

Dec. 29, 1925.

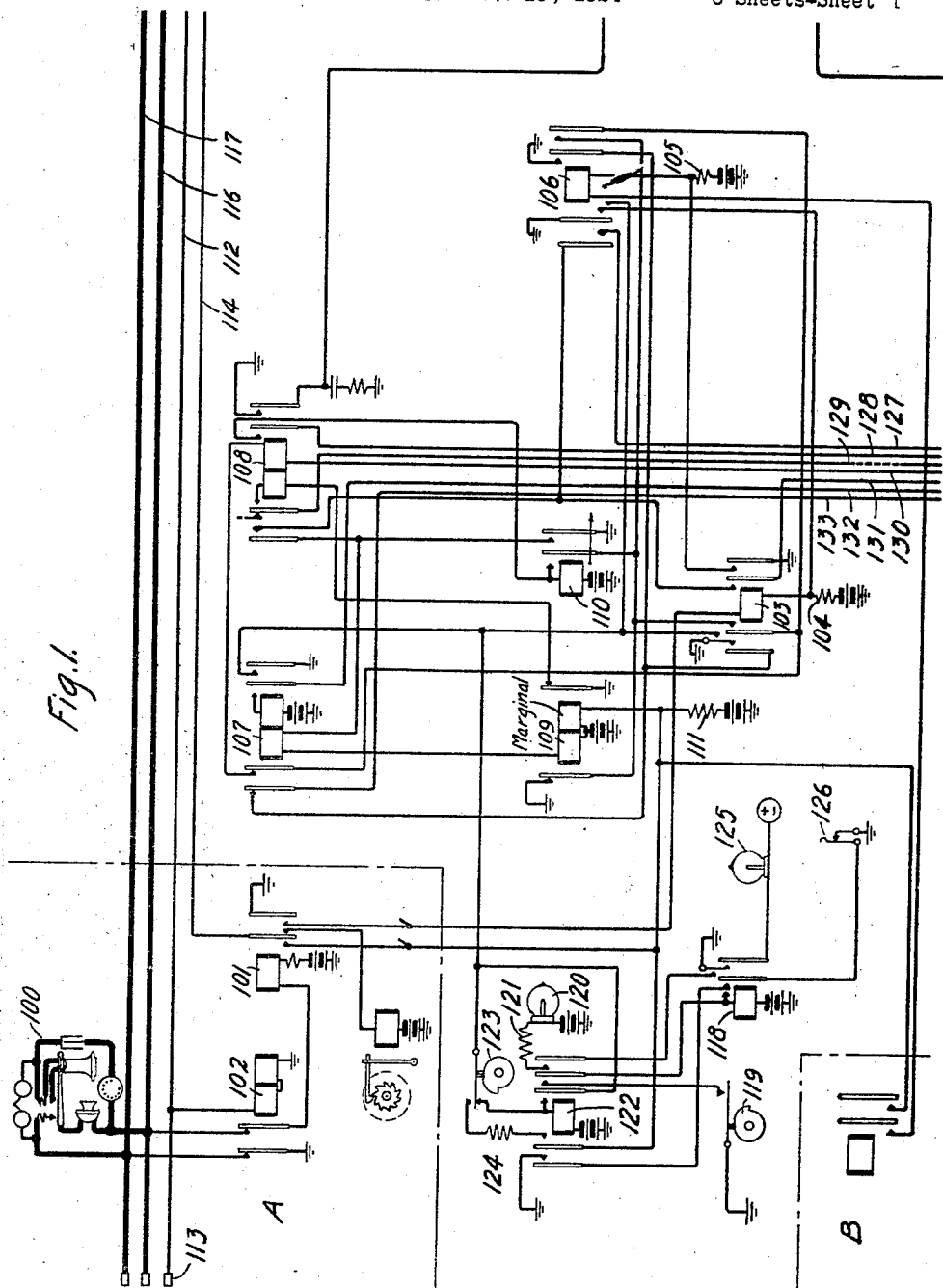
W. H. MATTHIES

1,567,072

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 16, 1924

6 Sheets-Sheet 1



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Dec. 29, 1925.

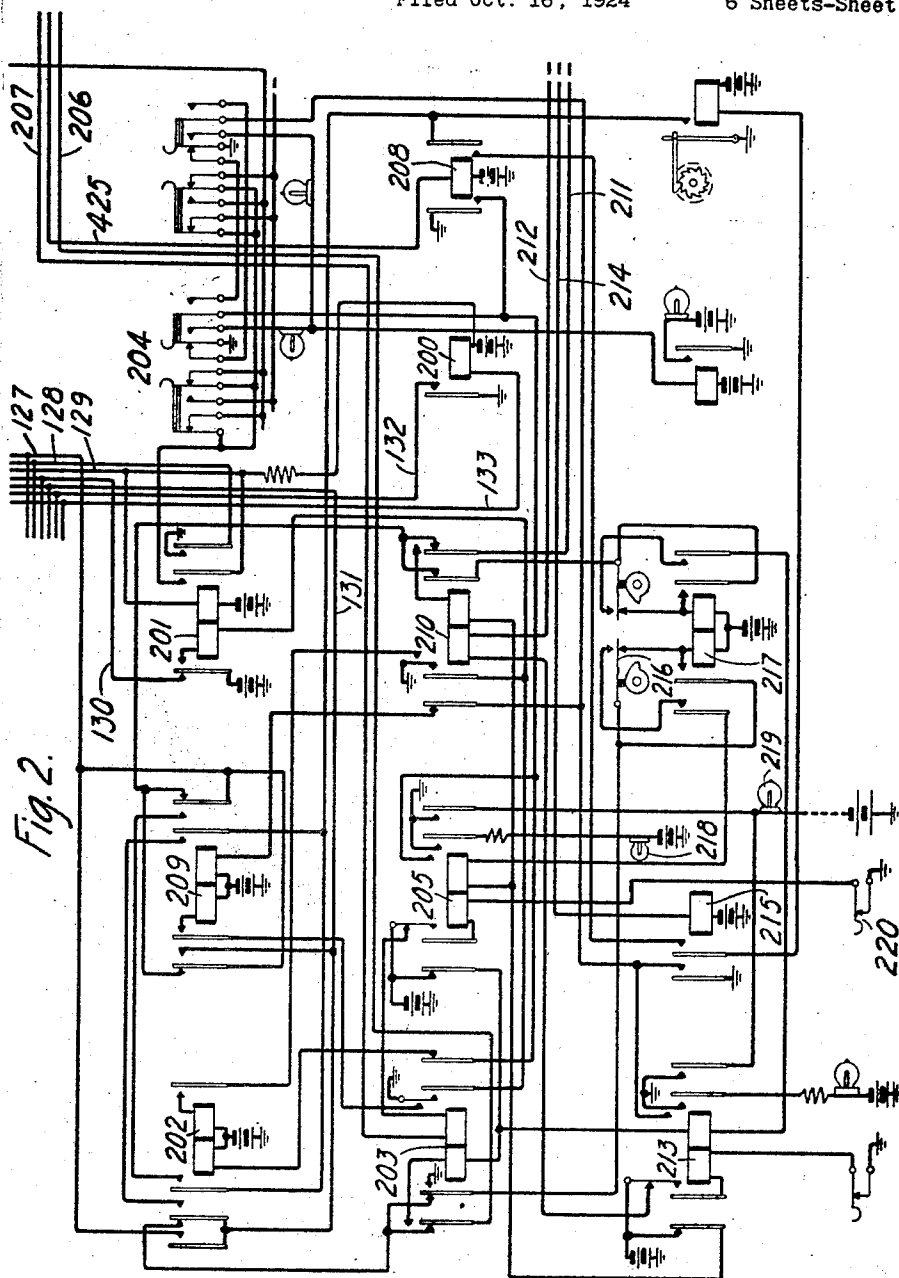
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6 Sheets-Sheet 2



