

April 16, 1929.

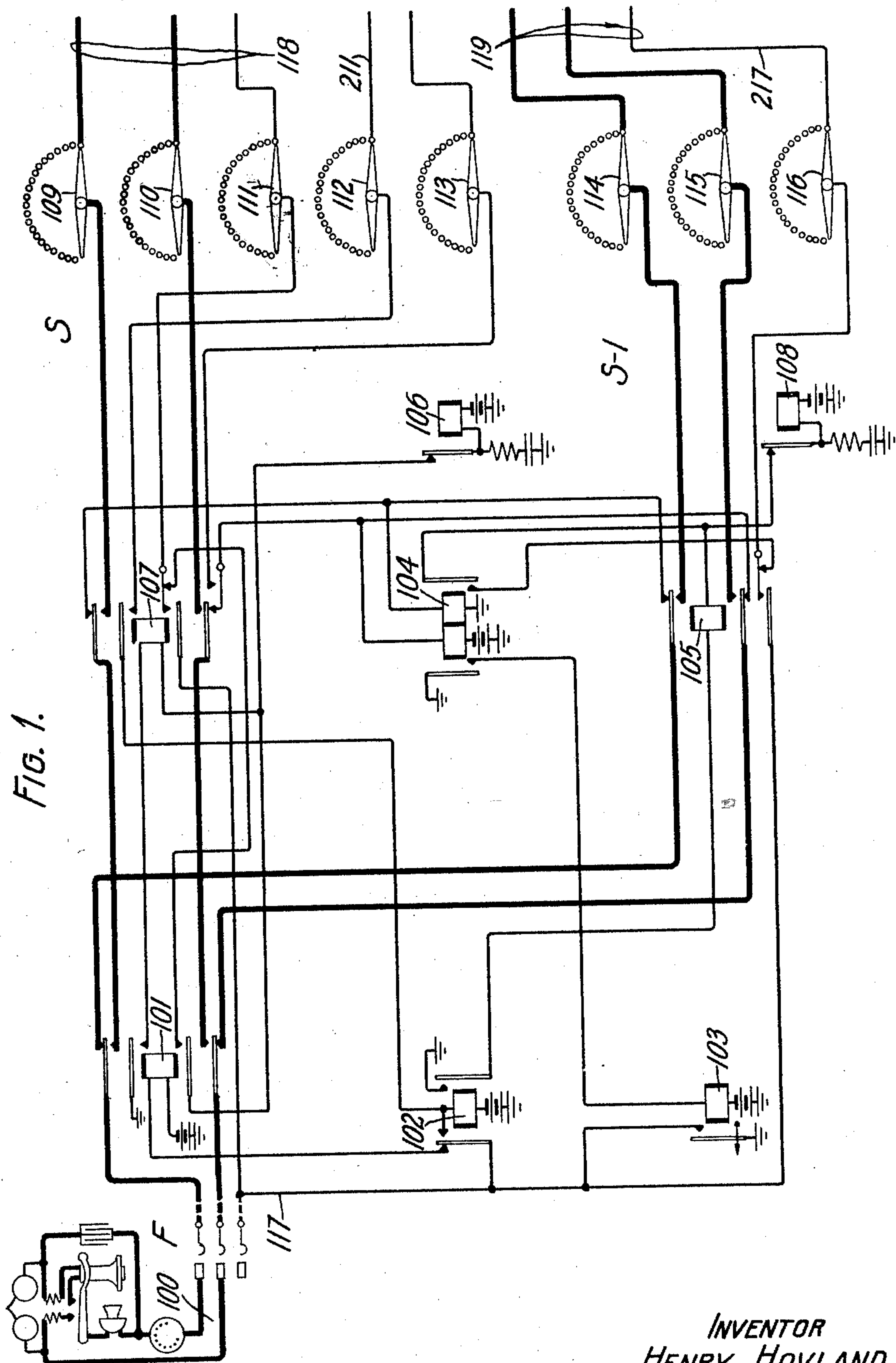
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1,708,946

