Oct. 16, 1951 E. VROOM 2,571,800

SIGNAL TRANSMITTER

Filed Aug. 9, 1950 2 SHEETS—SHEET 1

FIG. 1

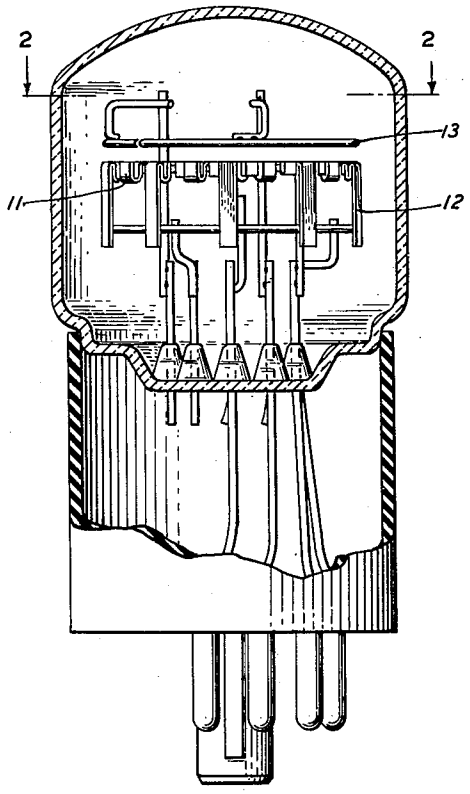
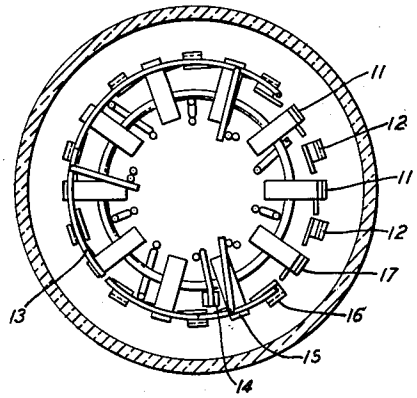


FIG. 2



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Oct. 16, 1951 E. VROOM 2,571,800

