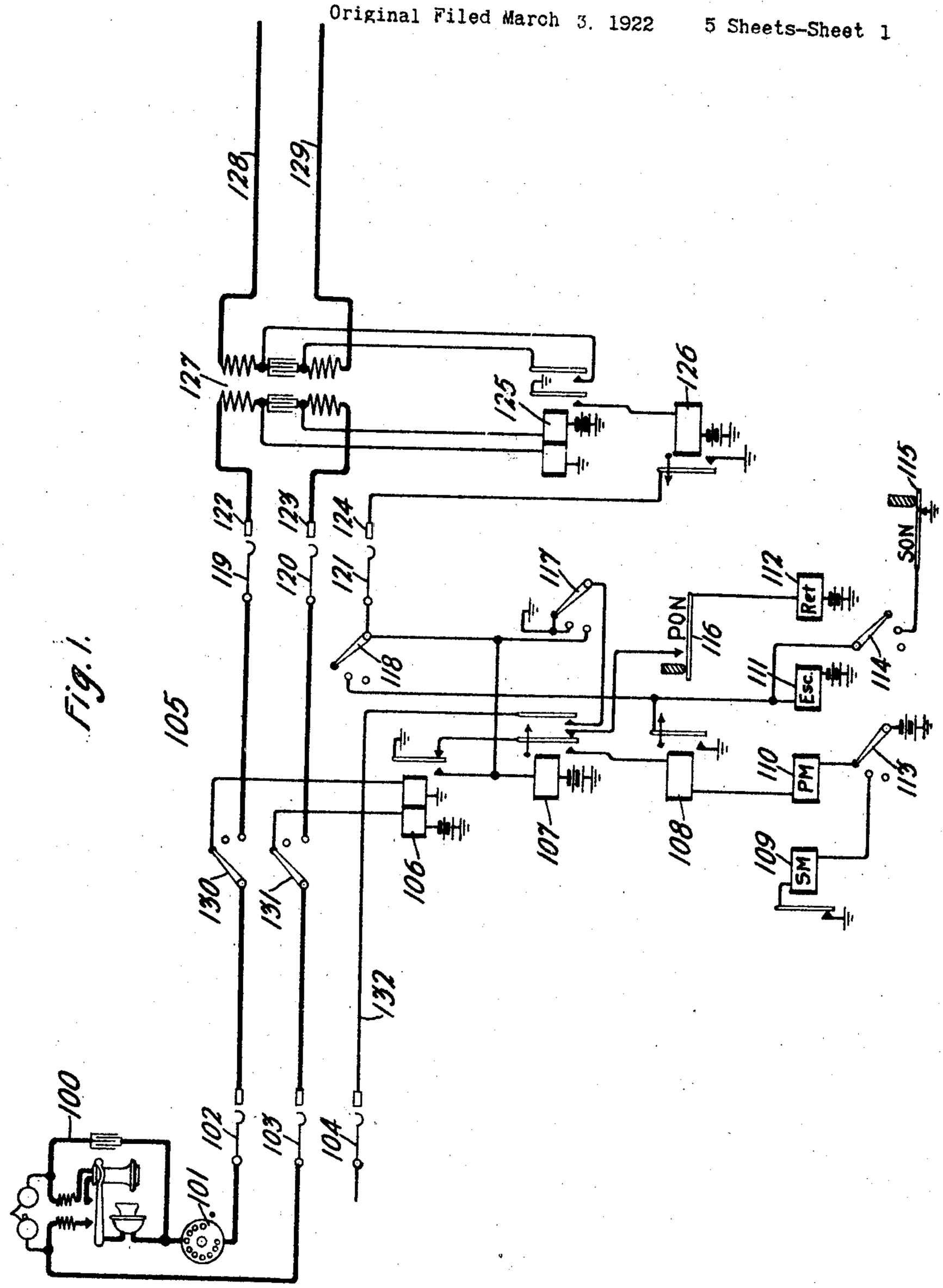
April 5, 1927. E. JACOBSEN 1,623,118

TELEPHONE EXCHANGE SYSTEM

Original Filed March 3, 1922 5 Sheets-Sheet 1

Fig. 1.



Inventor:
Emil Jacobsen
by Gerlach
Att'y.

April 5, 1927. 1,623,118

E. JACOBSEN

TELEPHONE EXCHANGE SYSTEM

Original Filed March 3, 1922 5 Sheets-Sheet 2

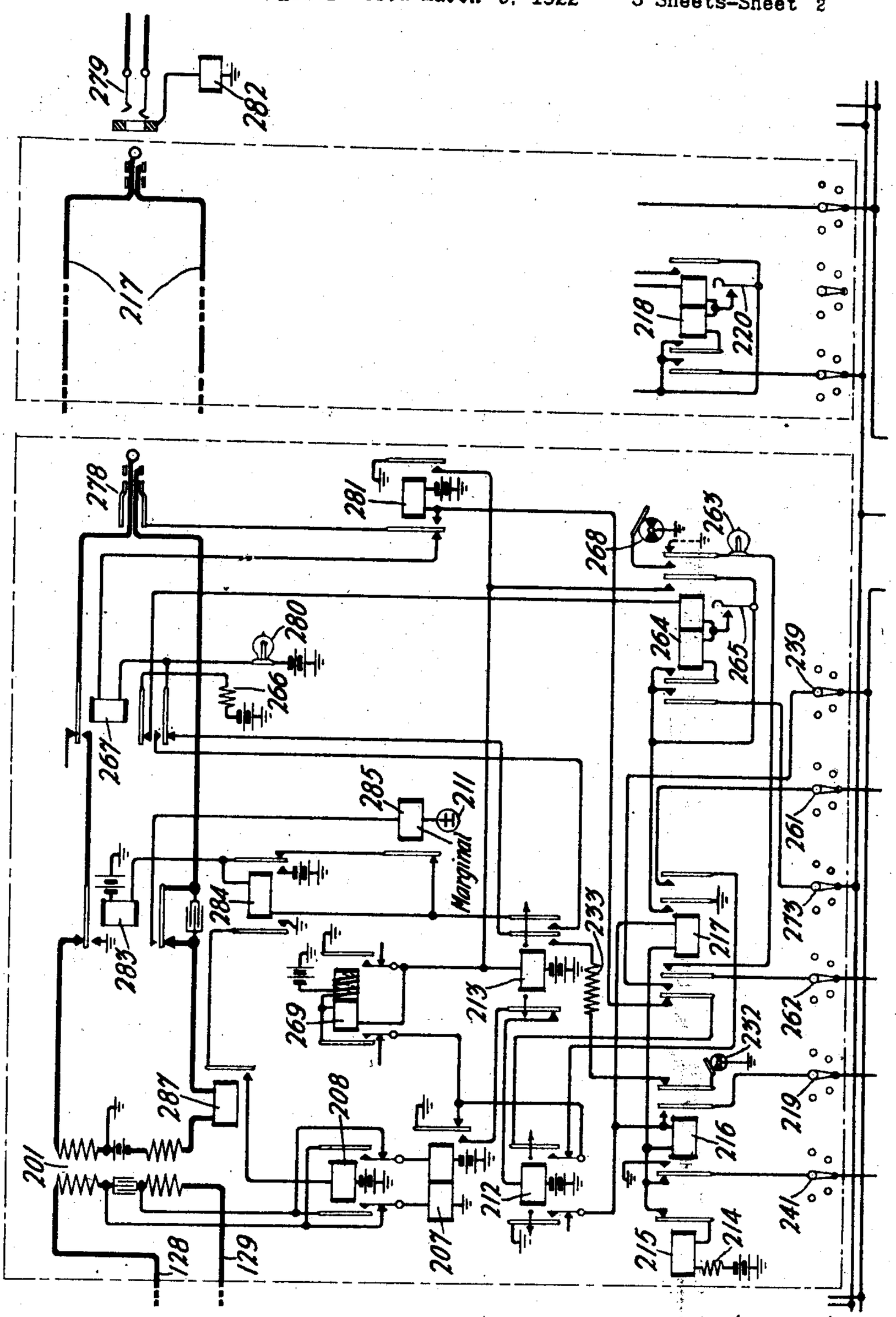


Fig. 2.

Inventor:
Emil Jacobsen
by [signature]
Att'y.

