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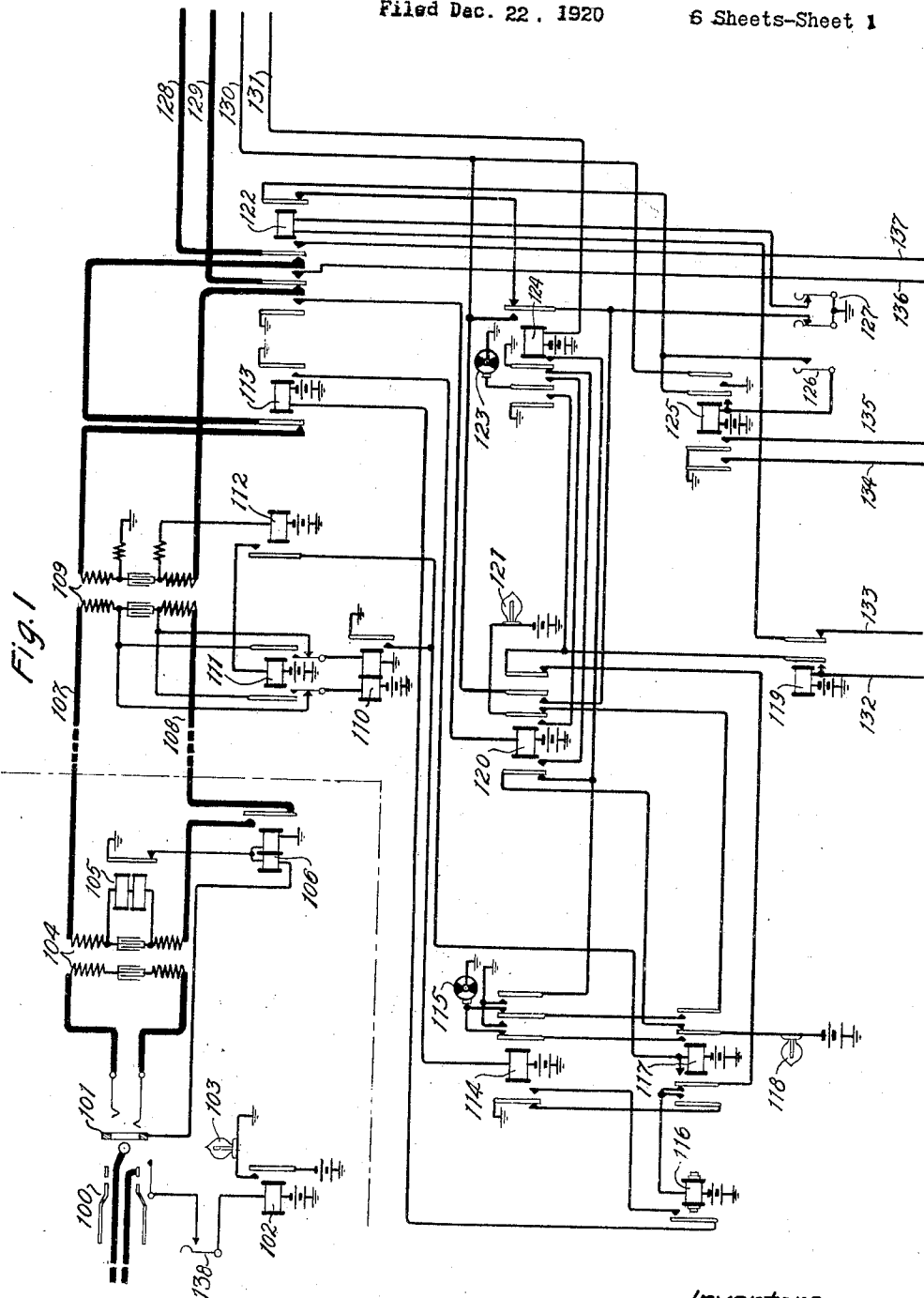
W. W. CARPENTER ET AL

1,478,022

TELEPHONE SYSTEM

Filed Dec. 22, 1920

6 Sheets-Sheet 1



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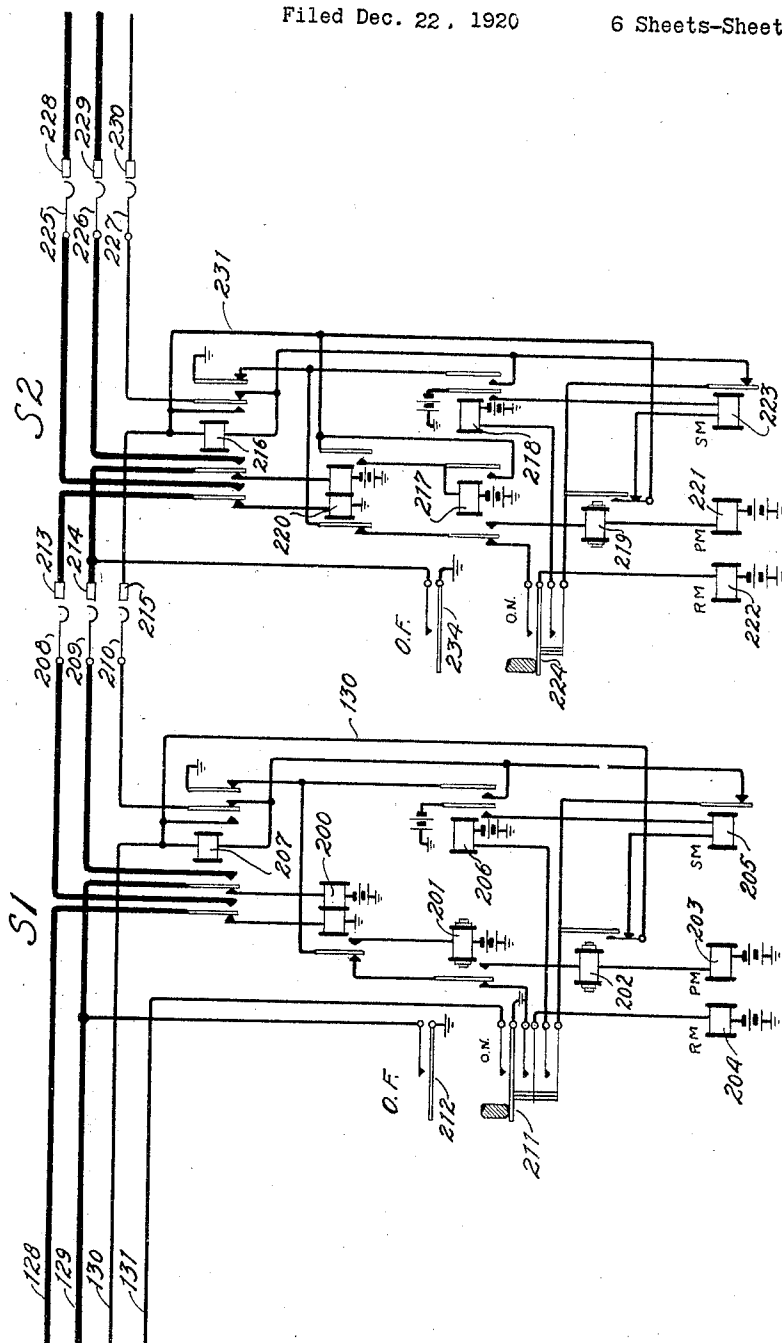
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6 Sheets-Sheet 2

Fig. 2



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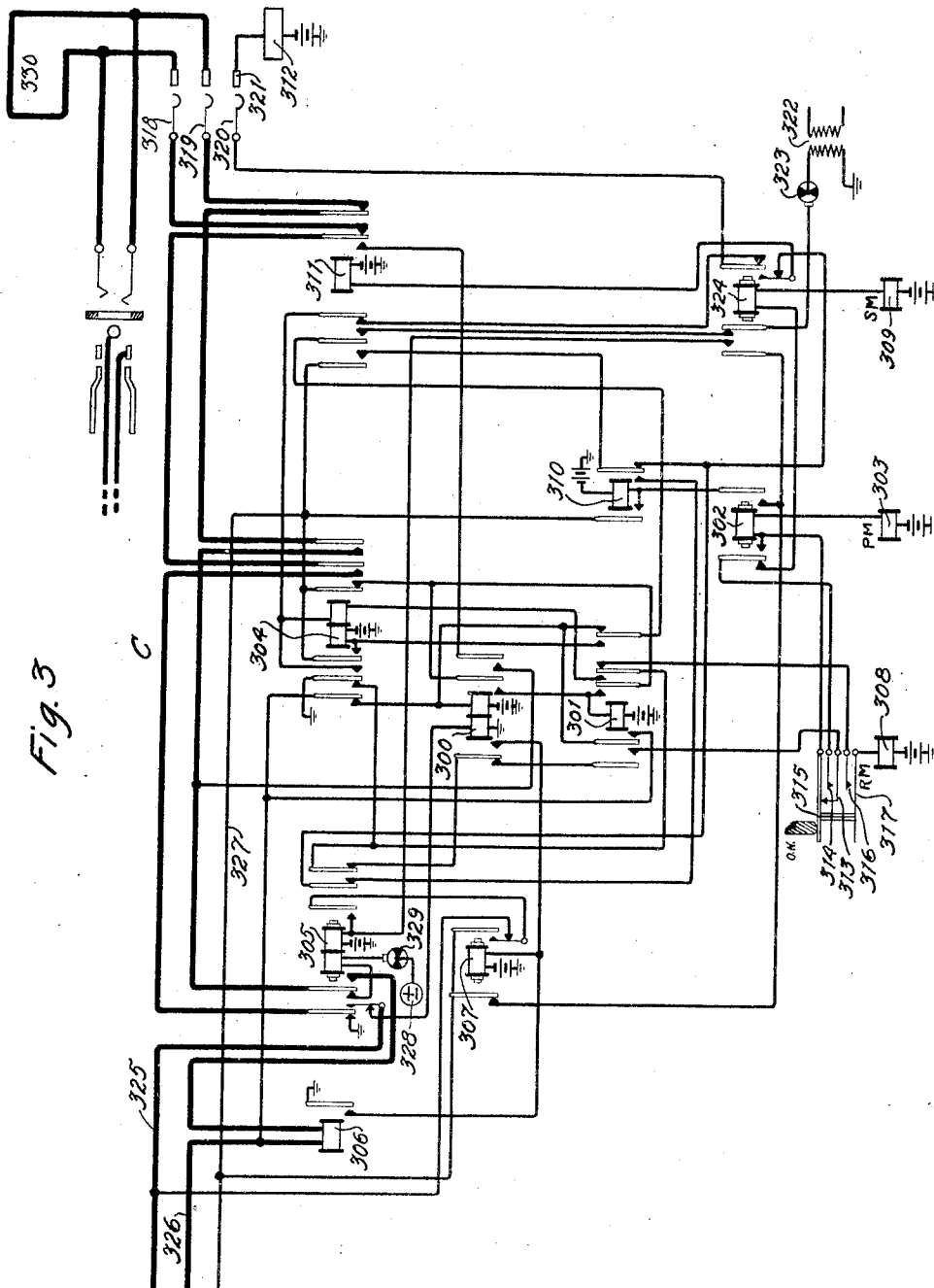
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TELEPHONE SYSTEM

