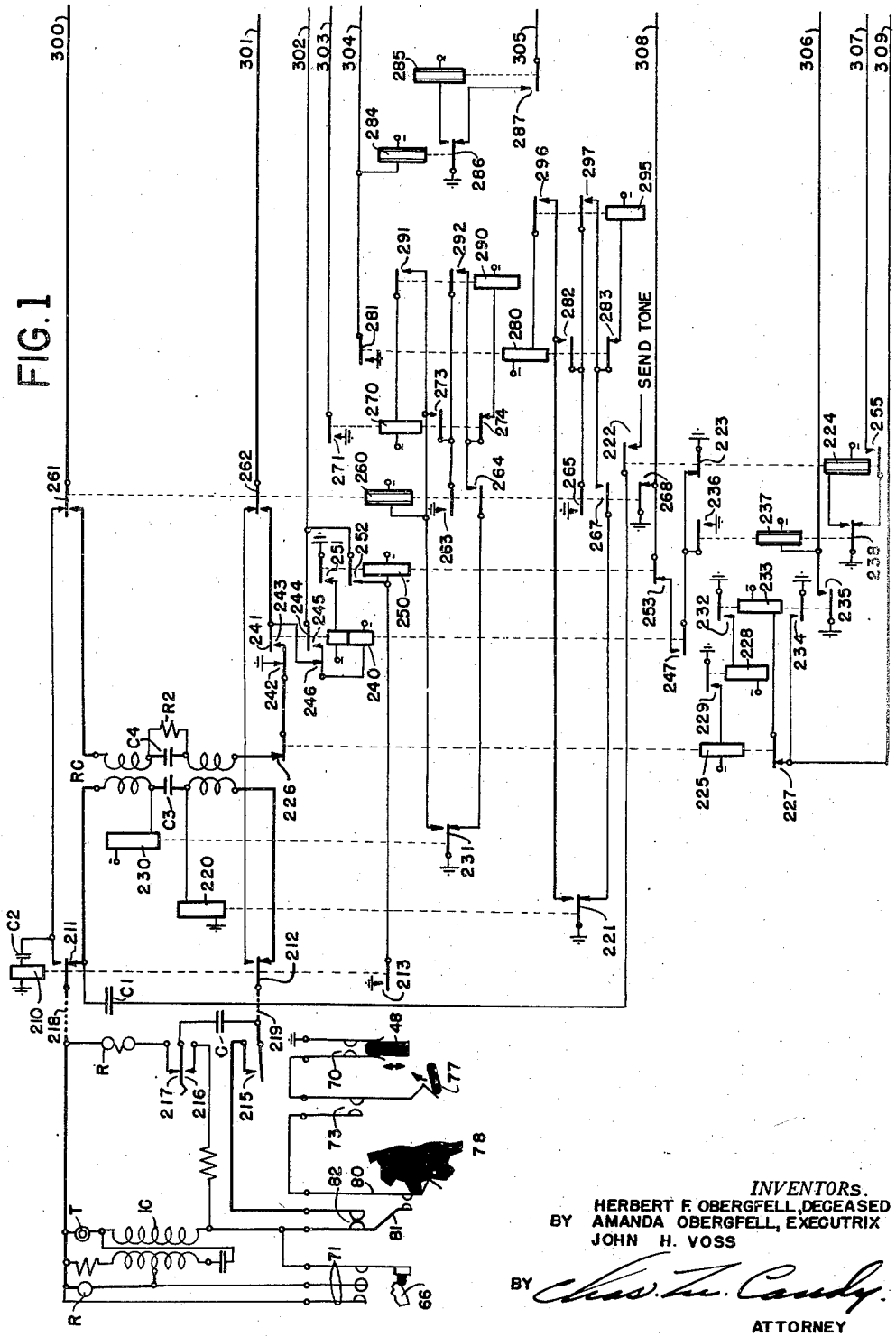
April 8, 1947. J. H. VOSS ET AL 2,418,609

TELEPHONE SYSTEM

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FIG. 1



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TELEPHONE SYSTEM

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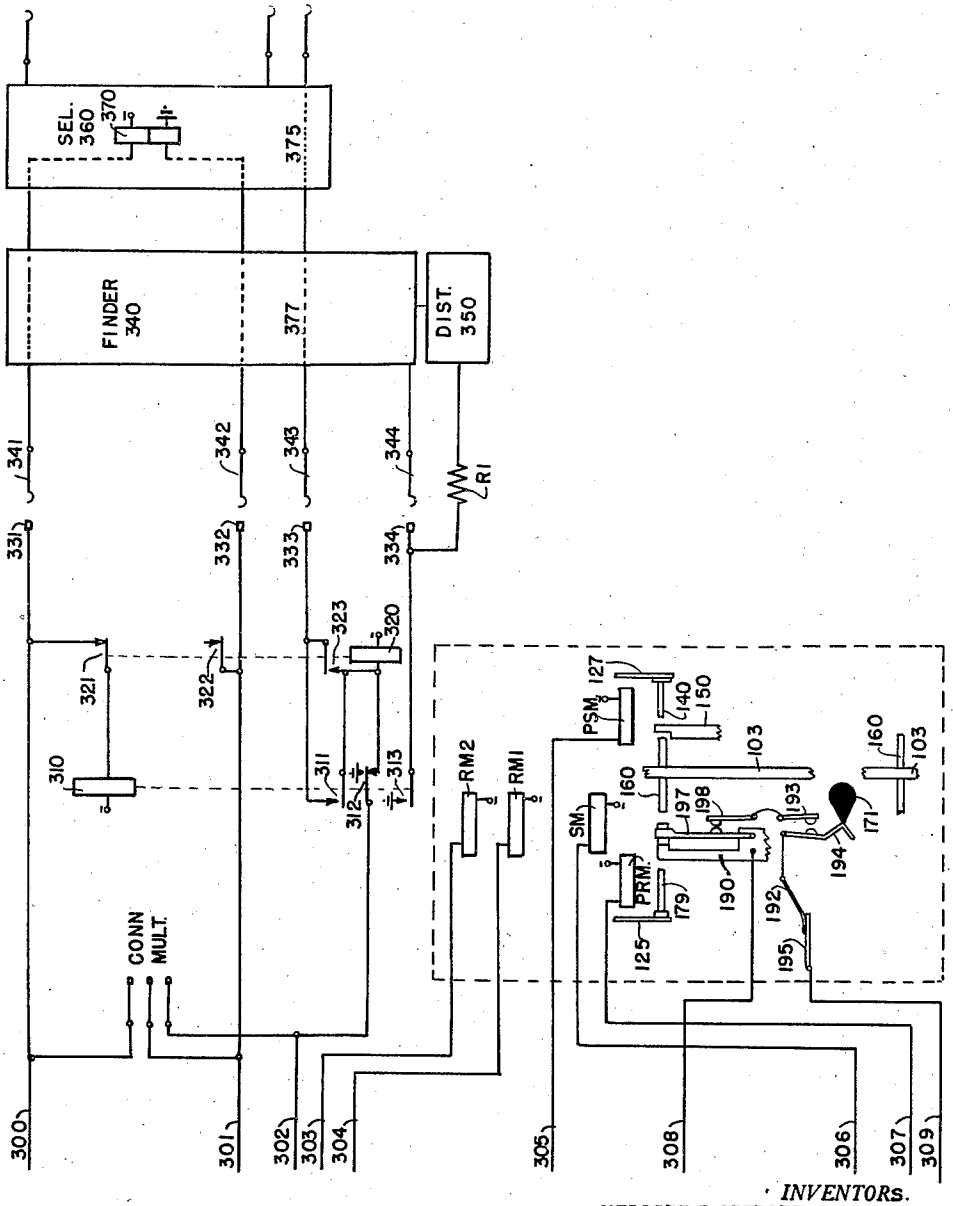


