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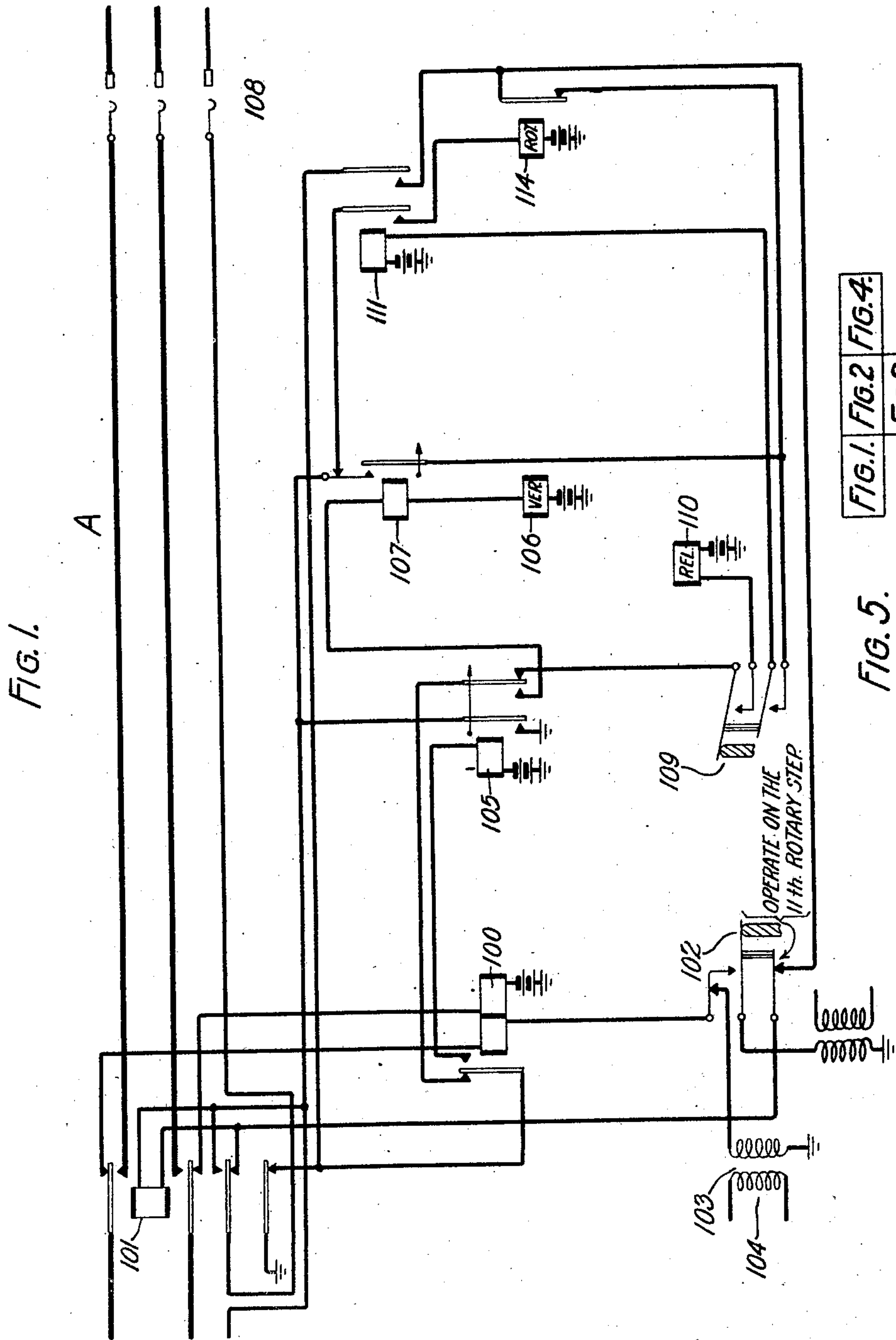
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1,705,906

TELEPHONE SYSTEM

Filed May 25, 1927

4 Sheets-Sheet 1



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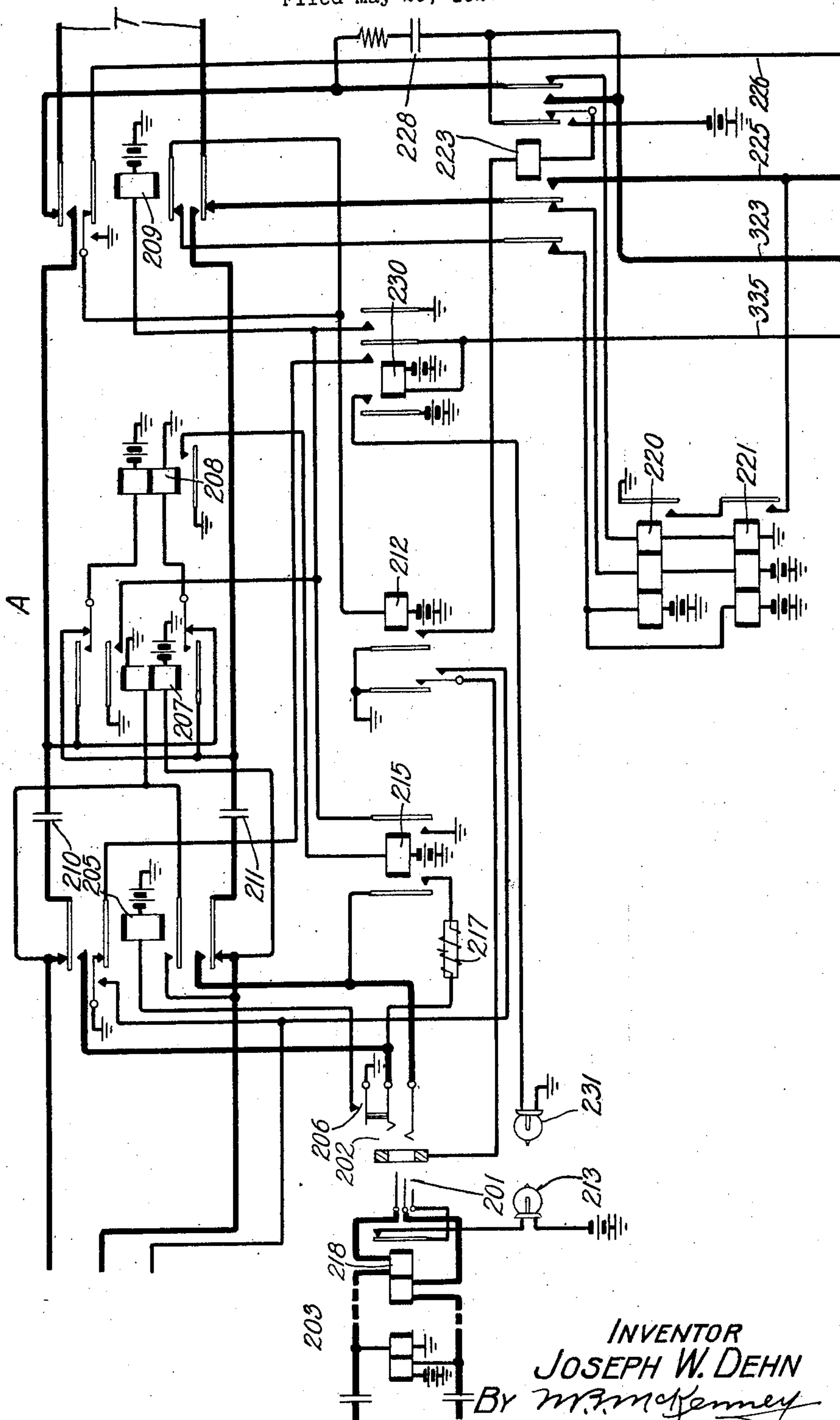
1,705,906

