

Aug. 11, 1953

E. VROOM

2,648,831

SELECTIVE SIGNALING SYSTEM

Filed Aug. 30, 1950

4 Sheets-Sheet 1

FIG. 2

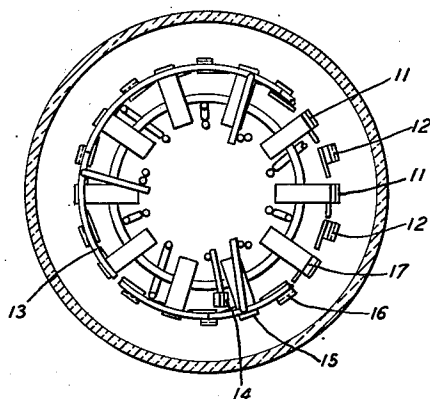
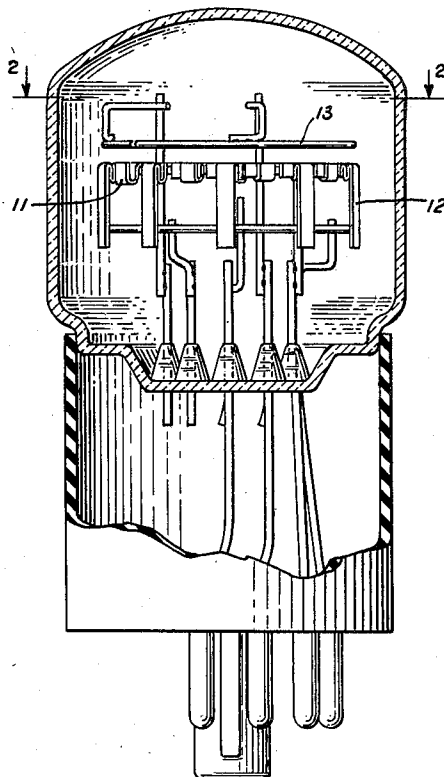