FIG. 2

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Patented Apr. 8, 1947

2,418,609

UNITED STATES PATENT OFFICE

2,418,609

TELEPHONE SYSTEM

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Application October 23, 1944, Serial No. 559,878

15 Claims. (Cl. 179—16)

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The present invention relates in general to automatic telephone systems and more particularly to improved circuit arrangement for interconnecting a subscriber's push-button calling device with a mechanical dial repeater which is individual to the subscriber's line.

The main object of the present invention is the provision of improved impulsing circuits for translating coded digits received from a code sending calling device to cause the operation of an impulse receiving and registering device to store and retransmit the translated digits.

Another feature of the invention relates to the circuit arrangements whereby the impulse receiving and registering device, which is individual to the subscriber's line, is arranged to receive and store the digits transmitted by the calling subscriber while a finder switch is hunting for the calling line after which the stored digits are transmitted to the automatic switch train. With this arrangement the calling subscriber can immediately dial, or key, the called subscriber's number without waiting for the customary dial tone to inform the subscriber that he may start dialling.

Another feature relates to the improved impulsing circuits whereby false operation of the impulse receiving and registering device is prevented when the subscriber initiates a call, answers a call or disconnects by replacing the receiver.

Other features of the invention relate mainly to further detail circuit improvements and will be apparent in the following description and in the claims.

These circuit improvements, along with the push-button calling device, being claimed in a copending application Ser. No. 551,010, filed August 24, 1944, and the mechanical dial repeater, being claimed in a copending application Ser. No. 554,912, filed September 20, 1944, was designed primarily for use by a subscriber who originates a large number of outgoing calls, such as a salesman or an order clerk. Such a subscriber may set up, or key, the digits of a called number without waiting for the automatic telephone switches, such as finders, to find the calling line, and may proceed to call the desired called party as soon as the receiver is removed from the cradle of the desk telephone. The push-button calling device is arranged to transmit loop and ground pulses over the subscriber's line to a pair of line relays which translate these incoming impulses into ground pulses to operate the impulse receiving and registering device. Each line relay

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controls a separate pulsing circuit and each such pulsing circuit extends to a stepping magnet in the impulse receiving and registering device. Each of these stepping magnets singly, or in combination, control the stepping of a selecting arm; such selecting arm being stepped one step for each magnet operation. On each loop impulse transmitted from the calling device, both line relays are operated to simultaneously control the two separate pulsing circuits thereby operating both stepping magnets to operate the selecting arm a distance of two steps. A ground pulse transmitted from the calling device causes only one of the line relays to be operated while the other is maintained thereby only one of the separate pulsing circuits is completed to operate only one of the magnets to step the selecting arm only one step. The selecting arm is moved a number of steps corresponding to the translated digits to select and displace a pin in the path of the sending arm in the impulse receiver and registering device, or mechanical dial repeater. The successive digits are stored and marked by the displaced pins.

When the finder switch finds the calling line and connects the associated selector switch to the calling line, a circuit is completed for causing the impulse receiving and registering device to start the transmission of outgoing impulses in accordance with the stored digits. A plurality of relays are operated to transmit the outgoing impulses and at the same time transmit a pulse to the sending magnet for each outgoing pulse. The sending magnet operates an arm step-by-step until such arm encounters the first displaced pin at which time the relay operations are stopped momentarily to operate a pin restoring magnet which restores the displaced pin. After the pin is restored the relays again transmit outgoing pulses and operate the sending magnet until the arm encounters the second displaced pin. This same cycle of operations continues until all displaced pins are restored at which time the stored digits would all be transmitted. The outgoing impulses operate the automatic switches to complete the desired connection.

Referring now to the drawings:

Figures 1 and 2 diagrammatically show the circuits by means of which the push button calling device and mechanical repeater control standard automatic telephone switches to complete desired connections.

Referring now in detail to Figures 1 and 2, the push-button calling device diagrammatically

illustrated in the upper left-hand corner of Figure 1 is connected in circuit with the subscriber's substation circuit comprising a receiver R, induction coil IC, transmitter T, ringer R and cradle springs 215, 216 and 217. The push button calling device is shown and described in the copending Sargisson and Obergfell application Serial Number 551,010 filed August 24, 1944. The same reference characters as used in the drawings showing the detail construction of the push-button calling device in the above-mentioned copending application are also used in the circuit diagram.

