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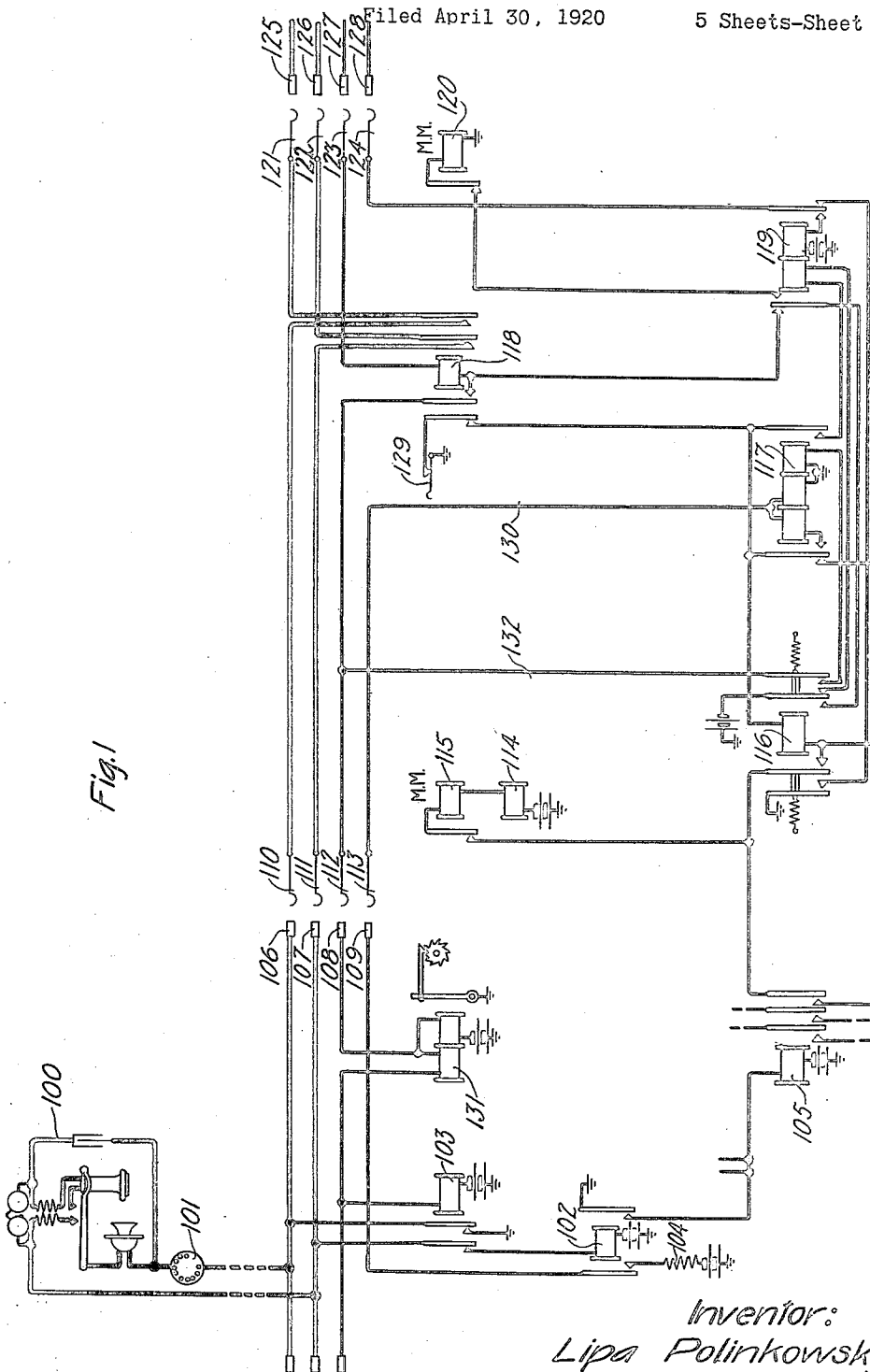
L. POLINKOWSKY

1,464,726

TELEPHONE EXCHANGE SYSTEM

Filed April 30, 1920

5 Sheets-Sheet 1



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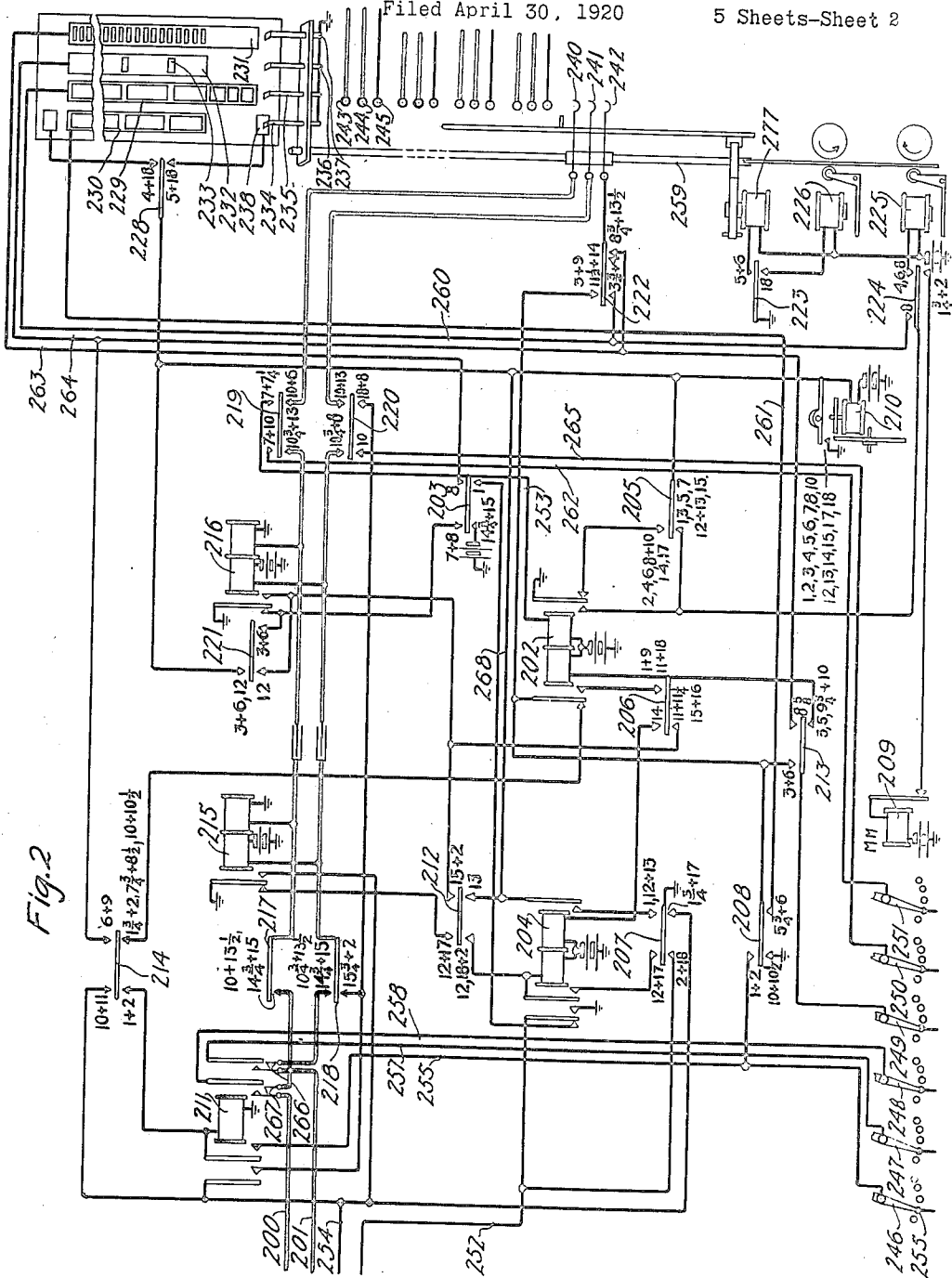
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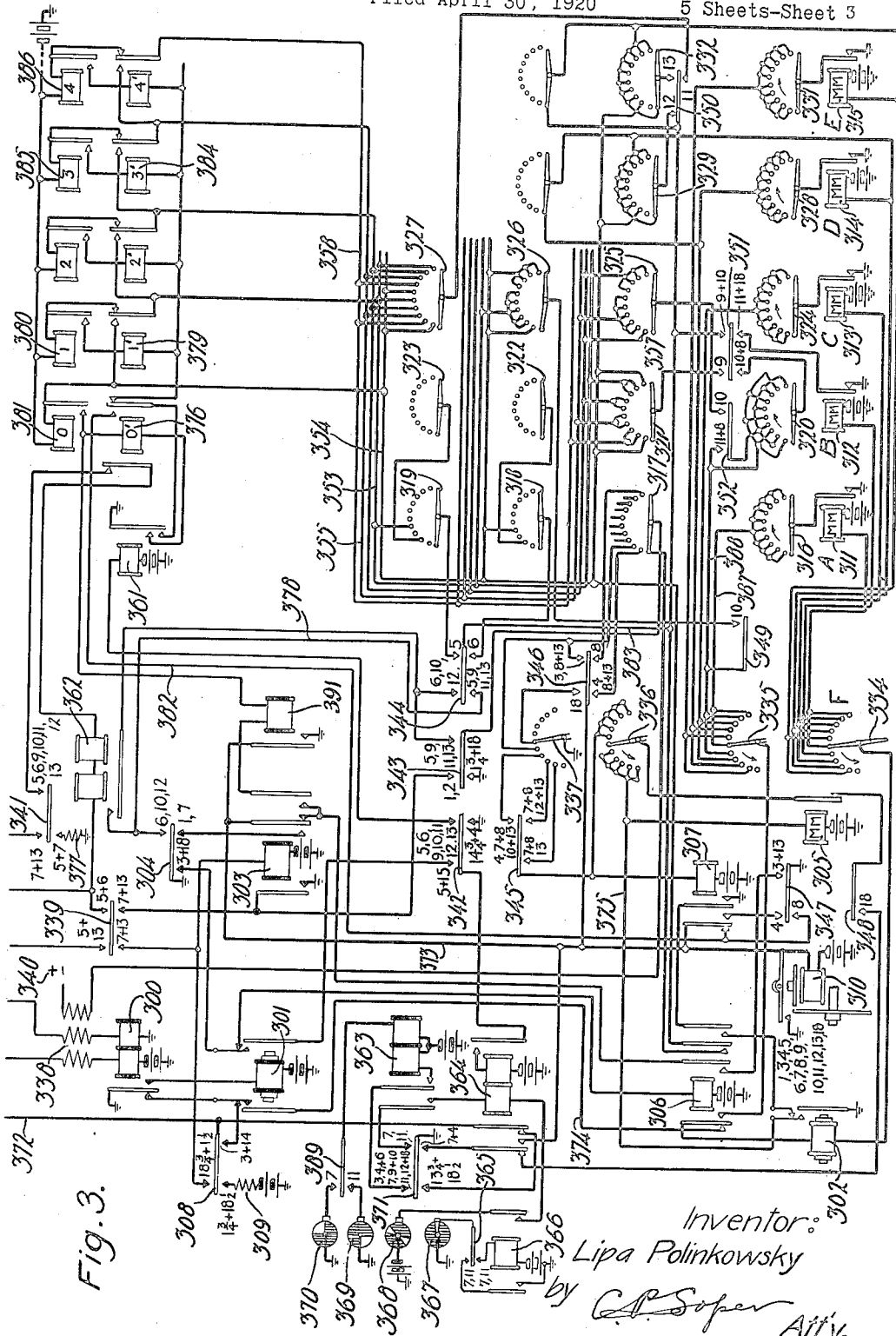


Fig. 3.

