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H. HOVLAND

1,841,123

TELEPHONE EXCHANGE SYSTEM

Filed March 24, 1930

3 Sheets-Sheet 1

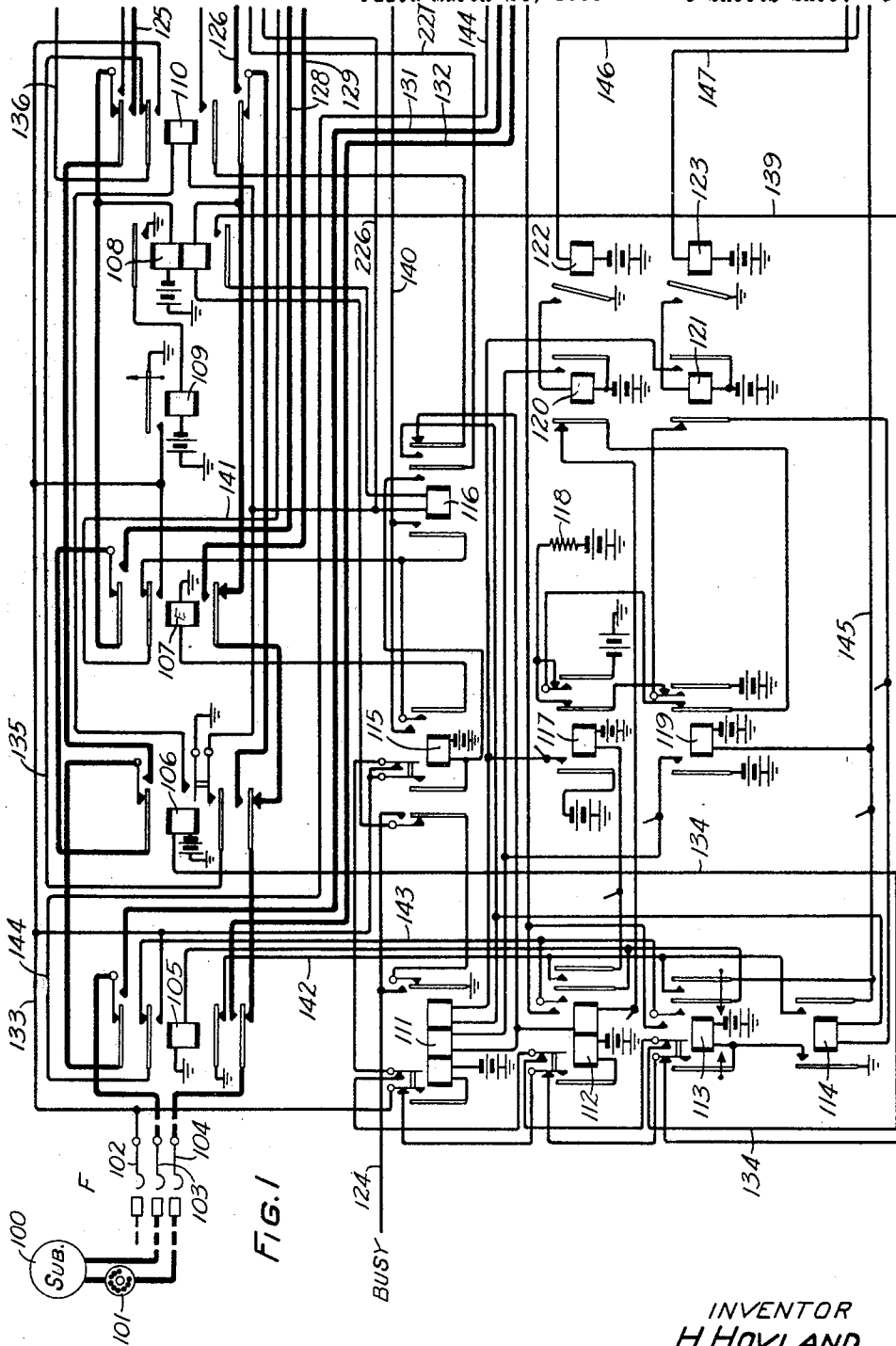


FIG. 1

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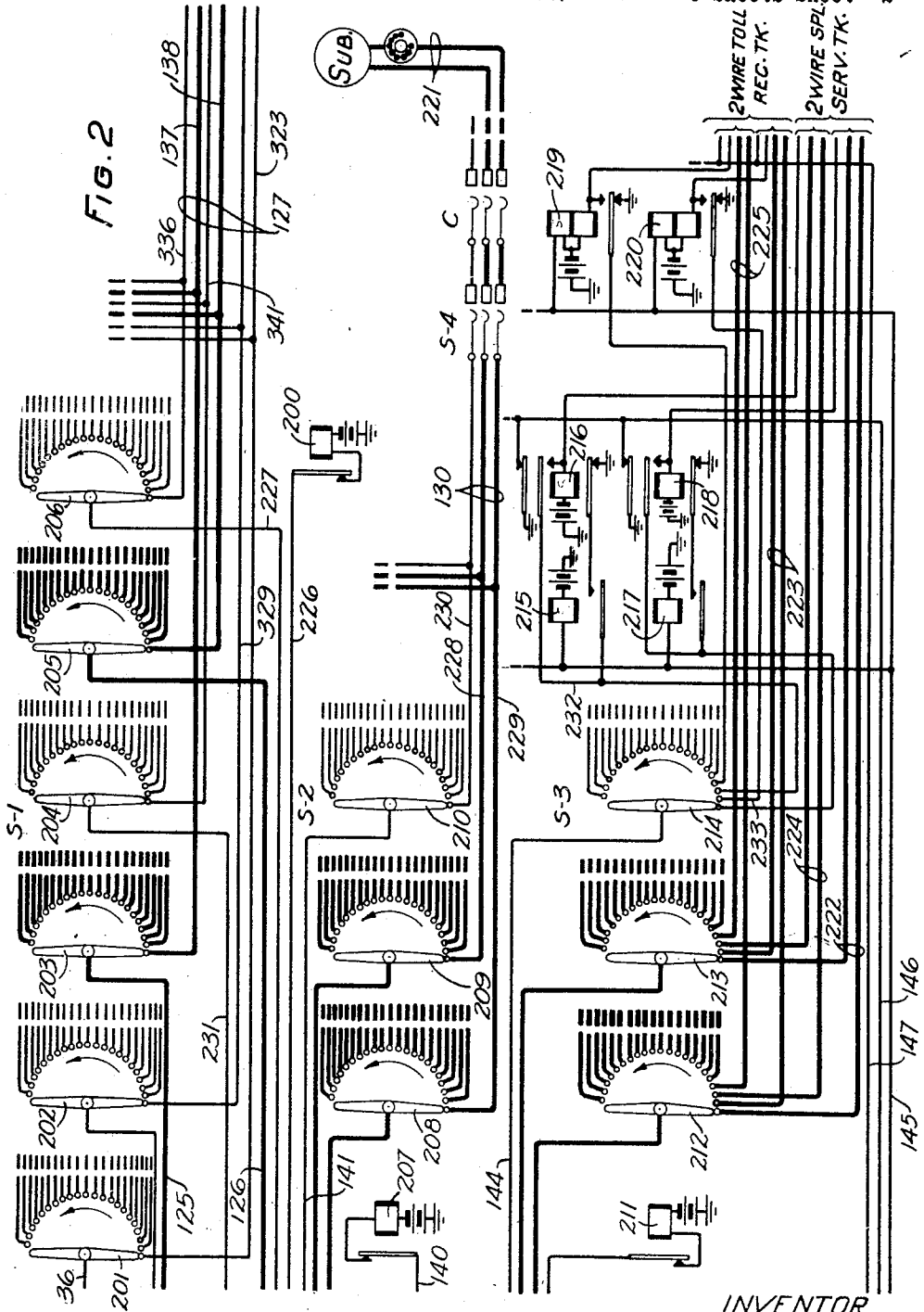
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TELEPHONE EXCHANGE SYSTEM

