

July 21, 1936.

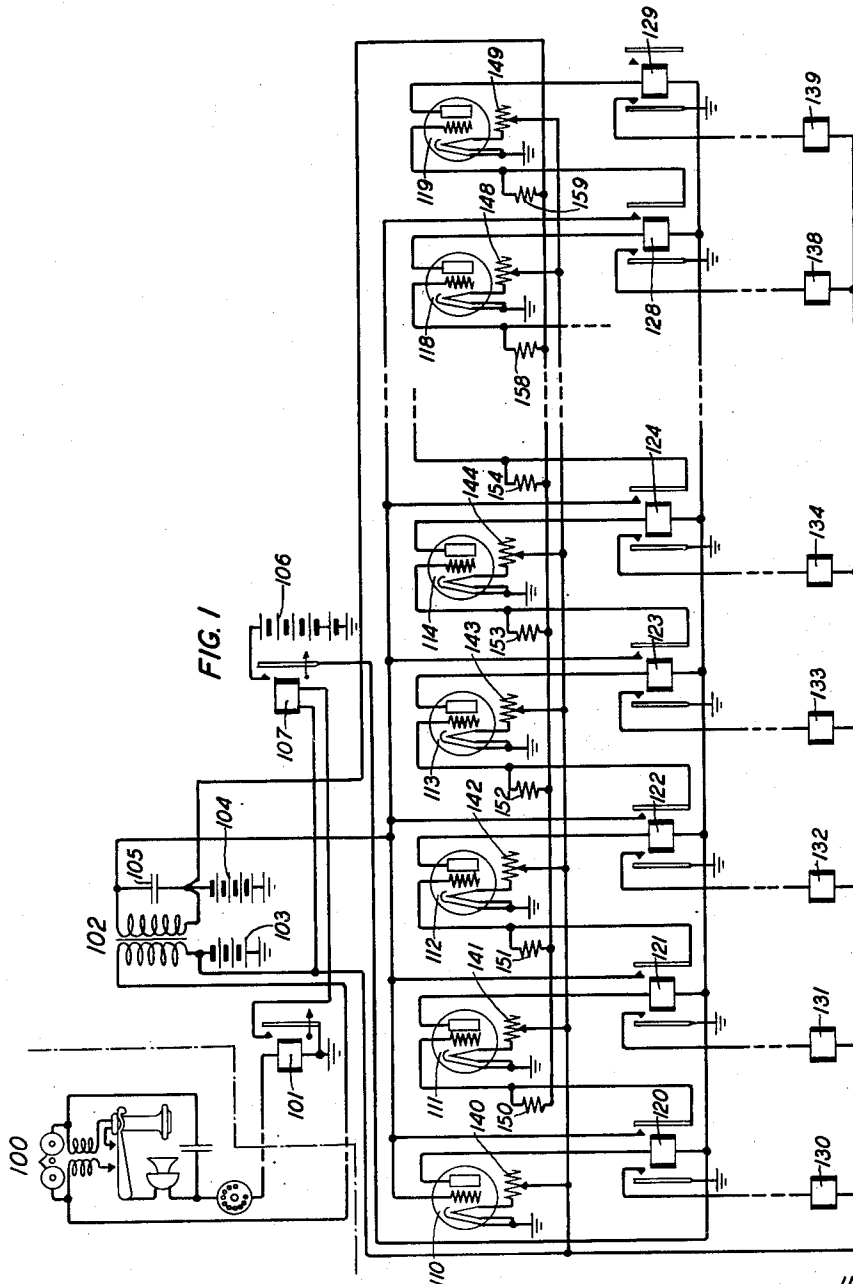
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2,048,506