TELEPHONE EXCHANGE SYSTEM

Filed June 13, 1927

3 Sheets-Sheet 1



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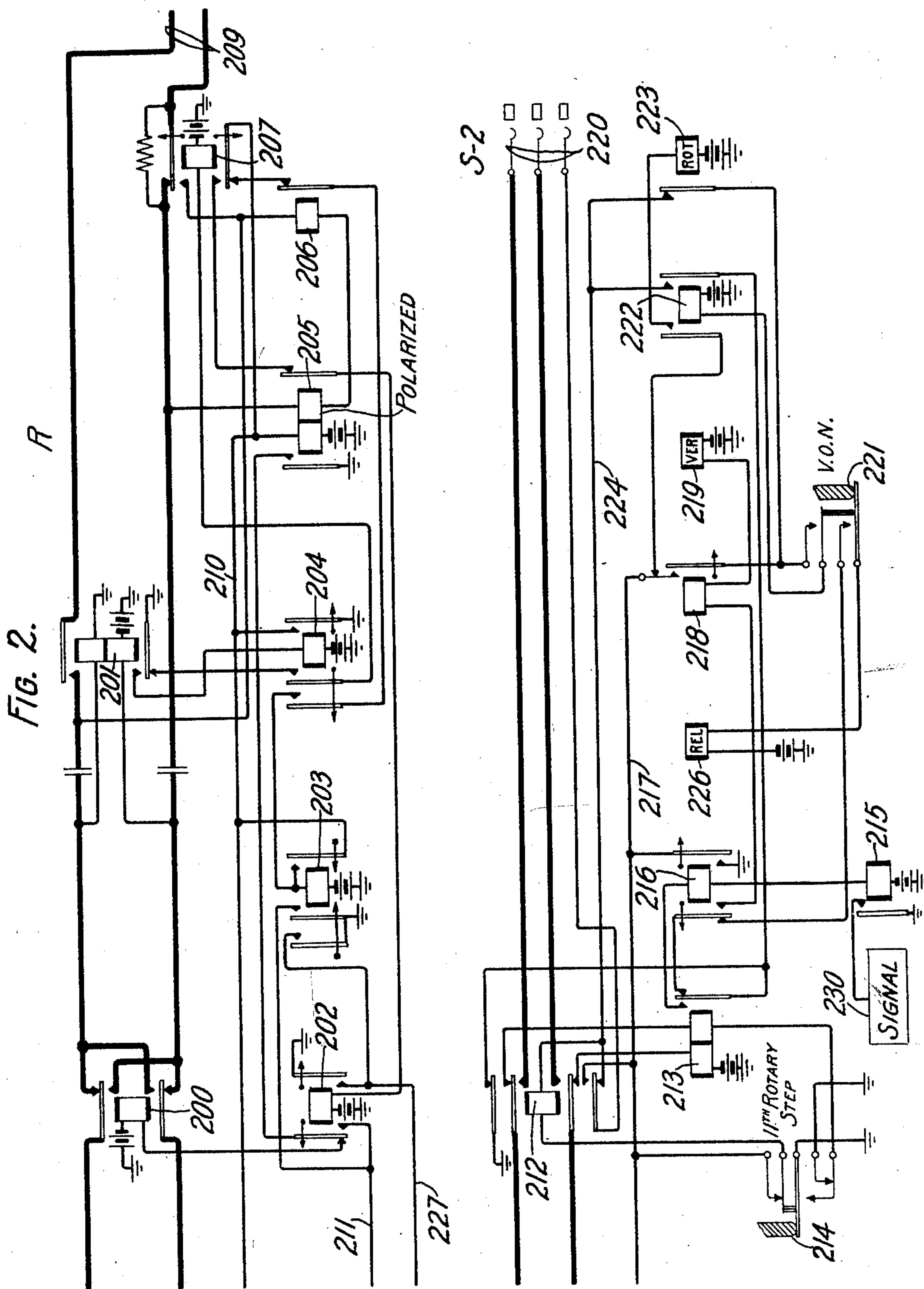
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3 Sheets-Sheet 2



