May 21, 1935. T. L. DIMOND 2,002,219

TELEPHONE SYSTEM

Filed Jan. 20, 1934 2 Sheets-Sheet 1

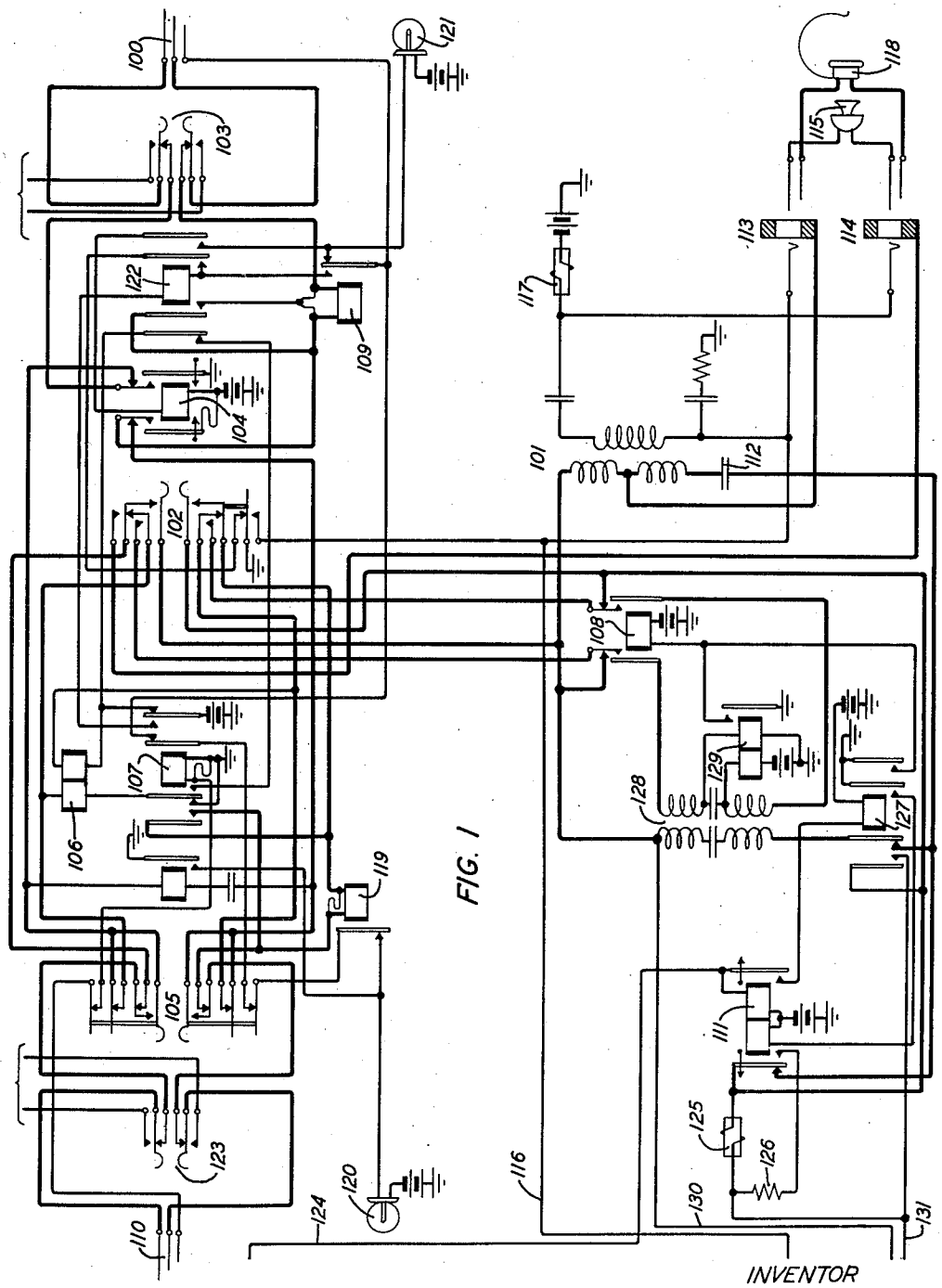


FIG. 1

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TELEPHONE SYSTEM

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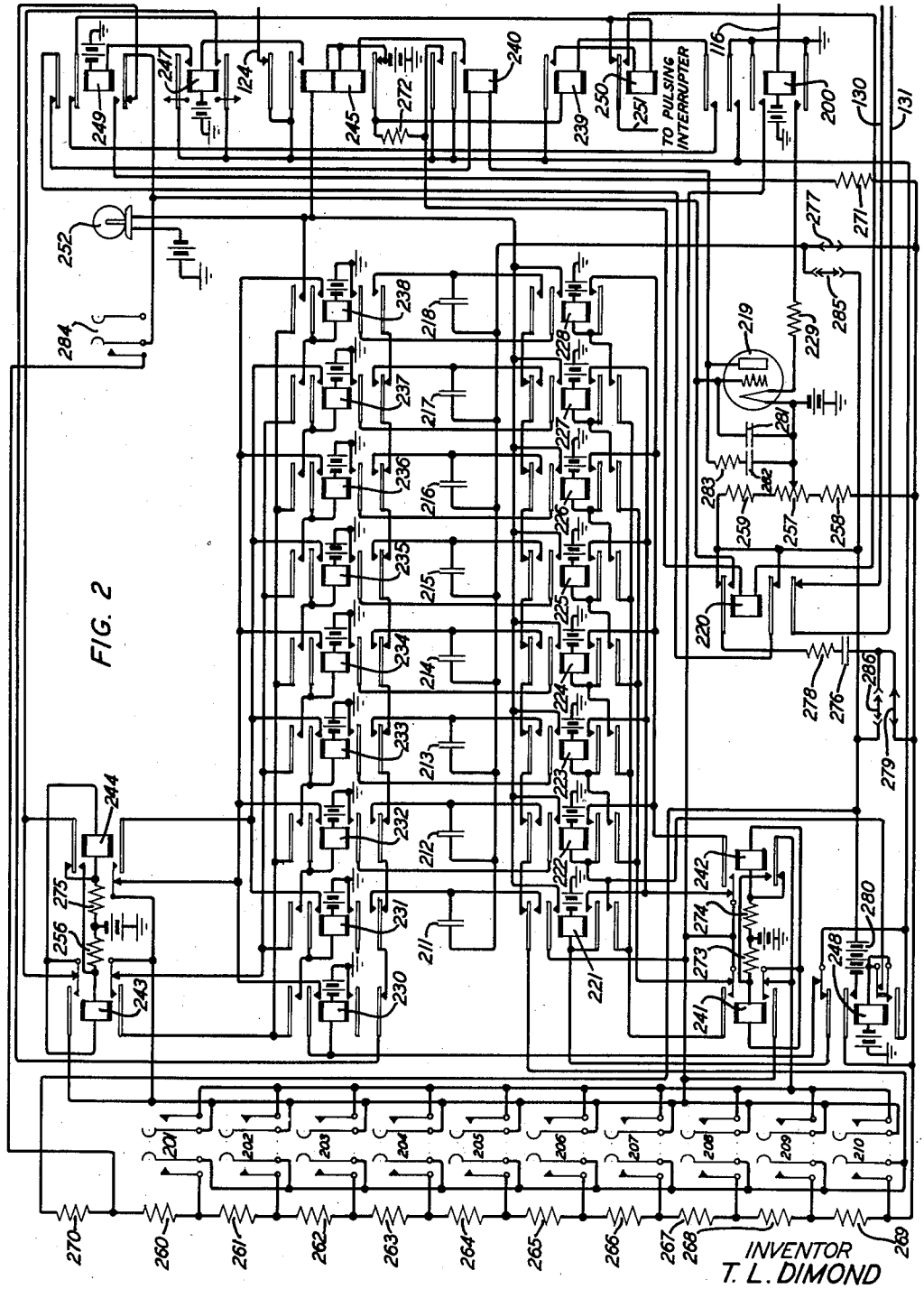


FIG. 2

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UNITED STATES PATENT OFFICE

2,002,219

TELEPHONE SYSTEM

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Application January 20, 1934, Serial No. 707,472

18 Claims. (Cl. 179—16)

This invention relates to telephone exchange systems and more particularly to key controlled senders for transmitting series of impulses for setting selector switches for establishing connections to subscribers' lines.