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4 Sheets-Sheet 2

FIG. 2.



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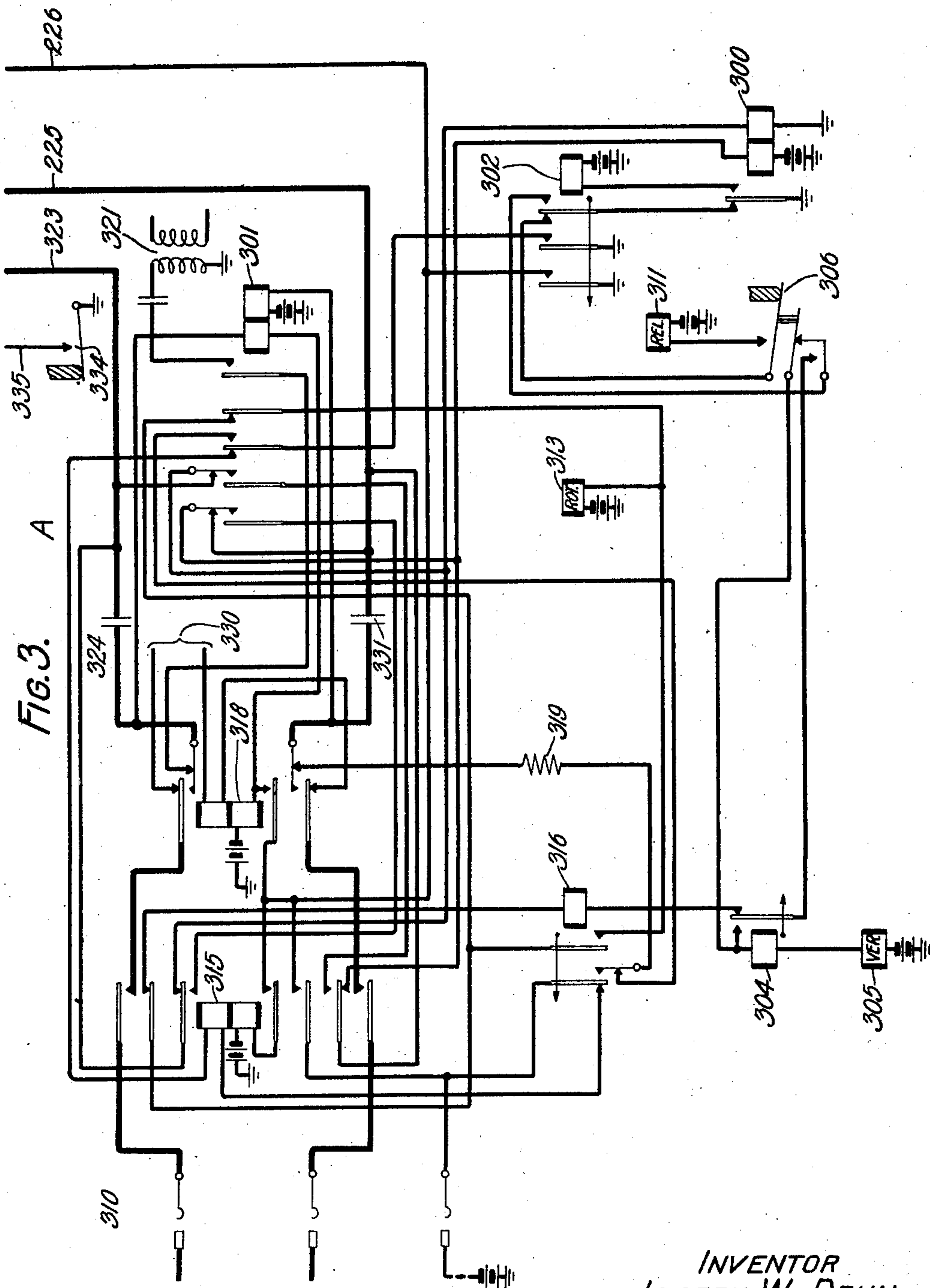
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TELEPHONE SYSTEM