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3 Sheets-Sheet 2



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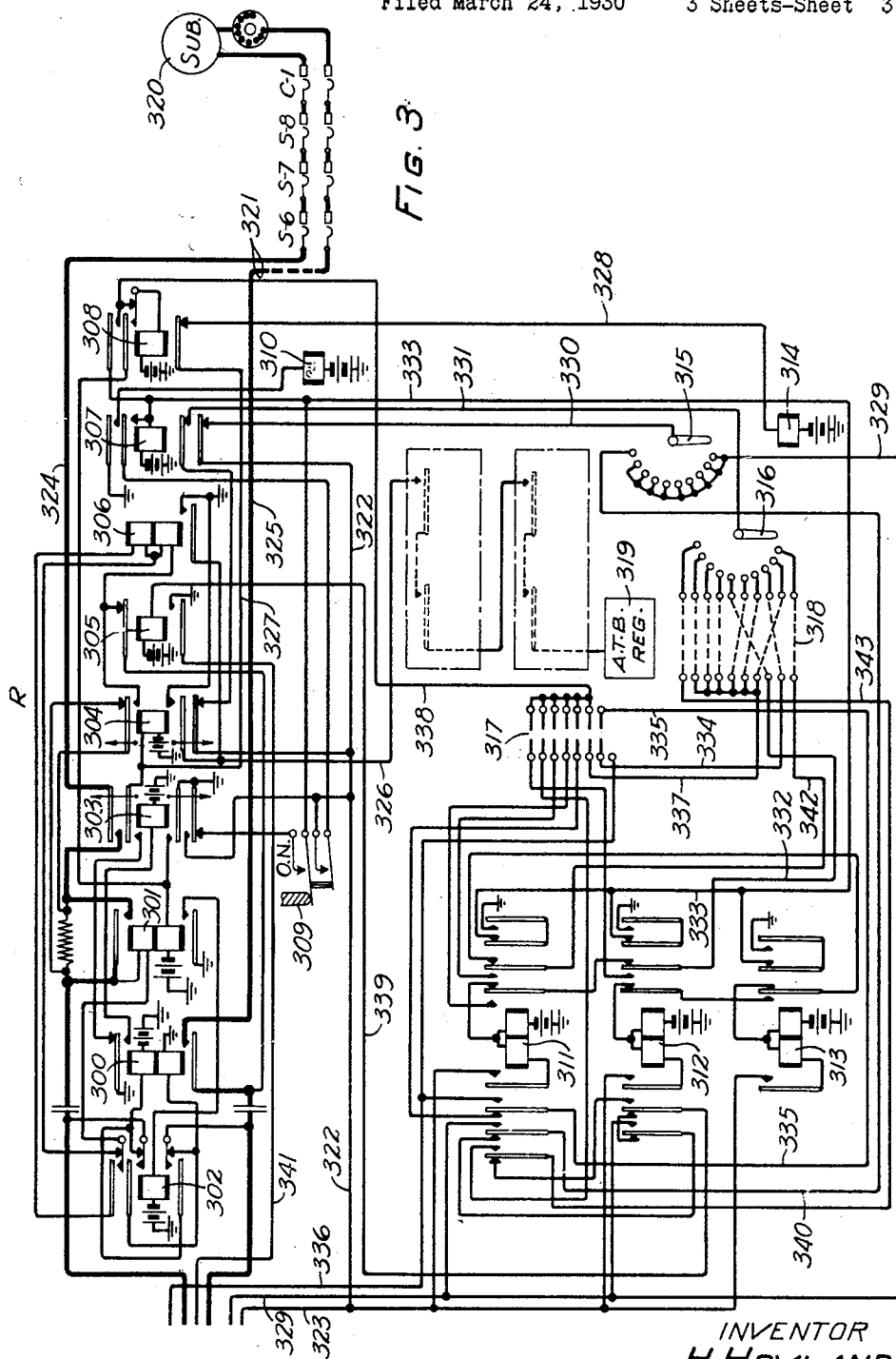
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TELEPHONE EXCHANGE SYSTEM

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

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## TELEPHONE EXCHANGE SYSTEM

Application filed March 24, 1930. Serial No. 438,383.

This invention relates to telephone exchange systems and particularly to systems involving both central offices and branch offices.

The objects of the invention are to render the branch office less dependent on the main office, to enable a more reliable service, and to otherwise improve systems of this character.

According to this invention, the branch exchange is equipped with a selecting unit comprising a plurality of separately operable switches one of which serves to extend a local calling line over an interoffice trunk to the main exchange, another to extend the calling line to local switches so the call may be completed to a local called line when it has progressed far enough to determine that this is its destination, and another to extend the calling line to special service trunks such as those leading to operators' positions.