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6 Sheets-Sheet 3



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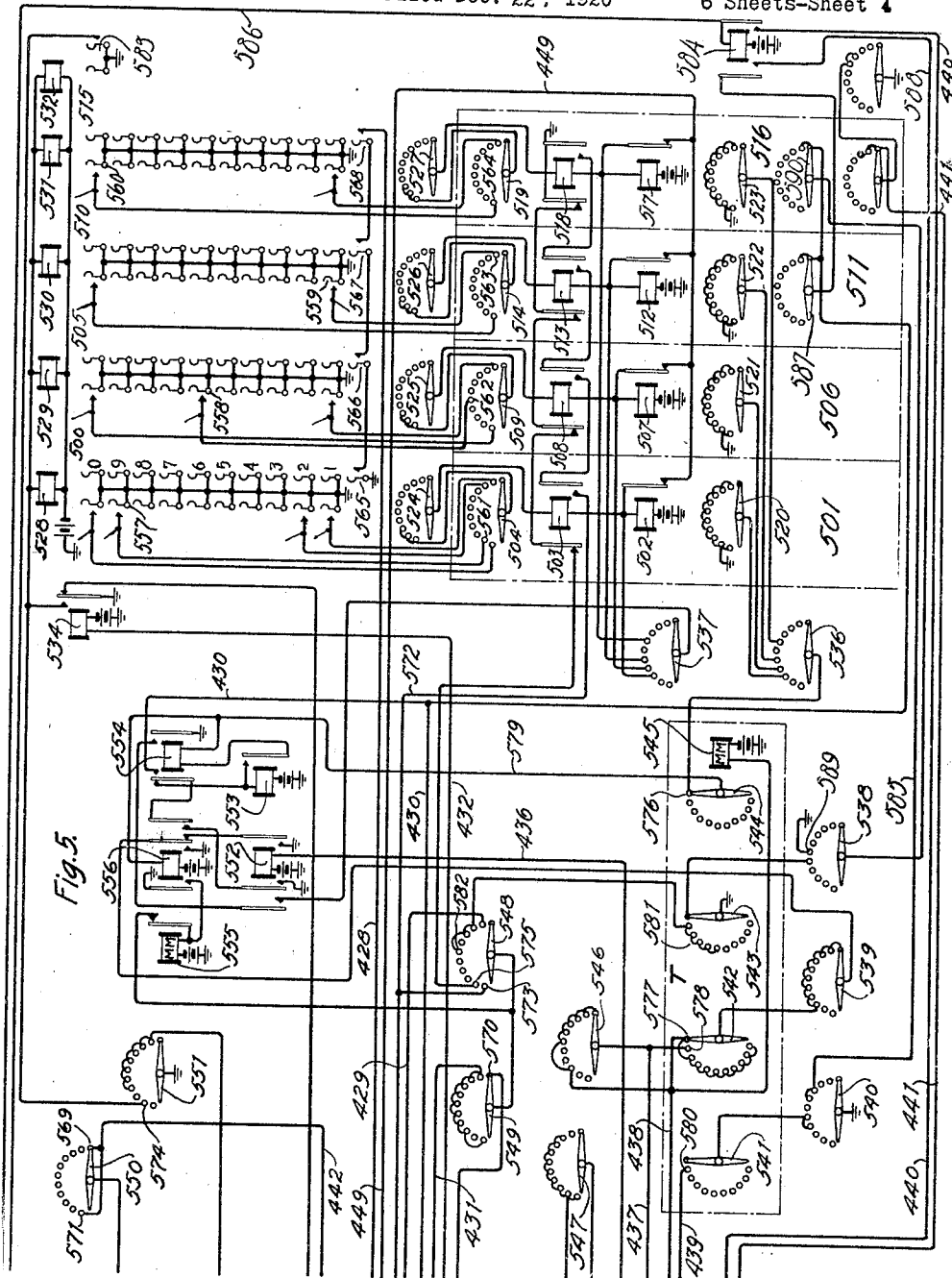
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TELEPHONE SYSTEM

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6 Sheets-Sheet 4



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TELEPHONE SYSTEM

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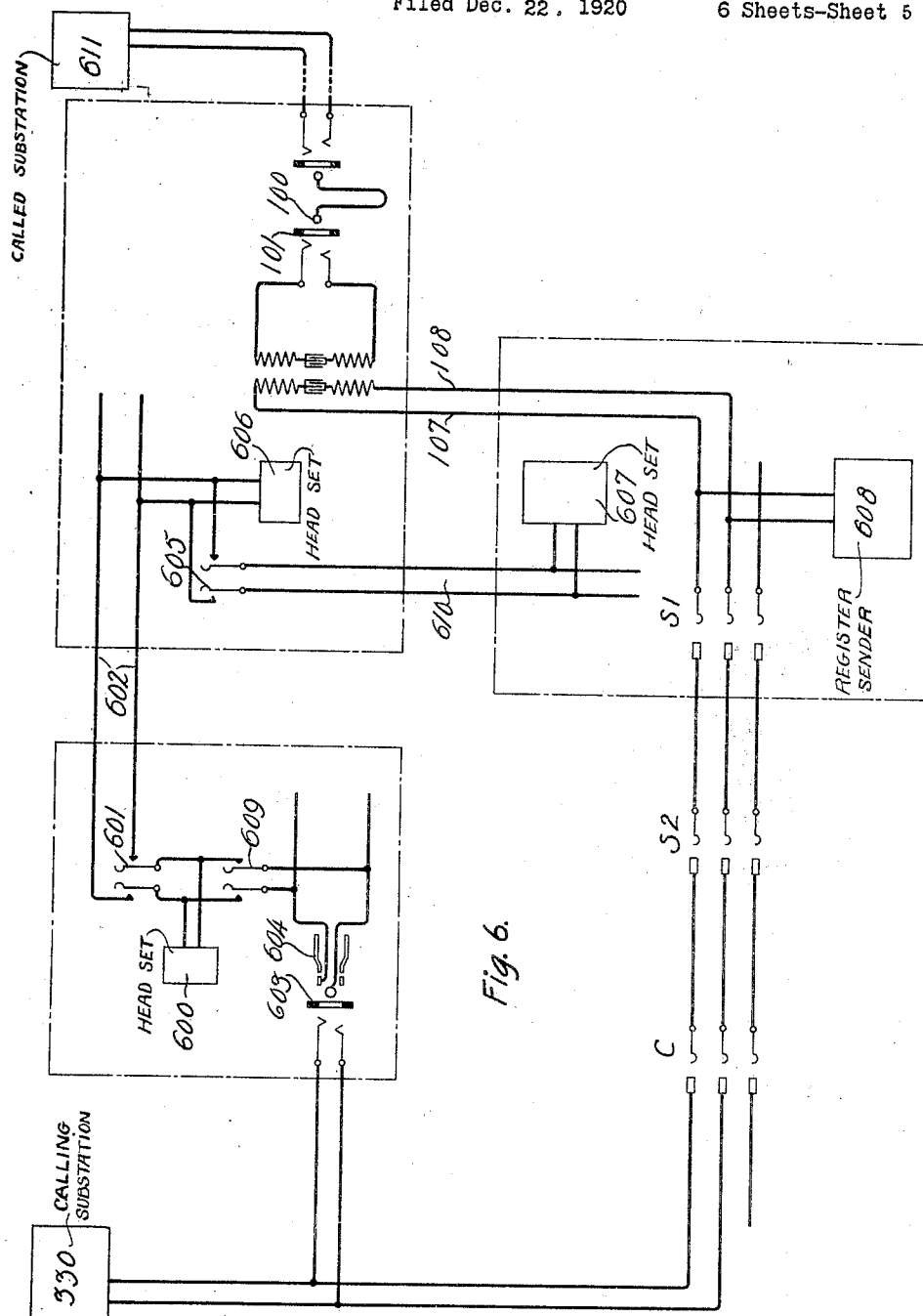


Fig. 6.

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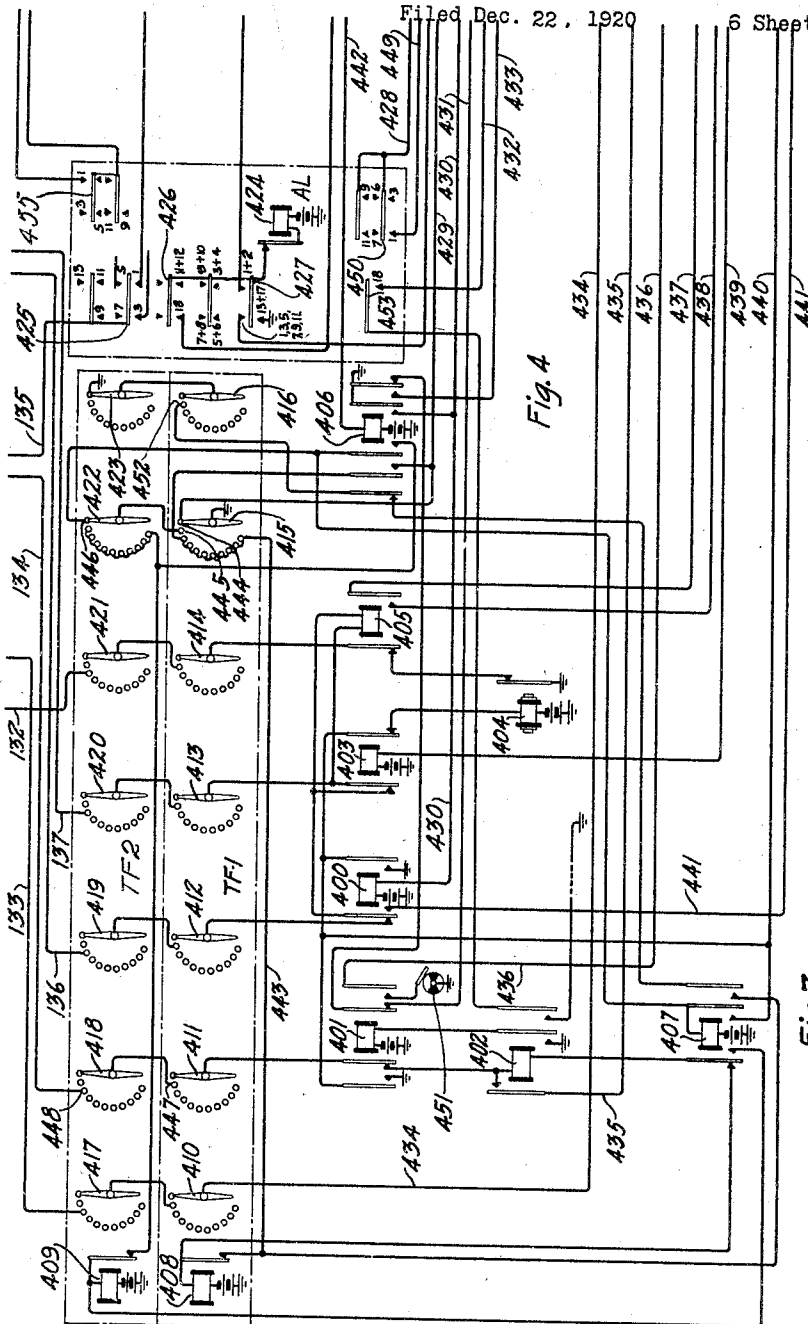


Fig. 4

Fig. 7.