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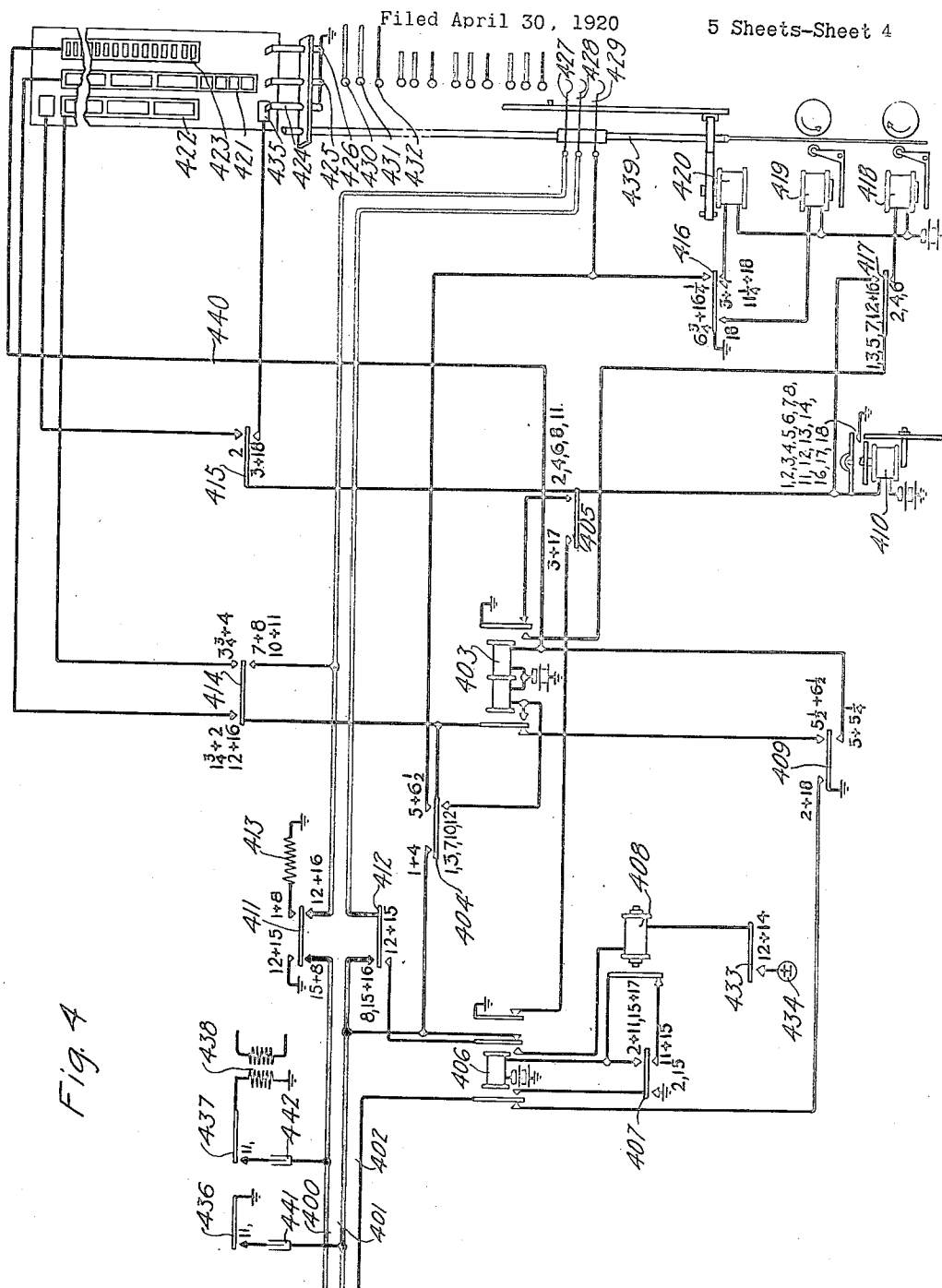
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TELEPHONE EXCHANGE SYSTEM

Filed April 30, 1920

5 Sheets-Sheet 4



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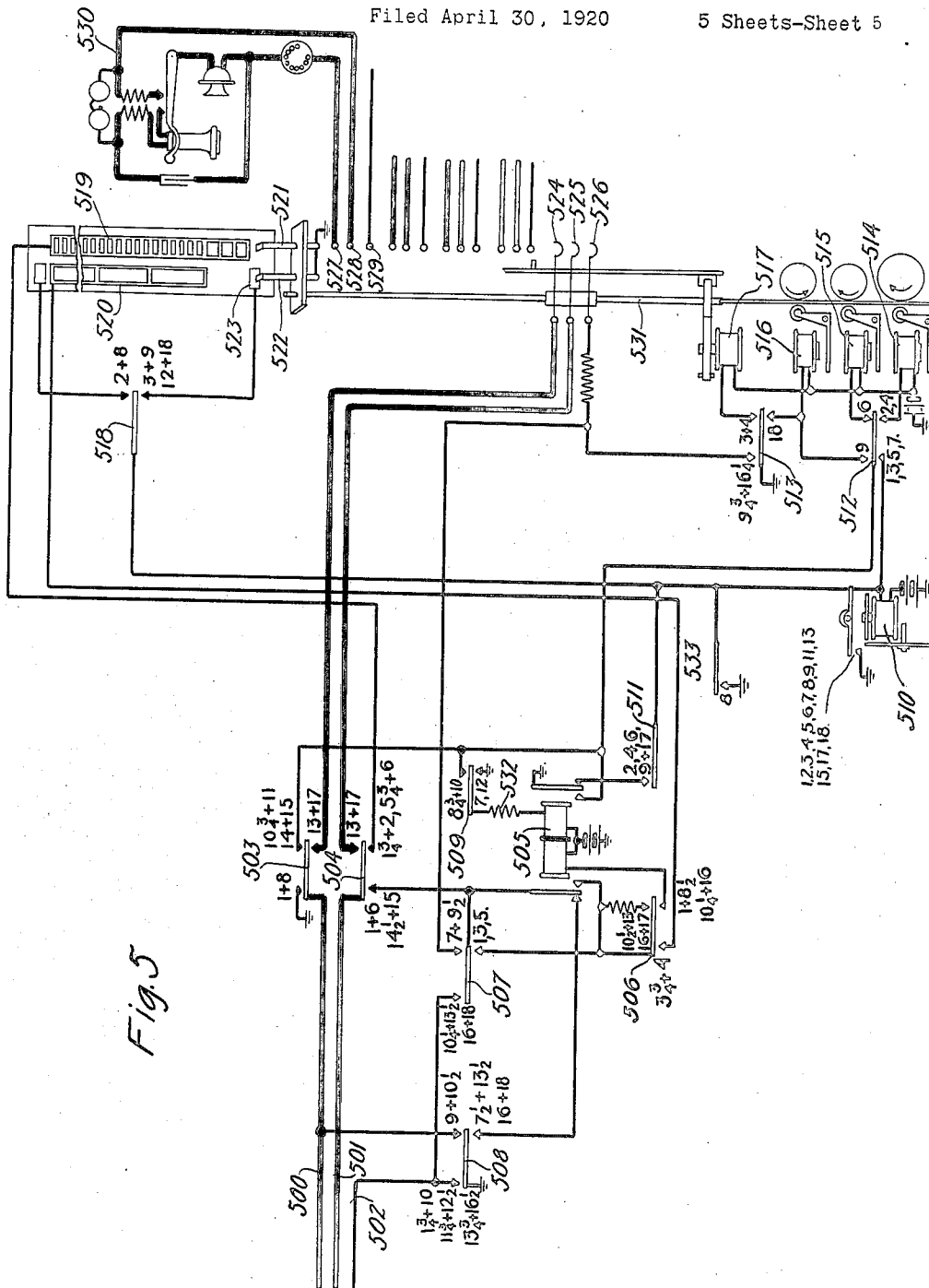
1,464,726

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TELEPHONE EXCHANGE SYSTEM

Filed April 30, 1920

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

LIPA POLINKOWSKY, OF ANTWERP, BELGIUM, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed April 30, 1920. Serial No. 377,931.

To all whom it may concern:

Be it known that I, LIPA POLINKOWSKY, a citizen of Russia, residing at Antwerp, Belgium, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems and more particularly to systems in which machine switching mechanism is used for establishing connections between subscribers' lines.

In machine switching telephone systems where register senders are employed for controlling the switches in the extension of connections, the registers of these senders are arranged to be positioned, either in response to calling transmitters or operators' keyboards, to record the desired designations. With the desired designation thus recorded the registers then serve to control the selecting operations of a series of switches to extend and complete the connection. If, during the automatic trunk-hunting movement of any of the switches in the series, all outlets of the group at that particular stage of the connection are found busy, the switch moves to an overflow position and comes to rest. In certain systems of the foregoing character it is customary to provide means whereby the switch, in finding all outlets busy, advances to its overflow position and causes the application of a tone-producing current to the calling line or the operation of a supervisory signal before an operator. The partially established connection may then be released in the usual manner. In other systems the advance of the switch to overflow position causes the connection to be released automatically, a busy signal being given at the same time to the subscriber. In either type of system the release of the unsuccessful connection causes the register sender to be restored to normal. If further attempts are made to establish the desired connection, it is first necessary to reset the controlling registers of the sender.

The object of this invention is the provision of means in a system of the above general character, for maintaining the registration of the desired designation during the release of the switches, when all outlets are found busy, and for thereupon reoperat-

ing said switches in a further attempt to establish the required connection.

A feature of the invention relates to means, operative upon the lapse of a definite interval after any switch has failed to find an idle outlet, for releasing the partially established connection and for placing the sender in condition to again control the switches in accordance with the registered designation in a further attempt to obtain a complete connection.

Another feature relates to means whereby a switch, which has been operated in accordance with the setting of certain registers of the controlling sender, may be released and reoperated under the control of such registers during the time that other registers of the sender are being set to control the operation of other switches which cooperate in the establishment of the desired connection.

These and other features contemplated by the present invention will become more apparent from a consideration of the following description and appended claims.

In the drawings Figs. 1, 2, 4 and 5, taken in order from left to right with Fig. 3 placed beneath Fig. 2, illustrate a telephone system embodying the principles of this invention.

Fig. 1 shows a subscriber's line and a preliminary switching unit comprising a line finder switch and a trunk finder switch for extending such line to an idle trunk circuit.

Fig. 2 shows a first group selector switch and an auxiliary switch individual thereto for associating an idle register-controlling mechanism with the circuits of the group selector switch.

Fig. 3 shows one of the register controlling mechanisms for controlling the operation of the selective switches in the extension of a connection.

Fig. 4 shows a second group selector switch and Fig. 5 shows a final selector switch having access to the terminals of called subscribers' lines.

The preliminary switching unit shown in Fig. 1 consists of a line-finding switch whose brushes are shown at 110, 111, 112 and 113, and a trunk-finding switch whose brushes are shown at 121, 122, 123 and 124. These finder switches are of the simple rotary type, driven step by step by a motor mag-

net over the terminals of an arcuate bank. The brush sets have no normal position but always remain in engagement with the terminals last taken for use.

5 The group selector switches shown in Figs. 2 and 4 and the final selector switch in Fig. 5 are of the well-known power driven panel type, such as disclosed in the patent to Craft and Reynolds No. 1,123,696,
10 issued January 5, 1915.

The register-controlling mechanisms, one of which is illustrated in Fig. 3, which control the selective movement of the switches, are of the reverteive impulse-sending type.
15 These controlling mechanisms comprise a plurality of registers A, B, C, D and E which are positioned under the control of a calling subscriber's impulse transmitter and in accordance with the numerical designations of called subscribers' lines. A side
20 switch F is provided for the purpose of associating the calling subscriber's line with the successive registers. After the first register A has been advanced in accordance
25 with the first series of impulses transmitted over the calling subscriber's line, the side switch F moves forward one position to associate the second register B. The next
30 series of impulses serves to set the register B, whereupon the side switch advances to associate the calling line with the third register C and so on. The registers, having
35 been thus positioned in accordance with the respective digits of the desired designation, are then effective to control the operation of the counting relay set which, in turn, cooperates with the fundamental circuit in the
40 usual manner to determine the extent of operation of the successive selector switches in the extension of the connection. The registers consist of small rotary step-by-step
45 switches, each comprising a plurality of superimposed contact levels with a rotating brush for each level. For clearness of illustration the several contact levels of each
50 register are shown in vertical alignment, one above the other, together with the brush arm co-operating with each of such contact levels. The register A is provided with
55 four levels of contacts and four corresponding brushes 316, 317, 318 and 319. The register B also has four levels of contacts and four corresponding brushes 320, 321, 322 and 323. The register C is likewise
60 provided with four levels of contacts with the corresponding brushes 324, 325, 326 and 327. The last two registers, D and E, are provided with only three levels of contacts each. Each of the several brushes of a register has two contact arms spaced 180° apart and rigidly mounted upon the same rotating
65 shaft. The stationary contacts are arranged in a semicircular bank, such that the movable brushes, having completed a half circle of rotation, are in normal position ready for

the next operation. Stepping magnets 311, 312, 313, 314 and 315, one for each of the respective registers, serve to drive the movable brushes step by step over the terminals of the stationary banks. The stationary
70 bank terminals of the registers may be wired to the counting relays shown at the top of Fig. 3 in any manner suitable for exercising the necessary control over the selective operations of the switches. Since the method
75 of wiring the registers to the counting relays is arbitrary and depends upon the type of translation required to satisfy the grouping of trunks and lines in the selective switches, it has been considered necessary to show
80 only a few of the connections between the register contact banks and the counting relays.

The side switch F consists of a rotary step-by-step switch, similar in construction
85 to the controlling registers, provided with four levels of stationary contacts. The brushes 334, 335, 336 and 337 of the side switch each have two contact wipers spaced 180° apart as shown in the case of the lower-
90 most brush 334. The brushes of the side switch are shown in their normal positions and are arranged to rotate in a direction opposite to the rotation of the register brush
95 arms, as illustrated by the arrows. As a further means for accomplishing the necessary circuit changes during the operation of the controlling mechanism a sequence switch
100 310 is provided for each controlling mechanism.

The sequence switch 310, together with the sequence switches 210, 410, and 510, associated with the selective switches, may be of the construction shown and described in the
105 patent to Reynolds and Baldwin No. 1,127,808, issued February 9, 1915.

In the system disclosed, the initiation of a call on a subscriber's line causes the automatic operation of an idle preliminary
110 switching unit. The line finder operates to find the calling line and the trunk finder operates to extend such line over a trunk circuit to an idle first group selector switch. The auxiliary selecting switch, the brushes of which are shown at 246, 247, 248, 249, 250
115 and 251, is thereupon started in operation to test and seize an idle register-controlling mechanism. An idle controlling mechanism having been associated with the first group selector switch, the calling subscriber's line
120 is extended to an impulse relay 300, which responds to series of impulses, to position the successive registers in accordance with the called line designation. After the first two registers, A and B, have been positioned,
125 a fundamental circuit is completed and the brush and group-selecting operations take place at the first-group selector switch. During the operation of the first group-selector switch, the subscriber continues to
130

transmit impulses to set the remaining registers C, D and E. When the first group selector has completed its operation, a fundamental circuit is completed for the operation of the second group-selector switch, provided at this time all of the remaining registers have been positioned. If the first group-selector switch, however, completes its operation prior to the setting of the remaining registers, the operation of the second group selector is delayed until the last of such registers has been positioned. The second group selector and final selectors are then operated under the control of the positioned registers and complete the extension of the connection to the called subscriber's line.

