Nov. 25, 1952 E. VROOM 2,619,528

SELECTIVE SIGNALING SYSTEM

Filed Aug. 15, 1950 2 SHEETS—SHEET 1

FIG. 2

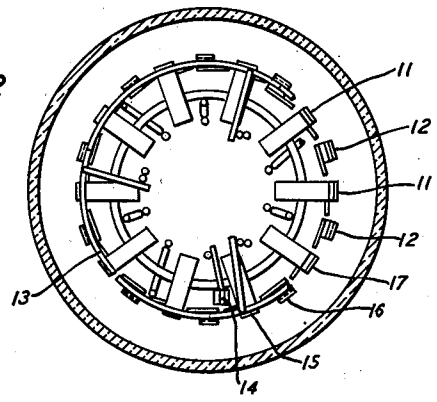
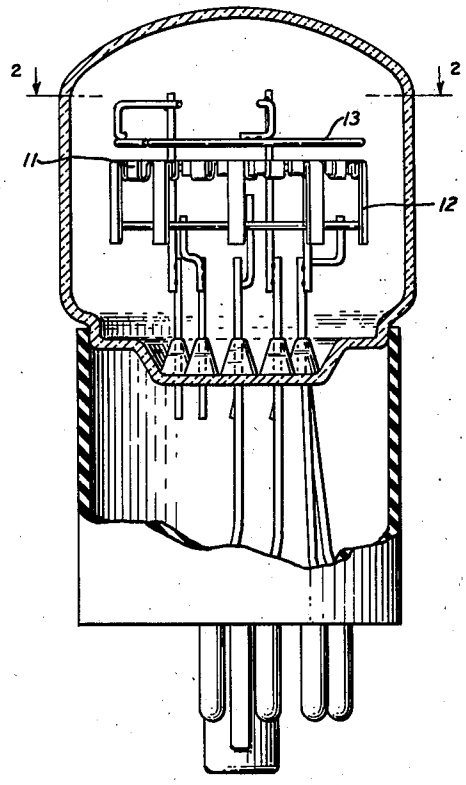


FIG. 1



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Filed Aug. 15, 1950 2 SHEETS—SHEET 2