Heretofore senders have been provided for controlling the setting of selector switches comprising groups of register relays, one group for each digit of a desired line number successively set by the operation of the keys of a ten-button keyset in accordance with the directory number of the desired line and pulsing means for transmitting successive series of impulses to selector switches. The number of impulses in each series transmitted has been counted either by a step-by-step counting switch or by a train of counting relays under the control of the group of register relays corresponding to the particular digit at the time being transmitted. Thus, for example, if the telephone area in which the sender is installed is of such an extent as to require eight digit numbers including a three-digit office code, four numerical digits and a station letter, the sender would require eight groups of register relays, each group comprising four relays or a total of thirty-two register relays for storing the digits of a line designation, or if the sender were of the type employing rotary step-by-step switches as registers, eight of these switches would be necessary.

It is the object of the present invention to simplify such sender circuits by the elimination of the register relays or register switches and impulse counting relays, or an impulse counting switch thus materially reducing the initial cost of installation and the subsequent expense of maintenance.

In accordance with the invention it is proposed to employ a group of condensers serving as registers for recording the successive digits of a line designation keyed by the operator thus replacing groups of register relays or register switches and to employ a gas-filled tube controlled successively by the condensers for counting the impulses in each series transmitted from the sender replacing the usual counting relays or impulse counting switch. In general, the register condensers are successively charged in response to the successive depression of keys of the operator's keyset, each condenser being charged to a degree commensurate with the value of the digit being keyed at the time such condenser is associated with the keyset. The usual interrupter controlled pulsing relay is provided for transmitting series of impulses for setting selector switches. The impulse counting arrangement controlled by this relay, as previously stated, comprises a gas filled tube which may be of the three-element type filled with an inert gas such as neon helium, mercury-vapor or argon or combination of gases of this group and which breaks down or flashes when the potential on its control or grid element is raised sufficiently above a critical value.

For controlling the transmission of series of impulses in accordance with the digits of a keyed line designation registered on the register condensers, the impulse counting circuit including the tube is successively associated with the condensers by a steering switch, for example, a chain of relays as herein disclosed. When the impulsing starts for any digit series the grid element of the tube is associated with the registering condenser corresponding to the digit being transmitted, thus raising the potential of the grid by the amount of the potential across the plates of the condenser.

In accordance with one embodiment of the invention there is associated with contacts of the pulsing relay a further condenser which, when the relay is normal, is charged to a definite potential from a source of energy. Upon the first operation of the pulsing relay to transmit an impulse to a selector switch this condenser is connected into circuit with the associated register condenser and discharges into it thus raising the potential across the plates of the register condenser by a predetermined increment and consequently raising the potential on the grid of the tube by the same increment. Upon the subsequent releases and operations of the pulsing relay, this operation is repeated to add further increments of potential to the associated register condenser until such condenser has received a total of ten increments of potential at which time the potenial on the grid of the tube will be raised to such an extent that the tube will break down or flash. When the tube flashes a relay connected to the plate element or anode of the tube will operate to stop further operation of the pulsing relay, to restore the tube to its normal condition, and to prepare circuits for pulsing the next digit series in accordance with the registration established on the next succeeding register condenser.

The counting device employing a gas-filled tube and two condensers for raising the potential on the grid of the tube to a point where the tube flashes has been made the subject matter of my copending application Serial No. 707,471, filed Jan. 20, 1934, and the present invention therefore relates more particularly to a specific appli-

cation of this arrangement in which the counting device successively performs counting operations to count trains of impulses transmitted in accordance with registrations established on a group of condensers serving as registers.

In accordance with a further embodiment of the invention the condenser associated with the contacts of the pulsing relay is arranged to become charged from the associated register condenser when the pulsing relay operates to transmit an impulse to a selector switch thus lowering the potential of the register condenser and the potential in the grid by one decrement and to become discharged when the pulsing relay releases. These operations are repeated until the registering condenser has become fully discharged when the tube flashes to arrest further operation of the pulsing relay, to restore the tube to its normal condition and to prepare circuits for pulsing the next digit series in accordance with the registration established on the next succeeding register condenser.

The features of the invention will be more clearly apparent from a consideration of the following description read in connection with the accompanying drawings which illustrate the employment of the invention at an operator's position in a private branch exchange associated with an automatic telephone exchange system of a type in which the selective operations thereof are controlled by series of impulses corresponding to the wanted line designation.

It is to be understood that this invention is not limited to a private branch exchange system but may be employed wherever an operator may be required to record a wanted line designation for the purpose of transmitting corresponding series of impulses to control the selective operations at the automatic exchange.

Referring to the drawings, Fig. 1 shows the cord circuit at a private branch exchange operator's position.

Fig. 2 shows the sender circuit which is associated with the operator's cord circuit for the purpose of transmitting series of impulses to the automatic exchange in accordance with the wanted line designation recorded by the operator on her keyset.

Keys **201** to **210** of the operator's keyset have digital values of 1 to 0 respectively. Steering-in relays **221** to **228** serve to connect register condensers **211** to **218**, one at a time, to keys **201** to **210**, at which time each register condenser receives its initial charge corresponding to the particular digit keyed. Steering-out relays **230** to **238** serve to connect the partially charged condensers **211** to **218** to the grid of tube **219** in proper sequence. Tube **219**, a gas-filled tube of the type which breaks down or flashes when the potential on its grid is raised sufficiently above a critical value, is used to control the number of impulses transmitted to the automatic exchange by the operation and release of pulsing relay **220**.

It is believed that the invention will be best understood from a detailed description of the manner in which the apparatus functions.

In response to a signal of a calling subscriber's line (not shown), the operator inserts the plug **100** of her cord into the answering jack of the line and operates her talking key **102**, thereby establishing a talking connection between the calling subscriber's substation and the operator's headset. This talking connection may be traced from the tip of the subscriber's line, tip conductor of plug **100**, upper back contact of key **103**, right back contact of relay **104**, middle upper back contact of key **105**, left winding of retard coil **106**, to ground over the left back contact of relay **107**, and also over the middle upper make contact of key **102**, left back contact of relay **108**, to one side of the left winding of induction coil **101**. The ring side of the subscriber's line is connected over the ring conductor of plug **100**, lower back contact of key **103**, winding of relay **109** which operates, left back contact of relay **104**, middle lower back contact of key **105**, right winding of retard coil **106**, to battery over the right outer back contact of relay **107**, and also over the middle lower make contact of key **102**, right back contact of relay **108**, left back contact of relay **111**, to the other side of the left winding of coil **101** through condenser **112**. The lower make contact of key **102** connects ground to lead **116** (the function of which will be described hereinafter) and also connects this ground over the tip of jack **113**, transmitter **115**, tip of jack **114**, to transmitter battery through retard coil **117** thereby completing the transmitter circuit. Receiver **118** is connected across the upper left winding of coil **101** over the sleeves of jacks **113** and **114** and over the uppermost and inner upper make contacts of key **102**.

Supervisory relay **109** operating, in the circuit hereinbefore described, opens the circuit from ground over the sleeve of the subscriber's line jack, sleeve conductor of plug **100**, back contact of relay **109**, to battery through lamp **121** associated with the rear or answering cord, thereby preventing this lamp from lighting. Lamp **120**, associated with the front or trunk cord, lights in a circuit from battery through the lamp, back contact of relay **119**, lower bottom contact of key **105**, inner right back contact of relay **107**, to ground over the sleeve conductor of plug **100** and the sleeve of the calling subscriber's line jack.

Assuming that the calling subscriber desires connection with an automatic exchange subscriber whose line designation is BEL 2483-W, the operator inserts plug **110** of her trunk cord into the jack (not shown) of a trunk outgoing to the automatic exchange, operating relay **107** from ground through the winding of relay **107**, uppermost back contact of key **105**, sleeve conductor of plug **110**, to battery over the sleeve of the outgoing trunk jack.