FIG. 1



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4 Sheets-Sheet 2

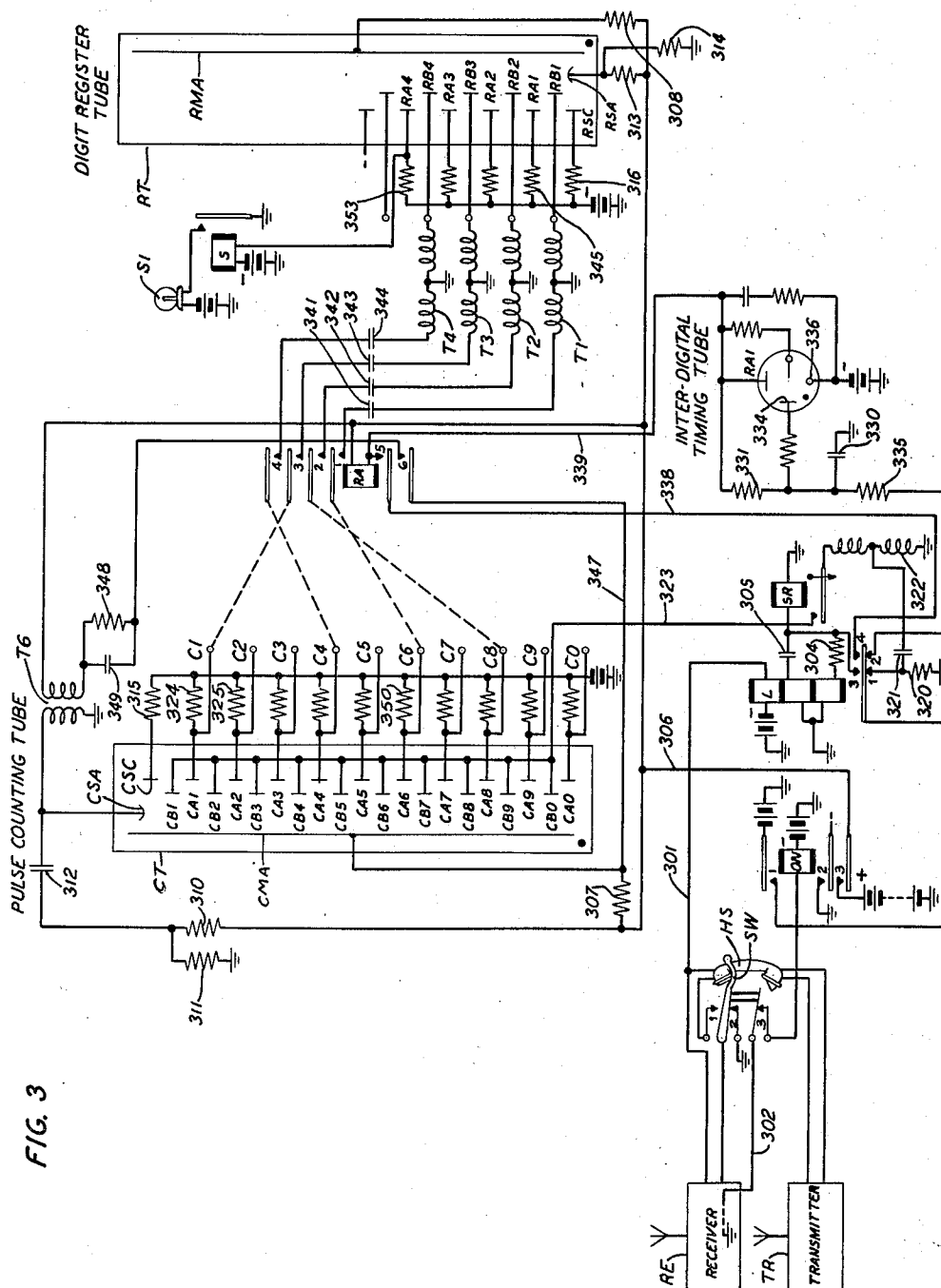


FIG. 3

RECEIVER
TRANSMITTER
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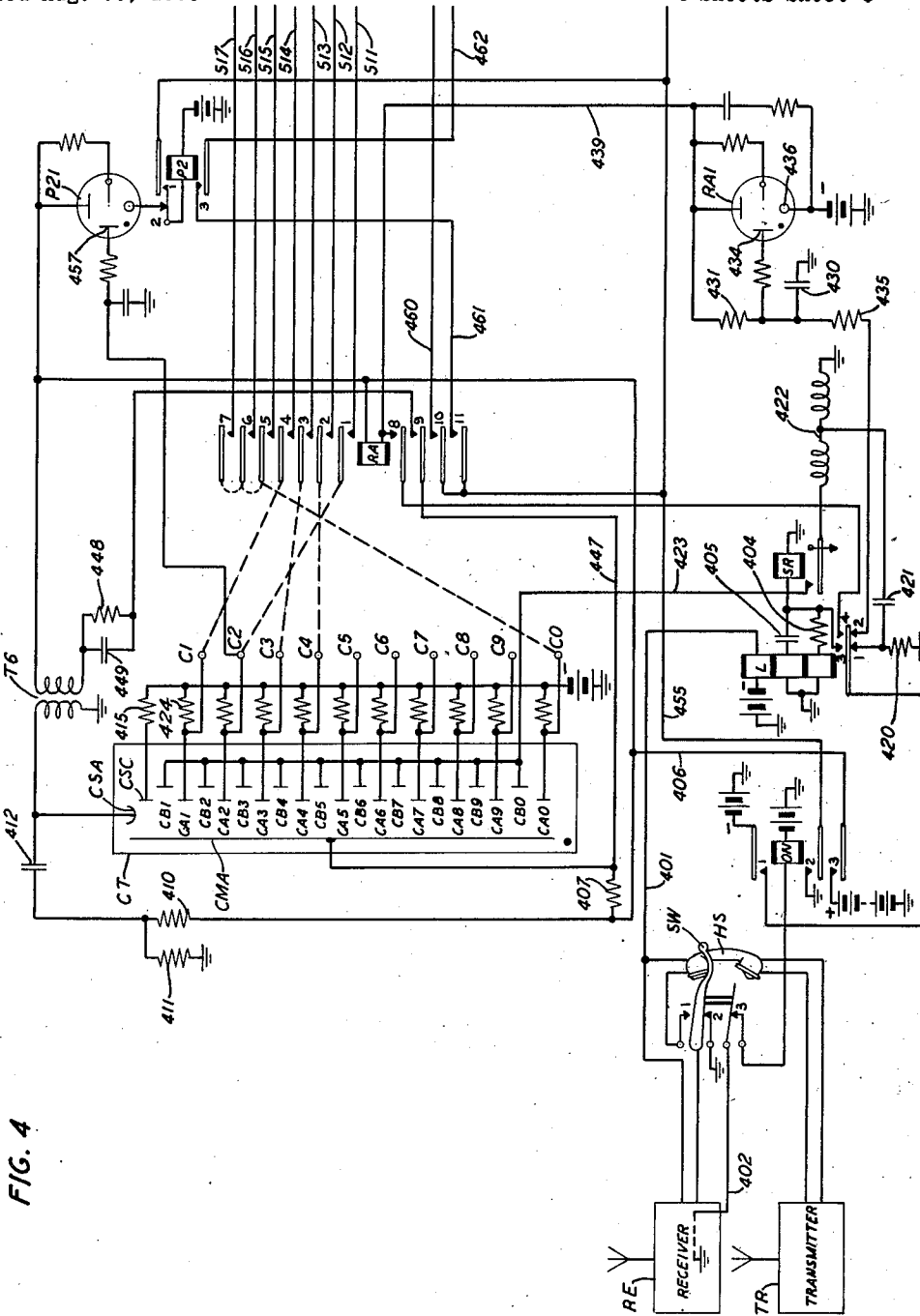