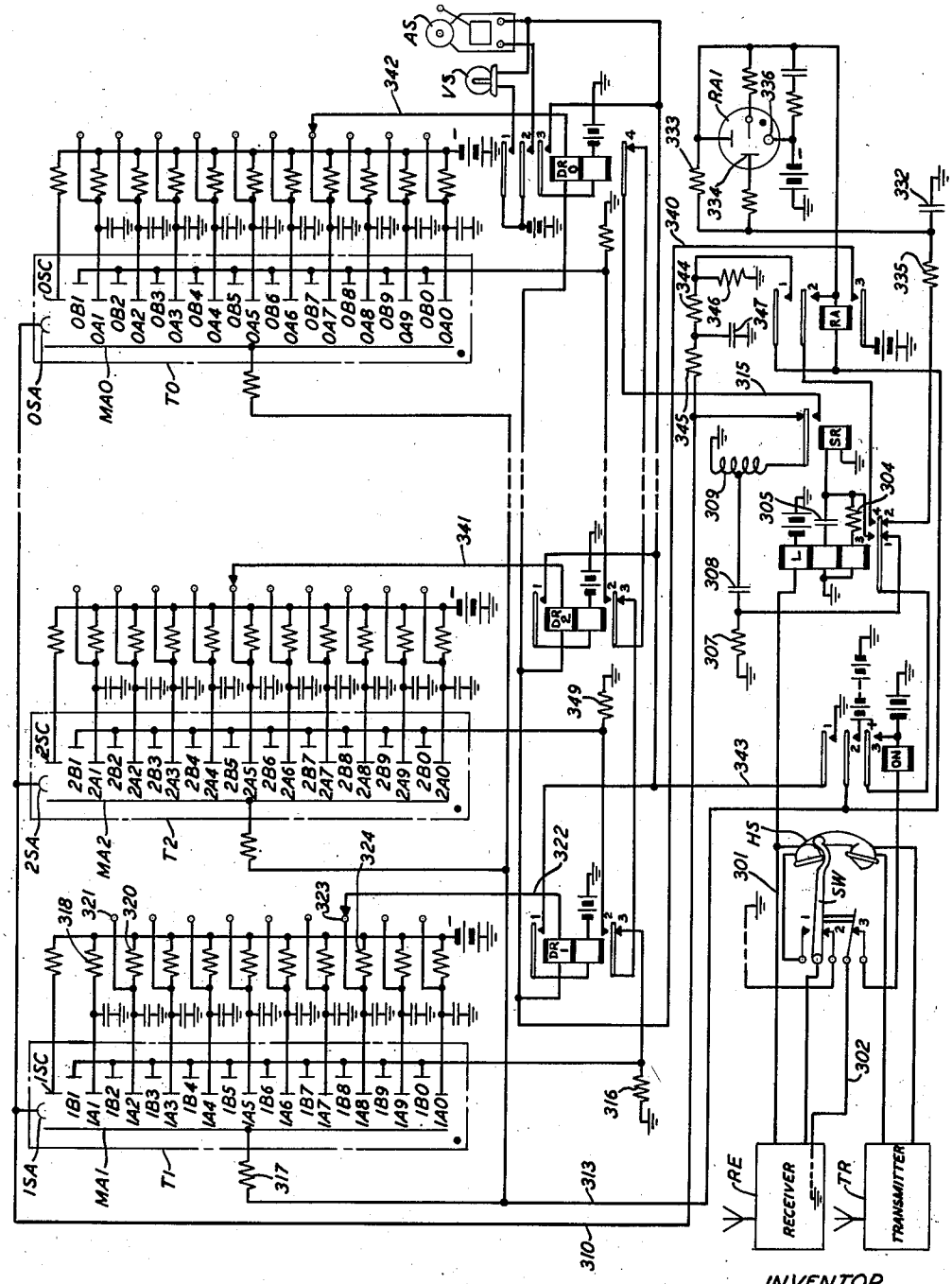

FIG. 3

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UNITED STATES PATENT OFFICE

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SELECTIVE SIGNALING SYSTEM

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Application August 15, 1950, Serial No. 179,415

10 Claims. (Cl. 177—353)

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This invention relates to a selective signaling system and more particularly to apparatus operable only in response to the receipt of a representation of the designation of that apparatus.

An object of this invention is the rapid and accurate ascertainment of the receipt of a selected one of a plurality of designations.

The invention may find application in many fields of communication such as in telephone or telegraph switching systems, mobile radio systems, ship-to-shore communication systems, train dispatching systems, etc. Such systems normally comprise a plurality of terminating or "called" stations each of which is suitably designated by a number, a series of letters, or a combination of numbers and letters. In order to establish a communication path to a particular one of such called stations, it is normally necessary for the called party to be informed audibly and/or visually that he is being called. However, in many systems, the signals representing a large group of designations are received by each of the stations. Consequently, it is desirable that means be provided to alert the called party only when his particular designation is received. Therefore, in general, this invention comprises a system operable in response to the receipt of a preselected one only of a plurality of composite signals to energize a visual or audible signal.

A feature of the invention is the utilization of cold cathode gaseous discharge stepping devices each having a plurality of cathodes.

Another feature of this invention is the provision of one multicathode gaseous discharge device for each digit or element of the subscribers' designations.

Another feature of this invention is a means for successively operating the multicathode gaseous discharge devices only if each of the successive digits or elements received correspond with the element or digit at that point in the sequence in the designation of the station with which the apparatus is associated.

The principles of the invention may be more fully understood from the following detailed description of a preferred embodiment thereof when read with reference to the accompanying drawings, in which:

Fig. 1 is an elevational view of a multicathode glow discharge device illustrative of one type of tube suitable for use in the present system;

Fig. 2 is a sectional view taken along 2—2 of Fig. 1 illustrating the arrangement of the several cathodes and the cooperative relation thereof with the anode, a portion of the anode being

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broken away to show certain of the cathodes more clearly; and

Fig. 3 is a circuit diagram representing a preferred ambodiment of the invention.

The multicathode stepping tubes which are employed in the present system may be of any suitable type. A tube operable in a suitable manner is disclosed, for example, in United States Patent 2,575,370 granted November 20, 1951, to M. A. Townsend, the disclosure of which is incorporated herein by reference. A representation of that tube is presented as Figs. 1 and 2 of the present disclosure.