In accordance with the principles of this invention, should the first or second group-selector switches find all trunks in the selected group busy at the time the test is made, these switches are restored to normal to release the partially established connection. The release of the partially established connection under these circumstances interrupts the regular advance of the register-controlling mechanism at the corresponding point in the progress of its operation. After the controlling mechanism has stood in its partially operated condition for a predetermined interval of time, means are rendered effective to place said controlling mechanism in its initial condition without disturbing the setting of the registers and in fact, without interfering with the regular operation of such registers as may not have been positioned at this time under the control of the calling subscriber's transmitter. With the switches thus released and the controlling mechanism returned to its initial set condition, said switches are again operated in accordance with the original setting of their controlling registers to make a further attempt to establish a through connection to the called line. This operation may continue so long as no idle trunks are found or until the calling subscriber abandons the call by hanging up his receiver.

A detailed description of the operation involved in the extension and completion of a connection will now be given. For this purpose it will be assumed that the subscriber at substation 100 desires to hold conversation with the subscriber at substation 530. Upon the removal of the receiver from the switchhook at the calling substation, a circuit is completed from battery through the winding of line relay 102, contact and outer armature of relay 103, over the loop of the substation 100, inner armature and contact of relay 103 to ground. Relay 102 becomes energized and closes a circuit from battery through resistance 104, contact and left-hand armature of relay 102 to test terminal 109 of the line finder switch, thus placing a selectable potential on said ter-

minal. Relay 102 also closes a circuit at its right-hand armature for the energization of relay 105. Relay 105 completes a circuit from battery through the winding of coil 114, winding of stepping magnet 115, armature and contact of said magnet, outer armature and contact of relay 105, back contact and left-hand armature of relay 117, contact and outer left-hand armature of relay 118, contact 129, to ground. A circuit in parallel to the one just traced is also closed through the winding of relay 116, to ground at contact 129. Relay 116, however, being shunted out, does not receive sufficient current to energize. The stepping magnet 115 interrupts its own circuit and advances brushes 110, 111, 112 and 113 over the terminals of the subscribers' lines. When the calling line is reached, a circuit is completed from battery, through resistance 104, contact and left-hand armature of relay 102, terminal 109, brush 113, conductor 130, middle winding of relay 117 to ground. Relay 117 energizes and opens the operating circuit of the stepping magnet 115. Relay 116 is now included in series with magnet 115, but magnet 115 does not receive sufficient current to continue its operation. Hence the brushes 110, 111, 112 and 113 are brought to rest in engagement with terminals 103, 107, 108 and 109 of the calling line. Relay 116 is made slow to attract its armatures and, therefore, does not operate in series with magnet 115 until after the lapse of a short interval following the operation of relay 117. With relay 117 energized, and while relay 116 is in its inoperative condition, a circuit is completed from battery through the inner right-hand armature and back contact of relay 116, left-hand winding of relay 119, contact and right-hand armature of relay 117, contact and outer left-hand armature of relay 118, contact 129 to ground. Relay 119, which serves as a test relay, attracts its armatures and locks up over its right-hand winding, provided the test brush 124 of the trunk finder is standing on the terminal 128 of a busy trunk. This holding circuit may be traced from battery through the right-hand winding and front contact and right-hand armature of test relay 119, brush 124, terminal 128, conductor 252, to ground either at the lower left-hand sequence switch contact 207 (2 to 18) or at the outer left-hand armature and front contact of relay 204, as will be hereinafter explained. Relay 119, by remaining energized in this circuit after the circuit through its left-hand winding is opened by the energization of relay 116, completes a circuit from ground through the winding of stepping magnet 120 of the trunk finder, armature and contact of said magnet, front contact and left-hand armature of relay 119, front contact and inner

right-hand armature of relay 116 to battery and ground. The stepping magnet 120 interrupts its own circuit and advances brushes 121, 122, 123 and 124 over the terminals of trunk lines in search of an idle one thereof. When an idle trunk is reached, the holding circuit of test relay 119 is opened and this relay deenergizes. Relay 119 opens the operating circuit of stepping magnet 120, thereby bringing the brushes of the trunk finder to rest in contact with the terminals of the trunk line leading to an idle first group selector switch. When relay 116 became energized after the lapse of the necessary interval, a circuit was closed from battery through the winding of cut-off relay 103, left-hand winding of register magnet 131, terminal 108, brush 112, conductor 132, outer right-hand armature and contact of relay 116, right-hand winding of relay 117 to ground. The cut-off relay 103, by energizing in this circuit, opens the circuit of line relay 102, which, in turn, permits the deenergization of relay 105. Relay 116 remains energized in series with magnet 115 by means of a circuit closed through the inner left-hand armature and contact of relay 116 to ground at contact 129, as above traced.

As soon as relay 119 releases its armatures a circuit is completed from ground through the outer left-hand armature and contact of relay 116, back contact and right-hand armature of relay 119, brush 124, terminal 128, conductor 252, outer left-hand armature and back contact of relay 204, lower right-hand contact 203 (1), conductor 253, right-hand winding of relay 202, to battery and ground. Relay 202 becomes energized and closes a circuit from ground through its right-hand armature and front contact, lower contact 205 (1), winding of sequence switch magnet 210 to battery and ground. Sequence switch 210 energizes in this circuit and moves from position 1 into position 2. As sequence switch 210 reaches position 2 a circuit is completed from ground through the lower right-hand contact 207 ($1\frac{1}{2}$ to 17), conductor 254, terminal 127, brush 123, winding of relay 118, back contact and left-hand armature of relay 119, front contact and inner right-hand armature of relay 116 to battery and ground. Relay 118 energizes in this circuit and opens the above-traced circuit for relay 116. Relay 116 thereupon releases its armatures. The deenergization of relay 116 opens the circuit through the right-hand winding of relay 117, permitting this latter relay to release its armatures. Relay 118 and cut-off relay 103, however, remain energized in a circuit from battery through the winding of relay 103, left-hand winding of register magnet 131, terminal 108, brush 112, inner left-hand armature and contact and winding of relay 118, brush

123, terminal 127, and thence to ground at contact 207.

In position 2 of sequence switch 210, the auxiliary selecting switch, the stepping magnet of which is shown at 209, is operated to select an idle register-controlling mechanism. If the test brush 246 of the auxiliary switch happens to be standing on a terminal individual to a busy register-controlling mechanism, the relay 202 remains energized in position 2 of sequence switch 210 by means of a circuit from battery through the left-hand winding of relay 202, upper right-hand contact 206 (1 to 9), front contact and left-hand armature of relay 202, upper left-hand contact 208 (1 to 2), brush 246, terminal 255, thence to a multiple terminal similar to terminal 255 at some other auxiliary switch, brush 246 at such other auxiliary switch, conductor 255, contact and inner left-hand armature and winding of a relay similar to relay 211, to ground. Relay 202, by remaining energized in this circuit, completes a circuit from battery through the winding and armature and contact of the stepping relay 209 here shown, lower right-hand contact 224 ($1\frac{1}{2}$ to 2), front contact and right-hand armature of relay 202 to ground. The stepping magnet 209 interrupts its own circuit and advances brushes 246, 247, 248, 249, 250 and 251 to search for an idle register-controlling mechanism. The test brush 246, on reaching a non-grounded terminal 255, opens the holding circuit of relay 202. Relay 202 releases its armatures and completes a circuit from ground through the right-hand armature and back contact of relay 202, upper contact 205 (2), winding of sequence switch magnet 210 to battery and ground. Sequence switch 210 advances from position 2 into position 3. After relay 202 has released its armatures and before sequence switch 210 leaves position 2, a circuit is closed from ground through the winding of relay 211, lower left-hand contact 214 (1 to 2), lower right-hand contact 214 ($1\frac{1}{2}$ to 2), back contact and left-hand armature of relay 202, upper left-hand contact 208 (1 to 2), brush 246, terminal 255, conductor 372, upper left-hand contact 308 ($18\frac{1}{2}$ to $1\frac{1}{2}$), of sequence switch 310, winding of relay 303, to battery and ground. Relays 303 and 211 energize in this circuit. Relay 211 immediately locks up through its inner left-hand armature and contact to conductor 255, independent of the contacts of sequence switch 210.

With the relay 211 energized, the calling subscriber's line is extended through to the windings of the stepping relay 300 at the register-controlling mechanism for the transmission of impulses thereto. The circuit including the windings of relay 300 may be traced from battery through the left-hand winding of said relay, left-hand winding of tone coil 338, brush 247, conductor 257, outer

right-hand armature and front contact of relay 211, conductor 201, terminal 126, brush 122, inner right-hand armature and contact of relay 118, brush 111, terminal 107, over the loop of the calling subscriber's line and returning by way of terminal 106, brush 110, contact and outer right-hand armature of relay 118, brush 121, terminal 125, conductor 200, contact and inner right-hand armature of relay 211, conductor 258, brush 248, middle winding of tone coil 338, right-hand winding of relay 300, to ground. Relay 300 energizes in series with the calling line and completes a circuit at its armature and front contact for the energization of relay 301. Relay 303, which energized in series with relay 211, completes a circuit from ground through the lower right-hand contact 304 (1), front contact and inner right-hand armature of relay 303, conductor 373, winding of sequence switch magnet 310, to battery and ground. Sequence switch 310 moves from position 1 into position 3. In position 3 of sequence switch 310, a circuit is established from the dialing tone source 340, through the right-hand winding of coil 338, first position contact and brush 317 of register A to ground at the lower left-hand contact 343 (1 $\frac{1}{2}$ to 18). Current flowing in this circuit induces a current in the left-hand windings of the coil 338 which, in turn produces a characteristic sound in the receiver at the calling subscriber's station to inform him that the apparatus is in condition to receive impulses.

The calling subscriber thereupon manipulates his impulse transmitter 101 in accordance with the first digit of the called number. At the first interruption of the calling line, relay 300 deenergizes and completes a circuit from ground through its armature and back contact, contact and left-hand armature of relay 301, conductor 374, back contact and left-hand armature of relay 306, winding of relay 302, brush 334 and the first position contact of side switch F, winding of stepping magnet 311 of register A, to battery and ground. Relay 302 energizes and completes a circuit from ground through its armature and contact, conductor 375, winding of stepping magnet 305, to battery and ground. The stepping magnet 305 of the side switch F and the stepping magnets of the several registers are arranged to advance the brushes which they control on deenergization. As soon as the calling subscriber's line is again closed at the end of the first impulse, relay 300 attracts its armature and opens the circuit of stepping magnet 311. Brushes 316, 317, 318 and 319 are, therefore, stepped forward one position. Relays 301 and 302 are made slow to deenergize and do not retract their armatures in response to the brief interruptions of their circuits during the transmission of a

series of impulses. Relay 302, by remaining energized, maintains the energizing circuit of the side switch stepping magnet 305. For each succeeding impulse in the first series, the stepping magnet 311 advances the brushes of the first register one position. After the lapse of a slight interval following the end of the first series of impulses, slow-to-release relay 302 becomes deenergized and opens the circuit of stepping magnet 305. Magnet 305 deenergizes and advances brushes 334, 335, 336 and 337 into engagement with the second position contacts. With the side switch F in its second position a circuit is closed from battery through the winding of sequence switch magnet 310, upper right-hand contact 343 (3), brush 337, position 2, to ground. Sequence switch 310 moves from position 3 into position 4.

The calling subscriber now operates his impulse transmitter 101 to send the second series of impulses for setting the second register B. In response to the first interruption of the line circuit, relay 300 deenergizes and completes a circuit from ground through its armature and back contact, contact and left-hand armature of relay 301, conductor 374, back contact and left-hand armature of relay 306, winding of relay 302, brush 334, position 2, winding of stepping magnet 312, to battery and ground. Magnet 312 energizes preparatory to advancing the brushes of the register. Relay 302 also energizes and closes the above-traced circuit for stepping magnet 305 of the side switch. At the end of the first interruption of the line circuit relay 300 attracts its armature, permitting the magnet 312 to deenergize and move the brushes forward one position. Relay 302, however, remains energized to maintain the energizing circuit of the side switch stepping magnet 305. For each succeeding impulse of the second series, magnet 312 is energized and deenergized to advance the brushes of the register B. At the end of the series, slow-to-release relay 302 retracts its armature, and the side switch stepping magnet 305 deenergizes and causes the movement of the brushes to the third position. With the side switch in its third position, a circuit is completed from battery through the winding of relay 307, upper right-hand contact 345 (4), brush 337, position 3, to ground. Relay 307 becomes energized and completes a circuit from battery through the winding of sequence switch magnet 310, outer armature and front contact of relay 307, upper left-hand contact 347 (4), to ground. Sequence switch 310 advances from position 4 into position 5.

The calling subscriber again operates his impulse transmitter 101 to transmit the third series of impulses for positioning the

third register C. In response to the first interruption of the line in the third impulse series, relay 300 becomes deenergized and closes a circuit from ground through its armature and back contact, contact and left-hand armature of relay 301, conductor 374, back contact and left-hand armature of relay 306, winding of relay 302, brush 334, position 3, winding of stepping magnet 313, to battery and ground. Relay 302, stepping magnet 313 and stepping magnet 305 all become energized in the manner above described. When the impulse relay 300 again energizes at the termination of the first impulse of the series, stepping magnet 313 deenergizes and advances the brushes of the register C one position. For each succeeding interruption of the line circuit during the transmission of the third series of impulses, magnet 313 operates to advance the brushes of register C forward one position. At the termination of this series, the stepping magnet 305 becomes deenergized and moves the brushes of the side switch to their fourth position.