Relay **107** operating, opens the circuit from ground over the sleeve conductor of plug **100** to battery through lamp **120** extinguishing this lamp, removes ground over its left back contact and through the left winding of coil **106** from the tip of the cord circuit, and removes battery over its outer right back contact and through the right winding of coil **106** from the ring of the cord circuit. Relay **107**, operating, also short-circuits the winding of relay **119**, and, in addition, connects battery over its right front contact, through the winding of relay **122**, front contact of relay **109**, to ground over the sleeve conductor of plug **100**, thereby operating relay **122**.

Relay **122** operating, short-circuits the left hand non-inductive winding of relay **109**, and at its left back contact, opens the circuit through the windings of retard coil **106**, these windings having been placed in series across the tip and ring of the cord circuit by the operation of relay **107**.

As hereinbefore stated, the operation of key **102**, connects ground over its lowermost contact to lead **116**. With ground on lead **116** a circuit is completed through the winding of relay **200** to battery. Relay **200** operating, connects ground

over its lower make contact, through resistance 229, to light the filament of tube 219, and connects ground over its upper inner make contact to the right armature springs of keys 201 to 210 inclusive, and to contacts of relays 221, 241, 242, 243 and 244. Relay 200 operating, also connects ground, over its upper middle make contact, to contacts of relays 239, 240, 245, 247 and 248, and this ground also operates relays 221 and 230 over the upper outer back contacts and armature of relay 246. Relay 200, in addition, closes a circuit from battery on the lower back contact of relay 245, winding of relay 239, upper outer make contact of relay 200, upper inner back contact of relay 249, back contact of relay 250, to the pulsing interrupter circuit over lead 251.

Relay 221 operating, locks over its lower inner make contact, upper back contact of relay 242, to ground over the upper inner contact of relay 200, and connects one side of the first register condenser, 211, over its upper outer make contact to the left armature springs of keys 201 to 210, inclusive. Relay 221 operating also connects ground from the upper inner make contact of relay 200, upper inner make contact of relay 221, to battery through lamp 252 which lights, and connects this same ground through the upper winding of relay 245 to battery, operating relay 245. Relay 221 operating, also prepares an operating circuit for relays 222 and 248. This circuit may be traced from the upper armature of relay 241, lower outer front contact of relay 221, to battery through the winding of relay 222 and also over the lower back contact and winding of relay 248 to battery.

Relay 230 operating, locks over its upper inner front contact, lower back contact of relay 244, to ground over the upper inner make contact of relay 200, and opens the circuit over its lower outer back contact, lower back contact of relay 249 to the grid of tube 219. Relay 230 also prepares an operating circuit for relay 231 from the lower armature of relay 243, upper front contact of relay 230, to battery through the winding of relay 231. Relay 245 operating opens the circuit from battery over its lower back contact, resistance 272, to the winding of relay 220 to prevent this relay from operating, and also disconnects battery over its lower back contact from the winding of relay 239 to release relays 239 and 250 if these relays had previously operated upon the closure of the upper outer front contact of relay 200. Relay 245 operating, also opens the circuit over its upper back contact to prevent ground over the upper middle front contact of relay 200 from being connected to the associated cord and telephone circuit, over lead 124, at this time. Relay 245 also connects ground from the upper middle front contact of relay 200, upper inner front contact of relay 245, to battery through the winding of relay 247, operating that relay.

Relay 247 operating, operates relay 249 in an obvious circuit, and also operates relay 243 in a circuit from ground over the upper middle front contact of relay 200, lower front contact of relay 247, upper back contact and winding of relay 243, to battery through resistance 256. Relay 249 operating, opens the circuit from the anode of tube 219, winding of relay 240, upper outer back contact of relay 249, to the positive terminal of B battery 280 over the lower inner back contact of relay 220. Relay 249 operating, also connects a negative bias to the grid of 219, from negative battery, potentiometer 257, resistances 258 and 271, lower front contact of relay 249 to the grid of tube 219. In addition, relay 249 opens the circuit through the winding of relay 239, over its upper inner back contact. Relay 243 operating, locks over its upper front contact to ground over the upper inner front contact of relay 200, thereby short-circuiting relay 244. Relay 243 operating, also operates relay 231 from ground over the upper inner front contact of relay 200, lower front contact of relay 243, upper outer front contact of relay 230, to battery through the winding of relay 231. Relay 231 operating, prepares an obvious operating circuit for relay 232 which is effective upon the future release of relay 243, and also, over its lower outer front contact, connects condenser 211 to the opened lower outer back contact of relay 230 in preparation for the connection of condenser 211 to the grid of tube 219 upon the future release of relays 230 and 249, which will be described in detail hereinafter. The sender circuit is now prepared for the recording of the wanted line designation and for the transmission of corresponding series of impulses to the automatic exchange.

Since it is assumed that the designation of the wanted automatic exchange line is BEL 2483-W, the operator successively depresses digit keys 202, 203 and 205 for registering the code BEL; these letters having a digit value of 2, 3 and 5 respectively, and keys 202, 204, 208 and 203 which have a digit value of 2, 4, 8 and 3 respectively, and finally, key 209 for registering the station designation W which has a digit value of 9.

Upon the depression of key 202 for the first letter B of the code, relay 241 operates from ground over the upper inner front contact of relay 200, right armature spring and right contact of key 202, lower normal contacts and winding of relay 241, to battery through resistance 273. Relay 241 operating, operates relays 222 and 248 over its upper front contact in a circuit hereinbefore described, and locks to ground over its lower front contact and upper inner front contact of relay 200. Relay 248 operated, locks over its lower armature and front contact to ground over the upper middle front contact of relay 200, opens the previously traced original operating circuit for relays 221 and 230, and closes a circuit from the negative terminal of B battery 280 to resistances 258, 269 and 271 and to condensers 211 to 218 inclusive, over strap 277 and to condenser 276 over strap 279. With negative battery connected to one side of the register condensers 211 to 218 inclusive, and the positive terminal of B battery 280 connected to resistance 270, condenser 211 receives a charge over the left contact and armature spring of key 202 and over the upper outer front contact of relay 221. This charge on condenser 211 is equal to the potential across resistances 262 to 269 inclusive, and is commensurate with the value of the digit 2 which corresponds to the keyed first code letter B. When the operator releases digit key 202, ground from the upper inner front contact of relay 200, over the right armature spring and right contact of key 202, is removed from the lower armature of relay 242 which removes the short-circuit around the winding of this relay. Relay 242 operates from ground over the upper inner front contact of relay 200, lower armature and front contact of relay 241, winding of relay 242, to battery through resistance 274. Relay 242 operating opens the previously traced locking circuit for relay 221 which releases. Relay 221 releasing, connects one side of the second register

condenser 212, over the upper outer front contact of relay 222, upper back contact of relay 221, to the left armature springs of the digit keys. Relay 221 releasing, also opens the circuit from ground over the upper inner front contact of relay 200, upper inner front contact of relay 221, to battery through lamp 252 and to battery through the upper winding of relay 245, extinguishing lamp 252 and releasing relay 245. The function of the release of relay 245 and the function of lamp 252 will be later set forth in detail under the description of the sending of impulses by the sender which follows this description of the recording of the wanted line designation.

Upon the depression of key 203 for the second letter E of the code, condenser 212 receives a charge over the left contact and armature spring of key 203, upper back contact of relay 221 and the upper outer front contact of relay 222. The charge on condenser 212 is equal to the potential across resistances 263 to 269 inclusive and is commensurate with the value of digit 3 which corresponds to the second code letter E. Key 203 depressed also connects ground from the upper inner front contact of relay 200, over the right armature spring and right contact of key 203, lower front contact of relay 242, to the winding of relay 241 and resistance 273 thereby short-circuiting and releasing relay 241. Relay 241 releasing, operates relay 223 from ground over the upper inner front contact of relay 200, upper normal contacts of relay 241, lower outer front contact of relay 222, to battery through the winding of relay 223. Relay 223 operating, prepares an obvious future locking circuit for itself, prepares an obvious future operating circuit for relay 224, and connects one side of condenser 213 to the upper back contact of relay 222. When the operator releases digit key 203, ground from the upper inner front contact of relay 200, over the right armature spring and right contact of key 203, lower normal contacts of relay 241, is removed from the winding of relay 242, releasing relay 242. Relay 242 releasing, opens the locking circuit for relay 222 which releases, and connects ground from the upper inner front contact of relay 200, upper normal contacts of relay 242, and lower inner front contact and winding of relay 223 thereby locking relay 223. Relay 222 releasing, connects one side of condenser 213, over the upper outer front contact of relay 223, upper back contacts of relays 221 and 222, to the left armature springs of the digit keys.