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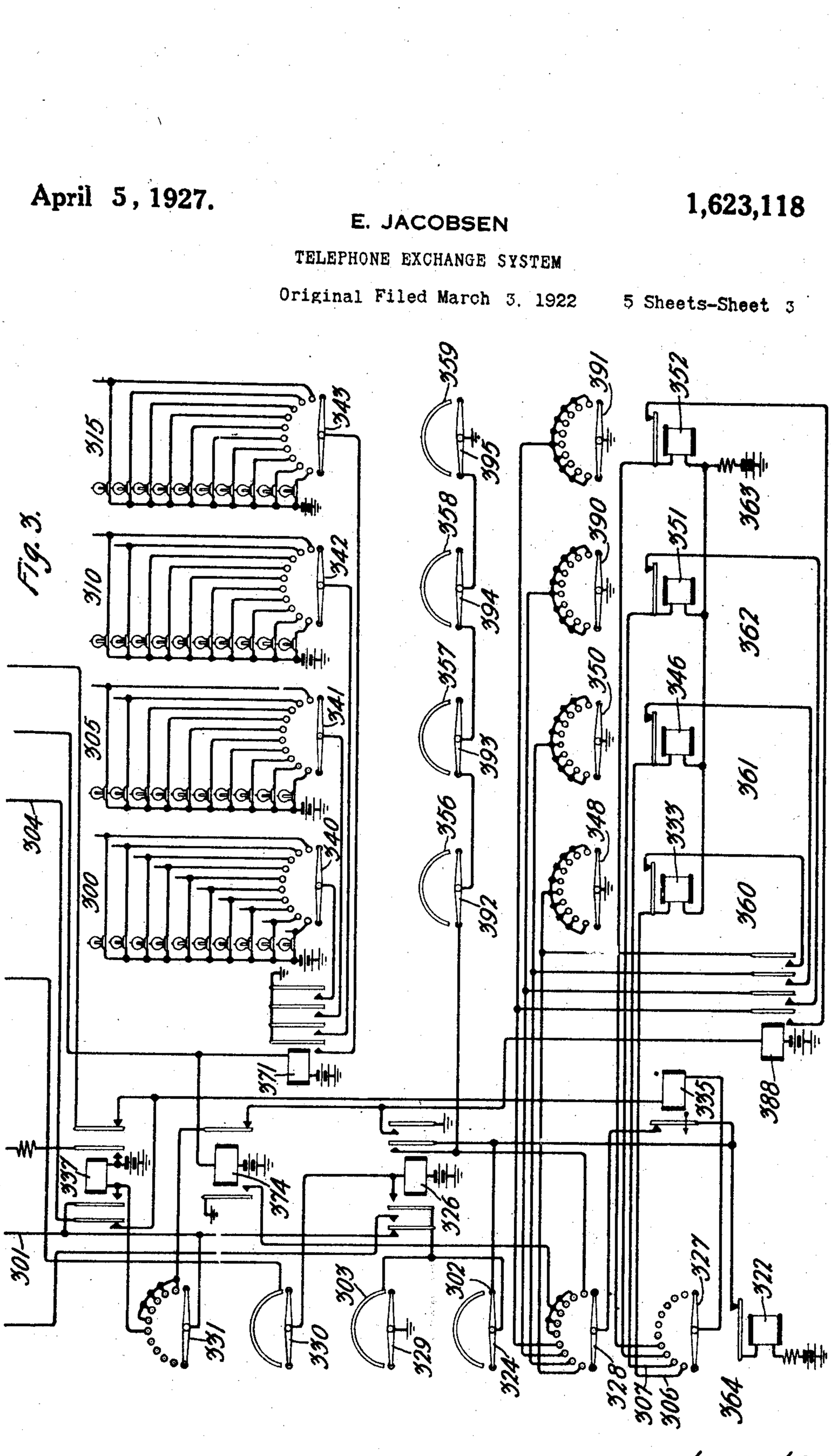
Fig. 3.



Inventor:
Emil Jacobsen
by J. E. Yoh
Att'y.

April 5, 1927. 1,623,118

E. JACOBSEN

TELEPHONE EXCHANGE SYSTEM

Original Filed March 3, 1922 5 Sheets-Sheet 4

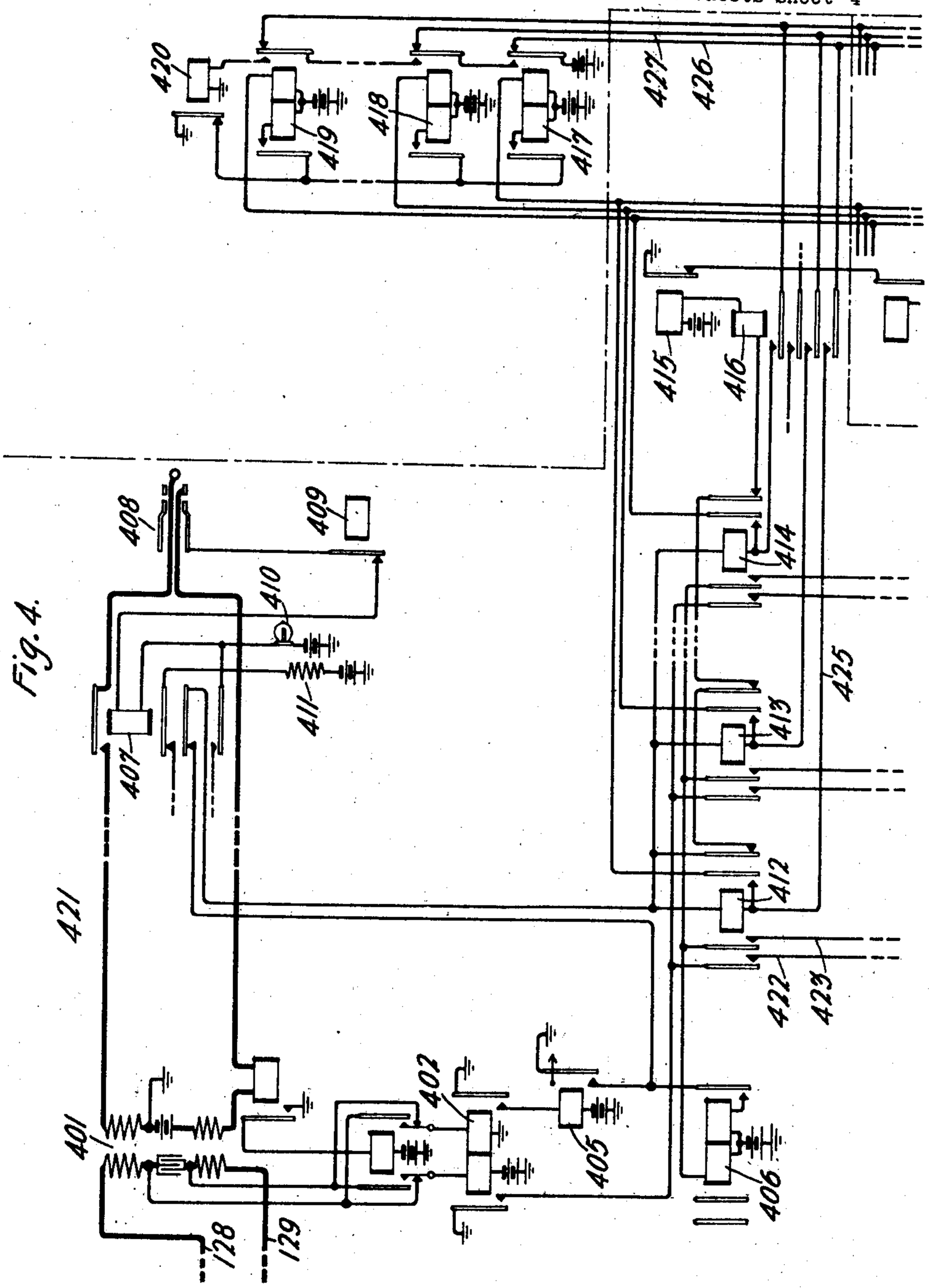


Fig. 4.

Inventor:
Emil Jacobsen
by [signature] Att'y.