The subscriber next manipulates his impulse transmitter to send a series of impulses according to the tens digit of the wanted number. The impulse relay 300, on first deenergizing, completes a circuit from ground through its armature and back contact, contact and left-hand armature of relay 301, conductor 374, back contact and left-hand armature of relay 306, winding of relay 302, brush 334, position 4, contact winding of stepping magnet 314 of register D, to battery and ground. For each impulse transmitted in the tens series, the stepping magnet 314 energizes and deenergizes to cause the progressive advance of the brushes of the register D. At the end of the tens series of impulses, the side switch stepping magnet 305 becomes deenergized and advances the brushes of the side switch to their fifth position.

The calling subscriber finally operates his impulse transmitter in accordance with the units digit to cause the setting of the register E. In a manner similar to that already described, relay 300, by retracting its armature at each impulse of the units series, completes a circuit including the brush 334 in its fifth position, for the energization of the stepping magnet 315. Magnet 315 causes the advance of the brushes of register E. At the termination of the units series of impulses, the stepping magnet 305 becomes deenergized and the brushes of the side switch move out of their fifth position. The stationary terminals of the side switch bank are so arranged that when one end of each brush moves out of position 5, the opposite end engages the first terminal on the right-hand side of the bank. The registers of the controlling mechanism have thus been posi-

tioned in accordance with the several digits of the desired designation.

The controlling mechanism is so arranged that brush and group selection of the first group selector switch may commence as soon as the first two registers, A and B, have been positioned by the calling subscriber's transmitter. It will be recalled that at the completion of the setting of the second register B the sequence switch 310 advanced into position 5. With sequence switch 310 in position 5 a fundamental circuit for controlling brush selection is completed from battery through the left-hand winding of relay 202, lower right-hand contact 213 (3), brush 249, upper left-hand contact 339 (5 to 13), upper right-hand contact 339 (5 to 6), winding of stepping relay 362, left-hand armature and contact of the 0' counting relay 376, upper right-hand contact 341 (5), lower left-hand contact 341 (5 to 7), resistance 377 to ground. Relays 202 and 362 become energized in this circuit. Relay 202 completes a circuit from ground through its right-hand armature and front contact, lower contact 205 (3) winding of sequence switch magnet 210, to battery and ground. Sequence switch 210 moves out of position 3 and into position 4. Relay 202 remains energized in position 4 of sequence switch 210 by means of a circuit from battery through its left-hand winding, upper right-hand contact 206 (1 to 9), front contact and left-hand armature of relay 202, upper left-hand contact 213 (3 to 6), and thence to ground as above traced. With sequence switch 210 in position 4 a circuit is closed for the up-drive power magnet 225 to cause the upward movement of the brush shaft 259 in its brush-selecting operation. The circuit of magnet 225 may be traced from battery through the winding of said magnet, upper right-hand contact 224 (4), to ground at the front contact and right-hand armature of relay 202. For each brush-tripping position approached by the shaft 259, the brush 235 engages a metallic segment of the commutator 229. A circuit is thereby closed from battery through the left-hand winding of relay 202, upper right-hand contact 206 (1 to 9), front contact and left-hand armature of relay 202, upper left-hand contact 222 (3 to 9), lower left-hand contact 222 (3½ to 4), conductor 260, commutator 229, brush 235 to ground. This direct circuit to ground maintains the energization of relay 202 and at the same time causes the shunting of the stepping relay 362 in the fundamental circuit. When relay 362 first energizes in series with relay 202, a circuit is closed from ground through the lower left-hand contact 343 (1½ to 18), upper right-hand contact 343 (5), armature and contact of stepping relay 362, conductor 378, lower left-hand contact 344 (5), upper right-hand contact

344 (5), brush 319 of register A, standing in its fifth position for example, conductor 353, armature and back contact of the number 1' counting relay 379, winding of the number 1, counting relay 380 to battery and ground. Relay 380 energizes and prepares a circuit from battery through the winding of relay 380, armature and contact of said relay, winding of relay 379, back contact and right-hand armature of relay 376, lower contact and armature of relay 361 to ground. Relay 361, it will be observed, is energized at this time by means of a circuit from battery through the winding of said relay, upper right-hand contact 342 (5), upper left-hand contact 342 (5 to 15), right-hand armature and contact of relay 301, lower left-hand contact 304 (3 to 18), to ground. The number 1' counting relay 379 does not energize at this time in series with relay 380 since it is shunted out by the direct circuit to ground, closed at the armature and contact of the stepping relay 362. As soon as the brush 235 engages the first metallic segment of the commutator 229 in the upward movement of the switch shaft 259, stepping relay 362 is deenergized as explained. Relay 379 is energized and locks up in series with relay 380 in the circuit traced. As brush 235 disengages the first metallic segment of the commutator stepping relay 362 again becomes energized. The stepping circuit is now closed by way of register brush 319, conductor 353, armature and front contact of relay 379, winding of the number 0 counting relay 381, to battery and ground. Relay 381 energizes and prepares a locking circuit for itself in series with the number 0' counting relay 376. As soon as the next metallic segment of the commutator is reached by brush 235, stepping relay 362 deenergizes and relays 381 and 376 lock up in the circuit closed to ground at the armature and contact of relay 361. The operation of relay 376 opens the holding circuit of relays 380 and 379, permitting these relays to release. Relay 376, at its left-hand armature opens the fundamental circuit and at its right-hand armature and front contact, completes a circuit from ground through the armature and lower contact of relay 361, conductor 382, back contact and outer armature of relay 307, winding of sequence switch magnet 310 to battery and ground. Sequence switch 310 advances from position 5 into position 6. In passing from position 5 to position 6, the upper right-hand contact 342 is momentarily opened to permit the deenergization of relay 361. Relay 361, by releasing its armature, opens the locking circuit of relays 381 and 376. In position 6 of sequence switch 310, the upper right-hand contact 342 is again closed and relay 361 becomes energized. As soon after the fundamental circuit is opened at the left-hand

armature and contact of relay 376, as brush 235 engages an insulating segment of the commutator 229, relay 202 deenergizes and completes a circuit from ground through its right-hand armature and back contact, upper contact 205 (4), winding of sequence switch magnet 210 to battery and ground. Sequence switch 210 thereupon moves from position 4 into position 5.

With sequence switch 210 in position 5 and sequence switch 310 of the controlling mechanism in position 6, the fundamental circuit is again established for controlling the group selecting movement of the switch. The only difference is that the fundamental circuit is now closed in position 5 of sequence switch contact 213 and in position 6 of sequence switch contact 341. Relay 202 becomes energized and completes a circuit from ground through its right-hand armature and front contact, lower contact 205 (5), winding of sequence switch magnet 210 to battery and ground. Sequence switch 210 is driven from position 5 into position 6. In position 6 relay 202 is maintained energized by means of the above described circuit including its left-hand winding and armature and upper left-hand contact 213 (3 to 6). With sequence switch 210 in position 6, the updrive power magnet 225 is energized to cause the advance of the brush shaft 259 in the group-selecting movement of the switch. The circuit of magnet 225 is traceable from battery through the winding of said magnet, upper right-hand contact 224 (6), to ground at the front contact and right-hand armature of relay 202. In position 5 of sequence switch 310, the trip magnet 277 is energized by means of a circuit from battery through the winding of said magnet, upper right-hand contact 223 (5 to 6), to ground. Magnet 277 operates to trip the selected set of brushes 240, 241 and 242, to make engagement with the trunk terminals in the bank. As the brushes 240, 241 and 242 approach each successive group of terminals in the section to which they have access, brush 234 engages a metallic segment of the group-selecting commutator 230. A circuit is thereby closed from battery through the left-hand winding of relay 202, upper right-hand contact 206 (1 to 9), front contact and left-hand armature of relay 202, lower right-hand contact 208 (5 to 6), conductor 261, commutator 230, brush 234 to ground. This direct circuit to ground maintains the energization of relay 202 and at the same time shunts the stepping relay 362 in the fundamental circuit. Relay 362, which energizes simultaneously with relay 202, completes a circuit from ground through the upper right-hand contact 304 (6), contact and armature of relay 362, upper left-hand contact 344 (6), lower right-hand contact 344 (6), brush 313 of the reg-

ister A standing in its fifth position, conductor 354, winding of the 0 counting relay 381 to battery and ground. Relay 381 energizes and prepares a locking circuit for itself and the 0' counting relay 376 as described. When brush 234 engages the first metallic segment of commutator 230, relay 362 deenergizes and permits the energization of relay 376 in series with relay 381. Relay 376 opens the fundamental circuit and also completes a circuit from ground through the armature and lower contact of relay 361, right-hand armature and front contact of relay 376, conductor 382, back contact and outer armature of relay 307, winding of sequence switch 310, to battery and ground. Sequence switch 310 moves out of position 6 and into position 7. In leaving position 6, contact 342 opens the circuit of relay 361 which, by deenergizing, causes the release of the counting relays 381 and 376. As soon as the fundamental circuit is opened by the counting relay 376, as the brush 234 engages an insulated segment of the commutator 230, relay 202 becomes deenergized and completes a circuit from ground through its right-hand armature and back contact, upper contact 205 (6), winding of sequence switch magnet 210, to battery and ground. Sequence switch 210 advances from position 6 into position 7.

With sequence switch 210 in position 7, relay 202 is immediately energized by means of a circuit from battery through the right-hand winding of said relay, upper right-hand contact 219 (7 to 7½), upper left-hand contact 219 (7 to 10), conductor 262, brush 251, upper left-hand contact 341 (7 to 13), lower left-hand contact 341 (5 to 7), resistance 377 to ground. Relay 202 completes a circuit from ground through its right-hand armature and front contact, lower contact 205 (7), winding of sequence switch 210, to battery and ground for moving said sequence switch out of position 7 and into position 8. If the first trunk in the selected group, upon the terminals of which brushes 240, 241 and 242 are now standing, is busy at this time, relay 202 remains energized in position 8 of sequence switch 210 by means of the following circuit: battery, through the left-hand winding of relay 202, upper right-hand contact 206 (1 to 9), front contact and left-hand armature of relay 202, upper left-hand contact 222 (3 to 9), test brush 242, to the grounded test terminal 245 of the busy trunk. Relay 202, by remaining energized, provides a circuit for the up-drive power magnet 225, traceable from battery through the winding of said magnet, upper right-hand contact 224 (8), to ground at the front contact and right-hand armature of relay 202. The brush shaft 259 is again moved upward in the trunk-hunting operation. Upon engagement of the brushes 240, 241 and 242 with terminals 243, 244 and 245 of an idle trunk in the group, no ground potential is found on test terminal 245 and the above-traced circuit of relay 202 is opened. Relay 202, however, remains energized by means of a circuit from battery through the right-hand winding of said relay, upper right-hand contact 203 (8), conductor 263, commutator 231, brush 237 to ground. When the brushes 240, 241 and 242 are accurately centered on the terminals of the idle trunk, brush 237 engages an insulating segment of commutator 231 and relay 202 deenergizes to open the circuit of power magnet 225. Relay 202, by deenergizing, also completes a circuit from ground through its right-hand armature and back contact, upper contact 205 (8 to 10), winding of sequence switch magnet 210, to battery and ground. Sequence switch 210 energizes in this circuit and leaves position 8. As soon as sequence switch 210 reaches position 8½, a path is closed from ground, through brush 236, commutator 232, conductor 264, lower right-hand contact 222 (8½ to 13½), test brush 242, to test terminal 245 of the seized trunk. The application of this ground to the multiples at terminal 245 renders the trunk non-selectable to other group selector switches.

It may be well to explain at this point that the commutator 232 comprises a metallic strip having a series of openings or insulating portions 233. The insulating segments 233 are so arranged with respect to the movement of the switch that the brush 236 is always in engagement with the metallic portion of the commutator 232 while brushes 240, 241 and 242 are in engagement with any set of trunk terminals in the group. If, however, brushes 240, 241 and 242 find all trunks in a given group busy, they are driven over the entire group and come to rest in the over-flow position at which time the brush 236 passes off the metallic portion of the commutator 232 and engages an insulating segment 233.

As sequence switch 210 passes through position 8½ a circuit is momentarily closed from ground through brush 236, commutator 232, conductor 264, upper right-hand contact 213 (8½), brush 249, upper left-hand contact 339 (5 to 13), lower left-hand contact 339 (7 to 13), winding of relay 303 to battery and ground. Relay 303 becomes energized and locks up in a circuit from battery through the winding of said relay, lower contacts 339 (7 to 13) to ground at the left-hand armature and contact of relay 303. When sequence switch 210 later arrives in position 9½, relay 202 is energized by means of a circuit from battery through the left-hand winding of said relay, lower right-hand contact 213 (9½ to 10), brush 249, upper left-hand contact 339 (5 to 13), lower right-hand contact 339 (7 to 13), to ground

at the left-hand armature and contact of relay 303. Relay 202 attracts its right-hand armature and opens the driving circuit of sequence switch 210 whereby said sequence switch comes to rest in position 10. Relay 303 also completes a circuit from ground through the lower right-hand contact 304 (7), front contact and inner right-hand armature of relay 303, conductor 373, winding of sequence switch magnet 310, to battery and ground. Sequence switch 310 advances from position 7 into position 8. Should, at this time, the calling subscriber not have completed the setting of the last three registers, C, D and E, the side switch F is standing in either its third, fourth or fifth position. In either case relay 307 is energized by means of a circuit from ground, brush 337 in its third, fourth or fifth position, contact 345 (7 to 8), winding of relay 307, to battery and ground. If, however, the registers have all been set or as soon as the setting of such registers is completed, relay 307 is deenergized and a circuit is completed from battery through the winding of sequence switch magnet 310, outer armature and back contact of relay 307, lower left-hand contact 347 (8) to ground. Sequence switch 310 thereupon advances into position 9.