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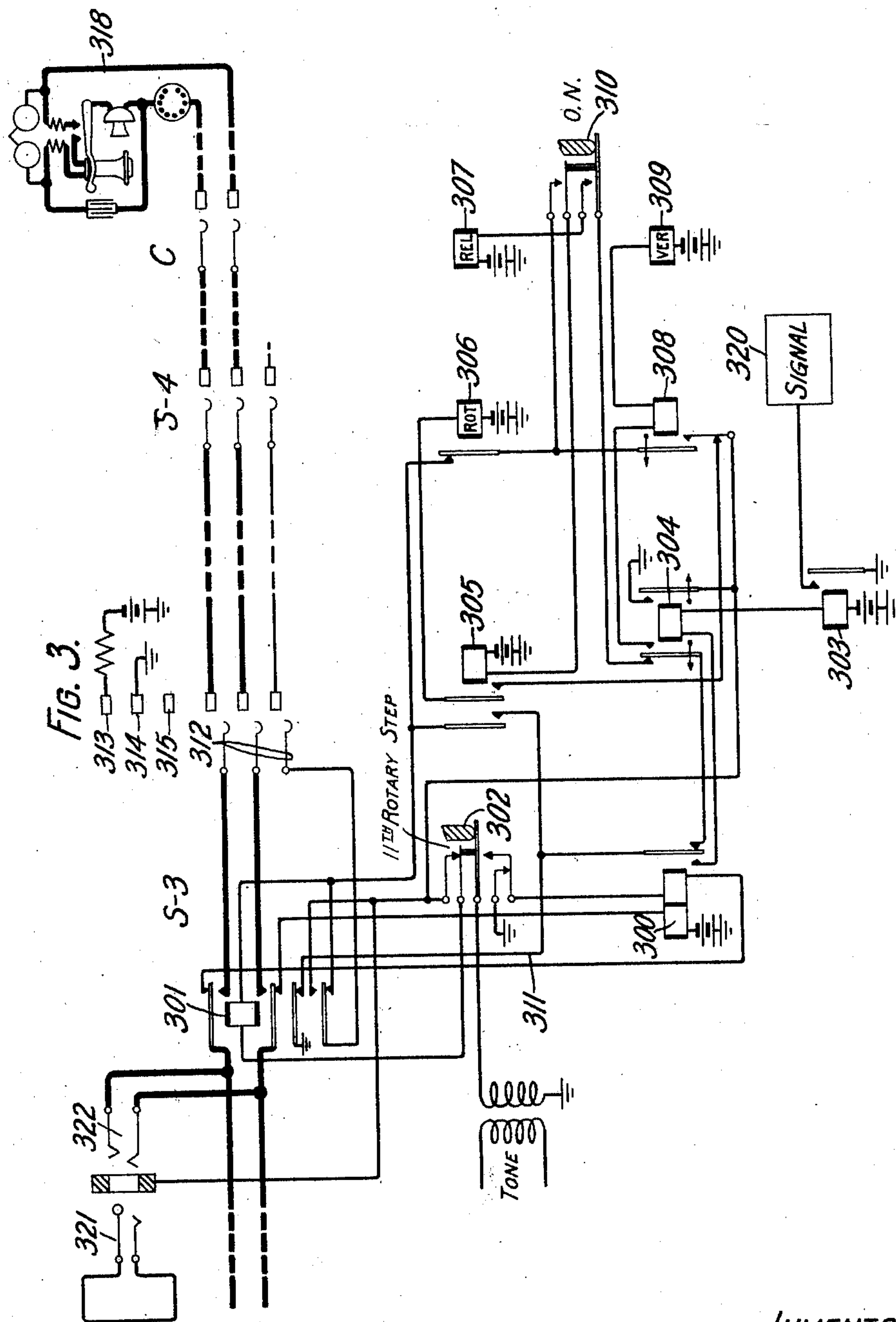
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TELEPHONE EXCHANGE SYSTEM

Filed June 13, 1927

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

Application filed June 13, 1927. Serial No. 198,456.

This invention relates to telephone exchange systems and particularly to improvements in the establishment of inter-office connections.

5 According to this invention, calls originating in satellites are first extended over trunk hunting switches to the central office where a selector switch is operated in accordance with the first digit. During the transmission of
10 the first digit a second trunk hunting switch in the satellite is caused to preselect an idle trunk leading to a local selector. If the call is a local one the central office selector sends
15 back a signal which brings about a release of the central office trunk and the extension of the subscriber's line to the preselected local switch.

According to another feature of the invention, an unstandard condition on a subscriber's line causes the operation of a signal at
20 the central office to attract the attention of an attendant who is able to transfer the signal back to the satellite to one of the local selector switches therein. By transferring the signal
25 to the satellite the central office trunk is freed.