TELEPHONE SYSTEM

Filed March 7, 1935

2 Sheets-Sheet 1



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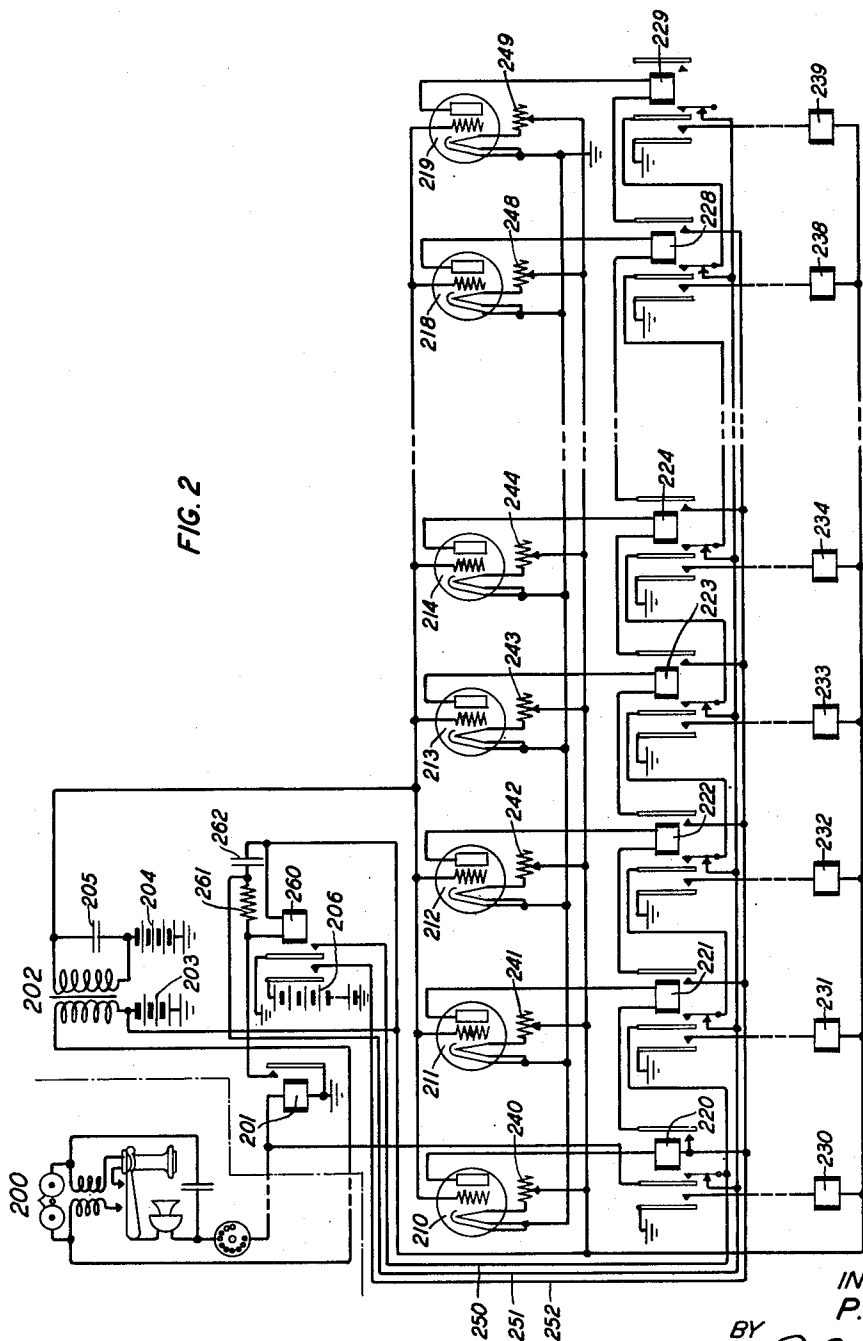
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FIG. 2



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TELEPHONE SYSTEM

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Application March 7, 1935, Serial No. 9,693

4 Claims. (Cl. 179-16)

This invention relates to signaling systems and more particularly to systems in which recording devices are operated in response to impulses.

5 The invention is particularly adaptable to dial telephone systems in which series of impulses dialed by a subscriber or operator are recorded in a central office sender for the purpose of setting digit registers to control the selective operation of selector switches. In order that proper response to dialed impulses may be obtained over both long and short dialing loops, it is essential that the responsive apparatus shall be accurately and sensitively responsive to the im-
10 pulses.