With sequence switch 310 in position 9 and sequence switch 210 in position 10, a fundamental circuit is completed through to the second group selector shown in Fig. 4 for controlling the brush-selecting operation. This circuit may be traced from battery through the left-hand winding of relay 403, lower right-hand contact 404 (1), upper left-hand contact 404 (1 to 4), conductor 401, terminal 244, brush 241, upper right-hand contact 220 (10 to 13), lower left-hand contact 220 (10), conductor 265, brush 250, winding of the stepping relay 362, left-hand armature and contact of relay 376, upper right-hand contact 341 (9), upper left-hand contact 341 (7 to 13), brush 251, conductor 262, upper left-hand contact 219 (7 to 10), lower right-hand contact 219 (10 to 6), brush 240, terminal 243, conductor 400, lower left-hand contact 411 (15 to 8), upper right-hand contact 411 (1 to 8), resistance 413, to ground. Relays 403 and 362 become energized in this circuit. Relay 403 completes a circuit from ground through its right-hand armature and front contact, upper contact 417 (1), winding of sequence switch 410, to battery and ground. Sequence switch 410 advances from position 1 into position 2. In position 2 of sequence switch 410, relay 403 remains energized by means of a circuit from battery through its left-hand winding and front contact and left-hand armature, and upper left-hand contact 404 (1 to 4), and thence to ground as described. Relay 403 also provides a circuit for the up-drive

power magnet 418 as follows: battery, through the winding of said magnet, lower contact 417 (2), to ground at the front contact and right-hand armature of relay 403. Power magnet 418 causes the advance of the switch shaft 439 in the brush-selecting movement. For each brush-tripping position approached by the shaft 439, brush 425 engages a metallic segment of commutator 421 and a circuit is closed from battery, through the left-hand winding and front contact and left-hand armature of relay 403, upper left-hand contact 414 (1½ to 2), commutator 421, brush 425, to ground. This circuit maintains the energization of relay 403 and causes the shunting of the stepping relay 362 in the fundamental circuit.

When the stepping relay 362 is energized in series with relay 403, a circuit is completed from ground, through the lower left-hand contact 343 (1½ to 18), upper right-hand contact 343 (9), armature and contact of relay 362, conductor 378, lower left-hand contact 344 (9), conductor 383, upper right-hand contact 351 (9 to 10), upper left-hand contact 351 (9), brush 321 of the second register B, standing in position 5 for example, conductor 355, armature and back contact of number 3' counting relay 384, winding of the number 3 counting relay 385, to battery and ground. Relay 385 energizes and prepares a locking circuit for itself and relay 384, relay 361 being energized at this time by the closure of sequence switch contact 342 in position 9. For each metallic segment encountered by the brush 425, relay 362 is deenergized and a pair of counting relays are energized and locked up. When the 0' counting relay 376 is finally operated, the fundamental circuit is opened and a circuit is also completed from ground through the armature and lower contact of relay 361, right-hand armature and front contact of relay 376, conductor 382, back contact and outer armature of relay 307, winding of sequence switch 310, to battery and ground. Sequence switch 310 moves from position 9 into position 10. Relay 361 becomes deenergized as sequence switch 310 leaves position 9 and again energized in position 10 of said sequence switch. The momentary release of relay 361 permits the deenergization of the counting relays. As soon after the fundamental circuit is opened at the controlling mechanism, as the brush 425 engages an insulating segment of the commutator 421, relay 403 becomes deenergized and opens the circuit of power magnet 418. Relay 403 also completes a circuit from ground, through its right-hand armature and back contact, upper right-hand contact 405 (2), winding of sequence switch 410, to battery and ground for driving said sequence switch out of position 2 and into position 3. When se-

quence switch 410 reaches position 2, a circuit is closed from battery through the winding of relay 406, upper right-hand contact 407 (2 to 11), lower left-hand contact 407 (2), to ground. Relay 406 becomes energized and closes a locking circuit for itself, traceable from battery, through the winding of said relay, upper right-hand contact 407 (2 to 11), front contact and left-hand armature of relay 406, conductor 402, terminal 245, brush 242, lower right-hand contact 222 ($8\frac{1}{2}$ to $13\frac{1}{2}$), conductor 264, over-flow commutator 232, brush 236, to ground.

In position 10 of sequence switch 310, and position 3 of sequence switch 410, the fundamental circuit is again closed and relays 403 and 362 become energized. Relay 403 completes a circuit from ground through its right-hand armature and front contact, upper contact 417 (3), winding of sequence switch magnet 410 to battery and ground for driving sequence switch 410 out of position 3 and into position 4. Relay 403 remains energized in position 4 by means of the circuit closed from battery through its left-hand winding and front contact and left-hand armature and sequence switch contact 404. Relay 403 provides a circuit for the up-drive power magnet 418 as follows: battery, through the winding of said magnet, lower contact 417 (4), front contact and right-hand armature of relay 403 to ground. The trip magnet 420 is energized at this time by means of a circuit from battery through the winding of said magnet, lower right-hand contact 416 (3 to 4), to ground. The selected set of brushes 427, 428 and 429 are thereby tripped into engagement with the terminals of the bank. As the brush shaft 439 advances under the control of power magnet 418 in the group-selecting movement, the brush 424 successively engages the metallic segments of the group-selecting commutator 422. By this means a circuit is closed from battery through the left-hand winding and front contact and left-hand armature of relay 403, upper right-hand contact 414 ($3\frac{1}{2}$ to 4), commutator 422, brush 424 to ground. This direct circuit to ground maintains the energization of relay 403 and also causes the shunting of the stepping relay 362 in the fundamental circuit. The stepping relay 362, on energizing in series with relay 403, completes a circuit from ground, through the upper right-hand contact 304 (10), contact and armature of relay 362, upper left-hand contact 344 (10), conductor 383, upper right-hand contact 351 (9 to 10), lower left-hand contact 351 (10 to 8), brush 320 of register B standing in its fifth position, upper right-hand contact 352 (10), brush 325 of register C, standing in position 3 for example, conductor 355, armature and back contact of counting relay 384, winding of relay 385, to battery and ground. Relay 385 energizes and prepares a locking circuit in the manner well understood. For each group of terminals passed over by the brushes 427, 428 and 429 the stepping relay 362 is operated and a pair of counting relays is energized and locked up. When the counting relay 376 is finally operated, the fundamental circuit is severed at the controlling mechanism and a circuit is also completed from ground, through the armature and lower contact of relay 361, right-hand armature and front contact of relay 376, conductor 382, back contact and outer armature of relay 307, winding of sequence switch 310, to battery and ground. Sequence switch 310 advances from position 10 into position 11. In passing from position 10 to position 11, sequence switch contact 342 momentarily opens the circuit of relay 361 which by deenergizing causes the release of the counting relays. As soon as the brush 424 encounters the next insulating segment of commutator 422 after the opening of the fundamental circuit at the counting relays, relay 403 becomes deenergized and opens the circuit of the power magnet 418. Relay 403 also completes a circuit from ground, through its right-hand armature and back contact, upper right-hand contact 405 (4), winding of sequence switch 410 to battery and ground. Sequence switch 410 moves from position 4 into position 5.

In position 5 of sequence switch 410, relay 403 is energized by means of a circuit from battery through the right-hand winding of said relay, lower right-hand contact 409 (5 to $5\frac{1}{2}$), to ground. Relay 403 completes a circuit from ground, through its right-hand armature and front contact and sequence switch contact 417 for driving sequence switch 410 out of position 5 into position 6. If the first trunk in the selected group, upon the terminals of which brushes 427, 428 and 429 are now standing, is busy, relay 403 remains energized in position 6 of sequence switch 410 by means of the following circuit: battery, through the left-hand winding and front contact and left-hand armature of relay 403, upper right-hand contact 404 (5 to $6\frac{1}{2}$), test brush 429, test terminal 432 of the busy trunk and thence by way of the test brush 429 at some other selector switch, to ground at a contact corresponding to contact 416, closed in position $6\frac{1}{2}$ to $16\frac{1}{2}$. Relay 403 provides a circuit from battery through the winding of power magnet 418, lower contact 417 (6), front contact and right-hand armature of relay 403 to ground. The brush shaft 439 is, therefore, driven upward in the trunk-hunting movement. When brushes 427, 428 and 429 engage the terminals 430,

431 and 432 of an idle trunk, the circuit of relay 403 is opened since no ground potential is found on the test terminal 432. Relay 403 is held energized, however, by means of a circuit from battery through the right-hand winding of said relay, conductor 440, commutator 423, brush 426 to ground, until the brushes 427, 428 and 429 are accurately centered on the terminals of the idle trunk. At this time, brush 426 engages an insulating segment of commutator 423 and relay 403 retracts its armatures to open the circuit of the up-drive power magnet 418. Relay 403 also completes a circuit including its right-hand armature and back contact and contact 405 (6) for driving sequence switch 410 out of position 6 and into position 7. On reaching position 6½, upper contact 416 is closed to apply ground potential over the test brush 429 to the test terminal 432 of the seized trunk to render such trunk non-selectable to other switches. In position 7 of sequence switch 410 a circuit is established from battery, through the left-hand winding of relay 403, lower right-hand contact 404 (7), lower right-hand contact 414 (7 to 8), brush 427, terminal 430, conductor 500, upper left-hand contact 503 (1 to 8) of sequence switch 510, to ground. Relay 403 becomes energized and locks up in a circuit from battery through its left-hand winding and front contact and left-hand armature to ground over the circuit traced. Relay 403 closes a circuit including its right-hand armature and front contact and upper contact 417 (7), for driving sequence switch 410 into position 8.

With sequence switch 310 in position 11 and sequence switch 410 in position 8 the fundamental circuit is extended through to the final selector for controlling brush selection. This circuit may be traced from battery, through the left-hand winding of relay 505, lower right-hand contact 506 (1 to 8½) lower right-hand contact 507 (1), lower left-hand contact 504 (1 to 6), conductor 501, terminal 431, brush 428, upper left-hand contact 412 (8), conductor 401, thence over the path described, through the winding of the stepping relay 362 and returning by way of conductor 400, lower left-hand contact 411 (15 to 8), upper right-hand contact 411 (1 to 8), resistance 413 to ground. Relays 505 and 362 become energized. Relay 505 closes a circuit from ground through its right-hand armature and front contact, lower left-hand contact 512 (1), winding of sequence switch magnet 510, to battery and ground. Sequence switch 510 moves from position 1 into position 2. In position 2 of sequence switch 510, relay 505 is maintained energized by means of a circuit from battery, through the left-hand winding of said relay, lower right-hand contact 506 (1 to 8½), front contact and left-hand armature of relay 505, lower left-hand contact 504 (1 to 6), and thence to ground as described. Relay 505 provides a circuit for the high speed up-drive power magnet 514 as follows: battery, through winding of magnet 514, lower right-hand contact 512 (2), front contact and right-hand armature of relay 505 to ground. The brush shaft 531 of the final selector is driven upward in the brush-selecting operation. Each time the brush 521 encounters a metallic segment of the brush-selecting commutator 519, a circuit is closed from battery, through the left-hand winding of relay 505, lower right-hand contact 506 (1 to 8½), front contact and left-hand armature of relay 505, lower left-hand contact 504 (1 to 6), lower right-hand contact 504 (1½ to 2), commutator 519, brush 521 to ground. This circuit holds the relay 505 energized and also serves to shunt the stepping relay 362 in the fundamental circuit. When relay 362 first energizes in series with relay 505, a circuit is completed from ground, through the lower left-hand contact 343 (1½ to 18), upper right-hand contact 343 (11), armature and contact of relay 362, conductor 378, lower left-hand contact 344 (11), conductor 383, lower right-hand contact 350 (11), brush 327 of register C standing in its third position, conductor 358, armature and back contact of the number 4' counting relay, winding of the number 4 counting relay 386, to battery and ground. Relay 386 energizes and upon the first deenergization of the stepping relay 362, locks up in series with the number 4' counting relay as above explained. For each brush-tripping position assumed by the switch shaft 531, a pair of counting relays is energized and locked up. When finally the 0' counting relay 376 becomes energized, the fundamental circuit is opened and all counting relays preceding the 0 counting relays are released. Relay 376 also completes a circuit from ground through the armature and lower contact of relay 361, right-hand armature and front contact of relay 376, conductor 382, back contact and outer armature of relay 307, winding of sequence switch magnet 310, to battery and ground. Sequence switch 310 advances into position 12. In passing from position 11 to position 12 the contact 342 opens to permit the momentary release of relay 361. The relay 361 permits the release of the 0 and 0' counting relays.

As soon after the fundamental circuit is opened at the 0' counting relay, as the brush 521 engages an insulating segment of the commutator 519, relay 505 becomes deenergized and opens the operating circuit of the power magnet 514. Relay 505 also completes a circuit from ground, through its right-hand armature and back contact, contact 511 (2), winding of sequence switch

magnet 510, to battery and ground for driving sequence switch 510 out of position 2 and into position 3. In position 3 of sequence switch 510 a circuit is completed from battery through the winding of the trip magnet 517, upper right-hand contact 513 (3 to 4), to ground. Magnet 517 operates to trip the selected set of brushes 524, 525 and 526.