Referring to the drawing, Figs. 1, 2 and 3 when taken in order illustrate the invention when embodied in a system employing
30 switches of the step-by-step type. Fig. 1 shows a calling subscriber's line, a line finder switch diagrammatically and two single movement rotary trunk hunting switches located in the local or satellite exchange. In
35 the upper portion of Fig. 2 is shown a repeater in the local office. The lower portion of this figure shows a first selector switch also in the local exchange. Fig. 3 shows a first selector in full, a second selector and connector diagrammatically and a called subscriber's line in the main exchange.
40

In the system shown a call originating in the satellite office is first extended over the line finder F and the trunk selector S to a trunk including the repeater R outgoing to
45 the central office. If the called line appears in the central office the calling subscriber transmits a number of digits to operate the selectors S³ and S⁴ and the connector C to seize the called line. The impulses of these
50 digits are repeated by the repeater R located at the satellite office. If, however, the called line appears in the satellite, the first digit transmitted will cause the selector switch S³

to step to a predetermined level of contacts which identify a local call. During the
55 transmission of the first digit the repeater R functions in a manner to initiate the operation of the trunk hunting switch S¹. The switch S¹ seizes an idle trunk leading to a local selector switch S² so that this switch
60 will be ready for operation when it is needed. At the end of the first digit the switch S³ in the central office steps into the predetermined level whereupon battery connections to the
65 tip and ring conductors of the trunk are reversed, reacting upon the repeater R in such a way that the calling subscriber's line is disconnected from the switch S, the repeater R and the central office trunk and is switched
70 to the preselected local selector switch S². The subscriber, continuing to transmit the remaining digits, sets the switch S² and other
75 switches, not shown, to extend his line to the called subscriber's line in the satellite. By this arrangement the changeover operation
80 from central office trunk to a local trunk in the satellite is effected without danger of mutilating impulses since the local trunk is preselected during the preliminary operation
85 of the central office selector.

In the event a central office trunk is seized due to some unstandard condition or is otherwise held for an unreasonable length of time, a permanent signal is brought into play at the
90 central office. The attendant in response to this signal short-circuits the tip and ring conductors of the trunk leading back to the satellite, causing the subscriber's line to be
95 switched from the central office trunk to a local selector where it operates another permanent signal to notify the attendant in the satellite.

A detailed description will now be given, first assuming that the subscriber of the line
100 in the satellite wishes to call another subscriber located in the same satellite. The subscriber of the line 100, on initiating the call, causes the operation of a line finder F to search for the calling line. During the
105 operation of the finder F ground potential is placed on the sleeve conductor 117 causing the operation of relay 101 in a circuit leading through the back contact of relay 102. Relay 101 closes a circuit for the stepping magnet 106 of the switch S. If switch S is standing
110 on a busy trunk the sleeve brush 111 is

grounded and the circuit of stepping magnet 106 may be traced as follows. Battery, through the winding and contact of the magnet, inner lower contact of relay 101, normal
 5 contact of relay 107 to the grounded brush 111. The magnet 106 interrupts its own circuit and steps the brushes 109 to 113 inclusive, from position to position until an idle trunk is reached. When an idle trunk 118
 10 is found the switch stops and relay 107 operates in a circuit from battery through the winding and contact of magnet 106, winding of relay 107, to ground at the contact of relay 101. During the stepping movement of the
 15 switch the relay 107 was short circuited and consequently did not operate. This relay operates now, however, in the circuit traced, but due to its resistance the stepping magnet 106 fails to energize.

20 If the line finder F should find the calling line 100 before the switch S finds an idle trunk, the tip and ring conductors of the subscriber's line are extended through the front contacts of relay 101 and the back con-
 25 tacts of relay 107 to the windings of relay 104. Relay 104 operates the relay 103 in an obvious circuit and relay 103 applies ground potential to the sleeve conductor 117.

When the idle trunk 118 is reached and
 30 the relays 101 and 107 operate, the subscriber's line is extended over the back contacts of relay 200 to the windings of the impulse relay 201 in the repeater. Relay 201
 35 operates and closes a circuit from battery through the left winding of relay 300, lower back contact of relay 301 over the lower side of the trunk 209, contact of relay 207, right
 40 winding of the electrically polarized relay 205, winding of relay 206, upper contact of relay 201 returning over the upper side of the trunk through the back contact of relay 301,
 45 right winding of relay 300, to ground at the normal contacts of the spring combination 302. Relays 300 and 206 operate in this circuit, but the direction of current flow is such
 50 that the polarized relay 205 does not operate.