Another feature is a system in which the interoffice trunk seized by the selecting switch is provided with a repeater for repeating impulses to set switches at the main office, said repeater being equipped with a register for recording the office code digits sent by the calling subscriber and repeated to the main office. As soon as all code digits have been recorded, the register exercises control over said selecting unit to determine whether the call is to continue its progress in the main office and the temporarily seized local trunk released, whether the interoffice trunk is to be released and the calling line extended locally to the called line, or whether both the interoffice trunk and the seized local trunk are to be released and the calling line extended over one of the special service trunks.

Another feature of the invention is a system in which two groups of trunks appear in the same row of contacts in a switch bank, each trunk being provided with an individual relay, the relays of one group serving when released to maintain an artificially busy condition on the respective trunks and the relays of the other groups serving the same purpose when energized, and in which selective means is provided for selectively energizing the relays of either group.

In the drawings, Fig. 1 illustrates a subscriber's line terminating in the bank of a line finder switch in a branch office and also a portion of a trunk circuit extending from the brushes of the finder switch.

Fig. 2 discloses three separate selector switches each terminating a branch of said trunk circuit, one of said switches serving to extend the trunk in the direction of the central office, another to extend the trunk to local selector switches, and the third one to extend the trunk to operators' positions. Fig. 2 also illustrates diagrammatically the local selectors and a local called line and the operators' trunks.

Fig. 3 shows a repeater circuit located at the branch office in the outgoing end of the trunk circuit which extends to the distant central office and there terminates in selector switches for completing a connection to a called line.

A calling subscriber's line in the branch office is extended by means of a finder switch F to a trunk having three different branches or outlets. One of these branches, comprising the talking conductors 125 and 126, extends to the brushes of the selector switch S—1, which has access to trunks such as the trunk 127 leading to the outgoing repeater R. The second branch, comprising the talking conductors 128 and 129, extends to the brushes of selector switch S—2, which has access to local trunks such as the trunk 130 leading to local first selectors such as the switch S—4. The third branch comprises the talking conductors 131 and 132 and extends to the brushes of selector switch S—3, which has access to two different kinds of trunks, some extending to special service operators' positions and others extending to toll recording operators' positions. The special service trunks and the toll recording trunks may appear in any desired relation in the bank of the switch S—3. As illustrated, for example, the brushes of the switch S—3 in their first position make connection with the special service trunk 222; in their second position, they connect with the recording trunk 223; in their third position, they connect with another special service

trunk 224; and in their fourth position they connect with a recording trunk 225.

A calling line in the branch office is first extended to the brushes of the selector S—1, and this selector is set in operation to seize an idle repeater and trunk outgoing to the central office. Since it is desirable to have a uniform number of digital places in the designation of a called line whether the call is being extended to a local subscriber in the branch office or to a central office subscriber, and since it is necessary to distinguish between local and central office calls, the system herein disclosed is arranged to utilize the first portion of the entire designation as a code to enable the apparatus to distinguish between the local and central office calls. The code may consist of either one or two digital places. As illustrated in the drawings, it is assumed that the code comprises the first two digital places in the designation. When the subscriber dials the first code digit, the impulses are repeated by the repeater R over the trunk 321 to operate the selector switch S—6. These impulses also operate the step-by-step register switch associated with the repeater R. The register switch transfers its registration to other parts of the apparatus, and at the end of the first series of impulses, it automatically releases. The first operation of the register switch initiates the operation of the switch S—2, which searches and finds the first idle trunk 130 extending to the local selector switch S—4. In this manner a connection to an idle local selector is prepared in advance in anticipation of a local call. The impulses representing the second code digit are likewise repeated to the central office to set the succeeding selector switch S—7 and also to cause the second positioning of the register switch. The two settings of the register switch are sufficient to determine the destination of the call, namely, whether it is to continue its progress through the central office, whether it is to be routed to switches in the local office, or whether it should be extended over a trunk to an operator's position. If the call is to continue its progress in the central office, succeeding impulses are repeated over the trunk 321 causing the setting of the remaining switches and the completion of the connection to a called subscriber's line 320. If, however, the call is a local one, the repeater R and trunk 321 are released, the calling subscriber's line disconnected from the switch S—1, and extended over the switch S—2 to the preselected trunk 130 extending to a first local selector switch S—4. Continuing series of impulses cause the setting of the local switches to complete the connection to the local called line 221.

Should the calling subscriber wish to make a special service call to an operator's position, he dials a special code consisting of the single digit 0. This results in the release of the

central office trunk and the operation of the selector switch S—3, which automatically tests the trunks in its bank and seizes the first idle one leading to the special operator's position. On the other hand, should the calling subscriber wish to obtain a toll recording operator, he dials another special code consisting of the digits 1 1 0. In this case, the repeater and central office trunk are released, and the selector S—3 set in motion to test and seize the first idle trunk extending to the toll recording position.

The finder F, selectors S—4, S—6, S—7, S—8 and connectors C and C—1 may be of any well-known type such as the two-motion Strowger switch having vertical and rotary selecting movements. The switches S—1, S—2, and S—3 and the register switch in Fig. 3 may be of the single movement step-by-step type.

A detailed description will now be given, and it will first be assumed for this purpose that the subscriber of line 100 at the branch office wishes to extend a connection to a local subscriber's line such as the line 221. The initiation of the call causes the operation of finder switch F, which sets its brushes 102, 103, and 104 on the terminals of the calling line. During the operation of the finder switch, ground potential is applied through the brush 102 to the sleeve conductor 133, which extends through the inner left normal contacts of relays 115, 111, 112, 113, conductor 134, winding of relay 106 to battery. Relay 106 operates and extends the tip and ring conductors of the subscriber's line to the armatures of relay 110. Relay 106 also initiates the hunting operation of the rotary selector switch S—1. The operating circuit of the switch S—1 may be traced from battery through the winding and contact of stepping magnet 200, conductor 226, inner lower contact of relay 106, conductor 135, inner upper back contact of relay 110, conductor 136 to the test brush 201 of the switch S—1. If the switch S—1 is standing on a busy trunk, ground potential on the brush 201 causes the magnet 200 to operate and step the brushes to the next position. The magnet interrupts its own circuit, and the stepping continues until an idle trunk 127 is reached. During the hunting movement of the switch S—1, another circuit also exists by way of conductor 226 through the winding of relay 110 to ground at the contact of relay 106. Relay 110, however, is shunted as long as busy terminals are encountered. When the first idle terminal is reached, the shunt is removed and relay 110 operates, opening the stepping circuit of the magnet 200 and extending the conductors of the calling line over the branch 125, 126 through brushes 203 and 205 to the trunk 127. Relay 110 being of high resistance does not permit the operation of the

