

July 23, 1929.

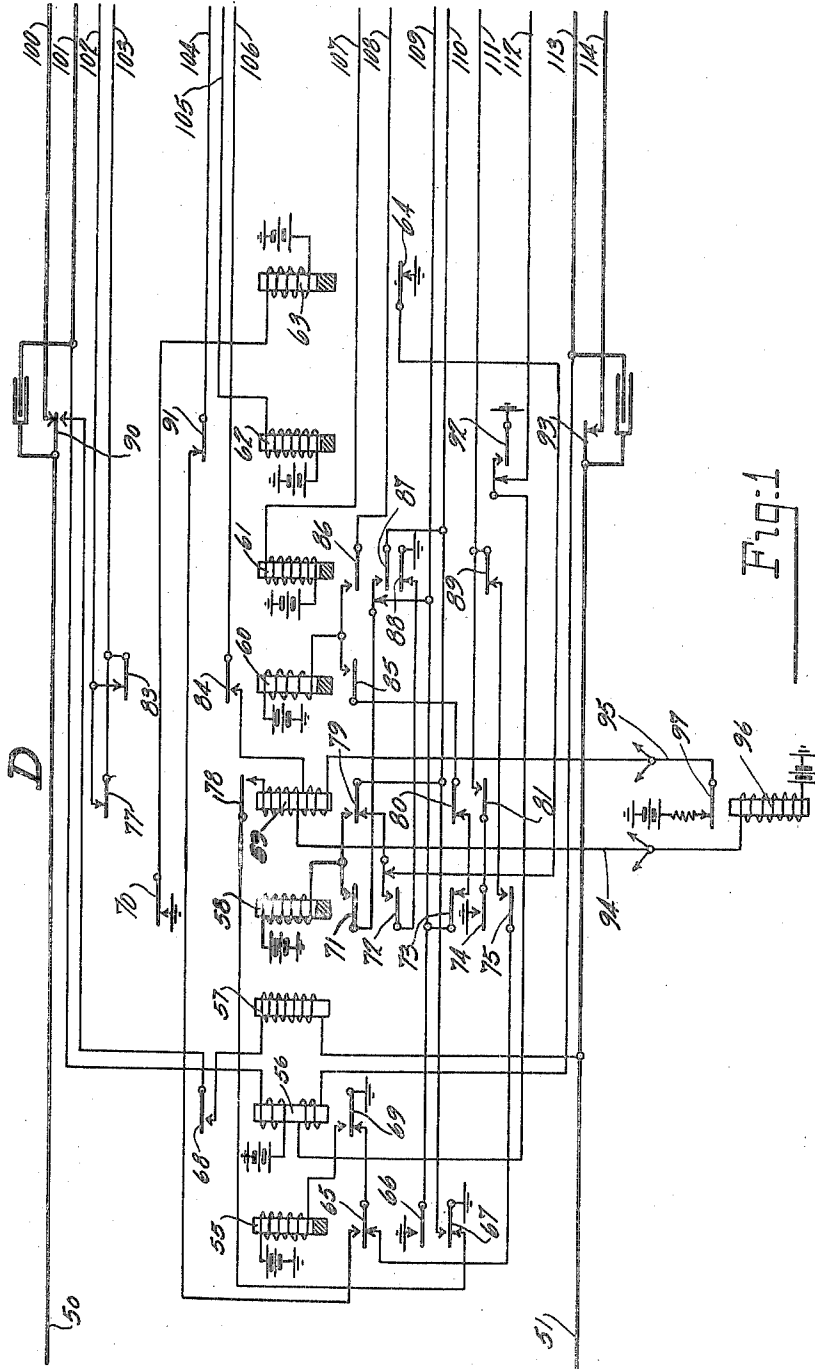
R. G. RICHARDSON ET AL

1,721,748

AUTOMATIC TELEPHONE SYSTEM

Original Filed July 8, 1921

3 Sheets-Sheet 1



— Inventors —
Rodney G. Richardson—John E. Gardner
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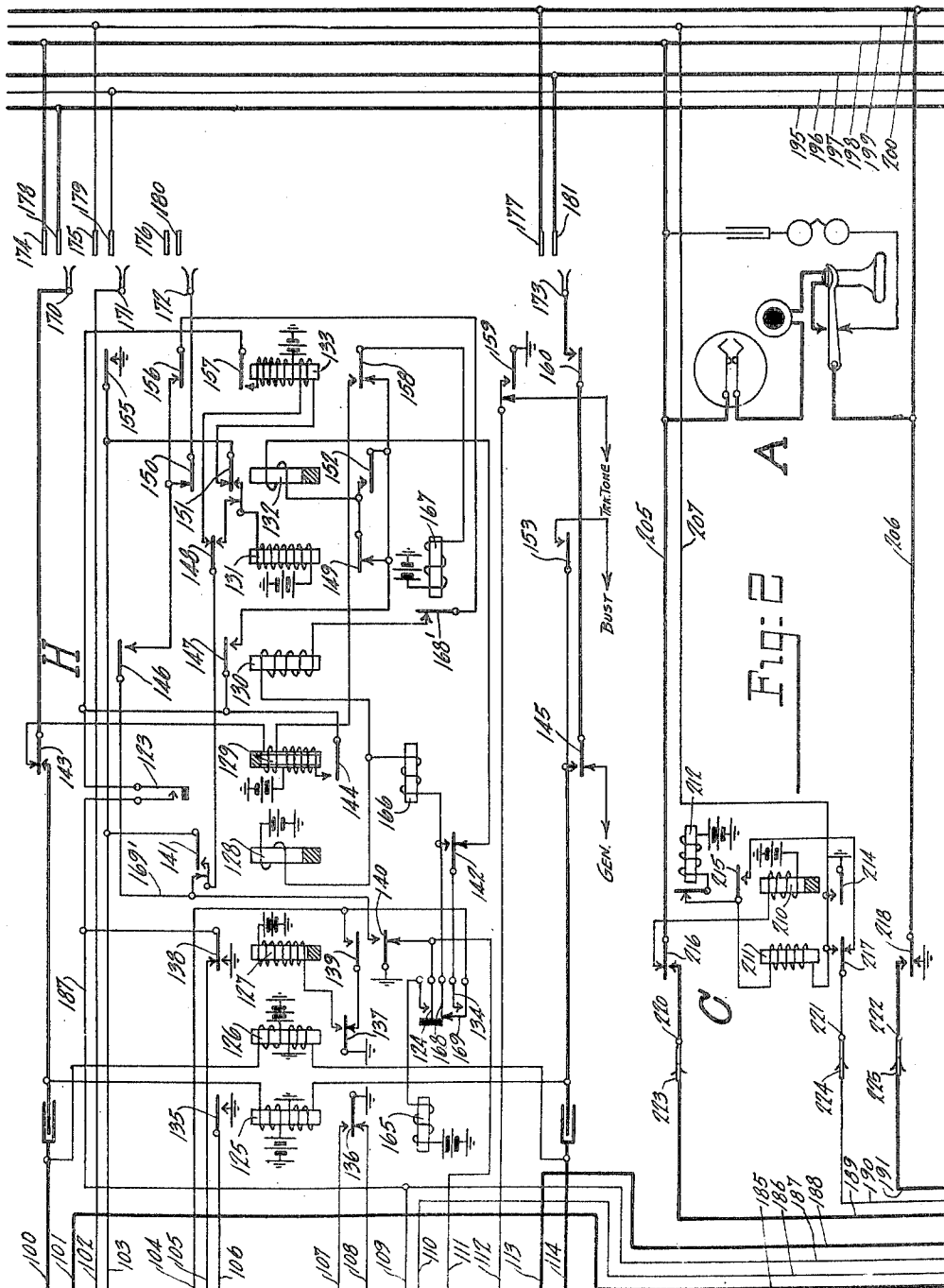
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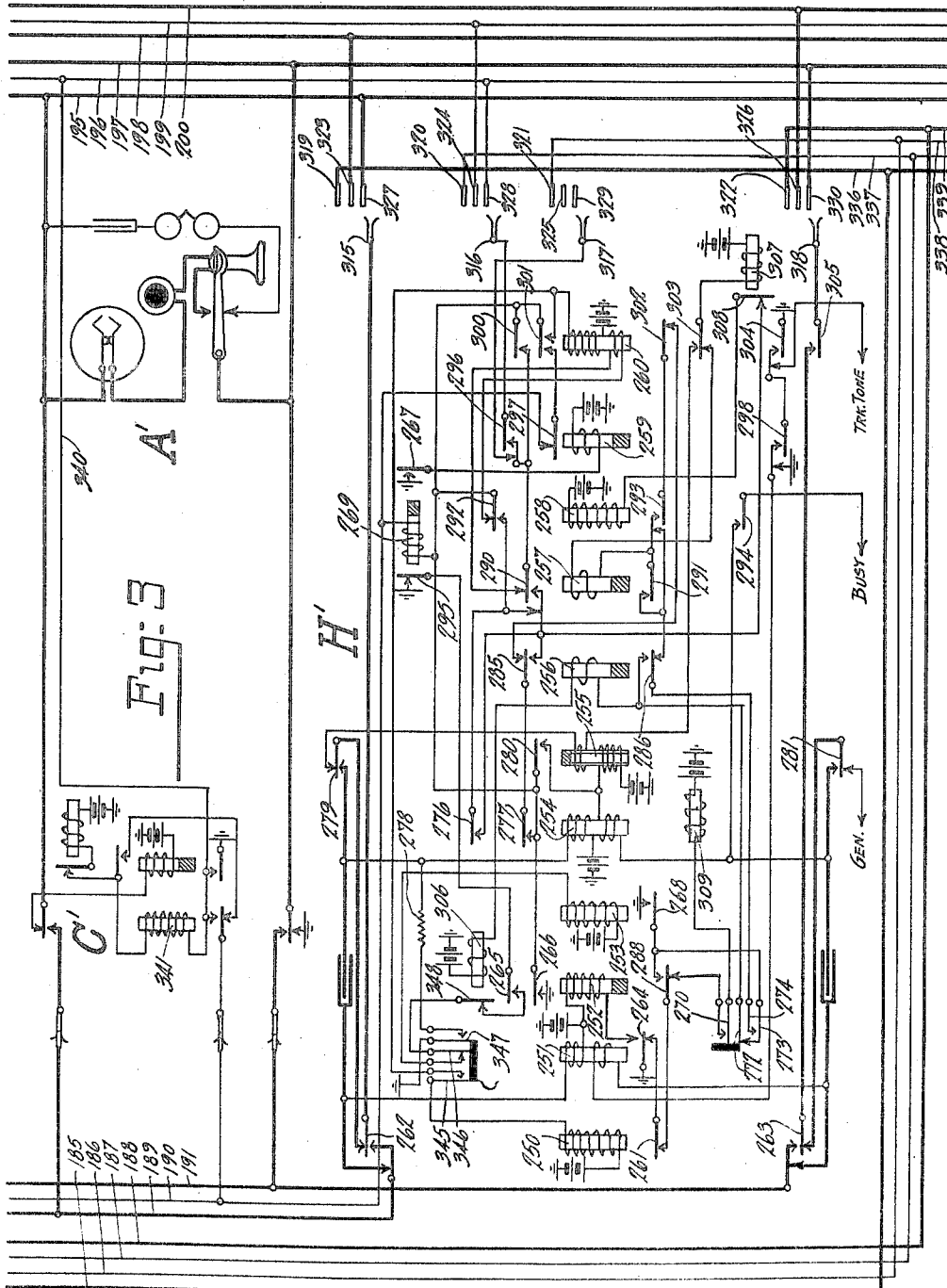
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UNITED STATES PATENT OFFICE.

RODNEY G. RICHARDSON AND JOHN E. GARDNER, OF CHICAGO, ILLINOIS, ASSIGNORS,
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AUTOMATIC TELEPHONE SYSTEM.

Application filed July 8, 1921, Serial No. 483,333. Renewed February 19, 1926.

The present invention relates in general to automatic telephone systems, and is more particularly concerned with such systems as are usually installed in mercantile establishments and the like, and which are commonly known at private automatic exchanges.

More specifically, the invention relates to the provision of improvements in the so-called passing or transfer call service which is used in systems of this character. Heretofore, a number of passing call schemes have been designed embodying a number of different principles of operation, and in the present invention still other novel operating principles are proposed which it is believed will render these systems more efficient and practical and add to their commercial value.

There are other objects of the invention not now specifically mentioned which, together with the foregoing, will be described hereinafter with reference to the accompanying drawings.

Referring now to the drawings, comprising Figs. 1, 2 and 3, therein is shown by means of the usual circuit diagrams sufficient of the apparatus of an automatic telephone system to enable the invention to be readily understood. In Fig. 1 is shown a two way trunk line comprising conductors 50 and 51 incoming to a private automatic exchange from the main office. This trunk line extends through the repeater D and terminates in the incoming connector H, Fig. 2. The relay group D is a form of repeater which is associated with the incoming connector H, and is used when a call is transferred from one party to another in the private automatic exchange, and is also used on outgoing calls over the trunk line comprising conductors 50 and 51 to the main exchange.

The incoming connector H, Fig. 2, is a switch of the usual Strowger type, the circuits of which have been slightly modified in accordance with the features of the present invention. The connector H has access to local subscribers' lines, two of which are shown at A, Fig. 2, and A', Fig. 3.