Fig. 1.	Fig. 2.	Fig. 3.
Fig. 4.	Fig. 5.	

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UNITED STATES PATENT OFFICE.

WARREN W. CARPENTER, OF BROOKLYN, NEW YORK, AND HENRY HOVLAND, OF EAST ORANGE, NEW JERSEY, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed December 22, 1923. Serial No. 432,427.

To all whom it may concern:

Be it known that we, WARREN W. CARPENTER and HENRY HOVLAND, citizens of United States, residing at Brooklyn, in the county of Kings and State of New York, and East Orange, in the county of Essex and State of New Jersey, respectively, have invented certain new and useful Improvements in Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and particularly to systems involving the use of machine switching apparatus for establishing connections.

The object of the invention is to provide means, in a system where selective switches are operated over an impulse circuit from a central office register sender to extend a connection to a subscriber's line, whereby the final one of said switches is controlled in response to a special condition impressed by the sender upon said impulse circuit to extend the connection to the subscriber's line regardless of its busy condition.

A feature of the invention relates to the provision of manually operable means for effecting a given operation of the impulse relay which normally serves to send operating impulses from the sender to actuate the switches to so modify the operation of the final switch that the subscriber's line is selected regardless of its busy condition and the usual busy signal rendered ineffective.

Other features and advantages of the present invention will become more readily understood from a consideration of the following description taken in connection with the appended claims.

Referring to the drawing which constitutes part of the application. Figures 1 to 5 inclusive, when arranged in the order illustrated in Fig. 7, disclose the detailed circuits and apparatus of a portion of a telephone system embodying the principles of the invention.

Fig. 1 shows, at the left of the broken line, a part of the equipment at a toll connecting operator's position and the outgoing end of a trunk circuit which leads to a selector switch at a cordless operator's position in the same office. To the right of the

broken line there is shown the incoming end of the trunk circuit at the cordless operator's position together with certain controlling and supervisory elements.

Fig. 2 at the left shows a selector switch in which terminates the trunk interconnecting the toll operator's position and the cordless operator's position. To the right of Fig. 2 is shown a second group selector switch.

Fig. 3 illustrates a final selector or connector switch to which the switches shown in Fig. 2 have access and serves for completing connections to the subscriber's lines.

Fig. 4 discloses a switching unit made up of two trunk finder switches which act to automatically associate an idle register sender with the particular trunk circuit at the cordless operator's position that has been taken for use in the extension of a toll connection. This figure further shows an allotter switch for assigning an idle register sender for use.

Fig. 5 shows an operator's keyboard consisting of a plurality of rows of number keys, one of which is provided for each cordless operator's position. This figure also illustrates one of a plurality of register sender units to which the operator's keyboard is common.

Fig. 6 is a schematic illustration of the circuits used by the operators and the manner in which these operators participate in the establishment of a toll connection between two subscribers' lines.

General description.

The present invention is particularly applicable to toll switching systems and has to do with the provision of means for enabling a toll connection to be set up over automatic switches to the line of a calling subscriber, who has previously initiated the toll call, regardless of whether his line has later been made busy, as by being called by other subscribers in the exchange or for any other reason. To accomplish this feature certain devices are provided in connection with the register sender at the cordless operator's position which controls the selective operation of the automatic switches in building the connection to the calling subscriber's line for so influencing the op-

eration of the final or connector switch that this switch will seize the subscriber's line even though it tests busy without causing the actuation of the usual busy signal. For a clearer conception of the manner in which a toll call is handled and the part played by each of the different operators, attention is called to the diagrammatic layout in Fig. 6. After having studied this schematic showing the functions of the selective switches and controlling mechanism shown in detail in the other figures will be more readily understood.

At the left of the figure a calling subscriber's line 330 is shown terminating in the jack 603 before an answering operator in the exchange. It will also be observed that the calling subscriber's line terminates in the multiples of a connector switch C in the same office. The subscriber at line 330, wishing to make a toll call, removes his receiver from the switch hook causing the illumination of the usual line signal at the answering operator's position. She answers the call by inserting the plug 604 of one of her cord circuits in the jack 603. The insertion of the plug in the jack may cause the association of the operator's head set 600 with the cord circuit by means of automatic devices, or, as illustrated for the sake of simplicity, her telephone set may be placed in talking relation with the calling subscriber's line by means of the ordinary listening-in key 609. The answering operator, on learning that the calling subscriber wishes a toll connection, connects her head set, as by means of a key 601, to an order wire 602 interconnecting her position with the position of a toll connecting operator, illustrated within the dotted rectangle in the upper right-hand corner of the figure. The toll connecting operator's head set 603 being thus placed in talking relation with the answering operator's equipment, she receives from the latter operator, orally, all the necessary information required for the completion of the connection.

The toll connecting operator next manipulates a key 605 which establishes a talking connection between her telephone set, over the order wire 610, and the telephone set 607 of a cordless operator. Over the order wire the toll connecting operator communicates with the cordless operator, gives her the number of the calling subscriber's line and also requests the assignment of an idle trunk to be used in the establishment of the toll connection. The cordless operator thereupon assigns a trunk, such as the trunk 107, 108, brings about the association of a register sender 608 with the assigned trunk and records the designation of the calling line on her keyboard. At this time the toll connecting operator may advise the answering operator, either by an oral

communication over the order wire 602, or by any other suitable signaling means, that she may take down her connection with the calling line by removing the plug 604 from the jack 603.

After the record of the calling subscriber's line has been set up on the registers of the sender 608, the switches S^1 , S^2 and C are directly operated to extend the assigned trunk 107, 108 back to the terminals of the calling subscriber's line 330. Should the connector switch C reach the terminals of the calling line prior to the time the answering operator removes the plug 604 from jack 603, or should the calling line be seized by another connection during the interval that might exist between the time the answering operator removed the plug 604 from the jack 603 and the time the connector switch C reaches the terminals of the calling line, a busy condition would be found thereon. However, by the provision of means to be taken up in detail hereinafter, the circuits are so arranged that the connector switch C will disregard such a busy condition of the calling subscriber's line.

In the meantime the toll connecting operator has inserted the plug 100 of her cord circuit in the jack 101 of the trunk assigned to her by the cordless operator and with the calling plug of her cord circuit has proceeded to establish a connection through to the called line 611.

When the connection has been completed in both directions, the called subscriber has answered and the toll connecting operator, failing to receive a busy signal, knows that the calling subscriber's line 330 has not been rendered busy, in the meantime, she brings about the application of ringing current to notify the calling subscriber, who may have replaced his receiver on the switch hook, that the desired party has been obtained.

Should, for one of the reasons above set forth, the calling subscriber's line be rendered busy while a toll connection is being established, the toll operator after having obtained the desired party may listen in on the connection established in the meantime and notify the calling subscriber at station 330 that she has succeeded in obtaining the toll connection. He may then discontinue the local call and converse with the subscriber originally called.

Comparing Figs. 1 to 5 inclusive with the diagram of Fig. 6, it will be seen that these figures illustrate the detailed circuits and equipment located at the cordless operator's position. The switches S^1 , S^2 and C, shown schematically in Fig. 6, are the switches disclosed in detail in Figs. 2 and 3. These switches, in the detailed showing, are arranged in accordance with the usual convention to build the connection from

left to right. The trunk circuit 107, 108 is shown in detail in Fig. 1 and interconnects the toll switching operator's position with the position of the cordless operator.

5 The register sender, shown as the rectangle 608 in the diagram, is shown in detail in Figs. 4 and 5. The calling subscriber's line 330 is shown at the extreme right of Fig. 3, to conform with the layout of the switches

10 in Figs. 2 and 3.

Description of apparatus.

The automatic switches shown in Figs. 2 and 3 are of the two motion step-by-step type in which a primary stepping magnet operates in response to a series of directive impulses to advance the brushes to select the desired group and then a secondary stepping magnet operates to move the brushes

15 over the chosen group to select a set of terminals therein.

The trunk finders consist of single movement rotary step-by-step switches each made up of a plurality of arcuate rows of terminals and cooperating brushes. A trunk finder unit consists of two of these rotary switches, one of which is designated TF¹ and the other is designated TF². The purpose of utilizing two switches per unit is to

25 increase the number of trunk circuits at the cordless operator's position that may be associated with the register sender without the necessity of employing large capacity switches. Half of the trunks, such as the trunk 107, 108 shown in Fig. 1 at the operator's position, are apportioned to the trunk finder TF¹ and the remaining half of said trunks are apportioned to the second trunk finder TF². When the operator assigns a

30 particular trunk for use by the toll connecting operator, the first trunk finder switch commences to rotate and search for this particular trunk. If the assigned trunk is related to the second trunk finder switch, the first trunk finder will continue to operate until it has made a test of all the trunks which it serves. Thereafter, the second trunk finder switch TF² begins to operate and finds the desired trunk. In the drawing the several sets of terminals and brushes of each of the trunk finder switches of a given unit are located within the area enclosed by the dotted rectangles. Within

35 the lower rectangle are shown the stepping magnet 408 and the brushes and terminals belonging to the trunk finder TF¹. The stepping magnet 409 and the several rows of terminals which comprise the second trunk finder switch TF² are shown within the area of the upper broken rectangle.

The operator's keyboard illustrated in Fig. 5 comprises four rows of ten keys each designated at 500, 505, 510 and 515. By the use of these keys the operator may record the number of any one of 10,000 lines.

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In addition to these keys the operator's position is equipped with a key 583 which places the sender in condition to accomplish the no test operation of the connector switch C. These keys are of the locking type and any depressed key will remain in its actuated position until released by the energization of an electromagnet. The release magnets for the thousands, hundreds, tens, units and no test key are shown respectively at 528, 529, 530, 531 and 532. In addition to the ten number keys a common contact is provided for each of the four rows. These contacts, which are identified by the characters 565, 566, 567 and 568, are closed whenever one of the keys in the corresponding rows is actuated.