The substation circuit is connected by line conductors 218 and 219 to individual circuits at the main exchange. These circuits include a ring-control relay 210, a pair of line relays, a repeating coil RC and other control relays. Some of these control relays, such as relays 260, 284, 285, 237 and 224, are of the slow-to-release type having copper sleeves to retard the release time of such relays. The mechanical dial repeater is diagrammatically shown in the lower left-hand corner of Figure 2 and is shown and described in the copending Henrikson and Obergfell application Serial Number 554,912, filed September 20, 1944. The same reference characters as applied to the drawings showing the detail construction of the mechanical repeater in the above-mentioned copending application are also applied to the circuit diagram.

The connector multiples Conn. Mult. are connected to the line and test conductors 300, 301 and 302 and are accessible to regular standard connector switches in the main automatic exchange.

Line conductor 300 is normally connected to line relay 310 in the usual manner while line conductor 301 is connected to an open circuit at contact 321 instead of the usual ground connection for a purpose which will be more fully described hereinafter. The usual line cut-off relay 320 is provided and is operated on both incoming and outgoing calls. The circuits terminate in finder bank contacts 331 to 334, inclusive, which are multiplied and accessible to standard finder switches, such as finder 340. These finders are of the standard vertical and rotary type of Strowger finders having a vertical motion to find the bank level containing the calling line and a rotary motion to find the calling line in the bank level. A distributor switch, such as distributor 350, is associated with the group of finders for controlling the same to find the calling line. The finders and distributor switch are of the general type such as shown in the Saunders Patent 1,849,694 issued March 15, 1932. A selector switch, such as selector 360, is tied tail to tail with each finder and has access to other selectors or connector switches in the usual manner dependent upon the capacity of the automatic exchange. The selector is of the well-known type of Strowger selector having directive vertical movement to select a group of trunks and automatic rotary movement to select an idle trunk from the selected group. Only line relay 370 of selector 360 is shown for the purpose of explaining the control of impulse transmission start relay 240 which operates when the finder switches through to the selector to start retransmission of the digits stored in the mechanical dial repeater.

Having briefly described the circuit layout a detail description will now be given. The calling subscriber will remove the telephone handset including the receiver R and transmitter T from the cradle and dial, or key, the digits of the called subscriber's number. As is customary in multi-office areas, the push-button calling device would be equipped with letters as well as digits on the push buttons and the calling subscriber would "key" the letters of the exchange and then the digits of the called subscriber's number in that exchange. Since this subscriber's line is equipped with an individual dial repeater, the subscriber need not wait for the customary dial tone but may start dialing immediately.

In response to the removal of the handset from the cradle, cradle spring 217 disconnects the ringer R, cradle spring 216 closes a point in the talking circuit, and cradle spring 215 completes a loop circuit through the substation circuit over the line conductors 218 and 219, back contacts and armatures 211 and 212, through the left hand windings of repeating coil RC and through the windings of line relays 220 and 230 to ground and battery for energizing line relays 220 and 230. At front contact 231 relay 230 completes a circuit for energizing slow-to-release relay 260. At back contacts 261 relay 260 disconnects ring control relay 210 and front contacts 261 completes a circuit for energizing line relay 310 as follows: from ground at contacts 242, contacts 226, through the right hand windings of repeating coil RC and resistance R2, front contacts 261, conductor 300, contacts 321 and the winding of line relay 310 to battery. At front contacts 262 relay 260 prepares a circuit for impulse transmission start relay 240 which circuit, however, is not completed until the finder switches through to the selector and at contacts 263, 264, 265 and 267 prepares circuits utilized in the impulsing circuits to rotary stepping magnets RM2 and RM1. At contact 268 relay 260 disconnects ground from conductor 308.

Relay 310, upon energizing, at contacts 313 grounds the vertical bank contact 334 and extends ground through the start resistance R1 to operate distributor 350 which in turn starts an idle finder in search of the calling line. At contacts 312, line relay 310, grounds conductor 302 and the multiples of connector test terminals to busy this line to the connectors and at contacts 311 marks the finder bank 333 and its multiples with calling potential through the winding of cut-off relay 320.

The calling subscriber need not wait for the customary dial tone, which is ordinarily transmitted to the calling line as soon as the finder switches through to the selector. During the time the finder is searching for the calling line the calling subscriber may dial, or key, the digits of the called number. Assuming that the first digit dialed is an even number, digit 6 for example, the rocker arm and its insulating plate 48 are operated, as described in the copending application Ser. No. 551,010, in response to the downward stroke of key 6 to separate springs 70 thereby disconnecting ground from springs 73. Also in response to the downward stroke of key 6, the clutch arm 66 is rotated off normal thereby causing the closure of shunt springs 77 which closes the usual shunt around the substation set and the clutch pawl slides over the next three adjacent teeth on the ratchet wheel. When key 6 restores the clutch returns to normal and rotates the impulse shaft and impulse wheel 78 a distance of three teeth thereby actuating spring 80 three times to separate contacts 82 three times. Contacts 82 interrupt the loop circuit extending to line relays 220 and 230 three times to cause

three successive deenergizations and energizations of both line relays. The closure of contacts 73 during the transmission of the last impulse is ineffective at this time because grounding springs 70 are open.

Each time line relay 220 deenergizes a circuit is completed for operating relay 295 as follows: from ground at back contacts 221, contacts 267 and 283 and through the winding of relay 295 to battery. Relay 295 at contacts 296 prepares a circuit for relay 280 and at contacts 297 completes a temporary locking circuit for itself. This locking circuit may be traced from ground at contacts 265, contacts 297 and 283 to relay 295.