15 It is therefore the object of the invention to provide an impulse responsive device whereby more accurate and faster impulse response may be realized over long dialing loops.

20 In accordance with the present invention, this object is realized by utilizing gaseous conductor or discharge tubes to respond to dial or other sources of impulses which in turn control relays. The relays may control registers to make
25 a record of the series of impulses dialed or transmitted. The gaseous conductor tubes employed are of the type filled with a low pressure gaseous content which, for purposes of illustration, might be neon, argon, helium, mercury vapor or combinations of gases of this group. A tube
30 of this character has a certain characteristic, namely, that the gaseous content will become ionized and thus conducting on one potential determined by the electrode design, the nature of
35 the gaseous content and its pressure, but once rendered conducting will maintain this condition of conductivity on a much lower potential. The tubes may be of the hot cathode type having their cathodes heated by conduction from
40 filaments energized by direct current as illustrated or the filaments may be energized by alternating current or the filaments may be heated by direct current and themselves serve as cathodes. The tubes might also be of the cold cathode type.

45 The invention has been illustrated in two modifications both of which show a dialing loop extending from a subscriber's substation to an impulse recording device, the recording device including ten gaseous discharge tubes which are successively responsive to a maximum of ten impulses in any dialed impulse series. A transformer is interpolated between the dialing loop and the recording device with its windings so
50 poled with respect to each other that only the

surges of potential induced in the secondary winding thereof upon the openings of the dialing loop by the substation dial are effective to cause the breakdown or ionization of the tubes. Each tube has an anode relay connected in the cathode-anode circuit thereof which becomes operative when the tube with which it is associated ionizes. Each anode relay, in addition to other functions to be later described, is instrumental in assisting in the control of a registering device.

15 In accordance with one embodiment of the invention, the control electrode of only the first of the ten tubes is normally associated with the secondary winding of the transformer, anode potential being supplied to all of the tubes upon the initial closure of the dialing loop. The control electrodes of the remaining tubes are normally disassociated from the secondary winding of the transformer. The anode relay of each
20 tube, except the last, is provided with contacts which, upon the operation of the relay, connect the control electrode of the next succeeding tube to the secondary winding of the transformer.

25 The circuit functions in the following manner: Upon the initial closure of the dialing loop, anode potential is connected to the anodes of all ten tubes through the windings of the associated anode relays and an inductive surge of potential is generated in the secondary winding
30 of the transformer which increases the negative bias on the control electrode of the first tube. In response to the first dialed impulse, the dialing loop is momentarily opened, thereby causing a surge of potential of the opposite polarity in the secondary winding of the transformer which reduces the bias on the control electrode of the first tube to such a degree that the first tube ionizes and operates its anode relay over its cathode-anode circuit. This anode relay closes a register operating circuit and connects the control electrode of the second or next succeeding tube to the secondary winding of the transformer. On the next closure of the dialing loop the negative bias on the control electrode
45 of the first two tubes is increased but without effect on either tube, the first tube remaining in its ionized condition and the second tube being blocked against ionization. On the next opening of the dialing loop the resulting surge of potential in the secondary winding of the transformer reduces the bias on the control electrode of the second tube to such a degree that the second tube ionizes and operates its anode relay. This anode relay closes a register oper-
55

ating circuit and connects the control electrode of the third or next succeeding tube to the secondary winding of the transformer. In a similar manner in response to successive closures and openings of the dialing loop successive tubes ionize and operate their anode relays, the number of tubes which are so controlled being dependent upon the number of impulses dialed. If ten impulses are dialed, all ten of the tubes will ionize in succession in response to successive impulses and will operate their anode relays.

In accordance with a further embodiment of the invention, the control electrodes of all ten tubes are connected in parallel to the secondary winding of the transformer and anode potential is applied only to the anode of the first tube upon the initial closure of the dialing loop. The anode relay of each tube except the last, is provided with contacts which, upon the operation of the relay, connect anode potential to the anode of the next succeeding tube.

