June 2, 1936. R. L. STOKELY 2,042,562

TELEPHONE SYSTEM

Filed April 11, 1935 3 Sheets-Sheet 1

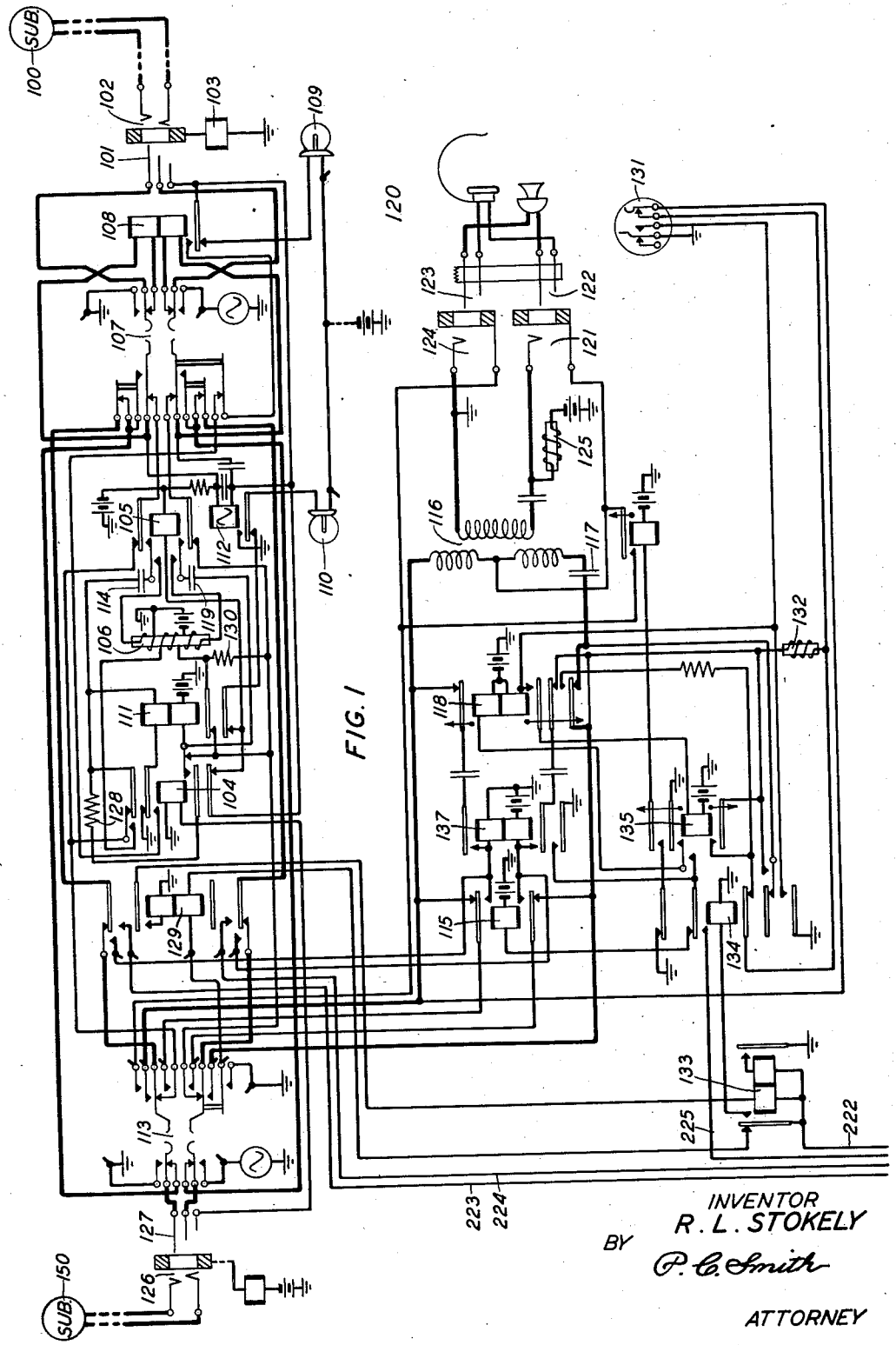

FIG. 1

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TELEPHONE SYSTEM

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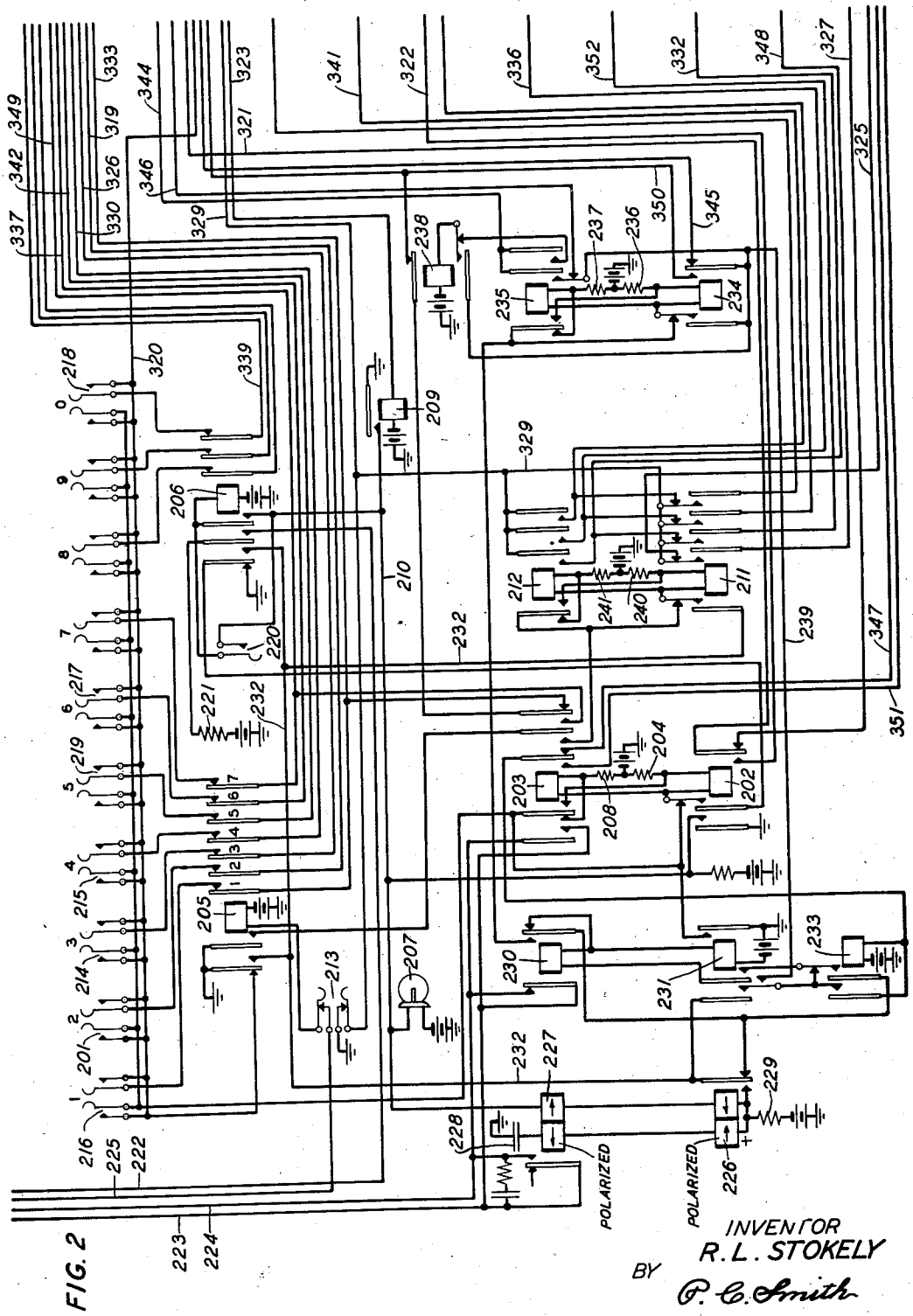