Each time line relay 230 deenergizes a circuit is completed for operating relay 290 as follows: from ground at back contacts 231, contacts 264 and 274 and through the winding of relay 290 to battery. Relay 290 at contacts 291 prepares a circuit for relay 270 and at contacts 292 completes a temporary locking circuit for itself. This locking circuit extends from ground at contacts 263 by way of contacts 292 and 274 to the winding of relay 290. At front contacts 231 line relay 230 temporarily opened the circuit to slow-to-release relay 260 but this relay, due to its slow-to-release characteristics, maintains its armature attracted during the impulsing period.

When the loop circuit is closed at contacts 82 line relays 220 and 231 reenergize. Relay 220 at front contacts 221 completes a circuit for energizing pulse relay 280 by way of contacts 296 and relay 230 at front contacts 231 again completes the circuit to relay 260 before it could fall away as well as completing a circuit for operating pulse relay 270 by way of contacts 291. Relay 280, upon energizing, at contacts 281 grounds conductor 304 to energize slow-to-release relay 284 and rotary stepping magnet RM1. At contacts 282 relay 280 completes a temporary locking circuit for itself from grounded contacts 265 by way of contacts 282 and 296. At contacts 283 relay 280 opens the locking circuit to relay 295. Relay 270, upon energizing, at contacts 271 grounds conductor 303 to energize rotary stepping magnet RM2. At contacts 273 relay 270 completes a temporary locking circuit for itself from grounded contacts 263 by way of contacts 273 and 291. At contacts 274 relay 270 opens the locking circuit to relay 290. Rotary magnets RM1 and RM2 in energizing position their pawls preparatory to stepping the pin setting arm 150 on the selecting member of the mechanical dial repeater.

Relays 270, 280, 290 and 295 are each arranged to restore their armatures within a predetermined time limit when their individual locking circuits are opened in order to correctly pulse the rotary magnets RM1 and RM2. This timing being independent of the time ratio of the make and break connections at contacts 221 and 231.

Relays 290 and 295 deenergize when their locking circuits are opened by the energization of relays 270 and 280. Relays 290 and 295 at contacts 291 and 296 open the locking circuits of relays 270 and 280 to cause the release of the latter relays. At contacts 271 and 281 relays 270 and 280 disconnect ground from conductors 303 and 304 to release magnets RM2 and RM1 to simultaneously step both magnets. While the circuit to relay 284 is interrupted at contacts 282 this relay, due to its slow release characteristics, maintains its armature attracted during each series of incoming pulses.

In response to the deenergization of both magnets RM1 and RM2, the selecting mechanism and pin setting arm 150 are rotated from its last occupied position a distance corresponding to two steps, or from above one pin, such as pin 160, past the next adjacent pin to above the next subsequent pin. Therefore, in response to a single loop pulse, line relays 220 and 230 cause magnets RM1 and RM2 to move pin selecting arm 150 two steps to select the second pin from its last occupied position. In the present example, since the key 6 has been actuated, three loop pulses are transmitted to line relays 220 and 230 to control the relays 270 and 280 in a manner similar to that above described, to simultaneously operate both magnets RM1 and RM2 three times. These three simultaneous operations of magnets RM1 and RM2 step the pin setting arm 150 six steps from the last occupied position to a new position above the sixth pin for the incoming digit 6 Series relay 284 deenergizes shortly after the third, or last, release of pulse relay 270 for this digit and at front contacts 286 opens the circuit to slow to release relay 285 which maintains its armature attracted for a short interval. During this short interval a circuit may be traced for energizing the pin setting magnet PSM as follows: from ground at back contacts 286, contacts 287, conductor 305 and thru the winding of pin setting magnet PSM to battery.

Magnet PSM momentarily operates its armature 127, the rod 140 and pin setting arm 150 to displace this selected sixth pin 160 to position it in the path of arm 190 of the sending member. Shortly after relay 284 releases relay 285 also releases and opens the circuit to magnet PSM which restores. Pin setting arm 150, the rod 140 and armature 127 are restored in response to the release of magnet PSM. It should be mentioned that as soon as the pin setting arm 150 is moved from its last occupied position, or the position corresponding to the occupied position of arm 190, cam 171 is rotated in unison with arm 150 and therefore cam 171 permits contacts 193 and 194 to close thereby preparing a circuit for controlling the retransmission of outgoing impulses. Transmission of these impulses, however, do not take place until the selector 360 is connected and ready to receive such impulses. All of the above circuit operations have taken place in response to the actuation and release of key 6.

Assuming that the next, or second, digit dialed is an odd number, digit 5 for example, the rocker arm and plate 48 are operated in response to the downward stroke of key 5 to permit the closure of springs 70 thereby connecting ground to contacts 73. The shunt springs 71 are again closed during the time the clutch is off normal and the impulse shaft and impulse wheel 78 are rotated a distance corresponding to three steps, or three cams of the impulse wheel 78, when key 5 restores. The impulse wheel 78 transmits two loop impulses and a ground pulse in this case because springs 70 are closed and are therefore effective when springs 73 close during the last impulse to change the last transmitted impulse from a loop to a ground impulse. Arm 77 is operated on the return operation of the clutch to close springs 73 during transmission of the last impulse in each series. During the transmission of the last pulse for each odd digit a circuit may be traced for maintaining line relay 230 energized while line relay 220 deenergizes. This circuit may be traced as follows: from ground at contacts 70, closed on all odd digits, contacts 73 closed on only the last pulse of each series, springs 80 and 81, shunt

springs 71, conductor 218, back contacts 211, upper left-hand winding of repeat coil RC and through the winding of line relay 230 to battery. Therefore, line relay 220 deenergizes three times and line relay 230 deenergizes only twice whenever the number 5 digit key is actuated and released. Rotary magnet RM1 is therefore operated and released three times while rotary magnet RM2 is operated and released two times thereby stepping pin setting arm 150 equivalent to five steps to select another pin in the manner similar to that previously described.

Relays 284 and 285 again operate, after transmission of the last pulse for digit 5, to momentarily operate the pin setting magnet PSM which in turn operates the pin setting arm 150 to displace the last selected pin 160 into the path of arm 190.