The circuit functions in the following manner: Upon the initial closure of the dialing loop, potential is connected to the anode of the first tube through the winding of the associated anode relay and an inductive surge of potential is generated in the secondary winding of the transformer which increases the negative bias on the control electrodes of all tubes. In response to the first dialing impulse, the dialing loop is momentarily opened thereby causing a surge of potential of the opposite polarity in the secondary winding of the transformer which reduces the bias on the control electrodes of all the tubes to the breakdown potential, but since the first tube is the only one which has positive potential on its anode, only the first tube ionizes and operates its anode relay over its cathode-anode circuit. This anode relay closes a register operating circuit and connects positive potential to the anode of the second or next succeeding tube. On the next closure of the dialing loop, the negative bias on the control electrodes of all tubes is increased but without effect since the first tube remains in its ionized condition and the second tube, although supplied with anode potential, is blocked. On the next opening of the dialing loop, the resulting surge of potential in the secondary winding of the transformer reduces the bias on the control electrodes of all tubes to the breakdown potential but since the first tube is already ionized and the second tube only, of the remaining tubes, has anode potential, only the second tube ionizes and operates its anode relay. This anode relay closes a register operating circuit and connects positive potential to the anode of the third or next succeeding tube. In a similar manner, in response to successive closures and openings of the dialing loop, successive tubes ionize and operate their anode relays, the number of tubes which are so controlled being dependent upon the number of impulses dialed.

A clearer understanding of the invention may be obtained from a consideration of the following detailed description read in connection with the accompanying drawings, in which:

Fig. 1 shows a subscriber's loop and that portion of a sender circuit involved in the recording of digits dialed by a subscriber. In this figure, only the control electrode of the first of the ten tubes is normally associated with the secondary winding of the transformer.

Fig. 2 shows a subscriber's loop and that portion of a sender circuit involved in the recording of digits dialed by a subscriber. In this figure,

the control electrodes of all ten tubes are normally connected in parallel to the secondary winding of the transformer.

It is to be understood that the invention is not limited to the circuit arrangements shown in Figs. 1 and 2, as the number of tubes, anode relays and register relays may be increased or decreased to perform the desired circuit functions.

Referring to Fig. 1, when a subscriber at substation 100 initiates a call and is connected through to the sender circuit in the usual manner, the dialing loop is established from ground through the winding of relay 101, through the contacts of the subscriber dial, over the subscriber's loop, through the primary winding of transformer 102 to the negative terminal of battery 103, thereby energizing relay 101. Relay 101 being energized, closes an obvious circuit for pulse change-over relay 107 which connects the positive terminal of battery 106 through the windings of anode relays 120 to 129, inclusive, to the anodes of all ten gaseous discharge tubes 110 to 119 inclusive, which are associated with anode relays 120 to 129, respectively.

Pulse change-over relay 107 is so constructed that it will remain energized during all openings of the dialing loop except the last, for each digit dialed. Upon the final opening of the dialing loop for each digit, however, change-over relay 107 is deenergized.

The control electrode or grid of the gaseous discharge tube 110 is connected to the negative terminal of battery 104 through the secondary winding of transformer 102. The control electrode of tube 110 is, therefore, negatively biased by this battery 104. A condenser 105 is connected across the secondary winding of transformer 102 in order to control the maximum voltage and the duration of the surge of potential within proper limits for functioning tubes 110 to 119. The rheostats 140 to 149, inclusive, are associated with tubes 110 to 119, respectively, and are used to control the current from battery 103 which heats the filaments and the cathodes of tubes 110 to 119, inclusive. Negative potential is connected to the cathodes of tubes 110 to 119, from the negative terminal of battery 106. The resistances 150 to 159, inclusive, are inserted between the control electrodes of tubes 111 to 119, respectively, and the negative terminal of battery 104 in order to maintain a slight negative potential on the control electrodes of tubes 111 to 119. This potential is just above the breakdown potential of the tubes.