April 5, 1927. E. JACOBSEN 1,623,118

TELEPHONE EXCHANGE SYSTEM

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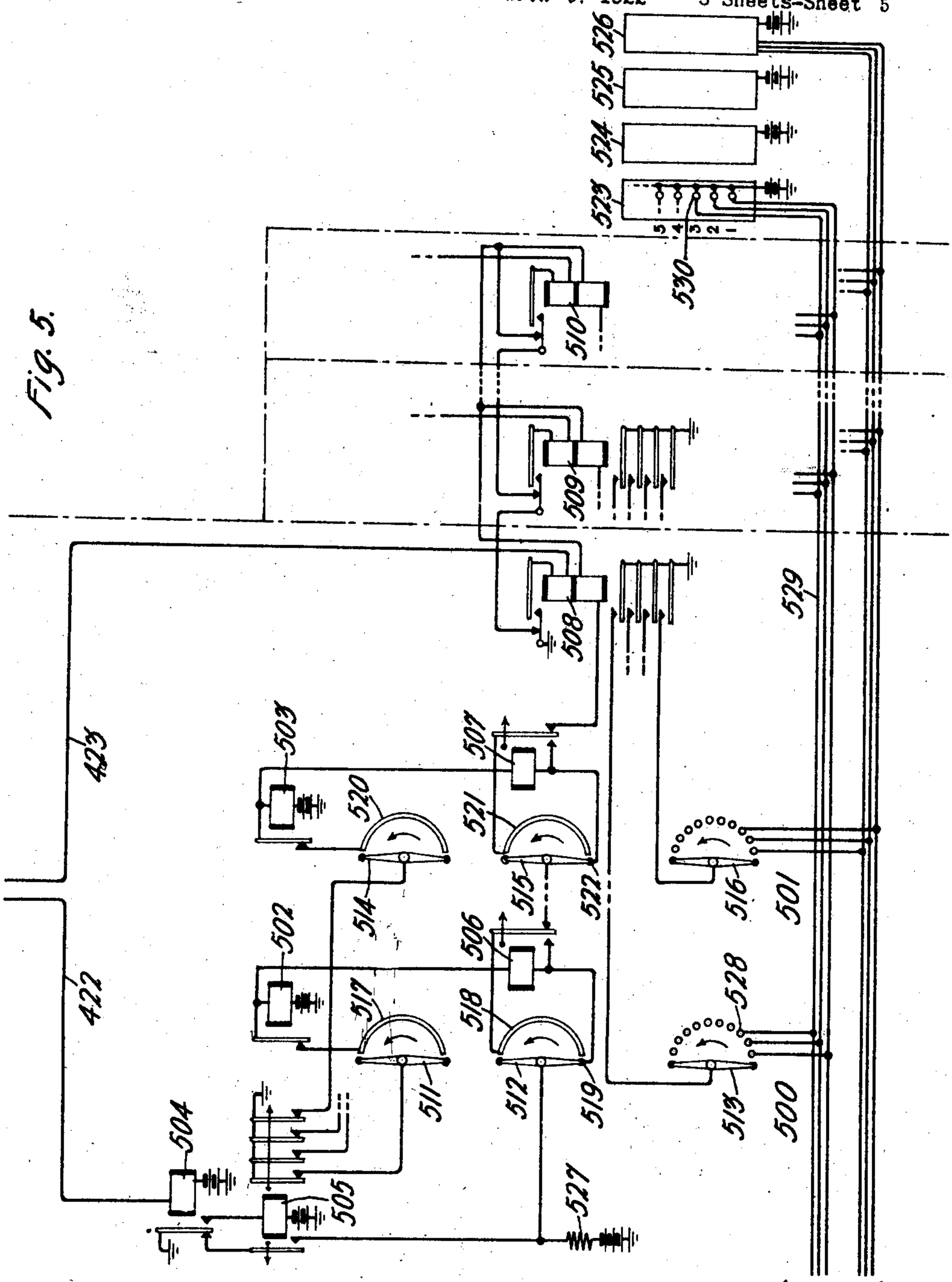
Fig. 5.



Inventor:
Emil Jacobsen
by Gerlach Att'y.

Patented Apr. 5, 1927. 1,623,118

UNITED STATES PATENT OFFICE.

EMIL JACOBSEN, OF PORT WASHINGTON, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed March 3, 1922, Serial No. 540,888. Renewed October 18, 1926.

This invention relates to telephone exchange systems and particularly to systems in which both automatic switching devices and operators' connecting circuits are employed in the establishment of connections.

In systems where certain offices are equipped with mechanical switching apparatus, whereas other offices involve operators' manual connecting circuits for setting up talking connections, it is found desirable to give the operators the necessary information regarding calls between offices of these types without the necessity of any oral communication either between the subscriber and an operator or between operators. With such information at her disposal the operator is enabled to complete the call incoming from the mechanical office to the desired line in the manual office. To this end the operators' positions are provided with call indicating devices which are operated in accordance with the designation of the wanted line. These indicating devices may be operated in response to digital impulse series transmitted by a subscriber, or originated by an operator, and serve to display the designation of the called line to the manual operator.

The object of this invention is to extend the calling party's line over automatic switches to an operator's position and then to operate an indicating device at such position.

A feature of the invention relates to a system in which a calling party transmits impulses to operate automatic switches to extend a connection to the connecting circuits at an operator's position and thereafter transmits impulses which operate an indicating mechanism at such position common to said circuits.

A further feature relates to a system in which a subscriber is provided with means for sending a plurality of impulses, a portion of said impulses operating selective switches to extend a connection to an operator's position, other of said impulses being transmitted directly over the extended connection to operate one of a plurality of registering mechanisms for controlling an indicating device at such position.

A still further feature relates to the provision in a system of this character of a plurality of indicator controlling registers common to the connecting circuits at the operator's position and a selecting switch for associating any register with one of the connecting circuits.

A further feature relates to the provision of an arrangement for controlling the setting of a register mechanism, associated with an operator's connecting circuit, by means in the connecting circuit which responds to incoming impulses.

Another feature consists in providing a signal at the operator's position to be rendered effective if impulses are sent at a time when no register is associated with the operator's connecting circuit.

Other and further features contemplated by the present invention will become apparent from the following description and the annexed claims.

Referring to the drawing, Figures 1, 2 and 3, when taken together, illustrate one embodiment of the invention, while Figs. 1, 4 and 5, when taken in a similar manner, disclose a modification of the system to which the invention is applicable.

Fig. 1 shows a single subscriber's line terminating in a central office equipped with automatic switches and also the outgoing end of an interoffice trunk accessible to said switches.

Fig. 2 illustrates a manual office in which trunks incoming from the distant automatic office terminate in cord circuits at an operator's position. The cord circuit in which the trunk leading from the automatic office terminates is given in detail while a second of the cord circuits at this position is illustrated schematically. Fig. 2, furthermore, discloses a register selector switch individual to the incoming trunk and serving to associate the same with indicator register sets.

Fig. 3 shows one complete indicator register set at the operator's position concerned and also a set of indicator lamps individual to the operator's position and common to each of the several indicator register sets.

Fig. 4 corresponds to Fig. 2 and illustrates an incoming trunk terminating in an operator's cord circuit together with an individual register selecting mechanism consisting of relays for attaching to the cord circuit the indicator register sets. In the upper right corner of this figure there are disclosed a number of relays which are provided in common to all the operators' cord circuits at this particular position.

Fig. 5 is a partial showing of one of the indicating register sets at the operator's position. This figure, furthermore, illustrates certain elements pertaining to other and similar register sets and also shows diagramatically the number indicating lamps at the operator's position common to all register sets.

The central office illustrated in Fig. 1 is of the full mechanical type and is provided with automatic switches of the class operated directly in response to impulses transmitted over the subscriber's line. The switches shown, for example, are those of the step-by-step type. The calls incoming from subscribers' lines to the mechanical office are first extended by a primary switch of any suitable character, such as the one illustrated by the brushes 102, 103 and 104, to a first selector switch 105 which alone, or in conjunction with as many succeeding switches as may be required, serves to extend the connection either to local lines or to trunks outgoing to distant offices.

As above mentioned, the central office illustrated in Figs. 2 and 3 is of the manual type, provided with operators' positions and cord circuits for completing connections to subscribers' lines. These positions are equipped with a number of cord circuits such as the one shown in full, each cord circuit having an individual step-by-step single motion selector switch for connecting the cord to idle indicator register sets. The selector switch is advanced by a stepping magnet on deenergization thereof and is so arranged as to normally stand on the terminals representing an idle register set.

The operator's position is further equipped with a number of the indicator register sets mentioned, one of which is shown in Fig. 3 and consists of a plurality of step-by-step rotary switches designated by the numerals 360, 361, 362 and 363 together with a control switch 364. The register switches each represent a digit of a called number and operate in response to impulses transmitted over the line to select the corresponding designated indicator lamps before the operator.

The indicator lamps, of which there are four groups 300, 305, 310 and 315 are common to all of the register sets at the position and may be associated with any one thereof to display the designation received.

The modification illustrated in Figs. 4 and 5, instead of employing a step-by-step register selector switch has an equivalent switch consisting of relays, three of which 412, 413 and 414 are illustrated. By means of this relay switch any one of the several register sets shown in Fig. 5 may be associated with the cord circuit at the operator's position. The number lamps 523, 524, 525 and 526 located at the position are, similarly, common to all indicator register sets. The indicator registers consist of step-by-step switches, two of which 500 and 501, belonging to one set are shown in full.