Relay 201 also closes an obvious circuit for slow release relay 204. Relay 204 at its right
 55 contact closes a circuit for the left winding of relay 205, but as above noted, the relay 205 does not attract its armatures. Relay 204 also applies ground potential to the sleeve conductor 210. This grounded sleeve con-
 60 ductor is extended back to the brush 111, inner lower front contact of relay 107 to the sleeve conductor 117. This circuit is completed before ground is removed from conductor 117 and thus a non-interrupted
 65 ground potential is maintained on the sleeve to prevent release.

The relay 300 at the central office in oper-
 70 ating closes a circuit from battery through the winding of relay 303, winding of slow release relay 304, front contact of relay 300, to
 75 ground at the back contact of relay 301. Re-

lays 303 and 304 operate. The apparatus is now ready to receive the first digit.

The subscriber manipulates his transmit-
 80 ter to send the first digit and on the first interruption of the line, relay 201 releases and
 85 closes a circuit from ground through its lower back contact, front contact of relay 204, winding of the slow release relay 207 to bat-
 90 tery. Relay 207 operates and closes a circuit from battery through the winding of slow re-
 95 lease relay 202, contact of relay 205, lower front contact of relay 207, sleeve conductor 210 to ground at the right contact of relay 204. Relay 202 completes a circuit from
 100 ground through its right contact, conductor 227, brush 113, lower front contact of relay 107, left winding of relay 104 to battery. Re-
 105 lay 104 operates and closes an obvious circuit for relay 103 which connects its grounded armature to the conductor 117.

Relay 104 also initiates the operation of
 110 the trunk hunting switch S¹ to preselect an idle local trunk. The stepping circuit for switch S¹ leads from battery through the winding and contact of stepping magnet 108,
 115 right contact of relay 104, lower normal contact of relay 105 to the brush 116. If the switch S¹ stands on a busy trunk the brush 116 is grounded and the stepping magnet 108
 120 operates to advance the brushes 114, 115 and 116 from position to position until an idle trunk 119 is reached. When the idle trunk is found the switch stops.

Returning now to the point where the sub-
 125 scriber commenced to operate his dial to transmit the first digit, relay 201 in releasing
 130 on the first interruption also opens the circuit of the impulse relay 300 at the central office. Relay 300 completes a circuit from ground at the middle lower contact of relay 301,
 135 conductor 311, back contact of relay 300, front contact of relay 304, winding of slow relay 308 and the vertical magnet 309 to bat-
 140 tery. The magnet 309 steps the brushes 312 up to the first level of contacts. On the first
 145 step of the switch the primary off-normal contact combination 310 is shifted and relay 305 operates in a circuit from battery
 150 through its winding, upper contacts 310, contact of relay 308 to ground at the contact of relay 304. Relay 305 locks in a circuit from
 155 battery through its winding, contacts 310, contact of the magnet 306, outer contact of relay 305 to the grounded conductor 311.

On the next closure of the line, relay 201 in
 160 the repeater operates and recloses the circuit of relay 300. The circuit is modified, how-
 165 ever, at the repeater so that it now extends over the upper conductor of the trunk 209, upper contact of relay 201, upper front con-
 170 tact of slow relay 207 to the lower side of the trunk 209. This revised circuit excludes the windings of relays 205 and 206.

For each succeeding interruption, the re-
 175 lay 201 releases to in turn release the relay

300 which causes the selector to step from level to level until it reaches the predetermined level containing the contacts 313, 314 and 315. These contacts are connected to battery and ground as illustrated. At the end of the first series of impulses the line is closed for an interval and the slow relay 207 releases, opening the circuit of relay 202. The relay 300 remains operated in the circuit first traced and after an interval relay 308 releases.