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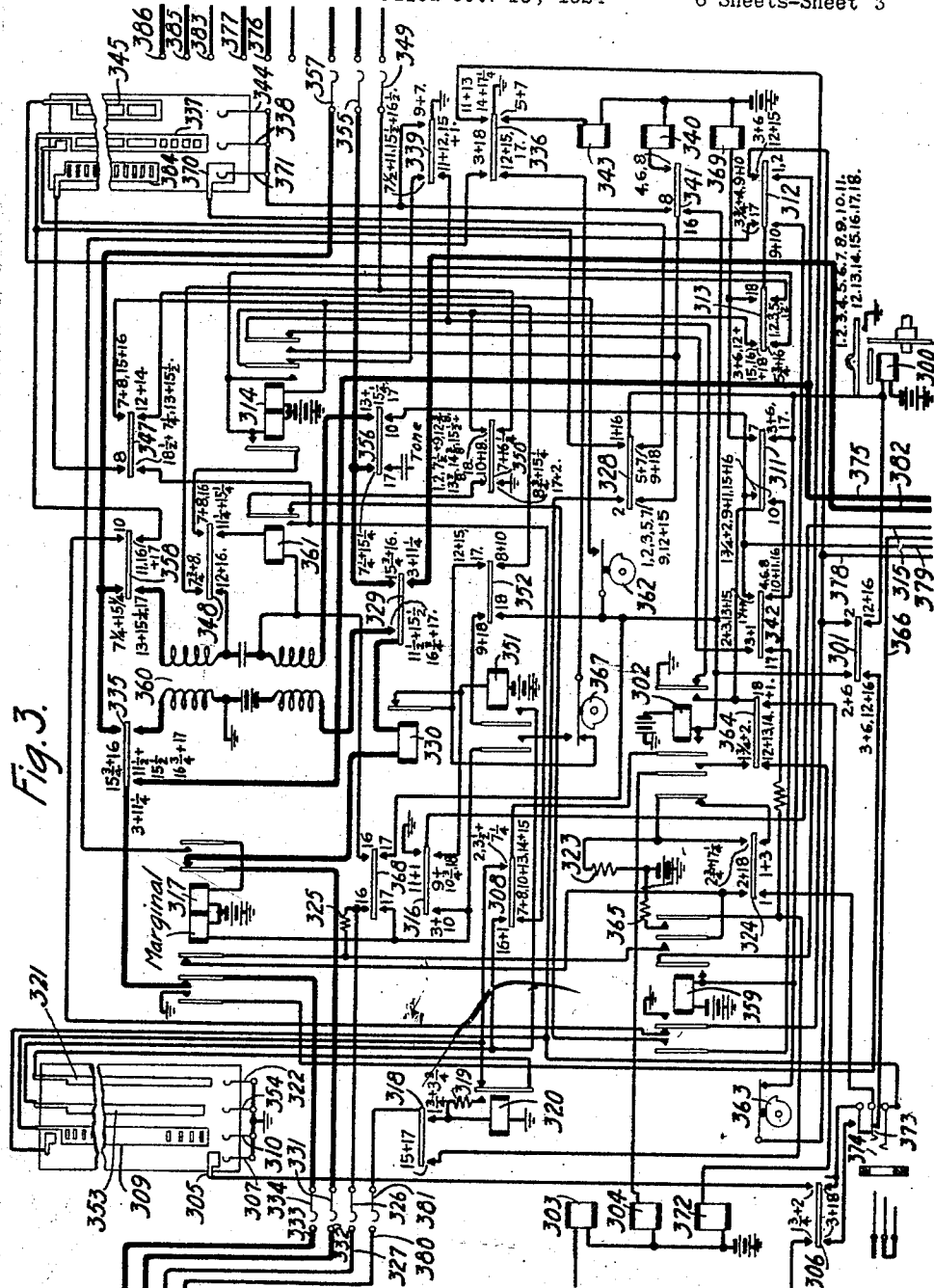
1,567,072