With sequence switch 310 in position 12 and sequence switch 510 in position 3, the fundamental circuit is again closed in the manner described, and relays 505 and 362 become energized. Relay 505 locks up over its left-hand armature and front contact, as explained, and also provides a circuit including its right-hand armature and front contact and contact 512 (3) for driving sequence switch 510 out of position 3 and into position 4. In position 4 of sequence switch 510, the high speed up-drive power magnet 514 is again energized to cause the advance of the shaft 531 in the group-selecting movement of the switch. For each metallic segment of the group-selecting commutator 520, encountered by the brush 522, a circuit is closed from battery through the left-hand winding of relay 505, lower right-hand contact 506 (1 to 8 $\frac{1}{2}$), lower left-hand contact 506 (3 $\frac{1}{2}$ to 4), commutator 520, brush 522, to ground. This circuit maintains the energization of relay 505 and at the same time causes the shunting of the stepping relay 362 in the fundamental circuit. Relay 362 on first energizing in position 12 of sequence switch 310, completes a circuit from ground through the upper right-hand contact 304 (12), contact and armature of relay 362, upper left-hand contact 344 (12), conductor 383, upper left-hand contact 350 (12), brush 329 of register D, standing in position 3 for example, conductor 354, winding of the 0 counting relay 381, to battery and ground. Relay 381 is energized and upon the first shunting of relay 362, relays 381 and 376 lock up in series with each other. Relay 376 opens the fundamental circuit and at the same time completes the circuit already described for advancing sequence switch 310 out of position 12 and into position 13. In passing from position 12 to position 13 contact 342 opens to permit the momentary deenergization of relay 361 which in turn opens the holding circuit of the 0 and 0' counting relays. As soon after the fundamental circuit has been opened at the controlling mechanism, as brush 522 engages an insulating portion of commutator 520, relay 505 is deenergized to open the operating circuit of the power magnet 514. Relay 505 also completes a circuit including its right-hand armature and back contact and contact 511 (4), for driving sequence switch 510 into position 5.

In position 5 of sequence switch 510 the fundamental circuit is closed for the final or units selection and relays 505 and 362 become energized. Relay 505 causes the advance of sequence switch 510 from position 5 into position 6, as explained. In position 6 of sequence switch 510 a circuit is closed for the low speed up-drive power magnet 515 from battery, through the winding of said magnet, upper right-hand contact 512 (6), to ground at the front contact and right-hand armature of relay 505. Brushes 524, 525 and 526 are thereby driven at low speed over the terminals of the selected group of ten lines. For each set of terminals engaged, the brush 521 makes contact with the metallic segment of the commutator 519, whereby a circuit is closed from battery through the left-hand winding of relay 505, lower right-hand contact 506 (1 to 8 $\frac{1}{2}$), front contact and left-hand armature of relay 505, lower left-hand contact 504 (1 to 6), lower right-hand contact 504 (5 $\frac{1}{2}$ to 6), commutator 519, brush 521, to ground. This circuit maintains the energization of relay 505 and causes the shunting of the stepping relay 362 in the fundamental circuit. When the stepping relay 362 first becomes energized in position 13 of sequence switch 310, a circuit is completed from ground through the lower left-hand contact 343 (1 $\frac{1}{2}$ to 18), upper right-hand contact 343 (13), armature and contact of relay 362, conductor 378, lower left-hand contact 344 (13), conductor 383, upper right-hand contact 350 (13), brush 332 of the register E, standing in its third position for example, conductor 354, winding of the 0 counting relay 381, to battery and ground. Upon the first shunting of the stepping relay 362, relays 381 and 376 lock up in series with each other and the fundamental circuit is opened. Relay 376 also completes the above-described circuit for advancing sequence switch 310 out of position 13. Contact 342 opens on leaving position 13 and relay 361 and the 0 counting relays become deenergized. As soon after the fundamental circuit is opened at the controlling mechanism, as the brushes 524, 525 and 526 are accurately centered upon the terminals 527, 528 and 529 of the called line, brush 521 moves upon an insulated segment of commutator 519 and relay 505 is deenergized. Relay 505 opens the circuit of the up-drive power magnet 515 and completes a circuit including its right-hand armature and back contact and contact 511 (6), for driving sequence switch 510 into position 7. Before continuing with the operations involved in testing the called line and applying ringing current thereto for signaling the called substation, a description will be given of the release of the register-controlling mechanism, and the manner in which sequence switch 210 of the first group selector advances to prepare the talking circuit at such selector in response to the

release of the register-controlling mechanism.

The units selection having been completed, sequence switch 310 is driven out of position 13 as explained. In leaving position 13, contact 339 opens the holding circuits of relays 303 and 202. Relay 202 deenergizes and closes a circuit from ground through its right-hand armature and back contact, upper contact 205 (8 to 10), winding of sequence switch magnet 210, to battery and ground. Sequence switch 210 leaves position 10 and advances into position 12. Before sequence switch 210 can reach position 12, however, sequence switch 310 at the register-controlling mechanism will have reached position 13½ to close the following circuit: battery, through resistance 309, lower left-hand contact 308 (1½ to 18½), inner left-hand armature and contact of relay 364, lower left-hand contact 371 (13½ to 18½) to ground. This direct circuit to ground shunts out the relay 211 which, up to this time, has been maintained energized in the circuit traced over conductor 372. Relay 211 consequently deenergizes and closes the following circuit for relay 215 in series with the calling line: battery, through the left-hand winding of relay 215, upper contact 218 (10½ to 13½), contact 266, conductor 201, thence over the loop of the calling line and returning by way of conductor 200, contact 267, contact 217 (10 to 13½), right-hand winding of relay 215 to ground. Relay 215 energizes and sequence switch 210, on later reaching position 12, comes to rest.

Relay 211, by retracting its right-hand armatures, opens the circuit of impulse relay 300. Relay 300 deenergizes and after a short interval the slow-to-release relay 301 retracts its armatures. When sequence switch 310 reaches position 18, a circuit is completed from battery through the winding of relay 306, make-before-break contact of relay 301, lower left-hand contact 304, (3 to 18) to ground. Since the brushes of the side switch F are in engagement with the first position contacts on the right-hand side of the bank, a circuit is now completed for the restoration to normal of the first register A. This circuit may be traced from battery, through the winding of stepping magnet 311, brush 334, standing in its first restoring position, winding of relay 302, left-hand armature and front contact of relay 306, brush 335, first restoring position, conductor 387, brush 316, armature and contact of stepping magnet 311 to ground. Relay 302 and magnet 311 energize in this circuit. Relay 302 closes the above-traced circuit for stepping magnet 305 of the side switch. The stepping magnet 311 opens its own circuit, deenergizes and advances the brushes of the register A one position. The

magnet 311, on deenergizing, completes its own circuit whereupon it again operates to advance the brushes another step. During the interruptions of the circuit of magnet 311, relay 302 remains energized to maintain the energization of the side switch stepping magnet 305. When the register has been completely restored to its normal position the brush 316 moves off the last terminal in the bank and the circuit of magnet 311 and relay 302 is permanently opened. After an interval relay 302 deenergizes and the stepping magnet 305 in turn operates to advance the brushes of the side switch to the second restoring position. In this position of the side switch, a circuit is completed from battery through the winding of stepping magnet 312 of register B, brush 334, second restoring position, winding of relay 302, left-hand armature and front contact of relay 306, brush 335, second restoring position, conductor 388, upper left-hand contact 352 (11 to 8), brush 320, position 5, lower left-hand contact 351 (10 to 8), lower right-hand contact 351 (11 to 18), armature and contact of magnet 312 to ground. Magnet 312 and relay 302 become energized. Magnet 312 interrupts its own circuit and advances the brushes of the second register B one position forward. The circuit for magnet 312 is now closed from battery through the winding of said magnet, brush 334, second restoring position, winding of relay 302, left-hand armature and front contact of relay 306, brush 335, second restoring position, conductor 388, brush 320, position 6, lower left-hand contact 351 (10 to 8), lower right-hand contact 351 (11 to 18), armature and contact of magnet 321 to ground. Magnet 312 again energizes and interrupts its own circuit to advance the brushes of the register another position. In this manner the second register B is restored to its normal position at which time relay 302 deenergizes to permit the release of magnet 305. The side switch is thereby advanced to its third restoring position. In a similar manner the three remaining registers, C, D and E, are returned to their normal positions at which time the brushes of the side switch will have reached their normal positions, as shown in the drawing. A circuit is now completed from battery through the winding of sequence switch magnet 310, upper left-hand contact 346 (18), brush 337 and its normally positioned contact to ground. Sequence switch 310 moves into position 1, thus completing the restoration of the register-controlling mechanism to its normal condition.

Returning now to the point at which the units selection had been completed at the final switch, a description will be given of the testing and ringing operations. When sequence switch 310 reaches position 7, a cir-

cuit is completed from battery, through the right-hand winding of relay 505, resistance 532, lower contact 509 (7), to ground. Relay 505 becomes energized and closes a circuit including its right-hand armature and front contact and contact 512 for driving sequence switch 510 into position 8. Assuming the called line 530 to be idle at this time, relay 505 immediately deenergizes as soon as sequence switch 510 leaves position 7. In position 8 of sequence switch 510 a circuit is closed by way of contact 533 (8), for driving said sequence switch into position 9. A circuit is then completed from ground, through the right-hand armature and back contact of relay 505, contact 511 (9 to 17), winding of sequence switch magnet 510 to battery and ground. Sequence switch 510 leaves position 9. On reaching position 12, contact 509 bottom is closed and relay 505 attracts its armatures. At its right-hand armature and back contact, said relay opens the circuit of sequence switch magnet 510, causing said sequence switch to stop in position 13. Relay 505 remains energized in position 13 by means of a circuit from battery through the left-hand winding of said relay, lower right-hand contact 506 ($10\frac{1}{4}$ to 16), front contact and left-hand armature of relay 505, upper left-hand contact 507 ($10\frac{1}{4}$ to $13\frac{1}{2}$), conductor 502, terminal 432, brush 429, upper right-hand contact 416 ($6\frac{3}{4}$ to $16\frac{1}{4}$), to ground.

As sequence switch 510 leaves position 8, the upper left-hand contact 503 is opened and relay 403 becomes deenergized. Relay 403 completes a circuit from ground through its right-hand armature and back contact and right-hand contact 405 (8), for driving sequence switch 410 out of position 8, through position 11 and into position 12. Sequence switch 410, on leaving position 11, opens the original holding circuit of relay 406 at the upper right-hand contact 407. Relay 406, however, remains energized by means of a circuit from battery through the winding of said relay, armature and contact of relay 408, lower right-hand contact 407 (11 to 15), front contact and left-hand armature of relay 406, conductor 402, and thence to ground.

In position 12 of sequence switch 410, ringing current is supplied to the called subscriber's line. The circuit for the application of ringing current may be traced from the ringing source 434, contact 433 (12 to 14), winding of relay 408, front contact and inner right-hand armature of relay 406, lower contact 412 (12 to 15), brush 428, terminal 431, conductor 501, upper right-hand contact 504 (13 to 17), brush 525, terminal 528, over the loop of the called substation 530, terminal 527, brush 524, lower right-hand contact 503 (13 to 17), conductor 500, terminal 430, brush 427, lower right-

hand contact 411 (12 to 16), upper left-hand contact 411 (12 to 15), to ground. The response of the called subscriber, by removing his receiver from the switchhook, decreases the resistance of the ringing circuit in the well-known manner to permit the energization of relay 408. Relay 408 opens the circuit of relay 406 which, in turn, completes a circuit from ground through its outer right-hand armature and contact, left-hand contact 405 (3 to 17), winding of sequence switch 410, to battery and ground. Sequence switch 410, leaves position 12 and on reaching position 15, closes the following circuit: battery, through the winding of relay 406, upper right-hand contact 407 (15 to 17), lower left-hand contact 407 (15), to ground. Relay 406 energizes and locks up over its left-hand armature and front contact to the grounded conductor 402. Relay 406 at its outer right-hand armature opens the driving circuit of sequence switch 410, permitting said sequence switch to stop in position 16.

Since the called subscriber has answered, a circuit is now closed for the energization of relay 216 in series with the called line. This circuit may be traced from battery, through the left-hand winding of relay 216, upper left-hand contact 220 ($10\frac{3}{4}$ to 8), upper right-hand contact 220 (10 to 13), brush 241, terminal 244, conductor 401, upper left-hand contact 412 (15 to 16), brush 428, terminal 431, thence over the loop of the called line circuit as explained in connection with the application of ringing current, and returning by way of terminal 430, brush 427, lower right-hand contact 411 (12 to 16), lower left-hand contact 411 (15 to 8), conductor 400, terminal 243, brush 240, lower right-hand contact 219 (10 to 6), lower left-hand contact 219 ($10\frac{3}{4}$ to 13), right-hand winding of relay 216, to ground. Relay 216 becomes energized and completes a circuit from ground through its armature and front contact, left-hand contacts 221 (12), winding of sequence switch magnet 210, to battery and ground. Sequence switch 210 thereupon advances into position 13 which is the talking position. A complete talking connection is now established between the calling and called subscribers' lines. Talking current is fed to the calling line through the windings of relay 215 and to the called line through the windings of relay 216.