Upon the depression of key 205 for the third letter of the code, condenser 213 receives a charge of potential over the left contact of key 205 over the circuit just previously traced. This charge on condenser 213 is equal to the potential across resistances 265 to 269 inclusive and is commensurate with the value of digit 5 which corresponds to the third code letter L. The depression of key 205 also operates relay 241 in a circuit from ground over the upper inner front contact of relay 200, right armature spring and right contact of key 205, lower normal contacts and winding of relay 241, to battery through resistance 273. This operating ground for relay 241 is also connected to the junction of the winding of relay 242 and resistance 274 over the lower armature and back contact of relay 242. Relay 241 operating, operates relay 224 from ground over the upper inner front contact of relay 200, upper front contact of relay 241, lower outer front contact of relay 223, to battery through the winding of relay 224. Relay 241 operating, also locks over its lower front contact to ground over the upper inner front contact of relay 200, and, in addition, connects this same ground to one side of the winding of relay 242. Relay 242 does not operate, however, since its winding is short-circuited by the ground over its lower armature and back contact under control of the depressed key 205. Relay 224 operated, connects one side of condenser 214 to the opened upper back contact of relay 223. When the operator releases key 205, the previously traced short-circuiting ground on the winding of relay 242 is removed and relay 242 operates. Relay 242 operating, opens the locking circuit for relay 223 which releases, and closes the locking circuit for relay 224 from ground over the upper inner front contact of relay 200, upper front contact of relay 242, and lower inner front contact and winding of relay 224 to battery. Relay 223 releasing, connects one side of condenser 214, over the upper outer front contact of relay 224, upper back contacts of relays 223, 222 and 221, to the left armature springs of the digit keys.

In a manner similar to that hereinbefore described in detail for the code letters BEL, the remaining digits 2483, and the station designation W which has a digit value of 9, are successively recorded, by the depression of keys 202, 204, 208, 203 and 209 in that order, on condensers 214, 215, 216, 217 and 218 respectively, each condenser being charged to a degree commensurate with the value of the digit keyed by the operator at the time that particular condenser is associated with the digit keys. The depression of key 202 for the thousands digit 2 charges condenser 214 to the potential across resistances 262 to 269 inclusive, and short-circuits relay 241 which releases. Relay 241 releasing operates relay 225. When key 202 is released relay 242 releases. Relay 242 releasing, releases relay 224 and locks relay 225. The operation of relay 225 and the release of relay 224 connect condenser 215 to the digit keys. The depression of key 204 for the hundreds digit 4 charges condenser 215 to the potential across resistances 264 to 269 inclusive, and operates relay 241. Relay 241 operating operates relay 226. When key 204 is released, the short-circuit around the winding of relay 242 is removed and relay 242 operates. Relay 242 operating, locks relay 226 and releases relay 225 which connects condenser 216 to the digit keys. The depression of key 208 for the tens digit 8 charges condenser 216 to the potential across resistances 268 and 269, and short-circuits relay 241 which releases and operates relay 227. The release of key 208 releases relay 242 which locks relay 227 and releases relay 226. The operation of relay 227 and the release of relay 226 connect condenser 217 to the operator's digit keys. When key 203 is depressed for registering the units digit 3, condenser 217 is charged to the potential across resistances 263 to 269 inclusive and relay 241 operates. Relay 241 operating operates relay 228. The release of key 203 removes the short-circuit from the winding of relay 242 and relay 242 operates. Relay 242 operating, locks relay 228 and releases relay 227. The operation of relay 228 and the release of relay 227 connect condenser 218 to the digit keys. The depression of the key 209 for the station designation W which has a digit value of 9, charges condenser 218 to the potential across resistance 269 and short-circuits the winding of relay 241 which releases. When key 209 is released, the circuit through relay 242 is opened and that relay releases. Relay 242 releasing, opens the locking circuit for relay 228 which releases. The regis-

tration of the wanted line designation being complete, recording keys 201 to 210 inclusive are now dissociated from the variously charged register condensers since relays 221 to 228 inclusive are all released.

As soon as register condenser 211 is charged in the manner hereinbefore described, and the first depressed digit key is released, the sender circuit functions to transmit corresponding impulses to the automatic exchange. As previously set forth, upon the release of the first operated digit key 202 relay 221 releases and in turn releases relay 245. Relay 245 releasing, connects battery over its lower back contact to the winding of relay 239 and connects this same battery through resistance 272 to the winding of relay 220. Relay 245 releasing, also opens the circuit through the winding of relay 247, and connects ground from the upper middle front contact of relay 200, over its upper back contact to lead 124 to cause the associated telephone and cord circuit (Fig. 1) to prepare for the transmission of impulses by the sender. The functions of the slow-to-release relay 247 will be subsequently described following the description of the preparation of the telephone and cord circuit for impulse transmission.

The ground over the upper back contact of relay 245, over lead 124, operates relay 111 through its right winding. Relay 111 operating, opens the circuit from condenser 112, left back contact of relay 111, to the ring conductor of plug 110, over the lower inner front contact of key 102, outer left front contact of relay 107, lower inner back contact of key 105 and lower back contact of key 123, and also opens the circuit from condenser 112, left back contact of relay 111, to the ring conductor of plug 100, over the right back contact of relay 108, lower middle front contact of key 102, lower middle back contact of key 105, left back contact of relay 104, winding of relay 109 and lower back contact of key 103. This opens the circuit of the operator's receiver 118 from the ring of the cord circuit. Relay 111 operating, also connects resistance 126 in parallel with coil 125, and operates relay 127 in a circuit from ground over lead 124, right front contact of relay 111, to battery through the winding of relay 127. Relay 127 operating, short-circuits the parallel combination of coil 125 and resistance 126 over its left front contact, and opens the circuit from the lower left winding of repeating coil 128 to condenser 112. Relay 127 operating, also closes an obvious circuit for holding relay 111 through the left winding of that relay, and also closes an obvious operating circuit for relay 108.

The tip of the answering cord from the tip conductor of plug 100, upper back contact of key 103, right back contact of relay 104, upper middle back contact of key 105, upper middle front contact of key 102 and left back contact of relay 108, is disconnected by the operation of relay 108, from the tip conductor of the trunk cord plug 110, over the upper inner front contact of key 102, upper inner back contact of key 105 and upper back contact of key 123, and is connected instead to ground through the upper right winding of repeating coil 128 and the right winding of relay 129. Similarly, the ring of the answering cord from the ring conductor of plug 100, lower back contact of key 103, winding of relay 109, left back contact of relay 104, lower middle back contact of key 105, lower middle front contact of key 102 and right back contact of relay 108, is disconnected by the operation of relay 108, from the ring conductor of the trunk cord plug 110, over the lower inner front contact of key 102, left outer front contact of relay 107, lower inner back contact of key 105 and lower back contact of key 123, and is connected instead to battery through the lower right winding of repeating coil 128 and the left winding of relay 129. Relay 129 operates from battery and ground through its windings, over the tip and ring conductors of plug 100, the circuits to which have just been traced, and over the calling subscriber's station loop (not shown). Relay 129 operating, provides an obvious holding circuit for relay 108. The operation of relays 108, 111 and 127 have prepared the cord and telephone circuit (Fig. 1) for the transmission of impulses by the sender circuit (Fig. 2) since, by their operation, the aforementioned relays have removed the apparatus normally connected across the tip and ring of the cord circuit toward plug 110. The fundamental pulsing circuit to the automatic exchange may be traced from the tip of plug 110, which is inserted in a jack (not shown) connecting to the automatic exchange, upper back contact of key 123, upper inner back contact of key 105, upper inner front contact of key 102, lead 130, lower outer back contact of pulsing relay 220, lead 131, left front contact of relay 127, lower inner front contact of key 102, left outer front contact of relay 107, lower inner back contact of key 105, lower back contact of key 123, to the ring conductor of plug 110.