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4 Sheets-Sheet 3



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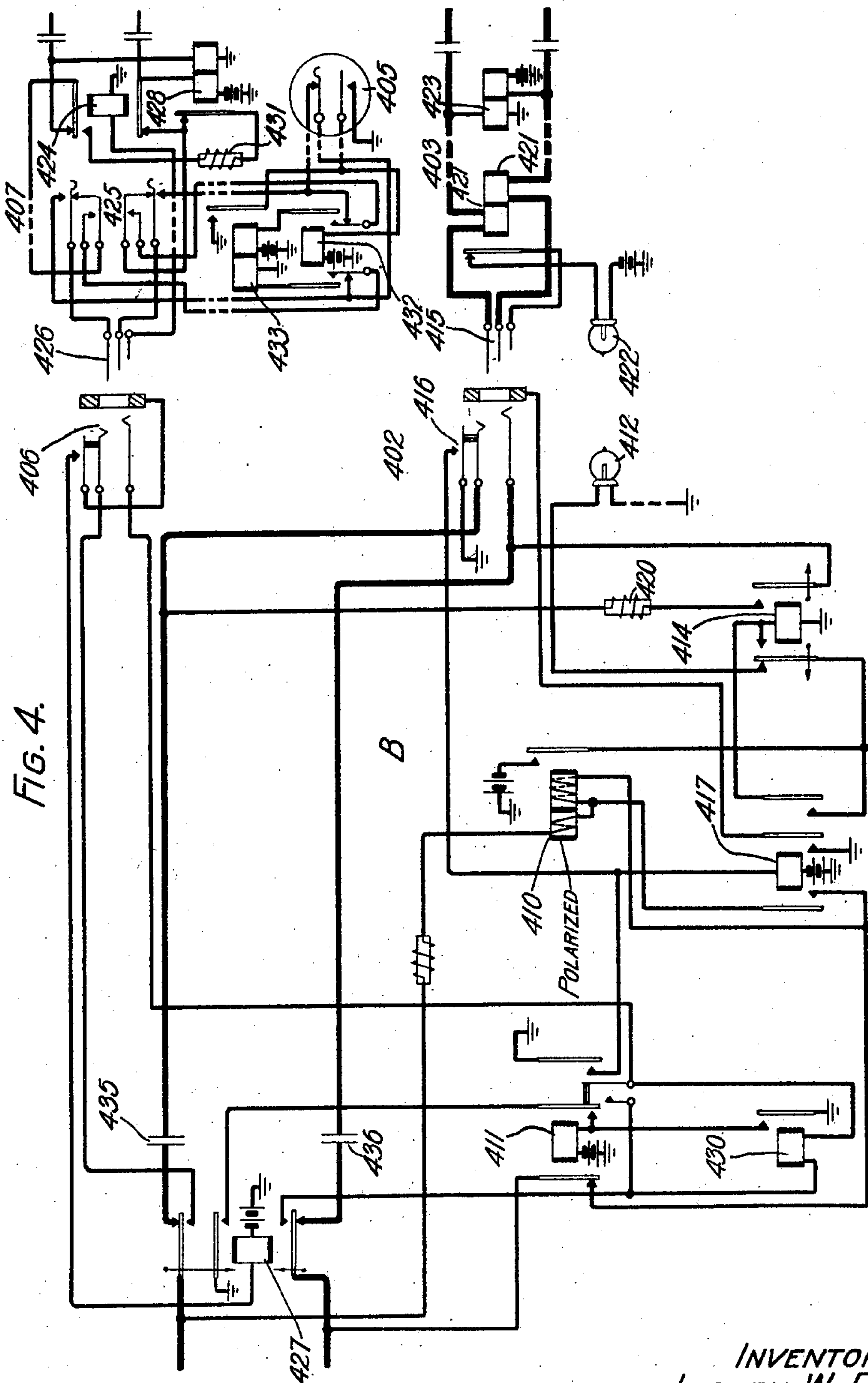
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TELEPHONE SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed May 25, 1927. Serial No. 194,033.

This invention relates to telephone systems and has for its object improvements in tie lines for use between exchanges.

In accordance with one feature of this invention there is provided a tie line circuit in which dialing impulses are transmitted from one terminal station to the other through a special dialing jack, so arranged that the dialing jack is connected, in response to the seizure thereof, to the tie line before a bridge connection across the conductors of the tie line is disconnected therefrom to prevent false operations of the impulse relays at the other terminal station.

In accordance with another feature of this invention there is provided a system having a tie line circuit in which the wanted lines are selected through automatically operated switches, and wherein the selective impulses incoming over the tie line are repeated to the automatic switches by a highly sensitive repeating relay arrangement. This repeating relay arrangement is disconnected from the tie line and the tie line connected through the automatic switches to the called subscriber for talking purposes when the called subscriber answers the call by removing his receiver from the hook.

The invention has been illustrated in the accompanying drawings in which Figs. 1, 2 and 3, when arranged as illustrated in Fig. 5, show the circuits of a tie line at one private branch exchange while Fig. 4 shows the circuits of this tie line at another private branch exchange. Referring to the drawings the circuits at station A, Figs. 1, 2 and 3 are so arranged that calls may be made from this station by seizing the tie line T either manually through a jack 202 by means of a private branch exchange operator's cord circuit shown partly at 203 or automatically from a private branch exchange subscriber through a selector shown in Fig. 1. These circuits at station A are also arranged so that calls incoming over the tie line T may be completed to private branch exchange subscribers at this station automatically through the actuation of the connector shown in Fig. 3 and so arranged that these calls may be completed through the lighting of a lamp at jack 202 automatically, from operations of said connector and the manual completion of the con-

nection, to the wanted private branch exchange subscriber through cord 203. The circuits associated with the tie line at station B, Fig. 4 are so arranged that calls originating from this station may be made by seizing the tie line through jack 402 from a cord circuit partially shown at 403 and by transmitting selective impulses from a dial 405 which may be associated through an ordinary cord 407 and the dialing jack 406 with the tie line for this purpose.

To illustrate the various features of this invention as embodied in this type of tie line circuit, descriptions of the above calls will be made in the order mentioned.