Subsequent digits are transmitted and registered in the mechanical dial repeater in the same manner as above described, it being remembered that loop impulses are transmitted for each even numbered digits and that both loop and a ground pulse are transmitted for each odd digit. For example, five loop impulses are transmitted from the calling device to line relays 220 and 230 for the digit "0," the line relays translating these five impulses into ten pulses to magnets RM1 and RM2, five to each magnet, for causing the mechanical repeater to take ten steps to select and operate the tenth pin. For the digit "9" four loop pulses, followed by a ground pulse, are transmitted from the calling device to line relays 220 and 230 to operate rotary magnets RM1 and RM2. In this case magnet RM1 is operated five times and magnet RM2 four times making a total of nine steps taken by the repeater to select the ninth pin. For the digit "1" only a single ground pulse is sent and line relay 220 alone transmits a single pulse to magnet RM1 to step the repeater one step.

For the digit "2" only a single loop pulse is transmitted from the calling device and both line relays 220 and 230 transmit a pulse to each of the magnets RM1 and RM2 to cause the repeater to take two steps. The other digits are transmitted and registered in the repeater in a manner apparent from the foregoing description.

Returning now to the operation of the distributor 350 and finder 340 and as a result of the operation of line relay 310, the finder wipers are operated in a vertical direction in the well-known manner until vertical wiper 344 encounters the vertical bank contact 334 marked by ground at contacts 313. As is well-known the finder wipers are now rotated in this level in search of the marking potential applied through the winding of cut-off relay 320 to bank contact 333. When finder test wiper 343 encounters this potential the switching relay (not shown) in the finder switches the line and test leads through to selector 360 and also completes the circuit for operating cut-off relay 320 from conductor 377, wiper 343, bank contact 333, contacts 311 and through the winding of relay 320 to battery. Cut-off relay 320 at contacts 321 disconnects line relay 310 and at contacts 323 completes a locking circuit for itself independent of contacts 311 from grounded conductor 377. Line relay 310 deenergizes and at contacts 311 opens the original energizing circuit of relay 320 which is now locked up through its own contacts. At contacts 313 relay 310 disconnects the marking ground from vertical bank contact 334 and start ground from the distributor 350. At front contacts 312 relay 310 disconnects direct ground from conductor 302 and the test conductor of the connector multiples but at the back contacts of armature 312 relay 310 substitutes ground extending by way of conductor 377, wiper 343, bank contact 333, contacts 323, and back contact 312 for maintaining conductor 302 and the test conductor of the connector multiples grounded thereby maintaining this line busy to the connectors.

When the finder switches through to the selector a circuit is completed for energizing line relay 370 as follows: from ground at contacts 242, contacts 226, right hand windings of repeating coil RC and resistance R2, front contacts 261, conductor 300, finder bank contact 331, finder line wiper 341, through contacts of the switching relay (not shown) in the finder and the upper winding of line relay 370 to battery. Line relay 370 energizes and operates the slow-to-release relay (not shown) in the selector to cause the latter relay to ground conductor 375 in the customary manner.

As soon as the finder finds the calling line and switches through to the selector a circuit is completed for operating relay 240 which initiates the retransmission of the digits registered in the repeater. Retransmission of the first digit may take place after the finder switches through while the repeater is still receiving subsequent digits from the calling device. The circuit for energizing relay 240 may be traced as follows: from ground through the lower winding of selector line relay 370, over the selector and finder line conductors to finder line wiper 342, bank contact 332, conductor 301, front contacts 262, contacts 246 and through the lower winding of relay 240 to battery. At contacts 244 and 245 relay 240 completes a locking circuit for its lower winding from grounded conductor 302 and opens its original energizing circuit at contacts 246.

At contacts 241 and 243 completes a loop circuit as well as the pulsing circuit for selector line relay 370 in place of its original energizing circuit from contacts 242. This circuit extends from ground through the lower winding of line relay 370, wiper 342, bank contacts 332, line conductor 301 front contacts 262, contacts 241 and 243, impulsing contacts 226, right-hand windings of repeat coil RC and resistance R2, front contacts 261, line conductor 300, bank contact 331, wiper 341, over the line conductors in the finder and selector through the upper winding of line relay 370 to battery. At contacts 247 relay 240 completes a circuit for relay 233 which is the first relay of a chain of three relays for controlling the transmission of outgoing pulses from the repeater. The circuit for energizing relay 233 may be traced as follows: from ground at contacts 223, contacts 247 and 253, conductor 308 through the frame of the repeater to stop contacts 197 and 198, repeater cam contacts 193 and 194, spring wiper contact 192, conducting ring 195, conductor 309, contacts 227 and through the winding of relay 233 to battery.

Relay 233, upon energizing, at contacts 232 completes an obvious circuit for energizing relay 228 and at contacts 234 completes a locking circuit for itself through contacts 227. At contacts 235 relay 233 completes an obvious circuit for slow-to-release relay 237 and also completes a circuit over conductor 306 for energizing sending magnet SM. Relay 237 at front contacts 238 completes a circuit for energizing slow-to-release relay 224 and at contacts 236 maintains conductor 308 grounded after energization of re-

lay 224. Relay 228 at contacts 229 completes an obvious circuit for energizing pulsing relay 225. Relay 224 at contacts 255 prepares a point in the circuit for pin restoring magnet PRM and at contacts 222 connects the Send Tone source through condenser C1 to the upper talking conductor for the purpose of advising the calling subscriber that the repeater is transmitting the registered digits. The disconnection of ground at contacts 223 is without effect because ground at contacts 236 has been substituted therefore.