FIG. 2

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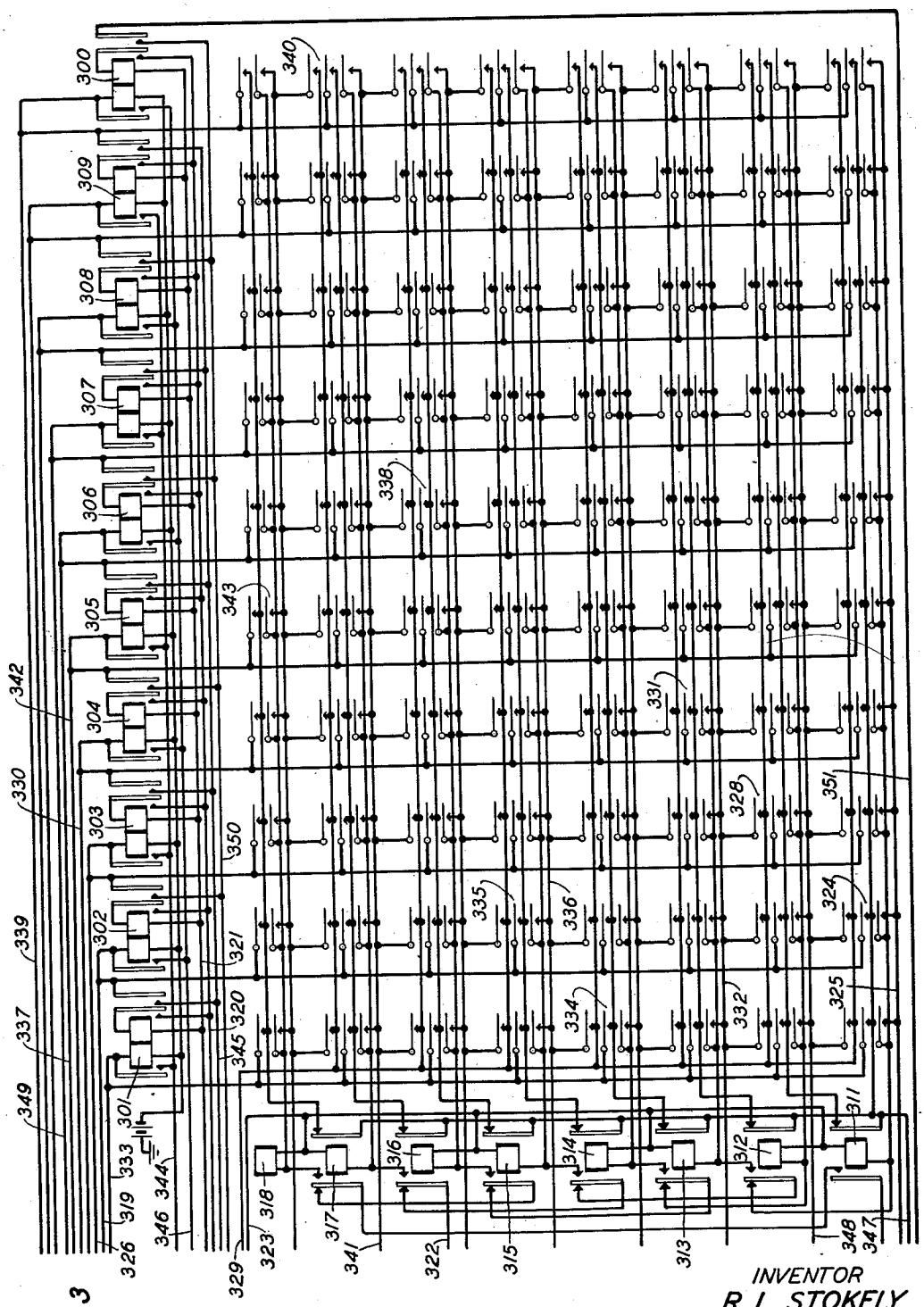

FIG. 3

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Patented June 2, 1936

2,042,562

UNITED STATES PATENT OFFICE

2,042,562

TELEPHONE SYSTEM

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Application April 11, 1935, Serial No. 15,788

18 Claims. (Cl. 179—90)

This invention relates to telephone systems and more particularly to a system in which connections are established by automatic switches under the control of a sender at an operator's position.

The invention relates more specifically to an improved type of impulse sender for enabling an operator at a private branch exchange switchboard or an operator at an "A" or toll switchboard to control the setting of selector switches to complete telephone connections with a minimum expenditure of time thus permitting the operator to perform her duties more efficiently and freeing her for the performance of other tasks.

Heretofore in private branch exchange systems associated with dial telephone exchange systems, a dial impulse sender has been provided at the private branch exchange operator's position to permit the operator to transmit impulses over trunks outgoing to offices of the dial telephone exchange, corresponding to the designations of wanted lines communicated to her by private branch exchange subscribers. Due to the nature of its structure the usual dial impulse sender is a comparatively slow means for sending impulses and consequently if the traffic from the private branch exchange to be trunked outside the exchange is at all heavy the operator has no time to perform other duties which may be alloted to her.

It has hitherto been proposed to provide the operator with a single set of digit keys by which the digits of a wanted line designation may be quickly and successively set up and concurrently recorded in a unitary registering device of the so-called cross-bar type. Thereafter, upon the operation of a start key by the operator, series of impulses, corresponding to the wanted line designation so recorded, are transmitted over the trunk with which the operator has previously made an outgoing connection for setting selector switches to complete the desired connection. Such a proposed system is disclosed in Patent No. 1,559,251 granted to R. W. Harper on October 27, 1925.

It is the object of this invention to provide in a system of the foregoing type an impulse sending device of improved, more simplified and more economical character.

In accordance with the present invention the impulse sending device comprises a single set of ten-digit keys, a digit registering device of the cross-bar type having a capacity for registering the office code digits, the numerical digits and the station's letter of the designation of any desired subscriber's line, impulsing means for transmitting impulses and means for causing the impulsing means to successively transmit impulses in accordance with the digits registered.

The cross-bar register may, for example, be of the type disclosed in the application of J. N. Reynolds, Serial No. 702,453, filed December 15, 1933 and comprises five vertical bars and a plurality of horizontal bars. Two selecting magnets are provided for rotating each vertical bar either to the left or to the right there thus being ten selecting magnets. An individual holding magnet is provided for rotating each horizontal bar. On each side of each vertical bar is a vertical row of sets of contact springs, there being as many sets of springs in each row as there are horizontal bars. There are thus a plurality of sets of springs coordinately arranged in ten vertical rows corresponding to the ten selecting magnets and in as many horizontal rows as there are holding magnets. Any contact set may be operated by the operation of one of the selecting magnets to rotate a vertical bar toward the vertical row in which a particular contact set is located followed by the operation of a holding magnet to rotate a horizontal bar corresponding to the horizontal row in which the contact set is located. Each horizontal row of ten sets of contact springs serves as a register for registering one of the digits of any subscriber's line designation, the lower row for registering the A office code digit, the next to the lower row for registering the B office code digit, the next row for registering the C office code digit, and the next rows for registering the thousands, hundreds, tens, units and station digits. Although the register has been illustrated as having a capacity for registering eight digits, it is possible due to the inherent structure of the cross-bar switch to register a maximum of ten digits by the addition of two more horizontal rows of contact sets and corresponding horizontal bars and holding magnets.

To register the several digits of a subscriber's line designation, keys of the key-set corresponding to the numerical values of the digits are successively operated, each operation of a key causing the operation of that one of the selecting magnets which has the same numerical value. A pair of relays is provided which operate in succession in response to the operation and release of any key for each odd digit series, and release in succession in response to the operation and release of any key for each even digit series and cause through their operation and release the

operation of successive holding magnets. Thus, in response to the keying of the first digit, one of the ten selecting magnets is operated followed by the operation and locking of the first or lowermost holding magnet and then followed by the release of the operated selecting magnet. During the time that the selecting and holding magnets are both operated, one of the ten contact sets of the lowermost horizontal row corresponding to the numerical value of the first digit keyed is operated and held operated by the first holding magnet after the selecting magnet releases. In response to the keying of the second digit one of the ten selecting magnets is again operated followed by the operation and locking of the second holding magnet and the release of the operated selecting magnet and a contact set of the second horizontal row corresponding to the numerical value of the second digit is operated and held operated by the second holding magnet after the selecting magnet releases. In a similar manner the several digits are registered.

When all digits have been thus registered a start key is operated which prepares an out-pulsing circuit over the operator's cord circuit and starts the operation of two impulse relays, one of which transmits impulses over the out-pulsing circuit and the other of which cooperates with a second pair of relays and the selecting magnets to count the number of impulses transmitted in any digit series or to count a delay interval of the proper duration to space successive impulse series. When a series of impulses has been transmitted corresponding to any digit registered on any horizontal row of contact sets and a corresponding number of the selecting magnets has been operated, a circuit is effective over the operated contact set of that row of contact sets to operate a stop relay to stop the transmission of further impulses over the out-pulsing circuit.

The first pair of relays previously mentioned also cooperates with the impulse relays, operating successively in response to the beginning and termination of the transmission of each impulse series transmitted by the impulse relays and releasing successively in response to the beginning and termination of the measurement of each delay interval. These relays function to alternately render the selecting magnets operable to count series of impulses transmitted by the impulse relays in accordance with the registration of the several digits previously keyed and to render certain of the selecting magnets operable to count off a spacing interval between the transmission of successive digit series to permit selector switches to perform their trunk hunting functions.

A third pair of relays is also provided which operate in succession and then release in succession under the control of the first-mentioned pair of relays to cause the successive release of the holding magnets following the termination of the transmission of successive impulse series whereby the several horizontal rows of contact sets which serve as digit registers are successively associated with the stop relay and selecting magnets to determine the number of impulses to be transmitted in successive impulse series.

A clear understanding of the invention may be had by reference to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 shows schematically two subscribers' lines between which a connection may be made, one cord circuit of a private branch exchange operator's position and the operator's position circuits which may be associated with any cord circuit of the position; and

Figs. 2 and 3 taken together show a key-set sender by means of which the operator may control the setting of selector switches to extend a connection to the line of any desired subscriber.

Fig. 2 shows a key-set and relay equipment of the sender, and Fig. 3 shows a cross-bar register upon which the digits of a wanted line number may be registered.