On the closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 102 which increases the negative bias on the control electrode of tube 110. It will be assumed that the subscriber dials the letter D as the first letter of the exchange code, which has the numerical equivalent of the digit 3. When the dial returns to normal upon its release, it, in the usual manner, opens the dialing loop three times.

On the first opening of the dialing loop by the dial contacts, an inductive surge of potential of the opposite polarity is generated in the secondary winding of transformer 102 which reduces the bias on the control electrode of tube 110 to such a degree that tube 110 immediately ionizes and becomes conducting. With tube 110 in the conducting condition, anode relay 120 is energized in a circuit extending from the negative terminal of battery 106, cathode and anode of tube 110, winding of relay 120, to negative

grounded battery 106 through the front contact of relay 107. Relay 120, being energized, closes its left front contact and its right front contact. The closure of the left front contact of relay 120 completes a path from ground, through the front contact of relay 120, the winding of register relay 130, to the negative terminal of battery 103, thereby causing the register relay 130 to become energized. Closure of the right front contact of relay 120 connects the control electrode of tube 111 to the secondary winding of transformer 102.

On the second closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 102 which increases the negative bias on the grids of tubes 110 and 111. Tube 110 will remain in its ionized condition. Tube 111 will be blocked against ionization by the high negative potential on its control electrode.

On the second opening of the dialing loop by the dial contacts, an inductive surge of potential is generated in the secondary winding of transformer 102. This surge of potential opposes the negative bias on the control electrode of tube 111. Therefore, the negative bias on the control electrode of tube 111 will be reduced to such a degree that tube 111 ionizes and becomes conducting. With tube 111 in the conducting condition, anode relay 121 is energized in a circuit extending from the negative terminal of battery 106, cathode and anode of tube 111, winding of relay 121, to negative grounded battery 106, through the front contact of relay 107. Relay 121, being energized, closes its left front contact and its right front contact. Closure of the left front contact of relay 120 completes a path from ground, through the front contact of relay 121, the winding of register relay 131 to the negative terminal of battery 103 thereby causing the register relay 131 to become energized. Closure of the right front contact of relay 121 connects the control electrode of tube 112 to the secondary winding of transformer 102.

On the third closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 102 which increases the negative bias on the control electrodes of tubes 110, 111, and 112. Tubes 110 and 111 will remain in their ionized condition. Tube 112 will be blocked against ionization by the high negative potential on its control electrode.

On the third and final opening of the dialing loop by the dial contacts, an inductive surge of potential is generated in the secondary winding of transformer 102, which opposes the negative bias on the control electrode of tube 112. The negative bias on the control electrode of tube 112 will be reduced to such a degree that tube 112 ionizes and becomes conducting. With tube 112 in the conducting condition, anode relay 122 is energized in a circuit extending from the negative terminal of battery 106, cathode and anode of tube 112, winding of relay 122, to negative grounded battery 106 through the front contact of relay 107. Relay 122, being energized, closes its left front contact and its right front contact. Closure of the left front contact of relay 122 completes a path from ground, through the front contact of relay 122, the winding of register relay 132, to the negative terminal of battery 103, thereby causing the register relay 132 to become energized. Closure of the right front contact of relay 122 connects the control electrode of tube 113 to the secondary winding of transformer 102.

On this third and final opening of the dialing loop by the dial contacts, relay 101 will become deenergized, in turn releasing relay 107 which opens its front contact thereby removing the negative grounded battery from the anodes of all tubes 110 to 119, inclusive. Tubes 110, 111 and 112 will become deionized and non-conducting. This will open the holding circuits for anode relays 120, 121, and 122, thereby permitting these relays to become deenergized and open their front contacts. Opening of the right front contacts of relays 120, 121 and 122 will remove the negative potential from the control electrodes of tubes 111, 112, and 113. Opening of the left front contacts of relays 120, 121, and 122 will open the holding circuits for the register relays 130, 131, and 132, thereby permitting these register relays to become deenergized.

