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SELECTING AND LOCKOUT CIRCUIT

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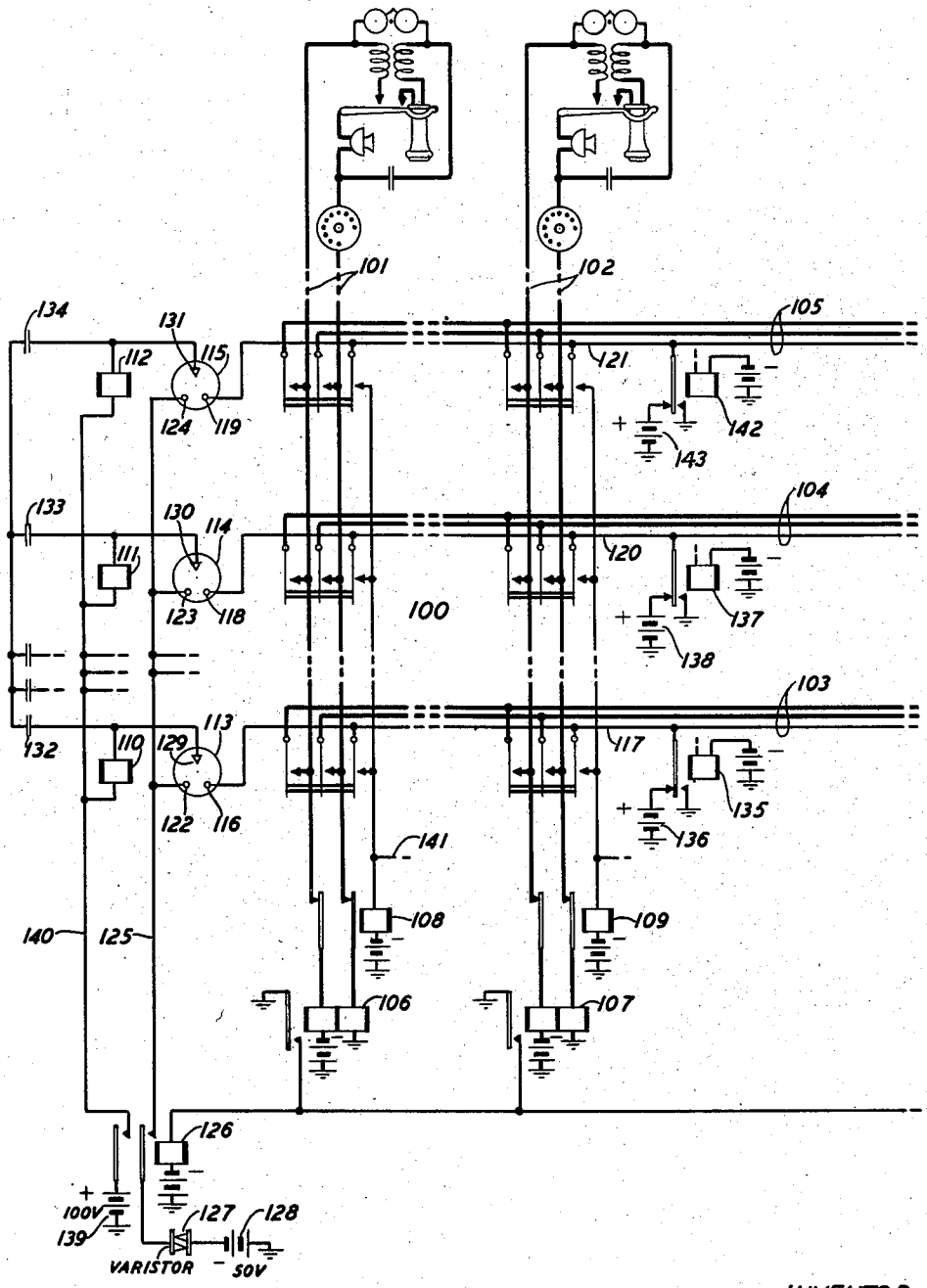

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SELECTING AND LOCKOUT CIRCUIT

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This invention relates specifically to improvements in selecting systems and more specifically to improvements wherein a non-linear impedance is used to decrease the probability of more than one circuit being selected.

One of the primary objects of this invention is to decrease the probability of more than one circuit being selected for use.

A second object of the invention is to utilize a non-linear impedance element as a common impedance to a plurality of space discharge tubes so as to prevent more than one discharge tube from ionizing during the same selecting operation by limiting the potentials of the other discharge tubes to a value less than that necessary for ionization.

A further object of the invention is to improve the operation of selecting systems generally.