There are shown throughout the drawing several relays of the slow-to-release type. These are the relays 107, 108, 126, 212, 213, 335, 405, 505, 506 and 507. They are represented conventionally as slow-to-release relays by means of an arrow carrying a weight. The direction in which the arrow points indicates the direction in which the relay moves its armature slowly.

It is believed that a better understanding will be had of the invention by giving a detailed description of the system. Assume first that the subscriber of line 100, which line terminates in the automatic exchange equipped with the switches of the step-by-step character, wishes to communicate with a subscriber whose line terminates in a distant manual office provided with operators' equipment, such as shown in Figs. 2 and 3. For obtaining this connection, the subscriber dials the complete number of the called line in the same manner as though said line terminated in an automatic exchange. Since, however, the called line is one which belongs to a distant manual office, only a portion of the digits of the number represents automatic switch operations while the remaining digits must be communicated to the distant operator in order that she may complete the connection which has been extended to her by the switches. It is desirable that this information be given the operator without the necessity of oral comunication with the calling subscriber and to that end, a system of the character shown has been provided. The initial series of impulses transmitted will cause the setting of automatic switches to seize the trunk 128—129 leading to the proper manual office. The remaining series of impulses representing the latter part of the called number follow in regular succession and are transmitted over the trunk to the manual office and there recorded on the registers of an indicator register set. These registers then determine the illumination of the proper indicator lamps to apprise the operator of the number of the called line.

When the subscriber of line 100 removes his receiver from the switchhook, the usual condition is created at the central office for causing the operation of the preliminary switch to set its brushes 102, 103 and 104 upon the terminals of an idle trunk leading to a selector switch 105. Immediately that the trunk is chosen a circuit is closed for the line relay 106 including the loop of the subscriber's station. Relay 106 at its front contact closes a circuit for slow-to-release relay 107. The subscriber next manipulates his dial 101 in accordance with the first digit of the desired number. For each opening of

the line, relay 106 retracts its armature and a circuit is closed from ground through the back contact of the said relay, inner armature and front contact of relay 107, winding of relay 108, winding of the primary stepping magnet 110, side switch arm 113 to battery. Relay 108 operates and being slow to release retains its armature during the transmission of the impulses. Magnet 110 responds to each impulse and steps the brushes 119, 120 and 121 from one group of terminals to another. Upon the energization of relay 108, a circuit is closed from battery through the winding of escape magnet 111, armature and contact of relay 108 to ground. Magnet 111 energizes preparatory to advancing the side switch into its second position.

When the impulse series is finished and the brushes of the switch are positioned with respect to the proper group of trunks, an interval follows at the end of which relay 108 releases its armature. The retraction of the armature of relay 108 opens the circuit of the escape magnet 111 which becomes deenergized and advances the side switch into its second position. Immediately that the switch arms 130 and 131 leave position 1, relay 106 deenergizes and opens the circuit of relay 107. Relay 107, however, is slow to release and before it can become deenergized, a circuit is closed traceable from battery through the winding of said relay, switch arm 118 (position 2) switch arm 114 (position 2), secondary off-normal contact 115 to ground. Furthermore, a circuit is closed from battery through the winding of escape magnet 111, switch arm 114 (position 2) contact 115 to ground. The escape magnet becomes energized preparatory to releasing the side switch into its third position.

With the side switch in position 2, a circuit is closed from battery through the switch arm 113, winding and armature and contact of the secondary stepping magnet 109 to ground. Magnet 109 energizes, interrupts its own circuit and steps the brushes 119, 120 and 121 on to the first set of terminals in the selected group. The first stop of the secondary magnet causes the contact 115 to open. However, the test brush 121 encounters the test terminal of the first trunk in the group slightly in advance of the opening of contact 115. Therefore, if the first trunks happens to be busy a ground potential exists on the test terminal and the escape magnet 111 and relay 107 are maintained energized. The circuit for magnet 111 leads through the second position contact and switch arm 118 to the test brush 121 while the circuit for relay 107 leads directly to the test brush 121. The switch continues to step until the test brush 121 encounters an ungrounded test terminal 124. At this time the circuits of magnet 111 and relay 107 are severed. The escape magnet releases immediately and advances the side switch into position 3 whereupon the stepping movement terminates.

As soon as the connection is extended through to the selected trunk, a circuit is completed from battery through the right winding of relay 125, lower left-hand winding of repeating coil 127, terminal 123, brush 120 thence over the loop of the calling line and returning to brush 119, terminal 122, upper left-hand winding of coil 127, left-hand winding of relay 125 to ground. Relay 125 operates and closes a circuit for relay 126. Relay 126 energizes and connects ground to the test terminal 124 to identify the selected trunk as busy to other switches. Immediately that the brush 121 moved on to the test terminal 124 of the idle trunk, the holding circuit of relay 107 was opened since no ground potential existed on said terminal 124. Relay 107, however, being slow to release holds its armatures until relay 125 has time to operate in series with the line to, in turn, close a circuit for relay 126. The ground applied to the test terminal 124 by relay 126 in addition to holding relay 107 operated, is also extended by way of switch-arm 117 to the test conductor 132.

The selector switch 105 has thus chosen an idle trunk 128, 129 leading to the desired manual office. The outgoing end of this trunk is equipped with a repeater mechanism which receives the impulses incoming from the subscriber's dial and repeats them over the trunk to the distant office, there to position the registers associated with the trunk. Relay 125 upon energizing, establishes a circuit from battery through the right-hand winding of relay 207, normal right-hand contact of relay 208, lower left-hand winding of repeating coil 201, conductor 129, lower right-hand winding of coil 127, outer contact of relay 125, upper right-hand winding of coil 127, conductor 128, upper left-hand winding of coil 201, left-hand normal contact of relay 208, left-hand winding of relay 207 to ground. Relay 207 becoming energized closes a circuit from ground through its front contact, left contact of slow-to-release relay 213, winding of slow-to-release relay 212 to battery. Relay 212 operates and completes a circuit from ground through its left contact, windings of relays 216 and 217 in parallel, contact and winding of stepping magnet 215, resistance 214 to battery. The relays 216 and 217 are operated but their combined resistance is such that the stepping magnet 215 of the selector switch does not receive sufficient current to operate. It is assumed that the brushes 241, 219, 262, etc. of the selector switch are standing on the terminals representing an idle indicator register set. Relay 216 applies ground through its left front

contact and brush 241 to the corresponding terminals in all other selector switches to identify the register set as busy. Relay 216, moreover, closes a circuit from ground through the left contact of relay 212, inner right contact of relay 216, brush 219, conductor 301, outer left back contact of relay 326, brush 324 of the control switch 364 and its normal position terminal 302, contact and armature and winding of the stepping magnet 322 to battery. The magnet 322 interrupts its own circuit and advances the brushes 327, 328, 324, etc. of the control switch on to their second position terminals. In the second position of the control switch, the brush 329 encounters the continuous arc 303 and a circuit is closed as follows for locking the relays 216 and 217 independently of relay 212: battery, through the winding and contact of magnet 215, windings or relays 216 and 217 in parallel, inner right contact of relay 216, brush 219, conductor 301, outer left back contact of relay 326, segment 303, brush 329 to ground. The preceding operations have all taken place in a very brief space of time and the apparatus is thus in condition to receive the next series of impulses transmitted by the subscriber's dial.

For each interruption of the line during the transmission of the next series of impulses, relay 125 retracts its armature and opens the circuit of relay 207. Each time the relay 207 releases its armature in response to the impulses sent over the trunk 128, 129 it closes a circuit from ground through its back contact, right-hand armature and front contact of relay 212, outer left front contact of relay 217, brush 239, conductor 304, outer left contact of relay 337, winding of slow-to-release relay 335, brush 327 (position 2), conductor 306, winding of stepping magnet 333 to battery. Relay 335 and magnet 333 become energized. At the end of each impulse when relay 207 attracts its armature, the circuit of relay 335 and magnet 333 is opened. Relay 335 retains its armature and magnet 333 becomes deenergized and advances the brushes 348, 392 and 340 from one position to another. At the end of the first series of impulses repeated to the manual office, an interval follows sufficient for relay 335 to become deenergized. A circuit is then completed from battery through the winding and contact of magnet 322, back contact of relay 335, brush arm 328 (position 2), brush 348 to ground. The magnet 322 interrupts is own circuit and advances the brushes of the switch 364 to their third position.