In general, the disclosed gaseous discharge device comprises an anode and a plurality of cold cathodes in cooperative relationship with the anode, the cathodes being mounted in a row which may be rectilinear, circular or of other geometrical form. The cathodes, or certain of them, are electrically grouped and are so constructed and arranged that the discharge between one cathode and the anode may be stepped or shifted selectively to a path between the anode and another cathode in response to signal pulses, the discharge shifting or advancing one position for each pulse.

Referring now to Figs. 1 and 2 of the drawings, the tube of the exemplary type comprises a plurality of cathodes 11, hereinafter referred to as "A" cathodes, and a second plurality of cathodes 12, hereinafter designated as "B" cathodes, all of the cathodes being mounted in a circular array with each "A" cathode 11 interposed two "B" cathodes 12. The main anode 13 may be and is shown to be ring-shaped, and is supported in spaced relation with the "A" and "B" cathodes. An auxiliary, start, reset or "normalizing" electrode 14 is also provided.

In one method of operating the stepping tube, the start electrode 14 is employed as a start anode cooperating with the electrode 15 which serves as a start cathode. A suitable positive potential is applied to the main anode 13, a potential negative relative to the main anode potential is applied to the start cathode 15, and a potential positive with respect to the start cathode potential is applied to the start anode 14. A discharge initially occurs between the start anode 14 and the start cathode 15, with conduction then transferring so as to exist between the main anode 13 and the start cathode 15. If a negative pulse then be applied to the "B" cathodes 12, the discharge will transfer initially so as to exist between the main anode and the first one of the "B" cathodes. This first "B" cathode is labeled 16

in Fig. 2. At the cessation of the pulse, the discharge will transfer so as to exist between the main anode and the first one of the "A" cathodes in a counter-clockwise direction in the structure as shown in Fig. 2. This first "A" cathode is labeled 17 in the structure as shown in Fig. 2 and is supplied with a suitable voltage through an impedance. In a similar manner, successive pulses applied to the "B" cathodes 12 will cause the conductive path in the tube to transfer so as to exist between the main anode 13 and the successive "A" cathodes 11. The directivity of the stepping is accomplished by the construction of the cathodes, in a manner fully set forth in the above-cited patent application or in any other suitable manner.

As the conductive path progresses step by step from position to position in the tube, the conduction is limited to one path at a time, i. e., the conduction between the main anode and the previous "A" cathode 11 is extinguished. This may be accomplished by utilizing a suitable impedance in series with the main anode of the device whereby the increased voltage drop across this impedance, resulting from the transfer of conduction to a "B" cathode 12, is sufficient to cause the voltage between the main anode 13 and an "A" cathode 11 to fall below the sustaining value.

A circuit embodying the principles of the invention is shown in Fig. 3 of the drawing. In this circuit a plurality of multicathode stepping tubes T1 to T0 is provided. These tubes may be of the type shown in Figs. 1 and 2, and in that event, in tube T1, main anode MA1 is the correlative of anode 13 in Fig. 2, the first "B" cathode 1B1 is shown as cathode 16 in Fig. 2, the "B" cathodes 1B2 to 1B0 are shown as the cathodes 12 in Fig. 2, the first "A" cathode 1A1 is shown as cathode 17 in Fig. 2, "A" cathodes 1A2 to 1A0 are the correlatives of cathodes 11 in Fig. 2, the start anode 1SA is shown as electrode 14 in Fig. 2, and the start cathode 1SC is shown as electrode 15 in Fig. 2. Tubes T2 to T0 are provided with electrodes similarly designated to those of tube T1 except for the appropriate change in the initial character in each designation.

As an exemplary embodiment of the invention, a portion of a mobile radio telephony system has been shown in Fig. 3. At each of the subscribers' stations, such as the one represented in Fig. 3, a radio receiver RE and a radio transmitter TR are provided. This apparatus may be of any suitable type well known in the art, and is associated with a telephone handset HS in the normal manner. It is assumed that receiver RE is continuously operative to receive all of a relatively large group of subscribers' telephonic designations, which are transmitted from one or more central points, and to apply all of these incoming designations to conductor 301 which is connected to battery through the upper winding of pulsing relay L. The receiver is further assumed to be operable in response to the receipt of any subscriber's designation to connect ground to conductor 302, whereby this ground is extended through the No. 3 contact of the switchhook SW to operate "off-normal" relay ON.