As previously stated, the release of relay 245 opens the circuit through the winding of slow-to-release relay 247 which releases after an interval sufficient to allow the cord and telephone circuit (Fig. 1) to function and clear the talking bridge from the trunk in the manner just set forth. Relay 247 releasing, opens the obvious circuit through the winding of relay 249 which releases, and also removes the ground, from the upper middle front contact of relay 200, lower front contact of relay 247, from one side of the winding of relay 244. This removes the short-circuit around relay 244 and relay 244 operates from battery through resistance 275 and winding of relay 244, upper front contact of relay 243, to ground over the upper inner front contact of relay 200. Relay 249 releasing, closes the circuit, over its upper inner back contact, from the winding and back contact of relay 250 to the winding of relay 239, closes the anode circuit for tube 219 over its upper outer back contact, and, over its lower armature, transfers the grid of tube 219 from the negative terminal of B battery 280 over the upper front contact of relay 248, resistance 271 and lower front contact of relay 249, to the opened lower contact of relay 230 over the lower back contact of relay 249. Relay 244 operating, closes a circuit from ground over the upper inner front contact of relay 200, lower front contact of relay 244, for locking relay 231 over the upper inner front contact and armature of that relay. Relay 244 operating, also opens the obvious locking circuit for relay 230 which releases. Relay 230 releasing, connects the partially charged condenser 211 over the lower outer front contact of relay 231, lower back contact of relay 230, lower back contact of relay 249 to the grid of tube 219 and to the upper front contact of pulsing relay 220. The potential on the grid of tube 219 is therefore raised by the amount of potential across the plates of condenser 211. The charge previously placed on

condenser 211 by the depression of digit key 202 is equal to eight increments of potential, and since ten increments of potential are required to cause tube 219 to break down or flash, the tube does not break down at this time.

Upon the connection of a ground pulse from the associated pulsing interrupter circuit (not shown), relay 239 operates from the ground pulse over lead 251, back contact of relay 250, upper inner back contact of relay 249, upper outer front contact of relay 200, winding of relay 239, to battery over the lower back contact of relay 245. Relay 239 operating, closes the circuit from ground over the upper middle front contact of relay 200 to the winding of relay 250 which does not operate since it is short-circuited. When the pulsing interrupter circuit removes the ground pulse from lead 251, the short-circuit is removed from relay 250 and relay 250 operates in series with relay 239. Relay 250 operating, connects lead 251 over its front contact to the winding of relay 220. On the next ground pulse over lead 251, relay 220 operates in a circuit to battery through resistance 272 and over the lower back contact of relay 245. Pulse relay 220 operating, opens the previously traced fundamental circuit to the automatic exchange, over its lower outer back contact. Relay 220 operating, also connects condenser 276, through resistance 278, to condenser 211 which is, as previously stated, connected at this time to the grid of tube 219 and to the upper front contact of relay 220. Condensers 211 and 276 are now in parallel, and condenser 276 discharges into condenser 211 thereby raising the potential across the plates of condenser 211 by one increment, consequently raising the grid potential of tube 219 by the same increment. On the next removal of the ground from lead 251, pulsing relay 220 releases and closes the fundamental circuit. Relay 220 releasing, also closes the charging circuit for condenser 276. This charging circuit may be traced from the positive terminal of B battery 280, upper back contact of relay 220, resistance 278, condenser 276, to the negative terminal of B battery 280 over strap 279 and the upper armature and front contact of relay 248. The next ground pulse over lead 251 again operates pulsing relay 220 over the previously traced circuit. Pulsing relay 220 operating, again opens the fundamental circuit to transmit the next open pulse to the automatic exchange, and again connects charged condenser 276 in parallel with partially charged condenser 211. Condenser 276 discharges into condenser 211 and thereby again raises the potential across the plates of condenser 211 and the potential on the grid of tube 219 by the predetermined increment. It will be noted that pulsing relay 220 has operated and released twice and has thereby transmitted two pulses over the fundamental circuit which correspond to the value of the assumed first letter B of the code of the wanted line designation. Since condenser 211 was initially charged with eight increments of potential by the operation of key 202, the two increments added by the two operations of pulsing relay 220 bring the total increments of potential across condenser 211 to ten. The voltage on the grid of tube 219 is increased accordingly, since condenser 211 is connected to the tube grid, and this grid voltage is now above the breakdown potential of the tube. When the ground pulse is now removed from lead 251, pulsing relay 220 again releases, closing the fundamental circuit, closing the charging circuit for condenser 276, and closing the circuit from the positive terminal of B battery 280, over its lower inner back contact, upper outer back contact of relay 249, winding of relay 240, to the anode of tube 219. With positive potential on its anode, tube 219 now breaks down or flashes. Relay 240 operates from positive B battery 280, over the anode-cathode circuit of tube 219, to negative B battery 280 through potentiometer 257, resistance 258 and over the upper inner armature and front contact of relay 248.

Relay 240 operating, connects the ground from the upper middle front contact of relay 200, over the upper outer armature and front contact of relay 240, to the winding of relay 220 to shunt relay 220 and thereby prevent its reoperation should a ground pulse be connected to lead 251 at this time. Relay 240 operating, also closes an obvious circuit through the lower winding of relay 245 which operates. Relay 245 operating, removes battery from the windings of relays 220 and 239 causing relays 239 and 250, which were holding operated in series, to release. Relay 245 operating, also closes an obvious operating circuit for relay 247, and, in addition, removes the ground from lead 124 for the purpose of restoring the talking bridge across the cord circuit in a manner which will later be described in detail. Relay 247 operating, connects ground from the upper middle front contact of relay 200, over its lower front contact, upper front contact of relay 244, to the junction of the winding of relay 243 and resistance 256. This ground short-circuits the winding of relay 243 which releases. Relay 247 operating, also completes an obvious operating circuit for relay 249 which operates. Relay 249 operating, opens the anode circuit of tube 219 over its upper outer armature and back contact, thereby releasing relay 240 and de-ionizing tube 219. Relay 249 operating, also transfers the grid of tube 219 from condenser 211, over a previously traced circuit, to the negative terminal of B battery 280, over the lower armature and front contact of relay 249, resistance 271, and the upper inner front contact of relay 248. Relay 243 releasing, operates relay 232 in a circuit from ground over the upper inner front contact of relay 200, lower normal contacts of relay 243, upper outer front contact of relay 231, to battery through the winding of relay 232. Relay 232 operating, prepares a locking circuit for itself over its upper inner front contact, to the opened lower back contact of relay 244, and connects condenser 212, over its lower outer front contact, to the opened lower back contact of relay 231. Relay 249, in releasing as previously stated, removes the shunt from the winding of pulsing relay 220 by opening the circuit from ground over the upper middle front contact of relay 200, the upper outer front contact of relay 240 to the winding of relay 220 and resistance 272. The release of relay 240 also opens the circuit through the lower winding of relay 245. Since it is assumed that the operator has recorded the entire wanted line designation, all of the steering in relays 221 to 228 inclusive are released and the circuit through the upper winding of relay 245 therefore being open, relay 245 releases.