FIG. 4

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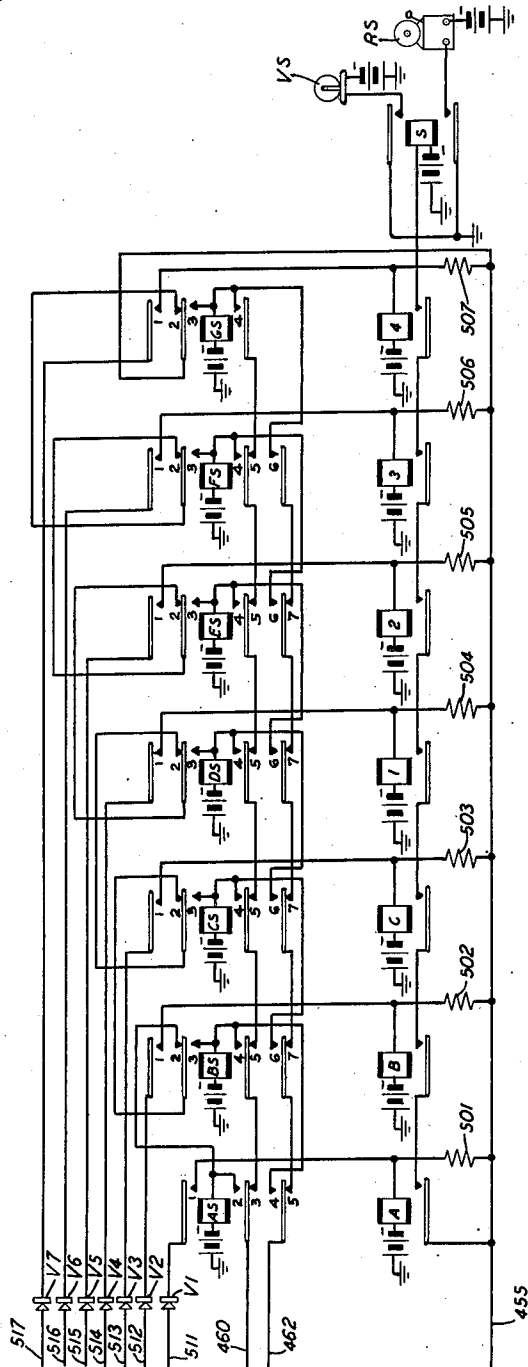
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SELECTIVE SIGNALING SYSTEM

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4 Sheets-Sheet 4

FIG. 5



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UNITED STATES PATENT OFFICE

2,648,831

SELECTIVE SIGNALING SYSTEM

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Application August 30, 1950, Serial No. 182,242

6 Claims. (Cl. 340-164)

1

2

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 the 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 the invention is the use of a single multicathode gaseous discharge device for successively counting the pulses representing all of the digits of a designation.

Another feature of the invention is a means for momentarily associating the pulse counting multicathode gaseous discharge device with a registering means during the interdigital pauses.

Another feature of the invention is the use of a multicathode gaseous discharge device as a registering means.

The principles of the invention may be more fully understood from the following detailed description of preferred embodiments 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 there-

of with the anode, a portion of the anode being broken away to show certain of the cathodes more clearly;

Fig. 3 is a circuit diagram representing one preferred embodiment of the invention; and

Figs. 4 and 5, when the latter is placed contiguous to and to the right of the former, show another 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 United States Patent 2,575,370 granted November 20, 1951 to W. 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 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 then be applied to the B cathode 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.