The subscriber next manipulates his dial 101 to transmit the next succeeding series of impulses whereupon the relay 125 intermittently releases and attracts its armature. For each impulse repeated over the trunk 128, 129, relay 207 retracts and attracts its armature. For each operation of relay 207, a circuit is closed as above traced from ground over the conductor 304 through the winding of relay 335, brush arm 327, (position 3), conductor 307, winding of stepping magnet 346 to battery. The relay 335 remains energized during this series while the magnet 346 operates to advance the brushes 350, 393 and 341 of the second register switch 361 to a position corresponding to the digit transmitted. At the end of this impulse series, relay 335 releases and a circuit is closed from battery through the winding and contact of magnet 322, contact of relay 335, brush arm 328 (position 3), brush 350 to ground. Magnet 322 advances the controlling switch 364 into its fourth position. In a manner identical to that already explained, the next series of impulses causes the stepping magnet 351 to position the brushes 390, 394 and 342 of the third register switch 362 on their proper terminals following which magnet 322 is operated to advance the control switch into position 5. Thereafter, the next and last series of impulses transmitted by the subscriber is effective to cause intermittent operation of magnet 352 to advance the brushes 391, 395, 343 of register 363 into their proper position. Following the transmission of the last series of impulses, the stepping magnet 322 is operated and the control switch 364 moves its brushes into their sixth position.

When switch 364 reaches position 6 a circuit is closed from battery through the winding of relay 337, brush arm 331, outer left back contact of relay 326, segment 303, brush 329 to ground. Relay 337 operates and locks through its inner left armature and contact to ground at brush arm 329 independent of brush arm 331. The record has now been recorded on the indicator register set and the next operation to take place is to display the number on the indicating lamps. This is performed by the operator who actuates an assignment key upon being informed that a called number is waiting to be displayed on the indicator.

When the relay 337 operates it completes a circuit from battery through its inner right contact, brush 262, inner left contact of relay 217, assignment lamp 263, outer right back contact of relay 264 to ground. The lamp 263 burns steadily and the operator observing the same knows that a number has been recorded on a register set and is awaiting her attention. In response to this signal she depresses the assignment key 265 individual to the cord circuit and a circuit is closed from battery through the resistance 266, inner lower contact of relay 267, right-hand winding of relay 264, contacts of key 265, inner right contact of relay 217 to ground. Relay 264 operates and locks through its two windings in series and

inner left contact independent of the key 265. The key 265 being of the non-locking type opens its contacts as soon as released by the operator. The relay 264 in operating shifts the circuit of the assignment lamp 263 so that it now leads through the interrupter 268 to ground. The lamp 263 flickers in this circuit and serves to identify to the operator the particular cord circuit at that position relating to the number which is about to be displayed on her indicator lamps.

Relay 264, furthermore, completes a circuit from ground through the inner right contact of relay 217, outer left contact of relay 264, brush 273, windings of relays 374 and 371 in parallel to battery. Relay 371 becomes energized and completes circuits from ground through each of the brushes 340, 341, 342 and 343 and thence through an indicator lamp in each group corresponding to the position in which the associated brush is standing, and thence to battery. The illumination of the lamps advises the operator of the desired line whereupon she seizes the plug 278 identified by the lamp 263 and inserts it in the jack 279. Relay 264 in addition to performing the functions above mentioned also closes a circuit from battery through the winding of relay 213 and from battery through the windings of relay 269 thence through the inner right contact of relay 264 to ground at the inner right contact of relay 217. Relays 213 and 269 become operated and lock to ground through the right contact of relay 269. Relay 213 opens the circuit of relay 212.

The relay 374, on operating, completes a circuit from ground through its left contact, brush 328 (position 6) contact of relay 335, contact and winding of magnet 322 to battery. The stepping magnet 322 interrupts its own circuit and steps the switch 364 over positions 7, 8, 9, 10 and into position 11 where the stepping circuit above traced is opened at the brush arm 328. The switch 364 remains in position 11 awaiting the release of the registers 360, 361, 362 and 363.

The insertion of the plug 278 into the jack 279 of the called line completes a circuit from battery through the lamp 280, winding of relay 267, left back contact of relay 281, sleeve of plug 278, sleeve of jack 279, winding of relay 282 to ground. Relay 267 operates completing the tip strand of the talking circuit. The operation of relay 267 also completes a circuit from battery through the winding of relay 283, right contact of relay 284, left contact of relay 285, outer right contact of relay 213, lower front contact of relay 267, winding of relay 267 and thence to ground through the winding of relay 282. This circuit permits the energization of relay 283 and maintains relay 267 operated in shunt of the lamp 280. Consequently the lamp 280 remains extinguished. Before proceeding further with the application of ringing current which is now about to be sent over the line, a description will be given of the manner in which the register set and the operator's number indicator are restored to normal.

Relay 267, on operating, opens the above traced holding circuit for relay 264. This relay becomes deenergized and opens the circuit of relays 374 and 371. Relay 371 severs the lamp circuits causing them to become extinguished. Upon the deenergization of relay 374, a circuit is closed from battery through the winding of relay 388, right contact of relay 374, brush arm 331 (position 11), outer left back contact of relay 326, segment 303, brush 329 to ground. Relay 388 operates and completes circuits from battery through each of the stepping magnets 333, 346, 351 and 352, contacts of relay 388 and thence, respectively, through the brushes 348, 350, 390 and 391 to ground. The magnets 333, 346, 351 and 352 interrupt their own circuits and step the corresponding brushes of the register switches forward into their normal position where the stepping circuits are opened and the switches are permitted to rest. When all of the register switches have been restored a series circuit is completed from ground through the brushes 395, 394, 393 and 392, brush 328 (position 11), contact of relay 335, contact and winding of magnet 322 to battery. Magnet 322 interrupts its own circuit and advances the control switch 364 into its normal position whereupon the relay 388 becomes deenergized. When the control switch 364 reaches its normal position, the above traced holding circuits of relays 337, 216 and 217 are opened at the brush 329. Relay 216 moves the busy ground from the multiples of the terminals on which brushes 241 are standing.

Returning to the point where the operator inserted the plug 278 into the jack of the called line, it will be recalled that the relay 283 was actuated in response to this act. The ringing circuit, which is completed by relay 283, may be traced from the source of ringing current 211, winding of relay 285, lower front contact of relay 283, ring of plug 278, ring of jack 279 over the called line and returning through the tip of jack 279, tip of plug 278, upper front contact of relay 267, upper front contact of relay 283 to ground. When the called subscriber responds the marginal relay 285 operates, and in so doing, opens the shunt which has been maintained around the winding of relay 284. With this shunt removed, the circuit previously traced through the winding 283, winding of relay 267 and thence to ground through the winding of relay 282 now in-

cludes the winding of relay 284. This latter relay becomes operated and closes a circuit from battery through its right front contact and winding and thence over the above traced circuit through the winding of relay 282. The relay 283 is thus shunted out and in retracting its armature closes the tip and ring of the talking circuit and disconnects the source of ringing current. With the talking circuit completed, the called subscriber's line is included in series with the right-hand windings of repeating coil 201 and the winding of relay 287. Relay 287 operates and a circuit is closed through the winding of relay 208 to ground at the left contact of relay 284. Relay 208 reverses the current over the trunk 128, 129 which may serve for the usual message register and coin-collect operations at the originating exchange.

At the end of conversation, the calling subscriber replaces his receiver on the switchhook whereupon the relay 125 becomes permanently deenergized. Relay 125 opens the circuit of relay 207 and this relay releases its armature. Relay 269 is shunted out by the direct application of ground at the back contact of relay 207. Relay 269, therefore, releases its armature and opens the holding circuit of relay 213. Relay 213 retracts its armature after an interval and opens the circuit previously traced through the windings of relays 284, 267 and 282. Relays 267 and 282, however, remain energized by a circuit from battery through the lamp 280 thence through the winding of relay 267 and, as previously traced, to ground through the winding of relay 282. The shunt thus being removed, lamp 280 becomes illuminated to advise the operator that the connection is no longer required. She thereupon proceeds to remove the plug 278 from the jack 279 in response to which act, the relay 267 and relay 282 become deenergized. All apparatus is now restored to its normal condition ready to be taken in connection with subsequent calls.

A brief description will be given of the manner in which the indicator register selector switch operates to preselect idle registers and associate them with the trunk circuit. Assume that the register set shown, upon the terminals of which the brushes 241, 219, 262, etc. are now standing, is chosen by another selector switch and made busy. Immediately that this happens a circuit is closed from battery through the resistance 214, winding and contact of stepping magnet 215, left back contact of relay 216, brush 241 thence over the multiples of the terminal upon which such brush is standing to the corresponding brush 241 of the other selector switch thence through the left front contact of the relay corresponding to relay 216 of the other cord circuit to ground. Magnet 215 operates in this circuit and advances brushes 241, 219, 262, etc. on to the terminals representing the next register set. If this register set is idle, the switch will stop, but if busy such switch will continue to operate until it reaches an idle register set.