For succeeding digits dialed, relay 101, relay 107, transformer 102 and tube 110 will function in the manner described hereinbefore. If the succeeding digit dialed is 2 or a digit of higher value, tubes 110 to 119, inclusive, anode relays 120 to 129 inclusive, and register relays 130 to 139 inclusive, will function in a manner similar to that described hereinbefore for tubes 111 and 112, anode relays 121 and 122 and register relays 131 and 132. The number of tubes, anode relays and register relays operating in this case depends upon the number of impulses in the digit dialed. On the final opening of the dialing loop by the dial contacts, relay 101 will become deenergized, in turn releasing relay 107 which opens its right front contact thereby removing negative grounded battery from the anodes of all tubes. The tubes become non-conducting and the associated relays release as described above.

Referring to Fig. 2, the control electrodes of all the tubes are normally connected in parallel to the secondary winding of transformer 202 and to the negative terminal of battery 204 which places a negative bias on the control electrodes of all tubes 210 to 219 inclusive. The condenser 205 is connected across the secondary winding of transformer 202 in order to control the maximum voltage and the duration of the surge of potential within proper limits for functioning tubes 210 to 219 inclusive. When a subscriber at substation 200 initiates a call and is connected through to the sender circuit in the usual manner, the dialing loop is established from positive grounded battery through the winding of relay 201, through the contacts of the subscriber dial, over the subscriber's line loop, through the primary winding of transformer 202 to the negative terminal of battery 203, thereby energizing relay 201. Relay 201 being energized, closes a circuit for energizing relay 260 from ground, through the front contact of relay 201, through the winding of relay 260 to the negative terminal of battery 203. Relay 260, being energized, locks up over a circuit closed from ground, the inner front contact of relay 260, conductor 250, the left back contact of relay 220, conductor 251, resistance 261, the winding of relay 260, to the negative terminal of battery 203. Closure of the outer front contact of relay 260 connects negative grounded battery over conductor 252, the winding of anode relay 220, to the anode of tube 210, thereby placing a positive potential on the anode of tube 210.

The filaments and the cathodes of all tubes 210 to 219, inclusive, are heated by current from battery 203. This current is controlled by rheostats 240 to 249 inclusive, which are associated

with tubes 210 to 219, respectively. A negative potential is placed on the cathodes of tubes 210 to 219 inclusive, from the negative terminal of battery 206.

On the closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 202 which increases the negative bias on the control electrode of tube 210. It will be assumed that the subscriber dials the letter D as the first letter of the exchange code, which has the numerical equivalent of the digit 3. When the dial returns to normal upon its release, it, in the usual manner, opens the dialing loop three times.

On the first opening of the dialing loop by the dial contacts, an inductive surge of potential of the opposite polarity is generated in the secondary winding of transformer 202 which substantially reduces the bias on the control electrodes of tubes 210 to 219, inclusive. Tube 210 immediately ionizes and becomes conducting. Tubes 211 to 219 inclusive, will not ionize because there is no positive potential on their anodes. With tube 210 in the conducting condition, anode relay 220 is energized in a circuit extending from the negative terminal of battery 206, cathode and anode of tube 210, anode relay 220, conductor 252, the outer front contact of relay 260, to negative grounded battery 206. Relay 220, being energized, closes its right front contact and its left outer contact and operates its left continuity contacts. Closure of the right front contact of relay 220 completes a path from negative grounded battery through the outer front contact of relay 260, conductor 252, the right front contact of relay 220, anode relay 221 to the anode of tube 211, thereby placing a positive potential on the anode of tube 211. Closure of the left outer front contact of relay 220 completes a path from ground through the left outer front contact of relay 220, the winding of register relay 230 to the negative terminal of battery 203, thereby causing the register relay 230 to become energized. Closure of the left continuity contacts of relay 220 completes a path from ground, the inner front contact of relay 260, conductor 250, the left inner front contact of relay 220 to the side of relay 201 which is connected to the dial, thereby short-circuiting the winding of relay 201. When the continuity contacts are fully operated, the previously traced locking circuit of relay 260 is opened.