Relay 245 releasing, connects battery over its lower back contact to the winding of relay 239, and through resistance 272 to the winding of pulsing relay 220, opens the circuit through the winding of relay 247, and again connects ground to lead 124 to cause the associated cord and tele-

phone circuit to prepare for the transmission of impulses, as hereinbefore described in detail. Relay 247 is slow-to-release to provide ample time for the cord and telephone circuit to clear the talking bridge from the trunk. When relay 247 releases, it opens the circuit through the winding of relay 249 which releases, and also opens the circuit from ground over the upper middle front contact of relay 200, lower front contact of relay 247, upper normal contacts of relay 243, to the winding of relay 244, releasing relay 244. Relay 244 releasing, opens the holding circuit for relay 231 which releases, and closes the holding circuit for relay 232 over the lower normal contacts of relay 244 to ground over the upper inner front contact of relay 200. Relay 249 in releasing, connects condenser 212 to the grid of tube 219 in a circuit over the lower outer front contact of relay 232, lower back contacts of relays 231 and 230, and lower back contact of relay 249. Relay 249 releasing, also closes the circuit from the positive terminal of B battery 280, over the lower inner back contact of relay 220, upper outer back contact of relay 249, winding of relay 240, to the anode of tube 219. In addition, the release of relay 249 closes the circuit from the associated pulsing interrupter, over lead 251, armature and back contact of relay 250, upper inner back contact of relay 249, upper outer front contact of relay 200, winding of relay 239, to battery over the lower back contact of relay 245. The first ground pulse from the pulsing interrupter circuit operates relay 239 in the circuit just traced. When the ground pulse is removed from lead 251, the short-circuit around the winding of relay 250 is removed and relay 250 operates in series with relay 239.

For the transmission of impulses corresponding to the second code letter E, the circuit now functions in a manner similar to that described for the transmission of the first code letter B. Each closure of ground to lead 251 by the pulsing interrupter circuit causes pulsing relay 220 to operate and open the fundamental circuit for transmitting an impulse to the automatic exchange. In addition, as previously described, each operation of relay 220 causes condenser 276 to discharge into condenser 212 and thereby add one increment of potential to the already partially charged condenser 212. Since the operation of digit key 203 initially charged condenser 212 to an equivalent of seven increments of potential, the addition of three increments of potential raises the potential across condenser 212 and on the grid of tube 219 to the breakdown potential of the tube. When now the release of relay 220 occurs, after relay 220 has opened the fundamental circuit three times, the closure of positive B battery, over the lower inner back contact of relay 220, to the anode of tube 219 causes the tube to break down and relay 240 operates in the anode-cathode circuit of the tube. Relay 240 operating, connects ground over its upper outer front contact to the winding of relay 220 to shunt relay 220 down and prevent its further operation at this time. Relay 240 operating, also connects ground over its upper inner front contact through the lower winding of relay 245 to battery. Relay 245 operates and removes the battery over its lower back contact from the windings of relays 220 and 239 releasing relays 239 and 250. Relay 245 operating, also closes an obvious operating circuit for relay 247, and removes the ground from lead 124 to cause the cord and telephone circuit to place the talking bridge back across the cord circuit. Relay 247 operating, closes an obvious operating circuit for relay 249, and connects ground from the middle upper front contact of relay 200, over the lower front contact of relay 247, upper normal contacts of relay 243, winding of relay 243, to battery through resistance 256. Relay 243 operates and causes relay 233 to operate in a circuit from ground over the upper inner front contact of relay 200, lower armature and front contact of relay 243, upper outer front contact of relay 232, to battery through the winding of relay 233. Relay 249 operating, opens the anode circuit of tube 219 thereby releasing relay 240, transfers the grid of tube 219 from condenser 212 to the negative terminal of B battery 280 over a previously traced circuit, and also opens the circuit over the upper outer front contact of relay 200 to the winding of relay 239. Relay 249 releasing, opens the shunt from the winding of relay 220, and opens the circuit through the lower winding of relay 245. Since relays 221 to 228 inclusive are released, the circuit through the upper winding of relay 245 is also open and relay 245 releases. Relay 245 in releasing, again connects battery to the windings of relays 220 and 239, again connects ground to lead 124 to cause the cord and telephone circuit to function and remove the talking bridge from the trunk, and opens the circuit through the winding of relay 247.

After an interval sufficient to permit the cord and telephone circuit to function, slow-to-release relay 247 releases, releasing relay 249 and removing the ground, over its lower front contact, which is shunting relay 244. Relay 244 now operates and opens the previously traced holding circuit for relay 232 which releases. Relay 244 operating, also provides a holding circuit for relay 233 over its lower front contact. The third register condenser 213 is now connected over the lower outer front contact of relay 233, lower back contacts of relays 232, 231 and 230 respectively, lower back contact of relay 249, to the grid of tube 219 and to the upper front contact of relay 220. Relay 249 releasing, also closes the anode circuit of tube 219 through the winding of relay 240, and, in addition, closes the circuit from the pulsing interrupter, over lead 251, back contact of relay 250, upper inner back contact of relay 249, upper outer front contact of relay 200, winding of relay 239, to battery over the lower back contact of relay 245. Ground pulses from the pulsing interrupter circuit cause the sender circuit to function as hereinbefore described, condenser 213 requiring five additional increments of potential before the grid of tube 219 reaches the breakdown potential. Pulsing relay 220 therefore operates five times and transmits five impulses, corresponding to the letter L, to the automatic exchange.

In a manner similar to that described for the transmission of the three letters of the code, the grid of tube 219 is progressively associated with register condensers 214, 215, 216, 217 and 218. Series of two, four, eight and three pulses for the thousands, hundreds, tens and units designations respectively, and a series of nine pulses for the assumed station designation W, are transmitted over the outgoing trunk to the automatic exchange in accordance with the registrations recorded on the respective register condensers. Following the transmission of the pulses for the third letter of the code, the operation and release of relay 247 releases relays 243 and 244. Relay 243 releasing, operates relay 234. Relay 244 releasing, holds relay 234 and releases relay 233. With relay 234 operated and

relay 233 released, thousands register condenser 214 is connected to the grid of tube 219. Following the thousands digit transmission, the operation and release of relay 247 reoperates relays 243 and 244. Relay 243 operating, operates relay 235. Relay 244 operating, holds relay 235 and releases relay 234. With relay 234 released and relay 235 operated, hundreds register condenser 215 is connected to the grid of the tube. At the conclusion of the hundreds digit series of impulses, the operation and release of relay 247 releases first relay 243 and then relay 244. Relay 243 releasing, operates relay 236. Relay 244 releasing, holds relay 236 and releases relay 235. With relay 236 operated and relay 235 released, the tens register condenser 216 is connected to the grid of tube 219. After the tens digit impulses have been transmitted, the operation and release of relay 247 operates relays 243 and 244. Relay 243 operating, operates relay 237, while the operation of relay 244 holds relay 237 and releases relay 236. The grid of tube 219 is now connected to units register condenser 217. When relay 247 operates and releases following the transmission of the units series of impulses, relays 243 and 244 release. Relay 238 is operated by the release of relay 243, and relay 244, in releasing, holds relay 238 and releases relay 237, thereby connecting the stations designation register condenser 218 to the grid of the tube. Condenser 218, initially charged only to the potential across resistance 269 by the depression of key 209, requires nine additional increments of potential before the voltage across its plates and the grid of tube 219 reaches the breakdown potential of the tube. Pulsing relay 220 therefore operates nine times, discharging condenser 276 into condenser 218, and opening the fundamental circuit, for each of its operations. In this manner, nine impulses are transmitted to the automatic exchange, these nine impulses corresponding to the digit value of the assumed station designation W.

Upon the release of pulsing relay 220 after the ninth and last pulse of the station designation has been transmitted, tube 219 breaks down and relay 240 operates in the anode-cathode circuit of the tube. Relay 240 operating, connects ground over its upper outer make contact, from the upper middle front contact of relay 200, to the winding of relay 220 to shunt relay 220 down and thereby prevent its further reoperation. Relay 240 operating, also operates relay 245 in an obvious circuit through the lower winding of that relay. Relay 245 operating, disconnects battery at its lower back contact from the windings of relays 220 and 239, thereby releasing relays 239 and 250 which were being held operated in series. Relay 245 operating, also closes an obvious operating circuit for relay 247, and removes the ground from lead 124 which causes the associated cord and telephone circuit to function and place the talking bridge back across the trunk. The operation of relay 247 closes an obvious operating circuit for relay 249, and, over its lower armature and front contact, connects the ground over the upper middle front contact of relay 200 to the winding of relay 243 which operates. Relay 243 operating, lights lamp 252 and provides a holding circuit for relay 245. These circuits may be traced from ground over the upper inner front contact of relay 200, lower front contact of relay 243, upper outer front contact of relay 238, to battery through lamp 252 and to battery through the upper winding of relay 245. Relay 249 operating, opens the anode circuit of tube 219 which releases relay 240, opens the operating circuit for relay 239, and, over its lower contacts, disconnects the condenser 218 from the circuit over the lower outer front contact of relay 238, the lower back contacts of relays 230 to 237 inclusive to the grid of tube 219 and transfers the grid of tube 219 to negative B battery 280 through resistance 271 and the upper front contact of relay 248. Lighted lamp 252 indicates to the operator that the sender has completed the transmission of impulses corresponding to the digits keyed.