One form of the invention is represented in Fig. 3 of the drawings. In this circuit, a multi-cathode pulse counting tube CT and a multi-cathode digit register tube RT are provided. These tubes may be of the type shown in Figs. 1 and 2, and in that event, in tube CT, main anode CMA is the correlative of anode 13 in Fig. 2, the first B cathode CB1 is shown as cathode 16 in Fig. 2, the B cathodes CB2 to CB0 are shown as the cathodes 12 in Fig. 2, the first A cathode CA1 is shown as cathode 17 in Fig. 2, A cathodes CA2 to CA0 are the correlatives of cathodes 11 in Fig. 2, the start anode CSA is shown as electrode 14 in Fig. 2 and the start cathode CSC is shown as electrode 15 in Fig. 2. Fewer of the cathodes of tube RT are employed than is the case in tube CT, but with that difference, the electrodes of tube RT are similarly designated to those of tube CT except for the appropriate change of 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 subscriber's stations, such as the one shown 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 the 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 re-

ceived 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 de-energized. When relay L operates, an energizing circuit for the lower winding of relay L is completed through resistor 304, No. 3 contact of relay L and through the No. 1 contact of relay ON 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, No. 3 contact of relay L, No. 1 contact of relay 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 ensure 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 ensuring a steady front contact closure.

When relay ON is operated, positive battery is connected through the No. 3 contact of relay ON, conductor 306, through resistor 307 to the main anode CMA of the pulse counting tube CT and also through resistor 308 to the main anode RMA of the digit register tube RT. This potential on conductor 306 is also reduced by the voltage-divider action of resistors 310 and 311 and applied through capacitor 312 to the start anode CSA of tube CT; and the potential on conductor 306 is also reduced by the voltage-divider action of resistors 313 and 314 and applied to the start anode RSA of the digit register tube RT. Since the start cathode CSC of tube CT is connected to negative battery through resistor 315, tube CT will undergo a control gap discharge between the start anode CSA and the start cathode CSC; and a transfer of discharge will immediately occur whereby the conductive path in tube CT will exist between the main anode CMA and the start cathode CSC. A similar initial discharge and transfer of discharge will occur in tube RT since the start cathode RSC of that tube is connected to negative battery through resistor 316. Both of the tubes CT and RT are now prepared for stepping.

Upon the initial operation of relay L, a circuit is completed from negative battery, No. 1 contact of relay ON, No. 3 contact of operated relay L, winding of relay SR and to ground whereby relay SR is operated. 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, negative battery is connected through the No. 1 contacts of relays ON and L and to ground through resistor 320, and, in parallel therewith, to ground through capacitor 321 and the lower winding of the pulse generator transformer 322. The resultant positive pulse transmitted by transformer 322 will be ineffective to create any change in the circuits. At the next operation of relay L at the end of the first pulse of the first digit of the received designation, capacitor 321 will discharge through resistor 320 to ground whereby a negative pulse will be transmitted by the pulse generator transformer 322 through the front contact of operated relay SR, conductor 323 and to all of the B cathodes CB1 to CB0 of tube CT. In response to this first negative pulse applied to the B cathodes of tube CT, the conductive path in that tube will be transferred so as to exist between the main anode CMA and the first B cathode CB1 thereof. As a result, due to the increased voltage drop across anode resistor 307, the potential at the main anode CMA of tube CT will drop to a point where the potential difference between the main anode CMA and the start cathode CSC is below the sustaining value, and that discharge path will thereby be extinguished. As the pulse attenuates, the discharge in tube CT will again transfer so as to exist between the main anode CMA and the first A cathode CA1 which is connected to negative battery through resistor 324. The rise in potential of cathode CA1 due to the potential drop across resistor 324 appears at output terminal C1.

At the next momentary release and reoperation of relay L in response to the second pulse of the first digit of the received subscriber's designation, the conductive path in tube CT is successively stepped to the next B cathode CB2 and then to the next A cathode CA2, with the prior conductive path between the main anode CMA and the A cathode CA1 being extinguished. The rise in potential of cathode CA2 due to the potential drop across resistor 325 appears at output terminal C2.

As the subsequent first digit pulses are received, relay L will continue to follow the pulses alternately to charge and discharge capacitor 321 whereby transformer 322 will continue to transmit negative pulses to the B cathodes of tube CT. The stepping of tube CT 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 terminals C1 to C0 associated with that A cathode will rise to a potential considerably positive relative to the negative 50-volt potential which is applied to the output terminals which are connected to the non-conducting A cathodes.

At the termination of the pulses representing any one digit, relay RA is operated and remains operated during the inter-digit delay period. At any time that relay L is operated, capacitor 330 is charging over a path from positive battery, No. 3 contact of relay ON, conductor 306, winding of relay RA, resistor 334, capacitor 330 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 the 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 330 will discharge, and, in fact, charge oppositely through resistor 335, No. 2 contact of released relay L, No. 1 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 330 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.

Upon the operation of relay RA, negative battery is connected through the No. 1 contact of relay ON, No. 4 contact of operated relay L, conductor 338, No. 5 contact of operated relay RA and to the winding of relay RA, whereby relay RA is locked operated under the control of relay L. This negative battery potential at the No. 5 contact of relay RA is also applied via conductor 339 to the main anode of tube RA1 whereby the conduction in tube RA1 is extinguished.