To completely disclose the invention Fig. 1 should be placed above Fig. 2 and Fig. 3 should be placed to the right of Fig. 2 with the conductors extending to the margins of the figures in alignment.

Although for the purpose of simplifying the disclosure no selector switches have been disclosed it is to be understood that sufficient switching stages including selector switches and a connector switch would be inserted between the trunk jack **126** and the called line **150** of Fig. 1 to enable the operator to establish a connection in the well-known manner with the called line. The switches may be of the well-known step-by-step type.

The key-set designated **200** in Fig. 2 comprises a group of ten keys of the non-locking type. As previously stated the register of Fig. 3 is of the so-called cross-bar type structurally similar to the cross-bar switch disclosed in the application of J. N. Reynolds hereinbefore referred to.

In order that the invention may more clearly be understood the operation of the apparatus in the establishment of a typical connection between subscriber's line **100** and subscriber's line **150** will now be described. When the subscriber whose line **100** terminates in the private branch exchange switchboard initiates a call the usual line lamp, not shown, is lighted as a signal to the operator that a connection is desired. In response to the signal the operator inserts the answering plug **101** into the jack **102** of the calling line thereby extinguishing the line lamp and establishing a circuit from ground through the winding of the line cut-off relay **103**, sleeves of jack **102** and plug **101**, lower back contact of relay **104** to battery through the winding of cord sleeve relay **105**. Relay **105** operates and establishes a talking battery supply circuit to the calling line which may be traced from battery, lower winding of retardation coil **106**, lower front contacts of relay **105**, inner lower left normal contacts of key **107**, lower winding of the answering supervisory relay **108**, lower right normal contacts of key **107**, rings of plug **101** and jack **102**, over the calling line loop, tips of jack **102** and plug **101**, upper right normal contacts of key **107**, upper winding of relay **108**, inner upper left normal contacts of key **107**, upper front contacts of relay **105**, to ground through the upper winding of retardation coil **106**. Relay **108** operates over this circuit and opens the circuit of answering supervisory lamp **109**, which otherwise would be lighted in a circuit completed over the sleeve of plug **109**. The insertion of plug **101** into jack **103** also causes the illumination of the calling supervisory lamp **110** over a circuit from ground through cut-off relay **103**, sleeves of jack **102** and plug **101**, lower back contact of relay **104**, lower back contacts of calling supervisory relay **111**, back contacts of relay **112**, lamp **110** to battery.

The operator then throws key **113** to the right or talking and dialing position and a talking circuit is established from the calling line over the tips of jack **102** and plug **101**, thence as traced to the upper front contacts of relay **105**, condenser

114, upper back contact of relay 104, inner upper right alternate contacts of key 113, upper back contact of relay 115, left windings of repeating coil 116, condenser 117, lower back contact of relay 118, lower back contact of relay 115, inner lower right alternate contacts of key 113, inner lower normal contacts of relay 104, condenser 119, lower front contacts of relay 105, thence as traced to the calling line over the rings of plug 101 and jack 102. With the operator's head-set 120 plugged up, this talking circuit is inductively connected to the operator's head-set receiver from the mid-point between the left windings of repeating coil 116, over the sleeves of jack 121 and plug 122, through the receiver, sleeves of plug 123 and jack 124, upper right contacts of key 113, to the upper left winding of repeating coil 116, and the operator's head-set transmitter is connected inductively thereto through the right winding of repeating coil 116 and the tips of jacks 124, 121 and plugs 122, 123. The operator's transmitter is supplied with talking current from the retardation coil 125. The operator is now enabled to converse with the calling subscriber to ascertain from him the number of the line to which he desires a connection.

It will be assumed that the line 150 with which the calling subscriber desires a connection may be reached over the trunk which terminates at the operator's switchboard in jack 126. The operator now inserts plug 127 of the cord circuit into jack 126 whereupon a circuit is established from battery over the sleeves of jack 126 and plug 127 to ground through the winding of cord sleeve relay 104. Relay 104 upon operating opens the circuit of calling supervisory lamp 110 and the circuit of relay 105 at its lower back contact so that lamp 110 is extinguished and relay 105 is released. Relay 105 upon releasing removes battery and ground supplied through the lower and upper windings of retardation coil 106 through the windings of relay 108 to the calling line and opens the talking circuit from the calling line to the operator's head-set previously traced through condensers 114 and 119. Relay 104 also disconnects battery and ground normally supplied respectively toward the tip and ring contacts of calling plug 127 through the windings of relay 111 and establishes a circuit from battery through the lower winding of relay 111, lower front contact of relay 104, resistance 128, upper winding of relay 111, inner upper front contact of relay 104, lower left normal contacts of key 107, front contact of relay 108, sleeves of plug 101 and jack 102 to ground. Relay 111 operates opening the circuit of lamp 110 at a second point and removing a shunt from resistance 130. A bridge is now prepared across the cord circuit which is effective after the talking key 113 is restored to normal extending from the tip of plug 127, upper left normal contacts of key 113, upper left normal contacts of key 107, upper back contacts of relay 129, upper right normal contacts of key 113, upper alternate contacts of relay 104, middle winding of retardation coil 106, resistance 130, lower right normal contacts of key 113, lower back contacts of relay 129, middle lower left normal contacts of key 107, lower left normal contacts of key 113 to the ring of plug 127 for holding purposes to be later described.

Assuming that the trunk terminating in jack 126 is connected to a first selector of the well-known step-by-step type, an operating circuit for the line or control relay thereof is effective over the tips of jack 126 and plug 127, upper left normal contacts of key 113, upper left normal contacts of key 107, upper back contacts of relay 129, next to upper right alternate contacts of key 113, pulsing contacts of dial 131, retardation coil 132, middle lower right alternate contacts of key 113, lower back contacts of relay 129, middle lower left normal contacts of key 107, lower left normal contacts of key 113, rings of plug 127 and jack 126. The operator may now proceed to operate the dial 131 to control selector switches to establish the desired connection.

It will, however, be assumed that instead of using her position dial the operator elects to control the establishment of the connection by her position key-set 200 and keys up the digits of the wanted line designation by successively depressing keys of the key-set in accordance with the digital values of the called line number given to her by the calling subscriber. Assuming that the number of the desired line is BElmont 4-1260-J the operator first depresses the No. 2 key 201 for the first office code letter B which has the numerical equivalent of 2. A circuit is now established for relay 202 extending from battery through resistance 204, winding and left normal contacts of relay 202, left contacts of key 201 to ground at the left back contact of relay 205. Relay 202 operates and locks over a circuit from battery through resistance 204, winding and inner left alternate contacts of relay 202 to ground at the left back contact of relay 206, and at its outer left front contact closes an obvious circuit for off-normal lamp 207. At its inner left front contact relay 202 also closes a circuit from battery, resistance 208, winding of relay 203, inner left front contact of relay 202 to ground at the left back contact of relay 206 but the winding of relay 203 being shunted over its left back contact and the left contacts of key 201 to ground at the left back contacts of relay 205 so long as key 201 remains depressed, relay 203 does not operate.

Key 201 also closes a circuit from ground at the left back contact of relay 205, over the right contacts of the key, the No. 2 right back contacts of relay 205, conductor 319, left winding of selecting magnet 302 to battery. Magnet 302 operates and locks in a circuit from ground at the left back contacts of relay 205, conductor 320, inner right front contact and right winding of magnet 302, conductor 321, right front contact of relay 202, conductor 322, left back contacts of holding magnets 316, 314 and 312, winding of holding magnet 311, conductor 323 to battery through the winding of off-normal relay 209. Relay 209 and holding magnet 311 operate in this circuit, relay 209 connecting off-normal ground to conductor 210 thereby keeping off-normal lamp 207 illuminated. The operation of selecting magnet 302 rotates the vertical bar (not shown), which is controllable either by magnet 301 or magnet 302 to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet 302. When the first holding magnet 311 subsequently operates, as previously described, it rotates the lowermost horizontal bar (not shown). With the two bars rotated contact set 324 is operated.

A holding circuit for magnet 311 is now established from battery on conductor 323, the winding of magnet 311, the lower contacts of contact set 324 to locking ground supplied to conductor 325 over the inner right normal contacts of relay 211, conductor 329 and the lower normal contacts of wipe-out key 213. The closure of contact set 324 also establishes a shunt around the right

winding of selecting magnet **302** extending from ground on conductor **325**, lower contacts of contact set **324**, left back contacts of magnets **312**, **314** and **316** thence as traced through the right winding of magnet **302** to ground on conductor **320**. Therefore, when the key **201** is released and the circuit through the left operating winding of magnet **302** is opened, magnet **302** releases restoring the vertical bar to its normal position. By thus operating the holding magnet through the locking winding of the selecting magnet the selecting magnet is held operated until the holding magnet is operated and locked, and the depressed key has been released. Consequently, it is only necessary for the key to be depressed long enough to operate the selecting magnet. The operated contact set **324** is maintained operated through the continued energization of holding magnet **311**.

