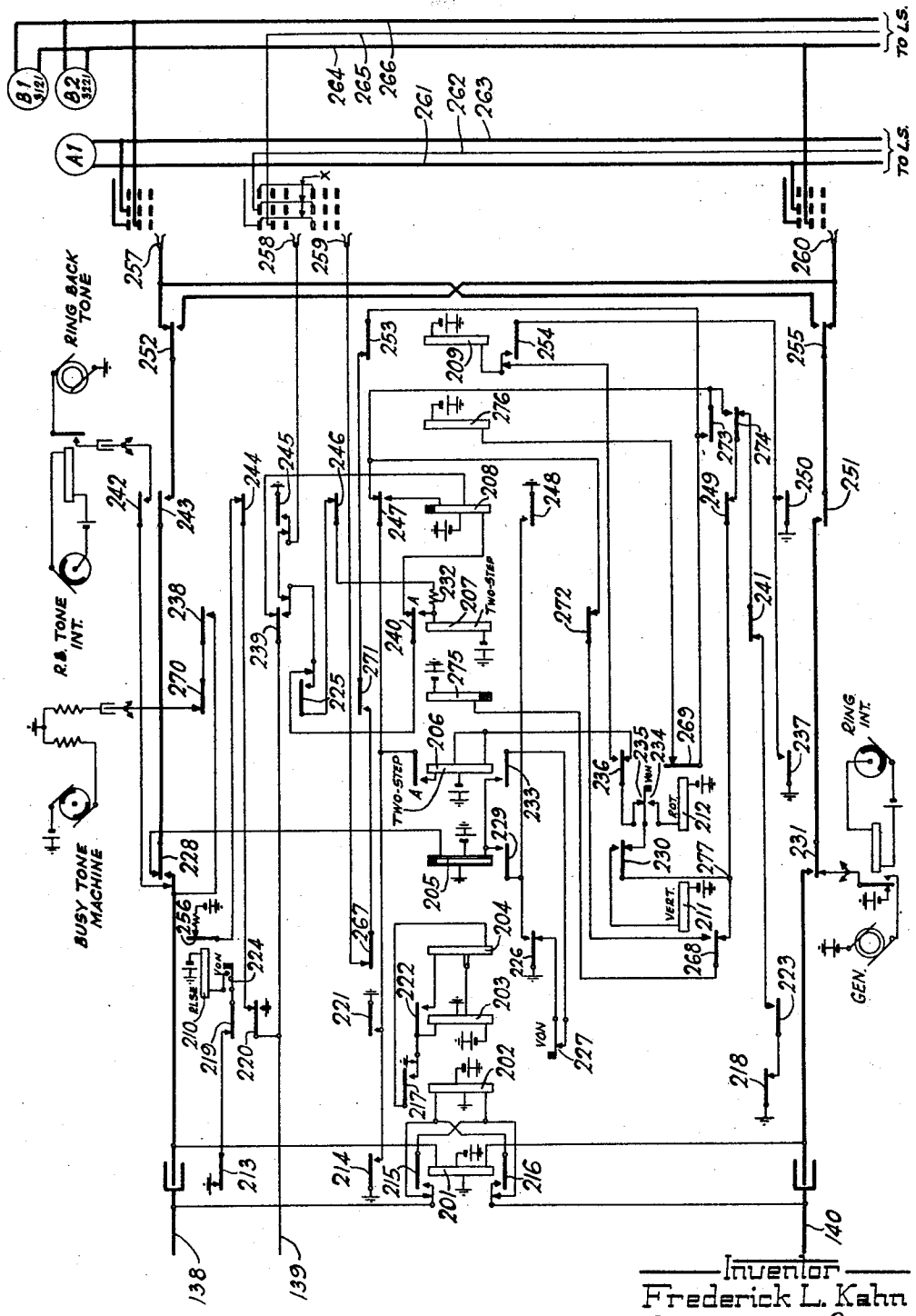
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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The present invention relates in general to automatic telephone systems, and its object, broadly stated, is to provide new and improved circuit arrangements for the type of switches known as rotary connectors. As to certain features of the invention, it may be considered as an improvement on the rotary connector shown in the application to Rudolph F. Stehlik, Patent No. 1,716,986, issued June 11, 1929.

Rotary connector switches are provided for the purpose of establishing a connection with an idle line of a group of lines, which are all listed under the same telephone number in the directory. Heretofore it has been the practice in case of night service to assign a number to one of the lines in a group which is different from the number assigned to the entire group for day service. The telephone number assigned for day service corresponds to the first line of the group, while the number assigned for night service corresponds to some number other than that of the first line in the group.

In the above-mentioned Stehlik patent the connector is arranged to hunt for the first idle line in a group of lines when the number of the first line is called and if all the lines in the group are busy the connector will come to rest on the last line of the group and will return busy tone to the calling subscriber. The connector is so arranged that if any line other than the first line in a group is called the switch will come to rest on the called line and will switch the connection through, if the line is idle, or will give busy tone to the calling subscriber, if the line is busy. It may be desirable in some cases to have the first line of the group, as well as all the rest of the lines, dialled direct without the automatic rotary action to select an idle line of the group if the first line happens to be busy. This result is accomplished by the present invention.

According to the present invention a three-digit connector is provided in which any line in a group of lines may be called direct, or in which the connector is operated to automatically select an idle one of the lines in a group of lines. This is brought about by the use of two discriminating relays which are both operated when a certain first digit is dialled and prepare the connector to operate as a regular connector. When a different predetermined first digit is dialled only one of the relays operates and the switch is then prepared to operate as a rotary connector and will automatically select an idle line in a group of lines.

Another object of the invention is to provide a connector which will function as a combined regular and rotary connector on certain levels, and which will function as a regular two-party line connector or an individual line connector on other levels. This is accomplished in the present invention by using a discriminating preliminary digit, which determines further operation of the connector on trunk hunting levels, and which determines the side of the line the ringing current will be transmitted over, on levels assigned for two-party service. Individual line service is the same as two-party line service, except that each subscriber has his individual line.

The foregoing objects and features together with others not specifically mentioned at this time will be further discussed in connection with the detailed description of the operation of the connector.

