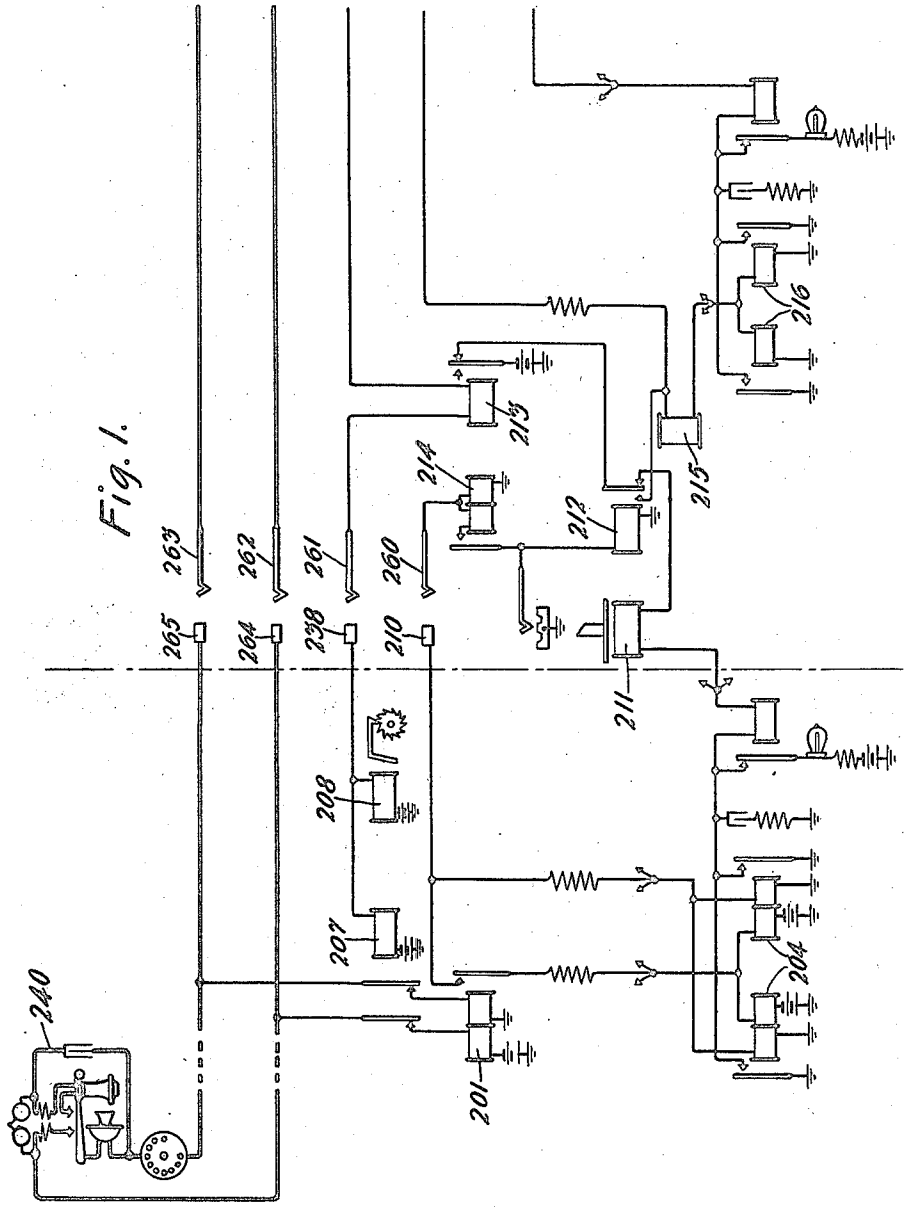
Feb. 5, 1924. 1,482,618

L. POLINKOWSKY ET AL

TELEPHONE EXCHANGE SYSTEM

Filed June 14, 1919 8 Sheets-Sheet 1



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TELEPHONE EXCHANGE SYSTEM

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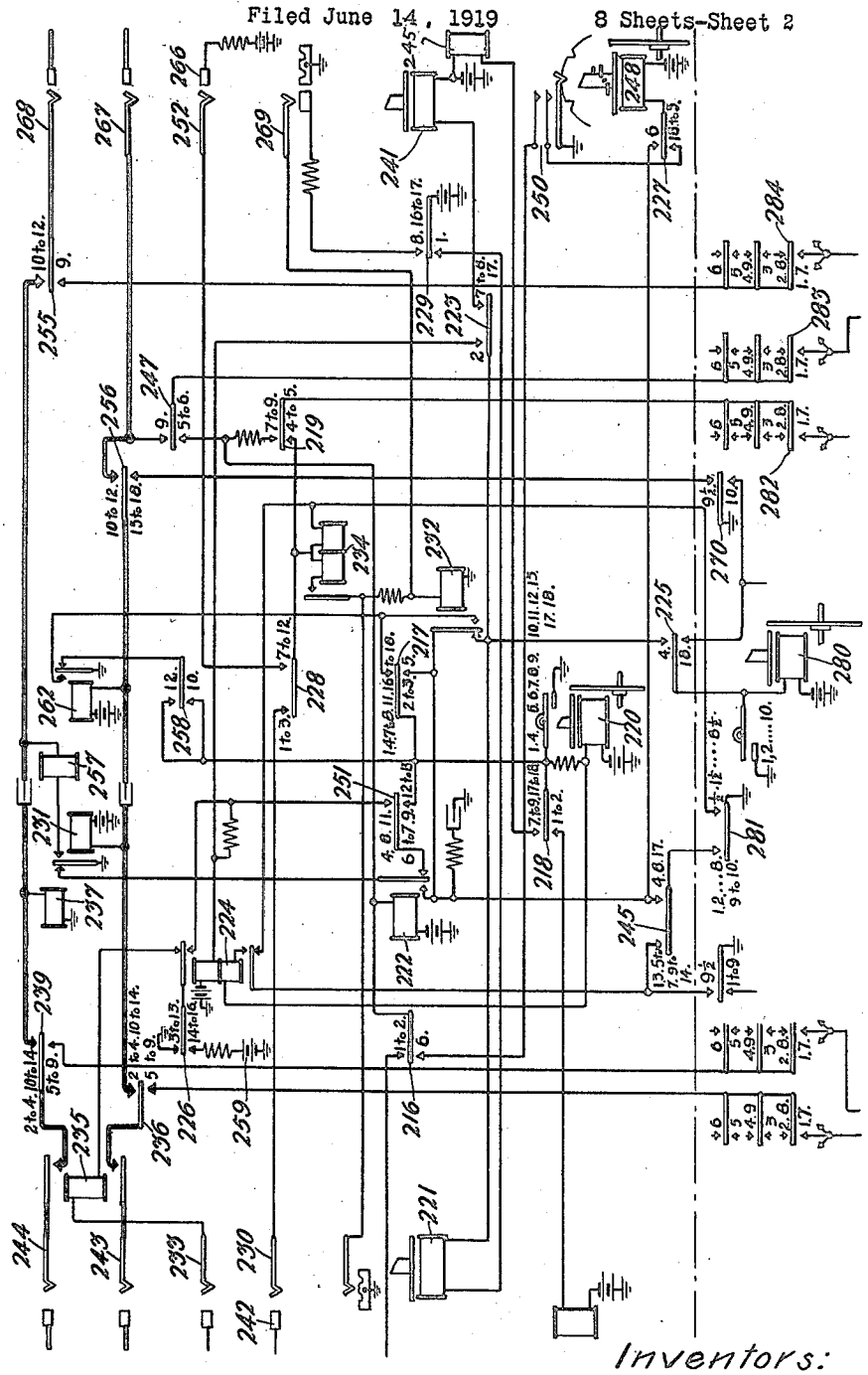

Fig. 2.

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TELEPHONE EXCHANGE SYSTEM

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Fig. 3.