After the conversation has been completed, the calling subscriber, by replacing his receiver on the switch-hook, causes the deenergization of relay 215. Relay 215 completes a circuit from ground through its armature and back contact, upper left-hand contact 212 (12 to 17), lower right-hand contact 212 (13), conductor 268, winding of sequence switch magnet 210 to battery and

ground. Sequence switch 210 moves from position 13 into position 14. A circuit is thereupon closed from ground through the right-hand armature and back contact of relay 202 and upper contact 205 (14), for driving sequence switch 210 out of position 14 and into position 15. In position 15 a circuit is completed from battery, through the left-hand winding of relay 202, lower left-hand contact 206 (15 to 16), upper right-hand contact 212 (15 to 2), upper left-hand contact 212 (12 to 17), back contact and armature of relay 215 to ground. Relay 202 energizes and completes a circuit including its right-hand armature and front contact and contact 205 for driving sequence switch 210 into position 17. In position 17, relay 202 becomes deenergized and completes a circuit by way of its right-hand armature and back contact and upper contact 205 for moving sequence switch into 18. A circuit is now established from battery through the winding of the down-drive power magnet 226, lower right-hand contact 223 (18), to ground. The power magnet 226 operates to restore the brush shaft 259 to its normal position, in which position a circuit is completed from battery, through the winding of sequence switch magnet 210, lower contact 228 (5 to 18) segment 238, brush 234 to ground. Sequence switch 210 thereupon moves into its normal position 1. When sequence switch contact 207 leaves position 17, the holding circuit of relay 118 and the cut-off relay 103 is opened to permit the release of these relays. The line relay 102 is thereby placed under the control of a subscriber's line 100 so that further calls may be initiated. As soon as sequence switch contact 207 leaves position 18 the busy ground is removed from test terminal 128, so that the trunk leading to the first group selector switch may be taken for use in connection with other calls.

When sequence switch 210 leaves position 13½ the lower right-hand contact 222 is opened to break the holding circuit of relay 406 at the second group selector. Relay 406 releases its armatures and completes a circuit including contact 405 for driving sequence switch 410 out of position 16, through position 17 and into position 18. In position 18 of sequence switch 410 a circuit is closed from battery, through the windings of the down-drive power magnet 419, lower left-hand contact 416 (18) to ground. The brush shaft 439 is restored to its normal position under the control of power magnet 419. The brush shaft having reached its normal position a circuit is closed from battery through the winding of sequence switch magnet 410, lower contact 415 (3 to 18), segment 435, brush 424, to ground. Sequence switch 410 thereby moves from position 18 into its normal position 1.

Sequence switch 410 on leaving position 16½ opens the upper contact 416 to permit the deenergization of relay 505 at the final selector switch. Relay 505 completes a circuit from ground, through its right-hand armature and back contact and contact 511 (9 to 17), winding of sequence switch magnet 510 to battery and ground. Sequence switch 510 moves from position 13, over positions 15 and 17, and into position 18. In this position a circuit is completed from battery, through the winding of the down-drive power magnet 516, lower right-hand contact 513 (18), to ground. The brush shaft 531 of the final selector switch is restored to its normal position under the control of the power magnet 516. In the normal position of the final selector switch a circuit is completed from battery through the winding of sequence switch magnet 510, lower contact 518 (12 to 18), segment 523, brush 522, to ground. Sequence switch 510 advances from position 18 into its normal position 1. All apparatus is now completely restored to its normal condition.

It will now be assumed that the called line 530 is busy at the time the units selection is completed at the final switch. At the end of the units selection, the sequence switch 510 advances from position 6 into position 7 in the manner hereinbefore described. In position 7, relay 505 energizes over its right-hand winding and lower contact 509. Since the called line is busy at this time a holding circuit is closed for relay 505, traceable from battery, through the left-hand winding of said relay, lower right-hand contact 506 (1 to 8½), front contact and left-hand armature of relay 505, upper right-hand contact 507 (7 to 9½), test brush 526, test terminal 529, thence by way of the test brush 526 at some other final selector switch, to ground at a contact corresponding to contact 513 closed in position 9½ to 16½. Sequence switch 510 advances through positions 7 and 8 in the manner explained. Upon leaving position 8½ the lower contact 506 is opened to sever the circuit traced for the left-hand winding of relay 505. The upper contact 509, however, closes in position 8½ prior to the opening of contact 506 in position 8½. Relay 505, therefore, remains energized by means of a circuit from battery through the right-hand winding of said relay, resistance 532, upper contact 509 (8½ to 10), front contact and right-hand armature of relay 505 to ground. Sequence switch 510 is therefore arrested in position 9. In this position the brush shaft 531 is restored to its normal position under the control of the down-drive power magnet 516. A circuit for this magnet may be traced from battery through the winding of said magnet, upper left-hand contact 512 (9), front contact and right-hand armature of relay 505 to ground. When the brush

shaft is in its normal position, a circuit is closed from battery through the winding of sequence switch magnet 510, lower contact 518 (3 to 9), segment 523, brush 522, to
 5 ground. Sequence switch 510 moves out of position 9 and into position 11. On leaving position 10, upper contact 509 is opened to permit the release of relay 505. Relay 505 completes a circuit including its right-hand
 10 armature and back contact and contact 511 (9 to 17), for driving sequence switch 510 into position 18. In position 18 the sequence switch 510 is energized by means of a circuit including contact 518, segment 523, and
 15 brush 522, for driving said sequence switch into position 1.

It will be observed that since the called line is found busy the sequence switch 510 is arrested in position 9 where it awaits the
 20 restoration of the final selector switch. When sequence switch 510 leaves position 8 the relay 403 at the second group selector deenergizes in the manner hereinbefore described. Sequence switch 410, therefore,
 25 leaves position 8. As sequence switch 410 passes through position 10 a circuit is closed from battery through the left-hand winding of relay 403, lower right-hand contact 404 (10), lower right-hand contact 414 (10 to
 30 11), brush 427, terminal 430, conductor 500, upper right-hand contact 508 (9 to 10½), to ground. The upper right-hand contact 508 will be closed at this time since the sequence switch 510 is waiting in position 9 for the
 35 final selector switch to release. Hence relay 403 attracts its armatures. Sequence switch 410, on arriving in position 11, comes to rest. In position 11 of sequence switch 410, a circuit is closed by way of contacts 436 and 437,
 40 condensers 441 and 442, and conductors 401 and 400 for applying a busy tone from the coil 438 to the calling subscriber's line. When the final selector switch has been restored, sequence switch 510 passes out of
 45 position 10½ and relay 403 deenergizes and completes the circuit already described for moving sequence switch 410 out of position 11 and into position 12.

The calling subscriber, on hearing the
 50 characteristic tone, knows that the called line is busy and replaces his receiver to the switchhook. From this point on release of the connection takes place in the manner above explained.

The case will next be considered in which
 55 the first group selector switch, after having performed the brush and group-selecting operations under the control of the register mechanism, finds all trunks in the selected
 60 group busy in its trunk-hunting operation. According to the principles of this invention, means are provided whereby, in such a case, the group selector switch is restored to its normal position automatically and the
 65 register-controlling mechanism is again

placed in condition for controlling the said switch in a further attempt to establish the desired connection, without disturbing the positioned registers or without interfering with the regular setting of such registers as
 70 may not have been positioned at this time. If, during the trunk-hunting movement of the first group selector switch in position 8 of sequence switch 210, all trunks in the
 75 group are busy, the brushes 240, 241 and 242 move to the overflow position and brush 236 engages an insulating segment 233 of the overflow commutator 232. Relay 202 deenergizes as soon as test brush 242 leaves the
 80 test terminal 245 of the last busy trunk in the group. Relay 202 completes a circuit from ground through its right-hand armature and back contact and upper contact 205 (8 to 10) for moving sequence switch 210
 85 out of position 8. In passing through position 8½, upper right-hand sequence switch contact 213 is closed, but relay 303 fails to energize at this time since the brush 236 is standing on an insulating segment 233 of commutator 232. Consequently relay 202
 90 does not energize when sequence switch 210 later reaches position 9¾. Therefore, sequence switch 210 continues to advance through position 10 and into position 12. Since relay 303 does not energize while sequence switch 210 is passing through position 8½, the sequence switch 310 of the controlling mechanism remains in position 7
 95 where it was driven immediately following the end of the group selection of the first group selector switch. When sequence switch 210 reaches position 12, relay 211 is still energized owing to the fact that sequence switch 310 has not left position 7. Relay 215 which normally energizes in series
 100 with the calling line upon the deenergization of relay 211, now remains inoperative and a circuit is completed from battery through the left-hand winding of relay 204, lower left-hand contact 212 (12), upper left-hand
 105 contact 212 (12 to 17), back contact and armature of relay 215 to ground. Relay 204 becomes energized and locks up in a circuit from battery through its left-hand winding and inner left-hand armature and upper
 115 left-hand contact 207 (12 to 17), to ground. Relay 204 completes a circuit from battery through the winding of sequence switch magnet 210, conductor 268, right-hand armature and contact of relay 204, upper
 120 right-hand contact 207 (12 to 13), to ground. Sequence switch 210 moves over position 13 into position 14. A circuit is then closed from ground through the right-hand armature and back contact of relay
 125 202 and upper contact 205 (14), for driving sequence switch 210 into position 15. In position 15 of sequence switch 210, a circuit is established from battery through the left-hand winding of relay 202, lower left-hand
 130

contact 206 (15 to 16), upper right-hand contact 212 (15 to 2), upper left-hand contact 212 (12 to 17), back contact and armature of relay 215 to ground. Relay 202 energizes and completes a circuit from ground through its right-hand armature and front contact, lower contact 205 (15), winding of sequence switch magnet 210 to battery and ground. Sequence switch 210 moves into position 17 and relay 202 deenergizes.

As sequence switch 210 reaches position 15½ a circuit is established from battery, through the left-hand winding of relay 215, lower contact 218 (15½ to 2), contact and outer left-hand armature of relay 211, lower right-hand contact 207 (1½ to 17), to ground. Relay 215 becomes energized and closes a holding circuit for itself from battery, through its left-hand winding, lower contact 218, (15½ to 2), contact and outer left-hand armature of relay 211, to ground at the front contact and armature of relay 215. Relay 202 being deenergized in position 17 of sequence switch 210, a circuit is closed including the right-hand armature and back contact of said relay and upper contact 205 (17), for driving sequence switch 210 out of position 17 and into position 18. In position 18, the brush shaft 259 of the first group selector switch is restored to its normal position in the manner hereinbefore described and sequence switch 210 is driven from position 18 into position 1. When sequence switch 210 reaches position 18 a circuit is completed from battery, through the left-hand winding of relay 216, upper left-hand contact 220 (10½ to 8), lower right-hand contact 220 (18 to 8), contact and outer left-hand armature of relay 211, to ground at the front contact and armature of relay 215. Relay 216 becomes energized in this circuit.

When sequence switch 210 leaves position 17, the lower right-hand contact 207 is opened, but a ground potential is applied to conductor 254 at this time over the front contact and armature of relay 215, thereby maintaining the energization of relays 103 and 118. As sequence switch 210 leaves position 17 the circuit of relay 204 is opened at the upper left-hand contact 207. Relay 204, however, immediately energizes again in position 18 of sequence switch 210 by means of a circuit from battery through the left-hand winding of said relay, lower left-hand contact 212 (18 to 2), upper right-hand contact 212 (15 to 2), front contact and armature of relay 216 to ground.

Since relay 204 is now energized in position 1 of sequence switch 210 a circuit is closed from battery through the winding of said sequence switch, conductor 268, right-hand armature and contact of relay 204, upper right-hand contact 207 (1) to ground. Sequence switch 210 thereupon moves into

position 2. In position 2, relay 202 being deenergized, a circuit is closed from ground through the right-hand armature and contact of said relay and upper contact 205, for driving sequence switch 210 into position 3. In position 3 of sequence switch 210, the holding circuits of relays 215, 216 and 204 are opened to permit the deenergization of these relays. During the time that sequence switch 210 was passing from position 18 to position 2, ground potential was maintained on conductor 252 at the outer left-hand armature and front contact of relay 204 to render the test terminal 128 busy.

As above explained the sequence switch 310 of the register-controlling mechanism advances into position 7 immediately following the group-selecting operation at the first group selector switch. As soon after the arrival of sequence switch 310 into position 7, as the pick-up interrupter 367 of the timing device shown at the left of Fig. 3, advances its metallic segment into engagement with the cooperating brush, a circuit is completed including lower contact 365 (7), for energizing relay 366. Relay 366 attracts its armatures and locks up in a circuit including its left-hand armature and contact and the contacts 365. Shortly following the closure of the pick-up interrupter 367, the interrupter 370 makes engagement with its cooperating brush and a circuit is closed from battery through the right-hand winding of relay 363, upper contact 389 (7), to ground at interrupter 370. Relay 363 locks up in a circuit from battery through its left-hand winding and contact and inner armature, upper left-hand contact 371 (7), to ground. After the elapse of a definite interval following the energization of relay 363, one of the metallic segments of the interrupter 368 makes engagement with its brush. A circuit is then closed from battery, through the interrupter 368, right-hand armature and contact of relay 366, left-hand winding of relay 364, contact and outer armature of relay 363, upper right-hand contact 371 (7), to ground. Relay 364 locks up in a circuit from battery through its right-hand winding and contact and armature, upper left contact 342 (5 to 15), right-hand armature and contact of relay 301, lower left contact 304 (3 to 13) to ground contact. When relay 364 becomes energized, a circuit is closed from battery through the winding of sequence switch magnet 310, front contact and outer left-hand armature of relay 364, lower right-hand contact 371 (7 to 4), to ground. Sequence switch 310 leaves position 7 and continues to rotate until it reaches position 5. It will be recalled that in the regular operation of the system sequence switch 310, in reaching position 13½, closes its lower left-hand contact 371 to shunt the relay 211 in

the trunk circuit. In the present case, however, this shunting circuit is maintained open at the inner left-hand armature and contact of relay 364. Hence the relay 211 remains energized and the calling line remains connected in series with the windings of relay 300 during the time that sequence switch 310 is moving from position 7 around to position 5. During this period, the calling subscriber may be sending impulses without interference to cause the positioning of the registers C, D and E. As sequence switch 310 leaves position 7, relays 366 and 363 deenergize, and on leaving position 4 relay 364 becomes deenergized. It will be seen that by the arrangement described, the sequence switch 210 has been returned to position 3 and sequence switch 310 to position 5 without releasing the connection of the calling line and without disturbing such of the registers as have been positioned at this time. With the group selector released and with sequence switches 210 and 310 in these positions, the apparatus is in the same condition as it was at the time brush selection was first undertaken. The fundamental circuit is, therefore, closed again and brush and group selection take place in the manner described, following which the trunk-hunting operation takes place in a second attempt to extend the calling line to an idle trunk. If an idle trunk is located during the second operation of the switch, the establishment of the connection proceeds in the manner specifically described. If, however, all trunks in the group are again found to be busy, the switch is released and after the lapse of the necessary time interval, is again operated and so on, so long as the calling subscriber retains his receiver off the switchhook.