These substations are of the usual automatic type and are provided at the exchange with the individual line switches C and C'.

These line switches are of the well known rotary type, and in common with the other line switches have access to trunk lines lead-

ing to local connector switches, one of these trunk lines being shown in the drawings terminating in the local connector H', Fig. 3.

The connector H', like the connector H, is of the well known Strowger type, and has the usual set of 100 bank contacts divided into ten rows, or levels. From the first nine levels of bank contacts the connector H' has access to local subscribers' lines in the same manner as has the incoming connector H. From the tenth level the connector H' has access to trunk lines such as the trunk line comprising conductors 50 and 51, Fig. 1, extending to the main exchange. In addition to the above, the connector H' is adapted to operate as a finder switch under certain conditions as will appear fully hereinafter.

Calls from the main exchange to the private automatic exchange.

Having briefly described the apparatus shown in the drawings, a detailed description of its operation will now be given. For this purpose it will be assumed that a calling subscriber in the main exchange desires to call the subscriber at substation A, Fig. 2, in the private automatic exchange, and it will be assumed further that the calling subscriber has operated a series of selector switches and finally a selector repeater in the main exchange to extend a connection to the trunk line comprising conductors 50 and 51. Immediately upon the trunk line, comprising conductors 50 and 51, being seized by the selector repeater in the main exchange, a bridge is placed across these trunk conductors and the line relay 126 of the incoming connector switch H is energized over the two trunk conductors in series. Upon energizing, relay 126 completes the circuit of the slow acting relay 127. The latter relay, upon energizing, at its armature 139 prepares the operating circuits of the incoming connector H and at armature 138 places ground upon the release trunk conductor 187 which extends to multiple bank contacts in the banks of the local connector switches, such as bank contact 320 accessible to the connector H', whereby the two way trunk line comprising conductors 50 and 51 is prevented from being seized for an outgoing call to the main exchange.