The rotary magnet 306 of the selector S^3 is next operated in a circuit from battery through its winding, contact of relay 305, normal contact of relay 308 to ground at the contact of relay 304. The rotary magnet 306 steps brushes 312 to the first set of terminals 313, 314 and 315 in the predetermined level. Magnet 306 opens the circuit of relay 305 which releases and in turn opens the circuit of magnet 306. If the terminals on which the brushes 312 are now standing are idle, no ground exists on test terminal 315 and a circuit is completed from battery through the winding of relay 305, upper contacts 310, contact of magnet 306, winding of relay 301, upper contact 302 to ground at the contact of relay 304. Had the sleeve terminal 315 been grounded relay 301 would be shunted over a path leading through the lower back contact of the relay to the test brush. Relay 301 in operating disconnects the relay 300 and extends the tip and ring conductors through to the terminals 313 and 314. It will be noted that the battery and ground connections applied to the terminals 313 and 314 are opposite to those applied to the windings of relay 300. This causes a reversal in the direction of current flowing through the right winding of relay 205 at the repeater. Accordingly, relay 205 operates and completes a circuit from ground through its armature, left front contact of relay 202, conductor 211, brush 112, upper inner contact of relay 107, winding of relay 102 to battery. It will be noted that the circuit of relay 202 is opened when relay 207 releases. Relay 202, however, is sufficiently slow in releasing to maintain its armatures attracted until after current reversal takes place over the trunk.

Relay 102 in operating closes a circuit from ground through its right contact, winding of relay 105, contact and winding of magnet 103 to battery. Relay 105 operates in this circuit. Relay 102 at its left back contact opens the circuit of relay 101 which releases and causes the release of relay 107. During the time relay 202 is operated it maintains the relay 104 operated in the circuit traced through the left winding of the latter relay. Relay 104 holds the relay 103 to maintain ground potential on the sleeve conductor 117. Relay 107 in releasing releases the relay 104, but relay 103 remains operated to provide a local circuit for relay 102 and to maintain ground po-

tential on the conductor 117 until after the connection has been extended to the selector S^3 in the satellite. With relay 101 released and relay 105 operated the tip and ring conductors of the calling line are extended through the brushes 114 and 115 and the back contacts of relay 212 to the windings of relay 213. The left winding of relay 213 is connected to battery and the right winding is connected through normal contacts of the spring combination 214 to ground. Relay 213 operates and completes a circuit from battery through the winding of relay 215, winding of slow release relay 216, front contact of relay 213 to ground at the back contact of relay 212. Relay 216 operates and places ground potential on sleeve conductor 217. This sleeve circuit is extended back to the brush 116 and the lower front contact of relay 105 to the sleeve conductor 117. After an interval relay 103 releases.

The disconnection of the subscriber's line 100 from the repeater R results in the deenergization of relays 201 and 204.

After an interval following the release of relay 300 the slow release relay 304 deenergizes. Since the sleeve terminal 315 is blank in the predetermined level no substitute ground potential is placed on the test brush before relay 304 releases. Therefore, when relay 304 releases the relay 301 also retracts its armatures. The release magnet 307 is now energized in a circuit from battery through its windings, closed contacts 310, back contacts of relays 304 and 300 to ground at the back contact of relay 301. Magnet 307 releases the switch S^3 in the well known manner.

The foregoing operations have all taken place in a very short interval of time. The subscriber next proceeds to transmit the second series of impulses representing the second digit of the wanted number. In response to the line interruptions relay 213 deenergizes and energizes and at each retraction closes a circuit from ground through the upper back contact of relay 212, back contact of relay 213, front contact of relay 216, winding of slow release relay 218, winding of the vertical stepping magnet 219 to battery. Magnet 219 steps the brushes 220 from one level to another. With relay 218 operated and the vertical off-normal spring combination 221 shifted a circuit is completed from battery through the winding of relay 222, closed contacts of the combination 221, front contact of relay 218 to the grounded conductor 217. Relay 222 locks in a circuit from battery through its winding, upper contacts of combination 221, back contact of the magnet 223, right contact of relay 222 to ground at the upper back contact of relay 212.