The accompanying drawing shows a three-digit, combined rotary, two-party, and individual line connector, which is one of a plurality of similar switches which are accessible to subscribers in a telephone system over the well-known lineswitch, associated master switch, and selector switches. The subscriber's lineswitch, master switch, and selector switch may be of the type shown in Fig. 1 of the Victor S. Tharp application, Serial No. 510,680, filed January 23, 1931. The connector is of the well-known vertical and rotary type switch having its bank contacts arranged in horizontal rows or levels. Four wipers are provided. The test wiper 259 and its associated bank are only used when the swtich is operating as a rotary connector. The automatic rotation is accomplished by strapping each test contact associated with the regular test wiper 258, with the exception

of the last one in the group, to the corresponding test contact associated with the auxiliary test wiper 259.

The substation A1 is one of a plurality of substations connected to a group of lines accessible to the connector. It is understood in the present case that the third level of a connector is set aside for lines of this type. The substations B1 and B2 are connected to the same line conductors 264 and 266. The line comprising conductors 264 and 266 is one of a plurality of two-party lines accessible over the second level of the connector.

The present invention, having been described in general, will now be described in connection with the detailed description of the operation of the apparatus shown on the drawing.

Referring to the drawing, it will be assumed that a calling subscriber desires to establish a connection with one of the lines in the group which includes the line extending to station A1. When the calling subscriber removes his receiver, his individual lineswitch operates as usual and seizes an idle trunk line leading to a selector switch. In response to the operation of the calling device, the selector switch is operated to select an idle trunk line leading to a connector. It will be assumed that the connector shown in the drawing is selected.

When an idle contact set is reached (for example, the contact set from which the conductors 138–140 extend to the present connector) a battery potential is encountered on the test contact thereof by wiper 128. The conductor 139 which extends to the present connector being connected to battery through armatures 220, 244, and 256 and their respective resting contacts.

When this battery potential is encountered by the test wiper 128, of the Tharp selector, the switching relay 104 energizes over its upper winding and locks itself over its lower winding. The operation of the switching relay 104 extends the calling subscriber's line conductors through the wipers 127 and 129, conductors 138 and 140, normally closed contacts controlled by armatures 215 and 216, upper and lower windings of the line relay 202, of the present connector, to battery and ground, respectively.

The line relay 202 energizes over the calling line loop, removes the shunt around the upper winding of the release relay 203 at the normally closed contacts controlled by armature 217, and at the same time it closes a circuit for both windings of the release relay 203 in series with the lower winding of the series relay 204, the circuit extending from ground, upper winding of release relay 203, armature 217 and its front contact, lower winding of series relay 204, lower winding of release relay 203, to battery. Release relay 203 energizes over this circuit and at armature 222 and its front contact it closes a circuit including both of its windings and the upper winding of the series relay 204. However, due to the fact that the high resistance upper winding of the release relay 203 is in series with the upper winding of series relay 204 over one circuit and in series with the lower winding of series relay 204 over the other circuit, relay 204 does not energize.

As a further result of its operation, release relay 203 opens a point in the circuit of the release magnet 210 at armature 219 and its resting contact, prepares the impulsing circuit at armature 223 and its front contact, and places ground potential on the release conductor 139 at armature 220 and its front contact, to maintain the preceding switches in their operated positions and also to busy the connector to all other selectors having access thereto. The connector is now prepared for dialling.

The calling subscriber now manipulates the calling device in accordance with the second digit in the telephone number. When the second digit is dialled, which in this case is assumed to be the digit 1, the circuit of the line relay 202 is opened once by the operation of the calling device at the calling subscriber's substation. When the line relay 202 falls back it places a short circuit around the upper winding of release relay 203 at the normally closed contacts controlled by armature 217, and by the same action it completes a circuit for the upper winding of series relay 204 in series with the lower winding of release relay 203 as follows: from ground, normally closed contacts controlled by armature 217, armature 222 and its front contact, upper winding of series relay 204, lower winding of release relay 203, to battery. Due to the fact that the high resistance upper winding of release relay 203 is shunted out in this circuit the series relay 204 energizes. The current flow through the lower winding of release relay 203 is insufficient to keep the relay energized; however, together with the shunt around the upper winding, the relay is made slow-to-release. The release relay 203, therefore, remains energized.

It may be well to discuss briefly at this time the operation of the line relay 202 in response to a series of impulses. Each time line relay 202 energizes following the first deenergization, a circuit is closed again for both windings of release relay 203 in series with the upper winding of series relay 204, and for both windings of release 203 in series with the lower winding of series relay 204. Release relay 203 is fully energized again over this circuit, but the current flow over both windings of series relay 204 is insufficient to keep the relay energized, however, enough current flows to make the relay slow-to-release. The series relay 204, therefore, remains energized during each series of im-

pulses, but subsequently deenergizes after the line relay comes to rest in its energized position between each series of impulses.

When the line relay 202 falls back responsive to the second digit 1, it closes a circuit from ground, armature 218 and its resting contact, armature 223 and its front contact, armatures 241, 274, 249, and 230 and their respective resting contacts, contacts 235 of the vertical off-normal springs VON, armature 236 and its resting contact, lower winding of two-step relay 206, to battery. Two-step relay 206 energizes over this circuit in its first step, closing contacts A only, to prepare a locking circuit for both of its windings in series, from ground at armature 221 and its front contact. It is obvious that the upper winding of two-step relay 206 is short circuited by its initial energizing circuit over its lower winding and cannot operate to its second step until the short circuit is removed. The line relay 202 subsequently energizes again as has been described hereinbefore, and opens the initial energizing circuit for two-step relay 206 at armature 218 and its resting contact. The opening of the original energizing circuit for the lower winding of two-step relay 206 removes the short circuit from its upper winding, permitting the relay to energize to its second step over a circuit including both windings in series. All the remaining armatures of the relay are operated when the circuit is completed to both the windings in series. Upon energizing to its second step, relay 206 prepares a circuit for the combination switch-over and ring-cut-off relay 205 at armature 233 and its front contact, it prepares a circuit for the combination discriminating and line reversing relay 209 at armature 236 and its front contact, and it prepares a locking circuit for relay 209 at armature 237 and its front contact. However, relay 209 is not energized at this time because the calling subscriber has only transmitted one impulse.