When the key **201** is released the previously traced shunt around the winding of relay **203** is opened and relay **203** operates. The operator then depresses key **214** to register the second code letter E of the desired line designation, the code letter E having the numerical equivalent of the digit 3. At its left contacts key **214** closes a shunt around the winding of relay **202** which extends from ground on conductor **320**, left contacts of key **214**, inner left front contacts of relay **203**, winding and inner left alternate contacts of relay **202** to ground at the left back contact of relay **206**. Relay **202** thereupon releases. Following the release of relay **202**, relay **203** is held operated in a holding circuit extending from battery through resistance **208**, winding of relay **203**, left normal contacts of relay **202**, left contacts of key **214** to ground on conductor **320**.

At its right contacts key **214** establishes a circuit for selecting magnet **303** extending from ground on conductor **320**, right contacts of key **214**, No. 3 right back contacts of relay **205**, conductor **326**, left winding of magnet **303** to battery. Magnet **303** operates and locks in a circuit from ground on conductor **320**, inner right front contact and right winding of magnet **303**, conductor **321**, right back contact of relay **202**, conductor **327**, left front contact of holding magnet **311**, left back contacts of holding magnets **317**, **315** and **313**, winding of holding magnet **312** thence to battery on conductor **323**. The operation of selecting magnet **303** rotates the vertical bar (not shown) which is controllable either by magnet **303** or magnet **304** to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet **303**. When the second holding magnet **312** subsequently operates as previously described it rotates the second horizontal bar (not shown). With the two bars rotated contact set **328** is operated.

A holding circuit for magnet **312** is now established from battery on conductor **323**, through the winding of magnet **312**, the lower contacts of contact set **328**, upper contacts of contact set **324**, conductor **329** to ground at the lower contacts of wipe-out key **213**. The closure of contact set **328** also establishes a shunt around the right winding of selecting magnet **303**, extending from ground on conductor **329**, over the upper contacts of contact set **324**, the lower contacts of contact set **328**, left back contacts of magnets **313**, **315** and **317**, thence as traced through the right winding of magnet **302** to ground on conductor **320**. Therefore, when key **214** is released and the circuit through the left winding of magnet **303** is opened, magnet **303** releases restoring the vertical bar to its normal position. The operated contact set **328** is maintained operated through the continued energization of holding magnet **312**.

When the key **214** is released the holding circuit of relay **203** is opened and relay **203** releases. The operator then depresses key **215** to register the office code digit 4. With relay **203** released the operation of key **215** causes the reoperation of relay **202** which locks and prepares the operating circuit of relay **203** in the manner previously described. At its right contacts key **215** establishes an operating circuit for selecting magnet **304** extending from ground on conductor **320**, right contacts of key **215**, No. 4 right back contacts of relay **205**, conductor **330**, left winding of magnet **304** to battery. Magnet **304** operates and locks in a circuit from ground on conductor **320**, inner right front contact and right winding of magnet **304**, conductor **321**, right front contact of relay **202**, conductor **322**, left back contacts of holding magnets **316** and **314**, left front contact of holding magnet **312**, winding of holding magnet **313** to battery on conductor **323**. The operation of selecting magnet **304** rotates the vertical bar (not shown) which is controllable either by magnet **303** or magnet **304** to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet **304**. When the third holding magnet **313** subsequently operates as previously described, it rotates the third horizontal bar (not shown). With the two bars rotated contact set **331** is operated.

A holding circuit for magnet **313** is now established from battery on conductor **323** through the winding of magnet **313**, the lower contacts of contact set **331**, and thence to ground on conductor **329**, either over conductor **332** and a right back contact of relay **211**, or over the upper contacts of contact set **328**. The connection of locking ground to the winding of magnet **313** also shunts the right winding of selecting magnet **304** and therefore when key **215** is released thereby opening the circuit through the left winding of magnet **304**, magnet **304** releases restoring the operated vertical bar to its normal position. The contact set **331** is maintained operated through the continued energization of holding magnet **313**.

When key **215** is released relay **203** operates and locks as previously described. The operator then depresses key **216** to register the thousands digit 1. With relay **203** operated a shunt is closed over the left contacts of key **216** around the winding of relay **203** and relay **202** releases. At its right contacts key **216** establishes a circuit for selecting magnet **301** extending from ground on conductor **320**, right contacts of key **216**, No. 1 back contacts of relay **205**, conductor **333**, left winding of magnet **301** to battery. Magnet **301** operates and locks in a circuit from ground on conductor **320**, inner right front contact and right winding of magnet **301**, conductor **321**, right back contact of relay **202**, conductor **327**, left front contact of holding magnet **311**, left back contacts of holding magnets **317** and **315**, left front contact of holding magnet **313**, winding of holding magnet **314**, thence to battery on conductor **323**. The operation of selecting magnet **301** rotates the vertical bar (not shown) which is controlled either by magnet **301** or magnet **302** to a position in which it is effective to assist in the clo-

sure of a contact set in the vertical row shown directly beneath magnet 301. When the holding magnet 314 subsequently operates as previously described it rotates the fourth horizontal bar (not shown). With the two bars rotated contact set 334 is operated.

A holding circuit for magnet 314 is now established from battery on conductor 323, winding of magnet 314, the lower contacts of contact set 334, the upper contacts of contact set 331 to ground on conductor 329. The connection of locking ground to the winding of magnet 314 also shunts the right winding of selecting magnet 301 and therefore when key 216 is released thereby opening the circuit through the left winding of magnet 301, magnet 301 releases releasing the operated vertical bar to its normal position. The contact set 334 is maintained operated through the continued energization of holding magnet 314.

When key 316 is released, the holding circuit of relay 203 is opened and relay 203 releases. The operator then depresses key 201 to register the hundreds digit 2. With relay 203 released the operation of key 201 causes the reoperation of relay 202 which locks and prepares the operating circuit of relay 203 in the manner previously described. At its right contacts key 201 establishes an operating circuit from selecting magnet 302 extending from ground on conductor 329, right contacts of key 201, No. 2 right back contacts of relay 205, conductor 319, left winding of magnet 302 to battery. Magnet 302 operates and locks in a circuit from ground on conductor 320, inner right front contact and right winding of magnet 302, conductor 321, right front contact of relay 202, conductor 322, left back contact of holding magnet 316, left front contact of holding magnet 314, winding of holding magnet 315, to battery on conductor 323. The operation of selecting magnet 302 rotates the vertical bar (not shown) which is controllable either by magnet 301 or magnet 302 to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet 302. When the fifth holding magnet 315 subsequently operates as previously described it rotates the fifth horizontal bar (not shown). With the two bars rotated contact set 335 is operated.

A holding circuit for magnet 315 is now established from battery on conductor 323, winding of magnet 315, the lower contacts of contact set 335, the upper contacts of contact set 334 to ground on conductor 329, or over conductor 336 and back contacts of relay 211 to ground on conductor 329. The connection of locking ground to the winding of magnet 315 also shunts the right winding of magnet 302 and therefore when key 201 is released thereby opening the circuit through the left winding of magnet 302, magnet 302 releases releasing the operated vertical bar to its normal position. The contact set 335 is maintained operated through the continued energization of holding magnet 315.

When key 201 is released the shunt around the winding of relay 203 is opened and relay 203 operates and locks as previously described. The operator then depresses key 217 to register the tens digit 6. With relay 203 operated a shunt is closed over the left contacts of key 217 around the winding of relay 202 and relay 202 releases. At its right contacts key 217 establishes a circuit for selecting magnet 306 extending from ground on conductor 320, right contacts of key 217, No. 6 right back contacts of relay 205, conductor 337, left winding of magnet 306 to battery. Magnet 306 operates and locks in a circuit from ground on conductor 320, inner right front contact and right winding of magnet 306, conductor 321, right back contact of relay 202, conductor 327, left front contact of holding magnet 311, left back contact of holding magnet 317, left front contact of holding magnet 315, winding of holding magnet 316 to battery on conductor 323. The operation of selecting magnet 306 rotates the vertical bar (not shown) which is controllable either by magnet 305 or magnet 306 to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet 306. When the sixth holding magnet 316 subsequently operates as previously described, it rotates the sixth horizontal bar (not shown). With the two bars rotated contact set 338 is operated.

A holding circuit for magnet 316 is now established from battery on conductor 323, winding of magnet 316, the lower contacts of contact set 338, the upper contacts of contact set 335 to ground on conductor 329. The connection of locking ground to the winding of magnet 316 also shunts the right winding of magnet 306 and therefore when key 217 is released thereby opening the circuit through the left winding of magnet 306, magnet 306 releases releasing the operated vertical bar to its normal position. The contact set 338 is maintained operated through the continued energization of holding magnet 316.

When key 217 is released the holding circuit of relay 203 is opened and relay 203 releases. The operator then depresses key 218 to register the units digit 0. With relay 203 released, the operation of key 218 causes the reoperation of relay 202 which locks and prepares the operating circuit of relay 203 in the manner previously described. At its right contacts key 218 establishes an operating circuit for selecting magnet 300 extending from ground on conductor 320, right contacts of key 218, outer right back contact of relay 206, conductor 339, left winding of magnet 300 to battery. Magnet 300 operates and locks in a circuit from ground on conductor 320, inner right front contact and right winding of magnet 300, conductor 321, right front contact of relay 202, conductor 322, left front contact of holding magnet 316, winding of holding magnet 317 to battery on conductor 323. The operation of selecting magnet 300 rotates the vertical bar (not shown) which is controllable either by magnet 308 or magnet 309 to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet 300. When the seventh holding magnet 317 subsequently operates as previously described, it rotates the seventh horizontal bar (not shown). With the two bars thus rotated contact set 340 is operated.