The removal of ground from lead 124 by the operation of relay 245, as previously described, removes ground from the winding of relay 127, over the right armature and front contact of relay 111 and relay 127 releases. Relay 127, in releasing, opens the circuit from ground over its inner right front contact and armature to the left winding of relay 111, opens the short-circuit around the combination of retardation coil 125 and resistance 126 over its left front contact, and connects the lower left winding of repeating coil 128 to condenser 112 of the telephone circuit so that conversation between the operator and the calling subscriber may take place in case dialing key 102 is not released immediately after the sender has transmitted the impulses to the automatic exchange. The circuits through both its windings being open, slow-to-release relay 111 releases. Relay 111 is sufficiently slow in releasing to hold resistance 126 in parallel with retardation coil 125 until the current in coil 125 is built up to a point where the connection of this coil across the tip and ring will not cause the transmission of a false pulse indication to the automatic exchange equipment.

The operator, upon noting the lighted lamp 252, restores the talking and dialing key 102 to normal which dissociates the operator's telephone circuit and the impulse transmitting sender circuit from the cord circuit and conversation between the calling subscriber and the called subscriber selected through the automatic exchange apparatus may now take place. The restoring of key 102 to normal also removes ground over its lower outer front contact and lead 116, from the winding of relay 200 which releases. Relay 200, in releasing, opens the circuit over its lower front contact through the cathode of tube 219, and also opens the off-normal ground over its upper front contacts from the various points in the sender circuit to which this ground was connected. The removal of the off-normal ground by the release of relay 200 releases relays 238, 243, 244, 245, 247, 248 and 249 and extinguishes lamp 252. The sender circuit is now normal and ready for association with another cord circuit when a connection to the automatic exchange is desired. The release of key 102 to normal also opens the circuit, through its upper and lower middle front contacts, to the windings of relay 129 through the right windings of repeating coil 128. Relay 129 now releases, releasing in turn relay 108. Relay 108, in releasing, disconnects the right windings of repeating coil 128 from the cord circuit.

When the calling subscriber replaces his receiver on the switchhook at the conclusion of the conversation, the calling station loop is opened releasing supervisory relay 109. Relay 109, in releasing, closes a circuit to light supervisory lamp 121 as a disconnect signal, and operates relay 104 which opens the tip and ring of the cord towards the automatic exchange. The operator observ-

ing the lighted lamp 121, removes the plugs 100 and 110 from the jacks into which these plugs had been inserted. When plug 110 is withdrawn, relay 107 releases, in turn releasing relay 122. The withdrawal of plug 100 releases relay 104 and extinguishes lamp 121, thereby restoring the cord circuit to normal.

In the event that only a partial wanted line designation has been keyed by the operator, the sender, after transmitting a series of impulses corresponding to the last digit which was keyed, will await the keying of the next digit before it connects the subsequent register condenser to the grid of tube 219. This is accomplished by holding relay 245 operated through its upper winding, after the release of relay 240, at the end of the last series of impulses which was transmitted, has opened the circuit through the lower winding of relay 245. The circuit for holding relay 245 operated may be traced from ground over the lower inner back contact of the last steering out relay (231 to 238) to operate, and over the upper inner armature and front contact of the last steering in relay (221 to 228) to operate, to battery through the upper winding of relay 245. Relay 245 remaining operated at this time, prevents the release of relay 247 which would cause relay 243 or 244 and the next steering out relay to function and connect the subsequent, still uncharged, register condenser to the grid of tube 219. This ground, which holds relay 245 through its upper winding, also causes lamp 252 to light as an indication to the operator that the sender has finished sending the digits keyed up to this time and is awaiting further keying by the operator.

Referring to Fig. 2, the purpose of condenser 281, which is connected between the cathode and the grid of tube 219, is to prevent surges on the leads connected to the grid from falsely causing tube 219 to break down. Condenser 282 is connected between the anode and cathode of tube 219 to prevent surges on the anode leads of the tube to falsely cause the tube to break down. Resistance 283, connected in series with condenser 282, prevents tube 219 from being falsely restored by the sudden surge into condenser 282 when the tube breaks down at the conclusion of each train of impulses.

If, due to breakage, deterioration or burning out, it is necessary to replace tube 219, the new tube may be calibrated in the circuit in the following manner. Relays 239 and 245 are blocked in their nonoperated position and the arm of potentiometer 257 is turned towards that end of the potentiometer which connects to resistance 258. The talking key 102 of an associated cord circuit is now operated which closes a ground to operate relay 200. Relay 200 operating, closes the cathode circuit of tube 219 and causes the sender circuit to prepare for the recording of digits as hereinbefore described in detail. Any digit key of the operator's keyset is now momentarily depressed for the purpose of closing the lead from the negative terminal of B battery 280. The depression of any digit key operates relay 241 which in turn operates relay 248 over the lower outer front contact of relay 221, relay 221 having previously operated upon the operation of start relay 200. Relay 248 operating closes the negative B battery lead. Calibrating key 284 is now held depressed which connects positive B battery through balancing resistance 270 to the grid of tube 219. Since the value of resistance 270 is such that the potential placed on the grid of tube 219 slightly exceeds the potential which would be placed on the grid by a register condenser charged to the equivalent of ten increments of potential, tube 219 breaks down and becomes conducting. This conducting condition of tube 219 may be observed by the operation of relay 240. With relay 240 operated, the tube is restored to its non-conducting condition by the momentary manual operation of relay 249. Potentiometer 257 is now slowly adjusted, turning its arm away from the side of the potentiometer connected to resistance 258, until tube 219 again breaks down, as indicated by the reoperation of relay 240. Calibration is now complete and relays 239 and 245 are unblocked and key 284 is released. Talking key 102 in the associated cord circuit is now restored, removing the ground through the winding of start relay 200 which releases. Relay 200, in releasing, opens the cathode circuit of tube 219 and releases relays 221, 241 and 248, thereby restoring the circuit to normal.

The foregoing description covers one embodiment of this invention in which the operations of pulsing relay 220 add increments of potential to the respective register condensers until the total potential across the register condenser is raised sufficiently to cause tube 219 to break down and terminate the transmission of pulses corresponding to the particular digit recorded on that register condenser.

By the substitution of straps 285 and 286 for straps 277 and 279 respectively, in Fig. 2, a second embodiment of this invention is disclosed. The circuits function in the same manner as hereinbefore set forth for the first embodiment of the invention with the following exception. Condenser 276, instead of being normally charged, is, under this condition, normally discharged in a circuit over the upper back contact of pulsing relay 220 and strap 286. As each register condenser is successively connected to the grid of tube 219 and to the upper front contact of pulsing relay 220, condenser 276 is connected in parallel with the register condenser during each operation of relay 220 and charges from the plates of the register condenser, thereby lowering the potential across the particular register condenser by one decrement of potential. Upon each release of pulsing relay 220, condenser 276 discharges and, on the subsequent reoperation of relay 220 again reduces the register condenser charge and consequently lowers the potential on the grid of tube 219. When the operations of pulsing relay 220 have connected condenser 276 to the register condenser a sufficient number of times, the charge on the particular register condenser and the potential on the grid of tube 219 are reduced below the breakdown potential of the tube. Upon the next release of pulsing relay 220, the closure of positive potential to the anode of the tube causes tube 219 to flash and become conducting. Relay 240 now operates in the anode-cathode circuit of the tube and stops further pulsing in the manner previously described. It will be noted that in this second embodiment of the invention, because of the substitution of strap 285 for strap 277, each register condenser is charged to a potential equal in increments to the number of the particular digit being registered. For example, in the registration of the digit 8, the register condenser is charged to a value equivalent to eight increments of potential. A corresponding series of eight impulses is therefore transmitted to the automatic exchange for this digit, since eight operations of the pulsing relay

200 are required to lower the charge on the register condenser, by eight decrements, to a value below the breakdown potential of tube 219. With the above exceptions, the circuits function in an identical manner for the second embodiment of the invention as they do for the first embodiment.