stepping magnet 200 in series therewith. The conductor 137 of the circuit 127 extends through the upper inner normal contact of relay 302 and the upper winding of the impulse relay 300 to battery while the conductor 138 extends through the lower normal contact of relay 302 and the lower winding of relay 300 to ground. Thus, the impulse relay 300 is included in series with the conductors of the calling subscriber's line 100. Relay 300 operates and closes an obvious circuit for the slow release relay 303. Relay 303 at its lowermost contact applies ground potential to the holding conductor 322. This ground potential is returned over conductor 323 through the test brush 201, conductor 136, inner upper front contact of relay 110 to the conductor 133 and serves to hold the finder switch F. With relays 300 and 303 operated, a bridge is closed across the conductors of trunk 321 extending to the selector switch S—6 in the distant central office. This bridge may be traced from the conductor 324 through the upper contact of relay 303, upper back contact of relay 304, upper winding of relay 301, upper normal contact of relay 302, lower winding of relay 306, upper contact of relay 305, lower contact of relay 300 to the other conductor 325. A circuit is also closed through the lower winding of relay 301 to ground at the contact of relay 303. Relay 301 is an electro-polarized relay which will not operate due to its lower winding alone and will only operate when its lower winding is energized and current flows through its upper winding in the proper direction. The closure of the trunk prepares the selector switch S—6 for the receipt of the first series of impulses. Relay 306 when operated places ground potential on the chain circuit 326 which extends through the contacts of similar relays related to other repeaters to the all-trunks-busy register device 319. The direction of current flow from the selector switch S—6 over the trunk 321 is such that the relay 301 does not operate.

The subscriber now proceeds to transmit the first two digits representing the code portion of the designation. The connecting frames 317 and 318 associated with the repeater may be wired in any desired manner to enable the use of different digits to identify the destination of the call. As shown in the drawings, it is assumed that local calls are identified by a code consisting of the digits 6 3. When the subscriber manipulates his impulse transmitter 101 to send the first series of six impulses, relay 300 releases on the first opening of the line and completes a circuit from ground through its back contact, armature and front contact of relay 303 and thence in parallel through the winding of relay 304 to battery and over conductor 327, lower contact of relay 308, conductor 328, through the

winding of the stepping magnet 314 of the register switch. Relay 304 is slow to release and retains its armatures attracted during the impulse series. The magnet 314 energizes to cause the advance of wipers 315 and 316 to their first position contacts. Relay 304 revises the trunk loop circuit extending to the central office so that it may now be traced from conductor 324 through the upper contact of relay 303, upper front contact of relay 304, upper contact of relay 305, lower armature and contact of relay 300 to the opposite conductor 325. This excludes the relays 301 and 306 to improve the pulsing conditions. Relay 300 in opening its lower contact when the first impulse is transmitted, opens the bridge across the trunk to cause the repeating of the impulse over the trunk 321 to the selector switch S—6. In like manner, the remaining impulses of the first series cause the stepping of the register switch and are also repeated over the trunk to set the selector S—6.

When the register switch takes its first step, brush 315 engages the contacts connected to conductor 329, and a circuit is completed from the grounded conductor 322, lower back contact of relay 307, conductor 330, brush 315, conductor 329, brush 202, uppermost front contact of relay 110 through the upper winding of relay 108 to battery. Relay 108 operates and closes an obvious circuit for slow-release relay 109, which energizes and connects its grounded armature to the holding conductor 133. Relay 108 also operates the relay 116 on a circuit traceable from battery through the winding and contact of magnet 200, conductor 226, winding of relay 116, lower contact of relay 108, conductor 139 through the outer left contacts of relays 113, 112 and 111 to the grounded conductor 133. Due to the high resistance of relay 116, the stepping magnet 200 does not operate in series therewith. The relay 116 initiates the hunting operation of the selector S—2 to preselect an idle trunk extending to a local selector. Stepping magnet 207 of the switch S—2 is energized in a circuit from battery through its winding and contact, conductor 140, left contact of relay 116, inner upper back contact of relay 107, conductor 141 to the testing brush 210. The switch continues to operate until an idle ungrounded terminal is reached, at which time the magnet 207 fails to receive energizing current and the switch comes to rest.

At the end of the first series of impulses, the register switch comes to rest with its brushes 315 and 316 on the No. 6 contacts. and slow-release relay 304 releases after an interval. Relay 304 completes a circuit from the grounded conductor 322, lower back contact of said relay, inner lower contact of relay 307, conductor 331, brush 316, thence to conductor 332, next to the inner right

armature and back contact of relay 312, inner right armature and back contact and right-hand winding of relay 311 to battery. Relay 311 is so adjusted that its right winding when energized is sufficient to close its inner left front contact and its outer right front contact but does not shift the remaining contacts until the left winding is energized. The same is true of relays 312 and 313. Relay 311 at its inner left contact closes a circuit from battery through both its windings and said contact to the grounded conductor 323. The left winding of the relay, however, is shunted by the presence of ground on conductor 332 and, therefore, is not effective at this time. Relay 311 at its outer right contact closes a circuit for energizing the relay 307. This circuit may be traced from ground through the outer right front contacts and next to the outer right back contacts of relay 311, conductor 333, winding of relay 307 to battery. Relay 307 at its inner upper front contact closes a locking circuit for itself extending through the lower off-normal contacts 309 of the register switch to ground at the front contact of relay 303. At its inner lower contact, relay 307 opens the original energizing circuit of relay 311, and the shunt now being removed, said relay energizes in the circuit including both its windings. Relay 311 thereupon shifts its remaining contacts removing ground potential from the conductor 333. Relay 307 at its uppermost contact closes an obvious circuit for the release magnet 310 which energizes and restores to normal the brushes 315 and 316 of the register switch. As the switch returns to normal, the contacts 309 reopen, and relay 307 releases, in turn releasing the magnet 310. Due to the fact that the brush 315 has returned to normal, ground potential is removed from conductor 329, permitting relay 108 to release, which in turn releases relay 116.