A holding circuit for magnet 317 is now established from battery on conductor 323, winding of magnet 317, the lower contacts of contact set 340, the upper contacts of contact set 338 to ground on conductor 329, or over conductor 341, the outer right normal contacts of relay 311 to ground on conductor 329. The connection of locking ground to the winding of magnet 317 also shunts the right winding of magnet 300 and therefore when key 218 is released thereby opening the circuit through the left winding of mag-

net 300, magnet 300 releases releasing the operated vertical bar to its normal position. The contact set 340 is maintained operated through the continued energization of holding magnet 317.

When key 218 is released the shunt around the winding of relay 203 is opened and relay 203 operates and locks as previously described. The operator then depresses key 219 to register the station's letter J which has the numerical equivalent of the digit 5. With relay 203 operated a shunt is closed over the left contacts of key 219 around the winding of relay 202 and relay 202 releases. At its right contacts key 219 establishes a circuit for selecting magnet 305 extending from ground on conductor 320, right contacts of key 219, No. 5 right back contacts of relay 205, conductor 342, left winding of magnet 305 to battery. Magnet 305 operates and locks in a circuit from ground on conductor 320, inner right front contact and right winding of magnet 305, conductor 321, right back contact of relay 202, conductor 327, left front contacts of holding magnets 311 and 317, winding of holding magnet 318 to battery on conductor 323. The operation of selecting magnet 305 rotates the vertical bar (not shown) which is controllable either by magnet 305 or magnet 306 to a position in which it is effective to assist in the closure of a contact set in the vertical row shown directly beneath magnet 305. When the eighth holding magnet 318 subsequently operates as previously described it rotates the eighth horizontal bar (not shown). With the two bars rotated contact set 343 is operated.

A holding circuit for magnet 318 is now established from battery on conductor 323, winding of magnet 318, lower contacts of contact set 343, upper contacts of contact set 340, to ground on conductor 329. The connection of locking ground to the winding of magnet 318 also shunts the right winding of magnet 305 and therefore when key 319 is released thereby opening the circuit through the left winding of magnet 305, magnet 305 releases releasing the operated vertical bar to its normal position. The contact set 343 is maintained operated through the continued energization of holding magnet 318.

It will thus be observed that relays 202 and 203 are operated in succession at the beginning and termination of the keying of each odd digit of the call designation and are released in succession at the beginning and termination of the keying of each even digit and control the successive operation of the holding magnets 311 to 318, inclusive, to successively cause the operation of contact sets of the cross-bar register to register the successively keyed digits. Should it be desired to extend the register for registering two additional digits it would only be necessary to add two holding magnets, associated horizontal bars and two additional horizontal rows of contact sets.

After keying all of the digits of the desired line number the operator depresses the start key 220 thereby establishing an operating circuit for start relay 206 which may be traced from ground on conductor 210 through the contacts of key 220 and winding of relay 206 to battery. Relay 206 upon operating locks over its inner left front contact to ground on conductor 210 independently of the start key 220, opens at its outer left back contact the locking circuit of relays 202 and 203 to restore these relays if they are operated at the time, at its right back contacts opens the operating circuits to selecting magnets 308, 309 and 300 to prevent their false operation should the Nos. 8, 9 or 0 keys be accidentally depressed, and establishes a circuit extending from battery through resistance 221 over its middle left front contact, conductor 222, left back contact of relay 133, lower winding of relay 129 to ground at the lower right alternate contacts of key 113.

Relay 129 operates locking in a circuit from ground through its upper winding and inner upper front contact, left winding of relay 133 to battery on conductor 222. Relay 133 operates in this locking circuit establishing a locking circuit for itself from ground over its right contact and right winding to battery on conductor 222, opening the initial operating circuit of relay 129 at its left back contact and establishing an operating circuit for relay 134 extending from battery on conductor 222 over its left front contact to ground through the winding of relay 134. Relay 129 upon operating splits the cord circuit, connecting the tip out-pulsing conductor 223 extending from the sender, over its middle upper front contact, the upper left normal contacts of key 107, the upper left normal contacts of key 113 over the tips of plug 127 and jack 126 to the tip of the outgoing trunk and connecting the ring out-pulsing conductor 224 over its inner lower front contacts, the middle lower left lower normal contacts of key 107, the lower left normal contacts of key 113 over the rings of plug 127 and jack 126 to the ring of the outgoing trunk. Relay 129 also establishes a circuit from ground through the upper winding of relay 137, upper front contact of relay 129, upper right alternate contacts of key 113, upper back contact of relay 115, inner upper right alternate contacts of key 113, upper back contact of relay 105, inner upper left normal contacts of key 107, upper winding of relay 108, upper right normal contacts of key 107, tips of plug 101 and jack 102 over the calling line loop, back over the rings of jack 102 and plug 101, lower right normal contacts of key 107, lower winding of relay 108, inner lower left normal contacts of key 107, lower back contact of relay 105, inner lower right alternate contacts of key 113, lower back contact of relay 115, middle lower right alternate contacts of key 113, lower front contacts of relay 129 to battery through the lower winding of relay 137. Relay 137 operates in this circuit.

Relay 134 upon operating closes over its lower front contact an obvious circuit through the lower winding of relay 118. Relay 118 operates, over its inner lower front contact extends its operating ground through the winding of relay 135, at its upper back and inner lower back contacts opens a future talking path between the calling and answering plugs of the cord circuit and at its lower back contact opens the talking circuit to the left windings of repeating coil 116. Since, however, relay 134 is operated the talking circuit to the repeating coil 116 is maintained at the middle lower alternate contacts of relay 134. Relay 135 upon operating closes a holding circuit from ground over its middle upper front contacts through the upper winding of relay 118 and connects ground over the upper front contact of relay 134, conductor 225, upper normal contacts of wipe-out key 213 through the winding of start relay 205 to battery.

Start relay 205 upon operating opens at its right back contacts the circuits extending from the Nos. 1 to 7 keys of the key-set to the operat-

ing windings of the selecting magnets **301** to **307**, inclusive, to prevent their false operation should any of these keys be accidentally depressed, at its left back contact removes operating ground from the keys of the key-set and at its outer left front contact connects ground over conductor **232** to the armature of the pulsing relay **226**. Pulsing relays **226** and **227** are polarized and differentially wound. At the time ground was applied to off-normal conductor **210** current flowed in a circuit from battery through resistance **229**, through the right windings of these relays to ground on conductor **210**, causing relays **226** and **227** to move their armatures to their front contacts. Relay **228** thus closes the out-pulsing circuit between the conductors **223** and **224**, this circuit being also closed at the time over the left back contacts of relay **230**.

When upon the operation of start relay **205** ground is applied over conductor **232** to the armature of relay **226**, the right windings of relays **226** and **227** become shunted and a discharge path for condenser **228** is established from ground on conductor **232**, front contact of relay **226**, left windings of relays **226** and **227** through condenser **228** to ground. The discharge current of condenser **228** energizes the left windings of relays **226** and **227** and since there is no current flowing through their right windings, relays **226** and **227** are operated to move their armatures against their back contacts. Upon the movement of the armature of relay **226** from its front contact, the shunt around the right windings of relays **226** and **227** is opened and these relays again energize. At the same time a charging circuit is made effective for condenser **228** through the left windings of these relays to battery through resistance **229**. Since the windings of these relays are differentially arranged the charging current flowing through the left windings will cause the left windings to oppose the right windings until the condenser **228** becomes fully charged, which charging time is determined by the values of condenser **228** and resistance **229**. As soon as the condenser **228** becomes fully charged current ceases to flow in the left windings of these relays and the energized right windings are then effective to move the armatures of the relays against their front contacts.

With the armature of relay **226** against its front contact ground on conductor **232** again shunts the right windings of the relays and establishes a discharge circuit for condenser **228** as previously described, the discharge current causing the relays to move their armatures against their back contacts. Relays **226** and **227** thus continue to operate cyclically in this manner so long as relay **205** remains operated to maintain ground on conductor **232**. The repeated operation of relay **227** transmits impulses over the out-pulsing loop previously traced in simulation of dial pulses. Since the first open period of the contacts of relay **227** may not be of the same duration as subsequent open periods, the first open period is made ineffective by the shunt around the contacts of relay **227** over the left back contact of relay **230**.

The first movement of the armature of relay **226** to its back contact, which occurs upon the operation of start relay **205**, closes a circuit from ground on conductor **232** over the back contact of relay **226**, the right back contact of relay **230**, winding of relay **231** to battery. Relay **231** operates and locks through the winding of relay **230**, the inner left front contact of relay **231**, the normal contacts of stop relay **233**, the outer left contact of relay **231** to ground on conductor **232**. The winding of relay **230** being shunted so long as the armature of relay **226** engages its back contact, relay **230** does not operate in this locking circuit. When relay **226** subsequently moves its armature from its back to its front contact, relay **230** operates opening the initial operating circuit of relay **231** and removing the shunt from the contacts of relay **227**. Since, however, at this time the armature of relay **227** is in engagement with its front contact the out-pulsing loop is maintained closed.