Following the second series of impulses the slow relay 218 releases and prepares a circuit for the rotary magnet 223 to rotate

the brushes in search of an idle trunk. The circuit for the magnet 223 leads from battery through its winding, left contact of relay 222, normal contact of relay 218 to the grounded conductor 217. Magnet 223 in energizing opens the locking circuit of relay 222. Relay 222 releases in turn releasing the magnet 223. If the trunk on which the brushes are now standing is busy relay 222 is reoperated in a circuit from battery through its winding, off-normal contacts 221, contact of magnet 223, conductor 224, lower back contact of relay 212 to the grounded test brush 220. A parallel circuit also leads through the winding of relay 212, normal contacts of the combination 214 to the grounded sleeve conductor 217. Relay 212, however, being shunted, does not operate. Relay 222 in operating recloses the operating circuit of magnet 223 and the switch takes another rotary step. This operation continues until an ungrounded trunk is reached at which time relay 222 remains deenergized to prevent further stepping of the switch. Relay 212 is also operated to extend the tip and ring conductors through to the brushes 220 and to the switch beyond. The resistance of relay 212 is such that the relay 222 does not operate in series therewith. Relay 213 releases and after an interval the slow relay 216 deenergizes. Before relay 216 releases, however, the grounded sleeve conductor is extended back from the selector beyond to maintain ground potential on the conductor 217.

In similar manner the subscriber transmits the remaining impulses and suitable switches are positioned to extend his line to the local called subscriber's line.

After conversation has been completed the subscribers replace their receivers and ground potential is removed from the sleeve conductor 217. Relay 212 thereupon releases and closes a circuit from battery through the winding of release magnet 226, closed contacts 221, back contacts of relays 216 and 213 to ground at the upper back contact of relay 212. The magnet 226 restores the selector switch S^2 in the well known manner. The removal of ground potential from conductor 217 and consequently from conductor 117 releases the relay 102 which in turn releases the relay 105. The finder switch F is also restored in the usual manner.

Assume next that the subscriber of line 100 wishes to hold conversation with the subscriber of line 318 located at the central office. The extension of the connection to the central office takes place in the same manner as that hereinbefore described. In response to the first digit the selector switch S^3 advances its brushes 312 to some level other than the predetermined level above mentioned. For example, the brushes 312 may be positioned on the terminals of an idle

trunk leading to the selector switch S^4 . In this case as soon as the idle trunk is seized a ground potential is placed on the sleeve brush to maintain the relay 301 operated following release of relay 304. The holding circuit of relay 301 may be traced from battery to the winding of relay 305, closed contacts 310, contact of magnet 306, winding of relay 301, contacts 302, lower front contact of relay 301 to the grounded sleeve brush 312. Relay 305 does not operate in this circuit. Inasmuch as the current flow over the trunk leading back to the satellite is not reversed in this case, polarized relay 205 does not operate. Consequently the subscriber's line 100 is not shifted as was the case when a local call was made. The subscriber continues to transmit impulses whereupon the selector S^4 and connector C are positioned in a suitable manner to complete the extension of a connection through to the called line 318.

After conversation has taken place the subscribers release the connection in the manner already described.

The permanent signal condition will next be described. Assume that the subscriber's line 100 is closed, due to some unstandard condition or that a subscriber leaves his receiver off the switchhook for an unreasonable length of time. This condition results in the seizure, in the manner fully described hereinbefore, of a trunk leading to central office. The relay 300 in operating causes the operation of relays 303 and 304. Relay 303 closes the circuit leading to a signal device 320. If the condition prevails for a certain length of time the attendant at the central office responds to the signal 320 and inserts the plug 321 in the jack 322. This short-circuits the relay 206 in the satellite and the relay releases. A circuit is now completed from battery through the winding of relay 203, outer left contact of relay 204, contact of relay 206, lower back contact of relay 207 to the grounded conductor 210. Relay 203, which is slow to operate, locks to the conductor 210 and completes a circuit from ground through its inner left contact, conductor 211, brush 112, contact of relay 107, winding of relay 102 to battery. Relay 203 at its outer left contact applies ground potential to the conductor 227 to operate the relay 104 which in turn operates relay 103. Relay 203 is made slow to operate to prevent its accidental operation due to momentary releases of relay 206 when current is reversed over the trunk 209. The circuit of relay 203 may also be closed momentarily on release of relay 207 and before relay 206 operates. Relay 102 in operating switches the subscriber's line through to the first selector S^2 as previously described and releases relays 101 and 107. Relay 103 holds ground potential on the sleeve 117 until relay 216 in the first selector operates to ground this conductor. The relay

215 operates in series with relay 216 at the first selector and closes a circuit to the signal device 230. This signal notifies the attendant at the satellite that a permanent signal condition exists on the subscriber's line.