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The operator's keyboard briefly described above is common to a plurality of trunk finder and register sender units. One of the register sender units at the operator's position is illustrated in detail in Fig. 5. The registers, of which there are four, one for each of the four digits of a subscriber's number, consists of single motion step-by-step rotary switches. The thousands register 501 is provided with a stepping magnet 502, the hundreds register 506 with a stepping magnet 507, the tens register 511 with a stepping magnet 512 and the units register 516 with a stepping magnet 517, which magnets operate to step the brushes of their respective registers from position to position. The stepping magnets, the brushes and their coacting terminal banks and the other elements pertaining to each of the four registers are shown within the corresponding broken rectangles at the right-hand side of Fig. 5.

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The sender control switch is likewise of the step-by-step rotary single motion design. This switch consists of a stepping magnet 555 and a plurality of brushes and terminal rows. The several brushes of the sender control switch are, for convenience, distributed throughout Fig. 5.

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Each of the register sender units is furthermore equipped with a time measure switch, the function of which is to regulate the advance of the sender control switch from one position to another in such manner that the automatic selective switches S¹ and S² are given a sufficient time to complete a maximum trunk hunting operation before the register sender is permitted to start the next selection. The time measure switch, generally designated by the letter T, comprises a small rotary step-by-step device including the stepping magnet 545 and a plurality of brushes and terminal rows. All the elements of the time measure switch are confined within the area of the broken rectangle in the lower left-hand corner of Fig. 5'.

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In order that a trunk finder and register sender unit may always be allotted for use,

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when one is idle, and to avoid confusion in apportioning the same, an allotter switch AL is provided. The allotter switch likewise consists of a small step-by-step device in which a stepping magnet 424 is designed to move the several switch contacts from one position to another. The several elements belonging to the allotter switch are shown within the space of the broken rectangle at the right of Fig. 4.

It is believed that a more thorough understanding of the invention may be had by giving a detailed description of the method of operation of the system.

Operation of system in detail.

Let it be assumed that the subscriber of line 330, wishing to obtain a toll connection with the subscriber of line 611, shown in Fig. 6, and omitted from Fig. 1 for sake of clearness, has initiated the call and that the necessary information regarding the connection has been communicated to the toll connecting operator. She thereupon requests the cordless operator to assign an idle trunk. The trunk 107, 108, being idle at this time, is assigned by the cordless operator.

At the time the cordless operator communicates the identity of the assigned trunk to the connecting operator she also depresses an assignment key 126 individual to said trunk. The purpose of this key is to cause the operation of the allotted trunk finder to associate an idle register sender to the trunk to which said key is individual. A circuit is completed from battery through the winding of relay 125, contacts of key 126, right-hand armature and contact of relay 122, back contact and right-hand armature of relay 124, closed contacts of key 127 to ground. Relay 125 operates and locks as follows before the contacts of key 126 open when released by the operator: battery through the winding and front contact and inner right-hand armature of relay 125, and thence to ground as traced through the left-hand contacts of key 127. Relay 125 establishes a circuit from ground through its inner left-hand armature and contact, conductor 135, lower right-hand contact 425 (1) of the allotter switch, brush 550 of the sender control switch, contact 569, conductor 442, winding of relay 406 to battery and ground. Relay 406 becomes energized and completes a circuit from ground through its outer right-hand armature and front contact, conductor 433, terminal 570, brush 549, contact and armature and winding of stepping magnet 555 to battery and ground. The magnet 555 energizes, interrupts its own circuit and deenergizes to advance the brushes of the sender control switch on to their first position terminals.

It may be well to note at this time that the sender control switch, the register switches, the time measure switch, the trunk finder

switches and the allotter switch are all designed to advance the brushes from one terminal to another upon deenergization of the stepping magnets.

With the sender control switch in its first position the relay 406 is maintained energized, the circuit therefor being now closed through the brush 550 and terminal 571.

The stepping magnet 408 of the first trunk finder TF¹ commences to advance the brushes 410, 411, 412, etc., from position to position to search for the calling trunk circuit. The circuit for operating magnet 408 may be traced from battery through the winding of said magnet, armature and contact thereof, conductor 443, through the connector terminals with which the brush 415 cooperates, intermediate left-hand armature and front contact of relay 406, terminal 444, brush 415 to ground. On the first operation of stepping magnet 408 the several brushes of the trunk finder TF¹ advance to their first position terminals. The operating circuit for the stepping magnet 408 therefore leads over the conductor 443 and thence directly to ground through the connector terminals and brush 415. Since the calling trunk is not represented in the terminals of the first trunk finder switch, the stepping magnet 408 will continue to operate until the brush 415 steps off the last one of the series of connected terminals and makes engagement with terminal 445. The circuit of magnet 408 being opened the switch comes to rest and a circuit is established as follows for operating the second trunk finder switch TF²: battery through the winding and armature and contact of stepping magnet 409, front contact and innermost left-hand armature of relay 406, terminal 446 upon which the brush 422 of the second trunk finder switch is now standing, brush 422, terminal 445, brush 415 to ground. Magnet 409 energizes, interrupts its own circuit and deenergizes to advance the brushes 417, 418, 419, etc. to the terminals representing the first trunk in the group which is served by the trunk finder switch TF². Hereafter the operating circuit for the stepping magnet 409 leads from battery through the winding and armature and contact of said magnet over the series of connected terminals, which brush 422 is now engaging terminal 445 and brush 415 to ground. In parallel to the above circuit a circuit is established from battery through the winding of relay 407, innermost left-hand armature and contact of relay 406, brush 422, terminal 445, brush 415 to ground. Relay 407 energizes for a purpose presently to be considered.

When the brushes of the second trunk finder reach the terminals identifying the assigned trunk circuit at the operator's position, a test circuit is closed from battery

through the winding of stepping magnet 409, front contact and left-hand armature of relay 407, winding of relay 402, contact and inner left-hand armature of relay 401, brush 411, terminal 447, brush 418, terminal 448, conductor 134, contact and outer left-hand armature of relay 125 to ground. The stepping magnet 409 energizes permanently in this circuit and the brushes are stopped in engagement with the proper set of terminals. The relay 402 also becomes energized and establishes a circuit as above traced from battery through the winding of magnet 409, front contact and left-hand armature of relay 407, thence through the winding and contact and left-hand armature of relay 402, conductor 435, brush 547 of the sender control switch, conductor 434, brush 410, brush 417, conductor 133, contact and outer right-hand armature of relay 119, winding of relay 122, right-hand contacts of key 127 to ground. Stepping magnet 409, relay 402 and relay 122 are locked in this circuit. Relay 402 at its inner right-hand armature closes an operating circuit for the relay 401. Relay 401 closes a holding circuit as follows for relay 407: battery through the winding and inner right-hand armature and contact of relay 407 to ground at the outer left-hand armature and contact of relay 401. Relay 401 also completes a circuit from battery through the winding of the slow to release relay 404, contact and right-hand armature of relay 403, outer left-hand armature and contact of relay 401 to ground. The function of the relay 404 will be taken up hereinafter.

The relay 122 which also energizes in the holding circuit serves to extend the conductors 136 and 137, which constitute the impulse circuit, from the sender to the first group selector switch. Relay 122 at its right-hand armature and contact opens the holding circuit of relay 125. Relay 125 removes ground from the conductor 135 whereby relay 406 releases its armatures. Relay 122 furthermore completes a circuit from ground through its outermost left-hand armature and contact, winding of relay 120 to battery and ground. Relay 120 becomes energized. Lamp 118 is illuminated in a circuit through the inner right-hand armature and back contact of relay 117, left-hand armature and front contact of relay 120, back contact and innermost left-hand armature of relay 124 to ground.

Registration of calling line number.

It will be assumed that the number of the calling subscriber's line 330, which is communicated to the cordless operator over the order wire 610, is 9610. Accordingly, as soon as the cordless operator has assigned the trunk 107, 108, she records the designation of the calling line by depressing the

proper keys in the thousands, hundreds, tens and units rows on the keyboard. The keys pertaining to this particular number are key 557 in the thousands row, key 558 in the hundreds row, key 559 in the tens row and key 560 in the units row. As soon as a key in each of the four rows has been actuated the common row contacts are closed and circuits are established for the stepping magnets 502, 507, 512 and 517 of the registers. These circuits lead in parallel from battery through the windings and armature and contacts of said magnets, conductor 449, lower left-hand contact 450 of the allotter switch, conductor 428, common contacts 563, 567, 566, 565 to ground. The stepping magnets of the registers interrupt their own circuits and advance the brushes from terminal to terminal in search of the depressed keys on the operator's keyboard. When the thousand register 501 finds the operated key 557, a circuit is closed from battery through the winding of magnet 502, winding of relay 503, brush 524 (position 1), brush 504, terminal 561, key 557 to ground. When the register 506 finds the depressed key 558 a circuit is completed from battery through the winding of magnet 507, relay 508, brush 525 (position 1), brush 509, terminal 562, key 558 to ground. In a similar manner the circuits are completed through the windings of magnets 512 and 517 and the corresponding relays 513 and 518 to ground through the operated keys 559 and 560, respectively. When the registers reach positions corresponding to these keys the magnets are thereby permanently energized and the brushes brought to rest. After the last register has found the depressed key a circuit is closed from ground through the right-hand armatures and contacts of relays 518, 513, 508 and 503 in series, conductor 572, terminal 573, brush 548, contact and armature and winding of stepping magnet 555 to battery and ground. Magnet 555 interrupts its own circuit and advances the sender control switch to its second position.

Release of actuated keys.

In position 2 of the sender control switch the depressed keys on the operator's keyboard are released inasmuch as they are no longer needed. The circuit for the release magnets 528, 529, etc. may be traced from battery through the windings of these magnets in parallel, terminal 574, brush 551 to ground. With the keys released the relays 503, 508, 513 and 518 become deenergized and close a series circuit from ground over the left-hand armatures and contacts, terminal 575, brush 548, contact and armature and winding of magnet 555 to battery and ground. The stepping magnet 555 again energizes and advances the sender control switch into position 3. The register sender

has thus received the record of the calling subscriber's line and is now in condition to transmit series of impulses in accordance with said record to operate the automatic switches to extend the toll connections over the assigned trunk 107, 108 back to the terminals of the calling subscriber's line 330.

Operation of first group selector switch.

The impulse circuit, which is completed over the left-hand armatures and front contacts of relay 122, may be traced from battery through the right-hand winding of relay 200 at the first group selector S^1 , back contact and inner left-hand armature of relay 207, conductor 129, middle left-hand armature and front contact of relay 122, conductor 136, brush 419, brush 412, back contact and left-hand armature of relay 400, contact and left-hand armature of relay 403, brush 413, brush 420, conductor 137, front contact and innermost left-hand armature of relay 122, conductor 128, outer left-hand armature and back contact of relay 207, left-hand winding of relay 200 to ground. Relay 200 energizes and closes a circuit from battery through the winding of slow to release relay 201, front contact and armature of relay 200, contact and outer right-hand armature of relay 207, to ground. It will also be noted that the relay 405 is included in a circuit in parallel to the circuit leading through the contact and left-hand armature of relay 403. Relay 405, however, remains inert so long as its winding is shunted by the contact and armature of relay 403.

