected discharge gaps, each including means for initiating a discharge therein, a plurality of time delay networks each individually connected to a different one of said means for initiating a discharge, means including a potential source for applying a potential to discharge one or more of said parallel connected discharge gaps, an auxiliary gaseous space path normally of high impedance in parallel connection through said time delay networks with the discharge initiating means for each of said parallel connected discharge gaps, an impedance element connected in a power supply circuit for said discharge initiating means and said auxiliary gaseous space path, means responsive to initial current flow in any one of said parallel connected gaps for initiating a discharge in said gaseous space path whereby the normally high impedance of said space path is reduced in value and an increased potential drop is thereby developed across said impedance element so that said discharge initiating means for each of said parallel connected discharged gaps is prevented from operating thereafter.

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