Assuming that the private branch exchange operator at station A has answered a call from a private branch exchange subscriber in the usual manner by means of the cord 203. The extension of the connection over tie line T may be initiated by the insertion of plug 201 of this cord into jack 202. Springs 206 of this jack are thereby closed to provide a circuit for the operation of relay 205. The circuit for this relay is obvious and when this relay operates it closes a circuit for the operation of relay 207. The circuit for relay 207 may be traced from battery, lower winding of relay 207, lower inner armature and front contact of relay 205, upper winding of relay 207 to ground. Relay 207 in operating reverses the normal connections from battery and ground through the windings of relay 208 for the tip and ring conductors of the tie line T for purposes hereinafter to be described. Relay 207 also closes a circuit for the operation of relay 209 as follows: battery, winding of relay 209, upper inner armature and front contact of relay 207 to ground. Relay 209 in operating completes the connections for the tip and ring conductors of line T from the battery and ground through the winding of relay 208 by way of the upper outer and the lower armatures and front contacts of relay 207 and the upper outer and lower outer armatures and front contacts of relay 209. It will be noted then that, due to the operation of relays 205, 207 and 209, the tip and ring conductors of tie line T are connected to the right-hand sides of condensers 210 and 211 and to battery and ground respectively, while the other sides of

the condensers are connected through the terminals of jack 202 and plug 201 to battery and ground in the cord circuit 203.

The operation of relay 205 also connects
 5 at its upper make-before-break contact the sleeve conductor for the selector of Fig. 1 to ground so as to make the tie line busy to the selector. The operation of relay 209 closes an obvious circuit for the operation of
 10 relay 212 and this relay in operating closes a connection to ground for the sleeve circuit of jack 202 to make it busy and to light the supervisory lamp 213 of cord 203 to indicate to the operator that the tie line has been con-
 15 nected.

The battery and ground connections through the windings of relay 208 will now cause the operation of relay 410 from the tip conductors of line T through both windings
 20 of relay 410 in series, the left hand armature and back contact of relay 411 to the ring conductor of line T. Relay 410 in operating closes a circuit for the lighting of lamp 412 as follows: battery, armature and front con-
 25 tact of relay 410, left hand armature and front contact of relay 414, lamp 412 to ground. The lighting of lamp 412 indicates to the private branch exchange operator at station B that a connection is desired over
 30 line T.

In answering this call this operator will insert plug 415 of cord 403 into jack 402. This operation closes a connection to ground at contacts 416 of jack 402 for the energizing
 35 circuit for relay 417. Relay 417 in operating closes a circuit for the operation of relay 414 as follows: battery, armature and front contact of relay 410, outer right hand armature and front contact of relay 417, winding of re-
 40 lay 414 to ground. Relay 414 in operating opens the circuit for lamp 412 and bridges the repeating coil 420 across the tip and ring conductors to jack 402 to cause the operation of the supervisory relay 421 from the bat-
 45 tery and ground supplied through the windings of relay 423 in cord 403 and thus prevent the lamp 422 from lighting on the actuation of relay 417 which as noted closes the sleeve circuit. The cord circuit 403 has only
 50 been shown in diagrammatic form as it forms no part of the invention in this application. For a more complete showing of suitable cord circuits for use in this connection reference may be had to the cord circuits shown in the
 55 copending application of W. B. Strickler, filed May 27, 1927, Serial No. 194,576. The operation of relay 417 also short circuits the left hand high resistance winding of relay 410 at its left hand armature and contact and thus
 60 reduces the resistance of the circuit through relay 208 to permit sufficient current to flow through this relay to cause it to operate. Relay 208 in operating closes an obvious circuit for the operation of relay 215 and this
 65 relay in operating closes an obvious holding

circuit for relay 209 and also by operating its left hand armature bridges retardation coil 217 across the tip and ring terminals of jack 202 and thus causes the supervisory relay 218 to be operated and causes lamp 213 to be
 70 extinguished to indicate to the private branch exchange operator at this station that the private branch exchange operator at station B has answered the call. As a connection is now completed through cord 203, tie line T
 75 and cord 403, the operator at station A will now give the wanted subscriber's number to the operator at station B. This operator may then complete the connection in the usual manner to the wanted subscriber's line and
 80 after this subscriber has been rung and answered the call, conversation between the calling and the called subscribers may begin.

In releasing this connection from station
 85 B plug 415 is removed from jack 402 and relay 417 releases. The release of this relay reinserts the high resistance winding of relay 410 in the circuit for relay 208 which is thereby released and this relay in releasing
 90 causes the release of relay 215 which removes the bridge through the retardation coil 217 from the tip and ring terminals of jack 202 to cause the supervisory relay 218 to be re-
 95 leased and the supervisory lamp 213 to be lighted to indicate to the operator at A that a release of the connection is desired. This operator will then remove plug 201 from jack 202 to cause the release of relay 205
 100 which in turn causes the release of relays 207, 209 and 212. The release of relay 209 causes the release of relay 410 and this relay in releasing causes the release of relay 414 so that the circuits at the two stations are now
 105 returned to normal condition.

If the release had been initiated from station A by the operator at this station removing plug 201 from jack 202, relays 205 and 207 would have been released. Relay 207 in releasing reverses the connections from bat-
 110 tery and ground through the windings of relay 208 for the line T, thus causing the release of relay 410. Relay 410 in releasing releases relay 414 and this relay in releasing removes the bridge through the retarda-
 115 tion coil 420 for the tip and ring terminals of jack 402 and thus causes the release of supervisory relay 421 and the lighting of lamp 422 over the sleeve circuit. The lighting of this lamp indicates to the operator at station
 120 B that release of the connection is desired, whereupon this operator removes plug 415 from jack 402 to cause the release of relay 417. This relay in releasing reinserts the high resistance winding of relay 410 in the
 125 circuit for relay 208 which then releases and causes the release of relay 215. Relay 215 in releasing opens the circuit for relay 209. This relay in releasing disconnects the tie line T from the circuits at station A, and causes
 130

the release of relay 212 which removes the ground on the sleeve of jack 202 and of the sleeve circuit for the selector, Fig. 1.

If a subscriber at station A desires to make a connection to a distant station by automatically selecting a tie line this connection may be made through the selector shown in Fig. 1. The subscriber may seize an idle selector, such as the one shown in Fig. 1, through a usual line finder (not shown) and thereby cause the operation of relay 100 over a circuit closed through the subscriber's loop over to the tip and ring conductors of this selector. This circuit may be traced from battery, right hand winding of relay 100, inner lower armature and back contact of relay 101 and ring conductor through the subscriber's loop back through the tip conductor, upper armature and back contact of relay 101, left hand winding of relay 100, 11th step rotary off-normal contacts 102, secondary winding of repeating coil 103 to ground. The secondary winding of this coil is connected to a tone source at 104. When this connection is completed a tone will be transmitted to the calling subscriber's telephone set indicating that a selector has been seized and that dialing for a tie line to the desired private branch exchange may begin.