When the sender control switch reaches position 3 a circuit is established from battery through the winding of relay 556, brush 544 and normal position terminal 576 of the time measure switch T, brush 536 (position 3), brush 520 to ground. Relay 556 becomes energized and closes a circuit from battery through the winding of magnet 555, contact and left-hand armature of relay 556 to ground. At the same time a circuit is closed from ground through the front contact and inner right-hand armature of relay 556, brush 539, brush 542, terminal 557, winding of stepping magnet 545 to battery and ground. Magnets 555 and 545 are energized preparatory to advancing their brushes to the next position when the operating circuits are opened. On the next closure of the constantly rotating interrupter 451 a circuit is completed from ground through said interrupter, contact and outer right-hand armature of relay 401, conductor 436, winding of relay 552 to battery and ground. Relay 552 completes a circuit from ground through its contact and inner left-hand armature, contact and outer right-hand armature of relay 556, left-hand armature and back contact of relay 554, winding of relay 553 to battery and ground. Relay 553 operates and com-

pletes a circuit from battery through its winding and contact and armature, winding of relay 554, conductor 579, and thence to ground at brush 520. Relay 554 does not energize since its winding is shunted by the direct circuit to ground at the interrupter 451. As soon as interrupter 451 opens relay 554 becomes operated and locks in series with relay 553. The next closure of the interrupter 451 and the consequent energization of relay 552 results in the establishment of a circuit from ground through the right-hand armature and contact of relay 554, outer left-hand armature and contact of relay 552, brush 537 (position 3), winding of stepping magnet 502 to battery and ground. Magnet 502 attracts its armatures and prepares to advance the brushes 561 and 520 to their next position terminals when its circuit is severed. At the same time a circuit is completed from ground through the contact and inner left-hand armature of relay 552, contact and outer right-hand armature of relay 556, left-hand armature and front contact of relay 554, conductor 430, winding of the stepping relay 400 to battery and ground. Stepping relay 400 attracts its armatures and opens the impulse circuit leading to the selector S^1 thereby permitting the release of relay 200.

Relay 200 on retracting its armatures closes a circuit from ground through the outer right-hand armature and contact of relay 207, armature and back contact of relay 200, armature and front contact of relay 201—which remains energized during the transmission of impulses—winding of slow to release relay 202, winding of the primary stepping magnet 203 to battery and ground. Magnet 203 operates to advance the brushes 208, 209 and 210 into operative relation with the first group of terminals. Relay 202 likewise energizes and establishes a circuit from battery through the winding of relay 206, lowermost springs of the off normal contact 211, armature and front contact of relay 202, conductor 130, middle armature and contact of relay 120, left-hand contacts of key 127 to ground. It will be noted that the off normal contact 211 is closed the instant the brush shaft takes its first primary step. Relay 206, on energizing, locks up in a circuit from battery through its winding, lower springs of contact 211, armature and contact of magnet 205, contact and outer armature of relay 206 to ground at the contact and outer right-hand armature of relay 207. At the first primary step of the selector switch S^1 a circuit is also closed from ground through the upper set of off normal springs 211, conductor 131, winding of relay 124 to battery and ground. Relay 124, at its right-hand armature and front contact, provides a substitute ground connection from the left-hand contacts of

key 127 to conductor 130 so that this conductor will remain grounded when later the relay 120 releases its armatures.

Relay 124, at its innermost left-hand armature and back contact, opens the circuit for the lamp 118 and this lamp becomes extinguished. Relay 124, in addition, completes a circuit from ground through the interrupter 123, middle left-hand armature and contact of said relay, contact and innermost right-hand armature of relay 120, lamp 121 to battery and ground. Lamp 121 is flashed in this circuit to indicate to the operator that the establishment of the connection is proceeding.

The next opening of the interrupter 451 causes the deenergization of relay 552 and the opening of the circuits of magnet 502 and relay 400. Magnet 502 advances its brushes to the next position and relay 400 closes the circuit for relay 200. Relay 200 in turn opens the circuit through the windings of relay 202 and magnet 203 and recloses the circuit for relay 201. Magnet 203 deenergizes but relay 202, being slow to release, does not retract its armature. For each succeeding closure and opening of the interrupter 451 relay 552 is operated to close and open the above traced circuits for the register stepping magnet 502 and the stepping relay 400. The register 501 advances from position to position while relay 400 causes the operation of relay 200, which in turn causes the stepping magnet 203 to advance the brushes of the selector switch from one group of terminals to the next. When all impulses have been sent the brush 520 of the register 501 disengages the last grounded terminal and relay 556 becomes deenergized. Relay 556 opens the circuits of the stepping magnets 555 and 545. Magnet 555 releases the brushes of the sender control switch into position 4 and the magnet 545 releases the brushes of the time measure switch to their next position. Relays 553 and 554 are also released as soon as ground is removed from conductor 579. The time measure switch is driven through a complete cycle by means of the interrupter 451 which continues to close and open the circuit of relay 552. The stepping circuit for advancing the time measure switch may be traced from battery through the winding of magnet 545 over the connector terminal cooperating with brush 542, brush 542, brush 539, inner right-hand armature and back contact of relay 556, right-hand armature and contact of relay 552 to ground. The purpose of the time measure switch, as set forth hereinbefore, is to delay the advance of the sender control switch for a time somewhat greater than that required by the automatic selective switch to perform a maximum trunk hunting movement. Hence, while the time measure

switch T is stepping through a revolution the first group selector S¹ is performing its hunting operation.

The stepping relay 400 remains permanently deenergized following the completion of the first series of impulses and thereby maintains the energizing circuit of relay 200. After an interval the slow to release relay 202 retracts its armatures and a circuit is closed from battery through the inner armature and contact of relay 206, winding of the secondary stepping magnet 205, normal contacts of relay 202 to the grounded conductor 130. Stepping magnet 205 becomes energized and advances the brushes 208, 209 and 210 on to the first set of terminals of the selected group. Magnet 205, at its armature and contact, opens the holding circuit of relay 206 which thereupon deenergizes and opens the operated circuit of magnet 205. Magnet 205 again becomes deenergized and closes the following circuit provided the first trunk in the group is busy at this time: battery through the winding of relay 206, lower springs of off normal contact 211, armature and contact of magnet 205, back contact and inner right-hand armature of relay 207, brush 210 to ground on the test terminal 215 of the busy trunk. In parallel with this circuit a circuit also leads through the winding of relay 207 through the grounded conductor 130. Relay 207, however, is shunted out by the direct connection to ground at the busy test terminal 215 and cannot operate. Relay 206 operates to close the energizing circuit for stepping magnet 205 which advances the brushes to the next set of terminals. This method of operation continues until an idle trunk is reached, the test terminal of which is identified by the absence of ground potential. Relay 206 therefore fails to energize and the brushes of the switch are brought to rest. Relay 207 is now energized in series with relay 206 to the grounded conductor 130 but the resistance of relay 207 is such that the relay 206 cannot operate in series therewith. The relay 207, at its front contact and inner right-hand armature, extends the grounded conductor 130 through the test brush 210 and terminal 215 to render the selected trunk busy to other switches. Relay 207, at its left-hand armatures, opens the circuit of relay 200 and extends the talking conductors 128 and 129 through to the brushes 208 and 209.

The impulse circuit for operating the second group selector S² is established from battery through the right-hand winding of relay 220, back contact and inner left-hand armature of relay 216, terminal 214, brush 209, front contact and inner left-hand armature of relay 207, conductor 129, thence, as above traced, through the contact and armature of the stepping relay 400 and re-

turning by way of conductor 128, outer left-hand armature and front contact of relay 207, brush 208, terminal 213, outer left-hand armature and back contact of relay 216, left-hand winding of relay 220 to ground. Relay 220 becomes energized and completes a circuit from battery through the winding of relay 217, contact and right-hand armature of relay 220, conductor 231 to the grounded test terminal 215. Relay 217 operates and locks up in a circuit from battery through its winding and armature and contact, and thence to the grounded conductor 231, independently of the right-hand armature and contact of relay 220.

Operation of the second group selector switch.

When the time measure switch reaches the next to its last position brush 542 disengages the last of the continuously connected terminals and steps on to the terminal 578. A circuit is now completed from battery through the winding of relay 403, conductor 439, terminal 580, brush 541, brush 540 (position 4) to ground. Relay 403 operates to remove the shunt from around the winding of relay 405. The purpose of this is to permit the relay 405 to make a test of the impulse circuit to determine if the selector switch S^1 has succeeded in finding an idle trunk. Since an idle trunk was found battery current is connected to the impulse circuit through the windings of relay 220 at the next switch S^2 and relay 405 immediately operates when the shunt is removed at the left-hand armature and contact of relay 403. Relay 405 closes a circuit from battery through the winding of stepping magnet 545, conductor 438, contact and right-hand armature of relay 405, conductor 437, terminal 578, brush 542, brush 539, and thence to ground at the right-hand armature and contact of relay 552. The time measure switch T advances to its normal position. Relay 403 is thereupon released, the shunt reclosed and relay 405 becomes de-energized.

As soon as the time measure switch T reaches its normal position, and since the sender control switch is now in position 4, a circuit is immediately established from battery through the winding of relay 556, conductor 579, brush 544, terminal 576, brush 536 (position 4), brush 521 of the hundreds register 506 to ground. Relay 556, in the manner above described, closes the energizing circuits of the stepping magnets 555 of the sender control switch and 545 of the time measure switch T. Upon the next closure of the interrupter 451, relay 552 operates and closes the circuit for relay 553. Relay 553 energizes and prepares a circuit from battery through its winding, contact and armature and the winding of relay 554 to grounded conductor 579. Relay 554 energizes immediately that the interrupter opens and locks in series with relay 553. At the next closure of the interrupter 451 a circuit is completed from ground through the right-hand armature and contact of relay 554, outer left-hand armature and contact of relay 552, brush 537 (position 4), winding of stepping magnet 507 to battery and ground. At the same time the above traced circuit is closed from ground through the contact and inner left-hand armature of relay 552, contact and outer right-hand armature of relay 556, left-hand armature and front contact of relay 554, conductor 430 and thence through the winding of the stepping relay 400 to battery and ground. Stepping magnet 507 is energized in order to advance the brushes 509 and 521 to the next position and relay 400 operates to open the impulse circuit to cause the release of relay 220 at the second group selector switch S^2 .