It has been mentioned before that the series relay 204 remains energized during a series of impulses. It will be noted that at armature 268 and its front contact an energizing circuit is completed for slow-to-release relay 275. The operation of the slow-to-release relay 275 is of no importance at this time, however, the function of the relay will be described hereinafter.

After the first series of impulses has been transmitted, which in this case was only one impulse, line relay 202 remains in an energized position. Therefore, the series relay 204 subsequently releases as has been hereinbefore described. Upon falling back, series relay 204 completes a circuit for the slow-acting combination switch-over and ring-cut-off relay 205, by way of ground, armature 226 and its resting contact, contacts 227 of the vertical off-normal springs VON, armature 233 and its front contact, lower winding of relay 205, to battery. Upon energizing, relay 205 prepares a locking circuit for itself at armature 229 and its front contact and it prepares a circuit for the vertical magnet 211 at armature 230 and its front contact. The closing of armatures 228 and 231 and their respective front contacts has no effect at this time.

The calling subscriber may now dial the third digit of the called number, which in this case is assumed to be the digit 3. The circuit of the line relay 202 is again intermittently interrupted in response to the operation of the calling device by the calling subscriber. The first time the line relay 202 falls back, series relay 204 energizes and remains in the energized position throughout the series of impulses as has been hereinbefore described. The operation of the series relay 204 opens the initial energizing circuit for the slow-acting combination switch-over and ring-cut-off relay 205 at armature 226 and its resting contact. However, it also completes a locking circuit for relay 205 before it falls back, the locking circuit extending from ground, armature 226 and its front contact, armature 229 and its front contact, lower winding of relay 205, to battery. As a further result of the falling back of line relay 202 a circuit is completed for the vertical magnet 211, from ground, armature 218 and its resting contact, armature 223 and its front contact, armatures 241, 274, and 249 and their respective resting contacts, armature 230 and its front contact, winding of vertical magnet 211, to battery. Each time the line relay 202 falls back this circuit is completed for the vertical magnet 211 and by its operation wipers 257–260, inclusive, are raised opposite the third level of the bank contacts.

At the end of the series of impulses for controlling the vertical movement, the line relay remains energized and series relay 204 shortly releases as has been described. The falling back of series relay 204 opens the locking circuit for the combination switch-over and ring-cut-off relay 205 at armature 226 and its front contact. Relay 205 then releases due to the fact that its initial energizing circuit has been opened, by the first vertical step of the switch, at contacts 227 of the vertical off-normal springs VON. The circuit for the rotary magnet 212 is prepared at armature 230 and its resting contact by the falling back of relay 205.

The calling subscriber now transmits the final digit of the called number, which in this case is the digit 1. Responsive to the operation of the line relay 202, the series relay 204 is energized again and remains energized throughout the series of impulses. Each time line relay 202 falls back a circuit is completed for the rotary magnet 212 from

ground, armature 218 and its resting contact, armature 223 and its front contact, armatures 241, 274, 249, and 230, and their respective resting contacts, contacts 234 of vertical off-normal springs VON (closed on the first vertical step of the switch), winding of the rotary magnet 212 to battery. By the operation of the rotary magnet 212, the wipers 257–260, inclusive, are rotated into engagement with the first set of bank contacts on the third level.

The wipers of the connector have now come into engagement with the first line of the desired group. The drawing shows only one line connected, that is, the line 261–263 extending to substation A1. It should be noted, however, that all the lines on this level are the same as the line shown. The straps indicated by the reference X, which are jumpered between the corresponding contacts in the banks accessible over wipers 258 and 259, are only placed on the contacts of lines that are listed under one telephone number. It should be noted, however, that the last line in a group of lines must not be strapped as shown, as the connector necessarily must stop on this line whether all the lines in the group are busy or not. If all the lines of a group are busy the connector will operate as a regular connector on this line and will give busy tone to the calling subscriber to indicate that all the lines listed under the one telephone number are busy.

It will be assumed, that the first line of the group is busy, that is, the test conductor, which is similar to test conductor 262, has been grounded by another connector or by the individual lineswitch associated with the first line. When the test wiper 258 encounters ground on the test contact, relay 207 is energized over the following circuit: battery, winding of busy relay 207, resistance 232, armature 246 and its resting contact, armature 225 and its front contact (relay 275 being slow-to-release does not fall back immediately), normally closed contacts controlled by armatures 239 and 245, respectively, test wiper 258 to the grounded test conductor similar to conductor 262. Relay 207 operates in its first step and operates only armature 240. Relay 207 does not operate in its second step at this time because the locking circuit including contacts A and armature 240 is opened at the normally closed contacts controlled by armature 225. It should be noted that the slow-to-release relay 275 is energized over a circuit from battery, winding of relay 275, armature 268 and its front contact, armature 272 and its resting contact, armature 247 and its resting contact, armature 221 and its front contact, to ground. The series relay 204 falls back shortly after the wipers of the connector have become engaged with the first set of bank contacts. As soon as series relay 204 falls back after the series of impulses, a circuit is completed for the rotary stepping relay 276 of the connector as follows: grounded test conductor similar to conductor 262, jumper X, bank contact associated with wiper 259, rotary test wiper 259, armature 267 and its resting contact, armature 271 and its front contact, (relay 275 being slow-to-release does not fall back when its circuit is opened at armature 268 and its front contact), armature 253 and its resting contact, self-interrupting springs 269 of the rotary magnet 212, winding of rotary stepping relay 276, to battery. Upon energizing stepping relay 276 completes a locking circuit for itself as follows: battery, winding of relay 276, self-interrupting contacts 269 of the rotary magnet 212, armature 273 and its front contact, armature 247 and its resting contact, armature 221 and its front contact, to ground. Stepping relay 276 also completes a new holding circuit for the slow-to-release relay 275 and an energizing circuit for the rotary magnet 212, the circuit extending as follows: ground, armature 221 and its front contact, armature 247 and its resting contact, armature 274 and its front contact, armature 249 and its resting contact to junction 277, whence one branch extends via armature 268 and its resting contact, winding of slow-to-release relay 275 to battery, and the other branch extends by way of armature 230 and its resting contact, contact 234 of the vertical off-normal springs VON, winding of rotary magnet 212, to battery. The slow-to-release relay 275 remains in its energized position over this circuit and the rotary magnet 212 energizes. The rotary magnet upon energizing advances its wipers 257–260 to the next set of bank contacts, and at its interrupter contacts 269, opens the circuit for the stepping relay 276. Upon falling back, the stepping relay 276 opens the energizing circuit for the rotary magnet 212 and the slow-to-release relay 275 at armature 274 and its front contact, and at armature 273 and its front contact opens its locking circuit. If the next bank contact encountered by rotary test wiper 259 is grounded by way of strap X and test conductor 262, stepping relay 276 will be energized over the previously traced circuit. The operation of the stepping relay 276 completes a locking circuit for itself at armature 273 and its front contact, and at armature 274 and its front contact completes the holding circuit for the slow-to-release relay 275 and the energizing circuit for the rotary magnet 212, as has been described hereinbefore. The alternate operation of the stepping relay 276 and the rotary magnet 212 continues, if all the intermediate lines of the group are busy, until the last line of the group is reached.