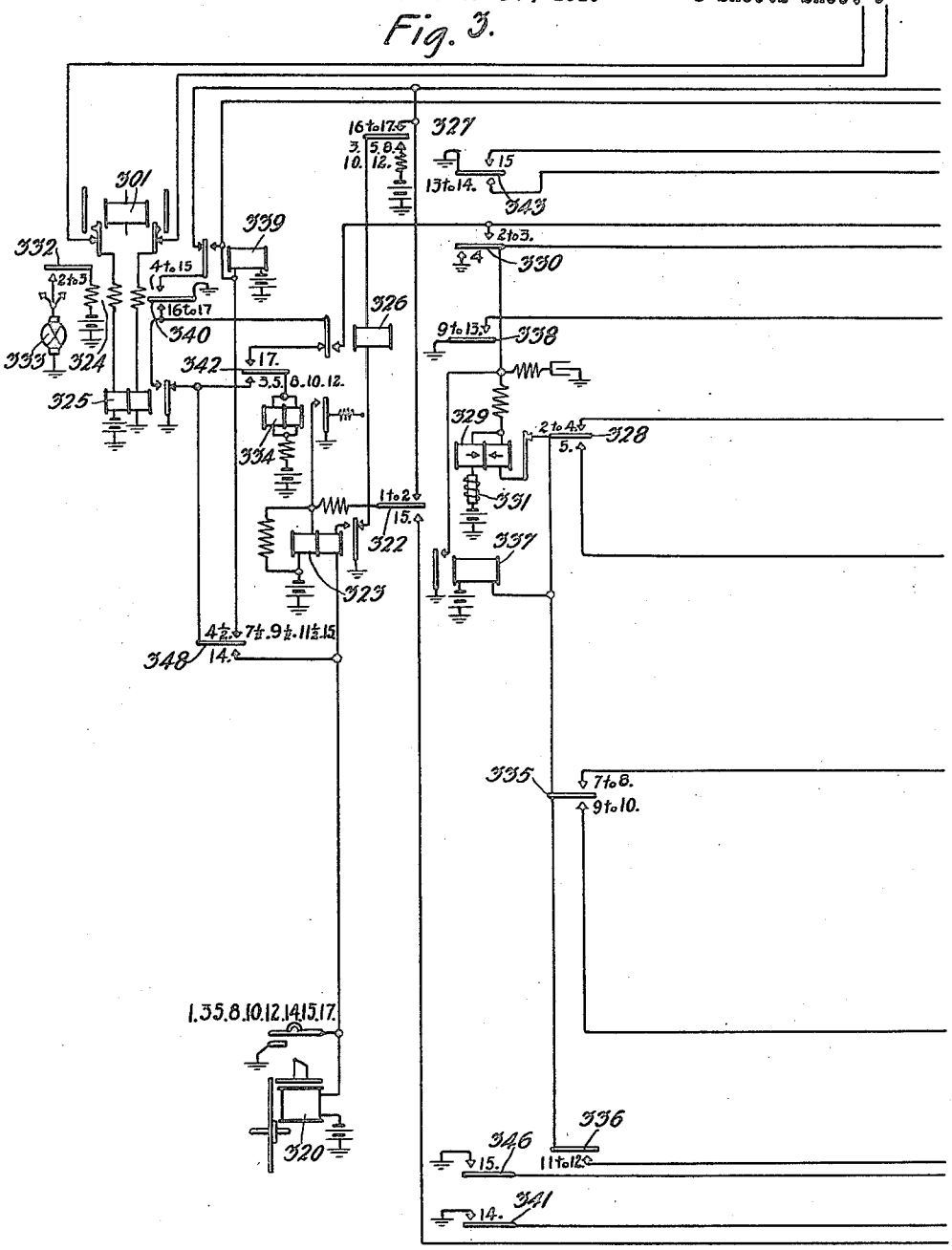

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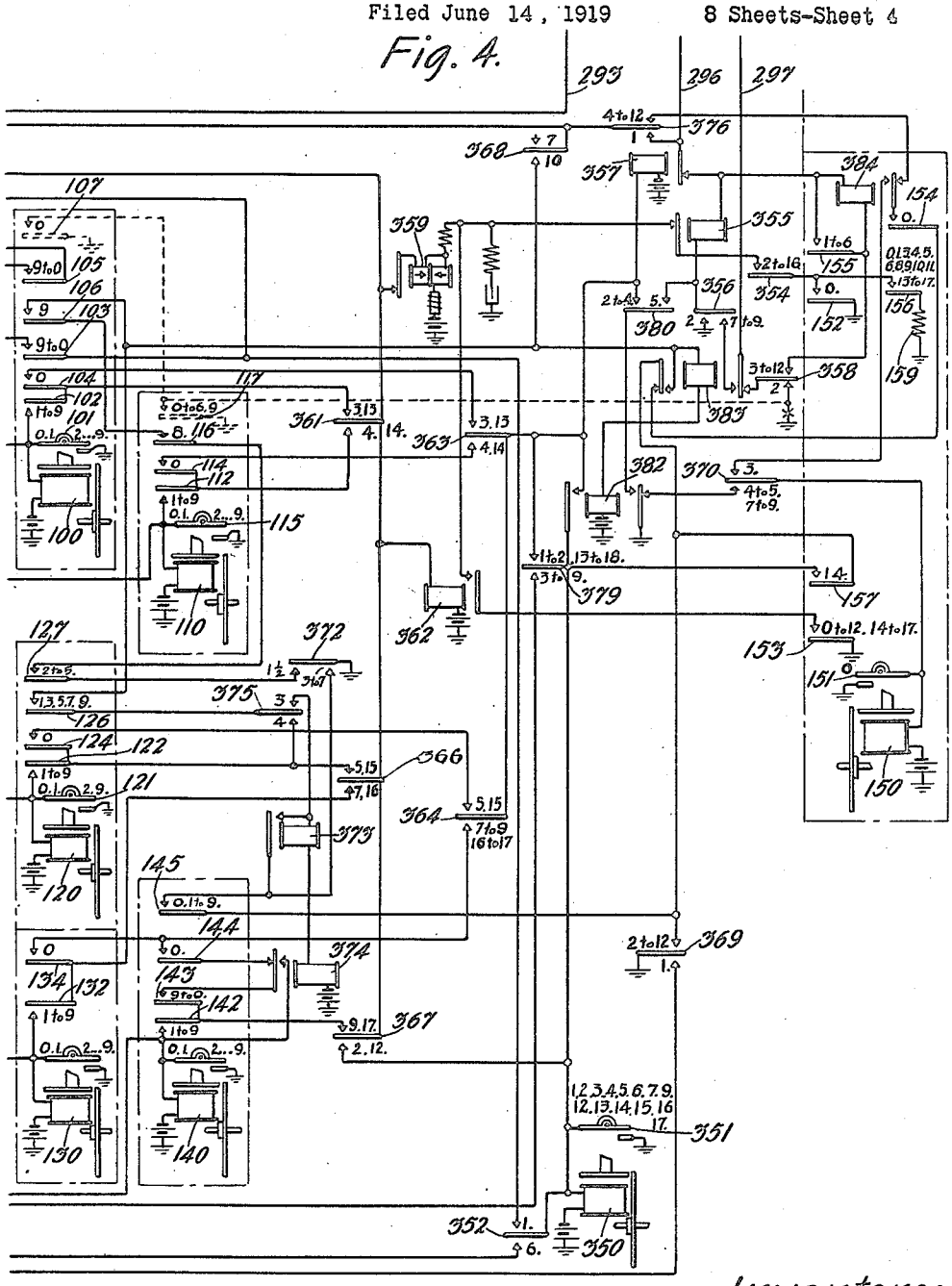
Fig. 4.



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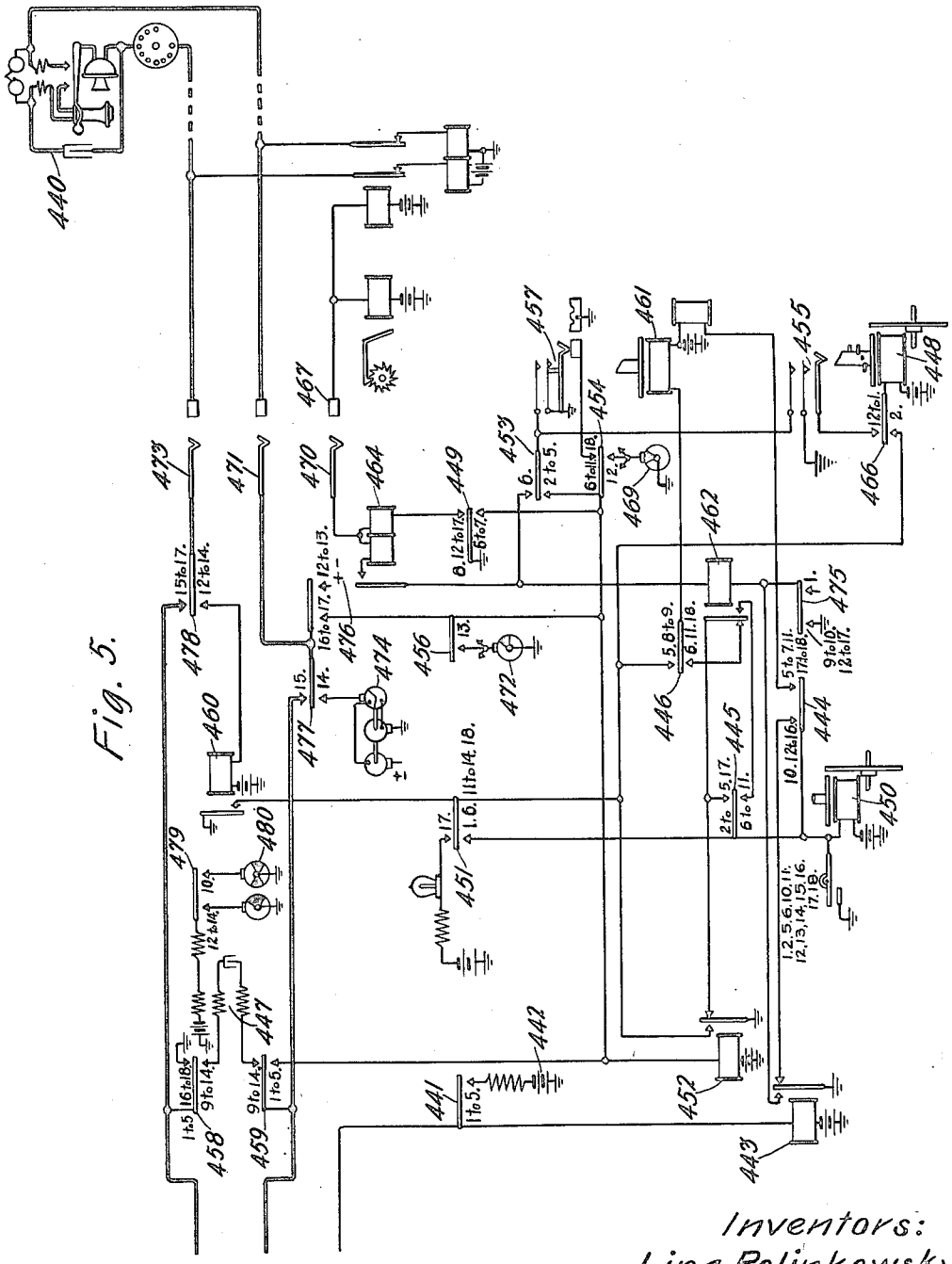

Fig. 5.

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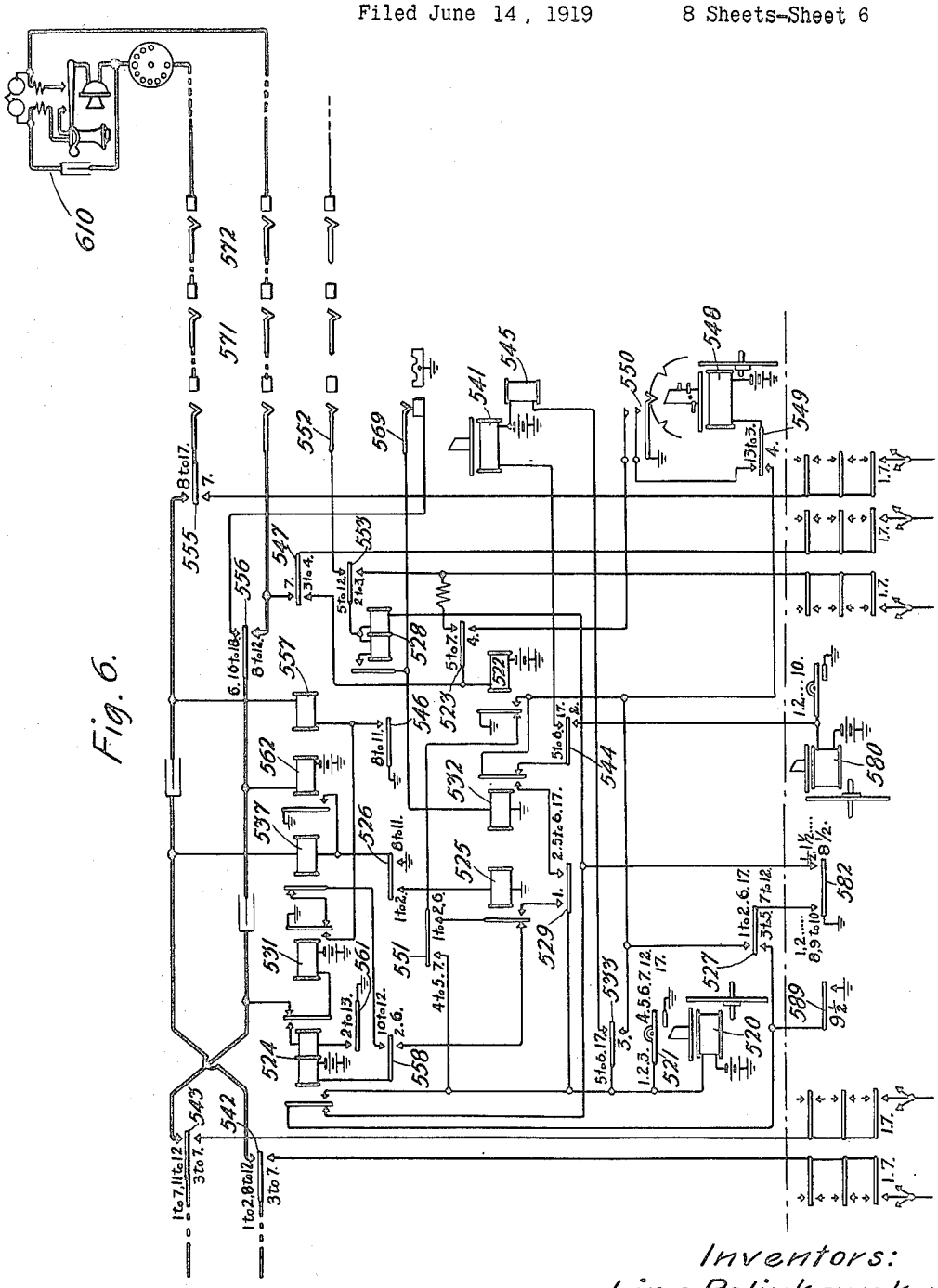

Fig. 6.