The calling subscriber in the main exchange may now operate his calling device in accord-

ance with the next digit of the desired number. By this operation a series of interruptions is produced in the circuit of the line relay of a selector repeater in the main exchange and this series is repeated to the line relay 126 of the incoming connector H in the usual manner. Relay 126 retracts its armature a plurality of times in response to the interruptions in its line circuit, each time sending an impulse of current over the following path: from ground by way of armature 137 and its back contact, armature 139 and its front contact, off normal springs 169 and 168, through the winding of the vertical magnet 166, and thence through the winding of the slow acting relay 128 to battery. The above is the circuit over which the first vertical magnet impulse is sent, but upon the first vertical step of the switch the off normal springs are shifted and the remaining impulses to the vertical magnet traverse a new circuit which is the same as the one previously traced, except that it includes the off normal springs 169 and 134, and armature 142 and its front contact, relay 128 being now in operated position. The vertical magnet 166 operates to raise the switch wipers 170 to 173, inclusive, step by step until they are placed opposite the level of bank contacts in which is located the contact set associated with the line of substation A. The slow acting relay 128 is energized in series with the vertical magnet and retains its armature attracted throughout the vertical movement of the switch, and at the termination thereof deenergizes and transfers the operating circuit to the rotary magnet 167.

The calling subscriber may now operate his calling device for the next and final digit of his desired number. As before, a series of interruptions is produced in the circuit of the line relay of the selector repeater in the main exchange and these are repeated to the line relay 126 of the connector H. The line relay 126 retracts its armature a plurality of times in response to these interruptions, each time sending an impulse of current from ground by way of armature 137 and its back contact, armature 139 and its front contact, off normal springs 169 and 134, armature 142 and its back contact, through the winding of the slow acting relay 132, armature 149 and its back contact, back contact and armature 158, and thence through the winding of the rotary magnet 167 to battery. The rotary magnet 167 operates to rotate the switch wipers 170 to 173, inclusive, into engagement with the set of bank contacts associated with the line of the called substation A, which, we will assume, are the bank contacts 174 to 177, inclusive. The slow acting relay 132 energizes in series with the rotary magnet and operates at its armature 151 to connect the test wiper 171 to the test relay 131.

Assuming that the desired line is busy at

this time, there will be a ground potential present upon the test contact 175 engaged by the test wiper 171 and a circuit will be completed extending from ground on the said test contact by way of the said test wiper, conductor 102, back contact and armature 77, conductor 103, armature 151 and its front contact, and through the winding of the test relay 131 to battery. Relay 131, upon energizing, prepares a point in its locking circuit at armature 148 which is closed immediately upon the deenergization of the slow acting relay 132, and at armature 153 places a busy tone from the busy machine on the lower heavy talking conductor. The calling subscriber, being informed by this signal that the desired line is inaccessible at the present time, replaces his receiver, thereby releasing the operated switches in a manner which will be described hereinafter.

The above is the normal operation of the connector H when the called line is busy, provided that this line is not one of a group of lines. Should the line of substation A be one of a group of lines listed under the same telephone number, it will be necessary to change the circuits of the connector H so as to enable it to select an idle line in the group of lines, or if all lines of the group are busy to return the busy signal to the calling subscriber. In order to effect these circuit changes the test contacts such as test contacts 175 and 176 of all the lines in the group except the last are connected together. Now when one of these grouped lines become busy there will be a ground potential present upon both the test contacts, such as 175 and 176. In order to describe the operation of the connector H under these conditions, it will be assumed that the line of substation A is one of a group of lines and it will, therefore, have its test contacts 175 and 176 connected together. Under these circumstances, immediately upon the connector H being operated into engagement with the bank contacts 174 to 177, inclusive, there being a ground potential on both the test contacts 175 and 176, the relay 131 will be energized as before described. Then, upon the deenergization of the slow acting relay 132, a circuit is completed which may be traced from grounded test contact 176, test wiper 172, armature 150 and its back contact, back contact and armature 156, armature 168' and its back contact, through the winding of relay 130 and thence through the winding of the slow acting relay 128 to battery. Both relays 128 and 130 are energized over this circuit. Relay 130, upon operating, establishes a locking circuit for itself at armature 146 which includes the interrupter contact 168' of the rotary magnet, and at armature 147 completes the rotary magnet circuit. Magnet 167 operates to rotate the switch wipers 170 to 173, inclusive, into engagement with the next set of bank

contacts and at armature 168' breaks the circuit of the stepping relay 130. The latter relay deenergizes opening the circuit of the rotary magnet which deenergizes also. The slow acting relay 128, which is energized in series with the stepping relay 130, operates to maintain the test wiper 171 in engagement with the test relay 131. Should the subscriber's line, associated with the next set of bank contacts, be busy also, the test relay 131 will be maintained energized. If this line is not the last one of the group the connector switch wipers will be rotated in the same manner as was before described. However, if this line is the last one in the group no circuit will be completed for the stepping relay 130 as there will be no ground potential present upon the test contact engaged by the test wiper 172 and the connector H will remain in engagement with this set of bank contacts and transmit a busy signal to the calling subscriber.

It will now be assumed that the line of substation A is idle, when the connector H is operated into engagement with its associated bank contacts. Under these conditions there will be no circuit completed for the test relay 131. Then, following the deenergization of the slow acting relay 132, a circuit is completed which may be traced from ground on conductor 169', by way of normally closed springs controlled by armature 141, armature 148 and its back contact, lower winding of the switching relay 133, back contact and armature 151, conductor 103, armatures 77 and 83 in multiple, conductor 102, test wiper 171, test contact 175, private normal conductor 207, through the winding of the switching relay 211 of the line switch C, and thence through the winding of the motor magnet 212 to battery. Both the relays 133 and 211 are energized over this circuit. However, due to a mechanical interlocking device controlled by the armature of line relay 210, relay 211 only partially attracts its armature, that is, enough to disconnect the line of substation A from its normal battery and ground connections in the line switch C. Relay 133, upon energizing, establishes a locking circuit for itself at armature 157, places direct ground upon the test contact 175 at armature 155, and at armatures 160 and 158 completes the ringing circuit. Ringing current from the generator lead is now intermittently applied to the line of substation A until the subscriber thereon responds. When this occurs, the ring cut-off relay 129 will be energized over the called subscriber's line loop. Relay 129, upon operating, establishes a locking circuit for itself at armature 144, at armatures 143 and 145 cuts off the ring and at the front contacts of these armatures finally completes the talking connection. Conversation may now take place between the calling subscriber in the main exchange and the called

subscriber at substation A, talking battery being supplied to the called subscriber from the windings of the back bridge relay 125. The back bridge relay 125 is, of course, energized over the called line loop and operates to complete the circuit of the slow acting relay 61 in the associated repeater D. Relay 61, upon energizing, prepares certain circuits the operation of which will be described shortly.

Transfer of calls.

Under certain conditions the called subscriber at substation A may find it necessary to call another subscriber in the private automatic exchange for the calling party. Assuming that it is necessary to call the subscriber at substation A', Fig. 3, the subscriber at substation A will go through the same procedure as if initiating a local call, that is, he will replace his receiver upon the switchhook and remove it and listen for the so-called trunk tone. The calling subscriber, upon hearing this tone, will operate his calling device for the two digits which constitute the number of the other private automatic exchange subscriber's line, which operations will now be described. When the receiver is replaced at substation A the back bridge relay 125 is deenergized. Upon deenergizing, relay 125 opens the circuit of the slow acting relay 61. After the deenergization of the back bridge relay 125 and before the deenergization of relay 61, an impulse of current is sent to the slow acting relay 60. Relay 60, upon energizing, establishes a locking circuit for itself at armature 85, and at armature 84 prepares a point in the circuit of the relay 59. When the receiver is again removed at substation A, the back bridge relay 125 is energized and a circuit is completed which may be traced from ground by way of front contact and armature 135, conductor 106, armature 84 and its front contact, lower winding of relay 59, common conductor 95 and thence to battery by way of armature 97 and its back contact. Relay 59, upon energizing, establishes a locking circuit for itself at armature 78 which includes its upper winding and that of the common relay 96. Relay 96, upon energizing, removes battery from the common conductor 95 so as to prevent any interference in transferring calls, as will be apparent later. Another result of the energization of relay 59 is that ground is removed from conductor 186 which terminates in the bank contact 321 in the set of bank contacts associated with the outgoing multiple of the two way trunk line, comprising conductors 50 and 51, which is accessible to the local connector H'. Another result of the energization of relay 59 is that at armature 81 a release circuit is prepared for releasing the connector H. A still further result of the energization of relay 59 is that at armature 77 ground is removed from the test contact 175 but as relay 59 also opens

the locking circuit of the slow acting relay 60 at armature 80 ground is replaced upon the test contact 175 after a short interval.