The subscriber now dials the second code digit consisting of three impulses. The register switch responds to these impulses and advances its brushes to the third position. Relay 304 reoperates, and impulses are repeated to the central office to set the second selector switch S—7. The relay 108 is reoperated causing the reoperation of relay 116. At the end of the series, the relay 304 releases, and a circuit is completed from the grounded conductor 322, lower back contact of relay 304, inner lower contact of relay 307, conductor 331, brush 316 in position 3, conductor 334 through the frame 317, conductor 335, next to the inner left armature and front contact of relay 311, conductor 336, brush 206, conductor 227, inner right front contact of relay 116, winding of relay 115 to battery. Relay 115 operates and locks through its inner left front contact to the grounded conductor 133. Relay 115 opens the circuit of

relay 106, which releases and disconnects the subscriber's line from the repeater. Relay 115 at the same time completes a circuit from ground through the winding of relay 107, contacts of relay 115, conductor 140, through the contact and winding of the stepping magnet 207 to battery. Relay 107 operates, but its high resistance prevents the operation of the stepping magnet. With relay 106 released and relay 107 operated, the subscriber's line is extended through the rotary selector S—2 to the first local selector S—4. This circuit may be traced from the finder brush 103 over the upper back contact of relay 105, upper back contact of relay 106, upper front contact of relay 107, conductor 128, brush 209 to conductor 228. The other side of the line may be traced from the finder brush 104 through the lower back contacts of relays 105 and 106, lower front contact of relay 107, conductor 129, brush 208 to the conductor 229. The conductors 228 and 229 are connected to battery and ground at the selector switch S—4 in the usual manner. During the switching of the subscriber's line from the repeater to the selector switch S—4, ground potential is maintained on the conductor 133 by reason of the slow-release character of relays 303 and 109. Before these relays release to remove ground potential from said conductor, a substitute potential is returned to this conductor from the selector switch S—4 over the sleeve circuit 230, brush 210, conductor 141, inner upper armature and front contact of relay 107 to conductor 133. The release of relay 106 opens the circuit of relay 110, and this latter relay releases disconnecting the upper winding of relay 108 from the brush 202. Relay 109 releases after an interval following the deenergization of relay 108. Relay 108 upon releasing causes the release of relay 116.

The disconnection of the subscriber's line from the repeater R causes the release of relay 300, which is followed after an interval by the release of relay 303. Relay 303 removes ground potential from conductor 322, releasing the relay 311. Relay 303 closes a circuit from ground through its lower back contact, off-normal contacts 309, winding of relay 307 to battery. Relay 307 energized closes a circuit for release magnet 310, which restores the register switch to normal. The register switch in its normal position opens the springs 309 and permits relay 307 to release.

The calling subscriber proceeds to transmit the remaining series of impulses to cause the setting of selector switch S—4 and connector switch C to complete the connection to the called line 221.

When the conversation is completed, the subscribers replace their receivers upon the switchhooks, and ground potential is removed from conductor 230. This permits

relay 115 to release, in turn releasing the relay 107. The removal of ground potential from conductor 133 also brings about the release of the finder switch F.

Assume next that the subscriber of line 100 wishes to establish a connection with a central office line such as the subscriber's line 320. The initiation of the call causes the operation of the finder switch and the extension of the line over the rotary switch S—1 to the repeater R as already fully explained. Since the call is for the central office, the code portion of the designation may be made up of any two digits other than the combinations 6 3, 0, and 1 1 0. It will be noted from an inspection of Fig. 3 that any code combination other than the ones reserved for local calls and operators' calls will result in the operation of the relay 308 either at the end of the first series of impulses or at the end of the second series. Assume for instance that the first two digits are 6 and 2. The first digit 6 causes the register switch to take up its corresponding position. During the setting of the register switch, conductor 329 is grounded, resulting in the operation of relays 108, 109 and 116 and also the operation of the rotary switch S—2. When the register switch has been fully positioned on its No. 6 terminals and relay 304 releases, relay 311 operates as above described. Relay 311 closes a circuit for relay 307, which operates and closes a circuit for magnet 310 to bring about the release of the register switch. The next digit 2 causes the positioning of the switch on its No. 2 terminals, and upon the release of relay 304, a circuit is completed from grounded conductor 322, lower contact of relay 304, inner lower contact of relay 307, conductor 331, brush 316 in position 2, conductor 337 through the frame 317, conductor 338, normal contact and winding of relay 308 to battery. Relay 308 operates and locks through its inner upper front contact to ground through the inner lower contact of relay 303. Relay 308 completes a circuit from battery through the winding of relay 307, uppermost contact of relay 308, conductor 338, thence as previously traced to the grounded conductor 322. Relay 307 energizes in this circuit and locks through its inner upper front contact through the lower off-normal contacts 309 to ground at the front contact of relay 303. Relay 307 is so adjusted that it closes its inner upper contact before it opens its inner lower contact, thus insuring the locking of the relay before its operating circuit is opened. Relay 307 energizes the release magnet 310, and the register switch is restored to its normal position.

Since ground potential is not applied in this case to the conductor 336, relay 115 does not operate. Relays 108, 109, and 116 release as above explained. The subscriber continues to transmit the remaining digits,

which are repeated to the central office causing the setting of switches S—8 and C—1 to complete the connection to the called line 320. When the called subscriber answers, current is reversed over the trunk 321 causing the operation of the electro-polarized relay 301. Relay 301 operates the relay 302, which reverses the direction of current flowing over the subscriber's line. This may serve to bring about the operation of a message register. Relay 302 modifies the circuit extending to the central office so that it now leads from the conductor 324 through the upper contact of relay 303, upper contact of relay 301, upper winding of the latter relay, upper front contact of relay 302, uppermost winding of relay 306, back contact of relay 305, lower contact of relay 300 to the conductor 325. This includes the additional resistance of the relay 306 in the talking circuit to improve the transmission characteristics of the line.

When conversation has been completed, the calling subscriber replaces his receiver causing the release of relays 300 and 303. Relay 303 removes ground potential from the holding conductor permitting the release of the energized relays in Fig. 1 and also the restoration of the finder switch F.