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Fig. 7

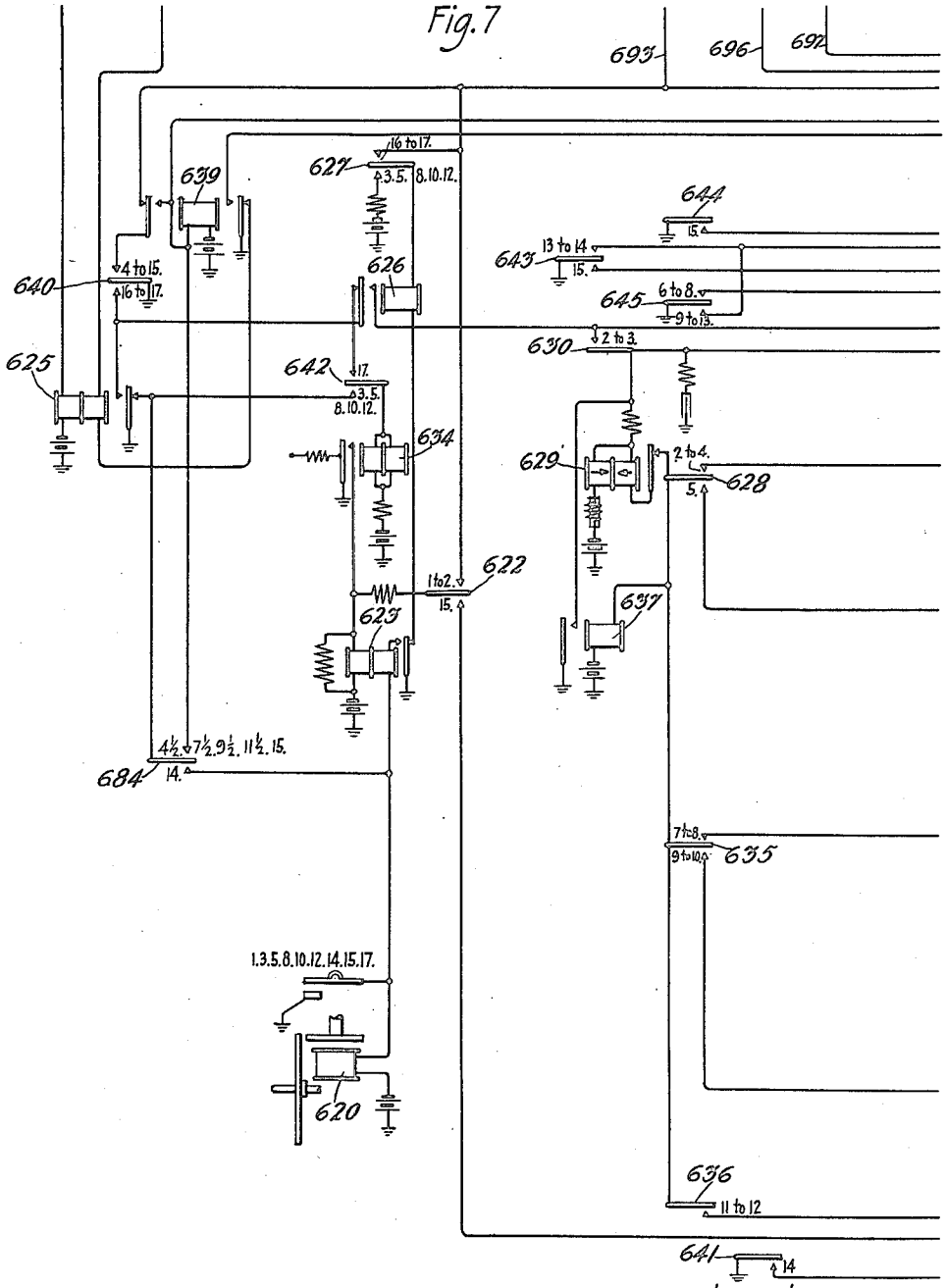

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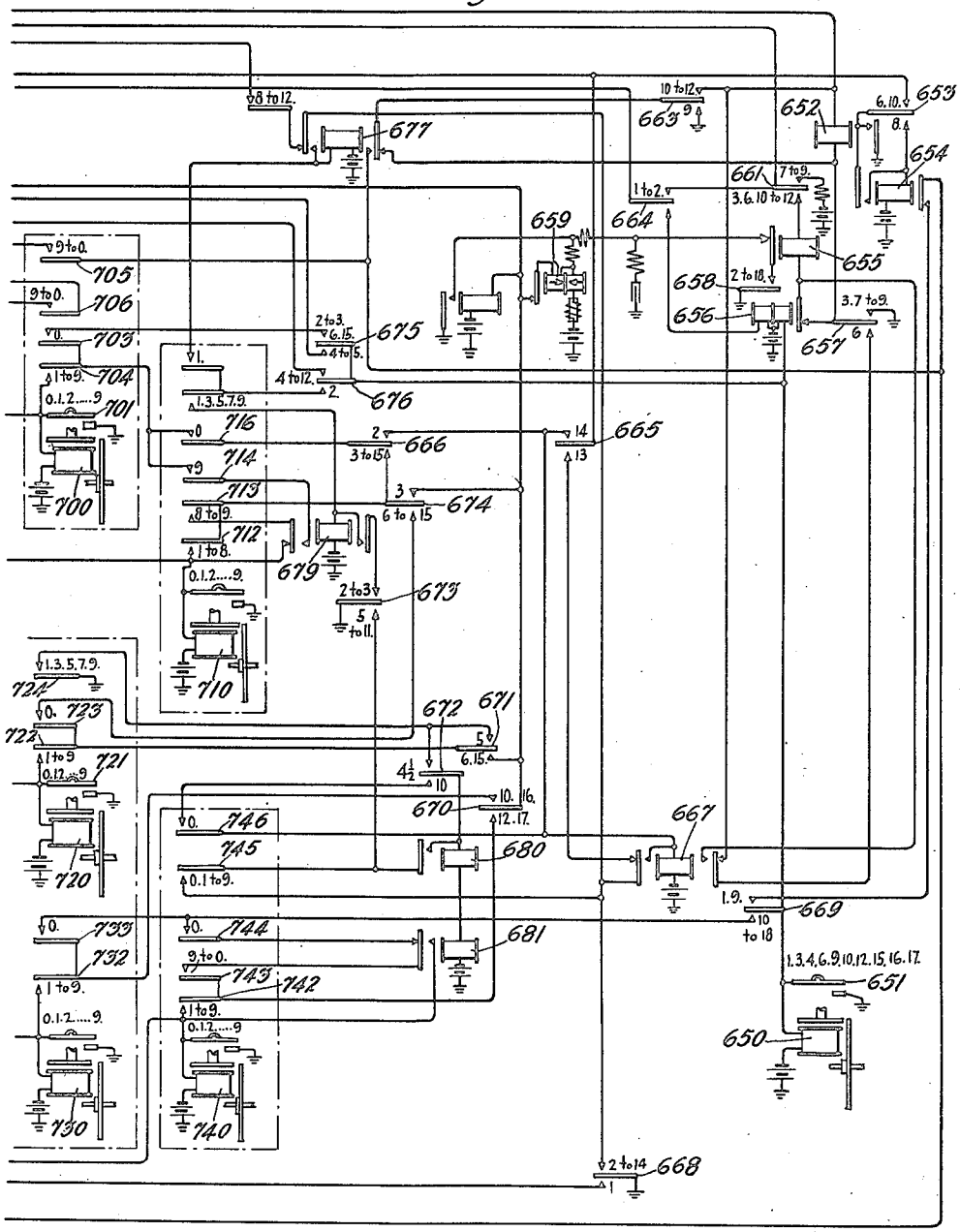
Fig. 8



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UNITED STATES PATENT OFFICE.

LIPA POLINKOWSKY, OF NEW YORK, N. Y., AND WILLIAM H. MATTHIES, OF HACKENSACK, NEW JERSEY, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed June 14, 1919. Serial No. 304,212.

To all whom it may concern:

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

This invention relates to telephone exchange systems in which machine switching apparatus is utilized for establishing connections between subscriber's lines.

More particularly it relates to a telephone system involving a plurality of switching stations or exchanges provided with interconnecting trunk lines, whereby subscribers whose lines terminate in one switching station may obtain connections with other lines local thereto, or by means of said interconnecting trunks may extend a connection to a distant exchange or switching station and thence to a desired line therein.

The object of the invention is the provision, in a system of this character where the designation of a called line is registered on a controlling mechanism at one switching station to control the automatic switches therein, of means whereby the registration of such designation is automatically transferred from said controlling mechanism to a distant switching station and there reproduced on a corresponding controlling mechanism to control the automatic switches in the distant switching station.

A feature of the invention is the provision of means whereby the controlling mechanism in one switching station is able to discriminate between local calls and outgoing calls to a distant station such that when the number of a line belonging to a distant station is registered a transfer device becomes effective to transfer the designation registered to the controlling mechanism in the distant switching station.

Another feature of the invention consists in the provision of a transfer device so arranged as to become automatically associated in succession with the several registers of the set comprising a register controlling mechanism to transfer the numerical designation registered on such mechanism to the corresponding registers of the register mechanism in a distant switching station.

A further feature of the invention, in a system where the controlling registers are adapted to be advanced to positions corresponding to the complements of the digits of the desired number, consists in the provision of means, which operates simultaneously with the restoration to normal of said registers, for advancing the corresponding registers of the register mechanism in a distant station to positions corresponding to the complements of said digits.

A still further feature consists in providing means whereby the automatic switches which are controlled in their selective movements by controlling registers are, dependent upon the positions assumed by said registers, advanced automatically in a selective operation independent of the control of the registers.

These and other features of the present invention will become more apparent as the description progresses.

Referring to the drawings, Fig. 1 shows a subscriber's line terminating in the multiple contacts of first line finder switches in a switching station or satellite and the operating circuits of one of these finder switches.

Fig. 2 shows one of a plurality of second line finder switches in the satellite, in the multiple terminals of which appear the connecting circuits leading from the first line finder switches. There is also shown in this figure, a first group selector of the satellite, together with means for associating an idle register controlling mechanism with the circuits individual to the second line finder and group selector.

Figs. 3 and 4 illustrate a set of controlling registers with the operating circuits therefor located at the satellite for controlling the movement of the selector switches.

Fig. 5, shows a final selector switch at the satellite and one of the subscriber's lines to which the switch has access as a called line.

Fig. 6, shows the incoming end of a trunk line leading from the first group selector of the satellite to a distant exchange, and the circuits of a first group selector in which said trunk terminates in the exchange, to-

gether with a diagrammatic illustration of a second group selector, and a final selector switch. This figure further shows means for associating an idle register controlling mechanism with the circuits of the first group selector in the exchange.

Figs. 7 and 8 illustrate a register controlling equipment at the exchange, similar in many respects to the register set at the satellite, which serves to control the selective operation of the successive selector switches to establish a connection to a called subscriber's line in the exchange.

In considering the circuits and apparatus for setting up a connection between two subscriber's lines in the satellite in connection with the following description, the drawings should be arranged as follows:

Figs. 1, 2 and 5 taken in order from left to right with Figs. 3 and 4 placed below Figure 2. In considering the establishment of a call from the satellite to a distant exchange in connection with the following description, Fig. 6 should be substituted for Fig. 5, and Figs. 7 and 8 placed below Fig. 6.