The operation of relay 100 closes an obvious circuit for the operation of slow-to-release relay 105 and this relay closes a connection from ground at its inner armature and front contact for the sleeve circuit to the line finder to hold the connection in the usual manner. As the selector shown in Fig. 1 may be of the usual step-by-step type for selecting a level of terminals from a plurality of levels and hunt for the terminals of an idle tie line on that level the calling subscriber may now operate his dial to actuate the selector to select the desired level in which terminals of tie lines leading to the desired private branch exchange are located. The selector itself forms no part of this invention and it is therefore considered that this explanation will be sufficient to understand the features of the invention as hereinafter described.

Relay 100 will follow the interruptions by the dial of the circuit therefor and operate the vertical magnet 106 over a circuit that may be traced from battery winding of the vertical magnet 106, winding of slow-to-release relay 107, outer right hand armature and front contact of relay 105, armature and back contact of relay 100 to ground at the lower armature and back contact of relay 101. Relays 105 and 107 will remain operated during the pulsing operations. The vertical magnet 105 steps the brushes 108 of the selector to the desired level, and on the first vertical step to advance the brushes the vertical off-normal springs 109 close connection to prepare the circuits for the operation

of the release magnet 110 and the operation of the rotary magnet 114 as hereinafter described. The immediate result from the operation of these off-normal contacts is the closing of a circuit for the operation of relay 111 as follows: battery, winding of relay 111, lower springs of contacts 109, armature and front contact of relay 107, inner right hand armature and front contact of relay 105 to ground. When the dialing is completed and the brushes 108 have arrived to the desired level or group of tie line terminals, relay 107 releases but relay 111 remains in locked position under control of a circuit completed through the armature and back contact of the rotary magnet 114. This holding circuit may be traced from battery, winding of relay 111, lower springs of the vertical off-normal contacts 109, armature and back contacts of rotary magnet 114, outer right hand armature and front contact of relay 111, to the ground at the lower armature and back contact of relay 101.

Relay 107 in releasing closes a circuit for the operation of a rotary magnet 114 over a circuit from battery, winding of rotary magnet 104, inner right hand armature and front contact of relay 111, make-before-break contacts of relay 107, inner right hand armature and front contact of relay 105 to ground. The first operation of rotary magnet 114 steps the brushes to the first set of terminals in the selected level and on the operation of rotary magnet 114 relay 111 will release if the first line in this level is idle. However, if the first line is busy the sleeve terminal of the brushes 108 is connected to ground. This ground shunts the winding of relay 101 which now is in a series circuit with the relay 111 extending to the ground at the inner armature and front contact of relay 105 through the middle lower armature and back contact of relay 101. Relay 101 is consequently prevented from operating under these circumstances but the ground on the sleeve terminal causes the reoperation of relay 111 over a circuit as follows: battery, winding of relay 111, lower springs of vertical off-normal contacts 109, armature and back contact of rotary magnet 114, lower normally closed springs of 11th step rotary contacts 102, middle lower armature and back contact of relay 101, sleeve terminal of the brushes 108 to the ground on the sleeve of the connected line. Such a ground may be traced, for example, through Fig. 2 to the outer left hand armature and front contacts of relay 212 or upper inner make-before-break contacts of relay 205 of tie line T if it is busy. On the operation of relay 101 rotary magnet 114 is again energized and these operations will continue until an idle tie line is found. When such a line is reached relay 101 will operate in the series circuit through relay 111 but relay 111 will not op-

erate under these circumstances due to the resistance characteristics of the winding of relay 101. The circuit for relay 101 in this case may be traced from battery through the
 5 winding of relay 111, lower springs of vertical off-normal contacts 109, armature and back contact of rotary magnet 114, lower
 10 springs of 11th step rotary contacts 102, winding of relay 101, to ground at the inner right hand armature and front contact of relay 105. Relay 101 in operating closes the
 15 tip, ring and sleeve conductors from the calling subscriber's line and the line finder through to the brushes 108 at its upper, lower inner and lower middle armatures and their respective front contacts.

On the completion of these connections a circuit is completed for the operation of relay 207 from battery, through the lower
 20 winding of relay 207, ring terminal of brushes 108, lower inner armature and front contact of relay 101, ring conductor through the subscriber's loop back to the tip conductor, upper armature and back contact of re-
 25 lay 101, tip terminal of brushes 108, the upper winding of relay 207 to ground. Relay 207 in operating closes the circuit for relay 209 and this relay in operating closes the circuit for the operation of relay 212 as
 30 hereinbefore described. Relay 212 in operating connects ground to the sleeve circuit to make the terminals of line T busy to other selectors and for holding relay 101 operated after relay 105 has released as it
 35 will after relay 100 is disconnected from the subscriber's loop by the operation of relay 101. The operation of relay 207 reverses the battery and ground connections through the windings of relay 208, for the tip and
 40 ring conductors of line T to cause the operation of relay 410. This relay in operating causes as hereinbefore mentioned the lighting of lamp 422 and when the operator at station B answers this call by inserting plug
 45 415 into jack 402, circuit changes take place to extend the connection from this operator to the calling subscriber at station A in the same manner as hereinbefore described in relation to the establishing of a connection
 50 between the operator at A and the operator at B except that connection in this case now extends through the selector shown in Fig. 1 to the calling subscriber.

When the calling subscriber at station A releases, relay 207 releases to reverse the bat-
 55 tery and ground connections through relay 408 and relay 410 releases and as hereinbefore described the operator at B is signaled to break down the connection. The operator at
 60 B now removes plug 415 from jack 402 causing the release of relay 417 which as hereinbefore described causes the release of relay 208 and relay 215. Relay 215 causes the release of relay 209 and this relay causes the
 65 release of relay 212 which thereby removes

the ground on the sleeve to the selector of Fig. 1. Relay 101 is thereby released and closes a circuit for the release magnet 110 as follows: battery, upper springs of off-normal
 70 contacts 109, outer right hand armature and back contact of relay 105, armature and back contact of relay 100, lower outer armature and back contact of relay 101 to ground. The selector circuits are thereby restored to normal condition and the line finder is released
 75 as is well known in the art by the removal of the ground connection from the sleeve and the release of relay 101.