SIGNAL TRANSMITTER

Filed Aug. 9, 1950 2 SHEETS—SHEET 2

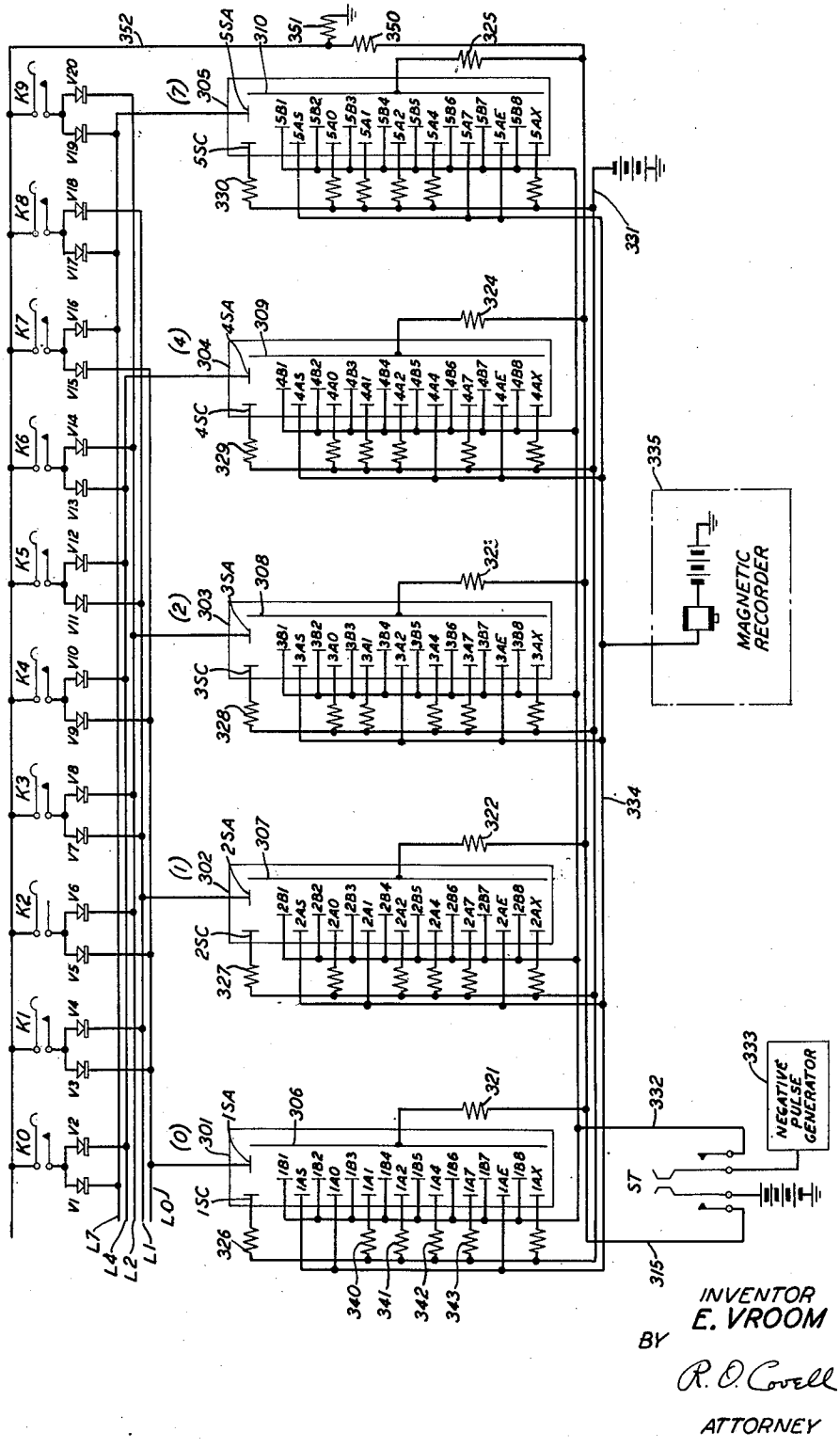

FIG. 3

Patented Oct. 16, 1951

2,571,800

UNITED STATES PATENT OFFICE

2,571,800

SIGNAL TRANSMITTER

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Application August 9, 1950, Serial No. 178,459

10 Claims. (Cl. 177—380)

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This invention relates to a signaling system and more particularly to a system for selectively generating and transmitting code pulses.

An object of this invention is the accurate and rapid transmission of signals.

Another object of this invention is the rapid translation of information into code pulses representing that information.

A feature of this invention is the use of multicathode gaseous discharge devices as code pulse generators.

Another feature of this invention is the use of a plurality of multicathode gaseous discharge devices operable selectively and cooperatively to transmit code pulses.

In general, the system utilizes multicathode gaseous discharge devices with each of those devices being arranged to operate in response to pulses applied thereto to advance the conductive path therein step by step from cathode to cathode. Selected ones of the cathodes of each of said devices are connected to a common output means. Means are provided selectively to energize said devices in accordance with the information to be transmitted whereby the selected devices cooperate to produce a series of code pulses representative of that information.