Relay 201 will become deenergized and open its front contact thereby opening the operating circuit for relay 260. Relay 260, however, will not release immediately as it is held energized by the discharge of condenser 262 through the winding of relay 260, this condenser having charged through resistance 261 when the operating circuit of relay 260 was established by the operation of relay 201. The values of resistance 261 and condenser 262 are such that relay 260 will remain energized for a definite time longer than the time elapsing between impulses of the digit being dialed. Relay 260 will become deenergized a predetermined time after the final opening of the dialing loop after each digit is dialed.

On the second closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 202 which increases the negative bias on the grids of tubes 210 to 219. Tube 210 will remain in its ionized condition. Tube 211 will be blocked against ionization by the high negative potential on its con-

trol electrode. Tubes 212 to 219 will not ionize since there is no positive potential on their associated anodes.

On the second opening of the dialing loop by the dial contacts, an inductive surge of potential is generated in the secondary winding of transformer 202. This surge of potential opposes the negative bias on the control electrode of tube 211. Therefore, the negative bias on the control electrode of tube 211 will be reduced to such a degree that tube 211 ionizes and becomes conducting. With tube 211 in the conducting condition, anode relay 221 is energized in a circuit extending from the negative terminal of battery 206, cathode and anode of tube 211, winding of anode relay 221, right contact of relay 220, conductor 252, the outer front contact of relay 260, to negative grounded battery. Relay 221, being energized, closes its right front contact and its left outer contact and operates its left continuity contacts. Closure of the right front contact of relay 220 completes a path from negative grounded battery, the outer front contact of relay 260, conductor 252, the right front contact of relay 221, winding of anode relay 222 to the anode of tube 212, thereby supplying a positive potential to the anode of tube 212. Closure of the left outer front contact of relay 221 completes a path from ground, the winding of register relay 231, to the negative terminal of battery 203, thereby causing the register relay 231 to become energized. Closure of the left continuity contacts of relay 221 completes a path from ground, the inner front contact of relay 260, conductor 250, the left continuity contacts of relay 221, conductor 251, resistance 261, winding of relay 260 and in parallel through condenser 262 to the negative terminal of battery 203, thus holding relay 260 operated and again charging condenser 262. When, however, the continuity contacts of relay 221 become fully operated, the normally closed contacts open, opening the previously traced locking circuit for relay 260. However, the condenser 262 which is shunted across relay 260 and resistance 261 now discharged through relay 260 and the resistance 261 and causes relay 260 to remain energized for a definite period of time after the impulse as hereinbefore described for the first impulse.

On the third closure of the dialing loop, an inductive surge of potential is generated in the secondary winding of transformer 202 which increases the negative bias on the control electrodes of tubes 210 to 219. Tubes 210 and 211 will remain in their ionized condition. Tube 212 will be blocked against ionization by the high negative potential on its control electrode. Tubes 213 to 219 will not ionize since there is no positive potential on their associated anodes.

On the third and final opening of the dialing loop by the dial contacts, an inductive surge of potential is generated in the secondary winding of transformer 202. This surge of potential opposes the negative bias on the control electrode of tube 212. Therefore, the negative bias on the control electrode of tube 212 will be reduced to such a degree that tube 212 ionizes and becomes conducting. With tube 212 in the conducting condition, anode relay 222 is energized in a circuit extending from the negative terminal of battery 206, cathode and anode of tube 212, anode relay 222, right contact of relay 221, conductor 252, the outer front contact of relay 260