Pulsing relay 225, upon energizing, at pulsing contacts 226 opens the previously traced loop circuit extending to selector line relay 370 to deenergize line relay 370 for the first pulse. At contacts 227 relay 225 opens the circuit for relay 233 whereupon relay 233 deenergizes to open the circuit of relay 228 at contacts 232 and to open the circuit of relay 237 and sending magnet SM. Relay 237, due to its slow-to-release characteristics, maintains its armature attracted during the retransmission of a series of pulses comprising a digit. Sending magnet SM deenergizes and steps the pin restoring arm 190 of the sending member one step over the next adjacent pin 160. Relay 228, upon deenergizing, at contacts 229 opens the circuit of pulsing relay 225 which closes the loop circuit to selector relay 370 at contacts 226 and which closes the original energizing circuit of relay 233 at contacts 227. Relay 233 again operates thereby again operating relay 228 and sending magnet SM as well as recompleting the circuit for relay 237 before it is restored. Relay 228 again operates pulsing relay 225 which again opens the loop circuit to line relay 370 to transmit another pulse at contacts 226 and again opens the circuit to relay 233 which deenergizes. Relay 233 again releases and opens the circuits to relay 228 and sending magnet SM which operates restoring arm 190 of the sending member another step. Relays 225, 228 and 233 operate and release within predetermined times according to their characteristics to cause the relay 225 to transmit loop pulses in accordance with the standard time intervals normally required for the operation of the automatic switches. Relays 228, 225, 233 and sending magnet SM operate in this manner until sending magnet SM operates restoring arm 190 to the first displaced pin 160 corresponding to the first registered digit. When the displaced pin is reached repeater stop spring 197 is disengaged from spring 198 with the result that the circuit for relay 233 is not again completed during the transmission of impulses for this registered digit. The selector line relay 370 is deenergized for each pulse to step the selector wipers in a vertical direction to select a group of trunks in the level corresponding to the retransmitted digit in the well-known manner.

Shortly after stop springs 197 and 198 are opened by the 1st displaced pin relay 237 deenergizes since the circuit to relay 233 was opened by the stop springs. At contacts 236 relay 237 disconnects ground from conductor 308, at front contact 238 opens the circuit to slow-to-release relay 224 which maintains its armature operated for a short period thereafter and at back contacts 238 momentarily completes a circuit through contacts 255 and over conductor 307 for the pin restoring magnet PRM.

Pin restoring magnet PRM is momentarily operated to operate its armature 125 and pin restoring rod 179 thereby pivotally operating pin restoring arm 190 to restore the displaced pin to its normal position. Shortly thereafter slow-to-release relay 224 deenergizes and at contacts 255 opens the circuit of pin restoring magnet PRM which restores its armature 125. The pin restoring rod 179 and pin restoring arm 190 are thereby restored to normal and stop springs 197 and 198 are permitted to close. The selector 360 is automatically operated in its rotary movement to select an idle trunk in the selected level during the release time of relays 237 and 224. When relay 224 closes contacts 223 the original circuit previously traced for relay 233 is again closed to energize relay 233. Relays 225, 228, 233, 237 and 224 operate in the same manner as previously described, relay 225 to transmit loop pulses at contacts 226 to operate subsequent automatic switches, relay 233 to transmit pulses to operate sending magnet SM until stop springs 197 and 198 are opened by the second displaced pin and relays 237 and 224 to control the operation and release of pin restoring magnet PRM as well as reinitiating the reenergization of relay 233 for a subsequent digit. In the same manner as just described, all of the registered digits, as determined by the displaced pins are retransmitted to operate the automatic switches to complete the connection to the called line. When the last pulse of the last registered digit is transmitted spring 194 engages cam 171 to separate springs 193 and 194 thereby preventing reenergization of relay 233. Springs 193 and 194 remain open until the pin selecting member and cam 171 are rotated on a subsequent call. Shortly after the last retransmitted digit sending tone is disconnected from the upper talking conductor thereby informing the calling subscriber that the repeater has completed retransmission of the digits.

When the called subscriber answers the talking circuit is completed over the talking circuit comprising the heavy talking conductors and repeating coil RC, the called subscriber being fed talking battery from the battery feed relay in the connector in the usual manner while the calling subscriber is fed talking battery through the windings of line relays 220 and 230.

After conversation and in response to the replacement of the handsets at both calling and called substations the apparatus and switch train is released. In response to the replacement of the handset at the calling substation line relays 220 and 230 deenergize and the latter relay at front contacts 231 opens the circuit of release relay 260. At back contacts 231 and 221 relays 290 and 295 again energize but the energization of these relays is without effect this time since the line relays are not reenergized as during pulsing. Relay 260 deenergizes after an interval and at contacts 263 and 265 open the locking circuits of relays 290 and 295 which deenergize. At contacts 268 relay 260 grounds conductor 308 to automatically restore, or spill out, any registered digits in the repeater in case a subscriber initiates and only partly registers some of the calling party's digits and then abandons the call. At contacts 261 and 262 relay 260 opens the loop circuit across conductors 300 and 301 to release the automatic switch train in the usual manner if not already released.

In response to the replacement of the handset on the cradle at either the calling or called party's desk set ground is removed from the control conductor 375 in the usual well-known manner. In response to this removal of ground, cut-off relay 320 and relay 240 deenergize. All of the apparatus is now returned to normal and may be used on subsequent calls.

In case the calling subscriber should abandon a call after one or more digits have been registered in the repeater the line relays 220 and 230 and the release relay 260 deenergize in the same manner as previously described. At contacts 261 and 262 the loop circuit to the automatic switch train is opened to release the switch train and the circuit to relay 240 is opened to cause the latter relay to release. At contacts 268 relay 260 grounds conductor 308 to cause the operation of relay 233 and the transmission of the registered digits stored in the repeater. The circuit for operating relay 233 extends from ground by way of contacts 268, conductor 308, through the frame of the repeater to the pin restoring arm 190, through stop springs 197 and 198, cam springs 193 and 194, wiper contact 192 and conducting ring 195, conductor 309, contacts 227 and through the winding of relay 233 to battery. In the same manner as previously described relay 233 operates relay 228, relay 237 and sending magnet SM. Relay 228 operates relay 225 which releases relay 233. Relay 225 operates its contacts 226 as before but since the loop circuit is opened at contacts 261 and 262 the operation of contacts 226 is without effect and the stored impulses may be "spilled out" without operating any switches. Stop springs 197 and 198 are controlled by the displaced pins corresponding to the stored digits to control the operation of relays 233, 237 and 224 and pin restoring magnet PRM in the same manner as previously described to restore all of the displaced pins. At the time the last pin is restored cam 171 opens cam springs 193 and 194 to stop further operations of relay 233. The repeater is now restored to normal and may be used on subsequent calls.