During the interval that ground is removed from the test contact 175 the relay 211 in the line switch C deenergizes and as the receiver is removed at substation A the line relay 210 immediately energizes. Relay 210, upon operating, at armature 214 completes a circuit which includes the switching relay 211 and the motor magnet 212 in series, and at its armature 215 connects the test wiper 221 to the above circuit at a point midway between the switching relay and the said motor magnet. The operation of the line switch C now depends upon whether the trunk line, the bank contacts of which its wipers are associated with, is busy or not. If this trunk line is busy, the test contact engaged by the test wiper 221 will be grounded and the motor magnet, being supplied with direct ground via the said test wiper, will operate as a buzzer to advance the switch wipers 220 to 222, inclusive, step by step until they are rotated into engagement with an idle trunk line. However, it will be assumed that the trunk line with which the switch wipers are associated when the line relay 210 energizes is idle, and it will be assumed further that this trunk line is the one shown in the drawings terminating in bank contacts 223-225, inclusive. Under these conditions the relay 211 will be energized. Relay 211, upon operating, disconnects the line conductors 205 and 206 of the substation A from the winding of the line relay 210 and from ground, respectively, and extends them by way of armatures 216 and 218, wipers 220 and 222, bank contacts 223 and 225, trunk conductors 189 and 191, normally closed springs controlled by armatures 262 and 263 to the upper and lower windings of the line relay 251 of the local connector H'. During the interval that the line switch C is operating the relay 60 in the repeater D is deenergized and a ground potential will be replaced upon the test contact 175, this serving to maintain the switching relay 211 energized after the deenergization of the slow acting relay 210.

The line relay 251 of the local connector H' is energized over the line loop of the substation A and operates at its armature 264 to complete the circuit of the slow acting relay 252. Relay 252, upon energizing, at armature 288 prepares the operating circuits of the connector H' and at armature 266 places ground upon the release trunk conductor 190 extending back to the line switch C through the winding of the slow acting relay 269. However, switching relay 211 is held energized by the ground potential on the private normal conductor 207 and as relay 269 is short circuited it will not energize in series with the switching relay 211 of the line switch C.

A circuit may now be traced extending

from ground by way of back contact and armature 295, armature 265 and its front contact, back contact and armature 348, spring 346 and its resting contact, and through the winding of the vertical stepping relay 253 to battery. Relay 253, upon energizing, at armature 268 sends an impulse of current over the following circuit: from ground by way of front contact and armature 268, off normal springs 273 and 272, through the winding of the slow acting relay 256 and thence through the winding of the vertical magnet 306 to battery. Magnet 306 operates to raise the switch wipers 315 to 318, inclusive, one step and at armature 348 opens the circuit of the stepping relay 253, which deenergizes, opening the circuit of the vertical magnet 306, which deenergizes also. The stepping relay 253 will be immediately energized again and will operate as before to again complete the vertical magnet circuit. However, the circuit over which the vertical magnet is energized is slightly different than before traced inasmuch as the off normal springs are now operated and the circuit for the vertical magnet includes the off normal springs 273 and 274 and armature 286 and its front contact, relay 256 now being energized. The alternate operation of the stepping relay 253 and the vertical magnet 306 will continue until the switch wipers are raised opposite the tenth level of bank contacts. The springs 345 to 347, inclusive, are shaft springs which are adapted to be operated when the switch wipers are brought opposite the tenth level of bank contacts. This may be accomplished by any suitable cam arrangement. When these springs are operated the circuit of the stepping relay 253 is opened and the vertical operation of the connector H' ceases. It will, of course, be understood that the slow acting relay 256 maintains its armatures attracted throughout the vertical movement of the switch. By the engagement of spring 347 with its working contact a circuit is completed extending from ground by way of spring 347 and its working contact, through resistance 278 and thence through the upper winding of relay 254 to battery. Relay 254, upon energizing, completes a circuit which may be traced from ground by way of front contact and armature 266, front contact and armature 277, armature 285 and its front contact, back contact and armature 308, and thence through the winding of relay 258 to battery. Relay 258, upon energizing, establishes a locking circuit for itself at armature 292, and at armature 293 prepares the rotary magnet circuit. Shortly after the termination of the vertical movement of the switch the slow acting relay 256 deenergizes, thereby completing the rotary magnet circuit. Magnet 307 operates to rotate the switch wipers 315 to 318, inclusive, into engagement with the first set

of bank contacts in the tenth level and at armature 308 opens the circuit of the stepping relay 258. The slow acting relay 257 is energized in series with the rotary magnet and operates at its armature 290 to connect the test wiper 317 to the test relay 258. It will be noted that all the conductors associated with the incoming trunk line similar to conductor 186 are normally grounded in the repeaters, such as D. However, in the repeater D the relay 59 is energized and ground is removed from the multiple bank contacts in which the conductor 186 terminates which in the switch H' is the bank contact 321. If the first trunk line in the tenth level with which the switch wipers 315 to 318, inclusive, are now associated is other than the multiples of the one shown in Fig. 1, there will be a ground potential present upon the test contact engaged by the test wiper 317 and the stepping relay 258 will be again energized. Relay 258, upon energizing, completes its locking circuit at armature 292 and at armature 293 completes the circuit of the rotary magnet. The rotary magnet 307 operates to rotate the switch wipers into engagement with the next set of bank contacts in the tenth level and at armature 308 opens the locking circuit of the stepping relay 258 which deenergizes opening the circuit of the rotary magnet which deenergizes also. The alternate operation of relay 258 and the rotary magnet 307 will continue until the switch wipers are rotated into engagement with the bank contacts associated with the outgoing multiples of trunk line shown in Fig. 1, the test contact 321 of which is ungrounded. When the switch wipers are brought into engagement with the bank contacts 319 to 322, inclusive, there will be no circuit completed for the stepping relay 258. Then, following the deenergization of the slow acting relay 257, a circuit is completed which may be traced from ground by way of the front contact and armature 266, armature 292 and its back contact, lower winding of the switching relay 260, back contact and armature 290, normally closed springs controlled by armature 296, test wiper 317, test contact 321, conductor 338, conductor 186, conductor 110, armature 79 and its front contact and thence through the winding of the slow acting relay 58 to battery. Both relays 58 and 260 are energized over this circuit. Relay 58, upon energizing, establishes a locking circuit for itself at armature 71 to ground on conductor 110, at armature 70 completes the circuit of the slow acting relay 63, and at armature 74 completes a circuit which extends from ground by way of front contact and armature 74, armature 81 and its front contact, conductor 111, off normal spring 124 and its working contact, and thence through the winding of the release magnet 165 to battery. Magnet 165 operates to restore the connector H to normal.