While this invention has been disclosed particularly in connection with a system employing step-by-step switches it should be understood that it may be applied to other types of systems.

What is claimed is:

1. In a telephone system, an exchange, a line appearing therein, a second exchange, a trunk interconnecting the exchanges, automatic switches and selectors in the first exchange, means for operating one of said automatic switches to extend the line over said trunk, means for transmitting impulses over said trunk, means rendered effective by the transmission of said impulses for causing another of said automatic switches to preselect an idle one of said selectors, and means effective if a certain number of impulses are sent over said trunk to release it and to extend the line to the preselected selector.

2. In a telephone system, an exchange, a line appearing therein, a second exchange, a trunk interconnecting the exchanges, automatic switches and selectors in the first exchange, means for operating one of said automatic switches to extend the line over said trunk, means for transmitting impulses over said trunk, means rendered effective by the transmission of said impulses for causing another of said automatic switches to preselect an idle one of said selectors, means responsive to a definite number of impulses sent to the second exchange for sending a signal back to the first exchange, and means responsive to said signal for releasing the trunk and extending the line to the preselected selector.

3. In a telephone system, a local office, lines appearing therein, a second office having selectors therein, a trunk interconnecting said offices, an automatic switch for extending a calling line over said trunk to the second office, means for sending impulses to position said selectors, a second automatic switch and selectors in the local office, means responsive to the sending of impulses for causing said second automatic switch to preselect an idle selector in said local office, and means effective if the impulses sent to the second office represent a local call for releasing said trunk and extending the calling line to the preselected selector in the local office.

4. In a telephone system, a local office, lines appearing therein, a second office having selectors therein, a trunk interconnecting said offices, an automatic switch for extending a calling line over said trunk to the second office, means for sending impulses to position said selectors, a second automatic switch and selectors in the local office, means responsive to the sending of impulses for causing said

second automatic switch to preselect an idle selector in said local office, means effective if the first series of impulses sent to the second office represent a local call to release said trunk and to extend the calling line through said second automatic switch to the preselected selector, and means responsive to succeeding impulses to operate said preselected selector.

5. In combination, a satellite office having lines appearing therein, two trunk hunting switches in said satellite, a central office, a trunk interconnecting the satellite and central office, means for operating one of said hunting switches to extend a calling line over said trunk, means for sending impulses, selector switches in the satellite, means responsive to the sending of impulses for setting the second hunting switch in operation to preselect an idle selector, means effective if a certain number of impulses are sent to transmit a signal from the central office to the satellite, means responsive to said signal to release the trunk and extend the calling line to the preselected selector, and means for operating said selectors to extend the calling line to a called line in the satellite.

6. In combination, an exchange having automatic hunting switches and selector switches therein, a signal associated with said selectors, lines appearing in the exchange, a distant office having selectors therein, a signal associated with said latter selectors, a trunk interconnecting the exchange and distant office, means for extending one of said lines through one of said hunting switches to the trunk, means responsive to such extension for actuating the signal at the distant office, means controlled from the latter office for releasing the trunk and extending said line through another hunting switch to an idle selector in the exchange, and means responsive to such extension for actuating the signal in said exchange.

7. In combination, a satellite having automatic hunting switches and selectors therein, a signal associated with said selectors, lines appearing in the satellite, a central office having selectors and a signal therein, a trunk interconnecting the satellite and central office, means responsive to an unstandard condition on one of said lines for extending the same over one of said hunting switches and over said trunk to the central office, means responsive to the extension of said line for rendering effective the signal in the central office, means controlled from the central office for releasing the connection extended thereto and for extending said line through another of said hunting switches to a selector in the satellite, and means responsive to such extension of said line for rendering effective the signal in the satellite.

8. In combination, a first office having selector switches therein, a signal associated

with said selectors, lines appearing in said office, a second office having selector switches therein, a trunk interconnecting said offices, means for extending a connection from one of 5 said lines over said trunk to a selector switch in the second office, means controlled from the second office for releasing the trunk and the extended connection and for extending said line to one of the selector switches in the first office, and means responsive to such extension 10 for actuating the signal in said first office.

In witness whereof, I hereunto subscribe my name this 10th day of June, A. D. 1927.

HENRY HOVLAND.