The last line of the group does not have the strap X between the test contacts accessible to test wipers 258 and the test contacts asso-

ciated with the rotary test wiper 259. Therefore, if the last line of the group is also busy the rotary test wiper 259 does not encounter the busy ground. Therefore, stepping relay 276 is not energized to complete the holding circuit for the slow-to-release relay 275 and the energizing circuit of the rotary magnet. The ground encountered by the test wiper 258, however, maintains the previously traced circuit for energizing the busy test relay 207 in its first step. The slow-to-release relay 275 subsequently falls back and at the normally closed contacts controlled by armature 225 it completes a circuit for energizing the busy test relay 207 to its second step, by way of the grounded test wiper 258, normally closed contacts controlled by armatures 245, 239, and 225, respectively, armature 240 and its front contact A, winding of relay 207, to battery. Upon energizing to its second step the busy test relay 207 opens a point in the circuit for the rotary magnet 212 at armature 241 and its front contact to prevent further rotation of the wipers, if the calling subscriber should inadvertently move his calling device, and at armature 239 and its front contact it transfers the locking circuit for itself from ground on the test contact to which wiper 258 has been rotated, to the ground at armature 220 and its front contact. At armature 238 and its front contact relay 207 connects the busy tone conductor from the busy tone machine to the upper side of the line. The calling subscriber, upon hearing the busy signal, will release his receiver thereby releasing the connector and all previously operated switches.

Referring back now to where the wipers 257–260 were rotated automatically from the first to the second set of bank contacts of the third level it will be assumed at this time that the second line of the group is idle. Under these circumstances the rotary test wiper 259 and the test wiper 258 will not encounter ground and consequently the stepping relay 276 will fail to energize again and the busy test relay 207 will fall back. Therefore, the slow-release relay 275 will subsequently fall back and complete the circuit for the slow-acting switching reay 208 over a circuit as follows: ground, armature 220 and its front contact, armature 239 and its resting contact, lower winding of the switching relay 208, armature 240 and its resting contact, normally closed contacts controlled by armatures 225, 239, and 245, test wiper 258, test conductor 262, and thence to battery by way of the bridge-cut-off winding of the associated lineswitch (not shown). Responsive to the closure of this circuit the bridge-cut-off armature of the lineswitch is operated to disconnect the line relay of the lineswitch from across the line conductors.

In the connector the slow-acting switching relay 208 energizes and at its lightly adjusted armature 247 closes a locking circuit for its upper winding, opens another point in the circuit for the rotary magnet 212 at armature 249 and its resting contact, opens its initial energizing circuit at the normally closed contacts controlled by armature 245, and by the same action places ground directly on the test wiper 258 and test conductor 262 at armature 245 and its front contact. The switching relay 208 also prepares a locking circuit for the combination switch-over and ring-cut-off relay 205 at armature 248 and its front contact, connects the ring-back-tone conductor to the upper line conductor at armature 242 and its front contact to indicate to the calling subscriber that the called line is being signalled. Furthermore, this relay connects up the line wipers 259 and 260 at armatures 243 and 251 and their respective front contacts. By the latter operation a signalling circuit is established whereby ringing current from the generator GEN is intermittently projected over the line to operate the ringer at station A1 over the following circuit: battery connected generator GEN, interrupter contacts of the ringing interrupter, armature 231 and its resting contact, armature 251 and its front contact, armature 255 and its resting contact, wiper 260, line conductor 261, to the ringer at substation A1. The return path for the ringing current includes the upper winding of the combination switch-over and ring-cut-off relay 205 and the battery.

When the call is answered, by the removal of the receiver at substation A1, a direct current bridge is closed across the associated line conductors 261 and 263 in the regular manner, whereupon the ring-cut-off relay 205 energizes.

Upon energizing, the combination switch-over and ring-cut-off relay 205 closes a locking circuit for itself at its lightly adjusted armature 229, disconnects the line wipers 257 and 260 from its own upper winding and the generator lead at armatures 228 and 231 and their respective resting contacts, and at the same time it opens the ring-back-tone circuit to the calling subscriber at the normally closed contacts controlled by armature 228. At armatures 228 and 231 and their respective front contacts the ring-cut-off relay 205 completes the talking connection.

Current is now supplied to the transmitter at substation A1 through the windings of the double-wound back-bridge relay 201, which is accordingly energized. The relay is a reversing relay and has the well known function of reversing the incoming trunk conductors 138 and 140, as regards to their connection with the windings of line relay 202. Relay 201 opens a point in the circuit for the release magnet 210 at armature 213 and its resting contact, and at armature 214 and its front contact closes an additional holding

circuit for relays 206 and 208. The reversing of the line conductors 138 and 140 is a standard operation, and is for the purpose of operating a subscriber's paystation or metering apparatus, and in some cases is used for supervisory purposes. The desired connection is now completed and the subscribers may converse as desired.