Incoming calls are completed by way of the connector multiples Conn. Mult. when a connector (not shown) engages these bank contacts. The automatic connector in the well-known manner grounds conductor 302 over the test bank contact to energize line cut-off relay 320. At contacts 321 relay 320 disconnects line relay 310 from conductor 300. The connector then connects ringing generator to the negative line conductor 300 to energize ring relay 210 by way of back contacts 261 and condenser C2. Each time ring relay 210 energizes in response to ringing current said relay at back contacts 211 and 212 disconnects the subscriber's line from the repeating coil RC and line relays 220 and 230 and at front contacts 211 and 212 completes the ringing circuit by way of conductor 218, ringer R, cradle springs 217, condenser C and conductor 219 for signalling the called subscriber. When the called subscriber answers by removing the handset from its cradle a direct current bridge, including cradle springs 215, is closed across conductors 300 and 301 to stop further applications of ringing current in the well-known manner. At contacts 213 relay completes an obvious circuit for energizing relay 250 which at contacts 252 locks itself to grounded conductor 302. At contacts 251 relay 250 completes an energizing circuit through the upper winding of relay 240 thereby causing the energization of relay 240 which also locks to grounded conductor 302 at contacts 244 and 245. At contacts 241 and 243 relay 240 prepares a point in the talking circuit.

After the called subscriber has removed his handset and when ring relay 210 is deenergized line relays 220 and 230 are energized over the subscriber's loop. At front contacts 231 the circuit is completed for energizing release relay 260 which energizes and completes the talking circuit at front contacts 261 and 262. Although relays 290 and 295 energize at this time, such energization is without effect for the reasons previously mentioned. Line relays 220 and 230 feed talking battery to the called subscriber while talking battery to the calling subscriber is fed from the connector switch. The talking circuit includes the heavy talking conductors, back contacts 211, 212, the windings of the repeat coil RC and front contacts 261 and 262.

After conversation and in response to the replacement of the handset, line relays 220 and 230 and release relay 260 deenergize. At front contacts 261 and 262 the loop circuit to the connector switch is opened to permit the release of the connector. When the connector releases ground is removed from conductor 302 to release relays 240, 250 and 320. The relays and apparatus are now all restored to normal and may be used on subsequent calls.

What is claimed is:

1. In an automatic telephone system, a subscriber's line, impulse receiving and retransmitting means individual to said subscriber's line and operative in response to a plurality of series of impulses transmitted thereto by the calling subscriber to store said plurality of series of impulses, a plurality of finders having access to said line, means responsive to the initiation of a call on said line for initiating the operation of one of said finders to hunt for the calling line, a selector switch associated with said one finder, means responsive to said one finder finding the calling line for connecting the calling line to said selector switch in readiness to receive impulses, and means for initiating the retransmission of said stored series of impulses over said last mentioned connection in response to the conditioning of said selector switch to respond to said impulses.

2. In an automatic telephone system, a subscriber's line, impulse receiving and retransmitting means individual to said subscriber's line and operative in response to a plurality of series of impulses transmitted thereto by the calling subscriber to store said plurality of series of impulses, a plurality of finders having access to said line, means responsive to the initiation of a call on said line for initiating the operation of one of said finders to hunt for the calling line, a selector switch associated with said one finder, means responsive to said one finder finding the calling line for connecting the calling line to said selector switch in readiness to receive impulses, means for initiating the retransmission of said stored series of impulses over said last mentioned connection in response to the conditioning of said selector switch to respond to said impulses, and means for transmitting a sending tone to the calling subscriber during the retransmission of said stored pulses.

3. In an automatic telephone system, a subscriber's line, a push-button calling device individual to said line and operative to transmit digits comprising coded pulses, circuit translating means individual to said line operated in response to the receipt of said coded pulses for translating said coded pulses into ground pulses corresponding to the transmitted digits, impulse receiving and retransmitting means operated in response to said translated ground pulses for storing said transmitted digits, a plurality of finders having access to said line, means respon-

sive to the initiation of a call on said line for initiating the operation of one of said finders to hunt for the calling line, a selector switch associated with said one finder, means responsive to said one finder finding the calling line for connecting the calling line to said selector switch in readiness to receive impulses, and means for initiating the retransmission of said stored digits over said last mentioned connection in response to the conditioning of said selector to respond to impulse transmission.

4. In an automatic telephone system, a calling device for transmitting coded digits comprising one or a plurality of loop pulses and a ground pulse corresponding to certain digits, a pair of line relays both operated in response to each transmitted loop pulse and only one of said relays operated in response to each transmitted ground pulse, circuit means controlled by each of said line relays for translating said coded digits comprising loop and ground pulses into pulses corresponding in number to the actual value of the transmitted digit, and an impulse receiving and retransmitting means operated in response to said translated digits for storing said translated digits.

5. In an automatic telephone system, a calling device for transmitting coded digits comprising one or a plurality of loop pulses, the number of loop pulses in a coded digit being equal to one-half the value of the digit transmitted, a pair of line relays both operated in response to each transmitted loop pulse, circuit means controlled by the operations of said line relays for translating each loop pulse into a plurality of pulses thereby translating the coded digits into pulses corresponding in number to the actual value of the transmitted digit, and an impulse receiving means operated by said translated pulses.

6. In an automatic telephone system, means for transmitting loop pulses, a pair of line relays both operated in response to each transmitted loop pulse, circuit means controlled by the operations of said line relays for translating each loop pulse into a plurality of pulses, and an impulse receiving means operated by each of said plurality of translated pulses.