In the system disclosed, where exchanges and satellites to the exchanges are involved with trunking facilities whereby a subscriber of the satellite is enabled to obtain telephone connections with subscriber's lines belonging to the exchange, provision is also made at the satellites such that a subscriber thereto may obtain connections directly to the lines of other subscribers local to his own satellite without the necessity of first extending the connection over a trunk to the exchange or of utilizing any of the exchange apparatus. Since the capacity of the satellite is relatively small as compared with that of the exchange, the number of selective operations for setting up a connection between two subscribers' lines belonging to the exchange is greater than the number of selective operations neccessary to establish a connection between two lines belonging to the satellite. Furthermore, the number of selective operations for setting up a connection from a subscriber's line local to a satellite over a trunk line to the exchange, and thence to a called subscriber's line in the exchange, is greater than the number of operations involved in the establishment of a connection between two lines local to the satellite. The present exchange system has a capacity of 20,000 lines, but could readily be adapted to accommodate any desirable number of lines up to 100,000 with the switch controlling mechanism shown by utilizing all levels of the group selector switches. Accordingly the register controlling mechanism shown in Figs. 7 and 8 at the exchange, comprises five registers for controlling the selecting operations of the first, second, and final selector switches in the establishment of a connection between any two subscribers' lines belonging to the exchange.

The satellites in this system, as the one represented by the circuits and apparatus shown in Figs. 1, 2, 3, 4 and 5, may be of any suitable capacity up to, say, 1800 lines. However, the satellite shown is assumed, for example, to have a capacity of 400 subscribers' lines, whereby only three selective operations are required for completing a connection between two lines belonging to the satellite. For this purpose, so far as the register controlling mechanism of the satellite switches is concerned, only three registers need be provided, one for controlling the group selector of Fig. 2, and the other two for controlling the tens and units selective movements of the final selector switch in Fig. 5. However, it is desirable that no distinction be made between the numbering of a subscriber's line to a satellite and a subscriber's line to the exchange. That is to say, it is desirable that the numbers of the satellite subscribers' lines, listed in the telephone directory, contain as many digital places as the numbers of the exchange lines. By such a provision a universal form of service is given to all subscribers' lines in the system, whereby subscribers to the satellite are not concerned as to whether or not a called line belongs to a satellite or to a distant exchange, and in fact, have no way of knowing from its designation in the directory.

To accomplish the foregoing purpose, the register controlling mechanism at the satellite is provided with five registers the same as the register set at the exchange, in order that a registeration may be made of each of the five impulse series transmitted to the satellite corresponding to the number of any line in the system regardless of whether it be a satellite or an exchange line. If the number set up on the satellite registers is one which designates a line belonging to the satellite, the register mechanism is so arranged that only the last three registers are effective to control the satellite switches. If the number set up on the satellite registers is one belonging to a line of a distant exchange, discrimination of this fact is made by the satellite register mechanism, whereby means are rendered effective to automatically advance the group selector of the satellite into connection with a trunk line outgoing to the exchange without disturbing the positioned registers. The trunk line having been seized in this manner, a special transfer mechanism is automatically associated, first with the first register in the satellite and operates to transfer the setting of such register to the corresponding register of the exchange register mechanism. Thus the register at the exchange which

controls the group selector in accordance with the first digit of a called number is set up to a position by said transfer mechanism corresponding to the position to which the first register of the satellite was advanced by the first digital series of impulses sent by a calling subscriber in the satellite. Thereupon the transfer mechanism is automatically associated with each of the succeeding registers at the satellite to transfer their respective settings to the corresponding registers in the exchange. When the registers at the exchange have all been set, they become operative in the usual manner to control the selective operations of the exchange switches to complete the connection to the desired line.

The register mechanism shown in the present system is of the type in which sequence switches are provided, one for the registration of each digit. Each sequence switch has ten positions and advances to a position corresponding to the number of impulses sent from the subscriber's dial during the setting period of the registers, and later runs through the remaining positions of its cycle to control the operation of the selector switches. It is therefore obvious that the number of steps taken by a register while controlling a selective switch is the complement of the number of impulses sent by the calling subscriber. In order that the switches be controlled in accordance with the numerical designations of the called numbers it only becomes necessary to arrange the calling subscriber's dial such that the complement rather than the actual digit itself be sent to the register. The subscriber's dial is further designed so that the last interruption of the line in each series of impulses is of comparatively longer duration than the interruptions of the preceeding impulses of the series. The reason for this will become apparent hereinafter.

It is believed that a more thorough understanding is to be had of this invention from a description of the operation of the system in which it is embodied in the establishing of a call from one subscriber's line to another. First, it will be assumed that a subscriber to the line 240 of the satellite desires to obtain a connection with another line local to his own satellite such as the line 440. On removing his receiver from the switchhook to initiate the call, a circuit is established from battery through the left-hand winding of line relay 201, contact and outer armature of cut-off relay 207 over the loop of the line and returning by way of the inner armature and contact of relay 207 through the right-hand winding of relay 201 to ground. Relay 201 attracting its armature closes a circuit from battery, through the inner windings of the common starting relays 204, armature and contact of relay 201 to place a selectable potential upon the multiple terminals 210 of all the first line finder switches having access to the group in which the calling line appears.

Relays 204 by attracting their armatures close a circuit from ground over the armatures and contacts and in parallel through the windings of the power magnets 211, back contacts and armatures of relay 212, back contacts and armatures of relays 213 of all idle first line finder switches. These switches rotate their brush carriages in the well-known manner to advance brushes 260, 261, 262 and 263 over the multiple terminals 210, 238, 264 and 265 in search of the calling line. As soon as a finder switch moves its test brush 260 into engagement with the test terminal 210 of the calling line, the selectable potential is found thereon and a circuit is closed over the brush 260, through the right-hand high resistance winding of test relay 214 to ground. Relay 214 attracts its armature and closes a circuit through its left-hand low resistance winding and the winding of the second test relay 212. This circuit being in shunt of the right-hand winding of relay 214 reduces the potential on multiple terminals 210 to render a calling line non-selectable. Relay 212 energizes when the brushes are accurately centered on the terminals of the calling line and opens the power circuit, thereby bringing the brush carriage to rest. A circuit is now completed from battery through armature and contact of relay 213, armature and front contact of relay 212, to place a selectable potential upon the multiple terminals 242 of the second line finder switches such as the one shown in Fig. 2. In parallel with this a circuit is established through the winding of holding magnet 215, through the windings of the common starting relays 216 to ground. Relays 216 energize and complete a circuit from ground over their armatures and contacts, contact 216 (1) of the sequence switch 220 associated with the circuits of the second line finder and first group selector shown in Fig. 2, through the winding of relay 222 to battery and ground. Relay 222 energizing, closes a circuit for the power magnet 221 from ground, armature and back contact of relay 231, armature and front contact of relay 222, armature and back contact of relay 232 through the winding of the power magnet 221, sequence-switch contact 229 (1) to battery and ground. The power magnet 221 operates to rotate the brush carriage carrying the brushes 230, 233, 243 and 244 over the terminals of the connecting circuits leading from the first line-finder switches. When the test brush 230 engages the test terminal 242 of the calling connecting circuit, a circuit is closed from

battery over armature and contact of relay 213, as above traced, to the terminal 242 and thence over the test brush 230, contact 228 (1) through the right-hand high resistance winding of test relay 234, back contact and lower armature of relay 224, contact 245 (1) contact 281 of sequence switch 280 to ground. Relay 234 energizes and closes a circuit through its left-hand low resistance winding, its contact and armature through the winding of the second test relay 232 parallel to the circuit above traced through the right-hand winding of relay 234. This circuit, being of comparatively low resistance, reduces the potential of the test terminals 242 to prevent another second line finder from seizing the calling connecting circuit. Relay 232, by attracting its armature, opens the circuit of the power magnet 221 to arrest a movement of the brush carriage with the brushes in engagement with the proper set of terminals. A circuit is also established from battery through the winding of sequence switch 220, contact 217 (1) front contact and armature of relay 232, front contact and armature of relay 222, back contact and armature of relay 231 to ground. Sequence switch 220 energizes in this circuit and moves from position 1, into position 4.

In position 3, and in the succeeding positions up to position 13 of sequence switch 220, a circuit is closed from battery, through the winding of the cut-off relay 207, terminal 238, brush 261, winding of relay 213, brush 233 through the winding of relay 235, back contact and upper armature of relay 224, contact 226 to ground. The cut-off relay 207 opens the circuit of line relay 201, which in turn permits relays 204 to be deenergized to arrest the movement of the remaining rotating first line finders. Relay 213 energizing in series with the cut-off relay 207, and relay 212 by deenergizing, open the circuit of the common starting relays 216. The relay 235 which also energizes in series with relays 207 and 213, closes the circuit of the calling line through to the sequence switch contacts 236 and 239. Sequence switch 220 being in position 3, at this instant, a bridge is placed across the calling subscriber's line, through relay 231, contact 236 (2) to (4), contact and armature of relay 235 over the loop of the line, upper armature and contact of relay 235, contact 239 (2) to (4), through the retardation coil 237 to ground. Relay 231 energizes in this circuit. As sequence switch 220 left position 2, it opened its contact 216 to permit the release of relay 222 and later on leaving position 3, it opened at its contact 228, the circuit of relays 234 and 232, which thereby deenergized. The release of relay 222 is without effect at this time.

In position 4 of sequence switch 220, the selection of an idle one of the register controlling mechanisms takes place. For this purpose a testing sequence switch 280 is provided to test the idle or busy condition of the register mechanisms, and upon finding an idle one associates the same with the connecting circuits shown in Fig. 2. The circuit for initiating the testing operation of sequence switch 280 extends from battery through winding of sequence switch 280, contact 225 (4), back contact and armature of relay 232, contact 245 (4) contact 281 of sequence switch 280, closed in the successive positions from 1 to 9, to ground. The circuits of the register mechanisms, such as the one shown in Figs. 3 and 4, are multiplied to corresponding contacts as contacts 282, 283 and 284 of a plurality of testing sequences switches 280. The circuits of the register mechanism shown in the drawings are associated with the connecting circuits of the second line finder and group selector when sequence switch 280 is in either position 1 or position 7. If, therefore, the register mechanism shown is idle when the sequence switch 280 reaches either position 1 or 7, a circuit is completed from battery through the left-hand winding of relay 323, contact 322 (1) of sequence switch 320, conductor 293, contact 282 of sequence switch 280, contact 219 (4) through the right-hand winding of relay 234, contact 281 of sequence switch 280, closed in its successive half positions, to ground. The contacts 282 of sequence switch 280 are arranged so that their circuit-closing positions extend over an angular distance sufficient to insure the closure of the above traced test circuit when contact 281 is in one of its half positions. Relay 234 energizes and closes a low resistance circuit through its left-hand winding, contact and armature and through the winding of relay 232 to ground. The low resistance of this circuit reduces the potential on the conductor 293 to prevent another sequence switch 280 from seizing the selected register mechanism. Relay 232 energizes and opens the circuit of sequence switch 280 which comes to rest. Relay 232 also closes a circuit from battery through the winding of sequence switch 220, contact 217 (4), front contact and armature of relay 232, contact 245 (4), contact 281, standing in either position 1 or position 7 to ground. Sequence switch 220 leaves position 4 and moves into position 5. When sequence switch 220 passes out of position 4 and into position 5 it opens at its contacts 236 and 239 the bridge across the calling line through relay 231 and retardation coil 237, permitting relay 231 to be deenergized. The calling line is now extended over contacts 236 and 239 to the stepping relay 325 of the

selected register mechanism for the transmission of impulses to register the designation of the called line. The impulse circuit including stepping relay 325 may be traced from battery through the left-hand winding of such relay, left-hand armature and contact of relay 301, contact 236 (5) contact and lower armature of relay 235, brush 243, brush 262, terminal 264, over the loop of the calling line, terminal 265, brush 263, brush 244, upper armature and contact of relay 235, sequence switch contact 239 (5) right-hand armature and contact of relay 301, through the right-hand winding of the stepping relay 325 to ground.