When the conversation is completed the two subscribers replace their receivers. Should the calling subscriber restore his receiver first, the line relay 202 will deenergize and open the circuit of the slow-release relay 203. Relay 203 subsequently deenergizes and removes the ground from conductor 139 at armature 220 and its front contact, releasing the preceding switches in the usual manner. The connector shown on the drawing, however, does not release due to the fact that the circuit for the release magnet 210 is opened at armature 213 and its resting contact, and it cannot be seized by any selector, because the battery potential is disconnected from conductor 139 at armature 244 and its resting contact. When the called subscriber at substation A1 hangs up his receiver, relay 201 deenergizes, removes the locking ground for relays 206 and 208 at armature 214 and its front contact, and closes a circuit for the release magnet 210 at armatures 213 and its resting contact. The operation of the release magnet 210 causes the switch shaft to restore to normal. When the switch shaft has been fully restored to normal the circuit for the release magnet 210 is opened at the contact 224 of the vertical off-normal springs VON. The release of relay 206 has no effect at this time. Upon subsequently restoring to normal, the switch-through relay 208 removes the locking ground for the combination switch-over and ring-cut-off relay 205 at armature 248 and its front contact, removes the ground potential from the test wiper 258 at armature 245 and its front contact, opens the speaking connection at armatures 243 and 251 and their respective front contacts, and connects battery to conductor 139 at armature 244 and its resting contact. If the called party hangs up first the connector is then released under control of the calling party.

Having described the operation of the switch as a regular rotary connector it will now be assumed that the calling subscriber desires to establish a connection with a particular one of the lines in a group. The same group of lines will be considered as before, and it will be assumed that the first line is wanted.

It will be assumed that the connector shown on the drawing has been seized over conductors 138–140 in the same manner as has been hereinbefore described. In response to the seizing of the connector over line conductors 138–140 the line relay 202 energizes and causes the release relay 203 to energize as before. The energization of the release relay 203 returns ground over release conductor 139 at armature 220 and its front contact to hold the preceding switches operated, prepares the impulsing circuit at armature 223 and its front contact, and at armature 219 and its resting contact opens the circuit for the release magnet 210.

The calling subscriber may now dial the next digit, which in this case is the digit 2. In response to the operation of the calling device by the calling subscriber, line relay 202 falls back and completes a circuit for the series relay 204 which remains energized during impulsing. Upon falling back, line relay 202 completes a circuit from ground, armature 218 and its resting contact, armature 223 and its front contact, armatures 241, 274, 249, and 230 and their respective resting contacts, contacts 235 of the vertical off-normal springs VON, armature 236 and its resting contact, lower winding of two-step relay 206 to battery. Two-step relay 206 energizes in its first step, closing its locking contact. When the line relay energizes, relay 206 operates fully to close all its contacts. The second time the line relay 202 falls back the impulsing circuit is completed over the above traced circuit, but this time including armature 236 and its front contact (two-step relay 206 having been energized by the first impulse), normally closed contacts controlled by armature 254, winding of relay 209 to battery. Upon energizing relay 209 immediately locks itself, from battery, winding of relay 209, armature 254 and its front contact, armature 237 and its front contact, to ground.

It is obvious that two-step relay 206 is energized and locked up when the first digit dialled to the connector is the digit 1 and that both the two-step relay 206 and relay 209 are energized and locked when the first digit dialled is the digit 2.

Upon energizing, relay 209 opens the circuit for the rotary stepping relay 270 at armature 253 and its resting contact to prevent the automatic rotary action of the connector, after the last digit is dialled, when the rotary test wiper 259 encounters a grounded contact. At armatures 252 and 255 and their respective front contacts, relay 209 also causes a reversal in the line conductors which is of no importance at this time.

After the first series of impulses have been transmitted, line relay 202 remains in its energized position. Therefore, the series relay 204 subsequently releases as has been hereinbefore described. Upon falling back, series relay 204 completes a circuit for the slow-acting combination switch-over and ring-cut-off relay 205 from ground, armature 226 and its resting contact, contact 227 of the vertical off-normal springs VON, armature 233 and its front contact, lower winding of relay 205, to battery. Upon energizing, re-

lay 205 prepares a locking circuit for itself at armature 229 and its front contact and it prepares a circuit for the vertical magnet 211 at armature 230 and its front contact. The operation of armatures 228 and 231 has no effect at this time.

The calling subscriber may now dial the third digit of the called number, which in this case is assumed to be the digit 3. The operation of the connector in response to the dialling of the digit 3 causes the line relay 202 to transmit impulses for operating the vertical magnet 211. It will suffice to say that by the operation of the vertical magnet 211 the wipers 257–260, inclusive, are raised opposite the third level of the bank contacts.

At the end of the series of impulses controlling the vertical movement, the line relay remains energized and the series relay 204 subsequently falls back. The falling back of series relay 204 opens the locking circuit for the combination switch-over and ring-cut-off relay 205 at armature 226 and its front contact. Relay 205 subsequently releases due to the fact that its initial energizing circuit has been opened, by the first vertical step of the switch, at armature 227 of the vertical off-normal springs VON. The circuit for the rotary magnet 212 is prepared at armature 230 and its resting contact by the falling back of relay 205. The calling subscriber now transmits the final digit of the called number, which in this case is the digit 1. Responsive to the interruption of the line relay 202, series relay 204 is energized again and remains energized throughout the series of impulses. When the line relay 202 falls back a circuit is completed to the rotary magnet 212 from ground, armature 218 and its resting contact, armature 223 and its front contact, armatures 241, 274, 249 and 230 and their respective resting contacts, contacts 234 of the vertical off-normal springs VON (closed on the first vertical step of the switch), winding of the rotary magnet 212 to battery. By the operation of the rotary magnet 212, the wipers 257–260, inclusive, are rotated into engagement with the first set of bank contacts.

The wipers of the connector have now come into engagement with the wanted line. It will be assumed that the desired line is busy. When the test wiper 258 encounters ground on the test contact, a circuit is completed for the busy test relay 207.