Let it be assumed that a signal has been received by receiver RE and that receiver RE has operated to energize relay ON and to cause current to flow through the upper winding of relay L to operate relay L so that its armature is contacting the Nos. 3 and 4 contacts thereof. As the several series of pulses representing the several letters or digits of the called party's designation are applied to conductor 301 through receiver RE, relay L will release at each pulse and reoperate at the termination of each pulse in the normal manner.

Additional windings are shown on relay L for special purposes. The lower winding of relay L is a biasing winding which opposes the upper or operating winding sufficiently to force relay L to release when the operating winding is deenergized. When relay L operates, the energizing circuit for the lower winding of relay L is completed through resistor 304, No. 3 contacts of relays L and ON and to negative battery. When, subsequently, the upper winding of relay L is deenergized, the current in the lower winding of relay L is such as to assist the start of the release of relay L. The middle winding of pulsing relay L functions as an aiding winding, assisting in both the operation and release of the relay. When relay L is operated capacitor 305 is charged over a path from ground, middle winding of relay L, capacitor 305, through the No. 3 contacts of relays L and ON and to negative battery. When relay L is released, the above-traced charging path is interrupted and capacitor 305 discharges through the winding of relay SR to ground. The current flow through the middle winding of relay L, as a result of the discharging of capacitor 305, is in a direction to aid the release of relay L and to insure the closure of the back contacts of that relay. When relay L is again operated, the charging path for capacitor 305 is reestablished and the current flowing through the middle winding of relay L as a result of the charging of that capacitor aids the operation of relay L thereby insuring a steady front contact closure.

Relay ON is arranged to operate prior to the operation of relay L. This may be accomplished by controlling the time at which the receiver RE grounds the leads 301 and 302 or by the characteristics of the relays per se. Upon the operation of relay ON and prior to the time that relay L has first operated, negative battery is connected through the No. 3 contact of relay ON, No. 1 contact of unoperated relay L and to ground through resistor 307 and, in parallel therewith, to ground through capacitor 308 and the upper winding of the pulse generator transformer 309. As a result of the surge of charging current for capacitor 308 through the upper winding of transformer 309, transformer 309 transmits a positive pulse through the back contact of unoperated relay SR, conductor 310 and to the start anodes 1SA to 0SA of all the stepping tubes T1 to T0. Since the start cathodes 1SC to 0SC are all connected to negative battery, which may supply, for example, a negative 50-volt potential, through individual resistors, each of the tubes T1 to T0 will undergo an initial discharge between its start anode and its start cathode. Since the main anodes MA1 to MA0 of all of the tubes are connected to positive battery which may supply, for example, a positive 135-volt potential, through individual resistors, via conductor 313, and through the No. 2 contact of relay ON, each of the tubes T1 to T0 will immediately undergo a transfer of discharge whereby conduction will exist between the main anode MA1 to MA0 and the start cathode 1SC to 0SC, respectively, of the tubes T1 to T0, respectively. All the tubes T1 to T0 are now prepared for stepping.

Upon the initial operation of relay L, a circuit is completed from negative battery, No. 3 contacts of relays ON and L, winding of relay SR and to ground whereby relay SR is operated. It will be noted that this operation of relay SR cannot occur until relay L has closed its No. 3 contact whereby ample time will have been provided for the transmission of the positive pulse by transformer 309 through the back contact of relay SR as was hereinbefore described. It may also be noted that relay SR is of the slow-to-release type so that it remains operated despite the several momentary interruptions of its energizing circuit resulting from the pulsing of relay L.