Relay **231** upon operating closes an operating circuit for relay **202** extending from ground at its right front contact, left normal contacts and winding of relay **202**, resistance **204** to battery. A circuit is also closed from ground through the left normal contacts of relay **202**, winding of relay **203**, resistance **208** to battery but the winding of relay **203** is shunted over its left back contact to ground at the right contact of relay **231**, and relay **203** does not operate. Relay **202**, however, operates and closes a locking circuit for itself from battery through resistance **204**, winding and left alternate contacts of relay **202**, outer left front contact of relay **206** to ground at the outer left front contact of relay **205**. Upon the subsequent movement of the armature of relay **226** to its back contact, with relay **230** operated, a circuit is established from ground on conductor **232** over the back contact of relay **226**, the right front contact of relay **230**, the left normal contacts and winding of relay **234**, resistance **236** to battery and over the left normal contacts of relay **234**, winding of relay **235**, resistance **237** to battery. Relay **234** operates and locks over its left alternate contacts, conductor **239**, the outer left front contacts of relay **231** to ground on conductor **232**, but the winding of relay **235** being shunted over its left back contact, the right front contact of relay **230** and the back contacts of relay **226** to ground on conductor **232**, relay **235** does not operate at this time. A circuit is now established for selecting magnet **301** extending from ground on conductor **239**, right front contact of relay **234**, upper back contact of relay **238**, outer right back contact of relay **203**, conductor **333**, left winding of selecting magnet **301** to battery, and magnet **301** operates. At the same time, with relay **230** now operated, the movement of the armature of relay **227** to its back contact has opened the out-pulsing circuit to transmit a first impulse. When relay **226** next moves its armature from its back to its front contact the shunt around the winding of relay **235** is opened and relay **235** operates in turn causing the operation of relay **238** in a circuit from ground on conductor **239**, right front contacts of relay **235**, normal contacts and winding of relay **238** to battery. Relay **238** then locks over its lower alternate contacts to ground on conductor **239** and at its upper back contact opens the operating circuit of selecting magnet **301**. Magnet **301** is, however, maintained operated over a circuit extending from battery through its left winding and left contacts, conductor **344**, inner right front contact of relay **235** to ground on conductor **239**. Relay **227** also has reclosed the out-pulsing circuit to terminate the first transmitted impulse.

When relays **226** and **227** next move their armatures to their back contacts relay **227** causes the transmission of a second impulse over the out-pulsing circuit and relay **226** closes a shunt around the winding of relay **234** extending from

ground on conductor 232, back contact of relay 226, right front contact of relay 230, left front contact of relay 235 to a point between resistance 236 and the winding of relay 234. Relay 234 now releases. Relay 235 is now maintained operated in a circuit from battery through resistance 237, winding of relay 235, left normal contacts of relay 234, right front contact of relay 230, back contact of relay 226 to ground on conductor 232. With relay 234 released a circuit is established from ground on conductor 239, right back contact of relay 234, conductor 345, outer right front contact of selecting magnet 301, left winding of selecting magnet 302 to battery. Selecting magnet 302 operates.

When relays 226 and 227 next move their armatures to their front contacts relay 227 recloses the out-pulsing circuit to terminate the second impulse and relay 226 opens the holding circuit of relay 235. Relay 235 releases and at its right transfer contacts opens the previously traced locking circuit for selecting magnet 301 which thereupon releases, and closes a holding circuit for magnet 302 which may be traced from ground on conductor 239, right normal contacts of relay 235, conductor 346, left contacts and left winding of magnet 302 to battery. It will be recalled that contact set 324 was operated to register the first code letter B. Therefore, at the time relay 234 released and caused the operation of magnet 302 a circuit was closed in parallel with the winding of magnet 302 extending over the middle contacts of contact set 324, conductor 347, the inner right back contact of relay 203 to battery through the winding of stop relay 233. Relay 233 upon operating locks over its outer front contact and the outer left contact of relay 231 to ground on conductor 232 and transfers the holding circuit of relays 230 and 231 so that the holding circuit extends from battery serially through the windings of these relays, inner left front contact of relay 231, the inner front contact of stop relay 233, the back contact of relay 226 to ground on conductor 232. Therefore, when relay 226 moved its armature from its back contact as previously described relays 230 and 231 released, relay 230 reclosing the shunt around the contacts of relay 227 to prevent the transmission of further impulses.

The release of relay 231 removes ground from conductor 239 and relay 238 and selecting magnet 302 now both release. The holding circuit of stop relay 233 is opened at the outer left contacts of relay 231 and relay 233 releases. At its right contact relay 231 opens the shunt around the winding of relay 203 and relay 203 operates in a circuit from battery through resistance 208, winding of relay 203, left alternate contacts of relay 202, outer left contacts of relay 206 and 205 to ground. Relay 203 upon operating closes a circuit from ground at the inner left contact of relay 205, middle right front contact of relay 203, left normal contacts and winding of relay 211, resistance 240 to battery and in parallel therewith through the winding of relay 212 and resistance 241 to battery. Relay 211 operates and locks over its left alternate contacts to ground on conductor 232 but relay 212, being shunted over its left back contact and the middle right front contact of relay 203 to ground at the inner left front contact of relay 205, does not operate at this time. With relay 211 operated the locking circuit of the first holding magnet 311 extending from battery on conductor 323 through the winding of magnet 311, lower contacts of contact set 324, conductor 325, the inner right normal contacts of relay 211, conductor 329 to ground at the lower normal contacts of wipe-out key 213, is opened and magnet 311 releases restoring the contact set 324. Relay 211 also establishes a new holding circuit for the second holding magnet 312 extending from battery on conductor 323, winding of magnet 312, lower contacts of operated contact set 328, conductor 348, inner right alternate contacts of relay 211 to ground on conductor 329 which replaces the holding circuit of magnet 312 previously traced from conductor 329 over the upper contacts of contact set 324. Relay 203 also at its outer left contact establishes a further shunt around the contacts of relay 227. The transmission of two impulses for the first code letter B has now been terminated and the circuits prepared for counting off a delay interval to permit the first selector switch, just operated, to hunt for an idle trunk in the selected group.

On the next movement of the armatures of relays 226 and 227 to their back contacts, relay 227 does not transmit an impulse over the out-pulsing circuit due to the operated condition of relay 203 and the released condition of relay 230, but relay 226 causes the operation of relay 231 in the manner previously described. Relay 231 upon operating locks through the winding of relay 230, connects ground to conductor 239 and connects ground over its right front contact and the inner left front contact of relay 203 to a point between the winding of relay 202 and resistance 204 thereby causing the release of relay 202. Relay 203 is now locked in a circuit from battery through resistance 208, winding of relay 203, left normal contacts of relay 202 to ground at the right contacts of relay 231. When relays 226 and 227 again move their armatures to their front contacts relay 230 operates in the locking circuit of relay 231. On the next movement of the armatures of relays 226 and 227 to their back contacts relay 234 operates and locks in the manner previously described and, since relay 203 is at the time operated, a circuit is established from ground on conductor 239, right front contact of relay 234, upper back contact of relay 238, outer right front contact of relay 203, conductor 349, left winding of selecting magnet 307 to battery. When relays 226 and 227 next move their armatures to their front contacts relays 235 and 238 operate and lock in the manner previously described, relay 235 establishing a locking circuit for magnet 307 extending from ground on conductor 239, inner right front contact of relay 235, conductor 344, left front contact and left winding of magnet 307 to battery. On the next movement of the armatures of relays 226 and 227 to their back contacts relay 234 releases as previously described and establishes an operating circuit for magnet 308 extending from ground on conductor 239, back contact of relay 234, conductor 345, outer right front contact of magnet 307, left winding of magnet 308 to battery. On the next movement of the armatures of the relays 226 and 227 to their front contacts, relay 235 releases opening the holding circuit of magnet 307, which also releases, and establishing a holding circuit for magnet 308 extending from ground on conductor 239, inner right normal contacts of relay 235, conductor 346, left front contact and left winding of magnet 308 to battery. As relays 226 and 227 continue in their

cyclic operation relays 234 and 235 are operated and released in succession in the manner previously described. Relay 234 upon operating causes the operation of selecting magnet 309 and relay 235 upon operating causes the locking of magnet 309 and the release of magnet 308. Relay 234 upon releasing causes the operation of selecting magnet 300 and relay 235 upon releasing causes the locking of magnet 300 and the release of magnet 309.