The invention consists of a plurality of selectable circuits, each individual circuit having a space discharge tube and a non-linear impedance, such as a silicon carbide varistor, common to all the space discharge tubes. A voltage is applied to the tubes and the common impedance, causing one of the tubes, at random, to draw slightly more current, known as dark current, than any of the other gas tubes. This current, however, is still of a small magnitude compared to full operating value and therefore the impedance of the varistor used as the common impedance element is large, causing a decrease in voltage applied to the control gaps of the discharge tubes. This decrease in applied voltage acts to lock out, or prevent from ionizing, all the space discharge tubes except the one which was drawing the most current. This lock-out effect is believed to take place within microseconds and before the current has risen above a few microamperes. This last-mentioned tube then ionizes completely and the current flow therethrough is large, which causes the resistance of the common non-linear impedance to decrease so that a current sufficient to operate relays can flow through the ionized tube. The advantage of using a non-linear impedance is that there is much less chance of more than one space discharge tube ionizing since there is a large enough voltage drop across the non-linear impedance, at the time of ionization of the control gap of said one tube, to successfully prevent any other tube from ionizing.

In the prior art there are several devices whereby a common resistance or common inductance has been used in series with a number of gas tubes connected in parallel with respect to each other. The function of these devices has been to preclude more than one tube from ionizing.

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In the instance of the common resistance however, there was a chance that more than one tube would ionize. To correct this deficiency a common inductance with resistance was used. It was found that the probability of more than one tube ionizing was considerably less than in the case where a resistance alone was used. But the use of the inductance presented a new problem, e. g., that the current was prevented, due to inductance in the common impedance from rising rapidly to a sufficient value to operate relays after the tube had ionized.

The objects of this invention are accomplished by constructing the non-linear impedance so that the potential drop across the impedance is greatest at the time before any of the control gaps of the tubes ionize, and so that potential drop across the impedance remains large enough while one of the tubes is ionizing to successfully prevent any other tube from ionizing, and finally so that after one of the tubes has ionized the impedance of the non-linear resistance, although considerably decreased, remains large enough to prevent any other tube from ionizing. This feature of the invention thus eliminates much of the possibility of more than one tube ionizing. Since there is no appreciable inductance present in the non-linear impedance there is less time lag between the ionizing of the main gap of the space discharge tube and the operation of the relay than if an inductance had been used. It can be seen, therefore, that this invention combines the advantageous features of both the inductive and resistive common impedances, and at the same time, eliminates those features which are disadvantageous. The incorporated advantageous features are the decreased probability of more than one gas tube ionizing and the decreased time lag between the ionizing of a gas tube and the increase of current therethrough to a value sufficient to operate a relay. In the telephone art time savings of milliseconds in operations which are repeated many times an hour are of economic importance.

The aforementioned features and other features of the invention will be described more fully in the following detailed description.

This invention is applicable generally to selecting and connecting systems but is disclosed in the drawing as used with a cross-bar switch in a telephone system. For explanation of cross-bar switch structure and operation, reference is made to Patent 2,021,329, issued to Reynolds, November 19, 1935.

Referring to the drawing, the subscribers' lines 101, 102, etc., appear in the vertical rows and the outgoing lines appear in the horizontal rows

103, 104, 105, etc. Individual line relays 106, 107, etc. and switch hold magnets 108, 109, etc. cooperate with the subscribers' lines, and select magnets 110, 111, 112, etc. cooperate with the outgoing circuits. Each outgoing circuit also cooperates with a space discharge tube such as 113, 114, 115, etc. Although other gases may be used it has been found that argon filled tubes give satisfactory results. Ionization in tube 113, for example, first occurs between the cathode 122 and start electrode 116 and then transfers to the gap between the anode 129 and cathode 122. The anodes of all the tubes are electrically connected together through condensers 132, 133, 134, etc. to positive battery 139 through armature of relay 126. The cathodes 122, 123, 124, etc. of the tubes are all electrically connected to negative battery 128 through armature of relay 126. The starting electrodes 116, 118, 119, etc. of the tubes are electrically connected through test conductors 117, 120, 121, etc. respectively, through armatures of relays 135, 137, 142, etc. respectively, to positive batteries 136, 138, 139, etc., respectively. Each of the anodes 129, 130, 131, etc. is connected to one of the select magnets 110, 111, 112, etc., respectively. The non-linear impedance 127, which is a common impedance to all the tubes, is connected to negative battery 128.