Relay RA, in operating, connects selected ones of the output terminals C1 to C0 of the pulse counting tube CT to the B cathodes of the digit register tube RT through individual capacitors 341 to 344 and individual transformers T1 to T4. The exemplary showing of Fig. 3 assumes the use of the four-digit code "6814" as the designation of the subscriber's station with which the apparatus is associated, but it will be apparent that the system may readily be modified in an obvious manner to accommodate codes comprising a greater or a fewer number of digits.

Since the digit register tube RT has been prepared for stepping as hereinbefore described, the conductive path in that tube may be stepped only by the application of a negative pulse to the first B cathode RB1. The application of negative pulses to any of the other B cathodes of tube RT will be ineffective at this time to modify the position of the conductive path in tube RT. The first B cathode RB1 is connected to ground through the secondary winding of transformer T1 and the primary winding of transformer T1 is connected through capacitor 341, No. 1 contact of operated relay RA and via the exemplary cross-connection to output terminal C6 of the pulse counting tube CT. Therefore, if the first received digit is "6" so that terminal C6 is at a relatively high potential, upon the operation of relay RA, a pulse will be transmitted through capacitor 341 and through the primary winding of transformer T1 to ground whereby the secondary winding of transformer T1 will apply a negative pulse to the first B cathode RB1 of tube RT. This pulse is momentarily amplified by a momentary increase in the potential of terminal C6 in a manner hereinafter to be described. As a result, the conductive path in the digit register tube RT will be stepped so as to exist between the main anode RMA and the B cathode RB1; and, as that pulse attenuates, the conductive path in tube RT will again transfer so as to exist between the main anode RMA and the first A cathode RA1 which is connected to negative battery through resistor 345. It will be ap-

parent that had any other initial digit been recorded in the pulse counting tube CT, this stepping of the digit register tube RT would not have occurred.

Relay RA, in operating, also effectively places a transient shunting path in parallel with resistor 307 which is in series with the main anode CMA of tube CT. Thus, upon the operation of relay RA, a circuit is completed through conductor 347, which is connected to resistor 307 and to the main anode CMA of tube CT, No. 6 contact of operated relay RA, through the parallel resistance-capacitance timing network comprising resistor 348 and capacitor 349, through the primary winding of transformer T6, and to conductor 306 which is connected to resistor 307 and to positive battery through the No. 3 contact of relay ON. Transiently, there will be a large current flow while capacitor 349 commences to charge over the above-traced path to the main anode CMA of tube CT, across the discharge path in tube CT to the A cathode CA6, resistor 350 and to negative battery. The potential at output terminal C6 will therefore rise due to the increased potential drop across resistor 350, and this potential will be applied through the No. 1 contact of operated relay RA and through capacitor 341 to the primary winding of transformer T1, in the manner hereinbefore described.

As the initial surge of charging current for capacitor 349 passes through the primary winding of transformer T6, a negative pulse is transmitted by the secondary winding of transformer T6, but this pulse is ineffective to create any change in the condition of the circuit. As the charging current for capacitor 349 passes its peak value and begins to decrease in value, the rate of change of current through the primary winding of transformer T6 will be opposite to that of the above-noted initial condition and therefore the secondary winding of transformer T6 will transmit a positive pulse to the start anode CSA of tube CT. As a result of the application of a positive pulse to the start anode CSA, a discharge is initiated between the start anode CSA and the start cathode CSC, an immediate transfer of discharge occurs whereby the conductive path in tube CT exists between the main anode CMA and the start cathode CSC, and the previously existing conducting path, which was assumed to exist between the main anode CMA and cathode CA6, is extinguished. This process whereby the tube is restored to its initial condition is referred to as "normalization" of the tube. It will be noted that the parameters of the charging circuit for capacitor 349 should be so selected that this normalization of the pulse counting tube CT will not occur prior to the transfer of the information stored in that tube to the digit register tube RT.

At the receipt of the first pulse of the second-received digit, relay L will release to release relay RA. Capacitor 349 will then discharge through resistor 348. At the termination of the first pulse of the second digit, relay L will reoperate and the pulse counting tube CT will be advanced one step in the manner hereinbefore described. Similarly, relay L will release and reoperate successively in response to the subsequent pulses representing the second digit and the conductive path in tube CT will be successively advanced accordingly. The circuits will continue to function in this fashion, with tube CT being stepped to a condition indicative of each received digit and then being "normalized" so that the conductive path in tube CT may then

be stepped to count the pulses representing the next digit.