Relay 220, on deenergizing, completes a circuit from ground through the outer right-hand armature and contact of relay 216, left-hand armature and contact of relay 220, left-hand armature and front contact of relay 217, winding of slow to release relay 219, winding of the primary stepping magnet 221 to battery and ground. Stepping magnet 221 operates and moves the brushes 225, 226 and 227 into operative relation with the first group of terminals. The relay 219 also becomes energized and completes a circuit from battery through the winding of relay 218, lower springs of the off normal contact 224—which operates on the first primary step of the switch—armature and front contact of relay 219 to the grounded conductor 231. Relay 218 attracts its armatures and closes a holding circuit for itself from battery through the winding of said relay, lower springs of contact 224, armature and contact of the secondary stepping magnet 223, contact and outer armature of relay 218 to ground at the contact and outer right-hand armature of relay 216.

Upon the next opening of the interrupter 451 relay 552 severs the energizing circuits of stepping magnet 507 and the stepping relay 400. Magnet 507 releases the brushes of the hundreds register to the next position and relay 400 closes the impulse circuit to cause the reenergization of relay 220. Relay 220 opens the circuit of relay 219 and magnet 221. The magnet 221 becomes de-energized but relay 219 being slow to release in character maintains its armature attracted during the transmission of impulses. For each succeeding closure of the constantly rotating interrupter 451 the stepping magnet 507 advances the brushes of the hundreds register one position and the

stepping relay 400 causes the primary stepping magnet 221 to move the brushes of the second group selector successively from one group of terminals to the next. When the last impulse of the series representing the depressed key 558 has been transmitted to the switch the brush 521 disengages the grounded terminals and relay 556 becomes deenergized. Relay 556 opens the holding circuits of the stepping magnets 555 and 545. Magnet 55 releases the brushes of the sender control switch to their fifth position terminals. The stepping magnet 545 advances the brushes of the time measure switch and this switch commences to make a complete rotation.

Following the completion of the impulse series relay 400 remains deenergized and relay 220 remains energized. After an interval has elapsed the slow to release relay 219 retracts its armature and completes a circuit from battery through the inner armature and contact of relay 218, winding of the secondary stepping magnet 223, normal contacts of relay 219 to the grounded conductor 231. Stepping magnet 223 operates to move the brushes 225, 226 and 227 on to the terminals of the first trunk of the selected group. Magnet 223 opens the locking circuit of relay 218 which becomes deenergized and in turn opens the energizing circuit of said magnet. On the deenergization of the magnet 223 a circuit is completed as follows, assuming the first trunk in the group to be busy at this time and a ground potential to exist on the test terminal 230: battery through the winding of relay 218, lower springs of the normal contact 224, armature and contact of magnet 223, back contact and inner right-hand armature of relay 216, brush 227 to the grounded test terminal 230. It will be noted that relay 216 is included in a circuit in parallel with the one just traced, but this relay cannot operate as it is shunted by the direct path to ground at the busy test terminal 230. Relay 218 operates and closes the above traced circuit for magnet 223 which in turn operates to advance the brushes to the next set of terminals and also to open the circuit of relay 218. This method of operation continues until an idle trunk is found at which time the shunt is removed from the winding of relay 216 and this relay operates in series with relay 218. The resistance of relay 216, however, is such as to prevent the operation of relay 218 and consequently the circuit of the secondary stepping magnet 223 is maintained open and the brushes of the switch are brought to rest on the terminals of the idle trunk. Relay 216 at its inner right-hand armature and contact extends the grounded third conductor through to the test terminal 230 to render the selected trunk busy to other switches. Relay 216 at its left-hand

armatures opens the circuit of relay 220 and extends the talking conductors through to the connector switch C. The impulse circuit for operating the connector switch C may now be traced from battery through the right-hand winding of relay 300, contact and outermost left-hand armature of relay 304, conductor 326, terminal 229, brush 226, thence over the lower talking conductor through the contact and armature of the stepping relay 400 at the sender and returning over the upper talking conductor to brush 225, terminal 228, conductor 325, normal contact at the outer left-hand armature of relay 305, left-hand winding of relay 300 to ground. Relay 300 becomes energized and closes a circuit from battery through the winding of relay 301, contact and inner right-hand armature of relay 300, contact and innermost right-hand armature of relay 304 to the grounded third conductor 327. Relay 301 locks in a circuit from battery through its winding and contact and innermost right-hand armature, contact and innermost right-hand armature of relay 304 to the conductor 327. Relay 300 also completes a circuit from battery through the winding of the slow to release relay 307, front contact and left-hand armature of relay 300, contact and outermost right-hand armature of relay 305 to ground at the back contact and middle left-hand armature of relay 304.

Operation of the connector switch.

Upon reaching the next to its last position the time measure switch T stops temporarily and a circuit is closed from battery through the winding of relay 403, conductor 439, terminal 580, brush 541, brush 540 (position 5) to ground. Relay 403 removes the shunt from around the relay 405 and this latter relay operates in series with the windings of relay 300 at the connector switch C. Relay 405 completes a circuit from battery through the winding of stepping magnet 545, conductor 438, contact and right-hand armature of relay 405, conductor 437, terminal 578, brush 542, brush 539, and thence to ground at the right-hand armature and contact of relay 552, which operates on the next closure of the interrupter 451. Stepping magnet 545 thereupon advances the time measure switch to its normal position and relay 403 deenergizes to reclose the shunt around the winding of relay 405.

Immediately that the time measure switch reaches its normal position relay 556 is again energized in a circuit over conductor 579, brush 544, terminal 576, brush 536 (position 5), brush 522 of the tens register 511 to ground. Relay 556 closes the circuits hereinbefore traced for energizing the stepping magnets 555 and 545. Upon the first closure of the interrupter 451 relay 552 energizes and closes a circuit for relay 553 which

in turn completes a circuit for relay 554 as above described. As the interrupter opens the relay 554 energizes in series with relay 553 to the grounded conductor 579.

5 The next time the interrupter 451 closes a circuit is completed as hereinbefore traced for the stepping relay 400. A circuit is also closed from ground through the right-hand armature and contact of relay 554, 10 outer left-hand armature and contact of relay 552, brush 537 (position 5), winding of the stepping magnet 512 to battery and ground. Magnet 512 energizes preparatory to advancing the brushes of the tens register 15 to their next position.

Relay 400 operates to open the impulse circuit thereby causing the energization of the relay 300 at the connector switch C. Relay 300, on deenergizing, completes a circuit from ground through the middle left-hand armature and back contact of relay 304, outermost right-hand armature and contact of relay 305, left-hand armature and back contact of relay 300, outer left-hand 25 armature and contact of relay 301, contacts 313 and 315, winding of slow to release relay 302, winding of the stepping magnet 303 to battery and ground. Primary stepping magnet 303 actuates to advance the brushes 30 318, 319 and 320 of the connector switch into operative relation with the first group of terminals. Upon the first primary step of the switch contacts 313 and 315 disengage one another but before this occurs the contact 313 makes engagement with contact 314. Consequently, the original energizing circuit of the primary stepping magnet is substituted by a circuit which leads as above traced through the left-hand armatures and 40 contacts of relays 300 and 301, thence by way of contacts 313 and 314, left-hand armature and front contact and winding of the slow to release relay, which is now energized, through the winding of the primary stepping magnet 303 to battery and ground. 45 The next time interrupter 451 opens relay 552 deenergizes and opens the circuits of the stepping magnet 512 and the stepping relay 400. Magnet 512 advances the brushes of the tens register to their next position 50 terminals and relay 400 closes the impulse circuit to permit the energization of relay 300. Relay 300 opens the circuit through the slow to release relay 302 and stepping magnet 303. The stepping magnet becomes deenergized but relay 302 retains its armature during the transmission of the impulses. For each succeeding impulse sent out by the register sender stepping magnet 512 operates to advance the brushes one step while relay 300 operates to cause the primary movement of the selector switch C. Following the last impulse of the series the brush 522 of the register 511 disengages the last 60 grounded terminal and opens the circuit of

relay 556. Relay 556 in turn opens the circuits of stepping magnets 555 and 545, whereupon the sender control switch moves out of position 5 and into position 6 and the time measure switch commences to make a complete revolution of its brushes. After 70 the lapse of the necessary interval, during which relay 300 is holding its armatures attracted by reason of the fact that stepping relay 400 at the sender is permanently deenergized, the slow to release relay 302 retracts its armatures. Relay 307 being slow to release remains energized during the retractions of the left-hand armature of relay 300. 80

When the time measure switch, which commences to rotate upon the deenergization of relay 556, reaches its sixth position, brush 543 makes engagement with the first one of the connected terminals 581 and a circuit is established as follows: ground 85 through brush 543, terminals 581, terminal 582, brush 548, contact and armature and winding of stepping magnet 555 to battery and ground. The magnet 555 operates in this circuit to advance the sender control switch from position 6 into position 7. Upon reaching the next to the last position the time measure switch completes a circuit from battery through the winding of magnet 545, the seventh position terminal co- 95 acting with brush 546, brush 546, terminal 578, brush 542, brush 539, and thence to ground at the right-hand armature and contact of relay 552. Magnet 545 energizes and upon the opening of interrupter 451 deenergizes to advance the time measure switch into its normal position. It will be observed that the brush 540 does not close the conductor 439 to ground in the sixth and 105 seventh positions of the sender control switch and consequently relay 403 remains deenergized.

When the sender control switch is in position 7 and the time measure switch at normal, a circuit is closed from battery through the winding of relay 556, conductor 579, brush 544, terminal 576, brush 536 (position 7), brush 523 of the units register 516 to ground. Relay 556 operates to close the circuits of stepping magnets 555 and 545. 110 When the interrupter 451 closes relay 552 becomes energized and establishes a circuit for the relay 553 which in turn closes a series circuit for itself and relay 554 to the grounded conductor 579. On the next opening of the interrupter relay 554 locks in series with relay 552. Following this the closure of interrupter 451 causes the operation of relay 552 and the above traced circuit is established for the stepping relay 400, also a circuit is closed from ground through the 120 right-hand armature and contact of relay 554, outer left-hand armature and contact of relay 552, brush 537 (position 7), wind- 130

ing of stepping magnet 517 to battery and ground. Magnet 517 energizes preparatory to advancing the brushes of the units register to their next position and relay 400 attracts its armature to open the impulse circuit thereby causing the deenergization of relay 300 at the connector switch.