The closure of the back contacts of relays 226 and 227, following the release of relay 235, causes relay 234 to again operate and with magnet 300 operated a circuit is closed from ground on conductor 239, right front contact of relay 234, conductor 350, outer right front contact of magnet 300, conductor 351, inner right front contact of relay 203, winding of stop relay 233 to battery. Relay 233 operates, locking over its outer front contact and the outer left front contact of relay 231 to ground on conductor 232 and establishing a holding circuit for relays 230 and 231 extending from battery through the windings of these relays, the inner left front contacts of relays 231 and 233, back contact of relay 226 to ground on conductor 232. On the next closure of the front contacts of relays 226 and 227, relay 235 operates without function and the locking circuit of relays 230 and 231 is opened. Relays 230 and 231 now release, relay 230 again establishing a shunt around the contacts of relay 227 and relay 231 releasing relay 233 and removing ground from conductor 239 thereby causing the release of relays 234, 235 and 238 and the release of selecting magnet 300. Relay 231 upon releasing also opens at its right front contact the holding circuit of relay 203 which now releases. With relay 203 released the shunt around the winding of relay 212 is opened and relay 212 operates in a circuit from battery through resistance 241, winding of relay 212, left alternate contacts of relay 211 to ground on conductor 232. Thus the cyclic operation of relays 226 and 227 to absorb one impulse and to successively operate and release selecting magnets 307, 308, 309 and 300 has measured a .6 seconds delay interval. The circuits are now conditioned for the transmission of impulses in accordance with the second registered code letter E.

On the next movement of the armatures of relays 226 and 227 to their back contacts relays 231 and 232 operate as previously described but since relay 230 is not operated, relay 227 does not open the out-pulsing circuit to cause the transmission of an impulse. On the next movement of the armatures of relays 226 and 227 to their front contacts relay 230 operates in the locking circuit of relay 231. On the next making of the back contacts of relays 226 and 227, relay 227 transmits a first impulse to the out-pulsing circuit, since relay 230 is now operated and relay 203 is released, and relay 226 causes the operation of relay 234 which, since relay 203 is unoperated causes the operation of selecting magnet 301 as previously described. On the next making of the front contacts of relays 226 and 227, relay 227 terminates the first impulse and relay 226 causes the operation of relays 235 and 238 and the establishment of a locking circuit for selecting magnet 301. On the next making of the back contacts of relays 226 and 227, relay 227 transmits a second impulse to the out-pulsing circuit and relay 226 causes the release of relay 234 and the operation of selecting magnet 302. On the next making of the front contacts of relays 226 and 227, relay 227 terminates the transmission of the second impulse and relay 226 releases relay 235 thereby releasing magnet 301 and locking magnet 302. On the next making of the back contacts of relays 226 and 227, relay 227 transmits a third impulse to the out-pulsing circuit and relay 226 reoperates relay 234 which, in turn, operates selecting magnet 303.

Since it was assumed that contact set 328 was operated to register the second code letter E, at the time magnet 303 operates a circuit in parallel therewith is established from ground on conductor 239, right front contact of relay 234, conductor 350, outer right front contact of magnet 302, middle contacts of contact set 328, right back contact of holding magnet 311, conductor 347, inner right back contact of relay 203, winding of stop relay 233 to battery. Relay 233 operates and locks to conductor 232 under the control of relay 231 and transfers the holding circuit of relays 230 and 231 to the control of relay 226. On the next making of the front contacts of relays 226 and 227, relay 227 terminates the transmission of the third impulse and relay 226 causes the operation of relay 235 which releases magnet 302 and locks magnet 303. Relay 226 also opens the locking circuit of relays 230 and 231 which release, relay 231 in turn releasing relays 233, 234, 235 and 238 and magnet 303 and removing the shunt from the winding of relay 203 which now operates in the manner previously described. With relay 203 operated a shunt is established from ground at the inner left front contact of relay 205, middle right front contact of relay 203, left front contact of relay 212, to a point between resistance 240 and the winding of relay 211 and relay 211 releases. The locking circuit of holding magnet 312 previously traced over conductor 348 and the inner right alternate contacts of relay 211 is now opened and magnet 312 releases thereby restoring contact set 328. With contact set 328 restored, the previously traced holding circuit of holding magnet 313 is now opened but magnet 313 is held operated over a circuit extending from battery on conductor 323, winding of magnet 313, lower contacts of operated contact set 331, conductor 332, next to inner right normal contacts of relay 211 to ground on conductor 329. A series of three impulses has now been transmitted over the out-pulsing circuit to set the second selector switch and the circuits are prepared to measure off a .6 seconds interval for permitting the second selector switch to hunt for an idle trunk.

The continued operation of relays 226 and 227 causes the release of relay 202, the sequential operation and release of relays 234 and 235 and the successive operation of selecting magnets 307, 308, 309 and 300 and the release of magnets 307, 308 and 309 in the manner previously described. Since, however, relay 203 is operated and its outer left contacts are closed, the repeated operation of relay 227 is not effective to transmit impulses to the out-pulsing circuit. When relay 226 moves its armature to its back contact following the operation of selecting magnet 300 the circuit of relay 233 is established and when relay 226 again moves its armature to its front contact with relay 233 operated, relays 230 and 231 are released followed by the release of relays 233, 234, 235, 238 and 203 and the release of selecting magnet 300 as previously described. When relay 203 releases, the circuit of relay 212 which extended from

battery through resistance 241, winding of relay 212, left normal contacts of relay 211, middle right front contacts of relay 203 to ground at the inner left front contact of relay 205 is opened and relay 212 releases, and the shunt around the impulse contacts of relay 227 is opened.

In response to the continued operation of relays 226 and 227, relays 230, 231, 202, 234, 235 and 238 operate in the manner previously described, the sequential operation and release of relays 234 and 235 causing the successive operation of selecting magnets 301, 302, 303 and 304 and the release of magnets 301, 302 and 303. At the time selecting magnet 304 operates a circuit is closed in parallel therewith from ground on conductor 239, right back contact of relay 234, conductor 345, outer right front contact of selecting magnet 303, middle contacts of contact set 331, right back contact of holding magnet 312, conductor 347, inner right back contact of relay 203, winding of stop relay 233 to battery. Relay 233 operates followed by the release of relays 230, 231, 233 and 238 and selecting magnet 304 and the operation of relays 203 and 211 as previously described. When relay 211 operates the holding circuit previously traced for holding magnet 313 is opened and magnet 313 releases restoring the operated contact set 331. The locking circuit of holding magnet 314 is now extended from battery on conductor 323, winding of magnet 314, lower contacts of contact set 334, conductor 352, next to inner right alternate contacts of relay 211 to ground on conductor 329. Thus a series of four impulses has been transmitted over the out-pulsing circuit and the circuit prepared to count the next delay interval of .6 second.

The circuits then function in the manner described to transmit further series of impulses as determined by the operated contact sets 334, 335, 338, 340 and 343, a .6 seconds delay interval being interpolated between the transmission of each digit series, the selecting magnets functioning as previously described to count the number of impulses transmitted in each series and to count off each delay interval. Following the completion of each impulse series one of the holding magnets is released. Thus when the last registered digit series has been transmitted or the digit series in accordance with the registered station's letter J as determined by the operated contact set 343, the locking circuit for holding magnet 318 is opened and magnet 318 releases. With all of the holding magnets now released there is no circuit effective for off-normal relay 209 and this relay releases removing off-normal ground from conductor 210 thus releasing start relay 206. All operated apparatus of the sender is now restored with the exception of relay 205, and lamp 207 is extinguished as a signal that the sender has completed its functions.

Relay 206 upon releasing removes battery from conductor 222 thereby releasing relays 129, 133, 134 and 205. With relay 134 released relays 118 and 135 are released in turn and with relay 129 released relay 137 is released thus restoring the operator's telephone and dialing circuit to its normal condition. The release of relay 129 also prepares a continuity circuit between the calling and answering plugs of the cord circuit, which is completed as soon as the operator restores the talking and dialing key 113 to its normal position. The talking circuit from the calling line 100 to the called line 150 may now be traced from the tip conductor of the calling line, tips of jack 102 and plug 101, upper right normal contacts of key 107, upper winding of relay 108, inner upper left normal contacts of key 107, upper back contact of relay 105, upper right normal contacts of key 113, upper back contact of relay 129, upper left normal contacts of key 107, upper left normal contacts of key 113, tips of plug 127 and jack 126, over the tip brushes of the selector switches (not shown) the called line loop, ring brushes of the selector switches, rings of jack 126 and plug 127, lower left normal contacts of key 113, middle lower left contacts of key 107, lower back contact of relay 129, inner lower right normal contacts of key 113, lower back contact of relay 105, inner lower left normal contacts of key 107, lower winding of relay 108, lower right normal contacts of key 107, rings of plug 101 and jack 102 over the calling line loop. The supervision and release of the connection are controlled in the usual manner and need not be described herein.

Should the operator desire to wipe out a connection at any time after a portion or all of the circuits have been operated she may do so by operating the wipe-out key 213. The operation of this key removes ground from conductor 329 thus restoring all of the operated holding magnets. With the holding magnets restored there is no circuit for relay 209 and this relay releases initiating the release of all operated sender and position equipment as previously described.

It should be noted from the foregoing description that relays 234 and 235 are operated in succession at the beginning and termination of each odd impulse of each transmitted impulse series and are released in succession at the beginning and termination of each even impulse of each impulse series and control the sequential operation of the selecting magnets as counting relays to count a number of impulses as determined by the setting of the registering means for that particular selection control. These relays also operate in succession and release in succession for successively operating the counting relays to count delay intervals between the transmission of impulse series.