In the small rectangle at the right-hand side of Fig. 2, a second cord circuit 217 at this same operator's position is illustrated. Moreover, the assignment key 220 and relay 218 are shown corresponding to the similar elements illustrated in connection with the cord shown in detail. There are, of course, several such cord circuits at the operator's position, each provided with an individual step-by-step selector switch for associating such cords with indicator register sets.

A description will now be given of the modifications shown in Figs. 4 and 5. Up to the point where the connection is extended over the trunk 128, 129 to the manual office all operations are identically the same as previously explained. Upon the operation of relay 125 in the mechanical office a circuit is closed substantially as described hereinbefore for the relay 402, this circuit including the left-hand windings of the repeating coil 401 and the trunk conductors 128 and 129. Relay 402 prepares a circuit for slow-to-release relay 405. Relay 405 immediately operates and establishes a circuit from ground through its contact, intermediate lower contact of relay 407 and thence in series through the outer right contacts of relays 412, 413 and 414, windings of relay 416 and 415 to battery. Relays 415 and 416 become operated and the above traced circuit is extended through the winding of relay 412, conductor 425, lowermost contact of relay 416, common conductor 426, right back contact of relay 417 to battery.

It is assumed that the first register set accessible to this operator's position is idle. The relay 417 represents the first register set and is common to all of the operator's cord circuits. If the register set is idle, the relay 417 is deenergized but if it is busy in connection with any cord circuit then the relay 417 will have its armatures attracted. The next relay 418 in a similar manner represents the second register set and so on, the relay 419 representing the last set of registers accessible to this operator.

Assuming then that the first register set is idle at the time the call appears on the trunk 421, the relay 417 is deenergized and accordingly the operation of relay 405 causes the energization of relay 412. Relay 412 on operating completes a circuit from ground through the contact of relay 405, intermediate lower contact of relay 407, winding and inner right contact of relay 412, right-hand winding of relay 417 to bat-

tery. Relay 417 operates in series with relay 412 and locks through its left-hand winding and contact to ground at the common relay 420. The purpose of relay 420 will be explained later.

In the same manner that relay 417, which is common to all cord circuits, represents the first register set at the operator's position, the relay 412 also represents this first register set and is individual to the particular cord circuit 421. The next relay 413 is also individual to the cord circuit 421 and represents the second register set. Relay 414 represents the last register set. Obviously, as many intermediate relays may be provided as there are sets of registers to be connected to the cord circuit. With the relay 412 operated, the cord circuit 421 is associated by way of conductors 422 and 423 with the register set illustrated in partial detail at the left of the vertical broken line in Fig. 5. Immediately, when relay 412 operates a circuit is established from ground through the left contact of relay 402, outer left contact of relay 412, conductor 422, winding of relay 504 to battery. Relay 504 operates and completes a circuit for the slow-to-release relay 505. The apparatus is now in condition to receive the incoming impulses repeated over the trunk 128, 129.

In response to each interruption of the series repeated over the trunk 128, 129, relay 402 releases and retracts its armatures. Relay 405 being slow to release maintains its armature during the brief interval between interruptions. At each retraction of the left-hand armature of relay 402, relay 504 becomes deenergized. Relay 505 being slow to release holds its armatures attracted during the operation and release of relay 504. Upon the first retraction of the armature of the relay 504, a circuit is closed from ground through the back contact of said relay, left contact of relay 505, brush 512, normal contact 519, winding of slow-to-release relay 506, winding of the stepping magnet 502 to battery. The relay 506 becomes operated in this circuit. The stepping magnet 502 of the first register switch 500 energizes and when relay 504 next attracts its armature, magnet 502 becomes deenergized and advances the brushes 511, 512 and 513 to their second position contacts. In the second position of the switch and thereafter until the switch again reaches its normal position, the brushes 511 and 512 are respectively in contact with the segments 517 and 518. On the next retraction of the armature of relay 504, a circuit is closed from ground through the back contact of said relay, left contact of relay 505, brush 512, segment 518, front contact of relay 506, winding of said relay and thence through the winding of magnet 502 to battery. When relay 505 again attracts its armature, magnet 502 becomes deenergized and the brushes are stepped to the next position. For each succeeding impulse, the brushes 511, 512 and 513 move forward one step, and relay 506 is maintained energized. At the termination of the series, relay 402 maintains its armatures attracted and relay 504, in turn, remains energized. After an interval the slow-to-release relay 506 becomes deenergized and releases its armature, thereby extending the stepping circuit through to the next register switch.

The circuit leading from the back contact of relay 506 is indicated by a dotted line which signifies that there may be a plurality of intermediate registers between the registers 500 and 501. For recording a four digit number there would be required, of course, four register switches and consequently two more switches will be interposed between the two shown in the drawing. Assume, therefore, that the next two series of impulses representing two digits are recorded on two registers identical in all respects to those shown in the drawing and that at the end of the third series, the stepping circuit is extended over the back contacts of relays similar to relay 506 to the brush 515 of the last register switch 501.

When, therefore, the first impulse of the last series is transmitted, relay 504 releases and establishes a circuit from ground through its back contact, left contact of relay 505, brush 512, segment 518, back contact of relay 506 thence through the brushes similar to brush 512 and back contact of relays similar to relay 506 of the two intermediate registers to the brush 515, terminal 522, winding of relay 507, winding of stepping magnet 503 to battery. Relay 507 attracts its armature and the stepping magnet 503 also becomes energized. At the end of the impulse, magnet 503 is released and advances the brushes 514, 515 and 516 forward one step. For each of the succeeding impulses, magnet 503 operates to drive the brushes forward through one position. At the end of the last series of impulses relay 504 remains permanently energized and after an interval slow-to-release relay 507 becomes deenergized. A circuit is now established from battery through resistance 527, brush 512, segment 518, back contact of relay 506 and thence through corresponding elements to the brush 515, segment 521, back contact of relay 507, lower winding of relay 508, normal contacts of relay 510, normal contacts of relay 509, normal contacts of relay 508 to ground.

Relays 508, 509 and 510 are each individual to an indicator register set and their purpose is to prevent the association of more than one register set with the number lamps at the same time. Assuming that no other register set is, at the time, associated with the number lamps, all of the relays 508, 509

and 510, etc. are deenergized and the circuit just traced is completed for the operation of relay 508.

Relay 508, on attracting its armatures, completes a circuit from ground through the upper front contact and upper winding of said relay, conductor 423, inner left contact of relay 412, left-hand winding of assignment relay 406 to battery. Relay 406 and relay 508 becomes energized. The relay 508 opens the series circuit thereby preventing the subsequent operation of one of the relays 509, 510, etc. and the second association of the corresponding register set with the number lamps. Relay 406 in operating, locks through its right-hand winding and right contact to the contact of slow-to-release relay 405. Relay 508, at its lower armatures, closes circuits through the brushes 513, 516 and also through the corresponding brushes of the intermediate registers (not shown) to each of the groups of indicator lamps 523, 524, 525 and 526. If, for example, the first digit is 3, the register brush 513 is standing on terminal 528 and a circuit is closed as follows for the No. 3 lamp: ground, through the upper inner contact of relay 508, brush 513, terminal 528, conductor 529, the lamp 530 to battery. In a similar manner, a lamp in each of the remaining groups is illuminated by circuits leading through the brushes of the three remaining registers.

The operator, on observing the number displayed on her lamps, seizes the plug 408 of the cord circuit 421 and inserts it in the jack of the desired line. The insertion of the plug in the jack completes a circuit for relay 407 in the manner described hereinbefore. Relay 407 operates and opens the circuit of relay 412 and also the circuit through the right-hand winding of relay 417. Relay 412 becomes deenergized but relay 417 remains locked through its left winding. The release of relay 412 causes the deenergization of relay 504 and also the deenergization of relay 508. After an interval following the release of relay 504, the slow relay 505 retracts its armatures. A circuit is closed thereupon from ground through the innermost right contact of relay 505, brush 511, segment 517, contact and winding of magnet 502 to battery. Similar circuits are closed for each of the succeeding stepping magnets. The stepping magnets of the several register switches interrupt their own circuit and advance the brushes they control forward to the normal positions. When the switches have been fully restored, the stepping circuits are opened at brushes 511, 514, etc. The register mechanism is now restored to its normal position and may be associated with cord circuit 421 or with other cord circuits as soon as the relay 417 becomes deenergized.

At the termination of the conversation, the calling subscriber replaces his receiver on the switchhook permitting the deenergization of relay 402. Relay 402 releases and after an interval relay 405 retracts its armature. Relay 405 opens the holding circuit of relay 406. In any suitable manner the operator is advised by the disconnect signal 410 that the connection is no longer required. Responding to this signal she withdraws the plug 408 from the jack of the called line.