The line and release relays 126 and 127 however remain energized as long as the calling subscriber in the main exchange has his receiver off the hook. The spring 123 is adapted to be controlled by both the vertical and release magnets, that is, as soon as the vertical magnet operates spring 123 engages its working contact, while as soon as the release magnet energizes the spring 123 breaks away from its working contact. This may be accomplished by placing the spring 123 on the double dog of the connector H. Upon the spring 123 breaking away from its working contact, the locking circuit of the relays 129 and 133 are opened and these relays deenergize, thereby disconnecting the wipers from their connections in the connector H. Relay 63, upon energizing, removes ground from the normally closed springs controlled by armature 72 of relay 58 so as to enable the local connector H' to be released under certain conditions, as will more fully appear hereinafter. As soon as the relay 157 in the incoming connector H deenergizes, the circuit of the back bridge relay 125 is opened and this latter relay then deenergizes. Upon retracting its armature 136, relay 125 opens the circuit of the slow acting relay 61 and before the latter relay deenergizes sends an impulse of current to the slow acting relay 60. The operation of relay 60 is but momentary and has no function at this time. Relay 61, upon deenergizing, transfers the locking circuit of relay 58 to the release trunk conductor 109 at armature 87 and at armatures 88 and 89 prepares certain circuits whose function will appear later. Returning now to the operation of the local connector H', when the switch wipers were raised opposite the tenth level the spring 345 engaged its working contact thereby preparing a circuit for the relay 250. Relay 260, upon energizing, establishes a locking circuit for itself at armature 301, also at this same armature short circuits the relay 269 included in the circuit which supplies ground to the holding circuit for the line switch C in order to prevent the relay 269 energizing immediately upon the release of the incoming connector H, and connects ground to the test wiper 317 at armature 300. Another result of the engagement of armature 301 with its working contact is that the circuit of relay 250 is completed. The latter relay, upon energizing, disconnects the local trunk conductors from the windings of the line relay 251 and extends them by way of armatures 262 and 263, wipers 315 and 318, bank contacts 319 and 322, conductors 336 and 339, conductors 185 and 188, conductors 101 and 113, to the upper and lower windings of the line relay 56 of the repeater D. Relay 56, upon energizing, completes the circuit of its associated slow acting relay 55. The latter relay, upon energizing, prepares the operating circuits of the con-

nector H at armature 65, at armature 67 opens
 the locking circuit of the relay 59, and also
 that of the common relay 96, and at the front
 contact of this armature places ground upon
 5 the conductor 110 thereby establishing a hold-
 ing circuit for relays 260 and 250 in the local
 connector H' and also the relay 211 in the line
 switch C in order to maintain the connector
 and line switch in their operated positions.
 10 As the circuits of relay 59 and 96 are now
 open these relays will deenergize. Relay 96,
 upon deenergizing, again places battery upon
 the common conductor 95, thereby allowing
 any other party to pass a call. Relay 59,
 15 upon deenergizing, places an additional
 ground upon the conductor 110 at armature
 79 and its back contact, which may be traced
 from ground by way of armature 88 and its
 back contact, armature 72 and its front con-
 20 tact, back contact and armature 79 to con-
 ductor 110, and at armature 81 opens the cir-
 cuit of the release magnet of the connector H.

The above operations wherein the line
 switch C selects an idle local connector and
 25 that connector switch operates as a finder to
 find the particular incoming trunk line takes
 but a very short interval of time, and, im-
 mediately upon the line of the subscriber at
 substation A being extended to the line relay
 30 56 of the repeater D, a trunk tone is given
 to the subscriber from the trunk tone machine
 by way of normally closed springs controlled
 by armature 159, conductor 112, normally
 closed springs controlled by armature 92,
 35 through the lower winding of the line relay
 56 to conductor 188. This tone is audible to
 the subscriber at substation A and notifies
 him that everything is in readiness to pass the
 call.

40 The subscriber at substation A may now op-
 erate his calling device in accordance with the
 first digit of the desired local subscriber's
 number, which in this case it will be assumed
 is that of the substation A'. By this opera-
 45 tion a series of interruptions is produced in
 the circuit of the line relay 56 of the repeater
 D and this relay deenergizes a plurality of
 times in response thereto. At the retraction
 of its armature 69 an impulse of current is
 50 sent over the following circuit: from ground
 by way of armature 69 and its back contact,
 armature 65 and its front contact, back con-
 tact and armature 91, conductor 104, off nor-
 mal springs 169 and 168, winding of the ver-
 55 tical magnet 166 and thence through the
 winding of the slow acting relay 128 to bat-
 tery. In the same manner as was before de-
 scribed, the magnet 166 operates to raise the
 switch wipers 170 to 173, inclusive, step by
 60 step until they are placed opposite the level
 of bank contacts in which is terminated the
 line of the desired substation. Slow acting
 relay 128 is energized in series with the verti-
 cal magnet and being slow acting maintains
 65 its armature attracted throughout the verti-

cal movement of the switch, and at the ter-
 mination of the vertical operation deener-
 gizes and transfers the impulsing circuit to
 the rotary magnet 167.

The subscriber at substation A may now 70
 operate his calling device for the next digit
 of his desired number. As before, the line
 relay 56 retracts its armature a plurality of
 times in response to the interruptions in its
 line circuit but this time the successive deen- 75
 ergizations of the line relay 56 are effective
 to send impulses of current to the rotary mag-
 net 167. Magnet 167 now operates to rotate
 the switch wipers into engagement with the
 bank contacts associated with the line of the 80
 desired called substation, which we will as-
 sume are the bank contacts 178 to 181, inclu-
 sive, associated with the line of the substa-
 tion A'. The slow acting relay 132 ener-
 gizes in series with the rotary magnet and 85
 operates to connect the test wiper 171 to the
 test relay 131.

Should the desired line be busy, the test
 relay 131 will be energized and will operate
 as before described to give a busy tone to the 90
 calling subscriber. Upon being informed by
 this tone that the desired line is inaccessible,
 the subscriber at substation A may converse
 with the calling subscriber and ascertain if
 another line will do. Should this be the case 95
 the subscriber at substation A will then re-
 place his receiver upon the switchhook, there-
 by opening the circuit of the line relay 56 at
 the repeater D. The latter relay, upon deen-
 ergizing, opens the circuit of the slow acting 100
 relay 55 which deenergizes after a short inter-
 val, thereby completing a circuit which
 may be traced from ground by way of arma-
 ture 69 and its back contact, armature 65 and
 its back contact, armature 75 and its front 105
 contact, back contact and armature 89, con-
 ductor 111, off normal spring 124 and its
 working contact, and thence through the
 winding of the release magnet 165 to battery.
 Magnet 165 operates in the usual manner to 110
 restore the connector H to normal, the line
 and release relays 126 and 127 remaining en-
 ergized as previously pointed out. The local
 connector H' and the line switch C are not re-
 leased at this time as conductor 110 is sup- 115
 plied with ground by way of armature 72 and
 its front contact over a circuit which may be
 traced from ground by way of armature 88
 and its back contact, armature 72 and its front
 contact, back contact and armature 79 to con- 120
 ductor 110. When the subscriber at substa-
 tion A again removes his receiver the line re-
 lay 56 will be energized to complete the cir-
 cuit of the slow acting relay 55 in the usual
 manner. The connector H may now be re- 125
 operated by the subscriber at substation A in
 the same manner as was before described, it
 being noted that immediately upon the slow
 acting relay 128 energizing that the locking
 circuit of test relay 131 is opened and the 130

busy tone removed from the lower heavy talking conductor.