If a call originates at station B the first action on the part of the private branch ex-
 80 change operator at this station would be to insert plug 415 of cord 403 into jack 402. Relay 417 is thereby operated over an obvious circuit and the operation of this relay short circuits the high resistance winding of relay
 85 410 and also causes the supervisory lamp 422 to be lighted. It should now be noted that on the establishing of this short circuit for the high resistance winding of relay 410 the pulse repeating relays 220 and 221 will oper-
 90 ate over a circuit as follows: battery, through the middle windings of relays 221 and 220 in series, inner left hand armature and back contact of relay 223, lower outer armature and back contact of relay 209 over the ring con-
 95 ductor of line T, left hand armature and back contact of relay 411, left hand armature and front contact of relay 417 through the left hand winding of relay 410, tip conductor of line T, upper outer armature and back
 100 contact of relay 209, outer right hand armature and back contact of relay 223, right hand windings of relays 220 and 221 in series to ground. It should be mentioned here that relay 221 may or may not be normally oper-
 105 ated over the circuit established through the two windings of relay 410, that is, it is immaterial whether or not this relay operates under these conditions, while relay 220 is adjusted so that it will not operate from the
 110 current normally flowing over the line through the two windings of relay 410. The immediate result of the operation of relays 220 and 221 will be to establish a connection to ground through the outer armatures and
 115 front contacts over the lead 225 for the operation of relay 300. The circuit for this relay may be traced from battery, through the left hand winding of relay 300, outer left hand make-before-break contacts of relay
 120 301, lead 225, armatures and front contacts of relays 221 and 220 in series to ground. Relay 300 in operating closes an obvious circuit for the operation of relay 302. Relay 302 in operating closes a circuit for the opera-
 125 tion of relay 212 as follows: battery, winding of relay 212, upper inner armature and back contact of relay 209, lead 226 to ground at the outer left hand armature and front con-
 130 tact of relay 302. Relay 212 in operating ap-

plies ground to the sleeve of jack 202 and the sleeve terminal of the connection to the selector in Fig. 1 to make this trunk busy. This ground on lead 226 also closes circuits for the left hand windings of relays 220 and 221 in parallel that extend from battery through the left hand windings of relays 220 and 221 in parallel, outer left hand armature and back contact of relay 223, lower inner armature and back contact of relay 209, inner upper armature and back contact of relay 209, conductor 226 to ground at the outer left hand armature and back contact of relay 302. The circuit for relay 221 aids the relay in releasing during the pulsing while the circuit for relay 220 acts as a holding circuit for this relay during the pulsing. This combination of pulsing relays therefore will be particularly sensitive to dialing impulses.

The operation of relay 302 also closes the circuit for the operation of relay 304 and vertical magnet 305 as follows: battery, winding of vertical magnet 305, winding of relay 304, normally closed lower vertical off-normal contacts 306, inner armature and front contact of relay 302 to the armature and back contact of relay 300. The connector circuit in Fig. 3 is now ready for the reception of dialing impulses from station B.

To dial the wanted subscriber the operator at station B will now insert in dialing jack 406 a plug such as 426 of any available cord such as 407 having a dial such as 405 associated therewith through the operation of the dial key 425. This cord has been shown only in diagrammatic form as it forms no part of this invention. For a more complete showing of cord circuits suitable for use in this connection reference may be had to the cord circuits shown in the copending application of W. B. Strickler, filed May 27, 1927, Serial No. 194,576. However, in order to dial, a connection must now be established over the tip and ring conductors of line T through the tip and ring conductors of the jack 406 and plug 426 through the pulsing contacts of dial 405. This connection must be closed before the bridge through the left hand winding of relay 410 is removed from across the tip and ring conductors of the line in order to maintain relays 220 and 221 operated and thus prevent any false impulses being transmitted to the connector in Fig. 3. To this end on the insertion of plug 426 in jack 406 a circuit will be completed from ground in the cord, the winding of relay 424, sleeve terminals of plug 426 and jack 406, the upper outer closed contacts of jack 406, winding of relay 427 to battery. Relay 427 is slow to operate, while relay 424 is quick to operate, so that the battery and ground connected (when the dial key 425 is operated) through the windings of relay 428 and the armatures and back contacts of relay 424 (before this relay is operated), to the tip and ring terminals of

plug 426 and jack 406, shall not cause the operation of relay 430 through the operated armatures of relay 427. When relay 427 now operates a circuit will be completed for relay 430 through the above mentioned circuit through the pulsing contacts of dial 405.

It should be understood that usually the operator will actuate the talking key 425 before she inserts plug 426 into jack 406. Should she, however, neglect to do so it may be operated after the connection is made with the dial jack. In this case it should be noted that the bridge through the retardation coil 431 is established across the tip and ring conductors on the operation of relay 424. This bridge will therefore under such circumstances complete the circuit for the operation of relay 430 and when the dialing key is operated this bridge will be in parallel with the bridge through the dialing contacts. With the dialing key operated the circuit for relay 430 may be traced from battery and ground through the windings of relays 221 and 220, tip and ring conductors of line T as hereinbefore described through a loop extending from the tip conductor of the line through the upper outer armature and front contact of relay 427, tip terminals of jack 406 and plug 426 upper outer made contacts of key 425, pulsing contacts of dial 405, lower outer made contacts of key 425, ring terminals of plug 426 and jack 406, winding of relay 430 through the lower armature and front contact of relay 427 back to the ring conductor of line T. Relay 430 in operating closes an obvious circuit for relay 411 which in operating closes a locking circuit for itself under control of a connection to ground through the upper inner armature and contact of relay 427. The operation of relay 411 causes a holding circuit to be established through its outer right hand armature and front contact for relay 417 to maintain this relay operated during dialing in case the operator inadvertently removes plug 415 from jack 402. This relay 411 also opens the bridge through the right hand winding of relay 410 across the tip and ring conductors and short circuits the winding of relay 430 so that the pulsing circuit will not be extended free of all encumbrances from the pulsing contacts of dial 405 through the two windings of relays 220 and 221.