Assume next that the subscriber of line 100 wishes to call the special service operator. On initiating the call, his line is extended through the rotary switch S—1 to the repeater R in the manner above described. To call the operator the subscriber dials the digit 0. This causes the setting of the register switch on its tenth position contacts. As the brush 315 leaves the ninth position contact, it removes ground potential from conductor 329 permitting the release of relays 108 and 116. The register switch in position 10 closes a circuit for operating relay 305. This circuit may be traced from battery through the winding of said relay, conductor 339, normal contacts of relay 312, normal contacts of relay 311, conductor 340, brush 315 to ground over conductor 330 as hereinbefore explained. Relay 305 completes a circuit from ground through its lower contact, conductor 341, brush 204, conductor 231, through the lower inner front contact of relay 110, right back contact of relay 116, right winding of relay 112, left contact of relay 120, inner right contact of relay 119, outer right contact of relay 117, resistance 118 to battery. Relay 112 operates and locks through its left winding and contact, left contact of relay 111 to the grounded conductor 133.

It may be noted at this point that relays 117, 119, 120, 121, 122, and 123 are common to a number of trunk circuits such as the one shown in Fig. 1. The relay 112, which is individual to the particular trunk circuit shown, and which receives its energizing potential from battery through the common



resistance 118, is so adjusted that it will not operate in parallel with the relay 114 of any other similar circuit. Likewise, the relay 114 is adjusted so that it will not operate in parallel with another relay 112. The purpose of this adjustment is to prevent a switch S—3 from starting to hunt for one type of operator's trunk appearing in its bank before another switch has completed its hunting for a trunk of the other type. The relay 112, for instance, indicates that the call is for a special operator's trunk whereas the relay 114 indicates that the call is for a recording trunk. Both of these trunks appear in the multiples of selector switches S—3 and, therefore, it is necessary to prevent a second switch hunting for one kind of trunk while a first switch is still in the act of hunting for a trunk of the other kind.

Relay 112 when operated as above described closes a circuit from battery through the winding or relay 117, outer right contact of relay 112, conductor 142 to ground at the back contact of relay 105. Relay 117 at its inner contact removes battery potential from the windings of all relays 114 in the group. Should a call be made for a toll recording trunk before the operator's trunk is selected, relay 111 is operated in a circuit from battery through the left contact of relay 117, right winding of relay 111, outer right front contact of relay 116 (the latter relay being operated in this case) to ground over conductor 231. Relay 111 operates and connects the busy-tone circuit 124 through its right contact, left contact of relay 115 through the lower winding of relay 108; thence over the subscriber's loop and returning to ground over the other winding of relay 108. The subscriber hears the tone and knows that the connection is unobtainable for the time being.

Relay 112 in operating opens the circuit of relay 106, and this relay releases, in turn releasing relay 110. The subscriber's line is now extended over the back-contacts of relays 105, 106, and 107 and the windings of relay 108 to battery and ground. This holds the relays 108 and 109 operated to maintain ground potential on the conductor 133 during the operating time of selector S—3.

Relay 112 also initiates the movement of the rotary switch S—3. The operating circuit may be traced from battery through the winding and contact of magnet 211, inner right contacts of relay 112, conductor 143, inner upper back contact of relay 105, conductor 144, to the test brush 214. A parallel circuit extends over the inner right contacts of relay 112 through the winding of relay 105 to ground. Relay 105 is shunted, however, so long as the brush 214 encounters grounded contacts. Since the switch S—3 is seeking an idle special service trunk, all trunks leading to the toll recording position should appear artificially busy in the switch.

The recording trunk 223, for instance, is provided with an individual relay 220 which connects ground potential through its back contact to the test terminal in the switch S—3. If the trunk is actually busy, the relay 220 will be operated and the busy potential is then extended through the front contact of the relay to the switch contact. The same is true of the next recording trunk 225, which is maintained in a nonselectable condition by the relay 219. The special service trunks such as the trunks 222 and 224 are provided with individual relays 217, 218 and 215, 216 respectively. If the first trunk 222 is busy, relay 218 will be operated and the busy ground potential is then extended through the upper contact of relay 218 to the test terminal in the switch S—3. The same is true of the trunk 224. Assume that the trunk 224 is idle. When, therefore, the test brush 214 reaches its third contact, no ground potential is found since relay 216 is released, and relay 105 immediately operates in series with the magnet 211. Due to the resistance of relay 105, the magnet cannot operate; accordingly the switch comes to rest.

As soon as the selector S—3 finds the idle trunk 224, ground is returned over the sleeve conductor to operate relay 216, which further extends the ground potential over conductor 144 through the inner upper front contact of relay 105, which is now operated, to the holding conductor 133. Relay 105 in operating releases relays 108 and 109 and extends the conductors of the subscriber's line through to the brushes 212 and 213 of the rotary switch S—3 and thence over the trunk 224 to the operator's position.

When the call has been completed, ground is removed from the holding conductor 133, and relays 105, 112, and 117 are released.

Assume next that the subscriber of line 100 wishes to extend a connection to a toll position reached over one of the trunks 223, 225, etc. In this case he dials the special code 1 1 0. On the completion of the first digit 1, the grounded conductor 331 is extended over the brush 316 to conductor 342, back contact of relay 311, inner right back contact and right winding of relay 313 into the battery. Relay 313 partially operates and in so doing completes a circuit from ground through its right contacts over conductor 333 to operate the relay 307. Relay 307 brings about the release of the register switch, and thereupon the relay 313 fully operates and locks to conductor 323. On the completion of the next digit 1, the grounded conductor 331 is extended over conductor 342 through the back contacts of relay 311, inner right front contact of relay 313, inner right contact and right winding of relay 312 to battery. Relay 312 partially operates and operates the relay 307, which restores the register switch to normal. Thereupon the relay 13