If the successive digits correspond to the correlative digits in the subject subscriber's designation, one pulse per digit will be transmitted to the digit register tube RT to advance the conductive path therein one step per digit. Therefore, if the preselected sequence of digits, i. e., "6814" is received, the conductive path in the digit register tube RT will have been stepped so as to exist between the main anode RMA and the A cathode RA4. This A cathode is connected to negative battery through resistor 353 and also through the winding of the signal relay S. Relay S will therefore be operated to energize a visual or audible signal such as lamp S1. It will be apparent that if any other series of digits is received or if the preselected digits are received in a different sequence, this subscriber will not be signaled.

If the subject subscriber is signaled, he lifts the handset HS and the No. 1 switchhook contact will be closed to connect the handset HS to the receiver RE. 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 the discharged tubes, releasing the operated relays and deenergizing the signal means.

Another embodiment of the invention is shown in Figs. 4 and 5. The apparatus represented in these figures differs from that shown in Fig. 3 primarily in the use of relays as the registering means in place of the multicathode stepping tube RT which was employed in the first-discussed embodiment of the invention. With the exceptions hereinafter to be noted, the elements shown on Fig. 4 are substantially identical to and are interconnected in substantially the same way as are the corresponding elements in Fig. 3 and the operation of these circuits is identical to the operation of the corresponding circuits in Fig. 3. These elements in Fig. 4 are designated identically to the corresponding elements in the circuit of Fig. 3 except for a change of the initial element of the designation where appropriate.

The registering means shown in Fig. 5 comprises a plurality of steering relays AS to GS which are sequentially operated as the successive digits are received, and a plurality of register relays A, B, C, 1, 2, 3 and 4 which are sequentially operated if the received digits correspond with the designation of the subscriber's station with which the subject apparatus is associated.

Upon the operation of relay ON (Fig. 4) ground is connected through its No. 2 contact to conductor 455, through resistors 501 to 507, through the windings of the register relays A, B, C, 1, 2, 3 and 4, respectively, and to negative battery. The resulting current flow is insufficient to operate the register relays, but serves to bias them so that they will operate more readily and also is sufficient to maintain any of those relays operated once they have been operated.

The ground on conductor 455 is also extended through the No. 2 back contacts of the steering relays GS to BS in series, through the winding of relay AS and to battery whereby relay AS is operated. Relay AS, in operating, prepares an energizing circuit for the first register relay A by connecting the winding of relay A through the

No. 1 contact of relay AS, varistor V1, conductor 511, to the No. 1 contact of relay RA. When relay RA operates during the first interdigital delay period, in the manner hereinbefore described, conductor 511 is connected to a preselected one of the output terminals C1 to C0 of the pulse counting tube CT. Let it be assumed that the initial digit of the designation of the subscriber's station with which the subject apparatus is associated is "2" (or the letter "A," "B" or "C" in standard telephone practice). Therefore, an exemplary connection is shown between the output terminal C2 and conductor 511 through the No. 1 contact of relay RA. If the first digit of the received designation is not "2", terminal C2 will be at negative battery potential and register relay A obviously will not be operated. If, however, two pulses have been received whereby the conductive path in tube CT includes A cathode CA2 thereof, upon the operation of relay RA a surge of current occurs in the circuit comprising the main anode CMA and the cathode CA2 of tube CT, varistor V1 and winding of relay A whereby relay A is operated. This surge of current results from the placing of the network comprising capacitor 449, resistor 448 and the primary winding of transformer T8 in shunt of the main anode resistor 407 in the manner hereinbefore described with respect to a similar surge of current through tube CT of Fig. 3. The parameters of that surge-producing circuit should be selected to produce a pulse of a predetermined duration for a purpose hereinafter to be noted.

At each operation of relay RA, the next succeeding steering relay BS to GS is operated to provide a successive association of the windings of the register relays B to 4 with the contacts of relay RA. Thus, at the operation of relay RA at the termination of the pulses representing the first received digit, ground is connected through the No. 2 contact of relay ON, conductor 455, No. 10 contact of relay RA, conductor 460, No. 2 contact and winding of relay AS and to battery whereby relay AS is locked operated. The ground on conductor 455 is also extended through the No. 11 contact of relay RA to conductor 461, No. 3 contact of relay P2, which is operated in a manner hereinafter to be described, conductor 462, No. 4 contact of operated relay AS, and through the winding of the second steering relay BS to battery whereby relay BS is operated. Relay BS locks operated through its No. 3 contact and through the No. 2 contacts of the succeeding steering relays CS to GS to ground on conductor 455. Relay BS, in operating, interrupts, at its No. 2 contact, the energizing circuit for relay AS. Relay BS, in operating, also connects the winding of the second register relay B through its No. 1 contact, varistor V2, conductor 512, to the No. 2 contact of relay RA. Since two successive digits may be the same in a subscriber's designation, it is therefore essential that the surge of current resulting from the shunting of the main anode resistor 407 cease before relay BS is operated. As an example, if the register relays A to 4 are operable with 0.003 second after energization and if the steering relays AS to GS require 0.008 second to operate, then the current surge may be continued for 0.005 second, for example.