to negative grounded battery. Relay 222, being energized, closes its right front contact and its left outer contact and operates its left continuity contacts. Closure of the right front contact of relay 222 completes a path from negative grounded battery through the outer front contact of relay 260, conductor 252, the right front contact of relay 222, winding of anode relay 223 to the anode of tube 213, thereby placing a positive potential on the anode of tube 213. Closure of the left outer front contact of relay 222 completes a path from ground, through the winding of register relay 232, to the negative terminal of battery 203, thereby causing the register relay 232 to become energized. Closure of the left continuity contacts of relay 222 completes a path from ground, the inner front contact of relay 260, conductor 250, the left inner front contact of relay 221, the left continuity contacts of relay 222, conductor 251, resistance 261, winding of relay 260 and in parallel through condenser 262 to the negative terminal of battery 203, holding relay 260 operated and again charging condenser 262. When, however, the continuity contacts of relay 222 become fully operated, the normally closed contacts open the locking circuit for relay 260. However, condenser 262 which is shunted across relay 260 and resistance 261 now discharges through relay 260 and resistance 261 and causes relay 260 to remain energized for a definite period of time after the impulse as described hereinbefore for the first and the second impulses.

On this third and final opening of the dialing loop by the dial contacts, relay 260 will become deenergized and will open its left outer front contact, thereby removing the negative grounded battery from the anodes of tubes 210, 211, 212 and 213, inclusive. Tubes 210, 211, and 212 will become deionized and non-conducting. This will open the holding circuits for anode relays 220, 221, and 222, thereby permitting these relays to become deenergized and open their front contacts and close their back contacts. Opening of the right front contacts of relays 220, 221 and 222 will open the individual anode circuits to the anodes of tubes 211, 212, 213. Opening of the left outer front contacts of relays 220, 221, and 222 will open the holding circuits for the register relays 230, 231, and 232, thereby permitting these register relays to become deenergized. Opening of the left inner front contacts of relays 220, 221, and 222 will open the circuit used for short-circuit relay 201 and the circuit for charging condenser 262 during pulsing. Closure of the left back contact of relay 220 restores the locking circuit for relay 260 so that it will again lock up on closure of the dialing loop when the next digit is dialed.

What is claimed is:

1. In a signaling system, an impulsing device, an impulse responsive device, a control circuit extending between said devices, a group of gaseous conductor tubes at said responsive device, a

relay in the cathode-anode circuit of each of said tubes operable upon the ionization of the tube with which it is associated, means for normally rendering the first of said group of tubes operable in response to the first impulse over said control circuit, and means controlled upon the operation of each of said relays for preparing the next succeeding tube of said group for operation whereby in response to successive impulses said tubes successively ionize and operate their associated anode relays.

2. In a signaling system, an impulsing device, an impulse responsive device, a control circuit extending between said devices, a group of gaseous conductor tubes at said responsive device, a relay in the cathode-anode circuit of each of said tubes operable upon the ionization of the tube with which it is associated, a transformer for connecting said control circuit with the control electrodes of said tubes having its windings poled that the control electrodes of said tubes are brought to the ionization potential only on the opening of said control circuit by said impulsing device, said first tube being operable in response to the first opening of said control circuit, and means controlled by the operation of each of said relays for preparing the next succeeding tube for operation whereby in response to successive openings of said control circuit said tubes successively ionize and operate their associated anode relays.

3. In a signaling system, an impulsing device, an impulse responsive device, a control circuit extending between said devices, a group of gaseous conductor tubes at said responsive device, a relay in the cathode-anode circuit of each of said tubes operable upon the ionization of the tube with which it is associated, means for normally connecting the control electrode of the first of said group of tubes with said control circuit, and means controlled upon the operation of each of said relays for connecting the control electrode of the next succeeding tube with said control circuit whereby in response to a series of impulses ionization potential is successively applied to the control electrodes of said tubes and said tubes successively ionize and operate their associated anode relays.

4. In a signaling system, an impulsing device, an impulse responsive device, a control circuit extending between said devices, a group of gaseous conductor tubes at said responsive device, a relay in the cathode-anode circuit of each tube operable upon the ionization of the tube with which it is associated, means for normally connecting the control electrodes of said tubes with said control circuit, and means controlled upon the operation of each of said relays for connecting anode potential to the anode of the next succeeding tube whereby in response to a series of impulses over said control circuit said tubes ionize in succession and operate their associated anode relays.

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