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

Fig. 3 is a circuit diagram representing a preferred embodiment 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 the United States patent application of W. A. Townsend, Serial No. 101,322, filed June 25, 1949, 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

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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 between 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 of suitable amplitude and duration 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 drawings. In this circuit, five multicathode stepping tubes 301 to 305 are provided. These tubes may be of the type shown in Figs. 1 and 2 having both a start anode and a start cathode. Thus, if that tube structure be employed, in tube 301, anode 306 is shown in Fig. 2 as anode 13, the first B cathode 1B1 is the correlative of cathode 16 in Fig. 2 and the other B cathodes 1B2 to 1B8 are shown as the cathodes 12 in Fig. 2, the first A cathode 1AS is shown as cathode 17 in Fig. 2 and the other A cathodes 1A0, 1A1, 1A2, 1A4, 1A7, 1AE and 1AX are the correlatives of cathodes 11 in Fig. 2, the start anode 1SA is the correlative of electrode 14, and the start cathode 1SC is shown as electrode 15 in Fig. 2. Similarly, tubes 302 to 305 are provided with electrodes similarly designated to those of tube 301 except for the appropriate change of the initial character in each designation.

The system is preferably arranged to transmit code pulses on the so-called two-out-of-five basis in which each of the several digits is represented by a particular combination of two elements. Thus, in the present system, in a discrete interval of time five pulses may be transmitted, time-spaced one from the other. Only two such pulses are transmitted, however, to represent any one digit, the time-spacial relation of the two pulses to the beginning of the discrete interval being selected in accordance with the digit which is to be represented. For example, the digit "1" may be represented by transmitting the first and the second of the five pulses, the digit "2" may be represented by the first and the third of the five pulses and so on, with the other digits being represented by other unique combinations of two of the five pulses. For convenience, the five pulses may be labeled the Nos. 0, 1, 2, 4 and 7 pulses so that, for all digits except the digit "0," the combination of pulses to be employed may be determined by the process of addition as follows:

Digit	Pulse Numbers
1	0,1
2	0,2
3	1,2
4	0,4
5	1,4
6	2,4
7	0,7
8	1,7
9	2,7
0	4,7

The several tubes 301 to 305 are arranged, as will hereinafter be demonstrated, to transmit the five pulses, respectively, combinations of which are employed to represent the digits. Consequently, those tubes are also designated, for

purposes of clarity, as the "0" tube, the "1" tube, the "2" tube, the "4" tube and the "7" tube, respectively. As will hereinafter be seen, each of the tubes 301 to 305 is also operative to transmit a "start" pulse to mark the beginning of the discrete interval and a "stop" or "end" pulse to mark the termination of the individual discrete interval.

To set the apparatus in operation, key ST is closed whereby positive battery, which may supply, for example, a positive 135-volt potential, is connected to conductor 315 and through resistors 321 to 325 to the anodes 306 to 310, respectively, of tubes 301 to 305, respectively. The start cathodes 1SC to 5SC of tubes 301 to 305, respectively, are connected through individual resistors 326 to 330, respectively, to conductor 331 which is connected to negative battery which may supply, for example, a negative 48-volt potential. When a suitable positive potential is applied to the start anode 1SA of the "0" tube 301, for example, in a manner hereinafter to be described, a discharge will be initiated between the start anode 1SA and the start cathode 1SC, and this discharge will immediately transfer so as to exist between the main anode 306 and the start cathode 1SC. Similiarly, if a suitable positive potential be applied to the start anode 2SA to 5SA of any of the other tubes 302 to 305, a discharge will be initiated between that start anode and the associated start cathode 2SC to 5SC and that discharge will immediately transfer so as to exist between the associated main anode 307 to 310 and the start cathode 2SC to 5SC.

The B cathodes of all of the stepping tubes 301 to 305 are connected in multiple to conductor 332, thence through the closed contacts of operated key ST to negative pulse generator 333. This generator may be of any well-known type arranged continuously to supply negative pulses of suitable amplitude and frequency. For example, the tube structure shown in Figs. 1 and 2 has been found properly to respond to pulses applied at a rate in excess of 8000 pulses per second.