312 fully operates and locks to the conductor 323. When the final digit 0 has been dialed, the register switch comes to rest in position 10 and the grounded conductor 331 is extended through brush 316, conductor 343, back contact of relay 311, front contact of relay 312, conductor 339, winding of relay 305 to battery. Relay 305 operates and places ground potential on conductor 341. With the switch in position 10, the grounded conductor 330 is also extended over conductor 340 to the back contact of relay 311, front contact of relay 312, conductor 329. The grounded conductor 329 causes the operation of relay 108 as above explained. The grounded conductor 341 extends through the brush 204, conductor 231, contact of relay 110 the right-hand armature and front contact of relay 116, winding of relay 114 through the common resistance 118 to battery. Relay 114 operates relay 119 in an obvious circuit. Relay 114 also operates all relays 215, 217, etc., individual to the special service trunks in order to render these trunks artificially busy so they will not be seized by the switch S—3. At the same time, relays 219, 220, etc. are operated to remove the artificially busy condition normally existing on the toll recording trunks to permit an idle one of these to be selected. The circuit may be traced from ground through the inner lower contact of relay 105, conductor 142, right contact of relay 114, conductor 145, thence in parallel through the windings of relays 215, 217, 219, 220, etc., to battery. If the special service trunk 224 is actually busy relay 216 is operated to extend the busy condition through its inner upper contact to the sleeve conductor 232. If the trunk is idle, the operation of relay 215 renders it non-selectable by means of a circuit from ground through the lower contact of relay 216, contact of relay 215 to the test conductor 232. The same is true of all other trunks leading to the special operator's position. If a recording trunk such as the trunk 223 is busy, its individual relay 220 is already operated to extend the busy condition through its front contact to the test conductor 233. If, however, the trunk is idle the relay 220 is operated over conductor 145, as explained, to remove the artificial busy condition.

Relay 119 at its inner right contact removes battery potential from all relays 112 in the group. At its left contact, it applies battery potential to the middle winding of relay 111 so that if a call is subsequently made for a special service trunk before the recording trunk has been selected relay 111 will operate in a manner similar to that hereinbefore described to connect the busy tone conductor 124 to the calling subscriber's line. Relay 114 operates relay 113 which is slow to attract its armatures so as not to start the hunting of switch S—3 until the trunk re-

lays have been fully operated. Relay 113 locks through its left contact and the contacts of relays 112 and 111 to the grounded conductor 133. Relay 113 at its right contacts closes substitute circuits for relay 119 and also for the other relays energized over conductor 145 by the relay 114. Relay 113 initiates the operation of the switch S—3 by means of a circuit from battery through the winding and contact of magnet 211 through the inner right contact of relay 113 and thence over conductor 143 as previously traced to the test brush 214. When an idle toll recording trunk has been found, relay 105 operates and causes the switch to cease its hunting operation. Relay 105 also extends the subscriber's line through to the toll recording trunk selected. The central office trunk is released in the manner already fully described.

When conversation has been completed, ground potential on the holding conductor 144 is removed in turn removing potential from the conductor 133. This permits the release of all energized relays and the restoration of the equipment to normal.

Should all of the special operators' trunks become busy, relays 216, 218, etc. are all energized and ground potential is removed from conductor 146. This permits the release of the normally energized relay 122. Relay 122 operates relay 120, which opens the common circuit to prevent the operation of any one of the relays 112. Relay 120 at its right contact applies battery potential to the middle windings of all relays 111 so that if an operator's call is attempted the busy tone is sent to the calling subscriber's line. In like manner if all of the toll recording trunks are busy, ground potential is removed from conductor 147 to permit the release of relay 123, which in turn operates relay 121. Relay 121 opens the common lead to prevent the operation of any of the relays 114 and applies battery potential to the right windings of all relays 111 so that if a toll recording call is initiated the busy tone is transmitted to the calling subscriber's line.

What is claimed is:

1. In a telephone system, a line, a circuit having three branches, automatic switches, each of said branches terminating in a separate one of said switches, means for connecting the line to said circuit, trunk lines appearing in each of said switches, selector switches to which said trunks extend, means for operating one of said automatic switches to extend said line over one of said trunks to the corresponding selector, means for sending impulses over the extended connection to operate said selector switch, and means depending on the number of impulses sent for releasing the extended connection and for extending the line over one of the trunks appearing in another of said automatic switches.

2. In a telephone system, a line, a trunk having a plurality of branches, automatic switches, each of said branches terminating in a separate one of said switches, means for extending the line to said trunk, trunk circuits appearing in each of said switches, means for operating one of said automatic switches to extend the line over one of said trunk circuits, means for sending over the extended connection impulses representing a desired designation, and means depending upon the nature of said designation for releasing the extended connection and for selectively extending the line over one of a number of said other automatic switches.

3. The combination in a telephone system of a subscriber's line, a trunk terminating in the brushes of a plurality of automatic switches, means for extending the line to said trunk, trunk circuits appearing in the terminals of said automatic switches, means responsive to the extension of the subscriber's line to said first mentioned trunk for operating one of said automatic switches to further extend the connection to the trunk circuits appearing therein, means for transmitting designation impulses over the extended connection, means responsive to the transmission of said impulses for operating a second one of said automatic switches to seize an idle one of the trunk circuits appearing in the terminals thereof, and means dependent upon the wanted designation for determining whether the connection is to continue its progress through the first selector switch or whether such switch is to be released and the connection from the subscriber's line extended through said second automatic switch or through a third one of said automatic switches.

4. The combination in a telephone system of a subscriber's line, three separate trunk hunting automatic switches, a connecting circuit appearing in the brushes of each of said automatic switches, means for extending the subscriber's line to said connecting circuit, trunks appearing in the terminal banks of said automatic switches, means for operating one of said automatic switches to extend the subscriber's line over one of said trunks, means for transmitting designation impulses over the extended connection, means responsive to the transmission of said impulses for initiating the movement of a second one of said automatic switches to preselect an idle trunk, and means responsive to said designation impulses and dependent upon the nature of the designation for releasing the connection extended over said first automatic switch, for operating the third one of said automatic switches to select an idle trunk and for extending the subscriber's line through said third automatic switch to the selected idle trunk.

5. In a telephone system, a branch office

having a plurality of automatic trunk hunting switches, a connecting circuit appearing in the brushes of each of said switches, a subscriber's line, means for extending the subscriber's line to said connecting circuit, a central office having selector switches therein, trunks appearing in the banks of one of said automatic switches and extending to the selector switches in said central office, local selector switches in said branch office, trunks appearing in the banks of a second one of said automatic switches and extending to said local selector switches, means for transmitting designation impulses over the subscriber's line, means responsive to said impulses for setting the switches in the central office, and means also responsive to said impulses for causing the release of the switches in the central office and the connection extended thereto and for extending the subscriber's line either through said second automatic switches to said local selector switches or through a third one of said automatic switches.