It will next be assumed that the first group selector succeeds in extending the calling line over an idle trunk, such as 400 and 401, but that the second group selector, in performing its trunk-hunting operation, finds all trunks in the selected group engaged. It will be recalled that sequence switch 410 is standing in position 6 and that relay 403 is energized dependent upon the presence of ground potential on test terminals 432 during the trunk-hunting movement of the second group selector switch. Since all trunks in the group are found busy, the brushes 427, 428 and 429 advance to the overflow position and relay 403 deenergizes. Relay 403 closes a circuit including its right-hand armature and back contact and right-hand contact 405 (6) for driving sequence switch 410 out of position 6 and into position 7. Relay 403 is not energized, as explained, in position 7 since the brush 427 is standing on an ungrounded overflow terminal. Therefore, sequence switch 410 remains in position 7.

It will also be recalled that sequence switch 310 of the register-controlling mechanism, passed into position 11 immediately following the group-selecting operation of the second group selector. As soon thereafter as interrupter 367 closes on its metallic segment, relay 366 is energized by means of a circuit including contacts 365 (11). Relay 366 attracts its armatures and locks up independent of the interrupter 367. After a definite time interval has elapsed following the energization of relay 366, the metallic segment of interrupter 369 makes engagement with its cooperating brush and closes a circuit including lower contact 389 (11), for the energization of relay 363. Relay 363 locks up in a circuit through its left-hand winding and inner armature and contact to ground at upper left-hand contact 371 (11). At the end of a definite interval following the energization of relay 363 one of the metallic segments of interrupter 368 engages its cooperating brush and a circuit is completed from battery through interrupter 368, right-hand armature and contact of relay 366, left-hand winding of relay 364, contact and outer armature of relay 363, upper right-hand contact of relay 371 (11), to ground. Relay 364 operates and locks up in a circuit from battery through its right-hand winding and contact and right-hand armature to ground at lower-left contact 304 (3 to 18). In the manner already described, relay 364 completes a circuit for driving sequence switch 310 out of position 11 and on into position 5, and at the same time opens the circuit which normally serves to shunt relay 211. When sequence switch 310 leaves position 11 it opens the circuit of relay 303 which is at this time energized in multiple with the relay 202 at the first group selector. Contact 339, in leaving position 13, also opens the circuit of relay 202 which deenergizes and closes a circuit from ground over its right-hand armature and back contact and upper contact 205 (10) for driving sequence switch 210 out of position 10 and into position 12. In position 12, since relay 211 remains energized, relay 215 remains deenergized and consequently the above-traced circuit for relay 204 is closed. Sequence switch 210 thereupon advances out of position 12, through position 13 and into position 14. From this point on the advance of sequence switch 310 into position 18, the release of the first group selector and the subsequent advance of sequence switch 210 into position 3, takes place in the manner hereinbefore described.

As sequence switch 210 leaves position 13 the lower right-hand contact 222 is opened to permit the deenergization of relay 406 at the second group selector. Relay 406 completes a circuit including its outer right-hand armature and contact and left-hand

contact 405 for driving sequence switch 410 out of position 7. Sequence switch 410 continues to advance until it reaches position 18. In passing through position 15, relay 406 is momentarily energized, but sequence switch 410, continuing to advance under the control of its master contact into position 16, opens the temporary energizing circuit of relay 406. This relay thereupon deenergizes and closes the above-traced circuit which drives sequence switch 410 out of position 16 and into position 18. In position 18 of sequence switch 410, the second group selector is released and said sequence switch thereupon returns to its normal position 1. The group selector switches are operated again in accordance with the setting of the controlling registers to make another trial in obtaining a through connection.

In the event that the calling subscriber abandons the call at any time after a register-controlling mechanism has been seized and associated with his line, means is provided to insure the restoration of the controlling mechanism. The calling subscriber, by hanging up his receiver at any time after sequence switch 310 has reached position 3, causes the release of relay 301 which in turn completes a circuit from ground, through the lower left-hand contact 304 (3 to 18), make-before-break contact of relay 301, winding of relay 306, to battery and ground. Relay 306 completes a circuit from battery through the winding of sequence switch magnet 310, conductor 373, inner right-hand armature and back contact of relay 303, inner right-hand armature and contact of relay 306, upper right-hand contact 347 (3 to 13), to ground. Sequence switch 310 is thereby driven into position 18 where the release of all positioned registers takes place.

In case the calling subscriber should abandon the call by hanging up his receiver on the switchhook at a time after the sender sequence switch 310 has reached position 7 and was in such position or in some position thereafter, release of the apparatus takes place in a manner somewhat different from that above explained, where it was assumed that abandonment took place with the sequence switch 310 in a position later than position 3 but earlier than position 7. It will be recalled that as soon as sequence switch 310 passes into position 7, the relay 303 becomes operated due to the forward movement of sequence switch 210 at this time and locks over the lower contacts 339 which remain closed until sequence switch 310 leaves position 13. With relay 303 operated, the release circuit for the sequence switch 310 hereinbefore traced is held open. Therefore, a substitute circuit must be provided to permit the sequence switch to restore when abandonment takes place after said sequence switch has

passed into position 7 and relay 303 has become energized.

Consider, for example, that abandonment occurs at a time when sequence switch 310 is in position 9 and when the selection to which this position of the sequence switch corresponds is in progress. Upon restoration of the subscriber's receiver to the switchhook, the relay 300 becomes deenergized and shortly thereafter the slow-to-release relay 301 retracts its armature. With relay 301 deenergized, the previously traced circuit of relay 306 is established and this relay becomes energized. Nothing happens, however, until all of the counting relays, which are now in progress of operation, have been energized marking the completion of the selection. As soon as the No. 0 counting relay 381 becomes operated, a circuit is completed from battery through the winding and armature and contact of this relay, thence to the winding of relay 391, outer right armature and contact of relay 303, innermost right armature and contact of relay 306, upper right contact 347 (3 to 13) to ground. Relay 391 energizes and a circuit is closed from ground through its contact and armature, conductor 373, winding of sequence switch magnet 310, to battery. Sequence switch 310 leaves position 9 and instead of stopping in position 10, as it normally would, it continues to rotate until it reaches position 18. As the sequence switch leaves position 13, relay 303 becomes deenergized and opens the circuit of relay 391 and relay 381. In position 18 of the sequence switch, the registers are restored to their normal position in the manner hereinbefore described.

What is claimed is:

1. In a telephone system, a telephone line, a selective switch, a controlling mechanism including a multi-position register, impulse sending means for advancing said register to one of its set positions, means controlled in accordance with the set position of said register for operating the selective switch to extend said telephone line, means for releasing said switch, and means for again operating said switch in accordance with the original setting of said register.

2. In a telephone system, a subscriber's line, a selective switch, a controlling mechanism including a multi-position register, means for sending series of impulses over the subscriber's line to variably set said register, means controlled in accordance with the set position of said register for operating the selective switch to extend said line, means for releasing said switch, and means for again operating said switch in accordance with the original setting of said register.

3. In a telephone system, a telephone line, a group of trunks, a selective switch

for connecting the telephone line to said trunks, a controlling mechanism including a multi-position register, impulse sending means for variably setting said register, means controlled in accordance with the set position of said register for operating said switch, means for automatically releasing said switch when all the trunks of said group are busy, and means for again operating said switch in accordance with the original setting of said register.

4. In a telephone system, a telephone line, a plurality of groups of trunks, a selective switch for connecting the telephone line to said trunks, a controlling mechanism including a multi-position register, impulse sending means for variably setting said register, means controlled in accordance with the set position of said register for operating the selective switch to select one of said groups of trunks, means for operating said switch to hunt for an idle trunk in the group, means operative when all trunks of the group are busy for releasing said switch, and means for again operating said switch in accordance with the original setting of said register.

5. In a telephone system, a telephone line, a selective switch, a controlling mechanism including a multi-position register, means for variably setting said register, means controlled in accordance with the set position of said register for operating said switch to extend the telephone line, means for releasing said switch, and means effective after the lapse of a definite time interval following the operation of said switch for again operating said switch in accordance with the original setting of said register.

6. In a telephone line, a group of trunks, a selective switch for connecting the telephone line to said trunks, a controlling mechanism including a multi-position register, means for variably setting said register, means controlled in accordance with the set position of said register for operating said switch, means for automatically releasing said switch when all trunks in said group are busy, and means effective after the lapse of a definite time interval following the operation of said switch for again operating said switch in accordance with the original setting of said register.

7. In a telephone system, a telephone line, a selective switch, a controlling mechanism including a multi-position register, means for setting said register, means controlled in accordance with the setting of said register for operating said switch to extend the telephone line, means for releasing said switch, a timing device, and means responsive to said timing device for again operating said switch in accordance with the original setting of said register.

8. In a telephone system, a telephone line, a plurality of groups of trunks, a selective switch for connecting said line to said trunks, a controlling mechanism including a register, means for variably setting said register, means controlled in accordance with the setting of said register for operating said switch to select one of said trunk groups, means for operating said switch to hunt for an idle trunk in the group, means for releasing said switch when all trunks of the group are busy, a timing device, means for rendering said device effective upon the completion of the group selecting operation of said switch, and means operated by said device after the lapse of a predetermined interval for causing said switch to again be operated in accordance with the original setting of said register.

9. In a telephone system, a subscriber's line, a plurality of selective switches, a controlling mechanism including a plurality of multi-position registers, impulse sending means for variably setting said registers, means controlled in accordance with the set positions of said registers for operating the selective switches to extend said subscriber's line, means for releasing said switches, and means for again operating said switches in accordance with the original settings of said registers.

10. In a telephone system, a telephone line, a plurality of selective switches, a controlling mechanism including a plurality of registers, means for variably setting said registers, means controlled in accordance with the settings of said registers for operating a variable number of said selective switches to extend said line, means for releasing the operated switches, and means for again operating the released switches in accordance with the original settings of said registers.

11. In a telephone system, a telephone line, a plurality of groups of trunks, a plurality of selective switches, a controlling mechanism including a plurality of registers, means for variably setting said registers, means controlled in accordance with the settings of said registers for operating said switches in succession to extend the telephone line over said trunks, means operative when all trunks of any of said groups are busy for releasing all of said switches previously operated, and means for again operating the released switches in accordance with the original settings of said registers.

12. In a telephone system, a telephone line, a plurality of selective switches, a controlling mechanism including a plurality of registers, means for setting said registers, means controlled in accordance with the settings of said registers for operating said switches to extend said line, means for re-

leasing said switches, and means effective after the lapse of a predetermined interval following the operation of the last switch for again operating the released switches in accordance with the original settings of said registers.

13. In a telephone system, a telephone line, a pair of selective switches, a controlling mechanism including a plurality of registers, means for setting said registers, means controlled in accordance with the settings of said registers for operating the selective switches to extend said line, means for automatically releasing either the first or both of said switches, and means effective after the lapse of a definite interval following the operation of each switch for again operating the released switches in accordance with the original settings of said registers.

14. In a telephone system, a subscriber's line, a selective switch, a controlling mechanism comprising a plurality of registers, means for successively associating the subscriber's line with said registers, means controlled over said line for setting said registers, means controlled by said controlling mechanism for operating said switch in accordance with the setting of a particular one of said registers, means for releasing said switch, and means for placing said mechanism in condition to again control the operation of said switch in accordance with the original setting of said particular register while other of said registers are being set under the control of the subscriber's line.

15. In a telephone system, a subscriber's line, a plurality of selective switches for extending said line, a controlling mechanism comprising a plurality of registers, means

for successively associating said line with said registers, means controlled over said line for setting said registers, means controlled by said mechanism for operating a portion of said switches in accordance with the settings of certain of said registers, means for releasing the operated switches, and means for placing said mechanism in condition to again control the operation of the released switches in accordance with the original settings of said certain registers while the remaining of said registers are being set under the control of the subscriber's line.

16. In a telephone system, a telephone line, a selective switch, a controlling mechanism, means for variably setting said mechanism to produce registrations thereon, means controlled in accordance with the setting of said mechanism for operating said switch to extend the telephone line, and means for causing said switch to again be operated in accordance with the same setting of said mechanism.

17. In a telephone system, a selective switch, a controlling mechanism, means for variably setting said mechanism to produce registrations thereon, means controlled in accordance with the setting of said mechanism for operating said switch to extend the telephone line, means for releasing said switch, means for measuring time, and means rendered effective as a result of a definite interval of time having been measured by said time measuring means for causing said switch to again be operated in accordance with the same setting of said mechanism.

In witness whereof, I hereunto subscribe my name this 2nd day of April A. D., 1920.

LIPA POLINKOWSKY.