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TELEPHONE EXCHANGE SYSTEM

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6 Sheets-Sheet 3



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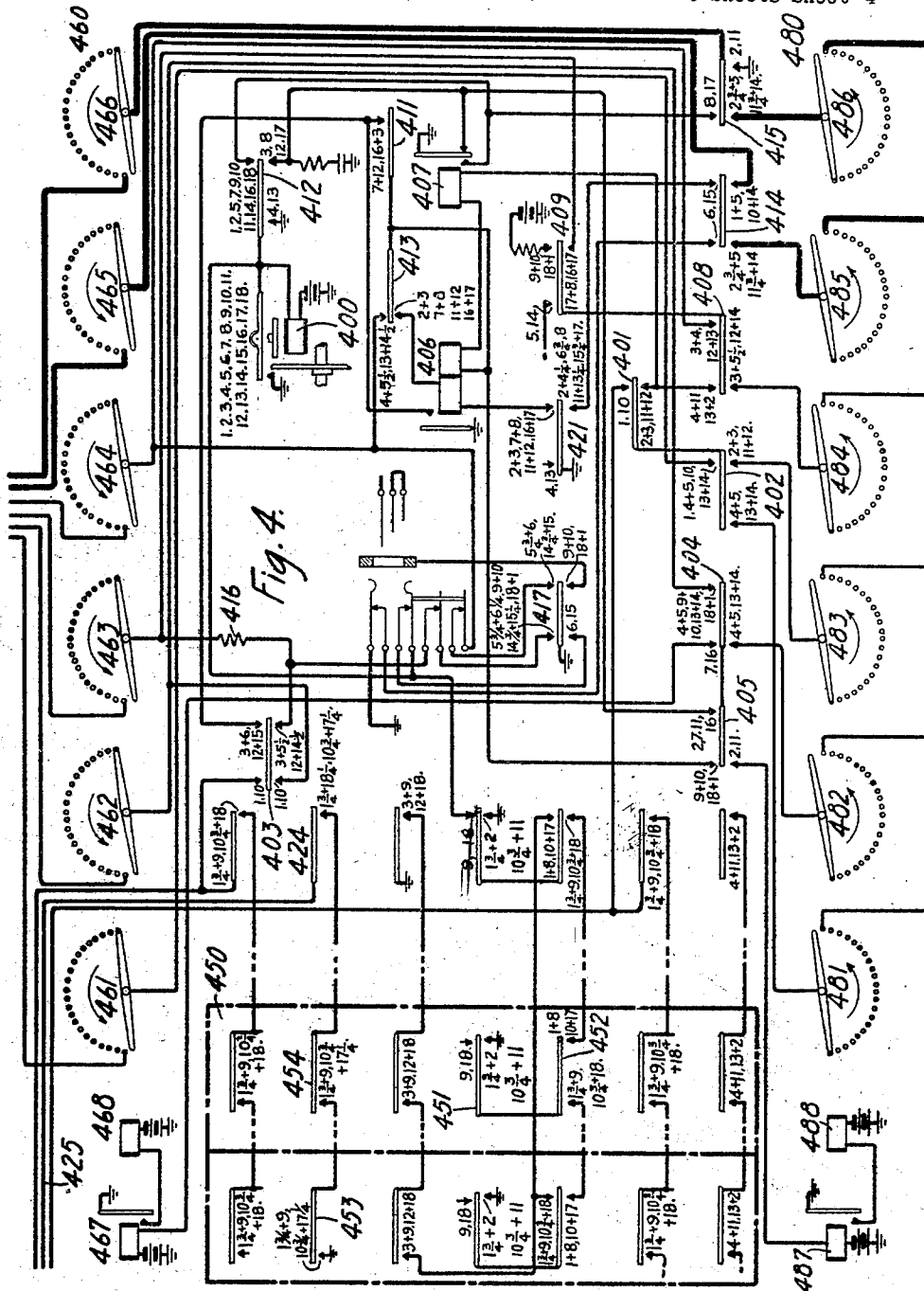
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TELEPHONE EXCHANGE SYSTEM

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6 Sheets-Sheet 4



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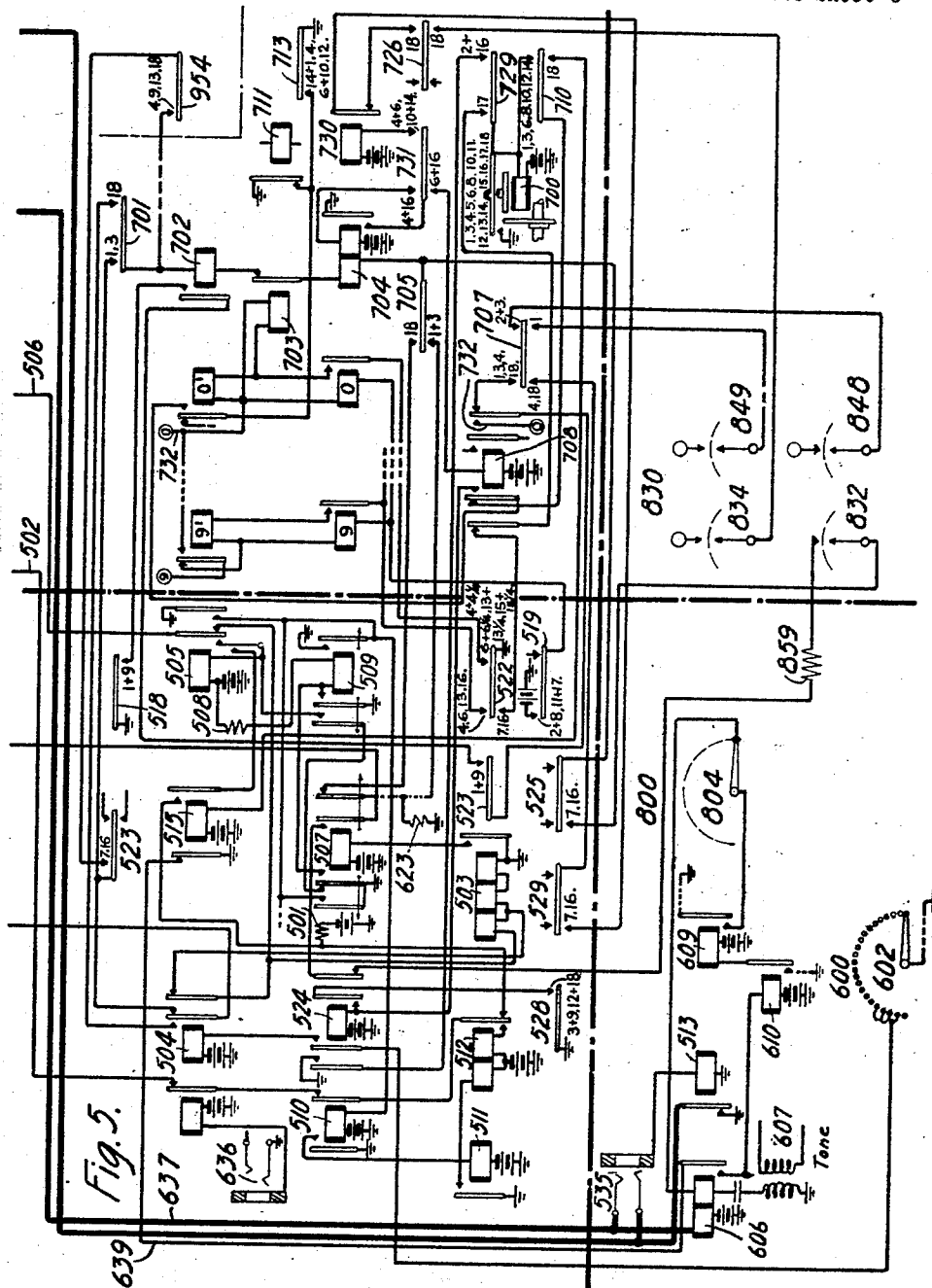
1,567,072