What is claimed is:

1. In combination, two condensers, means for placing a variable initial charge on the first of said condensers, a circuit for the second condenser, and means for altering the charge on the first condenser by connecting said second condenser alternately in parallel with said first condenser and into said circuit.

2. In combination, two condensers, means for placing a variable initial charge on the first of said condensers, and means for increasing said charge in steps by alternately charging said second condenser and discharging it into said first condenser.

3. In combination, two condensers, means for placing a variable initial charge on the first of said condensers, and means for decreasing said charge in steps by alternately charging said second condenser from said first condenser and discharging said second condenser.

4. In combination, two condensers, means including a keyset for placing an initial charge on the first of said condensers, the amount of said charge being determined by the digital value of the operated key of said keyset, a circuit for the second condenser, and means for altering the charge on the first condenser by connecting said second condenser alternately in parallel with said first condenser and into said circuit.

5. In combination, two condensers, means including a keyset for placing an initial charge on the first of said condensers, the amount of said charge being determined by the digital value of the operated key of said keyset, and means for increasing said charge in steps by alternately charging said second condenser and discharging it into said first condenser.

6. In combination, two condensers, means including a keyset for placing an initial charge on the first of said condensers, the amount of said charge being determined by the digital value of the operated key of said keyset, and means for decreasing said charge in steps by alternately charging said second condenser from said first condenser and discharging said second condenser.

7. In combination, a gaseous conductor device having a definite breakdown potential, a first condenser in a path across the terminals of said device, means for placing a variable initial charge on said condenser, a second condenser, a circuit for the second condenser, and means for altering the charge on said first condenser by connecting said second condenser alternately in parallel with said first condenser and into said circuit, said device becoming conducting when the charge on said first condenser reaches a predetermined amount.

8. In combination, a gaseous conductor device having a definite breakdown potential, a first condenser in a path across the terminals of said device, means for placing a variable initial charge on said condenser, a second condenser, and means for charging said second condenser and for discharging it periodically into said first condenser, said first condenser discharging through said device when it has acquired the breakdown potential thereof.

9. In combination, a gaseous conductor device having a definite breakdown potential, a first condenser in a path across the terminals of said device, means for placing a variable initial charge on said condenser, a second condenser, and means for charging said second condenser from said first condenser and for discharging it periodically, said device becoming conducting when the charge on said first condenser has been reduced to a predetermined amount.

10. In combination, a gaseous conductor device having a definite breakdown potential, a first condenser in a path across the terminals of said device, a source of current, means for placing a variable initial charge on said condenser from said source of current, a second condenser, contacts operable periodically, and circuit means controllable by said contacts to repeatedly charge said second condenser from said source of current and to discharge it into said first condenser, said first condenser discharging through said device when it has accumulated a potential equal to the breakdown potential of said device.

11. In combination, a gaseous conductor device having a definite breakdown potential, a first condenser in a path across the terminals of said device, a source of current, means for placing a variable initial charge on said condenser from said source of current, a second condenser, contacts operable periodically, and circuit means controllable by said contacts to repeatedly charge said second condenser from said first condenser and to discharge said second condenser, said device becoming conducting when the charge on said first condenser has been reduced to a predetermined amount.

12. In combination, a gaseous conductive device having a definite breakdown potential, a first condenser in a path across the terminals of said device, a source of current, means for placing a variable initial charge on said condenser from said source of current, a second condenser, a pulsing relay, means for periodically operating said pulsing relay to repeatedly charge said second condenser from said source of current and to discharge it into said first condenser, said first condenser discharging through said device when it has accumulated a potential equal to the breakdown potential of said device, and a second relay thereupon operable through said device for stopping the periodical operation of said first relay.

13. In combination, a gaseous conductive device having a definite breakdown potential, a first condenser in a path across the terminals of said device, a source of current, means including a keyset for placing an initial charge on said condenser from said source of current, the amount of said charge being determined by the digital value of the operated key of said keyset, a second condenser, a pulsing relay, means for periodically operating said relay to repeatedly charge said second condenser from said source of current and to discharge it into said first condenser, said first condenser discharging through said device when it has accumulated a potential equal to the breakdown potential of said device, and a second relay thereupon operable through said device for stopping the periodical operation of said first relay.

14. In combination, a gaseous conductive device having a definite breakdown potential, a group of condensers, a source of current, means for placing a variable initial charge on each of said condensers from said source of current, means for connecting the first of said group of condensers in a path across the terminals of

said device, a second condenser, a pulsing relay, means for periodically operating said relay to repeatedly charge said second condenser from said source of current and to discharge it into the first of said group of condensers until said first condenser has accumulated a potential equal to the breakdown potential of said device, a second relay thereupon operable through said device, and means controlled by said second relay for arresting the periodical operation of said first relay for a definite interval, for restoring said device to normal condition and for associating the next in order of said group of condensers in said path across the terminals of said device, the circuit functioning in this manner until all of said group of condensers are fully discharged.

15. In combination, a gas-filled tube having anode, cathode and grid elements and which does not flash until a definite potential exists between the cathode and grid elements, a group of condensers, a source of current, means for placing a variable initial charge on each of said condensers from said source of current, means for successively connecting said condensers in bridge of said cathode and grid elements, a second condenser, a pulsing relay, means for periodically operating said relay to repeatedly charge said second condenser from said source of current and to discharge it into the first of said group of condensers, said first condenser discharging through said tube when it has accumulated a potential equal to the flashing potential of said tube, a second relay connected to the anode element of said tube and operable when said tube flashes, and means controlled by said second relay for arresting the periodical operation of said first relay for a definite interval, for restoring said tube to normal condition and for causing the bridging of the next in order of said group of condensers between the cathode and grid elements of said tube, said circuit functioning in this manner until all of said group of condensers are fully discharged.

16. In a sender for controlling the setting of selector switches, a keyset, a group of condensers serving as digit registers, a source of current, means responsive to successive operations of keys of said keyset for placing charges on said condensers from said source of current in accordance with the digital values of the depressed keys, means for transmitting series of impulses for setting selector switches, means for counting the number of impulses in each series transmitted, and means for successively controlling said counting means in accordance with the charged condition of said condensers.

17. In a sender for controlling the setting of selector switches, a keyset, a group of condensers serving as digit registers, a steering switch for successively associating said condensers with said keyset, a source of current, circuit means controlled by said keyset for placing a charge on each condenser from said source of current when the condenser is associated with the keyset in accordance with the digital values of the depressed keys, means for transmitting series of impulses for setting selector switches, means for counting the number of impulses in each series transmitted, a second steering switch for successively associating said counting means with said condensers, and means for controlling said counting means in accordance with the charged condition of the condenser which is at the time associated therewith.

18. In a sender for controlling the setting of selector switches, a keyset, a group of condensers serving as digit registers, a source of current, means responsive to successive operations of keys of said keyset for placing initial charges on said condensers from said source of current in accordance with the digital values of the depressed keys, a pulsing relay, an impulse counting means comprising a gaseous conductive device having a definite breakdown potential and a secondary condenser, means for connecting the first of said group of condensers in a path across the terminals of said conductive device, means for periodically operating said pulsing relay to transmit a series of impulses for setting a selector switch and to repeatedly charge said secondary condenser from said source of current and to discharge it into the first of said group of condensers, said first condenser discharging through said device when it has accumulated a potential equal to the breakdown potential of said device, a second relay thereupon operable through said device, and means controlled by said second relay for arresting the periodical operation of said pulsing relay for a definite interval, for restoring said device to normal condition and for causing the connection of the next in order of said group of condensers across the terminals of said device, said impulse counting means functioning in this manner until all of said group of condensers are fully discharged and said pulsing relay has transmitted a series of selector switch setting impulses in accordance with the initial charged condition of each of said group of condensers.

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