The operation of the invention will now be described in detail. A subscriber of line 101 picks up his receiver. This closes the circuit through lines 101 and the winding of relay 106, thereby energizing relay 106. A circuit is thus completed from ground through the armature of relay 106, the winding of relay 126, to negative battery, and thence to ground, energizing relay 126, and closing the contacts of relay 126. This places positive 100 volts on the anodes of the tubes through the left armature of relay 126 and the select magnets 110, 111, 112, etc. It also places negative 50 volts on the left cathodes of the tubes through the right-hand armature of relay 126. Thus there is a difference of potential of 150 volts between the anodes and the left cathodes of the tubes, but this is insufficient to ionize the tubes. There is, however, a positive voltage of batteries 136, 138, 143, etc. applied to the right-hand starting electrodes of the tubes through conductors 117, 120, 121, etc. respectively. This creates a differences of potential between the cathodes and the starting electrodes of the tubes 113, 114, 115, etc. from batteries 136, 138, 143, etc. and battery 128. This difference of potential is sufficient to ionize the gas between the left-hand cathode and the right-hand starting electrode. But only one of the tubes will ionize. The tubes have inherently different characteristics and one of them, tube 113 for example, will begin to pass a little more space current than the others. As this initial space current is small compared to operating value, a large potential drop is created in non-linear impedance 127. This potential drop reduces the applied voltage across the tubes and prevents the tubes, other than tube 113, from ionizing. As long as the current through tube 113 is small there will be a large potential drop across the non-linear impedance 127 which will keep the other tubes from ionizing.

The non-linear impedance 127 is so designed that the potential drop across it is largest when the current passing through it is smallest. Thus, up until the time of ionization of tube 113 the potential drop across the non-linear impedance is at its largest value and will prevent any other tube from ionizing. When the tube 113 is fully ionized the potential drop across the non-linear impedance 127 is less than it was before ionization, but it is still large enough to preclude any other of the discharge tubes from ionizing. It can be seen, therefore, that the use of this non-linear impedance 127 decreases the probability of more than one tube ionizing.

Before relay 110 can operate, however, the ionization within the tube 113 must transfer to anode 129, so that an arc will exist between cathode 122 and anode 129. Conduction is effected between cathode 122 and anode 129 after ionization has been established between cathode 122 and starting electrode 116. After the transfer is made a completed circuit exists through positive battery 139, line 140, winding of select magnet 110, anode 129, across the space gap to cathode 122, line 125, through non-linear impedance 127, to negative battery 128. Select magnet 110 is operated almost immediately as non-linear impedance 127 contains no inductance.

The operation of select magnet 110 prepares the horizontal row of cross-bar contacts, which appear in outgoing circuit 103, for further operation. Thereafter in any suitable manner a circuit is closed over conductor 141 for the operation of hold magnet 108. The operation of hold magnet 108 closes the said cross-bar contacts and establishes a circuit from the subscriber's telephone to the outgoing circuit 103. At this time relay 135 which is under the control of the supervisory relay (not shown), operates to place ground potential upon the starting electrode and provides a holding circuit to ground for hold magnet 108. Since the voltage of battery 128 is insufficient to sustain an arc across the gap 122—116, said arc is extinguished. Relay 135 will remain energized as long as the subscriber of line 101 continues his call.

Referring again to hold magnet 108 which has just been energized over lead 141, it can be seen from the drawing that such energization of hold magnet 108 opens lines 101 to deenergize relay 106 which in turn causes relay 126 to deenergize. Deenergization of relay 126 opens the circuit from positive battery 139, armature of relay 126, line 140, select magnet 110, anode 129, space gap to cathode 122, line 125, armature of relay 126, non-linear impedance 127, to negative battery 128, deenergizing select magnet 110 and extinguishing tube 113. If the subscriber in line 102 should attempt to place a call, tube 113 would not be affected since relay 135 is energized and the armature of relay 135 connects starting electrode 116 to ground through line 117 causing potential difference between cathode 122 and starting electrode 116 to be insufficient to ionize tube 113.

When the subscriber of line 101 hangs up his receiver the supervisory relay (not shown) operates to deenergize relay 135. Deenergization of relay 135 opens the holding circuit for relay 108 which then becomes deenergized. In addition, the deenergization of relay 135 places a positive battery 136 on start electrode 116 to make tube 113 again ready for another subscriber.

In addition to the non-linear impedance 127 acting to keep the tubes, other than tube 113, from ionizing, condensers 132, 133, 134, etc. also act to further decrease the voltage applied across anodes and cathodes of tubes other than tube 113. This is accomplished as follows: When tube 113 starts to ionize, current passes through select magnet 110, causing a difference

of potential across said holding magnet. A current will flow from the positive side of said select magnet, along line 140, through select magnet 111, and will charge condenser 133. This charging current will produce a voltage drop across select magnet 111 and further decrease the voltage applied to anode 130. Similar circuits and charging currents will lower the anode voltage of tube 115.