The operator may now dial the number of the desired subscriber at the distant exchange. At the rotation of the dial from normal the off-normal contacts thereof will close a circuit for the operation of 432 and this relay in operating will open at its make-before-break contacts the connections for the bridge through retardation coil 431 across the tip and ring conductors and connect this bridge to battery and ground through the windings of relay 433 which now operates and provides a locking circuit for relay 432, so the

bridge will be permanently removed from the dialing circuit. At each interruption of the pulsing contacts of dial 405, relay 221 will release thus opening the circuit for relay 300 which will thus release in response to each interruption of the dial contact. Relay 300 in releasing causes the above mentioned circuit for relay 304 and vertical magnet 305 to be closed and the magnet 305 will follow the dial pulses while relay 304 which is slow to release will remain operated during the pulsing. The vertical magnet will step the brushes 310 of the connector to the desired level in which the terminals of the desired line are located. As the connector itself forms no part of this invention no detail description will be made thereof, except such operations thereof that may serve to clarify the description of the invention. On the first step of the brushes the vertical off-normal contacts 306 will be operated to prepare a circuit for the release magnet 311 and transfer the pulsing circuit for the magnet 305 and relay 304 through the armature and front contacts of relay 304 and the lower closed springs of the vertical off-normal contacts 306. When the impulses from dial 405 cease, relay 300 will remain operated and relay 304 release thus transferring the pulsing circuit from the vertical magnet 305 to the rotary magnet 313.

The circuit for the rotary magnet 313 may be traced from battery through the winding of this magnet, second inner armature and back contact of relay 303, upper middle armature and back contact of relay 315, winding of relay 316, armature and back contact of relay 304, lower closed springs of vertical off-normal closed contacts 306, inner left hand armature and back contact of relay 302 to the armature and back contact of relay 300 to ground. Relay 316 and rotary magnet 313 are operated in this circuit on the next series of impulses from dial 405. That is, relay 300 on releasing and operating causes the operation and release of the rotary magnet 313 which as stated is in a series circuit with relay 316. Relay 316 operates on the first impulse and being slow to release remains operated during the succeeding impulses. The rotary magnet steps the brushes 310 over the terminals of the selected level to the terminals of the wanted line. Relay 316 in operating prepares a busy test circuit by closing a connection through its outer left-hand armature and front contact for the sleeve terminal of the connector. It should be noted that the pulsing circuit for rotary magnet 313 will now extend through the inner left hand armature and front contact of relay 316.

If the wanted line is busy a ground will be present on the sleeve terminal of the wanted line and in this case relay 301 will operate over a circuit as follows: from battery, through the right hand winding of relay 301,

lower make-before-break contacts of relay 318, resistance 319, outer left hand armature and front contact of relay 316 to the sleeve brush and terminal of the selected line to ground. This circuit will be closed before relay 316 has time to release after the last impulse. Relay 301 in operating opens the original circuit for relay 316 and as relay 316 releases a locking circuit is provided for relay 301 through the make-before-break contacts of relay 316, the third armature and front contact of relay 210 to ground at the middle armature and front contact of relay 302. Relay 301 in operating applies tone from the busy tone source 321 through the first armature and front contact of relay 301 to the conductor 323 through condenser 324 by way of the upper make-before-break contacts of relay 318. This tone is transmitted through condenser 228 to the tip conductor of the line T and from there to the operator's telephone set in cord 407 at station B. This tone remains on the line until the operator at station B has removed her plug.

If the wanted line is idle, battery connection will be encountered on the sleeve of the wanted line and thus relay 301 will be prevented from operating through the above mentioned circuit prepared by the operation of relay 316. When relay 316 releases after the last impulse relay 315 will operate over a circuit from battery, through the sleeve circuit of the connected line and sleeve brush of the connector, the left hand armature and back contact of relay 316, upper winding of relay 315, third armature and back contact of relay 301 to ground at the middle armature and front contact of relay 302. Relay 315 in operating closes a locking circuit for itself through its lower winding and lower inner armature and front contact to ground at the outer left hand armature and front contact of relay 302. This relay also places a ground on the sleeve terminal of the wanted line for the operation of the usual cut-off relay. This connection is established through the second lower armature and front contact of relay 315 to ground at the outer left hand armature and front contact of relay 302.

A circuit will also be closed by the operation of relay 315 for ringing of the wanted subscriber. The circuit from the ringing source, which may be connected at the point 330, will extend through the upper armature and back contact of relay 318, upper outer armature and front contact of relay 315, the tip conductor and the bell of the wanted subscriber's set to the ring conductor, lower armature and front contact of relay 315, lower armature and back contact and winding of relay 318, back to the ringing source connected at point 330. The ringing current induces a tone through the condenser 324 to the tip conductor back to the calling operator at station B indicating to her that the wanted

subscriber's bell is being rung. This tone is introduced from the upper winding of relay 318 to the lower winding of this relay and finds a path through the left hand winding of relay 301 to the condenser 324. Relay 318 is so designed as not to operate on the ringing current but when the receiver is removed from the hook by a called subscriber, the direct current which is superimposed on the ringing current will operate relay 318 and this relay in operating establishes a locking circuit for itself from battery, through its lower winding, lower inner armature and front contact to ground at the left hand armature and front contact of relay 302. Relay 318 in operating cuts off the connection from the ringing source and closes a talking circuit through to the calling subscriber on the left hand side of the condensers 331 and 324 through the upper armature and lower outer armature and front contact of relay 318, upper and lower outer armatures and front contacts of relay 315 to the connected subscriber's line.

When the talking connection is completed relay 301 operates through both windings over the called subscriber's loop. This circuit may be traced from battery, through the right hand winding of relay 301, lower outer armature and front contact of relay 318, lower armature and front contact of relay 315 through the subscriber's loop, upper outer armature and front contact of relay 315, upper outer armature and front contact of relay 318, left hand winding of relay 301, lower inner armature and front contact of relay 318, to ground at the outer left hand armature and front contact of relay 302. Talking battery is now therefore provided for the called subscriber's line and the operation of relay 301 causes the battery for the operator at station B to be reversed. That is, battery will now be connected through left hand winding of relay 300, outer left hand armature and front contact of relay 301, upper inner armature and front contact of relay 315, to the tip conductor 323, while ground will be connected through the right hand winding of relay 300, second outer armature and front contact of relay 301, second outer lower armature and front contact of relay 315 to the ring conductor 225.