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TELEPHONE EXCHANGE SYSTEM,

Filed Oct. 16, 1924

6 Sheets-Sheet 5



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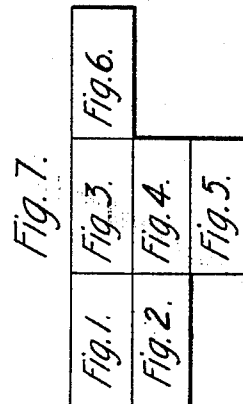
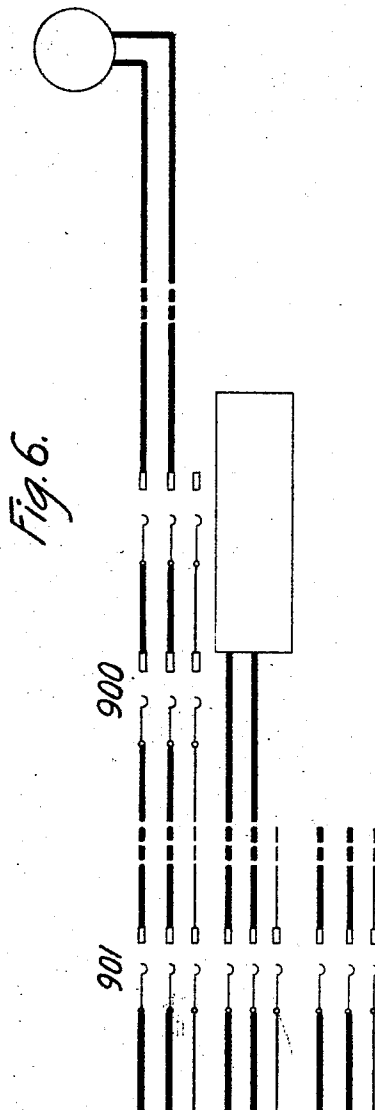
Dec. 29, 1925.

W. H. MATTHIES
TELEPHONE EXCHANGE SYSTEM

1,567,072

Filed Oct. 16, 1924

6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE.

WILLIAM H. MATTHIES, OF HACKENSACK, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed October 16, 1924. Serial No. 743,834.

To all whom it may concern:

Be it known that I, WILLIAM H. MATTHIES, a citizen of the United States of America, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

10 This invention relates to telephone systems and more particularly to systems employing automatic switches for extending connections.

15 This invention is particularly applicable to telephone systems in which connections are established under the control of register senders.

20 It is an object of the present invention to provide improved means for associating a subscriber's line with the selector switches for extending said line, and with the register sender for controlling said switches in their selective action.

25 A feature of the invention lies in the provision of a plurality of link circuits, one of which is always in readiness for use, and which are provided with means for connecting with a line finder and a register sender.

30 This and other features of the invention will be apparent from a consideration of the following description in connection with the drawings and appended claims.

35 Referring to the drawings, Fig. 1 shows one of a group of subscribers' lines together with a trip circuit common to the group of lines.

Fig. 2 shows a start circuit serving a plurality of trip circuits.

40 Fig. 3 shows a line finder-district selector circuit for extending the line of Fig. 1 to subsequent selectors.

45 Fig. 4 shows one of a plurality of link circuits serving the start circuit of Fig. 2 and having access to the line finder-district selector circuit of Fig. 3. A portion of two other link circuits is also shown.

Fig. 5 shows a portion of a sender circuit adapted to be selected by the link circuit of Fig. 4.

50 Fig. 6 shows in diagrammatic manner the switches and apparatus necessary to extend a call to a subscriber in a mechanical office.

Fig. 7 shows the manner in which the

several figures of the drawing should be arranged to disclose the invention completely. 55

It is to be noted that Fig. 5 is a skeletonization of the sender of the copending application of O. H. Kopp, Serial No. 743,919, filed Oct. 16, 1924, and the same reference numerals are applied to corresponding portions of the two drawings. 60

Subscribers' lines such as line 100 are connected to multiple terminals appearing before a plurality of line finders. These multiple terminals are arranged in a plurality 65 of groups each group being served by a separate brush set on each finder and each group being divided into two subgroups. A trip circuit is provided individual to each group; a start circuit is provided for all the 70 groups of lines served by the group of line finders; and a plurality of link circuits are provided for each group of lines and line finders. The line finders and link circuits are divided into two subgroups and each 75 such subgroup normally serves calls in the corresponding subgroups of lines. The arrangement is such that, except when all link circuits are busy, a link circuit will be in readiness to serve a call and will be connected 80 by its district finder to an idle line finder.

When a call is initiated by a subscriber in a particular group, the trip circuit individual to the group, and the start circuit 85 are taken for use by that line and means are provided for preventing the extension of a call in the other subgroup of the group or in any other group until a line finder has been started in search of this calling 90 line. Means are also provided for preventing the extension of a second call in this group, until after simultaneous calls in other groups have been taken care of. The operation of the start circuit causes the line 95 finder associated with the link circuit allotted for use to hunt for the calling line and also causes the link circuit to hunt for an idle sender. As soon as a particular link is taken for use with a call the next 100 link is allotted to serve the next incoming call in the particular subgroups which they serve. As soon as a brush set on the line finder has been tripped the start circuit will be freed to permit the extension of calls 105 in other groups. As soon as the line has

been found the trip circuit of the group is freed by the line finder to extend another call in the same group provided no call is awaiting extension in another group. As soon as selections are completed the sender and link circuit are released by the district selector circuit and the link circuit immediately hunts for another idle district.

When the subscriber at substation 100 moves his receiver from the switchhook a circuit is closed for line relay 101 extending from battery through that relay, inner contact of relay 102 over the subscriber's loop to ground at the outer contact of relay 102. Relay 101 operates and closes a circuit from battery, resistance 104, through the winding of relay 103 to ground at the outer contact of relay 101.

The operation of relay 103 closes a circuit from battery, resistance 105 to ground at the outer right contact of relay 106. This circuit is in shunt of the winding of relay 103, which relay serves the second subgroup of the group to which line 100 belongs, thus preventing the extension of a call from that subgroup, while the trip circuit is in use with line 100. The operation of relay 103 also closes a circuit from battery, through the winding of relay 200, conductor 133, outer left contact of relay 107, outermost left contact of relay 103 to ground.

Relay 200 operates and connects ground over its contact to the inner right armature of relay 107. When relay 107 operates, as subsequently described, it locks to this ground through its right winding and remains locked as long as relay 200 remains operated. With relay 107 operated, the operating circuit of relay 108 remains open and hence any other incoming calls in this group must await the release of relay 107 before they can be extended. Since relay 200 operates as soon as relay 103 or relay 106 operates, it will remain operated as long as a call awaits attention in any subgroup served by the start circuit of Fig. 2. The relay of each trip circuit corresponding to relay 107 operates as each call is served and locks to the contact of relay 200. When all waiting calls have been served the circuit of relay 200 is opened and that relay releases, releasing the relay 107 to permit the extension of other calls. Since the circuit of relay 200 extends over the back contact of relay 107, should simultaneous calls exist in all the groups served by the start circuit of Fig. 2, when one call has been served in each group and relay 107 of the last trip circuit has been operated, no circuit would exist for holding relay 200 operated and that relay would release permitting the relays 107 to release and close over their back contacts, circuits for again operating relay 200 should additional calls await attention.