When the low impedance negative pulse generator 333 applies the first pulse to the B cathodes of tube 301 after a discharge has been initiated in that tube, the conductive path will be transferred so as to exist between the main anode 306 and the first B cathode 1B1 of tube 301. As a result, due to the increased voltage drop across anode resistor 321, the potential at the main anode 306 of tube 301 will drop to a point where the potential difference between the main anode 306 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 301 will again transfer so as to exist between the main anode 306 and A cathode 1AS. Cathode 1AS is connected to negative battery via output conductor 334 and through an output means which may comprise the winding of the recording head of a magnetic recorder 335. The current flow in conductor 334 resulting from the including of cathode 1AS in the conductive path through tube 301 (or from the including of any other one of the "start" A cathodes 2AS to 5AS in the conductive path through any other one of the tubes 302 to 305, respectively) constitutes the "start" pulse which marks the beginning of a discrete interval of time during which pulses representative of a single digit will

As negative pulse generator 333 continues to

apply pulses to the B cathodes of tube 301, for example, the conductive path is successively stepped to B cathode 1B2, to A cathode 1A0, to B cathode 1B3, to A cathode 1A1, to B cathode 1B4, to A cathode 1A2, to B cathode 1B5, to A cathode 1A4, to B cathode 1B6, to A cathode 1A7, to B cathode 1B7, to A cathode 1AE, to B cathode 1B8 and to A cathode 1AX where the discharge rests. A similar stepping occurs in any other tube 302 to 305 which has been rendered conductive by the application of a suitable potential to the start anodes 2SA to 5SA, respectively.

The five A cathodes in each tube succeeding the "start pulse" A cathodes 1AS to 5AS, respectively, are successively labeled 1A0 to 5A0, 1A1 to 5A1, 1A2 to 5A2, 1A4 to 5A4 and 1A7 to 5A7, i. e., these five cathodes in each tube are designated in accordance with the above-described two-out-of-five code symbolism. The one of these five A cathodes in each tube which corresponds to the tube designation is connected to the output conductor 334. Thus, A cathode 1A0 in the "0" tube 301, cathode 2A1 in the "1" tube 302, cathode 3A2 in the "2" tube 303, cathode 4A4 in the "4" tube 304 and cathode 5A7 in the "7" tube 305 are all connected to the output conductor 334. The other four of the five digit-designating A cathodes in each tube are connected to negative battery through individual impedances and via conductor 331. For example, A cathodes 1A1, 1A2, 1A4 and 1A7 are connected through the individual resistors 340 to 343 and conductor 331 to negative battery. The final A cathodes 1AX to 5AX are also connected to conductor 331 through individual resistors. It will be noted that the "stop" or "end" cathodes 1AE to 5AE in the several tubes 301 to 305 are also connected to the output conductor 334.

It will therefore be seen that if tube 301 is stepped, a pulse will be applied to the output conductor 334 when the conductive path includes cathode 1AS whereby a "start" pulse will be transmitted, a pulse will be applied to the output conductor 334 when the conductive path includes cathode 1A0, and a pulse will be applied to the output conductor 334 when the conductive path in tube 301 includes cathode 1AE whereby a "stop" or "end" pulse will be transmitted. Similarly, as any other one of the tubes 302 to 305 is stepped, a "start" pulse will be transmitted when the conductive path therein includes the associated A cathode 2AS to 5AS, a digit-designating pulse will be transmitted when the conductive path includes the corresponding one of the A cathodes 2A1, 3A2, 4A4, or 5A7 and a "stop" or "end" pulse will be transmitted when the conductive path includes the associated cathode 2AE to 5AE.