At the time the register mechanism was selected, the relay 323 was energized in series with relay 234. A circuit was thereupon closed from ground over the armature and front contact of relay 323, right-hand winding thereof, through the winding of sequence switch 320 to battery and ground. Sequence switch 320 moved out of position 1. In leaving position 2, sequence switch 320 opened the original energizing circuit of relay 323 at its contact 322 permitting said relay to deenergize before sequence switch 320 reached position 3. Sequence switch 320 therefore comes to rest in position 3, and at its contact 332, closes the circuit from the interrupter 333 to the promary winding of a dialling tone coil 324. As relay 323 retracted its armature, a circuit was closed from battery, contact 327 (3) through the winding of relay 326, back contact and armature of relay 323 to ground, causing the energization of relay 326. When, therefore, stepping relay 325 becomes energized in series with the calling line, a circuit is closed from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 330 (3), through the right-hand winding of differential relay 329, armature and contact of such relay, contact 328 (3), through the winding of the tens thousand register 100 to battery and ground. A parallel circuit to the one just traced is also completed from battery through the coil 331, left-hand winding of differential relay 329, and thence to ground at the armature and front contact of relay 325. Relay 329, being differential, does not attract its armature when both of its windings are energized. The register 100, however, is energized and moves out of position 0. Between positions 0 and 1 of register 100, a direct circuit to ground is closed in the well-known manner by its local contact 101, thus shunting the right-hand winding of the differential relay 329. This relay now attracts its armature, and register 100, under the control of its local contact, advances into position 1. Relay 337 also energizes in a circuit over contact 328 (3) to ground at the local contact of register 100. Relay 337 remains energized over the circuit traced to ground at the local contact 101 of the register 100, until such register reaches position 1, and in so doing maintains the energization of relay 329 in a circuit to ground at the armature and contact of relay 337. This arrangement insures that the relay 329 cannot become deenergized until sequence switch 100 has advanced through a full position.

The calling subscriber on hearing the distinctive dialling tone in his receiver when sequence switch 320 moves from position 1 to position 3, knows that he may proceed with the manipulation of his dial. Upon the first interruption of the calling line at the subscriber's dial, relay 325 retracts its armature and opens the circuit of the left-hand winding of relay 329 which becomes deenergized. As the line circuit again closes, register 100 is energized once more and moves out of position 1, relay 329 again energizes, the register passes to position 2, and at the next interruption of the line circuit, relay 329 becomes deenergized. This procedure continues, the register advancing one position for each interruption of the line until the first series of impulses has been completed. At each retraction of the armature of relay 325, a momentary circuit is completed over contact 342 and the back contact and armature of relay 325 for relay 334. This relay, however, being slow-to-energize does not attract its armature. At the last interruption of the line circuit which, as has been noted, is comparatively longer than the preceding interruptions of the series, the circuit of relay 334 is closed sufficiently long to permit it to energize. A circuit is now completed from battery, through the left-hand winding of relay 323 to ground at the contact and armature of relay 334. Relay 323 energizes and closes a circuit to drive sequence switch 320 out of position 3. Before sequence switch 320 can reach position 5 to again close contact 342, the line circuit is closed at the subscriber's dial and relay 334 deenergizes to in turn permit the deenergization of relay 323 whereby sequence switch 320 comes to rest in position 5. Relay 326, which had its circuit opened at the back contact of relay 323, deenergized while sequence switch 320 was passing from position 3 to position 5. In passing through position 4, the register 100 is energized in a circuit from battery, through the winding of this register, contact 328 (4), contact and armature and right-hand winding of relay 329 to ground at contact 330 (4). The register 100. advances one step in addition to the position to which it was set by the subscriber's sender.

The control of the stepping relay 325 is now shifted from the tens thousand register

100, to the thousands register 110, and as soon as relay 326 energizes upon the arrival of sequence switch 320 in position 5, a circuit is established from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 105 of register 100, which, as will be hereinafter explained, is closed in either position 9 or position 0, right-hand winding of relay 329, armature and contact of such relay, contact 328 (5), through the winding of the register 110 to battery and ground. In a manner similar to that described, a parallel circuit is closed over the left-hand winding of relay 329 to prevent this relay from attracting its armature. The register 110 moves out of position 0 where it short-circuits the right-hand winding of the differential relay 329 to permit the energization of this relay. When the subscriber operates his dial to send the second series of impulses, the first interruption of the line circuit causes the release of relay 325 which in turn permits the energization of relay 329. The register 110 advances under the control of its local contact into position 1. For each succeeding interruption of the line circuit, register 110 moves forward one position and at the last interruption of the impulse series, relay 334 energizes to cause the operation of relay 323 which closes a circuit at its armature and front contact to drive the sequence switch 320 out of position 5. As sequence switch 320 moves from position 5 to position 8, the line circuit is again closed to cause the energization of relay 325 and the consequent deenergization of relays 334 and 323 so that sequence switch 320 will stop when it reaches position 8. Relay 326 deenergizes as sequence switch 320 leaves position 5, and again energizes when said sequence switch stops in position 8, similar to the manner described in connection with the setting of the first register. As relay 326 is again energized, a circuit is completed from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 105 of register 100, right-hand winding and armature and contact of relay 329, sequence switch contact 335 (8), through the winding of the hundreds register 120 to battery and ground.

The calling subscriber, manipulating his dial in accordance with the third digit of the desired number causes the register 120 to be advanced to its proper position under the control of the stepping relay 325. At the termination of the third series of impulses relay 334 is energized, causing the energization of relay 323 to close the circuit for sequence switch 320 which moves from position 8 into position 10. A circuit is thereupon completed from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 105, right-hand winding and armature and contact of relay 329, sequence switch contact 335 (10), through the winding of the tens register 130 to battery and ground. The interruption of the line circuit during the sending of the fourth series of impulses causes the advance of register 130 under the control of the stepping relay 325. At the end of this series, sequence switch 320 is energized in the manner already described, and moves from position 10 into position 12. A circuit for the control of the units register 140 is completed from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 105, right-hand winding and armature and contact of relay 329, sequence switch contact 336 (12), through the winding of the units register 140, battery and ground. As the calling subscriber operates his dial in accordance with the final digit, the stepping relay 325 operates as above described to control the positioning of the register 140. The last interruption of the line being of a comparatively long duration, relay 334 is energized and sequence switch 320 is driven from position 12 into position 14.

After the first three series of impulses have been sent from the calling subscriber's station and, correspondingly, the first three registers advanced to their set positions, group selection is proceeded with without waiting for the tens and units registers to be set. The first three registers 100, 110 and 120 and their associated circuits are capable of discriminating whether the number that is being registered is that of a line local to the satellite or an exchange line.

As hereinbefore stated, the capacity of the exchange system is 20,000 lines. These lines are numbered from 10,000 to 29,999, whereby the tens thousand register 100 is only utilized in two of its positions. When the first digit of a called number is 1, which indicates that the called line belongs to the first tens thousand group, register 100 is advanced under the control of the calling dial to its ninth position, the complement of the desired digit, and thereafter automatically advanced into its zero position as already described. If the first digit of the called number is 2, which indicates that such line belongs to the second tens thousand group, the register 100 is first advanced to the complementary position 8 and thereafter moved an additional step into its 9th position. Hence the contact 105 of the register 100 will always be closed in either the 9th or zero position of the tens thousand register.

The numbers of the subscribers' lines belonging to the satellite, of which it has been noted there are 400 in the present system, are assigned to the second group of 10,000 lines. Furthermore these satellite lines are

assigned to the second thousand in the second ten thousand, which corresponds to the 8th position of register 110, and comprise the 8th, 7th, 6th and 5th groups of 100 lines in the second thousand, which correspond to the 2nd, 3rd, 4th and 5th positions of register 120. Therefore when a call is made to a line belonging to the satellite, the register 100 is set to its 9th position, the register 110 to its 8th position, and the hundreds register 120 in either its 2nd, 3rd, 4th or 5th position.

The first three registers having been set, the sequence switch 320, it will be recalled, thereupon moves from position 8 to position 10. A circuit is then closed for the sequence switch 350, which controls the restoration to the positioned registers during the selective movements of the switches. This circuit may be traced from battery through the winding of sequence switch magnet 350, contact 352 (1), contact 103, contact 338 to ground. Sequence switch 350 leaves position 1. In position 1½ of sequence switch 350, a circuit is closed from battery through the windings of relays 382 and 383, contact 106 or register 100, contact 116 of register 110, contact 127 of register 120, to ground at contact 372. Relays 382 and 383 energize and lock up in a circuit from battery through the windings of these relays, front contact and left-hand armature of relay 383 to ground at contact 369. Sequence switch 350 continues to move over positions 2, 3, and 4 and comes to rest in position 5 by means of a circuit closed from battery, through the winding of such sequence switch, left-hand armature and contact of relay 382. Sequence switch contact 380, closed in positions 2 to 4, front contact and right-hand armature of relay 382 to ground. At the same time relay 357 is energized in a circuit from battery, through its winding, sequence switch contact 380, to ground at the right-hand armature of relay 382. Relay 357 serves to maintain the fundamental circuit open while sequence switch 350 is passing to position 5.

As sequence switch 350 moves into position 2, the relay 359, which controls the restoration of the registers, is energized over its right-hand winding, contact and armature of relay 355, sequence switch contact 354, contact 152 of sequence switch 150 to ground. Relay 359, by attracting its armature, insures that the registers remains undisturbed until the fundamental circuit is in condition to control the group selector.

In position 5 of sequence switch 350, the relay 357 deenergizes and the fundamental circuit is completed from battery through the winding of relay 222, contact 247 (5) of sequence switch 220, conductor 296, armature and contact of relay 357 through the winding of the stepping relay 355, contact 380 (5) to ground at the front contact and right-hand armature of relay 382. Relays 222 and 355 both energize, the latter opening the circuit of relay 359 which thereupon deenergizes. Relay 222 closes a circuit from battery through the winding of sequence switch magnet 220, contact 217 (5), front contact and armature of relay 222 to ground at the back contact and armature of relay 231. Sequence switch 220 moves out of position 5 and into position 6 where a circuit is closed for the trip spindle power magnet 248. This circuit may be traced from battery through the winding of magnet 248, contact 227 (6), front contact and armature of relay 222, back contact and armature of relay 231 to ground.

The trip spindle rotates in the well-known manner causing a short circuit of the stepping relay 355 in the fundamental circuit for each brush tripping position. When the relay 355 is first deenergized as a result of the short circuit produced by interrupter 250, a circuit is established from battery through the winding of the register 120 contact 122, contact 366 (5), contact and armature and left-hand winding of the relay 359, contact and armature of relay 355, contact 354 and contact 152 to ground. In parallel thereto a circuit is also closed through the right-hand winding of relay 359 to ground at the contact 152.

The relay 359 being differential, does not attract its armature when both windings are energized. The register 120 however, is energized and moves out of the position to which it was set from the calling subscriber's dial. As soon as the local contact 121 is closed between positions, a direct circuit is afforded to ground, thus short-circuiting the left-hand winding of the differential relay 359, permitting this relay to become energized. The register 120 continues to move under the control of its local contact into the next position.