In addition relay 103 closes a circuit from

battery, over the back contact of relay 201, right winding of trip relay 108, inner left contact of relay 107, innermost left contact of relay 103, left contact of relay 109 to ground. Relay 108 operates in this circuit and closes a locking circuit for itself from ground, right contact of relay 109, left winding and inner left contact of relay 108, over the inner left back contact of the trip relays of the other groups of lines, conductor 129, right winding of start relay 201 to battery.

Relay 201 operates in this circuit. A circuit is now closed for relay 110 extending from battery through the winding of relay 110, right contact of relay 108, conductor 128, to ground at the outer right contact of relay 201. Relay 110 locks in an obvious circuit to ground at the left back contact of relay 109. Relay 108, together with relay 103 prepares a circuit from the outer contact of relay 110, outer left front contact of relay 108, inner right contact of relay 103, conductor 131, left back contact of relay 202, outer left back contact of relay 203, conductor 206, upper contact of cam 401, upper contact of cam 402, brush 461 and its associated terminal, conductor 378, upper contacts of cam 301, winding of relay 302, to battery, the line finder of Fig. 3 having been assumed to have been allotted for use by the switch 460 and the sequence switch 300 therefore standing in position 2.

The operation of relay 108 also closes a circuit from ground over its outer right contact, through the winding of the trip magnet 303, serving the group in which line 100 appears on the line finder frame, to battery. Relay 110 upon energizing closes a circuit from battery, through the left winding of relay 109, left winding of relay 107, outer contact of relay 110 to ground. Relay 107 operates and locks through its right winding and inner right contact to the contact of relay 200.

The operation of relay 302 closes a circuit from battery, through the winding of updrive magnet 304, middle left contact of relay 302, upper contact of cam 364, left front contact of relay 302 to ground.

Under the control of the updrive magnet 304 the line finder shaft is moved upwards. Due to the operation of the trip magnet 303 the set of brushes serving the group of lines to which line 100 belongs is tripped. When the magnet leaves the tripping zone a circuit is closed from ground over brush 307, through commutator segment 305, upper contacts of cam 306, outer left normal contact of key 204, inner right contact and right winding of relay 201 to battery. Relay 201 is held operated in this circuit but the circuit through the locking winding of relay 108 is shunted and that relay releases, in turn releasing the trip magnet 303. As soon as brush 307 leaves segment 305 the

circuit of relay 201 is opened and that relay releases again connecting battery to the operating windings of relay 108 and the corresponding relays in other trip circuits, so that subsequent calls may be served.

Relay 302 closes a locking circuit for itself over its inner left contact, right contact of cam 308, back contact of relay 320, commutator segment 321, brush 322, to ground, which is closed as soon as the line finder moves upward. Relay 302 also closes a circuit from battery, over the inner left contact of relay 205, right winding of relay 203, conductor 207, left contacts of cam 403, brush 462, and its associated terminal, conductor 379, upper left contact of cam 311, right front contact of relay 302 to ground. The operation of relay 203 removes ground from conductor 206 thus preventing the start of another line finder until the brushes are tripped. Relay 203 locks in a circuit from battery, over the outer left contact of relay 205, left winding and outer left front contact of relay 203, left back contact of relay 202, conductor 131, inner right contact of relay 103, outer left contact of relay 108, outer contact of relay 110 to ground. The operation of relay 203 also closes a locking circuit for relay 201 from battery, left contact and left winding of relay 201, inner right contact of relay 203 to ground. The circuits just traced are established before relay 108 is released by the shunting action of commutator segment 305. As soon, however, as relay 108 deenergizes it opens the locking circuit of relay 203, restoring the start circuit to condition to serve subsequent calls.

When relay 302 operates it also closes a circuit from ground through its right front contact, upper left contact of cam 311, conductor 379, brush 462, and its associated contact, right contact of cam 404, upper left contact of cam 405, right winding of relay 406, winding of relay 407, upper left contact of cam 408, upper right contact of cam 409, resistance 410 to battery. Relays 406 and 407 operate, relay 406 closing a locking circuit for itself and relay 407 from battery, through resistance 410, upper right contact of cam 409, upper left contact of cam 408, winding of relay 407, right winding of relay 406, contact of cam 411, contact of relay 406 to ground. Relay 407 closes a circuit from battery, through the winding of sequence switch magnet 400, upper contact of cam 412, contact of relay 407 to ground. Magnet 400 operates advancing the link circuit sequence switch to position 2.

In position 2 ground is connected from the right contact of cam 415 to brush 466 and its associated contact, conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay

314 to battery. Relay 314 operates, but performs no function until the calling line has been found. Ground from the front contact of relay 406 is also extended over the contact of cam 411, upper left contact of cam 405, upper right contact of cam 404, left contacts of cam 403, conductor 207, right winding of relay 203, inner left contact of relay 205 to battery, holding relay 203 operated until the link circuit sequence switch is moved out of position 1. When the link circuit sequence switch arrives in position 2 relays 406 and 407 release. The release of relay 407 completes a circuit from ground at the back contact of relay 407, upper right and lower left contact of cam 405, winding of magnet 487 to battery. Magnet 487 operates and closes an obvious circuit for magnet 488. Magnet 488 is the rotary magnet for sender selector switch 480 and causes the switch to rotate in search of an idle sender.

An idle sender is characterized by the connection of battery, through a 150 ohm resistance, such as resistance 501, to conductor 502 and its corresponding terminal in the set engaged by brush 483. With the link circuit sequence switch in position 2 ground is connected over the upper right contact of cam 421, through the left winding of relay 406, lower contact of cam 413, right winding of relay 406, winding of relay 407, lower contact of cam 401, lower right contact of cam 402 to brush 483.

When brush 483 encounters a terminal corresponding to an idle sender, to which battery is connected, relay 406 operates, short circuiting its left hand winding over its contact and the contact of cam 411, permitting relay 407 to operate in series with the right hand winding of relay 406. The operation of relay 407 opens the circuit of magnet 487 and closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 412, front contact of relay 407 to ground advancing the link sequence switch to position 3.