Should the calling subscriber hang up during the interval when the subscriber at substation A had his receiver upon the switchhook the line relay 126 would deenergize and open the circuit of the slow acting relay 127. Relay 127, upon deenergizing, would remove ground from the release trunk conductor 109 and at armature 140 would complete the circuit of the release magnet 165. By the operation of magnet 165 the connector H would be restored to normal. As ground is removed from the release trunk conductor 109, the locking circuit of the slow acting relay 58 in the repeater D is opened and this relay would deenergize opening the circuit of the slow acting relay 63. During the interval after the deenergization of relay 58 and before the deenergization of relay 63 ground is removed from the conductor 110. Upon ground being removed from holding conductor 110, the relays 250 and 260 in the local connector H' would deenergize as would the switching relay 211 of the line switch C. Upon relay 250 deenergizing the connector H' would be restored to normal by the release magnet 309. Relay 63, would deenergize after a short interval and again ground conductor 110. In this manner all the apparatus would be released.

However, it will be assumed that when the connector H is operated into engagement with the bank contacts 178 to 181, inclusive, the associated line is idle. Under these conditions there will be no ground potential present upon the test contact 179 engaged by the test wiper 171 and no circuit is completed for the test relay 131. Then, following the deenergization of the slow acting relay 132, the switching relay 133 of the connector H and the switching relay 341 of the called line switch C', Fig. 3, associated with the substation A', are energized in series. Relay 341 operates in the usual manner to disconnect the line of the substation A' from its normal battery and ground connections to the line switch C'. Relay 133, upon energizing, operates in the usual manner to establish a locking circuit for itself and complete the ringing circuit. Another result of the energization of relay 133 is that the trunk tone is removed from the line of substation A so as not to interfere with the conversation. If the subscriber at substation A' fails to answer, the subscriber at station A may of course replace his receiver and release the connector H the same as in the case when the called line is busy, after which he can reoperate the connector to connect with another line. In case the subscriber at substation A' answers, ring cut-off relay 129 is energized and, upon operating, establishes a locking circuit for itself and cuts off the ring. The back bridge re-

lay 125 is energized over the called subscriber's line loop and operates to complete the circuit of the slow acting relay 61. Relay 61, upon energizing, transfers the locking circuit of the slow acting relay 58 from the release trunk conductor 109 to the holding trunk conductor 110 at armature 87, and at armature 88 removes one ground from the trunk conductor 110. However, as the relay 55 is energized at this time this removal of ground at armature 88 has no effect. The conversation may now take place between the calling subscribers in the main exchange and the subscribers at substation A and substation A'.

Should the subscriber at substation A desire to retire from the conversation at any time he may do so by merely replacing the receiver on the switchhook. Upon so doing, the circuit of the line relay 56 is opened and this relay deenergizes and opens the circuit of the slow acting relay 55. Relay 55, upon deenergizing, removes ground from the holding trunk conductor 110 at armature 67. By this operation the circuits of the relays 250 and 260 in the connector H' and the relay 211 in the line switch C are opened and these relays deenergize. As before, relay 250, upon deenergizing, completes the release magnet circuit of the connector switch H'. In this manner the connector H' and line switch C are restored to normal. As ground is removed from the holding trunk conductor 110, the locking circuit of the slow acting relay 58 is opened and this relay deenergizes and opens the circuit of the slow acting relay 63. The latter relay, upon deenergizing, again places ground upon the conductor 110. When the conversation is finally terminated between the calling subscriber in the main exchange and the second called subscriber at substation A', the calling subscriber will replace his receiver upon the switchhook and release the connector H as before described and the operated switches in the main exchange will be restored to normal in the well known manner.

It will be apparent that the subscriber at substation A' after being called by the subscriber at substation A can, after the subscriber at A has retired from the connection, in turn pass the call in the same manner as was before described.

Should the subscriber at substation A be very busy he might not have the time to transfer the call to another private automatic exchange subscriber and under these conditions he will hang up his receiver and remove it again and wait until he hears a trunk tone, after which he may request the calling subscriber to call the private automatic exchange subscriber's number to which the call is desired to be transferred. By these operations the connector H will be re-

leased by the subscriber at substation A and re-operated under the control of the calling subscriber in the usual manner.

It will be remembered that during the interval that the local connector H' was operating as a finder the relay 59 in the repeater D was energized in series with the common relay 96. Now should another party in the private automatic exchange attempt to pass the call during this interval he will be unable to do so until the connector H' has established connection with the trunk line. This operation will now be briefly described. For this purpose it will be assumed that the relay 96 is energized when the subscriber at substation A attempts to pass the call. When the subscriber at substation A replaces his receiver the relay 60 is energized as before described and operates to establish a locking circuit for itself and to prepare the energizing circuit of the relay 59. When the receiver is again removed at substation A the relay 59 is not energized as there is now no battery on the common conductor 95, the relay 60 therefore remains locked energized. The line switch C does not operate at this time as the relay 59 is deenergized and the test contact 175 remains grounded. Now as soon as the local connector operating as a finder finds the incoming trunk line, the relay in the associated repeater which corresponds to the relay 55 in the repeater D will energize and open the circuit of the relay similar to relay 59 and that of the common relay 96. When relay 96 deenergizes battery is again supplied to conductor 95 and the relay 59 will be energized and the operations will proceed as before. During the short interval that the apparatus is not functioning the subscriber at substation A hearing no trunk tone will not operate his calling device. The relay 96, therefore, prevents any interference which might arise should two local connector switches be operating as finders at once.

45 *Local connections between subscribers in the private automatic exchange.*

Having described how calls incoming from the main exchange may be transferred from one party in the private automatic exchange to another, the manner in which certain local connections in the private automatic exchange are established will now be briefly described. For this purpose it will be assumed that the subscriber at substation A desires to call the subscriber at substation A'. Under these conditions the subscriber at substation A will remove his receiver and operate his calling device in accordance with the digits of the desired number. When the receiver is removed at substation A the line switch C operates in the usual manner to extend the associated line to an idle local connector switch, which, we will assume, is the connector switch H'.

The line relay 251 is immediately energized over the calling line loop and operates to complete the circuit of the slow acting relay 252. Relay 252, upon energizing, prepares the operating circuits of the connector H' at armature 288 and at armature 266 completes a holding circuit for the line switch C, which may be traced from ground by way of front contact at armature 266, through the winding of the low resistance slow acting relay 269, release trunk conductor 190, bank contact 224, test wiper 221, armature 217 and its front contact, through the winding of the switching relay 211 and thence through the winding of the motor magnet 212 to battery. It will be understood that this holding circuit is completed before the slow acting relay 210 has had time to deenergize. A branch of this holding circuit also extends by way of the private normal conductor 207 to multiplied bank contacts in the banks of the local and incoming connector switches which have access to the line of substation A whereby the said line is protected from intrusion in the usual manner. Relay 269 is energized in series with the switching relay 211 of the line switch C and operates at armature 295 to open the circuit of the stepping relay 253 and at armature 267 closes the circuit of the slow acting relay 259. The latter relay, upon energizing, at armature 296 cuts off the test wiper 317 and places the test wipers 316 into operative relation with the switch circuits, and at armature 298 connects the trunk tone to the calling subscriber's line. Before proceeding further, it will be well to note certain adjustments of the armatures on the slow acting relay 252 and the armatures on the slow acting relay 269. Armature 266 is adjusted to engage its working contact a short interval before the armature 265 engages its working contact, while on the relay 269 the armature 295 is adjusted to break away from its resting contact before the other two armatures are operated. The reason for this adjustment is to prevent the stepping relay 253 from energizing and starting the automatic vertical operation of the switch.

By the trunk tone signal the calling subscriber is notified that he may now operate his calling device. By this operation a series of interruptions is produced in the circuit of the line relay 251 and this relay retracts its armature 264 a plurality of times each time sending an impulse of current over the following path: from ground by way of the said armature and its back contact, armature 261 and its back contact, armature 288 and its front contact, off normal springs 273 and 274, through the winding of the slow acting relay 256, and through the winding of the vertical magnet 306 to battery. The above is the circuit over which the first impulse to the vertical magnet is sent, but upon the first vertical step of the switch the off normal springs are shifted and the remaining impulses are sent

to the vertical magnet over a circuit which is the same as the one previously traced except that it includes the off normal springs 273 and 274 and armature 286 and its front contact, relay 256 being now energized. Magnet 306 operates in the usual manner to raise the switch wipers 315 to 318, inclusive, step by step until they are placed opposite the desired level of bank contacts. The slow acting relay 256 is energized in series with the vertical magnet and operates in the usual manner.