When relay RA releases at the receipt of the first pulse of the second digit, ground is removed from conductors 460 and 462 and relay AS will release. At the end of the second digit, relay RA will again operate, extending the connection from the winding of relay B to an output terminal

of tube CT, such as, as an exemplary connection, to output terminal C4 of tube CT. Assuming the second digit of the subject subscriber's designation to be the digit "4," if the second received digit is the digit "4," relay B will be operated. Since relay AS is released, the ground on conductor 462 resulting from the reoperation of relay RA will be extended through the No. 5 contact of relay AS, No. 6 contact of relay BS and through the winding of relay CS to battery whereby relay CS is operated. Relay CS locks operated through its No. 3 contact and through the No. 2 contacts of the succeeding steering relays DS to GS to ground on conductor 455. Relay CS also interrupts the above-traced locking path for relay BS but relay BS remains operated as long as relay RA remains operated due to the application of the ground on conductor 460 through the No. 3 contact of relay AS and the No. 4 contact of relay BS to the winding of relay BS.

As the succeeding digits are received, the steering relays AS to GS are successively operated and the register relays A to 4 are operated if the successive received digits correspond with the designation of the station with which the subject apparatus is associated. In that event, the ground on conductor 455 is extended through the front contacts of all of the register relays A to 4, through the winding of relay S and to ground. Relay S, in operating, lights the visual signal lamp VS and energizes the signal bell RS. When the subject called subscriber answers, relay ON releases to restore the circuits to normal. If the incoming pulses do not designate the particular station shown in Figs. 4 and 5, when receiver RE removes the ground from conductor 462 relay ON will be released to restore the circuits to normal.

It will be noted that in some cases, the delay between the operation of relays ON and L and the receipt of the first pulse of the first digit may be of sufficient duration to permit the discharge of tube RA1 with a resultant operation of relay RA. Therefore, means are provided to prevent the second steering relay BS from being improperly operated in response to this operation of relay RA. This means comprises gaseous discharge device P21 and relay P2. The start electrode 457 of tube P21 is connected to the output terminal C2 of the stepping tube CT. Therefore at the first time that the conductive path in tube CT includes A cathode CA2, the potential at output terminal C2 will rise and this increased potential will be applied to the start electrode 457 of tube P21. Since the cathode of tube P21 is connected to negative battery through the No. 2 contact and winding of relay P2, a discharge will occur between the start electrode 457 and the cathode of tube P21. It is to be noted that this discharge in tube P21 will occur even though the duration of the conductive path in tube CT between the main anode CMA and the cathode CA2 is only momentary, i. e., the discharge will occur even though the initial digit of the received designation is greater than "2." In the event that the digit "1" is employed as a first digit in any of the subscribers' designations, it is obvious that the start electrode 457 of tube P21 should be connected to output terminal C1 of the stepping tube CT.

Since the main anode of tube P21 is connected to positive battery via conductor 456 and the No. 3 contact of relay ON, the discharge in tube P21 will immediately transfer so as to exist across the main gap of tube P21 and relay P2 will be

operated. Relay P2 locks operated through its No. 1 contact and to ground via conductor 455. Relay P2, in operating, closes its No. 3 contact to permit the normal operation of the circuits as hereinbefore described.

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 gaseous conduction device having an anode and a plurality of cathodes and responsive to electrical impulses applied thereto to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said cathodes, an impulse generator connected to said device and operable to transmit a series of groups of electrical impulses representing the elements of a code, counting means operable to count electrical indications applied thereto, apparatus operable at the termination of each of said groups of impulses for connecting only successive preselected ones of said cathodes to said counting means and to then restore said device to normal, said device being operative to transmit electrical indications to said counting means if the conductive path through said device successively includes said successive preselected ones of said cathodes, and signal means operable by said counting means if said counting means has counted a number of said electrical indications equal to the number of elements of said code.