At the first release of relay L in response to the first pulse of the first digit of the received designation, capacitor 308 will charge over the above-traced path. A positive pulse is transmitted by transformer 309 in response to the charging in the same manner as above described, but since relay SR is now operated, this pulse will be transmitted through the front contact of operated relay SR, conductor 315, through back contacts of all of the operated register and steering relays DRo to DR1 and to ground through resistor 316 whereby a positive pulse will be applied to all of the "B" cathodes 1B1 to 1B0 of tube T1. This positive pulse will be ineffective to create any change in the condition of the circuits at this time. At the next operation of relay L at the end of the first pulse of the first digit of the received designation, capacitor 308 will discharge through resistor 307 to ground whereby a negative pulse will be transmitted by the pulse generator transformer 309 over the above-traced path to ground through resistor 316 whereby a negative pulse will be applied to all of the "B" cathodes 1B1 to 1B9 of tube T1. In response to this first negative pulse applied to the "B" cathodes of tube T1, the conductive path in that tube will be transferred so as to exist between the main anode MA1 and the first "B" cathode 1B1 thereof. As a result, due to the increased voltage drop across anode resistor 317, the potential at the main anode MA1 of tube T1 will drop to a point where the potential difference between the main anode MA1 and the start cathode 1SC is below the sustaining value, and that discharge path will thereby be extinguished. As the pulse attenuates, the discharge in tube T1 will again transfer so as to exist between the main anode MA1 and the first "A" cathode 1A1 which is connected to negative battery through resistor 318. Although the potential drop across the "A" cathode resistor 318 may be employed as an output signal indicative of the registration of the digit "1," this has not been done in the preferred embodiment of the invention inasmuch as the digit "1" is normally not employed as the first digit of a subscriber's designation.

At the next momentary release and reoperation of relay L in response to the second pulse of the first digit of the received designation, the conductive path in tube T1 is successively stepped to the next "B" cathode 1B2 and then to the next "A" cathode 1A2, with the prior conductive path between the main anode MA1 and the "A" cathode 1A1 being extinguished. The rise in potential of cathode 1A2 due to the potential drop across resistor 320 appears at output terminal 321.

As the subsequent first digit pulses are received, relay L will continue to follow the pulses

alternatively to charge and discharge capacitor 308 whereby transformer 309 will continue to transmit negative pulses to the "B" cathodes of tube T1. The stepping of tube T1 continues in the above-described manner, with the conductive path therein finally resting on that one of the "A" cathodes corresponding with the number of pulses received. Therefore, the output terminal associated with the selected "A" cathode carries a potential considerably positive relative to the potential which is supplied to the output terminals which are connected to the non-conducting "A" cathode.

An output conductor 322 is connected to a selected one of the "A" cathode output terminals of tube T1. This connection is made in accordance with the first digit of the designation of the particular subscriber's station with which the apparatus is associated. Thus, assuming the first digit of the designation to be "8" (or a corresponding letter), output conductor 322 is connected to output terminal 323 which is connected to the eighth "A" cathode 1A8 of tube T1, as shown.

At the termination of the pulses representing any one digit, relay RA is operated and remains operated during the interdigital delay period. At any time that relay L is operated, capacitor 332 is charging over a path from positive battery, No. 2 contact of relay ON, winding of relay RA, resistor 333, capacitor 332 and to ground. As a consequence, a rising positive potential is applied to the start anode 334 of tube RA1. However, the time constant of that circuit is longer than the time between he pulses representing any one digit of a subscriber's designation, and consequently prior to the time that a discharge is initiated in tube RA1, relay L will momentarily release and capacitor 332 will discharge, and, in fact, charge oppositely through resistor 335, No. 2 contact of released relay L, No. 3 contact of relay ON and to negative battery. At the end of the pulses representing any one digit, however, an interdigital time will elapse and during this longer period capacitor 332 will rise to a sufficient positive potential to initiate a discharge in tube RA1 between the start anode 334 and the cathode 336, which is connected to negative battery. Since the main anode of tube RA1 is connected to positive battery through the winding of relay RA, tube RA1 will undergo an immediate transfer of discharge whereby the conductive path will exist across the main gap of tube RA1 and relay RA will be operated.

Relay RA, in operating, connects negative battery through its No. 3 contact to conductor 340 which extends to the operating windings of all of the register and steering relays DR1 to DR0. The other terminal of each of the operating windings of these relays is connected to one of the tube output conductors, such as conductors 322, 341 or 342. Under this condition, if the initial digit received corresponds to the initial digit of the designation of the subscriber's station with which the subject apparatus is associated, relay DR1 will be operated. Thus, assuming that the digit "8" has been received, terminal 323 will have risen to a potential positive relative to the negative battery connected to the left-hand terminal of relay DR1 and, as a result, relay DR1 will be operated. It will be seen that had the initial digit been any other digit than "8," the conductive path in tube T1 would not have included "A" cathode 1A8, terminal 323 would not have been at an elevated potential

at the commencement of the interdigital delay period and relay DR1 would not have been operated.