As was previously indicated, two pulses are transmitted to designate each digit. Consequently, two of the tubes 301 to 305 are discharged and stepped simultaneously. The selective and simultaneous actuation of any two of the five tubes 301 to 305 is accomplished by means of the key-set comprising keys K0 to K9. The potential on conductor 315 is reduced to an appropriate value by the voltage-divider action of resistors 350 and 351 and the resulting potential is applied via conductor 352 to the upper contacts of all of the keys K0 to K9. Each of these keys is connected to two of the five leads L0, L1, L2, L4 and L7 through a pair of varistors V1 to V20. These connections are arranged in accordance with the above-listed code systems, i. e., key K0 is connected to conductors L4 and L7, key K1 is connected to conductors L0 and L1, key K2 is connected to conductors L0 and L2, and so on. Conductors L0 to L7 are also connected to the start anodes 1SA to 5SA, respectively, of the "0," "1," "2," "4" and "7" tubes 301 to 305, respectively. Therefore, if key K0 be operated, the positive potential on conductor 352 is applied through that key, through varistors V1 and V2 and via conductors L4 and L7 to the start anodes 4SA and 5SA of the "4" and "7" tubes 304 and 305, respectively. These tubes will therefore undergo a discharge and will step through their cycles. Therefore, a "start" pulse will be transmitted, a first digit-designating pulse will be transmitted when the conductive path in the "4" tube 304 includes its cathode 4A4, a second digit-designating pulse will be transmitted when the conductive path in the "7" tube 305 includes its cathode 5A7 and an "end" pulse will be transmitted when the conductive paths in the two tubes include cathodes 4AE and 5AE. This series of pulses will represent the digit "0." It may be noted that although both of the discharged tubes transmit "start" and "end" pulses, since the B cathodes of the tubes are connected to a common pulse source, the tubes are stepped simultaneously so that only one start pulse and only one end pulse will be transmitted per cycle of operation of the two tubes.

The operation of any other one of the keys K0 to K9 will operate the appropriate pair of the tubes 301 and 305 in a similar fashion to transmit pulses indicative of the selected digit. It will be seen that any number comprising any number of digits may be transmitted by successively operating the proper ones of the keys K0 to K9.

Varistors V1 to V20 are unidirectional current conducting devices and may be gas diodes, "dry" rectifiers, etc. These varistors are represented conventionally, i. e., they represent a low impedance to conventional current flow when the arrow sides thereof are at a positive potential relative to the other sides. The varistors V1 to V20 are provided to prevent the operation of any tubes other than the selected pair of tubes. By the nature of the connections to the conductors L1 to L7, were it not for the varistors V1 to V20, all of the tubes 301 to 305 would, improperly, be operated upon the closure of any one of the keys K0 to K9.

It will be apparent that the code basis may be varied from that shown. For example, ten tubes may be provided with the several keys K0 to K9 being individual to those tubes and with an appropriate two of the A cathodes in each tube, in addition to the "start pulse" cathode and the "end pulse" cathode, being connected to the output conductor whereby only one tube need be operated to transmit a representation of any one digit.

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 communication system, a pulse source, a plurality of gaseous conduction devices each having a first electrode and a plurality of other electrodes, output means, means connecting selected ones of said other electrodes in each of said devices to said output means, and means for selectively initiating a discharge in said de-

vices, each of said devices when discharged being responsive to pulses transmitted from said pulse source to advance the conductive path therethrough step by step so that said path exists between said first electrode and successive ones of said other electrodes.

2. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, and means for initiating a discharge in selected ones of said devices simultaneously, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

3. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, a plurality of switches, a source of potential connected to said switches, and means connecting each of said switches to selected ones of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is applied to the ones of said devices connected thereto, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

4. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes, a second plurality of cathodes and a start electrode, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, a plurality of switches, a source of potential connected to said switches, and means connecting each of said switches to the start electrodes in selected ones of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is simultaneously applied to the ones of said start electrodes connected thereto, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

5. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes, a second plurality of cathodes and a start electrode, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting selected ones of said first plurality of cathodes in each

of said devices to said output means, a plurality of switches, a source of potential connected to said switches, and means connecting each of said switches to two of said start electrodes, each of said switches being connected to the start electrodes in a different pair of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is simultaneously applied to the ones of said start electrodes connected thereto, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

6. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes, a second plurality of cathodes and a start electrode, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, a plurality of switches, a source of potential connected to said switches, and means including a pair of unidirectional current conducting devices connecting each of said switches to two of said start electrodes, each of said switches being connected to the start electrodes in a different pair of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is simultaneously applied to the ones of said start electrodes connected thereto, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

7. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes, a second plurality of cathodes and a start electrode, switch means for connecting said pulse source to said second plurality of cathodes in each of said devices, a source of potential, switch means for connecting said source of potential to the anodes of all of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, a plurality of switches, means for connecting said source of potential to said plurality of switches, and means connecting each of said switches to two of said start electrodes, each of said switches being connected to the start electrodes in a different pair of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is simultaneously applied to the ones of said start electrodes connected thereto, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

8. In a communication system, a pulse source, a plurality of gaseous conduction devices each having a main anode, a first plurality of cathodes, a second plurality of cathodes, a start anode and a start cathode, means for applying a potential to all of said start cathodes, switch means for connecting said pulse source to said second plu-

rality of cathodes in each of said devices, a source of potential, switch means for connecting said source of potential to the main anodes of all of said devices, output means, means connecting selected ones of said first plurality of cathodes in each of said devices to said output means, a plurality of switches, means for connecting said source of potential to said plurality of switches, and means including a pair of unidirectional current conducting devices connecting each of said switches to two of said start anodes, each of said switches being connected to the start anodes in a different pair of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is applied simultaneously to the ones of said start anodes connected thereto, each of said devices being responsive to the application of a discharge-initiating potential to the start anode thereof to undergo a discharge between the start anode and the start cathode thereof and thereafter immediately to undergo a transfer of discharge whereby said discharge exists between the start cathode and the main anode thereof and being thereafter responsive to pulses transmitted from said pulse source to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said main anode and successive ones of said first plurality of cathodes.

9. In a communication system, a pulse source, a plurality of gaseous conduction devices each having an anode, a first plurality of cathodes and a second plurality of cathodes, means connecting said pulse source to said second plurality of cathodes in each of said devices, output means, means connecting a certain one of said first plurality of cathodes in each of said devices to said output means, means connecting a different one of said first plurality of cathodes in each of said devices to said output means, means connecting an additional one of said first plurality of cathodes in each of said devices to said output means, the said additional one of said first plurality of cathodes being different in each of said devices, and means for initiating a discharge in selected ones of said devices simultaneously, each of said devices when discharged being responsive to pulses transmitted from said pulse source 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.

10. In a communication system, a pulse source, a plurality of gaseous conduction devices each having a main anode, a first plurality of cathodes, a second plurality of cathodes, a start anode and a start cathode, means for applying a potential to all of said start cathodes, switch means for connecting said pulse source to said second plurality of cathodes in each of said devices, a source of potential, switch means for connecting said source of potential to the main anodes of all of said devices, output means, means connecting a certain one of said first plurality of cathodes in each of said devices to said output means, means connecting a different one of said first plurality of cathodes in each of said devices to said output means, means connecting an additional one of said first plurality of cathodes in each of said devices to said output means, the said additional one of said first plurality of cathodes being different in each of said devices, a plurality of switches, means for connecting said source of potential to said plurality of switches, and means including a pair of unidirectional current conducting devices connecting each of said switches to two of said start anodes, each of said switches being connected to the start anodes in a different pair of said devices whereby upon the selective operation of any of said switches a discharge-initiating potential is applied simutaneously to the ones of said start anodes connected thereto, each of said devices being responsive to the application of the discharge-initiating potential to the start anode thereof to undergo a discharge between the start anode and the start cathode thereof and thereafter immediately to undergo a transfer of discharge whereby said discharge exists between the start cathode and the main anode thereof and being thereafter responsive to pulses transmitted from said pulse source to said second plurality of cathodes therein to advance the conductive path therethrough step by step so that said path exists between said main anode and successive ones of said first plurality of cathodes.

EDWARD VROOM.

No references cited.