During the time that the register 120 is advancing from one position to the next, relay 362 is energized in a circuit from battery through the winding thereof, contact 366 (5), contact 122 to ground at the local contact 121. Relay 362 closes a substitute circuit from battery through the right-hand winding of relay 359 to ground at the contact 153 of sequence switch 150, to maintain the energization of relay 359 until the register 120 fully advances to its next position. As the brush tripping spindle reaches its first tripping position, the short circuit is removed on contact 250 and relay 355 once more energizes. The register 120 having advanced to a full position, the local contact 121 is opened and relay 362 becomes deenergized. Both of the above circuits for the right-hand winding of relay 359 being open, said relay releases its armature. Reg-

ister 120 is again energized in the circuit above described, including the left-hand winding of relay 359, contact and armature of stepping relay 355 and contact 152. Register 120 advances through another position, the relay 355 is short-circuited a second time by the interrupter 250, and relay 359 becomes energized. This operation continues until the register 120 is fully restored to its zero position. On the next deenergization of relay 355 after register 120 reaches position 0, a circuit is closed from battery, through the winding of sequence switch magnet 350, left-hand armature and contact of relay 382, contact 364 (5), contact 124 (0), contact 366 (5), contact and armature and left-hand winding of relay 359, contact and armature of relay 355 to ground at contact 152. In parallel to the circuit above described, a circuit is also completed for relay 357. Sequence switch 350 moves from position 5 into position 6 while relay 357 energizes to maintain the fundamental circuit open. After the interrupter contact 250 is opened, relay 222 deenergizes and closes a circuit from battery, through the winding of sequence switch 220, contact 251 (6), back contact and armature of relay 231 to ground, to drive sequence switch 220 out of position 6 and into position 7. The relay 222 is now energized in a circuit from battery through the winding of said relay, contact 219 (7), conductor 293, back contact and armature of relay 339, contact 340 of sequence switch 320 to ground.

In position 7 of sequence switch 220 the power magnet 241 is energized by means of the circuit completed from battery, through the winding of this magnet, contact 223 (7), back contact and armature of relay 232, front contact and armature of relay 222 to ground at the back contact and armature of relay 231. The power magnet 241 operates to rotate the group selector brush carriage, advancing its brushes over the terminals of the selected level of trunks. In reaching the test terminal of an idle trunk a selectable potential is found thereon and a circuit closed from battery 442 at the final selector shown in Figure 5, contact 441 (1) of sequence switch 450, terminal 266, brush 252, contact 228 (7) through the right-hand high resistance winding of test relay 234, back contact and lower armature of relay 224, contact 245 (7), contact 281 to ground. The relay 234 energizes in this circuit and closes a low resistance path to ground through its left-hand winding, contact and armature, and the winding of relay 232 in parallel with the circuit through its right-hand high resistance winding. This low resistance circuit reduces the potential on test terminals 266 to render the selected trunk busy to other group selector switches. Relay 232 also energizes to establish a circuit from battery, through the winding of sequence switch 220, contact 217 (7), front contact and armature of relay 232, front contact and armature of relay 222 to ground at the armature of relay 231. The sequence switch 220 moves over position 8 and into position 9, in which position the register equipment is connected over contacts 255 and 247 with the circuits of the final selector. The energization of relay 232 also opens the above traced circuit of power magnet 241 to discontinue the operation of the brush carriage.

The fundamental circuit which is prepared by sequence switch 220 advancing into position 9, is held open at the register mechanism until sequence switch 350 moves into position 7, which only takes place after the tens and units registers 130 and 140 have been positioned from the calling subscriber's substation. After the units register has been set, it will be recalled, sequence switch 320 advances into position 14. In this position a circuit is completed from battery through the winding of sequence switch 350, contact 352 (6), contact 341 (14), to advance sequence switch 350 out of position 6 and into position 7. The fundamental circuit is now completed for the final selector and may be traced from battery through the winding of relay 452 contact 459 (1) of sequence switch 450, brush 267, contact 247 (9) conductor 296, armature and contact of relay 357, through the winding of stepping relay 355, contact 356 (7), front contact and right-hand armature of relay 383, conductor 297, contact 255 (9), brush 268, contact 458 (1) to ground. Both relays 355 and 452 energize in the above traced circuit. Relay 452 closes a circuit from battery through the winding of sequence switch magnet 450 contact 451 (1) to ground at the front contact and armature of relay 452 to drive sequence switch 450 out of position 1 and into position 2.

The power magnet 448 of the tripping spindle is then energized in a circuit traceable from battery through the winding of said magnet, contact 466 (2), front contact and armature of relay 452 to ground. The tens register 130 is now restored to its normal position to control the tens selection of the final selector in a manner similar to the restoration of the hundreds register 120. The circuit for energizing the register 130 may be traced from battery through the winding of the said register, contact 132, contact 366 (7), contact and armature and left-hand winding of relay 359, contact and armature of relay 355 to ground at the contact 152. In parallel therewith the relay 357 is also energized to open the fundamental circuit as above described. Sequence switch 350 thereupon advances into position 9.

When the interrupter contact 455 is opened after register 130 reaches position zero, relay 452 becomes deenergized since the fundamental circuit is now open at the register mechanism. Sequence switch 450 moves into position 5 by means of a circuit including the contact 445 and the back contact and armature of relay 452. Sequence switch 350 leaving position 7, opens the circuit of relay 357 at contact 366 so that the fundamental circuit is again completed at the register mechanism in position 9 of sequence switch 350 prior to the time that sequence switch 450 of the final selector reaches position 5. Relays 452 and 355 are again energized, and a circuit is completed thereby for the power magnet 461, traceable from battery through the winding of said magnet, contact 446 (5) to ground at the front contact and armature of relay 452. The brush carriage of the said selector is rotated in the usual manner to trail brushes 470, 471 and 473 over the terminals of the tens level determined by the position of the brush tripping spindle. For each set of terminals passed over by the selected set of brushes, a short circuit is placed around the stepping relay 355 in the fundamental circuit by the interrupter contact 457. Relay 452 remains energized during the closures of the contact 457 and relay 355 intermittently retracts and attracts its armature due to the short circuit closed from battery through the winding of relay 452, contact 453 (5), and interrupter contact 457. During this operation the units register 140 is returned to its normal position in a circuit from battery through the winding of said register, contact 142, contact 367 (9), contact and armature and left-hand winding of relay 359, contact and armature of relay 355 to ground at contact 152. When register 140 reaches position 0, which corresponds to the brushes of the final selector, having been advanced to the proper set of terminals, and as soon thereafter as relay 355 retracts its armature a circuit is closed from battery, through the winding of sequence switch 350, left-hand armature and contact of relay 382, contact 364 (9), contact 144 (0), back contact and armature of relay 374, contact 143 (0), contact 367 (9), contact and armature and left-hand winding of relay 359, to ground at contact 152. Sequence switch 350 moves out of position 9 and into position 12.

In position 10 of sequence switch 350 relay 339 is energized in a circuit from battery, through the winding of said relay, contact 368 (10), front contact and left-hand armature of relay 383, to ground at contact 369. Relay 339 energizes and opens the circuit hereinbefore traced for relay 222. Relay 222 deenergizing, closes a circuit from battery through sequence switch winding 220, contact 251 (9), back contact and armature of relay 222, back contact and armature of relay 231 to ground, to drive sequence switch 220 into position 10. In this position a circuit is closed at the back contact and armature of relay 262 including contact 258 (10), to drive sequence switch 220 out of position 10 and into position 11. On leaving position 9, sequence switch 220 disconnects the calling subscriber's line from the register mechanism at its contacts 239 and 236, and connects said line in series with the supervisory relay 231 and retardation coil 237. The register set now being disconnected from the calling subscriber's line stepping relay 325 releases its armature to close a circuit from ground, armature and back contact of relay 325, contact 348 (14), through the winding of sequence switch magnet 320 to battery, to drive said sequence switch out of position 14 into position 15. A circuit is then closed from battery through the winding of sequence switch 350 contact 367 (12), to ground at contact 343 (15), whereby sequence switch 350 moves into position 13.

The registers 100 and 110 which remained inactive during the setting up of the switches are now returned to their normal positions. The circuit for energizing register 100 may be traced from battery through the winding of said register, contact 102 (9), contact 361 (13), to ground at contact 343 (15). When the register 100 reaches position 0, sequence switch 350 is advanced into position 14 in a circuit over contact 379 (13), contact 363 (13), contact 104 (0), contact 361 (13), to ground at contact 343 (15). In this position the register 110 is restored to normal by means of a circuit from battery, through the winding of said register, contact 112, contact 361 (14), to ground at contact 343 (15). In position 0 of register 110, a circuit is closed to drive sequence switch 350 into position 15, which circuit leads from battery, through the winding of said sequence switch, contacts 379 and 363 (14), contact 114 (0), contact 361 (14), contact 343 (15), to ground. Sequence switch 350 is driven into position 16 in a circuit including contact 379 (15), contact 364 (15), contact 124 of register 120, contact 366 (15), and contact 343 (15). In position 16 of sequence switch 350 a circuit is closed to drive the same into position 17, traceable from battery through the winding of said sequence switch, contact 379 (16), contact 364 (16), contact 134 (0) of register 130, contact 366 (16) to ground at contact 343 (15). In position 17 a circuit is finally closed to drive sequence switch 350 into position 1, which includes contacts 379 and 364 (17), contact 144 (0) of register 140 back contact and armature of relay 374, contact 143 (0), contact 367 (17), and contact 343 (15). In position 1 a circuit is completed for the energization of relay 323 from battery through the left-hand winding thereof, con-

tact 322 (15) to ground at contact 369 (1). Relay 323 energizes and closes at its armature and front contact a circuit to drive sequence switch 320 out of position 15 and into position 17. A circuit is then closed from battery through the windings of relay 334, contact 342 (17), back contact and armature of relay 326, contact 340 (17) to ground. Relay 334 attracts its armature and closes a holding circuit for the left-hand winding of relay 323 to maintain this relay energized, whereby sequence switch 320 continues to move over position 17 and into position 1. The register controlling equipment has now been disassociated from the cord circuit and completely restored to its normal condition, ready to be taken for use in controlling subsequent connections.

As soon as the interrupter contact 457 is opened at the time the brushes of the final selector are set upon the proper terminals, relay 452 deenergizes, since, as already seen, the fundamental circuit is open, at this time, at the register mechanism. Sequence switch 450 thereupon advances into position 6 by means of a circuit including contact 445 (5) and the back contact and armature of relay 452. In position 6 relay 452 is again energized in a circuit from battery, through the winding thereof and contact 449 (6) to ground. Sequence switch 450, therefore, continues to move into position 10, a circuit being closed therefor, including contact 451 (6) and the front contact and armature of relay 452.

In passing through position 8 a test is made to determine whether the called line is busy or idle. Assuming it to be idle, a selectable potential will exist on the test terminal 467 and a circuit is closed by way of test brush 470 through the right-hand high resistance winding of test relay 464 to ground at contact 449 (8). Relay 464 energizes and closes a low resistance circuit to ground through its left-hand winding, contact and armature and the winding of relay 462 and contact 475 (9–10). This low resistance circuit reduces the potential on terminals 467 sufficiently to render the called line non-selectable to other connector switches. Relay 462 attracts its armature and closes a circuit from battery, through the winding of sequence switch 450, contact 445 (10), front contact and armature of relay 462 to ground at the back contact and armature of relay 452, to drive sequence switch 450 over position 11 and into position 12. A ringing current is now immediately applied to the called line from the source 476. A circuit is also established for relay 452, to ground at the interrupter 469 which, when closed causes said relay to energize to complete a circuit to drive sequence switch 450 into position 13. This circuit may be traced from battery, through the winding of said sequence switch, contact 451 to ground at the front contact and armature of relay 452. In position 13 relay 452 is connected to a second interrupter 472 which, when closed, causes relay 452 to energize to drive sequence switch 450 into position 14. The interrupters 469 and 472 are arranged to provide a predetermined interval of time between the closures of the above mentioned circuits so that sequence switch 450 is brought from position 12 into position 14 after the lapse of a definite interval. In position 14 the ringing source 476 is disconnected and ringing current is supplied by means of the ringing machine 474. The circuit for the ringing current may be traced from the ringing machine 474, contact 477 (14), brush 471 over the called line and through the ringer thereof, returning by way of brush 473, contact 478 (14), through the winding of ringing control relay 460 to ground. During the time ringing current is being impressed upon the line, the calling subscriber is informed of this fact by a characteristic sound produced in his receiver by means of the closure of the primary circuit of tone coil 447 at sequence switch contact 479 (14). When the called subscriber answers, relay 460 is energized and closes a circuit over its armature and contact, contact 451 (14) through the winding of sequence switch 450 to battery and ground to drive said sequence switch into position 15. The calling line is now connected directly through to the called line over sequence switch contacts 477 and 478, and relay 262 and retardation coil 257 are included in bridge of the called line. Relay 262 energizes and closes a circuit from its armature and front contact, contact 217 (11), through the winding of the sequence switch 220, to drive said sequence switch into position 12.