It should be noted that during dialling of the last digit the operation of the series relay 204 completes a circuit for the slow-to-release relay 275 from battery, winding of slow-to-release relay 275, armature 268 and its front contact, armature 272 and its resting contact, armature 247 and its resting contact, armature 221 and its front contact, to ground. After the series of impulses have been completed the series relay 204 subsequently falls back, but the slow-to-release relay 275 remains in its energized position for a short interval thereafter. When the test wiper 258 encounters ground on the test contact, relay 207 is energized over the following circuit: battery, winding of busy relay 207, resistance 232, armature 246 and its resting contact, armature 225 and its front contact (relay 275 being slow-to-release does not fall back immediately), normally closed contacts controlled by armatures 239 and 245, respectively, test wiper 258, to the grounded test conductor similar to conductor 262. Relay 207 operates in its first step and operates only armature 240. The rotary test wiper 259 also encounters ground on its bank contact which is connected to the same bank contact to which test wiper 258 is engaged with, by means of the strap X. In the previous connection the rotary stepping relay 276 energizes when the rotary test wiper 259 encounters ground and causes the rotary magnet 212 to rotate the wipers to the next set of bank contacts. In establishing the present connection this circuit is opened by the operation of relay 209 at armature 253 and its resting contact. Consequently there will be no automatic rotation of the wipers when a busy line is reached.

The slow-to-release relay 275 subsequently falls back and at the normally closed contacts controlled by armature 225 it completes a circuit for energizing the busy test relay 207 to its second step, by way of the grounded test wiper 258, normally closed contacts controlled by armatures 245, 239, and 225, respectively, armature 240 and its front contact A, winding of busy test relay 207, to battery. Upon energizing to its second step the busy test relay 207 opens a point in the circuit for the rotary magnet 212 at armature 241 and its front contact to prevent further rotation of the wipers, should the calling subscriber move his calling device, and at armature 239 and its front contact it transfers the locking circuit for itself from ground on the test conductor to which wiper 258 has been rotated, to the ground at armature 220 and its front contact. At armature 238 and its front contact, relay 207 connects the busy-tone conductor from the busy-tone machine to the upper side of the line. The calling subscriber, upon hearing the busy signal, will replace his receiver, thereby releasing the connector and all previously operated switches.

Assuming now that the called line is idle when the connection is established. Under these circumstances the test wiper 258 will not encounter ground and consequently the busy test relay 207 will not be energized. The slow-to-release relay 275 subsequently falls back and completes the circuit for the slow-acting switching relay 208 over a cir-

cuit as follows: ground, armature 220 and its front contact, armature 239 and its resting contact, lower winding of switching relay 208, armature 240 and its resting contact, normally closed contacts controlled by armatures 225, 239, and 245, test wiper 258, test conductor (similar to the test conductor 262), and thence to battery by way of the bridge-cut-off winding of the associated lineswitch (not shown). Responsive to the closure of this circuit the bridge-cut-off armature of the lineswitch is operated to disconnect the line relay of the lineswitch from across the line conductor.

In the connector the slow-acting switching relay 208 energizes and at its lightly adjusted armature 247 closes a locking circuit for its upper winding, opens another point in the circuit for its rotary magnet 212 at armature 249 and its resting contact, opens its initial energizing circuit at the normally closed contacts controlled by armature 245, and by the same action places ground directly on the test wiper 258 and the test conductor (similar to test conductor 262) at armature 245 and its front contact. The switching relay 208 also prepares a locking circuit for the combination switchover and ring-cut-off relay 205 at armature 248 and its front contact, connects the ring-back-tone conductor to the upper line conductor at armature 242 and its front contact to indicate to the calling subscriber that the called line is being signalled, and it connects up the line wipers 257 and 260 at armatures 243 and 251 and their respective front contacts. By the latter operation a signalling circuit is established whereby ringing current from the generator GEN is intermittently projected over the line to operate the ringer at the wanted subscriber's station. The return path for the ringer current includes the upper winding of the combination switchover and ring-cut-off relay 205 and the battery.

When the call is answered, by the removal of the receiver at the called substation, a direct current bridge is closed across the associated line conductors in the regular manner, whereupon the ring-cut-off relay 205 energizes.

Upon energizing, the combination switchover and ring-cut-off relay 205 closes a locking circuit for itself at its lightly adjusted armature 229, disconnects the line wiper 260 from its own upper winding and the line wiper 257 from the generator conductor at armatures 228 and 231 and their respective resting contacts, and at the same time it opens the ring-back-tone circuit to the calling subscriber at the normally closed contacts controlled by armature 228. At armatures 228 and 231 and their respective front contacts the ring-cut-off relay 205, completes the talking connection.

Current is now supplied to the transmitter at the wanted subscriber's station through the windings of the double-wound back-bridge relay 201, which is, accordingly, energized. This relay is a reversing relay and has the well known functions of reversing the incoming line conductors 138 and 140, as regards to their connection with the windings of the line relay 202. Relay 201 opens a point in the circuit for the release magnet 210 at armature 213 and its resting contact, and at armature 214 and its front contact it closes an additional holding circuit for relays 206 and 208. The reversing of the line conductors 138 and 140 is a standard operation, and is for the purpose of operating a subscriber's paystation or metering apparatus, and in some cases is used for supervisory purposes. The desired connection is now completed and the subscribers may converse as desired.

When the conversation is completed the two subscribers replace their receivers. A detailed description of the circuit operations during the release of the connector shown on the drawing has been given hereinbefore and it will suffice to say that the switch is restored to its normal position when the two subscribers replace their receivers.

It is evident now that the connector can be used to select the first idle line in a group of lines which are all listed under one telephone number, or may be operated as a regular connector to establish a connection with any particular line in a group of lines listed under one number. This feature is particularly desirable in the case of night listing of telephones when only certain of the lines, in a group of lines listed under one number are available for connection after business hours.

A detailed description of the operation which takes place when a calling subscriber desires to establish a connection with the party-line subscriber B1 whose telephone number is 3121 will now be given. When the calling subscriber removes his receiver and dials the digit 3 the operation of the lineswitch and the selector is exactly the same as before. The selector is positioned to the third level of the selector banks to engage the bank contacts to which conductors 138—140, inclusive are connected.

In response to the seizing of the connector, in the present case, over line conductors 138 and 140, the line relay 202 and the release relay 203 are energized and the connector is prepared to receive the second digit of the telephone number, which in this case is the digit 1. It has been mentioned above that when the first digit dialled into the connector is the digit 1 the two-step relay 206 is energized and locked up over both its winding in series to ground at armature 221 and its front contact.

In response to the third digit of the tele-

phone number, which is the digit 2, the vertical magnet 211 raises the wipers of the switch to the second level. The detailed circuit for operating the vertical magnet has been traced hereinbefore and it is not thought necessary to repeat the circuit operation at this time.