In position 3 a circuit is prepared extending from ground through the right and middle windings of relay 503, outer right back contact of relay 504, right back contact of relay 505, conductor 506, brush 484 of sender selector 480, lower left and upper right contacts of cam 408, brush 464 of district finder 460 to conductor 315, left contact of cam 316, left winding of relay 317 to battery, which circuit is not completed until the district circuit reaches position 3.

In the meantime the line finder shaft continues to move upwards until it reaches the terminal corresponding to the calling subscriber's line. When these terminals are encountered a circuit is completed from battery, through the right winding of relay 109 and resistance 111, inner front contact of

line relay 101, conductor 114, terminal 380 brush 381, right contact of cam 318, winding of relay 320 to ground. Relay 320 operates and closes a circuit in shunt of its winding through resistance 319, right front contact of relay 320, commutator segment 321, brush 322 to ground. Relay 109, which is marginal, is so adjusted as not to operate in the circuit previously traced in series with relay 107 or in the circuit traced for the winding of relay 320. With resistance 319 in parallel with relay 320 relay 109 operates and locks through its left hand winding, left winding of relay 107, outer left contact of relay 110 to ground. The operation of relay 109 opens the locking circuit of relay 110 and relay 110 releases after an interval due to the fact that relay 110 is slow to release. Relay 320 opens the locking circuit of relay 302 and that relay releases as soon as brush 310 encounters an insulating segment of centering cam 309.

The release of relay 302 opens the circuit of updrive magnet 304 and stops the line finder on the calling subscriber's line. It also connects battery through resistance 323 and its left back contact, lower right and upper left contacts of cam 324, inner back contact of relay 317, resistance 325, brush 326, and terminal 327, over conductor 112, winding of cut-off relay 102 to ground. Relay 102 operates and releases line relay 101 removing the calling condition from terminal 380. The operation of relay 102 also opens the circuit of relay 110 permitting its release.

The release of relay 101 permits relay 103 to release and also opens the circuit of relay 320. The connection of battery with terminal 327 marks terminal 113 and the other multiple terminals of calling line 100 in the terminal banks of final selectors with reduced battery potential to render the line busy as such final selectors. The release of relay 302 also closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, right back contact of relay 302 to ground. Sequence switch 300 is advanced in this circuit to position 3.

When sequence switch 300 leaves position 2 the circuit of relay 314 is opened and that relay releases. When the sequence switch 300 reaches position 3, the previously traced circuit for relays 503 and 317 is completed. Relay 317, being marginal, does not operate at this time. Relay 503 operates and closes an obvious circuit for relay 507 which in turn closes a circuit from battery, through resistance 508, winding of relay 509, left front contact of relay 507 to ground. Relay 509 operates and locks over its outer left front contact. Relay 509 closes a circuit for relay 510 from battery, winding of relay 510,

to ground at the right front contact of relay 509 which circuit is also closed at the outer left front contact of relay 507. It also starts the timing switch, of which brush 602 forms a part, in the manner disclosed in the above identified application of O. H. Kopp. The operation of relay 510 closes an obvious circuit for relay 511 which in turn closes a circuit through the left winding of relay 512.

The operation of relay 512 opens the circuit previously traced from battery, through resistance 501, to relays 406 and 407 and these relays release. The release of relay 407 closes a circuit from battery, through the winding of sequence switch magnet 400, lower right contact of cam 412, back contact of relay 407 to ground. Sequence switch 400 is advanced to position 4 from which position it is moved to position 5 by means of ground over the lower left contact of cam 412.

In position 5 of the link sequence switch the dialing leads and the fundamental circuit leads are cut through directly from the district circuit to the sender circuit. The dialing circuit may be traced from battery, through the left winding of relay 606, conductor 637, sender selector brush 485, and its corresponding terminal, lower contacts of cam 414, district finder brush 465 and its corresponding terminal, conductor 382, lower contact of cam 329, winding of relay 330, right back contact of relay 317, line finder brush 331, terminal 332, conductor 116 through the subscriber's substation, conductor 117, terminal 333, brush 334, middle left back contact of relay 317, left contact of cam 335, conductor 375, brush 466, and its associated terminal, lower left contact of cam 415, brush 486, and its associated terminal, left back contact of relay 513 to ground.

In position 5 of the link circuit sequence switch 400, relays 406 and 407 are connected in a circuit extending from brush 484, left contacts of cam 408, winding of relay 407, right winding of relay 406, upper contact of cam 413, to brush 464. The circuit of these relays is extended from these brushes as will be later described. When the dialing circuit above traced is completed, relay 606 operates and closes a circuit from battery, through the winding of relay 610, front contact of relay 606, conductor 639, left back contact of relay 515 to ground. Relay 610 operates and closes a circuit from battery, through the winding of relay 609, right front contact of relay 610, and thence to ground. As soon as relay 609 operates the dialing tone circuit is completed as follows: from source of tone 607, right winding of relay 606, normal terminal and brush 804 of register switch 800, contact of relay 609, and thence to ground.

Due to the closure of this circuit a tone is induced in the left winding of relay 603 and over the dialing circuit to the receiver of the subscriber's telephone to indicate that dialing may be started. The subscriber now dials the number of the wanted subscriber.

The registers of the sender are positioned, the translator 830 operated and selections made under the control of the sender as described in the copending application of O. H. Kopp, Serial No. 743,919, filed Oct. 16, 1924. After the completion of final units selection with the district selector sequence switch 300 in position 10, sender control sequence switch, cams of which are disclosed to the left of the vertical broken line and above the horizontal broken line of Fig. 5, in position 7, and sender sequence switch 700 in position 15, a fundamental circuit is completed from battery at the incoming selector 900 through the office selector 901, terminal 386, brush 357, upper contact of cam 358, inner left back contact of relay 359, conductor 378, brush 461 and its corresponding contact, upper right and lower left contacts of cam 402, brush 481 and its corresponding contact, inner right back contact of relay 504, upper left contact of cam 523, contact of cam 954, of the class sequence switch, winding of relay 702, back contact of relay 703, left winding of relay 704, lower contact of cam 525, translator brush 832, compensating resistance 859, outer right back contact of relay 524, inner right contact of relay 507, brush 482 and its corresponding contact, lower left and upper right contacts of cam 404, brush 462 and its corresponding contact, conductor 379, lower right and upper left contacts of cam 329, brush 355, terminal 385, through office selector 901 to ground (not shown) at the incoming selector 900. Relays 702 and 704 operate and relay 704 locks through its right winding, outer right contact of cam 731 to ground on the contact of relay 714. Relay 704 also closes a circuit from battery through the winding of relay 708, lower left contact of cam 731, to ground at the contact of relay 704. The operation of relay 708 closes a circuit from battery, upper contact of cam 519, winding of the No. 0 counting relay, conductor 732, outer right front contact of relay 708, contact of cam 523, contact of stepping relay 702, contact of cam 518 to ground. The No. 0 counting relay operates in this circuit and closes the usual locking circuit for itself through the winding of the No. 0' counting relay and relay 703. The incoming selector then opens the fundamental circuit, permitting the operation of the No. 0' counting relay and relay 703. The operation of the No. 0' counting relay closes a circuit from battery, winding of relay 524, inner left front contact of relay 708, front contact of the No. 0' counting relay to