The calling subscriber may now dial the next and final digit of his desired number. As before, a series of interruptions is produced in the line circuit of relay 251 and this relay deenergizes a corresponding number of times each time sending an impulse of current to the rotary magnet 307. Magnet 307 operates to rotate the switch wipers step by step until they are placed in engagement with the set of bank contacts associated with the line of substation A', which we will assume are the bank contacts 327-330, inclusive. The slow acting relay 257 is energized in series with the rotary magnet and operates to connect the test wiper 316 to the test relay 258.

If the desired line is busy, relay 258 will be energized in the usual manner. Relay 258, upon operating, prepares a point in its locking circuit at armature 292 and at armature 294 places the busy tone on the lower heavy talking conductor. By this signal the calling subscriber is notified that the desired line is busy and he may replace his receiver upon the switchhook, thereby releasing the operated switches in the usual manner.

It will now be assumed that the line of substation A' is idle, when the wipers of the connector H' are brought into engagement with the bank contacts 327-330, inclusive. Under these conditions there will be no circuit completed for the test relay 258. Then, following the deenergization of the slow acting relay 257, the switching relay 260 is energized in series with the switching relay 341 of the line switch C'. Relay 341 operates to disconnect the line of the substation A' from its normal battery and ground connections in the line switch C'. Relay 260, upon energizing, establishes a locking circuit for itself at armature 301, at armature 304 removes the trunk tone from the subscriber's line and at armatures 305 and 303 completes the ringing circuit. The slow acting relay 269 remains energized throughout the connection as the armature 301, upon engaging its front contact, cannot short circuit the relay as the slow acting relay 259 is energized. Ringing current from the generator lead is now intermittently applied to the line of substation A' until a response is obtained. When the called subscriber answers the ring cut-off relay 255 is energized over the called line and operates to establish a locking circuit for itself at

armature 280 and at armatures 279 and 281 cuts off the ring and at the front contacts of these armatures finally completes the talking connection. Conversation may now be carried on between the calling and called subscribers over the heavy talking conductors, talking battery being supplied to the calling subscriber from the windings of the line relay 251 and to the called subscriber from the windings of the back bridge relay 254.

When the conversation is completed both subscribers will replace their receivers upon their respective switchhooks. When the receiver is replaced at substation A the connector H' is released in the usual manner, as is the line switch C.

Connections from the private automatic exchange to the main exchange.

Having described the operation of the connector H' when a local subscriber is called, its operation when a call is made to a subscriber in the automatic main exchange by way of one of the incoming two way trunk lines will now be described briefly. For this purpose it will be assumed that the subscriber at substation A desires to extend a connection to a subscriber in the main exchange. As the outgoing multiples of these trunk lines terminate in the tenth level of bank contacts in the local connector switches he will remove his receiver and operate his calling device for the digit 0. When the receiver is removed at substation A, line switch C operates in the manner previously described to extend the line of substation A to an idle local connector switch, which, we will assume, is the connector switch H'. In response to the operation of the calling device for the digit 0 the wipers of the connector switch H' are raised under control of the line relay 251 and the vertical magnet 306 until they are brought opposite the tenth level of bank contacts. When the switch wipers are brought opposite the tenth level the springs 345 to 347, inclusive, are operated in the usual manner. By the engagement of spring 347 with its working contact relay 254 is energized and, as the slow acting relay 256 is also energized, it operates to complete the circuit of the stepping relay 258. Shortly after the termination of the vertical movement of the switch the slow acting relay 256, which was energized in series with the vertical magnet, deenergizes and completes the circuit of the rotary magnet 307. Magnet 307 operates to rotate the switch wipers into engagement with the set of bank contacts associated with the first trunk line in the tenth level. The trunk selecting operation of the connector H' will take place in the usual manner, that is, the stepping relay 258 and the rotary magnet 307 will be alternately energized until the test wiper 316 engages the ungrounded test contact, which we will assume is the test contact 320 of the contact

set 319 to 322, inclusive. When this occurs there will be no circuit completed for the stepping relay 258. Then, following the de-energization of the slow acting relay 257, the switching relay 260 is energized over a circuit which may be traced from ground by way of front contact and armature 266, armature 292 and its back contact, lower winding of the switching relay 260, back contact and armature 290, front contact and armature 296, test wiper 316, test contact 320, conductor 337, conductor 187, armature 138 and its back contact, conductor 105 and thence through the winding of the slow acting relay 62 to battery. Relays 260 and 62 are energized over this circuit. Relay 62, upon energizing, disconnects the incoming trunk conductors 50 and 51 from the windings of the line relay 126 of the incoming connector H at armatures 90 and 93, and at armature 92 places direct ground on the conductor leading to the lower winding of the line relay 56 of the repeater D.

Returning to the operation of the connector H', relay 260, upon energizing, establishes a locking circuit for itself at armature 301 and at the same time completes the circuit of relay 250. Relay 250, upon energizing, disconnects the line conductors of the calling substation A from the windings of the line relay 251 and extends them by way of armatures 262 and 263, wipers 315 and 318, bank contacts 319 and 322, conductors 336 and 339, conductors 101 and 113, and the upper and lower windings of the line relay 56 of the repeater D. Relay 56, upon energizing, completes the circuit of the slow acting relay 55 at armature 69. Relay 55, upon energizing, places ground on the release trunk conductor 109, thereby establishing a holding circuit for the connector switch H' and the line-switch C. Another result of the energization of relay 56 is that a bridge is completed across the trunk conductors 50 and 51 which may be traced from the trunk conductor 50, armature 90 and its front contact, armature 68 and its front contact, winding of the impedance coil 57, and thence to trunk conductor 51. Upon this bridge being placed upon the trunk conductors 50 and 51 the line relay of the incoming switch in the main exchange is energized.

When the calling device at the calling substation is operated in accordance with the remaining digits of the main exchange subscriber's number successive series of interruptions are produced in the circuit of the line relay 56 of the repeater D. By means of armature 68 and its front contact these are repeated to the switches in the main exchange in order to complete the desired connection. The operation of the switches in the main exchange takes place in the usual manner.

When the connection is completed and the conversation terminated the subscriber at

switches by replacing his receiver upon the switchhook. By this operation the circuit of the line relay 56 is opened and this relay de-energizes opening the bridge across the trunk conductors 50 and 51 at armature 68 and at armature 69 breaking the circuit of the slow acting relay 55. By the removal of the bridge across trunk conductors 50 and 51 the release of the switches in the main exchange is initiated. Relay 55, upon deenergizing, removes ground from the release trunk conductor 109, thereby causing the release of the connector H' and the line switch C.

Having fully described the features of the invention, what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What we claim as our invention is:

1. In an automatic branch exchange, incoming and local directly controlled connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange by means of one of said incoming connectors, and means including one of said local connectors for enabling the called subscriber to release and reoperate the incoming connector in use to transfer the call.

2. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, and means including the line switch of the called line and one of said local connectors for enabling the called subscriber to reoperate the incoming connector in use to transfer the call.

3. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means including the line switch of the called line and one of said local connectors for enabling the called subscriber to reoperate the incoming connector in use to transfer the call, and means whereby the subscriber first called can disconnect his line from the transferred connection after the second called subscriber has answered.

4. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means including the line switch

of the called line and one of said local connectors for enabling the called subscriber to reoperate the incoming connector in use to transfer the call, and means for enabling the called subscriber to transfer the call to another line in case the line to which it is first attempted to transfer the call is busy.

5. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means including the line switch of the called line and one of said local connectors for enabling the called subscriber to reoperate the incoming connector in use to transfer the call, and means for enabling the called subscriber to transfer the call to another line in case no answer is obtained from the line to which it is first attempted to transfer the call.

6. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means including the line switch of the called line and one of said local connectors for enabling the called subscriber to transfer the call, and means whereby the subscriber first called can disconnect his line from the transferred connection after the second called subscriber has answered.

7. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, and means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use in order to transfer the call.

8. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use over a new path, and means whereby the called subscriber can then release and reoperate such incoming connector to transfer the call.

9. In an automatic branch exchange, subscribers' lines and individual line switches

therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means controlled automatically by the switch-hook at the called station for operating the line switch of the called line and one of said local connectors to connect with the incoming connector in use over a new path, and means whereby the called subscriber can reoperate such connector to transfer the call.

10. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means responsive to the removal, the replacement, and the subsequent removal of the receiver at the called station for operating the line switch of the called line and one of said local connectors to connect with the incoming connector in use over a new path, and means whereby the called subscriber can reoperate such connector to transfer the call.

11. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use over a new path, means whereby the called subscriber can then release and reoperate such incoming connector to transfer the call, and means whereby the subscriber first called can disconnect his line from the transferred connection by releasing his line switch and the local connector in use.

12. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use over a new path, means whereby the called subscriber can then release and reoperate such incoming connector to transfer the call, means whereby the subscriber first called can disconnect his line from the transferred connection by releasing his line switch and the local connector in use, and means whereby the subscriber on

the line to which the call has been transferred can operate his line switch and another local connector to connect with their incoming connector in use in order to transfer the call a second time.

13. In a telephone system, a connector switch, called lines accessible thereto, line switches associated with said called lines, trunk lines leading to other connector switches accessible to said line switches, means for operating said first mentioned connector switch into connection with one of said called lines, and means including the line switch associated with the called line and one of said other connector switches for releasing the first mentioned connector switch.

14. In a telephone system, a connector switch, called lines accessible thereto, line switches associated with said called lines, trunk lines leading to other connector switches accessible to said line switches, means for operating said first mentioned connector switch into connection with one of said called lines, means including the line switch associated with the called line and one of said other connector switches for releasing the first mentioned connector switch, and means for reoperating said first connector switch into connection with another of said called lines.

15. In a telephone system, telephone lines, automatic switches, means including a series of said automatic switches controlled from a calling one of said lines for establishing a connection with a called one of said lines, means including another series of said switches for releasing said first established connection while maintaining a connection with said calling line, means for then extending the connection to include another called one of said lines, and means operative thereafter for releasing the first one of said called lines from said connection.

16. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming connectors, means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use in order to transfer the call, and means for giving a signal to the called subscriber to notify him when the incoming connector is connected with.

17. In an automatic branch exchange, subscribers' lines and individual line switches therefor, incoming and local connectors for use in establishing main to branch and local connections, respectively, means for completing a call from the main exchange to one of said lines by means of one of said incoming

connectors, means whereby the called subscriber can operate his line switch and one of said local connectors to connect with the incoming connector in use in order to transfer the call, means whereby the called subscriber can reoperate the incoming connector to accomplish the transfer, and means for giving the called subscriber an audible signal to notify him when the said connector is ready to be reoperated.

18. In a telephone system, a telephone line having an individual line switch, a cut-off relay for said switch, a connector switch for connecting with said line, a private wiper in said connector and a circuit established thereover for energizing said cut-off relay and means controlled by a single actuation of the switch-hook at the station on said line for opening said circuit momentarily to deenergize said relay while maintaining said connector in connection with said line.

19. In a telephone system, a telephone line having an individual line switch, a cut-off relay for said switch, a connector switch for connecting with said line, a private wiper in said connector and a circuit established thereover for energizing said cut-off relay, means controlled by the switch-hook at the station on said line for opening said circuit momentarily to deenergize said relay while maintaining said connector in operative relation with said line, other connector switches accessible to said line switch, said line switch being responsive to the deenergization of its cut-off relay to connect with an idle one of said other connectors, and means for operating such connector to connect the said line with said first connector over a new path.

20. In a telephone system, automatic switches, means whereby calling subscribers can control said switches as connector switches to connect with desired called lines, and means whereby called subscribers can control said switches as finder switches to connect with predetermined trunk lines.

21. In a telephone system, automatic switches, means for directly controlling said switches from calling stations to connect with desired called stations, means for initiating the operation of one of said switches from a called station, and means for operating the started switch as a finder switch independent of directive substation control to connect with a predetermined trunk line.

22. In an automatic branch exchange, a group of trunk lines connecting with a main exchange, directly controlled local connectors for use in setting up connections between lines in the branch exchange, and means responsive to the removal of the receiver at a local station for operating one of said connectors automatically to connect with one of said trunk lines.

23. In an automatic branch exchange, a group of trunk lines connecting with a main

exchange, local connectors for use in setting up connections between lines in the branch exchange, means whereby a calling local subscriber can directly control one of said connectors to select said group of trunk lines, the connector operating automatically thereafter to connect with the first idle trunk line, and means whereby a local subscriber who has been called over one of said trunk lines can operate one of said connectors as a finder switch to connect with the particular trunk over which such subscriber has been called.

24. In an automatic branch exchange, a group of trunk lines connecting with a main exchange, local connectors for use in setting up connections between lines in the branch exchange, said connectors having primary and secondary movement, means whereby a calling local subscriber can cause a directive primary and automatic secondary movement of one of said connectors to connect with an idle one of said trunk lines, and means whereby a called local subscriber can cause automatic primary and secondary movements of one of said connectors to connect with a predetermined one of said trunk lines.

25. In a telephone system, two automatic exchanges and an interconnecting trunk line including a repeater, and means in one exchange for operating said repeater to repeat switch controlling impulses to automatic switches in either exchange.

26. In a telephone system, two automatic exchanges and an interconnecting trunk line including a repeater, means whereby a calling subscriber in the first exchange can operate said repeater to repeat switch controlling impulses to an automatic switch in the other exchange, and means whereby a called subscriber in said first exchange can operate said repeater to repeat switch controlling impulses to a switch in the same exchange.

27. In a telephone system, a connector switch, subscribers' lines and trunk lines

accessible thereto, a subscribers' line having a lineswitch individual thereto, means in said lineswitch controlled by said associated line for automatically connecting said line with said connector regardless of whether said line is initially calling or engaged in a call as a called line, and means in said connector responsive to the seizure by said line when said line is engaged in a call for automatically selecting a trunk line.

28. In a telephone system, a connector switch, subscribers' lines and trunk lines accessible thereto, a subscribers' line having a lineswitch individual thereto, means in said lineswitch controlled by said associated line for automatically connecting said line with said connector regardless whether said line is initially calling or engaged in a call as a called line, means in said connector operated when said connector is seized by said line when said line is initially calling for extending the call to a desired subscribers' line under directive control of said calling line, and means in said connector responsive to the seizure of said line when engaged in a call for automatically selecting a trunk line.

29. In a telephone system, an established connection between a calling and a called line including a trains of switches and a trunk line, connector switches having access to subscribers' lines and to said trunk line, a lineswitch individual to said called line, means in said lineswitch controlled from said called line for actuating said switch to seize one of said connectors, and means in said connector responsive to the seizure for automatically establishing connection with said trunk line.

In witness whereof, I hereunto subscribe my name this 30th day of June, A. D. 1921.

RODNEY G. RICHARDSON.

In witness whereof, I hereunto subscribe my name this 30th day of June, A. D. 1921.

JOHN E. GARDNER.