Relay 300, upon deenergizing, establishes a circuit from ground through the middle left-hand armature and back contact of relay 304, outer right-hand armature and contact of relay 305, left-hand armature and back contact of relay 300, outer left-hand armature and contact of relay 301, contact 318 and 314, left-hand armature and contact of relay 302, winding of slow to release relay 324, winding of the secondary stepping magnet 309 to battery and ground. Magnet 309 operates to advance the brushes 318, 319 and 320 into engagement with the first set of line terminals in the selected group. Relay 324 also energizes in series with the stepping magnet and retains its armatures during the transmission of the units impulses. In the manner well understood the stepping relay 400 energizes and deenergizes to send impulses over the impulse circuit and the units register stepping magnet 517 is operated to restore the units register 516 to its normal position. When the last impulse of the units impulse has been sent, which means that the brushes of the connector switch have been driven to the terminals of the calling subscriber's line 330, brush 523 of the register disengages the grounded terminals and opens the circuit of relay 556. Relay 556 in turn opens the circuits of the stepping magnet 555 and 545 of the stepping magnet 555, releases the brushes of the sender control switch out of position 7 and into position 8 and magnet 545 commences to rotate to drive the time measure switch through a complete cycle. Before continuing to describe the manner in which the calling subscriber's line is tested and preparation made for the application of ringing current, the release of the register sender will first be taken up and also the effect of its release upon the circuits of the first group selector switch.

Release of the register sender.

When the time measure switch reaches position 3 its brush 543 encounters the first connected terminal 581 and a circuit is closed from ground through the brush 543, brush 548 and its eighth position terminal, contact and armature and winding of stepping magnet 555 to battery and ground. The stepping magnet 555 operates to advance the sender control switch into position 9. In this position the circuit just traced is reclosed by brush 548 and magnet 555 again energizes and deenergizes to move the sender control switch out of position 9

and into position 10. The movement of the sender control switch through positions 8 and 9 takes place while the brush 543 of the time measure switch is moved over the connected terminals 581. As the sender control switch leaves position 9 its brush 547 opens the circuit traced hereinbefore for magnet 409, relay 402 and relay 122. Relay 402, at its inner right-hand armature and contact, opens the circuit of relay 401. Relay 401 becomes deenergized and disconnects the interrupter 451 from conductor 436. Relay 401 also completes a circuit from battery through the winding and armature and contact of magnet 555, brush 549 (position 10), conductor 431, contact and inner right-hand armature of relay 401 to ground at the back contact and outer right-hand armature of relay 406. Magnet 555 interrupts its own circuit and advances the sender control switch into normal position. Relay 401, at its outer left-hand armature, opens the holding circuit of relay 407 and this latter relay becomes deenergized. The magnet 409 which also deenergizes at this time advances the brushes of the trunk finder TF² to their next terminals. Trunk finder TF² is now restored to its normal position by means of a circuit from battery through the winding and armature and contact of magnet 409, through the connected terminals with which brush 422 cooperates, terminal 445, brush 415 to ground. When the trunk finder TF² reaches normal brush 422 engages terminal 446 and a circuit is completed from battery through the winding of relay 407, terminal 446, brush 422, terminal 445 and brush 415 to ground. Relay 407 operates and closes a circuit from battery through the winding and armature and contact of magnet 408, contact and outer right-hand armature of relay 407, contact and outermost left-hand armature of relay 406, terminal 452, brush 416, brush 423 and its normal position terminal to ground. Stepping magnet 408 operates in this circuit and advances the brushes of the trunk finder TF¹ to their normal position. The trunk finder switches now being restored both magnets 409 and 408 remain inactive and relay 407 is released.

Relay 122, on deenergizing at the time the sender control switch moves into position 10, disconnects the talking conductors 128 and 129 from the impulse conductors 136 and 137, and extends said talking conductors through to the right-hand windings of the repeating coil 109 in the trunk circuit. Relay 122, at its outer left-hand armature and contact, opens the circuit of relay 120. Relay 120, at its innermost right-hand armature, opens the circuit for flashing the lamp 121. The termination of the flashing of lamp 121 indicates to the operator

2. The second part of the document focuses on the role of communication in achieving organizational goals. It highlights the importance of clear and concise communication, both internally and externally. The text provides guidelines for effective communication, such as using appropriate language, being open to feedback, and ensuring that all team members are informed and aligned. It also discusses the benefits of regular communication, such as improved collaboration and faster decision-making.

5. The fifth part of the document focuses on the importance of financial management and budgeting. It emphasizes that sound financial management is essential for the long-term success of any organization. The text outlines the steps for creating a budget, including identifying goals, estimating costs, and allocating resources. It also discusses the importance of monitoring and controlling expenses, and provides tips for how to optimize financial performance.

direction as to prevent the energization of the polarized relay 105. Relay 110 completes a circuit from ground through its armature and contact and the winding of relay 114 to battery and ground. Relay 114 becomes energized and a circuit is established from battery through the winding of relay 113, armature and contact of relay 116, front contact and left-hand armature of relay 114 to ground. Relay 113 operates and closes a circuit from ground through its right-hand armature and contact, winding of relay 117 to battery and ground. Relay 117 locks in a circuit from battery through its winding and front contact and inner left-hand armature, contact and outermost right-hand armature of relay 120 to ground at the contact and outermost left-hand armature of relay 124. Relay 117 also opens the operating circuit of relay 116 and this latter relay releases its armature. After relay 116, which is made slow to release, retracts its armature, relay 113 again deenergizes and closes the trunk circuit at its left-hand armature and contact. Relay 117 also opens the circuit of lamp 118.

During the energization of relay 113 the upper talking conductor is opened for a sufficient interval to permit the release of relay 305 at the connector switch. Relay 305, on retracting its armatures, completes a circuit from the ringing source 328, interrupter 329, left-hand winding and back contact and inner left-hand armature of relay 305, contact and outermost right-hand armature of relay 304, outer right-hand armature and contact of relay 311, brush 319, thence over the loop of the calling subscriber's line, brush 318, back contact and inner right-hand armature of relay 311, middle right-hand armature and contact of relay 304 to ground at the outer left-hand armature and contact of relay 305. Relay 305, being marginal, does not operate in series with the high resistance of the ringer magnet at the substation 330. When the calling subscriber removes his receiver from the switch hook, relay 305, being included in a low resistance circuit, attracts its armatures and locks up in a circuit from battery through the right-hand winding and contact and innermost right-hand armature of said relay, normal contacts of relay 207, conductor 325, and thence over the upper side of the talking circuit to ground at the upper right-hand winding of repeating coil 109, this circuit having been completed in the meantime by the release of relay 113. The ringing current is thus disconnected from the calling subscriber's line. Since the calling subscriber's receiver is off the switch hook and the left-hand armatures of relay 305 are attracted, the relay 306 is now included in a direct circuit from the calling subscriber's substation through to the right-hand windings of the repeating

coil 109 and the battery supply relay 112. Relay 306 becomes energized and closes a circuit for relay 307. Relay 307 at its make before break contact shifts the holding circuit for relay 305 from the upper talking conductor to the third conductor 327. This circuit may be traced from battery through the right-hand winding and contact and inner right-hand armature of relay 305, front contact and right-hand armature of relay 307 to conductor 327. The relay 112, which also energizes in series with the calling subscriber's line, closes a circuit from battery through the winding of relay 111, contact and armature of relay 112 to ground at the contact and armature of relay 110. Relay 111, at its armatures and contacts, reverses the connection of the windings of relay 110 to the talking conductors 107, 108. This reversal of current causes the polarized relay 105 at the toll operator's position to retract its armatures. Relay 105 removes the shunt from around the high resistance winding of relay 106, whereupon the flow of current is reduced through the winding of relay 102. Relay 102 thereupon deenergizes and opens the illuminating circuit of lamp 103 which advises the toll connecting operator that the calling subscriber has removed his receiver from the switch hook. The calling and called subscribers may now converse with one another over the toll connection.

Release of the established connection.

When the conversation has terminated the calling subscriber at line 611, by replacing his receiver to the switch hook, causes the actuation of the usual supervisory signal at the toll connecting operator's position. Likewise, the replacement of the calling subscriber's receiver to the switch hook causes the deenergization of relay 112, which in turn permits the deenergization of relay 111. Relay 111 again reverses the current over the trunk 107, 108 and the polarized relay 105 releases its armature to reclose the shunt around the right-hand winding of relay 106. Relay 102 now operates and lamp 103 illuminates to notify the toll connecting operator that the connection should be taken down. She thereupon removes the plug 100 from the jack 101 causing the deenergization of relays 102 and 106. Relay 106 opens the circuit of relay 110, which latter relay releases its armatures and opens the circuit of relay 114. Relay 114 completes a circuit from battery through the lamp 118, inner right-hand armature and front contact of relay 117, innermost right-hand armature and contact of relay 114, interrupter 115 to ground. The interrupter 115 causes the lamp 118 to flash, indicating to the cordless operator that the switches should be released. The cordless operator thereupon depresses her disconnect key 127 which removes ground

potential from the conductor 130. The removal of this ground potential causes the release of relays 207, 216, 217, 304 and 305. Relay 207 completes a circuit from battery through the winding of release magnet 204, middle springs of the off normal contact 211, back contact and armature of relay 201, back contact and armature of relay 200, contact and outer right-hand armature of relay 207 to ground. The release magnet 204 operates to restore the brushes of the selector switch S^1 to their normal position. Similarly, a circuit is completed from battery through the winding of release magnet 222, upper contacts 224, back contact and left-hand armature of relay 217, contact and left-hand armature of relay 220 to ground at the contact and outer right-hand armature of relay 216. Magnet 222 also operates to restore the brushes of the selector switch S^2 . The release of relay 304 at the connector switch establishes a circuit from battery through the winding of the release magnet 308, contacts 317 and 316, back contact and middle right-hand armature of relay 301, back contact and middle left-hand armature of relay 304 to ground. The release magnet 308 energizes and causes the release of the brush shaft of the connector switch C. All apparatus taken in connection with the establishment of the toll connection has now been completely returned to its normal condition.

Calling subscriber's line busy.

It will next be considered that the calling subscriber's line 330 has been rendered busy during the time that the toll connection is being obtained by the toll operator. Consequently, the test brush 320 of the connector switch C on engaging the test terminal 321 of the calling subscriber's line at the termination of units selection encounters a ground potential thereon. A circuit is thereupon established from battery through the winding of relay 311, front contact and right-hand armature of relay 324, test brush 320 to the grounded test terminal 321. Relay 311 operates and locks up in a circuit as follows immediately that the slow to release relay 324 retracts its armatures: battery through the winding of relay 311, make before break contacts at the right-hand armature of relay 324, back contact and right-hand armature of relay 310, contact and outermost left-hand armature of relay 311 to the grounded conductor 327. Upon the next closure of the constantly rotating interrupter 323, following the deenergization of relay 324, a circuit is closed from ground through the left-hand winding of coil 322, interrupter 323, inner left-hand armature and contact of relay 324, contact and middle left-hand armature of relay 311, outermost right-hand armature and front contact of

relay 301, left-hand winding of relay 304 to battery and ground. Relay 304 operates and locks in a circuit through its left-hand winding to the grounded conductor 327 and relay 304 opens the holding circuit of relay 301. For each succeeding closure of the interrupter 323 a circuit is established over the above traced path to the outermost right-hand armature and back contact of relay 301, right-hand winding of relay 300 to battery and ground.