ground at the contact of relay 711. Relay 524 operates and locks over its inner right contact to ground over the contact of cam 528. Relay 524 in operating closes a circuit through the winding of relay 504, inner left contact of relay 524, No. 18 to 21 terminals and brush 602 of time measure switch 600 to ground. Relay 524 opens the fundamental circuit and advances sequence switch 700 to position 17. When sequence switch 700 leaves position 16, the circuit of relays 704 and 708 is opened and these relays release. Relay 708 in releasing advances sequence switch 700 to position 18 in which position talking selection is made.

When relay 504 operated it opened the shunt around the right winding of relay 503 and the high resistance right winding is included in the circuit of relay 503, which circuit it will be remembered, includes the winding of relay 351, and the left winding of relay 317 in parallel. This increase in resistance decreases the current through relay 351 to such an extent that it deenergizes. The release of relay 351 in turn releases relay 314 which closes a circuit from battery through the winding of sequence switch magnet 300, lower right and upper left contacts of cam 342, outer right back contact of relay 314, back contact of relay 312 to ground. Sequence switch 300 is advanced to position 12 in this circuit. As soon as sequence switch 300 reaches position 11 ground is connected over the upper contact of cam 316, conductor 315, brush 464 and its corresponding terminal, upper contact of cam 413, right winding of relay 406, winding of relay 407, left contacts of cam 408, brush 484 and its corresponding terminal, right back contact of relay 505 to the right winding of relay 503. Since both sides of this relay are now connected to ground relay 503 releases. The release of relay 503 in turn releases relay 507 causing the operation of relay 505 and the release of relay 509 in turn. Talking selection now takes place as described in the application of O. H. Kopp, supra.

At the completion of talking selection the No. 0' counting relay is operated closing a circuit from ground at the contact of relay 711, front contact of the No. 0' counting relay, inner left back contact of relay 708, lower contact of cam 710, winding of relay 515 to battery.

The operation of relay 515, connects battery, through resistance 501, and the right contact of relay 515, over the inner front contact of relay 505 in parallel with battery through the winding of relay 505 to conductor 506, and thence over the brush 484 and its corresponding terminal left contacts of cam 408, winding of relay 407, right winding of relay 406, upper contact of cam 413, brush 464 and its corresponding ter-

minal, upper left contact of cam 316 to ground. Relays 406 and 407 operate in this circuit. The operation of relay 407 closes a circuit from battery through the winding of sequence switch magnet 400, upper right contact of cam 412, front contact of relay 407 to ground. Sequence switch 400 advances in this circuit to position 6. The operation of relay 406 connects ground through its contact and the right contacts of cam 403, resistance 416, brush 463 and its corresponding terminal to conductor 366 to mark the district selector busy to other link circuits until ground is placed on conductor 366 over the upper left contact of cam 417, contact 418 of make busy jack 419, through resistance 416 and brush 463 in positions $5\frac{3}{4}$ to $6\frac{1}{4}$ of sequence switch 400 which keeps the district busy until the link circuit is disconnected. When switch 400 leaves position $5\frac{1}{2}$ the circuit of relays 406 and 407 is opened and these relays release. At the same time the circuit of relay 505 is opened at cam 408 and that relay releases. Switch 400 is moved to position 7 in a circuit from battery through the winding of sequence switch magnet 400, contact 420 of make busy jack 419, lower left contact of cam 417 to ground. When switch 400 arrives in position 7 ground is connected over the upper right contact of cam 421, left winding of relay 406, lower contact of cam 413, right winding of relay 406, winding of relay 407, upper left contact of cam 408, lower right contact of cam 409 to brush 463.

At the same time a circuit is completed from battery, through the winding of magnet 467, upper left contact of cam 404, upper right contact of cam 405, back contact of relay 407 to ground. Magnet 467 operates and closes an obvious circuit for magnet 468. The energization of magnet 468 rotates the district finder switch 460 in search of an idle district selector. An idle district selector is characterized by battery through 150 ohm resistance connected to a terminal of the arc served by brush 463. As soon as brush 463 encounters a terminal to which battery is connected through 150 ohms, relay 406 is operated connecting ground through its contact and the upper contact of cam 411 to its right winding and the winding of relay 407, in which circuit relay 407 also operates. The operation of relay 407 opens the circuit of magnet 467 and switch 460 comes to rest with its terminals engaging an idle district.

The operation of relay 407 also closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 412, front contact of relay 407 to ground, in which circuit sequence switch 400 is advanced to position 8. In position 8 ground is connected over the front contact of relay 407, upper contact of cam 415, brush

466 and its associated contact, conductor 375 of the district selector just seized, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. The operation of relay 314 closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, lower contact of cam 339, to ground advancing the sequence switch to position 2. The advance of sequence switch 300 to position 2 removes battery from conductor 366 permitting the release of relays 406 and 407. The release of relay 407 closes a circuit for advancing sequence switch 400 to position 9. The link circuit sequence switch remains in position 9 until the sequence switch of the next link circuit moves out of position 1 or 10 due to the receipt of a call as previously described. The dotted rectangle 450 represents the next link circuit. It will therefore be seen that when the sequence switch of link 450 moves from position 1 to position 2 a circuit is closed from ground over cam 451, right contact of cam 452, lower contact of cam 422, upper contact of cam 423, winding of sequence switch magnet 400 to battery advancing sequence switch 400 to position 10. Since the link circuit performs two cycles of operation to one revolution of the sequence switch position 10 is the equivalent of position 1 and the link circuit is now ready to respond to the reception of a call. The link circuit sequence switch now remains in position 10 and the sequence switch of the associated district in position 2 until another call is received.

At the termination of the conversation the selector switches are restored to normal as described in the above identified application of O. H. Kopp. When sequence switch 300 associated with the district selector reaches position 1 battery is disconnected from brush 381 and cut-off relay 102 releases, restoring the subscriber's line to normal in readiness for subsequent calls.

While the line finders and link circuits are divided into two groups each of which serve lines in particular subgroups, the start circuit for Fig. 2 is so arranged that if all the link circuits in the group normally serving a particular calling line are busy, a link circuit and line finder of the other group will be employed.