2. In a signaling system, a gaseous conduction device having an anode, a first plurality of cathodes and a second plurality of cathodes and responsive to electrical impulses applied to said second plurality of cathodes 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 connected to said second plurality of cathodes of said device and operable to transmit a series of groups of electrical impulses representing the elements of a code, counting means operable to count electrical indications applied thereto, apparatus operable at the termination of each of said groups of impulses for connecting only successive preselected ones of said first plurality of cathodes to said counting means, means controlled by said apparatus to restore said device to normal, means for transmitting electrical indications to said counting means if the conductive path through said device successively includes said successive preselected ones of said first plurality of cathodes, and signal means operable by said counting means if said counting means has counted a number of said electrical indications equal to the number of elements of said code.

3. In a signaling system, a first gaseous conduction device having an anode and a plurality of cathodes and responsive to electrical impulses applied thereto to advance the conductive path therethrough step by step so that said path exists between said anode and successive ones of said cathodes, an impulse generator connected to said first device and operable to transmit a series of groups of electrical impulses representing the elements of a code, a second gaseous conduction device having a plurality of distinct conduction positions and responsive to electrical indications

applied thereto to advance the conductive path therein step by step from position to position, apparatus operable at the termination of each of said groups of impulses for connecting only successive preselected ones of the cathodes of said first device to said second device and to then restore said first device to normal, said first device being operative to transmit electrical indications to said second device if the conductive path through said first device successively includes said successive preselected ones of said cathodes of said first device, and signal means operable by said second device if said second device has counted a number of said electrical indications equal to the number of elements of said code.

4. In a signaling system, a first gaseous conduction device having an anode, a first plurality of cathodes and a second plurality of cathodes and responsive to electrical impulses applied to said second plurality of cathodes 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 connected to said second plurality of cathodes of said first device and operable to transmit a series of groups of electrical impulses representing the elements of a code, a second gaseous conduction device having a plurality of distinct conduction positions and responsive to electrical indications applied thereto to advance the conductive path therein step by step from position to position, apparatus operable at the termination of each of said groups of impulses for connecting successive preselected ones of said first plurality of cathodes of said first device to said second device, means controlled by said apparatus to restore said first device to normal, means for transmitting electrical indications to said second device if the conductive path through said first device successively includes said successive preselected ones of said first plurality of cathodes of said first device, and signal means operable by said second device if said second device has counted a number of said electrical indications equal to the number of elements of said code.

5. In a signaling system, a first gaseous conduction device having an anode, a first plurality of cathodes and a second plurality of cathodes and responsive to electrical impulses applied to said second plurality of cathodes 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 connected to said second plurality of cathodes of said first device and operable to transmit a series of groups of electrical impulses representing the elements of a code, a second gaseous conduction device having an anode, a first plurality of cathodes corresponding in number to the number of elements in said code and a second plurality of cathodes and responsive to electrical indications applied to the said second plurality of cathodes thereof 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 thereof, apparatus operable at the termination of each of said groups of impulses for connecting successive preselected ones of said first plurality of cathodes of said first device to said second plurality of cathodes of said second device, means controlled by said apparatus to restore said first device to normal, means for transmitting electrical indications to the successive ones

of said second plurality of cathodes of said second device if the conductive path through said first device successively includes said successive preselected ones of said first plurality of cathodes of said first device, and signal means connected to the last one of said first plurality of cathodes of said second device and operable if the conductive path in said second device has been advanced to include said last one of said first plurality of cathodes of said second device.

6. In a signaling system, a first gaseous conduction device having an anode, a start electrode, a first plurality of cathodes and a second plurality of cathodes and responsive to electrical impulses applied to said second plurality of cathodes to advance the conductive path there-through step by step so that said path exists between said anode and successive ones of said first plurality of cathodes, means for initially applying a discharge-initiating potential to said start electrode, an impulse generator connected to the second plurality of cathodes of said first device and operable to transmit a series of groups of electrical impulses representing the elements of a code, a second gaseous conduction device having an anode, a start electrode, a first plurality of cathodes corresponding in number to the number of elements in said code, and a second plurality of cathodes and responsive to electrical indications applied to the said second plurality of cathodes thereof 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

thereof, means for applying a discharge-initiating potential to the start electrode of said second device, apparatus operable at the termination of each of said groups of impulses for connecting successive preselected ones of said first plurality of cathodes of said first device to the successive ones of said second plurality of cathodes of said second device, means operable a timed interval after each operation of said apparatus to apply a discharge-initiating potential to the start electrode of said first device to restore said first device to normal, means comprising a capacitor and a transformer individual to each of said second plurality of cathodes of said second device for applying electrical indications to successive ones of said second plurality of cathodes of said second device if the conductive path through said first device successively includes said successive preselected ones of said first plurality of cathodes of said first device, and signal means connected to the last one of said first plurality of cathodes of said second device and operable if the conductive path in said second device has been advanced to include said last one of said first plurality of cathodes of said second device.

EDWARD VROOM.

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