The calling subscriber may now operate his calling device to transmit the final digit of the telephone number, which is in this case the digit 1. In response to the dialling of the digit 1, line relay 202 is momentarily de-energized, and causes the rotary magnet 212 to rotate the wipers 257–260, inclusive, of the switch into engagement with the first set of bank contacts on the second level. The final digit has now been received and the wipers of the connector have engaged the terminals of the called line. If the line is busy, there will be a ground potential on the test conductor 265. When the test wiper 258 encounters a grounded bank contact the busy-test relay 207 is energized in its first step to close contact A only, and after a short interval slow-to-release relay 275 falls back and completes the circuit for energizing the busy test relay 207 in its second step, by this action relay 207 transfers the locking circuit for itself from the grounded test wiper 258 to ground at armature 220 and its front contact. The calling subscriber now receives a busy-tone signal from the busy-tone machine indicating that the wanted subscriber's line is busy. Upon hearing the busy signal the calling subscriber will hang up his receiver, thereby releasing the entire connection.

It will be assumed that when the wipers 257–260 are rotated into engagement with the wanted subscriber's line, to which conductors 264–266 are connected that the line is idle, therefore, no ground is encountered by the test wiper 258. Therefore, the busy-test relay 207 is not energized. As soon as the slow-to-release relay 275 falls back a circuit is completed for the slow-acting switching relay 208 as follows: ground, armature 220 and its front contact, armature 239 and its resting contact, lower winding of switching relay 208, armature 240 and its resting contact, normally closed contacts controlled by armatures 225, 239, and 245, test wiper 258, test conductor 265, thence to battery by way of the bridge-cut-off winding of the associated lineswitch (not shown). Responsive to the closure of this circuit the bridge-cut-off armature of the lineswitch is operated to disconnect the line relay of the lineswitch from across the line conductors.

In the connector the slow-acting switching relay 208 energizes and at its lightly adjusted armature 247 closes a locking circuit for its upper winding, opens another point for the circuit for the rotary magnet 212 at armature 249 and its resting contact, opens its initial energizing circuit at the normally closed contacts controlled by armature 245, and by the same action places ground directly on the test wiper 258, and test conductor 265 at armature 245 and its front contact. The switching relay 208 also prepares a locking circuit for the combination switch-over and ring-cut-off relay 205 at armature 248 and its front contact, connects ring-back-tone conductor to the upper line conductor at armature 242 and its front contact, to indicate to the calling subscriber that the called line is being signalled, and it connects up the line wipers 257 and 260 at armatures 243 and 251 and their respective front contacts. By the latter operation a signalling circuit is established whereby ringing current from the generator GEN is intermittently projected over the line to operate the ringer at substation B1 over the following circuit: battery connected generator GEN, interrupter contacts of the ringing interrupter, armature 231 and its resting contact, armature 251 and its front contact, armature 255 and its resting contact, wiper 260, line conductor 264, ringer at substation B1, to ground. The above circuit is intermittently opened and closed by the operation of the ringing interrupter and the ringer at substation B1 is thus operated at intervals to signal the called subscriber. When the called subscriber at substation B1 removes his receiver to answer the call, the ringer thereat is disconnected and a direct current circuit is completed over the other line conductor 266, wiper 257, armature 252 and its resting contact, armature 243 and its front contact, armature 228 and its resting contact, upper winding of the ring-cut-off relay 205, to ground. The combination switch-over and ring-cut-off relay 205 energizes over this circuit and closes a locking circuit for itself at its lightly adjusted armature 229 and its front contact, from ground at armature 248 and its front contact, through the lower winding of relay 205 to battery. Relay 205 also opens its initial energizing circuit at armatures 228 and 231 and their respective resting contacts, completes a talking connection at their respective front contacts, and by the same action disconnects the ring-back-tone conductor from the upper line conductor 138.

Current is now supplied to the transmitter at substation B1 through the winding of the double-wound back-bridge relay 201, which is accordingly energized. The functions of relay 201 have been described hereinbefore and it will suffice to say that after the conversation is completed the release of the connector is controlled by the last party to hang up.

It should be noted that the rotary test wiper 259 does not encounter ground on any of its associated bank contacts due to the fact that the second level is not allotted to lines of a group which are listed under one telephone number. If, however, a condition should

arise wherein it would be necessary to use the second level for a group of lines, straps or jumpers similar to strap X are all that are required to change the operation of the connector from a regular connector to a rotary connector.

It will now be assumed that the calling subscriber desires to establish a connection with the subscriber at substation B2, whose telephone number is 3221. The setting up of the connection is exactly the same as described in establishing a connection with the subscriber at substation B1, whose telephone number is 3121, except that the second digit dialled is a 2 instead of a 1. The first digit 2 dialled into the connector (the second digit of the telephone number), locks up the two-step relay 206 as before, in addition completes an energizing circuit for relay 209 which accordingly energizes and locks itself at armature 254 and its front contact. The connection is then completed as previously described, but in this case the ringing current is transmitted by way of armature 255 and its front contact, line wiper 257, line conductor 266, through the ringer and ground at substation B2. It should be noted that the operation of relay 209 causes the ringing current to be transmitted over the opposite line conductor from that used in signalling the subscriber at substation B1.

When the subscriber at B2 responds to the ringing of his bell by removing his receiver a direct current circuit is completed over the other line conductor 264, line wiper 260, armature 252 and its front contact, to the upper winding of the ring-cut-off relay 205.

The ring-cut-off relay 205 is energized over this circuit as before and the talking connection is completed. The release of the connector has been described hereinbefore and it will suffice to say that the connector is released under control of the last party to hang up.

The operation of the connector to establish a connection with individual line subscribers is exactly the same as has been described in connection with establishing a connection with the subscriber at substation B.