When all the link circuits belonging to one group are in use so that none of them has its sequence switch standing in position 1 or 10 a circuit is completed from ground at the contact of cam 453, of the last link circuit of the group, contact of cam 454 of link circuit 450, contact of cam 424, conductor 425, winding of relay 208 to battery. Relay 208 operates and closes a circuit from battery through the left winding of relay

202, back contact of relay 203, left contact of relay 208 to ground. Relay 202 operates and disconnects conductor 131 from conductor 206 leading to the corresponding group of link circuits and transfers it over the back contacts of relays 209 and 210 to conductor 211 leading to the other group of link circuits. When now the allotted line finder in the second group starts, relay 210 is operated in a circuit from ground over conductor 212 (corresponding to conductor 207) left winding of relay 210, inner left back contact of relay 213 to battery. Relay 210 closes a locking circuit for relay 202 from battery through the right winding and right contact of relay 202, inner left front contact of relay 210 to ground, preventing the release of relay 202 should a link circuit in the first group become free before a calling line has been found. Similarly, if all the links circuits in the second group become busy, ground through all the link circuits of this group to conductor 214 will cause the operation of relay 215 which will operate relay 209, disconnect conductor 127 from conductor 211 and transfer it to conductor 206 leading to the first subgroup of link circuits.

If for any reason a line finder fails to start within a reasonable time a circuit will be completed from ground at the outer right front contact of relay 110, outer left front contact of relay 108, inner right front contact of relay 103, conductor 131, inner left back contact of relay 202, inner left back contact of relay 203, contact of interrupter 216, left winding of relay 217 to battery. Relay 217 operates when interrupter 216 closes its lower contact and locks through its inner left front contact to the above traced circuit, independent of the interrupter contact. After an interval, when interrupter 216 closes its upper contact, the above traced circuit is extended over interrupter contact, outer left contact of relay 217, right winding of relay 205, left back contact of relay 213 to battery. Relay 205 operates and locks in a circuit from battery through the inner left front contact and left winding of relay 205, key 220 to ground. The operation of relay 205 closes a circuit from battery through the left winding of relay 202, outer right contact of relay 203, inner right contact of relay 205 to ground, transferring calls from the first to the second group of link circuits. Circuits are also closed for lamp 218 at the start circuit frame and lamp 219 at the trouble desk.

It will be clear from the foregoing description that the arrangement of the present invention provides means for very rapidly associating a calling line with the district selector and register sender since a line finder is always held in readiness to serve a calling line and the sender selector of the

link circuit operates during the time that the line finder is hunting. According to this arrangement, also, the use of link circuit and line finder-district selector units is distributed, thus producing even wear on the various pieces of apparatus.

What is claimed is:

1. In a telephone exchange system, a plurality of subscribers' lines divided into groups, a trip circuit for each group, a start circuit common to all groups, a plurality of link circuits, a plurality of line finders, a plurality of register senders, means in said link circuits for preselecting a line finder and means in said link circuit responsive to the initiation of a call over said trip, start and link circuits to said line finder for hunting for an idle register sender.

2. In a telephone exchange system, a plurality of subscribers' lines, a plurality of link circuits, a plurality of line finders, a plurality of register senders, means in said link circuits for preselecting a line finder, and means responsive to the initiation of a call from one of said subscribers' lines through a link circuit to the preselected line finder for causing said preselected line finder to hunt for the calling line and for causing said link circuit to hunt for an idle sender.

3. In a telephone exchange system, a plurality of subscribers' lines, a plurality of link circuits, means for extending a call from a subscriber's line to one of said link circuits, a plurality of line finders, a plurality of register senders, means in said link circuit for preselecting a line finder, means for causing said preselected line finder to hunt for said calling line and means for simultaneously causing said link circuit to hunt for an idle sender.

4. In a telephone exchange system, a plurality of subscribers' lines, a plurality of link circuits, a plurality of line finders, means effective as soon as a link circuit becomes idle for associating said link circuit with an idle line finder, means for allotting said link circuits for use and means responsive to the initiation of a call from one of said subscribers' lines over said allotted link circuit, to allot the next link circuit.

5. In a telephone exchange system, a plurality of subscribers' lines, a plurality of line finders, a plurality of link circuits, a plurality of selector switches, means including one of said link circuits for controlling the extension of a connection over one of said line finders and over said selector switches, means for releasing a link circuit as soon as a connection is completed, means for causing said link circuit to immediately hunt for and connect with an idle line finder, means for maintaining all such idle link-line finder combinations in a sub-allotted condition, means for allotting one of said link-line

finder combinations and means responsive to the extension of a call from one of said subscribers' lines to said allotted link-line finder combination to allot the next idle combination.

6. In a telephone exchange system, a plurality of subscribers' lines divided into groups, each group divided into subgroups, a plurality of link circuits serving a particular subgroup in each of said groups of lines, a plurality of line finders, a plurality of selector switches, means including one of said link circuits for controlling the extension of a connection over one of said line finders and over said selector switches, means for releasing a link circuit as soon as a connection is completed, means for causing said link circuit immediately thereupon to hunt for and connect with an idle line finder, means for maintaining all such idle link-line finder combinations in a sub-allotted condition, means for allotting one of said link-line finder combinations, means responsive to the extension of a call from one of said subscribers' lines to said link-line finder combination to allot the next idle combination and means responsive to the employment of all the link-line finder combinations in one group to cause the allotted link-line finder combinations of said second group to serve calls in both groups of lines.

7. In a telephone exchange system, a plurality of subscribers' lines divided into groups, each group divided into subgroups, a plurality of link circuits serving a particular subgroup in each of said groups of lines, a

plurality of line finders, means effective as soon as a link circuit of each subgroup becomes idle for associating it with an idle line finder, means for allotting said link circuits for use, means responsive to the initiation of a call from a subscriber's line in a subgroup to cause the allotment of the next idle link circuit associated with such subgroup, and means responsive when all link circuits associated with a subgroup of lines are in use to cause the allotted link circuits associated with another subgroup to serve lines of both subgroups.

8. In a telephone exchange system, a plurality of subscribers' lines divided into groups, each group divided into subgroups, a plurality of link circuits serving a particular subgroup in each of said groups of lines, a plurality of line finders, means effective as soon as a link circuit of each subgroup becomes idle for associating it with an idle line finder, means for allotting said link circuits for use, means responsive to the initiation of a call in one subgroup over an allotted link circuit for causing the preselected line finder to hunt for the calling line, and means operative after a predetermined interval if said line finder fails to start hunting, to transfer said call to an allotted link circuit and preselected line finder of another subgroup.

In witness whereof, I hereunto subscribe my name this 3rd day of October A. D., 1924.

WILLIAM H. MATTHIES.