When the toll operator has succeeded in obtaining the called party she depresses the key 138, as hereinbefore explained, and the relay 113 is caused to attract its armature to open the upper talking conductor. The opening of this circuit causes the deenergization of relay 305, as explained. Although relay 305 retracts its armatures it cannot apply ringing current to the calling subscriber's line due to the fact that relay 311 is holding the ringing circuit open at its right-hand armatures. For each opening and closure of the interrupter 323, a current is induced in the left-hand winding of relay 300 which flows over the normal contacts at the outer left-hand armature of relay 305 over the upper talking conductor to the repeating coil 109. The repeating coil 109 induces the current which is in turn transmitted over the trunk 107, 108 to the toll operator's telephone receiver. The characteristic sound produced in the toll operator's receiver notifies her that the calling subscriber's line has been rendered busy as by being called by some other subscriber in the exchange. The toll operator thereupon removes plug 100 from the jack 101 which brings about the operation of the disconnect lamp 118 at the cordless operator's position in the manner hereinbefore discussed. The cordless operator causes the release of the switches S^1 , S^2 and C.

The toll operator immediately connects her telephone set to the order wire 610 and asks the cordless operator to set up the same connection to the calling subscriber's line and this time to provide for seizing said line regardless of its busy condition. The cordless operator thereupon depresses the keys on her board in the manner previously explained and also actuates the no test key 583. The key 583 completes a circuit from ground through its contacts, upper right-hand contact 455 (1) of the allotter switch AL, conductor 586, winding of relay 584 to battery and ground. Relay 584 locks up on the following circuit as soon as the relay 401 has become energized following the completion of the operation of the trunk finder switches: battery through the winding and right-hand armature and contact of relay 584, conductor 440 to ground at the outer left-hand armature and contact of relay 401. The first and second selector switches

S¹ and S² are again operated under the control of the register sender to extend the newly assigned trunk 107, 108 through to the connector switch C. The connector switch C is operated in its tens movement at which time it will be recalled the sender control switch is standing in position 5. When the tens register reaches its last position, at which time the last impulse of the tens series is being sent, and also in the normal position of said register, a circuit is closed as follows for the continued energization of relay 400: battery through the winding of relay 400, conductor 430, brush 587 of the tens register, left-hand armature and contact of relay 584, conductor 588, brush 538, terminal 589 to which the sender control switch immediately advances, to ground. The sender control switch remains in position 6 during the interval required by the time measure switch T to advance its brush 543 to the first one of the connected terminals 581, as hereinbefore explained. During this time the relay 400 is being held energized and consequently relay 300 at the connector switch is maintained deenergized to hold the stepping circuit closed through the windings of relay 302 and magnet 303. The relay 307 is therefore given time in which to release its armatures before relay 300 can again become energized to close the circuit for said relay 307. The deenergization of relay 307 causes the closure of a circuit from battery through the winding of relay 310, right-hand armature and contact of relay 302, contact and left-hand armature of relay 307 to the grounded conductor 327. Relay 310 operates and locks in a circuit from battery through its winding and contact and left-hand armature to the grounded conductor 327.

As soon as brush 543 reaches the first one of the connected terminals 581, the sender control switch is advanced, as described, into position 7 where units selection takes place. When the brushes of the connector switch are moved to the terminals of the calling line 330, following the last units impulse, relay 305 is operated and locked up in the manner already discussed. Relay 311 is also operated in a circuit from battery through its winding, front contact and right-hand armature of relay 324 to the grounded test terminal 321. Relay 311 releases, however, upon the deenergization of relay 324 since the previously traced circuit for locking relay 311 is now opened at the back contact and right-hand armature of relay 310. Relay 304 is also actuated in a circuit from battery through the winding of cut-off relay 312, terminal 321, brush 320, right-hand armature and back contact of relay 324, contact and innermost left-hand armature of relay 311, right-hand winding of relay 304, front contact and mid-

dle right-hand armature of relay 301 to ground at the back contact and middle left-hand armature of relay 304. Relay 304 locks up through its left-hand winding through the grounded conductor 327.

The toll operator again depresses the key 138 to bring about the closure of the trunk 107, 108 leading to the cordless operator's position and also to cause the temporary opening of the upper talking conductor leading to the connector switch C. Relay 305, however, is not released due to the opening of the upper talking conductor as in the case previously discussed. Since the calling subscriber's receiver is off the switch hook due to the fact that he is conversing with another party, a circuit is completed through the armatures and contacts of relay 311, 304 and 305 through to the right-hand windings of the repeating coil 109. Consequently, relay 306 has operated and completed a circuit for relay 307. Relay 307, by attracting its armatures, closes a locking circuit for relay 305 from battery through the right-hand winding and contact, innermost right-hand armature of relay 303, front contact and right-hand armature of relay 307 to the grounded conductor 327. Therefore, the operation of key 138 by the toll connecting operator does not cause the application of ringing current to the calling subscriber's line 330. The toll connecting operator listens in and noting that the calling subscriber is engaged in conversation over a local connection, interrupts and notifies him that the toll connection which he originally requested has been obtained. The calling subscriber may thereupon request the party with whom he is conversing to hang up his receiver in order that he may talk with the subscriber at the distant end of the toll connection. After the conversation has been completed the usual supervisory signals are operated at the toll operator's position and she initiates the release of the connection which proceeds in the manner already explained.

Allotment of register senders.

A consideration will now be given to the method of allotting the register sender units for use in controlling the selective switches. According to the disclosure in this case the register sender as shown in this case with the allotter switch AL is in its first position. As will presently be seen the next register sender mechanism (not shown) is assigned for use in position 2 of the allotter switch. After the allotted register sender has been associated with the cord circuit in the manner described and the registration set up on the numerical registers, the allotter switch AL is advanced for the purpose of assigning the next idle sender. This advance occurs when the sender control switch reaches position 4. At that time a circuit is completed

from battery through the winding of the armature and contact of the allotter stepping magnet 424, upper right-hand contact 427 (1 + 2) to ground through the fourth position terminal and brush 551 of the sender control switch. The allotter magnet 424 operates to advance the contact of the allotter switch into position 3. If the next register sender happens to be busy at this time the allotter switch continues to move into position 5 by means of a circuit similar to the one traced for driving said switch into position 3. Should the next register sender in order be idle, the allotter switch stops in position 5. The next time an assignment key 126 is depressed by the cordless operator the grounded start conductor 135 is extended by way of the upper right-hand contact 425 (5), and thence through the winding of a relay corresponding to relay 406 individual to the allotted register sender.

Should all the register senders be engaged simultaneously the circuit is completed from battery through the winding of relay 534, conductor 432, contact 453, outer right-hand armature and contact of relay 402, thence through the outer right-hand armatures and front contacts of the relays corresponding to relay 402 individual to the other register senders to ground. Relay 534 becomes energized and closes a circuit from battery through the windings of the key release magnets 528, 529, etc. to ground at the front contact and armature of said relay. The release magnets are operated to insure that none of the keys on the operator's keyboard can be locked in their actuated position until one of the register senders becomes available for use. Since all of the register senders are busy the allotter switch 424 continues to advance from one allotting position to another by means of circuits similar to the one described in detail until it reaches position 13. In this position a circuit is completed from battery through the winding and armature and contact of magnet 424 to ground on the lower left-hand contact 427 (13 + 17). The stepping magnet 424 therefore continues to operate until the switch reaches position 18 where it comes to rest. When one of the register senders becomes idle the series circuit through the armatures and contacts of relay 402 is operated and relay 534 becomes deenergized. Relay 524, at its armature and back contact, closes a circuit including contact 426 (18) to drive the allotter switch into its first allotting position. The idle register sender is immediately found by the allotter and assigned.

What is claimed is:

1. In a telephone system, a subscriber's line, a selective switch for extending connections to the subscriber's line, a register sender, an impulse circuit, a relay, means under the control of the register sender for

operating said relay to send impulses over said circuit to operate said switch, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, means controlled by the register sender for altering the operation of said relay, and means responsive to such operation of said relay for placing said selective switch in condition to extend a connection to the subscriber's line regardless of its busy or idle condition without rendering effective said signaling means.

2. In a telephone system, a subscriber's line, a selective switch for extending connections to the subscriber's line, a register sender, an impulse circuit, a relay, means under the control of the register sender for operating said relay to send impulses over said circuit to operate the selective switches, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, means controlled by the register sender for causing a prolonged operation of said relay, and means responsive to such operation of said relay for placing the selective switch in condition to extend a connection to the subscriber's line when busy without rendering effective said signaling means.

3. In a telephone system, a subscriber's line, a selective switch for extending connections to the subscriber's line, a register sender, an impulse circuit, a relay, means under the control of the register sender for operating said relay to send series of impulses over said circuit to operate the selective switch, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, means controlled by the register sender for causing a prolonged operation of said relay between certain of said series of impulses, and means responsive to such operation of said relay for placing the selective switch in condition to extend a connection to the subscriber's line when busy without rendering effective said signaling means.

4. In a telephone system, a subscriber's line, a selective switch for extending connections to the subscriber's line, a register sender, an impulse circuit, a relay, means under the control of the register sender for operating said relay to send series of impulses over said circuit to operate the selective switch, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, means controlled by the register sender for altering the operation of said relay to send a comparatively long impulse over the impulse circuit, and means at the selective switch responsive to such long impulse for placing said switch in condition to extend a connection to the subscriber's line when busy

without rendering effective said signaling means.

5. In a telephone system, a subscriber's line, a selective switch for extending connections to the subscriber's line, an operator's position, a register sender, an impulse circuit, a relay, means under the control of the register sender for operating said relay to send impulses over said circuit to operate the selective switch, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, means controlled by the operator for causing the register sender to alter the operation of said relay, and means responsive to such altered operation of said relay for placing the selective switch in condition to extend a connection to the subscriber's line when busy without rendering effective said signaling means.

6. In a telephone system, a subscriber's line, a series of step-by-step selector switches for extending connections to the subscriber's line, a register sender, an impulse circuit, means under the control of the register sender for sending impulses over said circuit to operate said switches, signaling means, means operative when the subscriber's line is found busy for rendering the signaling means effective, and means controlled over

the impulse circuit by said register sender for placing the final one of said switches in condition to extend a connection to the subscriber's line regardless of its busy condition without rendering effective said signaling means.

7. In a telephone system, a subscriber's line, a step-by-step selective switch for extending connections to the subscriber's line, a register sender, an impulse circuit, a relay, means under the control of the register sender for operating said relay to send impulses over said circuit to operate the switch, signaling means, means operative when the subscriber's line is found busy by said switch for rendering the signaling means effective, means controlled by the register sender for altering the operation of said relay, and means responsive to such operation of said relay for placing the selective switch in condition to extend a connection to the subscriber's line regardless of its busy condition without rendering effective the signaling means.

In witness whereof, we hereunto subscribe our names this 17th day of December A. D., 1920.

WARREN W. CARPENTER.
HENRY HOVLAND.