When groups of lines are listed under one telephone number it is not necessary to use an entire level for each group because the connector works equally as well when only two or three lines are in each group. For example, in the present case the bank contacts on three lines are shown strapped by the jumper X and with only four lines in this particular group the fourth set of bank contacts accessible to wipers 258 and 259 is not strapped. The telephone number of the group of lines in this case is 3131. If all the lines in the group are busy the connector will automatically rotate its wipers to the fourth set of bank contacts and if that line is also busy will return busy tone to the calling subscriber. Another group of lines may be wired on the remaining set of bank contacts on the third level, that is, the fifth, sixth, seventh, eighth, ninth, and tenth sets of bank contacts of the level, the X jumpers being wired between the bank contacts associated with wipers 258 and 259 on the fifth to the ninth sets of bank contacts, inclusive. However, the tenth set of bank contacts will not be jumpered by means of the strap X. The telephone number listed in the directory for the group of lines in this case will be 3135. In response to the last digit dialled, which is the digit 5, the rotary magnet will be controlled by impulses from the line relay to rotate the wipers 257–260 of the switch to the fifth set of bank contacts on the third level. After the impulse series, the series relay 204 subsequently falls back and prepares the rotary test circuit to the rotary stepping relay 276. Then, if the rotary test wiper 259 encounters ground on the fifth set of bank contacts by way of the jumper X and the associated test conductor, the connector will be automatically rotated to the next set of bank contacts. This automatic rotation of the wipers continues until an idle line is reached. If all the lines in the group are busy the connector will automatically rotate the wipers to the tenth set of bank contacts. Due to the fact that the tenth set of bank contacts is not strapped, by means of the jumper X, the rotary test wiper 259 is not grounded. However, the regular test wiper 258 encounters the grounded bank contact and busy tone is transmitted to the calling subscriber to indicate that all the lines in the group are busy.

What is claimed is:

1. In an automatic telephone system, a connector switch, a group of lines accessible to said switch, means responsive to a predetermined first digit for preparing said switch to operate as a regular connector to select any particular line in said group of lines, and means responsive to a different predetermined first digit for preparing said switch to operate as a rotary connector to automatically select the first idle line encountered in said group of lines.

2. In a telephone system, a connector, a group of lines, means for directively operating the wipers of said connector to engage the first line in said group of lines, means operated when said first line is busy for automatically rotating said wipers to hunt for an idle line in said group, and means controlled by a calling subscriber before the directive operation of said connector is completed for preventing said automatic rotation if said first line is busy.

3. In a telephone system, a rotary connector, a group of lines accessible to said connec-

tor, means for operating said connector in a primary and secondary movement to select said group of lines, and means responsive before said primary and secondary movements for either causing said connector to automatically rotate to select the first idle line in said group or for causing said connector to remain connected to the first line of the selected group regardless of the idle or busy condition of said first line.

4. In a telephone system, a three-digit connector switch, a group of lines accessible to said switch, means for operating a pair of relays responsive to impulses indicative of a particular first digit, means for operating only one of said pair of relays responsive to a different first digit, means responsive to impulses of the second and third digits for operating said switch to select said group of lines, and means including said relays for determining whether said switch will hunt for an idle line in the group or not.

5. In a telephone system, a three-digit connector switch, means responsive to a first digit dialled by a calling subscriber for preparing said switch for further operation, a group of lines accessible to said switch, means responsive to the remaining digits dialled for selecting said group of lines or any particular line in said group, means determined by the value of said first digit for controlling the operation of said connector after the group of lines or particular line in said group has been selected, and means including said last-mentioned means for automatically rotating the wipers of said switch to find an idle line in said group if the first line in the group is busy or for preventing automatic rotation regardless of the busy or idle condition of the first line or particular line.

6. In a telephone system, a three-digit connector, a plurality of control relays, all of which are operated responsive to a first digit of a predetermined value and one of which is operated responsive to a first digit of a predetermined lesser value, the operation of the said one of said relays preparing said connector to respond to the second and third digits, a group of lines, means responsive to said second and third digits for advancing the wipers of said switch to engage the first line of said group of lines, means for automatically advancing said wipers if said first line is busy to hunt for the first idle line in said group, and contacts operated when both of said relays are operated for preventing said automatic advancement of the wipers whether the first line is busy or idle.

7. In an automatic telephone system, an automatic switch controlled by a plurality of series of impulses transmitted by a calling subscriber, a two-step relay operated through its first step by the first impulse of the first series, contacts on said relay for operating it through its second step when said first impulse of said first series is terminated, a second relay operated and locked up responsive to a second impulse of said first series, a group of lines accessible to said switch, means for positioning the wipers of said switch responsive to the second and third series of impulses to select said group, means responsive when the first line of said group is busy for automatically rotating the wipers of said switch to select an idle line in said group, and contacts on said second relay for preventing said automatic rotation of the wipers of said switch regardless of the busy or idle condition of the first line of said group.

8. In a telephone system, a calling line, a group of lines, a connector switch controllable over the calling line to select said group of lines among other lines accessible to said switch, an auxiliary slow-acting relay, a motor magnet and means for operating the same automatically to cause said switch to select the first idle line in said group, said means including a stepping relay for sending impulses to said magnet and said auxiliary relay, means effective when the last line in said group is encountered for preventing said stepping relay from energizing whether said last line is busy or idle, and means responsive to the release of said stepping relay and then said auxiliary slow-acting relay for connecting said calling line with a source of busy signalling current if said last line is busy and for connecting a source of signalling current to signal the party on said last line if said line is idle.

9. In a telephone system, a three-digit connector for establishing connections with two-party lines, a group of lines, means responsive when the wipers of said connector are engaged with the first line in said group of lines for automatically rotating said wipers to search for an idle line in said group if said first line is busy, means for preventing said automatic rotation of the wipers regardless of the busy or idle condition of the first line in said group, means responsive when the wipers of said connector engage a two-party line for transmitting signalling current to signal one of the subscribers on said two-party line, and means including said automatic rotary preventing means for transmitting the signalling current to signal the other subscriber on said two-party line.

10. In an automatic connector switch, a wiper reversing relay operated under control of a calling subscriber, a two-step relay operated under control of a calling subscriber through its first step to close a locking circuit for itself which operates the relay through its second step when its initial energizing circuit is opened, contacts on said relay for preparing a circuit for said wiper reversing relay, a source of current for signalling a wanted subscriber when the connection has been established, said source of

current normally applied to one of the line conductors when a connection is established, and contacts on said wiper reversing relay for directing said signalling current over the other side of the line.

In witness whereof, I hereunto subscribe my name this 24th day of November, A. D. 1931.

FREDERICK L. KAHN.