7. In an automatic telephone system, means for transmitting loop pulses, a pair of line relays both operated in response to each transmitted loop pulse, circuit means controlled by the operations of said line relays for translating each loop pulse into a plurality of pulses, an impulse receiving means having a plurality of stepping magnets, and means for simultaneously operating said plurality of stepping magnets in response to each said translated plurality of pulses to step said impulse receiving means a plurality of steps to make a selection.

8. In an automatic telephone system, means for transmitting loop pulses, a pair of line relays both operated in response to each transmitted loop pulse, circuit means controlled by the operations of said line relays for translating each loop pulse into a plurality of pulses, an impulse receiving means having a plurality of stepping magnets, a selecting device in said impulse receiving means, means for simultaneously operating said plurality of stepping magnets in response to each said translated plurality of pulses, and a differential gear mechanism operated by the simultaneous operation of said stepping magnets for operating said selecting device a plurality of steps to make a selection in accordance with the number of translated pulses received.

9. In a telephone system, a calling device for transmitting pulses in accordance with the digits in a called number, an impulse receiving and retransmitting device including a selecting arm operated step by step in response to the incoming pulses transmitted from said calling device to make selections in certain positions in accordance with the transmitted digits, a sending arm in said device normally having the same relative position as said selecting arm and adapted to follow said selecting arm, a stepping magnet for operating said sending arm over the same path as said selecting arm, circuit means including a plurality of relays for controlling the transmission of outgoing pulses and for correspondingly operating said stepping magnet to operate said sending arm step by step to the positions selected by said selecting arm, a circuit controlled by said sending arm at each said selected position for controlling said circuit means and relays to divide said outgoing pulses into groups corresponding to the digits transmitted from said calling device, an automatic switch train, and means for delaying the operation of said circuit means and said relays until such time as said automatic switch train is ready to respond to said outgoing pulses.

10. In a telephone, a subscriber's line, a pair of line relays terminating said subscriber's line; a calling device at the subscriber's substation for transmitting impulses comprising a pair of interrupter springs, a make-before-break spring for controlling said interrupter springs, a pair of grounding springs, and a pair of normally open springs closed only during the transmission of the last impulse of each series, a loop pulsing circuit including both said line relays, said interrupter springs and both conductors of said line in series; a grounded pulsing circuit including said pair of grounding springs, said pair of normally open springs, said make-before-break spring and one of said interrupter springs, one of the line conductors of said line, and one of said line relays in series; and subscriber controlled means for operating said calling device to transmit loop and ground impulses over said impulsing circuits to operate said line relays whereby both said line relays deenergize for each loop impulse and said one line relay is maintained energized over said grounded pulsing circuit while the other line relay deenergizes during each ground impulse.

11. In a telephone system, a subscriber's line, a pair of line relays terminating said line, subscriber controlled means for operating said line relays in response to the initiation of an outgoing call and in response to answering an incoming call and for restoring said line relays in response the subscriber disconnecting from such calls, subscriber controlled means for restoring and reoperating said line relays by transmitting impulses thereto, pulsing relays, means controlled by the restorations and reoperations of said line relays during impulse transmission for operating said pulsing relays to transmit outgoing impulses, and means including said last means for preventing the operation of said pulsing relays during the operations and restorations of said line relays for initiating outgoing calls, for answering incoming calls and for disconnecting from such calls.

12. In a telephone system, a subscriber's line, a pair of line relays terminating said line, subscriber controlled means for operating said line relays in response to the initiation of an outgoing call and in response to answering an incoming call and for restoring said line relays in response to the subscriber disconnecting from such

calls, an impulse calling device on said subscriber's line for transmitting loop and ground pulses over said line to restore and reoperate said line relays a plurality of times dependent upon the number of loop and ground pulses transmitted, a pair of pulse repeating relays for transmitting outgoing impulses, means controlled by the restorations and reoperations of said line relays during loop impulsing for operating both said pulsing relays to transmit a pair of outgoing impulses for each loop pulse and during ground impulsing for operating only one of said pulsing relays to transmit a single outgoing pulse for each ground pulse, and means including said last means for preventing operations of said pulse repeating relays during the operations and restorations of said line relays for initiating outgoing calls, for answering incoming calls and for disconnecting for such calls.

13. In a telephone system, a subscriber's line, a pair of line relays terminating said line, an impulse calling device on said line for transmitting loop and ground pulses over said line to operate said line relays, both said lines being operated in response to each loop pulse and only one of said line relays being operated in response to each ground pulse, a pair of pulse repeating relays operative for transmitting outgoing impulses, a separate circuit for controlling the operations of each of said pulse repeating relays, contacts on said one of said line relays for controlling one of said separate circuits, and contacts on the other of said line relays for controlling the other of said separate circuits.

14. In a telephone system, a subscriber's line, a pair of line relays terminating said line, an impulse calling device on said line for transmitting loop and ground pulses over said line to operate said line relays, both said lines being operated in response to each loop pulse and only one of said line relays being operated in response to each ground pulse, a pair of pulse repeating relays operative for transmitting outgoing impulses, a separate circuit for controlling the operations of each of said pulse repeating relays, contacts on said one of said line relays for controlling one of said separate circuits, contacts on the other of said line relays for controlling the other of said separate circuits, and an impulse receiving and registering device controlled by the transmission of said outgoing impulses in response to the operations of pulse repeating relays.

15. In a telephone system, a subscriber's line, a calling device on said subscriber's line for transmitting both loop and ground pulses corresponding to the digits in a called number in response to the subscriber initiating a call, an impulse receiving and registering device inidividual to said subscriber's line operated in response to said loop and ground pulses of said transmitted digits for registering said digits, automatic switches, means including said receiving and registering device for retransmitting said registered digits as loop impulses only to operate said automatic switches to complete the desired connection in accordance with said registered digits, and means operative in the event the calling subscriber abandons the call for operating said receiving and registering device to erase said registrations without operating any of said automatic switches.

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