What is claimed is:

1. In an arrangement for interconnecting any one circuit of a first group of circuits to any circuit of a second group, the combination comprising a plurality of gaseous discharge tubes, each including a main space path and a control space path, a power source, a resistance element having a negative current coefficient of resistance, individual control means for said first circuit operatively responsive to a calling condition, connecting means rendered effective responsive to operation of the individual control means of any of said first group of circuits for connecting said resistance element and said power source to the control space paths of said gas discharge tubes, whereby said control space paths are connected in a low impedance parallel connection with respect to one another and the combination thereof is connected in series with said power source and said resistance element through said connecting means when any one of said first group of circuits requests to be connected to one of said second group of circuits thereby applying an ionizing potential to said control space paths through said resistance element, a second power source, a plurality of actuating means individually connected to each of said main space paths, means connecting said second power source to all of said actuating means, one of said actuating means interconnecting one of said second group of circuits associated therewith to the calling one of said first group of circuits, said resistance element preventing more than one of said control space paths from being ionized at the same time by developing a potential thereacross opposing the potential of said first power source incident to the ionization of one of said control space paths, the resistance of said element thereafter being reduced due to current flow therethrough so as to facilitate rapid operation of the actuating means associated with said ionized main space path.

2. In an arrangement employing a plurality of gaseous discharge devices wherein only one of said devices is to be fully ionized within a short time interval to the exclusion of the other of said devices, each of said devices comprising a main space path and a control space path, a power supply, means connecting said power supply with the main space path of each of said devices, a plurality of impedance elements individually connected in series with a different main space path and said power supply through said connecting means, said control space paths connected in a low impedance parallel connection, a resistance element having a negative current coefficient of resistance connected through said connecting means in series with said parallel connected control space paths, said resistance element preventing more than one of said control space paths from being ionized at the same time by developing a potential thereacross opposing the potential applied to said parallel connected control space paths incident to the ionization of one of said control space paths

thereby locking out the other of said parallel connected control space paths and said resistance element thereafter reducing its resistance value due to increased current flow therethrough so as to prevent a high value surge potential from being developed thereacross due to ionization transfer to one of said main space paths thereby diminishing the time interval during which the impedance element associated with said ionized main space path attains peak potential thereacross.

3. In an arrangement employing a plurality of gas discharge devices each including a main space path and a control space path, a load impedance element connected in each of said main space paths, means connecting said control space paths in a low impedance parallel circuit, a power supply for said control paths and said main paths, respectively, a resistance element having a negative current coefficient of resistance connected in series with said control paths' power supply, and means for connecting said power supplies to said space paths substantially simultaneously, said negative resistance element developing a potential thereacross opposing the potential applied to said parallel connected control space paths incident to the ionization of one of said control space paths to effectively reduce the potential applied to said gas discharge devices to prevent ionization of the control space paths of another of said devices.

4. In an arrangement for interconnecting any one of a first group of lines with any one of a second group of lines, the combination of a plurality of gas discharge tubes each having an anode, a cathode and a control electrode, each tube individual to a different second line, oppositely poled first and second power sources, individual control means for each first line operatively responsive to a calling condition thereon, means common to said first and second lines operated responsive to operation of the individual control means of any first line for connecting one of said power sources to the anodes of said tubes and the other of said power sources to the cathodes of said tubes, a resistor element normally having a high resistance and having a negative current coefficient of resistance connected in series with said other power source and each of said cathodes, current discharge being initiated between the control electrode and cathode of some one of said tubes responsive to operation of said common means followed by current discharge between the anode and cathode of said tube, the normally high resistance of said resistor element blocking initiation of discharge in any other of said tubes, and individual means for each of said second lines operatively energized by the current discharge between the anode and cathode of the associated tube to establish connection of a calling first line to the second line with which said energized tube is individually associated, the decrease in normal resistance of said resistor element upon initiation of current discharge in any tube effecting fast operation of the individual means of the second line with which said energized tube is individually associated.

5. In combination a first plurality of lines, a second plurality of lines, a switching device comprising contact means for interconnecting any one of said first lines and any one of said second lines, electromagnets one for each of said second lines, and hold electromagnets one for each of said first lines, gas discharge tubes one for each of said second lines, a first source of positive elec-

trical potential with respect to ground, means individual to each second line normally connecting the start anode of the individual gas discharge tube to said first source of positive potential, a source of negative electrical potential with respect to ground, a resistor having a normally high impedance and a negative current coefficient of resistance, relay means individual to each first line operated to request interconnection of the first line to any idle one of said second lines, relay means common to said first lines rendered effective by operation of the individual relay means of any first line for closing a connection from the cathodes of all of said gas discharge tubes in parallel through said resistor to said source of negative potential, a second source of positive electrical potential with respect to ground, means including said common relay means for connecting said second source of positive potential through the winding of each of said select electromagnets to the main anodes of the gas discharge tubes thereby effecting the energization of the most sensitive one of said gas discharge tubes individually associated with an

idle one of said second lines and the energization of the individually associated one of said select electromagnets, and contact means closed by operation of the energized one of said select electromagnets to connect the winding of the hold electromagnet of a first line the individual relay means of which is operated to the start electrode of the gas discharge tube individually associated with the energized one of said select electromagnets.

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