When the conversation is completed and the calling subscriber restores his receiver to the switchhook, relay 231 deenergizes and a circuit is completed from ground, over the armature and back contact thereof, armature and back contact of relay 222, contact 251 (12), through the winding of sequence switch 220 to battery. Sequence switch 220 moves out of position 12, over position 13 and into position 17 where a circuit is closed from battery, through the power magnet 241, contact 223 (17), back contact and armature of relay 232, contact 245 (17), and contact 281 to ground. Power magnet 241 operates to restore the brush carriage to its normal position, when the brush carriage reaches its home position, a circuit is closed from battery, contact 229 (17), interrupter brush 269, through the winding of relay 232 to ground. Relay 232 energizes to open the circuit of power magnet 241 whereby the brush carriage ceases to rotate. A circuit is also closed from battery through the

winding of sequence switch 220, contact 217 (17), front contact and armature of relay 232, contact 245 (17) to ground at contact 281, whereby sequence switch 220 moves from position 17 into position 18.

The second line finders, as the one shown in Fig. 2, are arranged in pairs so that when both finders of a pair are idle, only one at a time is capable of hunting for a calling circuit. To accomplish this, the circuits are so arranged that when idle, the sequence switch 220 of the finder to be taken for use, stands in position 1, whereas the sequence switch of the other finder of the pair stands in position 18. The sequence switch 220 is driven from position 18 into position 1 by means of a circuit closed from battery through the winding of sequence switch 220, contact 217 (18), to ground at the front contact and armature of relay 262. Relay 262 is energized in a circuit including contact 256 (18) and contact 270.

When sequence switch 220 leaves position 12, it opens at contact 228, the circuit of relay 443, which was closed at the time the test brush 252 of the group selector was set upon the terminal 266. Relay 443 retracting its armature, closes a circuit including contact 444 to drive sequence switch 450 from position 16 into position 17. If the called subscriber has replaced his receiver to the switchhook, sequence switch 450 moves into position 18 in a circuit including contact 445 (17) and the back contact and armature of relay 452. In position 18 the brush carriage of the final selector is rotated to its normal position by power magnet 461. The circuit for this magnet includes contact 446 (18), back contact and armature of relay 462, and the back contact and armature of relay 452. When the brush carriage is fully restored, a circuit is closed from ground, contact 457 in its home position, sequence switch contact 454 (18), and through the winding of relay 452 to battery. Relay 452 attracts its armature and opens the circuit of power magnet 461 bringing the brush carriage to rest. A circuit is also closed from ground, armature and front contact of relay 452, contact 451 (18), through the winding of sequence switch 450 to battery, to drive said sequence switch into its normal position 1.

Assuming that the called line is busy during the time sequence switch 450 of the final selector is passing through position 8, no selectable potential will be found on the test terminal 467 and consequently the test relays 464 and 462 will not be energized. Sequence switch 450, therefore, comes to rest in position 10, in which position a busy tone interrupter 480 is connected in the primary circuit of the tone coil 447 at sequence switch contact 479. The calling subscriber hearing the busy tone, replaces his receiver to the switchhook. Relay 231 is deenergized and closes a circuit from ground, over its armature and back contact, armature and back contact of relay 222, contact 251 (11), through the upper winding of relay 224 to battery and ground. Relay 224 attracts its armature and closes a circuit from battery, through the winding of sequence switch 220, lower winding of relay 224, front contact and armature thereof, contact 245 (11), to ground at the contact 281. Sequence switch 220 moves over positions 12 and 13 into position 17. In position 17, restoration of the group selector takes place in the manner already described.

The connection above described is one in which no translation is required at the final selector switch. That is to say, the hundreds digit of the called number is even and the corresponding line is located in the first or even section of terminals at the final selector. As is well understood in systems of this character, the final switches have a capacity of 200 lines, which are arranged in two groups or sections of 100 lines each. To make connection with the terminals of a called line belonging to an even hundreds groups the brushes are driven over a number of terminals corresponding to the number of the called line; whereas, if connection is desired with a line belonging to an odd hundreds group, it is necessary to provide translation so that the final selector brushes, after having been advanced over a number of terminals corresponding to the number of the called line, will be made to advance ten additional positions into connection with the proper line in the second or odd section of the selector bank. Assuming that a connection is required with a line belonging to an odd hundreds group, it becomes necessary that the hundreds register 120 provide for translation. As sequence switch 350 passes through position 3, a circuit is closed from battery through the windings of relay 374 and 373, contact 375 (3), contact 126 of the hundreds register, which is closed in all odd positions, front contact and left-hand armature of relay 383, to ground at contact 369. Relays 374 and 373 energize and lock up in a circuit over the contact and armature of relay 373, contact 145, to ground at contact 369. Hundreds and tens selections take place in the manner already described. When, during units selection, however, the register 140 reaches position 0, no circuit is provided to drive sequence switch 350 out of position 9 as in case before described, since relay 374 is energized. Units register 140, therefore, continues to operate through a complete additional cycle, whereby the brush carriage of the final selector is advanced to the proper set of terminals in the second section of the bank. On passing from position 0 to position 1,

the holding circuit of relays 374 and 373 is open at contact 145, permitting these relays to deenergize. Hence, when the register 140 again returns to its zero position the usual circuit is closed to drive sequence switch 350 out of position 9 and into position 12.

The case will now be assumed in which the subscriber at satellite line 240 desires to establish a connection with the line of a subscriber belonging to a distant exchange, as the line 610. The number of the line 610 will be taken for example as 12453. The operation of the first line finder, second line finder and the association with the proper cord circuit of an idle register controlling mechanism at the satellite proceeds in precisely the same manner as that already described.

When the register mechanism is connected to the cord circuit shown in Figure 2, and the impulse circuit established through from the calling line to the stepping relay at the register mechanism, the dialing tone is placed upon the calling line to indicate that the apparatus is in condition to receive the registration of the called number. The calling subscriber thereupon operates his dial in accordance with the digits of the called number, which in effect, results in the transmission of series of impulses corresponding to the complements of the digits of such number. That is, in the case assumed nine impulses are sent for the first digit, eight impulses for the second digit, six impulses for the third digit, five impulses for the fourth digit and seven impulses for the fifth digit. In response to these impulses the tens thousand register 100 of the satellite mechanism is advanced to its ninth position under the control of the calling subscriber's dial and subsequently automatically moved into its zero position as hereinbefore explained; the thousands register 110 is advanced to its eighth position; the hundreds register 120 is advanced to its sixth position. The tens register 130 to its fifth position and the units register 140 to its seventh position. It will be observed that the number of the exchange line assumed has for its tens thousand digit the Figure 1, or in other words that this line belongs to the first tens thousand group.

Since the called line is one which belongs to a distant exchange, it becomes necessary, in accordance with the principles of the present invention, to provide means whereby the numerical designations, which have already been registered at the controlling equipment in the satellite, may be reproduced at the registering mechanism in the exchange for the purpose of controlling the selective switches therein to set up the desired connection. Accordingly, there is provided a transfer sequence switch 150 which is automatically associable in succession with the several registers of the set in the satellite. This transfer sequence switch first operates to restore the register with which it is associated to its zero position, which is to advance such register through a number of positions corresponding to the actual digit of the called number, and thereafter the transfer register continuing to operate transfers to the corresponding register of the exchange controlling mechanism a number of impulses corresponding to the complement of the digit. It will, therefore, be obvious that when this register in the exchange becomes effective to control the selective operation of a selector switch, it will operate through a number of positions in returning to normal, corresponding to the actual digit of the called number. In short, the settings of the registers at the satellite are transferred successively to the corresponding registers in the exchange by means of the transfer sequence switch 150.

While the number of registers in the satellite is the same as the number of registers in the exchange, namely five registers, and all of which are required for controlling the operations of the exchange switches in establishing a connection, provision must be made such that a connection may be made from the satellite over a trunk line to the exchange without utilizing one of the satellite registers. This is accomplished, as will be hereinafter explained in detail by means operative to automatically advance the group selector in the satellite into connection with a trunk line leading to the exchange.

When the first three registers in the satellite have been set from the calling subscriber's substation, the sequence switch 320 moves into position 10. In this position, the circuit hereinbefore traced for relays 382 and 383, which included contact 106 of register 100, contact 116 of register 110 and contact 127 of register 120, in the case of a local call, now remains open since register 100 is standing in position 0 and register 120 in position 6. The fact that relays 382 and 383 are not energized at this time is what determines that the number being registered is that belonging to an exchange line. A circuit, however, is closed for sequence switch 350, traceable from battery to the winding of said sequence switch, contact 352 (1), contact 103 (0), contact 338 (10) to ground. While sequence 350 is passing from position 1 to position 2, relay 357 is energized in a circuit from battery through the winding thereof, contact 379 (1 to 2) and local contact 351 to ground. As soon, however, as sequence switch 350 reaches position 2 the local contact 351 is opened, the relay 357 releases its armature and establishes a circuit from battery through the winding of relay 222, Figure 2, contact 247 (5), conductor

296, armature and contact relay 357, winding of relay 355, contact 356 (2) to ground, and both relays 222 and 355 energize. The relay 222 closes a circuit from battery through the winding of sequence switch 220, contact 217 (5), front contact and armature of relay 222 to ground at the back contact and armature of relay 231. The sequence switch 220 moves out of position 5 and into position 6. Relay 359 which energized by means of a circuit through its right-hand winding, contact and armature of relay 355, contact 354 and contact 152 to ground as soon as sequence switch 350 reached position 2, is again deenergized by the attraction of the armature of relay 355. The sequence switch 220, reaching position 6, closes a circuit for the trip spindle power magnet 248 of the group selector including the front contact and armature of relay 22. The tripping spindle rotates and upon the first short-circuit of the fundamental circuit by the interrupter contact 250, stepping relay 355 deenergizes and a circuit is closed for the relay 357 from battery, through the winding of said relay, contact 379 (2), contact 367 (2), contact and armature and left-hand winding of relay 359, contact and armature of relay 355, contact 354 (2) to ground at contact 152. Relay 357, energizing, opens the fundamental circuit whereby the relay 222 is permitted to deenergize as soon as the interrupter contact 250 is opened as the tripping approaches the first brush tripping position. The deenergization of relay 222 closes a circuit from battery through the winding of sequence switch 220, contact 251 (6), back contact and armature of relay 222 to ground at the armature of relay 231, whereby sequence switch 220 advances into position 7.

In parallel with the circuit for relay 357, a circuit is also closed from battery, through winding of sequence switch 350, contact 367 (2), to ground at the contact 152. The sequence switch 350 thereupon advances into position 3. The tripping spindle of the group selector has thus been positioned to select the set of brushes having access to the first level of trunks, which level is assigned to trunks leading to the exchange. With the sequence switch 220 in position 7, power magnet 241 is energized as hereinbefore described, and the brush carriage rotates to select an idle trunk. When an idle trunk is found, test relays 234 and 232 becomes energized, the brush carriage ceases to rotate and sequence switch 220 is advanced into position 9.