It will be noted that the reversal of battery and ground connections for the tip and ring conductors causes the operation of relay 223 over a circuit as follows: battery, through the winding of relay 300, to the tip conductor 323 as hereinbefore described, inner right hand armature and back contact of relay 223, winding of relay 223 to ground at the make-before-break contacts of relay 212. Relay 223 operates and closes a locking circuit for itself directly to battery under control of the contacts of relay 312 and opens the original energizing circuit. Relay 223 in operating disconnects relays 220 and 221 from the tip and ring

conductors of line T and connects the tip and ring conductors 323 and 225 to the tip and ring conductors of line T. Thus it will be seen that the repeating relays 220 and 221 will be disconnected from the talking connection as soon as the wanted subscriber has answered the call. In order to complete this talking circuit from battery and ground at relay 300 to the operator at station B the operator at this station will now remove plug 426 from dialing jack 406 and thus release relays 427 and 411 to reconnect relay 410 across the tip and ring conductor of line T and connect there conductors through condensers 435 and 436 to the calling operator. When this transfer is completed relay 410 will operate to cause the operation of relay 414 and this relay in turn connects the retardation coil 420 across the tip and ring conductors to cause the operation of the supervisory relay 421 and the extinguishing of lamp 422 to indicate to the operator at this station that the talking connection has been completed.

If the called subscriber releases the connection relay 301 will be released. Relay 301 in releasing reverses the battery and ground connections from relay 300 to the line and thus causes the release of relay 410. Relay 410 in releasing causes the release of relay 414 and this causes the lighting of lamp 422 to indicate to the operator at this station that disconnection is desired. She will then remove plug 415 from jack 402 to cause the release of relay 417 to reinsert the high resistance winding of relay 410 in the circuit. This will release relay 300 which in turn will release relay 302. Relay 302 in releasing will close the circuit for release magnet 311 through the vertical off-normal contacts 306 and thus return the connector switch to normal position. Relays 315 and 318 are also released by the release of relay 302.

If a connection is desired from station B to the operator at station A the operator at B will proceed in the same manner as when a subscriber at station A is selected automatically except that the digit zero is dialed. In this case the connector of Fig. 3 will be advanced to the zero level. In this position a connection will be closed to ground through the operation of the contacts 334. This connection closes a circuit over lead 335 for the operation of relay 230. Relay 230 in operating closes an obvious circuit for lighting lamp 231 associated with jack 202 to indicate to the operator at station A that a connection is desired over this line. Relay 230 in operating closes an obvious connection for the operation of relay 209 which disconnects the connector from the line T so that the connector is thereby returned to normal condition. Relay 230 in operating provides a locking for itself through its inner right hand armature and front contact to ground at the upper inner armature and back contact of relay 205. The operator

at station A answers this call by inserting plug 201 in jack 202 and the operation of relay 205 under these circumstances opens this circuit for relay 230, while relay 209 is held operated by the operation of relay 207 as hereinbefore described. The operation of the circuits from this point are identical with the operations when a connection is extended from the operator at station A to the operator at station B.

It should be understood that the particular arrangements of circuits shown are merely illustrative of one application of the invention and that it is capable of being applied to various other tie line arrangements without departing from the spirit thereof.

What is claimed is:

1. In a telephone system, a line connecting two stations, impulse transmitting means at one station and impulse responsive means at the other station, relays at said second station for repeating impulses incoming over the line to said impulse responsive means, and means responsive to the first repeated impulse for changing the character of response of said repeating relays to succeeding incoming impulses so that one of said repeating relays only repeats said succeeding impulses.

2. In a telephone system, impulse transmitting means, two relays having each a first and a second winding associated with said transmitting means so that said relays will respond to an impulse from said means and repeat said impulse, a third winding for each of said relays, and means responsive to the first actuation of said relays for closing energizing circuits through the third windings, said third windings being so connected in the energizing circuit that one of said relays is energized thereby to lock in actuated position while the other relay is energized to release more quickly between succeeding impulses incoming through its first and second windings.

3. In a telephone system, a line connecting two stations, impulse transmitting means at one station, a connector at the other station, two relays at said other station for repeating impulses incoming from the first station to said connector, means responsive to the actuation of said impulse repeating relays by the first impulse incoming thereto for seizing said connector, and means responsive to the seizure of said connector for locking one of said repeating relays in actuated position and causing the other of said repeating relays to independently respond to succeeding im-

pulses and repeat the same to the connector.

4. In a telephone system, a line, a jack, a cord circuit, a bridge connection across the conductors of said line, and means responsive to the connection of the cord to the jack for establishing a second bridge connection across the conductors of said line and then removing the first mentioned bridge connection.

5. In a telephone system, a line terminating in a jack, another jack, a cord circuit, a bridge connection across the conductors of said line, and means responsive to the connection of said cord circuit with said second jack for establishing a bridge through the cord circuit and the associated jack across the conductors of said line, for disconnecting the first mentioned jack from the line and for thereafter opening the first mentioned bridge.

6. In a telephone system, a line, a jack, a cord circuit, a dial in said cord circuit, means for establishing a bridge circuit through the impulse contacts of said dial across the conductors of said cord, a bridge connection across the conductors of said line, means responsive when the bridge through the dial is established and the cord is connected with said jack for establishing a connection between the conductors of said line through said bridge in the cord and through said jack and for thereafter opening the bridge connection normally established across the conductors of said line.

7. In a telephone system, a line, impulse transmitting means at one end of said line, relays connected to the other end of said line responsive to impulses from said transmitting means for repeating the same, subscribers' lines, a connector responsive to impulses repeated by said relays for selecting a corresponding subscriber's line and connecting it with the line conductors of said connector, a relay connected to one of the line conductors of said connector, means for operating said relay in response to the seizure of the connected subscriber's line by the subscriber thereof, means controlled by the actuation of said relay for disconnecting the impulse repeating relays from the line, for connecting the line to the connected subscriber's line through the conductors of the connector and for disconnecting the relay itself from its connection with one of the line conductors of the connector.

In witness whereof, I hereunto subscribe my name this 18th day of May, A. D. 1927.

JOSEPH W. DEHN.