6. In a telephone system, a subscriber's line, a plurality of automatic trunk hunting switches, a connecting circuit terminating in each of said switches, a non-numerical switch for extending the subscriber's line to said connecting circuit, a group of trunks appearing in one of said automatic switches, a second group of trunks appearing in a second one of said automatic switches, a third and a fourth group of trunks appearing in the third one of said automatic switches, means for extending the subscriber's line over the first one of said automatic switches in response to the initiation of a call, means for sending designation impulses over the extended connection, means responsive to said impulses and dependent on the designation for releasing the extended connection and for routing the calling subscriber's line either through said second or said third automatic switches, and means also dependent on the wanted designation for determining whether the subscriber's line is to be extended over a trunk in the third group or over a trunk in the fourth group appearing in said third automatic switch.

7. In a telephone system, a line, a trunk, a selector switch in which said trunk terminates, an automatic switch for connecting the line to said trunk, means for sending over the connection impulses designating a called station, a repeater in said trunk for repeating said impulses over the trunk to operate said selector switch, a register associated with said repeater for recording a certain portion of said designating impulses, a second automatic switch, a second selector switch, a trunk accessible to said second automatic switch and extending to said second selector switch, and means controlled by the register for releasing the connection extended to the first selector switch and for causing impulses subsequently

transmitted to be sent over a connection including said second automatic switch and the corresponding trunk for operating said second selector switch.

5 8. In a telephone system, a subscriber's line, a plurality of automatic switches, a connecting circuit terminating in each of said switches, means for connecting the line to said connecting circuit, trunks appearing in  
10 said automatic switches, means responsive to a call on said line for extending the same over the connecting circuit through one of said automatic switches to a trunk appearing therein, means for sending impulses to said  
15 trunk, registering means associated with said trunk and operated in accordance with the nature of said impulses for causing the release of the extended connection over said first mentioned automatic switch, and means controlled by said registering means for routing  
20 the calling subscriber's line over said connecting circuit through either of a number of said other automatic switches to an idle trunk appearing therein.

25 9. In a telephone system, a subscriber's line, a plurality of automatic trunk hunting switches, a connecting circuit appearing in the brushes of each of said switches, means for connecting the subscriber's line to said  
30 connecting circuit, trunks appearing in the terminals of said automatic switches, means responsive to a call on the subscriber's line for extending a connection over said connecting circuit and through a first one of said automatic switch to an idle trunk appearing therein, registering means associated with said  
35 last mentioned trunk, means for sending impulses to said trunk to cause the operation of said registering means, means controlled by said registering means dependent upon the nature of the impulses transmitted for releasing the connection extended through said automatic switch and for automatically connecting the subscriber's line over the connecting circuit through a second one of said automatic switches to an idle trunk appearing therein, and means also controlled by said  
40 registering means in accordance with the nature of the impulses transmitted for extending the subscriber's line over said connecting circuit through a third one of said automatic switches to an idle trunk appearing therein.

10. The combination in a telephone system of a subscriber's line, a plurality of automatic trunk hunting switches, trunks appearing in said switches, a connecting circuit appearing in the movable terminals of each of said switches, means for connecting the subscriber's line to said circuit, registers associated with the trunks appearing in a first one of said automatic switches, means responsive to a call on said line for extending the same over the said first automatic switch to an idle trunk, means for sending a number of series of impulses over the extended

connection, means responsive to a portion of said impulses for operating the corresponding register, means controlled by said register for determining whether the connection is to continue over said first automatic switch and the associated trunk appearing therein or whether such connection is to be released and the calling line extended over said connecting circuit to another of said automatic switches, and means also controlled by said  
70 register for determining the particular one of said other automatic switches over which the connection is to be further extended.

11. In a telephone system, a selector switch having a row of contacts and brushes coacting therewith, two groups of trunks appearing in said contacts, relays, one for each of said trunks, the relays of one group serving when released to maintain the corresponding trunks artificially busy, the relays of the other group serving when operated to maintain the corresponding trunks artificially busy, and means for selectively operating said groups of relays.

12. In a telephone system, a selector switch having a row of contacts and brushes coacting therewith, two groups of trunks, the trunks of said groups appearing promiscuously in said contacts, relays, one for each of said trunks, means for selectively operating a portion of said relays, means controlled by the operated relays and by the unoperated relays for rendering one of said groups of trunks artificially busy, and means for selecting a trunk in the other of said groups.

13. In a telephone system, a selector switch having a single row of contacts and brushes coacting therewith, two separate groups of trunks appearing in said contacts, relays, one for each of said trunks, the relays of one group serving when released to maintain the corresponding trunks artificially busy, the relays of the other group serving when operated to maintain the corresponding trunks artificially busy, and selective means for operating said relays to shift the artificial busy condition from one group of trunks to the other.

14. In a telephone system, a selector switch having a single row of contacts and brushes coacting therewith, two separate groups of trunks appearing in said contacts, relays, one for each of said trunks, the relays of one group serving when released to maintain the corresponding trunks artificially busy, the release of the other group serving when operated to maintain the corresponding trunks artificially busy, and selective means for operating said relays to shift the artificial busy conditions from one group of trunks to the other.

15. In a telephone system, a selector having a row of contacts and brushes coacting therewith, two groups of trunks appearing in said contacts, relays, one for each of said

trunks, the relays of one group serving when released to maintain an artificial busy condition on said trunks and when operated to maintain an actual busy condition on said trunks, and selective means for operating said relays to shift the artificial busy condition from one group of trunks to the other.

16. In combination, a selector switch having a row of contacts and brushes coacting therewith, two groups of circuits appearing promiscuously in said contacts, relays, one for each of said circuits, certain of said relays serving when deenergized to render the corresponding circuits non-selectable, other of said relays serving when energized to render the corresponding circuits non-selectable and selective means for operating said relays to change the non-selectable condition from certain of said circuits to other of said circuits.

17. In a telephone system, a line, a circuit having a plurality of branches, automatic switches, each of said branches terminating in a separate one of said switches, means for extending the line to said circuit, trunks appearing in each of said switches, means responsive on the connection of said circuit to said line for operating one of said switches to extend the line over a trunk appearing in said switch, means for sending over the extended connection a series of impulses representing a desired designation, means responsive to the first series of impulses for actuating another of said switches to select an idle trunk appearing in said other switch, and means responsive to a second series of impulses for releasing the extended connection and for extending the line through said other switch to the idle trunk selected thereby.

In witness whereof, I hereunto subscribe my name this 21st day of March, 1930.

HENRY HOVLAND.

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