Relay DR1 locks operated over a path from negative battery, locking winding and No. 1 contact of relay DR1, conductor 343, and to ground through the No. 1 contact of relay ON. Relay DR1, in operating opens its No. 3 contact to disconnect the pulse-generator transformer 309 from the "B" cathodes of tube T1 and closes its No. 2 contact to connect that pulse source to the "B" cathodes of the next succeeding counting tube T2.

Relay RA, in operating, also completes a circuit from positive battery, No. 2 contact of relay ON, No. 1 contact of relay RA, resistors 344 and 345 and via conductor 310 to the start anodes 1SA to 0SA of all of the stepping tubes T1 to T0. The application of this positive potential to the start anode 1SA of tube T1 causes the conductive path in tube T1 to transfer so as to exist momentarily between the start anode 1SA and the start cathode 1SC. The discharge will then transfer so as to exist between the main anode MA1 and the start cathode 1SC of tube T1. Thus, tube T1 may be restored to its initial condition in this manner if desired. The network comprising resistors 344 and 346 and capacitor 347 provides a time delay to ensure that tube T1 will not be restored to normal before relay DR1 has had time to operate and lock operated.

When relay RA operates, negative battery is connected through the No. 3 contact of relay ON, No. 4 contact of operated relay L, and through the No. 2 contact of relay RA to the winding of relay RA and to the main anode of tube RA1 whereby relay RA is locked operated under the control of relay L and tube RA1 is extinguished.

At the first pulse representing the second digit of the received designation, relay L momentarily releases thereby releasing relay RA so that negative battery is no longer connected to the operating windings of the DR-series of relays. At the termination of this pulse, relay L reoperates and transformer 309 transmits a negative pulse through the front contacts of operated relay SR, conductor 315, No. 4 contact of relay DR0, No. 3 contact of relay DR2, No. 2 contact of operated relay DR1 and to ground through resistor 349 whereby a negative pulse is applied to the B cathodes 2B1 to 2B0 of the second digit counting tube T2. Tube T2 is stepped in a manner similar to the operation of tube T1 and, at the next interdigital pause, relay DR2 is operated if, but only if, the second-received digit corresponds to the second digit of the designation of the subscriber's station with which the apparatus is associated, herein assumed to be the digit 5.

The apparatus continues to operate in this fashion, with the succeeding DR-series relays being operated if the successive received digits correspond, respectively, with the successive digits of the subject subscriber's designation. As each DR relay except the last operates, it locks operated and transfers the pulse lead to the next succeeding stepping tube.

If the received designation does correspond to the designation of the subscriber's station the register and steering relays DR1 to DR0 will be successively operated; otherwise, at least relay DR0 will remain unoperated. Upon the operation of relay DR0, signifying that the subject subscriber should be signaled, the visual signal comprising lamp VS and the audible signal comprising bell AS will both be operated over paths from battery through the contacts of operated relay DR0 to ground through the No. 1 contact of relay ON.

When the called subscriber lifts the handset HS, the No. 1 switchhook contact will be closed to connect the handset HS to the receiver RE and the No. 3 switchhook contact will be opened to release relay ON. On the other hand, if the incoming pulses do not designate the particular station shown in Fig. 3, relay ON will be released when the receiver RE removes the ground from conductor 302. In either case, relay ON, in releasing, restores the apparatus to normal, extinguishing all of the discharged tubes, releasing the operated relays, and deenergizing the audible and visual signals if they have been energized.

It is to be understood that the above-described arrangements are but 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 spirit and scope of the invention.

What is claimed is:

1. In a signaling system, a plurality of gaseous conduction devices each having a plurality of distinct conduction positions and each responsive to electrical impulses applied thereto to advance the conductive path therein step by step from position to position, an impulse generator operable to transmit a series of groups of electrical impulses, a chain of relays comprising a relay individual to each of said devices, means including contacts on each of said relays for normally electrically connecting said impulse generator to the first one of said devices, means for operating each of said relays only if the conductive path in the one of said devices to which each of said relays is individual is stepped to a preselected position, each of said relays except the last one of said relays being operable to transfer the connection of said impulse generator to the next succeeding one of said devices, signal means, and means responsive to the operation of the last one of said relays for operating said signal means.

2. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, means normally electrically connecting said impulse generator to said second plurality of cathodes in said first device, and apparatus including said means connected to a preselected one of said first plurality of cathodes in each of said devices and operative only in response to the advancement of the conductive paths to include the respective preselected ones of said first plurality of cathodes in the successive ones of said devices for successively electrically connecting said impulse generator to the said second plurality of cathodes in the successive ones of said devices.

3. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of

cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, means normally electrically connecting said impulse generator to said second plurality of cathodes in said first device, apparatus including said means connected to a preselected one of said first plurality of cathodes in each of said devices except the last one of said devices and operative only in response to the advancement of the conductive paths to include the respective preselected ones of said first plurality of cathodes in the successive ones of said devices for successively electrically connecting said impulse generator to the said second plurality of cathodes in the successive ones of said devices, signal means, and means responsive to the advancement of the conductive path in the last one of said devices to include the preselected one of the said first plurality of cathodes in said last device for operating said signal means.

4. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, means normally electrically connecting said impulse generator to said second plurality of cathodes in said first device, apparatus connected to a preselected one of said first plurality of cathodes in each of said devices for successively electrically connecting said impulse generator to the said second plurality of cathodes in the successive ones of said devices, and means operable at the termination of each of said groups of pulses for operating said apparatus only if the conductive paths in the successive ones of said devices have been advanced to include the respective preselected ones of said first plurality of cathodes in the successive ones of said devices.

5. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, means normally electrically connecting said impulse generator to said second plurality of cathodes in said first device, apparatus connected to a preselected one of said first plurality of cathodes in each of said devices for successively electrically connecting said impulse generator to the said second plurality of cathodes in the successive ones of said devices, means operable at the termination of each of said groups of pulses for operating said apparatus only if the conductive paths in the successive ones of said devices have been advanced to include the respective preselected ones of said first plurality of cathodes in the successive ones of said devices, signal means, and means responsive only to the advancement of the conductive path in the last one of said devices to include the preselected one of the said first plurality of cathodes in said last device for operating said signal means.

6. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, and a chain of relays comprising a relay connected to a preselected one of the said first plurality of cathodes in each of said devices and operative only in response to the advancement of the conductive path to include the said preselected cathode in the associated one of said devices for electrically connecting said impulse generator to the next succeeding one of said devices.

7. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, and a chain of relays normally electrically connecting said impulse generator to said second plurality of cathodes in said first device and comprising a relay connected to a preselected one of the said first plurality of cathodes in each of said devices and operative only in response to the advancement of the conductive path to include the said preselected cathode in the associated one of said devices for electrically connecting said impulse generator to the next succeeding one of said devices.

8. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, a chain of relays normally electrically connecting said impulse generator to said second plurality of cathodes in said first device and comprising a relay connected to a preselected one of the said first plurality of cathodes in each of said devices and operative only in response to the advancement of the conductive path to include the said preselected cathode in the associated one of said devices for electrically connecting said impulse generator to the next succeeding one of said devices, and signal means operative in response to the operation of the one of said relays associated with the last one of said devices.

9. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of elec-

trical impulses, a chain of relays normally electrically connecting said impulse generator to said second plurality of cathodes in said first device and comprising a relay connected to a preselected one of the said first plurality of cathodes in each of said devices, and apparatus operable at the termination of each of said groups of pulses for successively operating said relays only if the conductive paths in the successive ones of said devices have been advanced to include the preselected ones of said first plurality of cathodes in the successive ones of said devices.

10. In a signaling system, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, each of said devices being responsive to pulses applied to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, an impulse generator operable to transmit a series of groups of electrical impulses, a chain of relays normally electrically connecting said impulse generator to said second plurality of cathodes in said first device and comprising a relay connected to a preselected one of the said first plurality of cathodes in each of said devices, apparatus operable at the termination of each of said groups of pulses for successively operating said relays only if the conductive paths in the successive ones of said devices have been advanced to include the preselected ones of said first plurality of cathodes in the successive ones of said devices, and signal means operative in response to the operation of the one of said relays associated with the last one of said devices.

EDWARD VROOM.

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