Considering the impulse series generated by the impulsing relays 226 and 227 for transmission over the out-pulsing circuit to selector switches as odd impulse series and the impulse series generated for measuring delay intervals at even impulse series, relays 202 and 203 are operated in succession at the beginning and termination of each odd impulse series and are released in succession at the beginning and termination of each following or even impulse series for alternately causing the selecting magnets to count the impulses in said odd impulse series to control the setting of selector switches and to count the impulses in said even impulse series to measure delay intervals between the transmission of the odd impulse series.

Relays 211 and 212 are also operated in succession at the termination of each odd impulse series transmitted for setting selector switches and at the termination of the next even impulse series generated for measuring a delay interval and are released in succession at the termination of the next odd impulse series and the following even impulse series for successively releasing the holding magnets 311 to 318, inclusive, for controlling the transmission of successive odd impulse series to selector switches in accordance with the operated contact sets in successive horizontal rows of contact sets.

What is claimed is:

1. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating impulses and for controlling the setting of selector switches in accordance with the setting of said registering means, and means controlled by said impulse generating means during each selection control to operate said selecting magnets as counting relays to count a number of impulses as determined by the setting of the registering means for that particular selection control.

2. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating impulses and for transmitting certain of said impulses in digit series for controlling the setting of selector switches in accordance with the setting of said registering means, and means controlled by said impulse generating means during the transmission of each digit series of impulses to operate said selecting magnets as counting relays to count a number of impulses as determined by the setting of the registering means for that particular digit series.

3. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating impulses and for transmitting certain of said impulses in digit series for controlling the setting of selector switches in accordance with the setting of said registering means, and means controlled by said impulse generating means for successively operating certain of said selecting magnets as counting relays to count delay intervals between the transmission of successive digit series of impulses.

4. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating series of impulses for controlling the setting of selector switches in accordance with the setting of said registering means, a pair of relays operated in succession at the beginning and termination of each odd impulse of each impulse series and released in succession at the beginning and termination of each even impulse of each impulse series, and circuits controlled by said relays during each selection control for operating said selecting magnets as counting relays to count a number of impulses as determined by the setting of the registering means for that particular selection control.

5. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating series of impulses and for transmitting certain of said series of impulses for controlling the setting of selector switches in accordance with the setting of said registering means, a pair of relays operated in succession at the beginning and termination of each odd impulse of each of the other series of impulses and released in succession at the beginning and termination of each even impulse of each of the other series of impulses for successively operating certain of said selecting magnets as counting relays to count delay intervals between the transmission of said certain series of impulses.

6. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating series of impulses and for transmitting alternate ones of said series of impulses for controlling the setting of selector switches in accordance with the setting of said registering means, means controlled by said impulse generating means during the generation of each series of impulses to operate said selecting magnets as counting relays to determine the number of impulses to be generated in each series, and means for alternately causing said selecting magnets to count the impulses in said alternate series transmitted to control selector switches and to count the impulses in the other series to measure a delay interval between the transmission of said alternate series of impulses.

7. In an impulse sending device a plurality of registering means for registering the several digits of a call designation, a group of selecting magnets, means for selectively operating said magnets in response to each successive digit of a call designation for selectively and successively setting said registering means, means for generating series of impulses and for transmitting alternate ones of said series of impulses for controlling the setting of selector switches in accordance with the setting of said registering means, means controlled by said impulse generating means during the generation of each series of impulses to operate said selecting magnets as counting relays to determine the number of impulses to be generated in each series, and a pair of relays operated in succession at the beginning and termination of each odd impulse series and released in succession at the beginning and end of each even impulse series for alternately causing said selecting magnets to count the impulses in said odd impulse series transmitted to control the setting of selector switches and to count the impulses in said even impulse series to measure a delay interval between the transmission of said odd series of impulses.

8. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generat-

ing impulses and for controlling the setting of selector switches under the control of said operated registering elements, and means controlled by said impulse generating means during each selection control to operate said selecting magnets as counting relays to count a number of impulses as determined by the registering element operated to register the digit for that particular selection control.

9. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating impulses and for transmitting certain of said impulses in digit series for controlling the setting of selector switches under the control of said operated registering elements, and means controlled by said impulse generating means during the transmission of each digit series of impulses to operate said selecting magnets as counting relays to count a number of impulses as determined by the registering element operated to register the digit for that particular digit series.

10. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating impulses and for transmitting certain of said impulses in digit series for controlling the setting of selector switches under the control of said operated registering elements, and means controlled by said impulse generating means for successively operating certain of said selecting magnets as counting relays to count delay intervals between the transmission of successive digit series of impulses.

11. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating series of impulses for controlling the setting of selector switches under the control of said operated registering elements, a pair of relays operated in succession at the beginning and termination of each odd impulse of each impulse series and released in succession at the beginning and termination of each even impulse of each impulse series, and circuits controlled by said relays during each selection control for operating said selecting magnets as counting relays to count a number of impulses as determined by the registering element operated to register the digit for that particular selection control.

12. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating series of impulses and for transmitting certain of said series of impulses for controlling the setting of selector switches under the control of said operated registering elements, a pair of relays operated in succession at the beginning and termination of each odd impulse of each of the other series of impulses and released in succession at the beginning and termination of each even impulse of each of the other series of impulses for successively operating certain of said selecting magnets as counting relays to count delay intervals between the transmission of said certain series of impulses.

13. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating series of impulses and for transmitting the odd ones of said series of impulses for controlling the setting of selector switches under the control of said operated registering elements, means controlled by said impulse generating means during the generation of each series of impulses to operate said selecting magnets as counting relays, and means for alternately causing said selecting magnets to count the impulses in said odd series transmitted to control selector switches and to count the impulses in the even series to measure delay intervals between the transmission of said odd series of impulses.

14. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set and holding magnets for

successively operating the bars of the other set in response to successive digits, said registering elements being operable through the conjoint operation of bars of each set, means for generating series of impulses and for transmitting the odd ones of said series of impulses for controlling the setting of selector switches under the control of said operated registering elements, means controlled by said impulse generating means during the generation of each series of impulses to operate said selecting magnets as counting relays, and a pair of relays operated in succession at the beginning and termination of each odd impulse series and released in succession at the beginning and end of each even impulse series for alternately causing said selecting magnets to count the impulses in said odd impulse series to control the setting of selector switches and to count the impulses in said even impulse series to measure delay intervals between the transmission of said odd series of impulses.

15. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, a key-set for selectively operating said magnets in accordance with each digit of a call designation for selectively operating the bars of one set, holding magnets for operating the bars of the other set, a pair of relays operated in succession at the beginning and termination of the keying of each odd digit of a call designation and released in succession at the beginning and termination of the keying of each even digit of a call designation, and circuits controlled by said relays for operating said holding magnets to successively operate the bars of the other set, said registering elements being operable through the conjoint operation of the bars of each set.

16. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set, holding magnets for operating the bars of the other set, a pair of relays operated in succession at the beginning and termination of the recording of each odd digit of a call designation and released in succession at the beginning and termination of the recording of each even digit of a call designation and circuits controlled by said relays for operating said holding magnets to successively operate the bars of the other set, said registering elements being operable through the conjoint operation of bars of each set, means for generating series of impulses and for transmitting the odd ones of said series of impulses for controlling the setting of selector switches under the control of said operated registering elements, means controlled by said impulse generating means during the generation of each series of impulses to operate said selecting magnets as counting relays, and means for operating said pair of relays in succession at the beginning and termination of each odd impulse series and for releasing said relays in succession at the beginning and termination of each even impulse series for alternately causing said selecting magnets to count the impulses in said odd or selection control series of impulses and to count the impulses in said even impulse series to measure delay intervals between the transmission of said odd impulse series.

17. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set, holding magnets and means for successively operating said holding magnets in response to each successive operation of said recording means to successively operate the bars of the other set, said registering elements being operable through the conjoint operation of bars of each set, means for transmitting series of impulses for controlling the setting of selector switches under the control of said operated registering elements and a pair of relays operated in succession and released in succession under the control of said impulse generating means for successively releasing said holding magnets.

18. In an impulse sending device a unitary digit registering mechanism comprising a bank of coordinately arranged registering elements, each horizontal row of elements comprising a register for registering one digit of a call designation, two sets of coordinately arranged bars, a group of selecting magnets, recording means for selectively operating said magnets in response to each successive digit of a call designation for selectively operating the bars of one set, holding magnets and means for successively operating said holding magnets in response to each successive operation of said recording means to successively operate the bars of the other set, said registering elements being operative through the conjoint operation of bars of each set, means for generating series of impulses and for transmitting the odd ones of said series of impulses for controlling the setting of selector switches under the control of said operated registering elements, and a pair of relays operated in succession at the termination of each odd series and of the following even series of impulses and released in succession at the termination of the next odd series and of the following even series of impulses for successively releasing said holding magnets for placing said impulse generating means under the control of the operated registering element in successive rows of elements.

RAY L. STOKELY.