When the next call is received on the cord circuit 421 or on any other cord circuit at the operator's position, the previously traced circuit for relays 415 and 416 or relays corresponding thereto is closed. Since relay 417 pertaining to the first register set is locked at this time, the operation of relay 416 closes a circuit as follows: ground through the contact of relay 405, contact of relay 407, winding of relay 413, next to the lower contact of relay 416, conductor 427, right back contact of relay 418, right front contact of relay 417 to battery. Consequently, this time the relay 413 operates and locks in series with the right-hand winding of relay 418. Relay 418 locks through its left-hand winding to the contact of relay 420 in the same manner as relay 417. Therefore, relay 413 being operated, the cord circuit is associated with the second register set notwithstanding the fact that the first register set may have been idle at this time. In this same manner, the registers are taken for use in succession for handling the incoming calls until all registers have been used. At this time, a circuit is closed over the right front contacts of relays 417, 418, 419, etc. for the relay 420. Relay 420 operates and releases all the relays 417, 418, 419, etc. whereby the register sets may again be taken for use one after the other.

From the foregoing description it will be seen that a plurality of calls may come in on different cords at the same time, each being registered on a different idle register set. The register set shown, to which relay 508 is individual, has first choice of the common lamps. When relay 508 acts it opens the operating circuit of relays 509, 510, etc., of other register sets and prevents such sets from being associated with the lamps until the first set has been disassociated therefrom. Likewise the register set represented by relays 509, 510, etc., have the same definite preference over each other in acquiring access to the common lamps.

Should a connection be extended to the operator's cord circuit, shown in Fig. 2, and impulses transmitted over the extended connection at a time when the register selector switch is still seeking for an idle register, these impulses serve to operate a signal notifying the operator that an abnormal condition exists. As soon as the trunk 128, 129

is seized the relay 207 operates as previously explained and closes a circuit for the slow relay 212. Relay 212 operates but relays 216 and 217 remain deenergized since they are now shunted by a direct ground on the terminals encountered by the test brush 241 of the register selector switch. On the first impulse transmitted over the selected trunk, with this condition existing, a circuit is closed from battery through the winding of relay 281, outer left back contact of relay 217, right front contact of relay 212, back contact of relay 207 to ground. Relay 281 operates and closes a circuit from ground through its right contact, winding of relay 213 to battery. Slow-to-release relay 213 becomes energized. For each impulse the relay 207 attracts and retracts its armature and relay 281 is energized and deenergized correspondingly. Relay 213 maintains its armatures attracted and a circuit is closed as follows: battery, through the lamp 280 lowermost back contact of relay 267, inner right contact of relay 213, resistance 233, outer right contact of relay 216, interrupter 232 to ground. Interrupter 232 causes the lamp 280 to flash. The operator, seeing the flashing signal 280, knows that a call has been extended to her position when the apparatus is not in condition to receive the same. She thereupon takes the proper steps to answer the subscriber's wants as by extending the connection to a trouble operator.

What is claimed is:

1. In a telephone system, a telephone line, an automatic switch, an operator's position, a plurality of connecting circuits thereat, an indicating device at said position common to said circuits, means in said line for transmitting a plurality of impulses thereover, said switch being responsive to certain of said impulses for extending said line to one of the connecting circuits at the operator's position, other of said impulses being directed to said position, and means responsive to such impulses for operating said indicating mechanism.

2. In a telephone system, a telephone line, an automatic selector switch, an operator's position, a plurality of connecting circuits thereat, a number indicating device at said position common to all of said circuits, an impulse transmitter in said line for sending a plurality of impulses thereover said switch being responsive to certain of said impulses for extending said line to any one of the connecting circuits at the operator's position, other of said impulses being directed to said position, and means responsive to said latter impulses for operating said indicating device.

3. In a telephone system, a telephone line, an automatic switch, an operator's position, a plurality of connecting circuits thereat, an indicating device at said position common to said circuits manually operated means for transmitting a plurality of impulses over said line, said switch being responsive to certain of said impulses for extending said line to one of the connecting circuits at the operator's position, other of said impulses being directed to said position, and means responsive to said latter impulses for operating said indicating mechanism.

4. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a plurality of connecting circuits thereat, an indicating device at said position common to said circuits, means controlled by the subscriber for sending a plurality of impulses over said line, said switch being responsive to a portion of said impulses for extending said line to one of said connecting circuits, other of said impulses being directed to said position, and means responsive to said latter impulses for operating said indicating device.

5. In a telephone system, a subscriber's line, automatic switches, an operator's position, a plurality of connecting circuits thereat, an indicating device at said position common to said connecting circuits, means for sending series of impulses over said line, a certain number of the initial series of impulses being sent directly to said switches for operating the same to extend said line to one of the connecting circuits at the operator's position, the subsequent series of impulses being directed to said position, and means responsive to said last-mentioned series of impulses for operating said indicating device.

6. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a plurality of trunks leading from the automatic switch to the said position and terminating in connecting circuits, an indicating device at said position common to said connecting circuits, means for sending series of impulses over said line, a certain number of the initial series of impulses being sent to said switches for operating the same to extend a connection over one of said trunks to the corresponding connecting circuit at the operator's position, the succeeding series of impulses being sent over the extended connection to the operator's position, and means responsive to said last-mentioned impulses for operating said indicating device.

7. In a telephone system, a subscriber's line, automatic switches, an operator's position, a plurality of connecting circuits at said position, an indicating device common to said connecting circuits, means for sending series of impulses over said line in uninterrupted succession, a certain number of the impulse series being sent directly to said switches for operating the same to extend said line to one of the connecting circuits

at the operator's position, the subsequent series of impulses being directed over the extended connection to said position, and means responsive to said latter impulses for operating said indicating device.

8. In a telephone system, a subscriber's line terminating in a first office, an automatic switch in said office, an operator's position in a second office, trunks interconnecting said offices and terminating in cord circuits at said operator's position, an indicating device at said position common to said cord circuits, means for sending impulses over the subscriber's line, certain of said impulses being sent directly to said switch for operating the same to extend the subscriber's line over one of said trunks to the corresponding cord circuit at the operator's position in the second office, other of said impulses being sent directly over the extended connection to the operator's position, and means responsive to said last-mentioned impulses for operating said indicating device.

9. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit at said position, a plurality of register devices, an indicating device common to said register devices, means for sending a plurality of impulses over said line, said switch being responsive to certain of said impulses for extending said line to the connecting circuit at the operator's position, means for associating any one of said register devices with said connecting circuit, other of said impulses being sent directly to said position for setting the associated register device, and means for operating said indicating device in accordance with the setting of said register device.

10. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit at said position, a plurality of step-by-step register mechanisms, an indicating device at said position common to all of said register mechanisms, means controlled by the subscriber for sending a plurality of impulses over said line, said switch being responsive to certain of said impulses for extending said line to the operator's position, means for associating any one of said register mechanisms with said connecting circuit, other of said impulses being sent directly to said position, means responsive to said last-mentioned impulses for variably setting the associated register mechanism, and means for operating said indicating device in accordance with the setting of said register mechanism.

11. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit leading from said automatic switch to the operator's position, a plurality of register mechanisms, an indicating device comprising a plurality of designation lamps common to said register mechanisms, means for transmitting impulses over the subscriber's line, said switch being responsive to certain of said impulses for extending said line over the connecting circuit to the operator's position, other of said impulses being sent directly over said connecting circuit to said position, means for associating an idle register mechanism with said connecting circuit, means responsive to said last-mentioned impulses for setting the associated register mechanism, and means for operating said indicating device in accordance with the setting of said mechanism.

12. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a plurality of connecting circuits leading from said switch to the operator's position, a plurality of register mechanisms common to said circuits, an indicating device common to said register mechanisms, means for sending impulses over the subscriber's line, said switch being responsive to certain of said impulses for extending said line over any one of said connecting circuits to the operator's position, means for associating any one of said register mechanisms with the connecting circuit over which the connection has been extended, other of said impulses being sent directly over the extended connection to the operator's position, means responsive to said last-mentioned impulses for variably setting the associated mechanism, and means for operating said indicating device in accordance with the setting of such register mechanisms.

13. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit at said position, a plurality of register mechanisms, an indicating device common to said register mechanisms, means for transmitting impulses over said line, said switch being responsive to a portion of said impulses for extending said line to the connecting circuit at the operator's position, means individual to said connecting circuit for connecting an idle one of said register mechanisms with said connecting circuit, other of said impulses being sent directly over said connecting circuit to the operator's position for variably setting the connected register mechanism, and means for operating said indicating device in accordance with the setting of said register mechanism.

14. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit incoming to said position, a plurality of register mechanisms, a switch individual to said connecting circuit for associating any one of said register mechanisms with said connecting circuit, an indicating device common to said register

mechanisms, means for sending a plurality of impulses over said line, said switch being responsive to certain of said impulses for extending the subscriber's line over the connecting circuit to the operator's position, other of said impulses being sent directly to said position for variably setting the associated register mechanism, and means for operating said indicating device in accordance with the setting of the associated register mechanism.

15. In a telephone system, a subscriber's line, an automatic switch, an operator's position, a connecting circuit leading from the automatic switch to the operator's position, a plurality of register mechanisms, a step-by-step selector switch individual to said connecting circuit for associating any one of said register mechanisms with the connecting circuit, an indicating device at said position common to said register mechanisms, means for transmitting a plurality of impulses over the subscriber's line, said switch being responsive to certain of said impulses for extending said line over the connecting circuit to the operator's position, other of said impulses being transmitted over said connecting circuit to variably set the register mechanism associated with said connecting circuit, and means for operating said indicating device in accordance with the setting of said register mechanism.

16. In a telephone system, a subscriber's line, an automatic switch, a manual exchange, a trunk line leading from the automatic switch to the manual exchange and terminating in a cord circuit, an impulse repeater in said trunk line, a plurality of register sets, an automatic switch individual to the cord circuit for associating an idle register set therewith, means controlled by the subscriber for sending impulses first to operate the automatic switch to extend said line over the trunk and subsequently to operate said repeater to control the register set associated with said cord circuit.

17. In a telephone system, a subscriber's line, an automatic exchange having switches therein, a manual exchange, a trunk line leading from the automatic exchange and terminating in a cord circuit at the manual exchange, an impulse repeater in said trunk line, a plurality of register sets, an automatic switch individual to the cord circuit for associating an idle register set therewith, means controlled by the subscriber for transmitting impulses first to operate the automatic switches in the first exchange to extend said line over the trunk to the cord circuit at the manual exchange, and subsequently to operate said repeater to in turn control the register set associated with the cord circuit in said manual exchange.

18. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, automatic substations having access to said trunk lines for calling the subscribers in the manual exchange, a plurality of register sets for registering the telephone numbers of called manual stations, and an automatic switch for each of said cord circuits for connecting its associated cord circuit with an idle register set when the cord circuit is taken for use.

19. In a telephone system, a manual exchange and an automatic exchange, a trunk line accessible to automatic switches in the automatic exchange and terminating in a cord circuit in the manual exchange, a series of step-by-step register switches for registering the numbers of manual lines called over said trunk lines, a switch individual to said cord circuit for extending a connection to the first of said register switches when a line is being called, and a relay in said cord circuit for successively controlling all of said registers.

20. In a telephone system, a manual exchange and an automatic exchange, a trunk line accessible to automatic switches in the automatic exchange and terminating a cord circuit in the manual exchange, a series of step-by-step register switches for registering the numbers of manual lines called over said trunk line, a stepping magnet for each of said switches, a switch individual to said cord circuit for extending a connection to the first of said register switches when a line is being called, and a relay in said cord circuit for successively operating said magnets over a conductor passing through said individual switch.

21. In a telephone system, a plurality of register sets accessible to calling automatic stations for registering called telephone numbers, a common set of indicating lamps for indicating numbers so registered to an operator, and means for causing numbers registered at the same time to be indicated by said lamps successively.

22. In a telephone system, a line, an automatic switch, an operator's position, a connecting circuit thereat, a register device and means for associating the same with said connecting circuit, means for operating said switch to extend the line to said connecting circuit, means for sending impulses over the line to set said register device, a signal at the operator's position, and means for operating said signal if the impulses are sent at a time when the register device is not associated with said connecting circuit.

23. In a telephone system, a line, an automatic switch, an operator's position, a connecting circuit thereat, a plurality of register devices and means for associating any one of said devices with said connecting circuit, means for operating said switch to extend the line to said connecting circuit, means for sending impulses over the line to

set the associated register device, a signal at the operator's position, and means for operating said signal if the impulses are sent at a time when no register device is associated with said connecting circuit.

24. In a telephone system, a line, an automatic switch, an operator's position, a connecting circuit thereat, a plurality of register devices, a switch individual to said connecting circuit for preselecting an idle one of said register devices and associating the same with said connecting circuit, means for operating said automatic switch to extend the line to said connecting circuit, means for sending impulses over the line to set the associated idle register device, a signal at the operator's position, and means for operating said signal if the impulses are sent at a time when no idle register device is associated with said connecting circuit.

25. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, automatic substations having access to said trunk lines for calling the subscribers in the manual exchange, a plurality of register sets for registering the telephone numbers of called manual stations, and an automatic progressively movable switch individual to each of said cord circuits for connecting its associated cord circuit with an idle register set when the cord circuit is taken for use.

26. In a telephone system, a manual exchange and an automatic exchange, interoffice trunk lines terminating in plug ending cord circuits in the manual exchange, office selectors in the automatic exchange having access to said trunk lines and operable by calling subscribers responsive to the first digits in called numbers, a plurality of sets of register switches associated with said cord circuits for registering the remaining digits in called numbers, an automatic switch individual to each of said cord circuits for connecting with an idle register set whenever a connection is extended to the associated cord circuit, an indicating device comprising a plurality of lamps, and means for operatively connecting operated register sets with said indicating device one at a time.

27. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, manual subscribers' lines accessible to said cord circuits, automatic subscribers' stations having access to said trunk lines for calling the said manual lines, a plurality of register sets for registering the telephone numbers of manual lines so called, and an automatic progressively movable hunting switch individual to each of said cord circuits for connecting its associated cord circuit with an idle register set when the cord circuit is taken for use.

28. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, manual subscribers' lines accessible to said cord circuits, automatic subscribers' stations having access to said trunk lines for calling the said manual lines, a plurality of register sets for registering the telephone numbers of manual lines so called, an automatic switch individual to each of said cord circuits for connecting its associated cord circuit with an idle register set when the cord circuit is taken for use, a set of indicating lamps common to said register sets, and means for switching registered calls on to said lamps one at a time.

29. In a telephone system, a manual exchange and an automatic exchange, a trunk line accessible to automatic switches in the automatic exchange and terminating in a cord circuit in the manual exchange, a series of step by step register switches for registering the numbers of manual lines called over said trunk lines, a switch individual to said cord circuit for extending a connection to the first of said register switches when a line is being called, and a relay in said cord circuit for successively controlling all of said registers.

30. In a telephone system, a manual exchange and an automatic exchange, a trunk line accessible to automatic switches in the automatic exchange and terminating in a cord circuit in the manual exchange, a series of step by step register switches for registering the numbers of manual lines called over said trunk line, a stepping magnet for each of said switches, a switch individual to said cord circuit for extending a connection to the first of said register switches when a line is being called, and a relay in said cord circuit for successively operating said magnets over a conductor passing through said individual switch.

31. In a telephone system, an automatic exchange and a manual exchange, serially related switching devices in both exchanges which are controlled by a calling automatic subscriber in accordance with the digits in called automatic and manual telephone numbers, respectively, means in the last switching device in the series in the automatic exchange for completing the connection to a called automatic line, number indicating means controlled by the switching devices in the manual exchange, operator's equipment for completing the connection to a called manual line, means for automatically signalling the called subscriber in both cases, and means for giving the calling subscriber a uniform audible signal during the ringing operation in both cases.

32. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, automatic substations having access to said trunk lines for calling

the subscribers in the manual exchange, a plurality of register sets for registering the telephone numbers of called manual stations, and a step by step automatic switch for each of said cord circuits for selecting an idle register set and for connecting its associated cord circuit therewith when the cord is taken for use.

33. In a telephone system, a manual exchange, trunk lines terminating in cord circuits in said exchange, manual subscribers' lines accessible to said cord circuits, automatic subscribers' stations having access to said trunk lines for calling the said manual lines, a plurality of register sets common to said cord circuits for registering the telephone numbers of manual lines so called, and a non-restoring automatic switch individual to each of said cord circuits for connecting its associated cord circuit with an idle register set when the cord circuit is taken for use.

34. In a telephone system, a manual exchange and an automatic exchange, a trunk line accessible to automatic switches in the automatic exchange and terminating in a cord circuit in the manual exchange, a series of register switches for registering the numbers of manual lines called over said trunk lines, a switch individual to said cord circuit for extending a connection to the first of said register switches when a line is being called, a relay in said cord circuit controlled over said trunk line by decimal impulses corresponding to the digits in the called number, an operating magnet in the first register switch controlled by said relay responsive to the first digit, and operating magnets in the other register switches successively controlled thereafter by said relay responsive to the remaining digits.

In testimony whereof, I have signed my name to this specification this 2nd day of March, 1922.

EMIL JACOBSEN.