A circuit is now established from battery through the winding of relay 525, Figure 6, contact 526 (1) of sequence switch 520, winding of relay 537, contact 542 (1), brush 267, contact 247 (9), conductor 296, armature and contact of relay 357 through the winding of relay 384, contact 358 (3), back contact and right-hand armature of relay 383, conductor 297, contact 255 (9), brush 268, contact 543 (1), back contact and right-hand armature of relay 524, through the winding of relay 531 to battery and ground. Relay 525, having a high resistance winding, energizes in the circuit traced, whereas the relays 531, 537 and 384 remain inert. Relay 525 closes a circuit from battery through the winding of sequence switch 520, contact 529 (1), front contact and armature of relay 525, contact 551 (1) to ground over the back contact and armature of relay 522 to drive sequence switch 520 out of position 1 and into position 2.

In position 2 of sequence switch 520, the selecting sequence switch 580 is rendered effective to associate an idle register controlling mechanism in the exchange with the cord circuit of the first group selector, shown in Figure 6. The circuit for this sequence switch is traceable from battery to the winding thereof, contact 544 (2), back contact and armature of relay 532, contact 527 (2) to ground at contact 582 of searching sequence switch 580, closed in its successive positions from 1 to 10. The searching sequence switch 580 under the control of its local contact begins to rotate, and upon reaching a position corresponding to an idle register mechanism a circuit is closed from battery through the left-hand winding of relay 623 of such idle mechanism, contact 622 (1), conductor 693, contact 553 (2), right-hand high resistance winding of test relay 528 to ground at contact 582, closed in its successive half positions. Relay 528 energizes and closes a low resistance circuit over its left-hand winding and armature, and through the winding of relay 532 in parallel with the circuit through its right-hand winding. This low resistance circuit serves to render the selected register mechanism busy as is well understood. Relay 532 energizing closes a circuit from battery through the winding of sequence switch 520, contact 529 (2), front contact and armature of relay 532, contact 527 (2) to ground at contact 582 whereby sequence switch 520 moves into position 3. In this position the closure of the contacts 542 and 543 completes a circuit from the register mechanism in the satellite through to the stepping relay 625 at the register mechanism in the exchange. Relays 625 and 384 energize in series with each each other. The energization of relay 532 also opens the above traced circuit for searching sequence switch 580, which ceases to rotate.

At the time the test relays 528 and 532 are energized, relay 623, Figure 7, also attracts its armature to close a circuit through its right-hand winding for sequence switch 620. Sequence switch 620 moves out of position 1

and comes to rest in position 3, since on leaving position 2 it opens contact 622 to permit the deenergization of relay 623. In position 3 of sequence switch 620, relay 626, is energized in a circuit from battery over contact 627 (3) and the back contact and armature of relay 623. Relay 626 closes a circuit from ground, armature and front contact of stepping relay 625, armature and front contact of relay 626, contact 630 (3), through the right-hand winding of differential relay 629, armature and contact of said relay, contact 628 (3), through the winding of the tens thousand register 700 to battery and ground. A parallel circuit for the left-hand winding of relay 629 is also closed to prevent said relay from attracting its armature. The register 700, however, energizes and moves out of position 0. Between position 0 and position 1 of register 700, the right-hand winding of relay 629 is short-circuited at the local contact 701 and relay 629 energizes. Relay 637 also energizes over a circuit to ground at the local contact 701 to insure the maintenance of the energization of relay 629 until the register has advanced a full position. Register 700 moves into position 1, where it awaits the deenergization of the stepping relay 625 in the impulse circuit.

When relay 384 in the satellite energizes a circuit is completed from battery through the winding of transfer sequence switch 150, contact 370 (3), front contact and armature of relay 384, contact 154 (0) of sequence switch 150, back contact and left-hand armature of relay 383 to ground at contact 369. The transfer sequence switch under the control of its local contact 151 runs through a complete cycle of operation. In position 1, sequence switch 150 closes at its contact 155 a short circuit around relay 384. On sequence switch 150 leaving position 0, relay 359 which has been energized in a circuit to ground at the contact 152 (0) now retracts its armature. When sequence switch 150 reaches position 1, a circuit is closed from battery through winding of relay 357, contact 363 (3), contact 104 of register 100, which it will be remembered is standing in position 0, contact 361 (3), contact and armature and left-hand winding of relay 359, contact and armature of relay 355, contact 354 (3), contact 156 (1), resistance 159 to ground. Relay 362 is also energized in a circuit from battery through the winding thereof, contact and armature and left-hand winding of relay 359 to ground at contact 156 (1). The resistance 159 is so selected that the total resistance in series with the right-hand winding of relay 359 is such, as compared with the resistance of relays 362 and 357 which at this time, are connected in series with the left-hand winding of relay 359, as to prevent the operation of the relay 359. Relay 357 attracting its armature opens the impulse circuit which contains the stepping relay 625 in the exchange, thereby permitting the deenergization of the latter relay. Relay 625 retracting its armatures opens the circuit of the left-hand winding of relay 629. Relay 629 deenergizes. As soon as relay 362 attracts its armature it closes a low resistance circuit for the right-hand winding of relay 359 to ground at contact 153 of register 150, whereby the current flowing in the left-hand winding of relay 359 is now insufficient to neutralize the effect of the right-hand winding, and consequently said relay attracts its armature. The above traced circuits of relay 362 and 357 are opened. These relays deenergize and the impulse circuit is again closed permitting the operation of relay 625. Relay 625 again closes the above traced circuit for register 700 which thereupon advances another step into position 2. When the transfer sequence switch advances its contact 156 to the next circuit closing position, relays 357 and 362 are energized and the impulse circuit is opened a second time at the armature and contact of relay 357 to permit the deenergization of relay 625. This operation continues, the register 700 in the exchange being advanced one position for each closure of the contact 156 of sequence switch 150, until ten interruptions have been produced in the impulse circuit. The last interruption occurs while sequence switch 150 is passing to position 14. During this time it will be noted that contact 153 is opened in position 13 and consequently the energization of relay 359 is delayed, whereby relay 357 remains energized for a longer period of time than in the preceding interruptions. Relay 625 at the exchange, being deenergized during this longer interruption of the impulse circuit closes a circuit for the slow to energize relay 634. Relay 634, being slow to energize, does not attract its armature during the short interruptions of the impulse circuit but only operates in response to the last impulse of the series, which, as seen, is of a comparatively longer duration. Relay 634 closes a circuit for the left-hand winding of relay 623, which relay in turn energizing closes a circuit to drive sequence switch 620 into position 5.

The register 700 has thus been driven to position 0, corresponding to the position of the tens thousand register 100 in the satellite, and stepping relay 625 is ready to control the setting of the thousands register 710.

The transfer sequence switch 150 passing from position 13 to position 17 maintains its contact 156 closed to prevent the deenergization of relay 359 and the consequent energization of relay 357. In position 14 of sequence switch 150 a circuit is completed from battery through the winding of sequence switch 350, contact 157 (14) to

ground at contact 369 to drive sequence switch 350 out of position 3 and into position 4. When the sequence switch 150 reaches position 0 at the end of its first cycle, it is immediately energized in a circuit over contact 370 (4) to ground at the right-hand armature of relay 382 and commences a second cycle of operation. With sequence switch 620 in position 5 and the impulse circuit closed while the transfer sequence switch is passing over positions 13 to 0 during its first revolution, relay 625 being energized, a circuit is closed from ground, armature and front contact of said relay, armature and front contact of relay 626, contact 706 (0), right-hand winding, armature and contact of differential relay 629, contact 628 (5) through the winding of register 710 to battery and ground. Register 710 energizes and moves from position 0 into position 1, the relay 629 being energized in a well-known manner. When the sequence switch 150 leaves position 0 on beginning its second cycle of operation, relay 359 deenergizes and on coming into position 1, said sequence switch closes a circuit from battery through the winding of the thousand register 110, contact 112 closed in position 8, contact 361 (4), contact and armature and left-hand winding of relay 359, contact and armature of relay 355, contact 354, contact 156 (1), resistance 159 to ground. The thousands register 110 is first driven to normal from the position which it was set under the control of the calling subscriber's dial whereafter sequence switch 150 operates to transfer to the thousands register 710 in the exchange the setting of register 110. The register 110 energizes in the circuit just traced and moves out of position 8. Between positions 8 and 9 the left-hand winding of relay 359 is short-circuited at local contact 115, and relay 359 energizes. Register 110 passes into position 9. As soon as relay 362 deenergizes after register 110 has reached position 9. and the contact 156 of sequence switch 150 is opened after passing its first closed position, relay 359 again deenergizes. In its second circuit closing position, the contact 156 closes the circuit for register 110 as above traced, whereupon said register moves from position 9 and position 0. In the next circuit closing position of contact 156, relay 357 is energized in a circuit from battery through the winding thereof, contact 363 (4), contact 114 (0) of register 110, contact 361 (4), contact and armature and left-hand winding of relay 359, contact and armature of relay 355 to ground over contact 156. In parallel to the circuit just traced, relay 362 is likewise energized. Relay 357 attracts its armature to produce the first interruption in the impulse circuit, permitting relay 625 to deenergize. Relay 362 attracting its armature immediately closes a low resistance circuit through the right-hand winding of relay 359 as above described to permit the energization of said relay, which results in the deenergization of relays 362 and 357, and the closure of the impulse circuit. Relay 625 energizing closes the above traced circuit for register 710, whereby said register advances a second step. This operation proceeds, the register 710 being advanced one step for each of the remaining circuit closing positions of contact 156 of transfer register 150, coming finally to rest in position 8, the complement of the second digit of the desired number. The last interruption of the impulse circuit being relatively long, relay 634 attracts its armature and sequence switch 620 is advanced into position 8.

Sequence switch 150 passing position 14 a second time closes at its contact 157 the circuit for driving sequence switch 350 out of position 4, into position 5, where sequence switch 150, on reaching its zero position, is again energized and starts on its third cycle of operation. The hundreds register 120, which is standing in position 6, is restored to its normal position under the control of sequence switch 150 by means of a circuit from battery through the winding of said register, contact 122, contact 366 (5), and thence to ground over contact 156. It will be noted that if the hundreds register 120 happens to be standing in an odd position in which contact 126 is closed, said register is not advanced to an additional position due to the fact that relay 383 is deenergized. Hence, translation at the hundreds register in the satellite does not occur, but the hundreds register in the exchange is set up to a position corresponding exactly to the position to which register 120 was advanced under the control of the calling subscriber's dial.

In position 8 of sequence switch 620 a circuit is established for the hundreds register 720 from ground, armature and front contact of relay 625, armature and front contact of relay 626, contact 706 (0), right-hand winding, armature and contact of relay 629, contact 635 (8), through the winding of register 720 to battery and ground, whereby said register moves from positions 0 to position 1. When register 120 in the satellite reaches position 0 under the control of the transfer sequence switch a circuit is closed for relay 357 from battery through the winding thereof, contact 364 (5), contact 124 (0), contact 366 (5), and thence to ground over contact 156 of sequence switch 150. In parallel thereto, relay 362 is also energized. Relay 357 opens the impulse circuit, permitting relay 625 and relay 629 to deenergize. Upon the next closure of the impulse circuit, relay 625 energizes and register 720 advances into position 2. This op-

eration continues, register 720 moving through one step for each of the remaining closed positions of contact, 156 coming to rest in position 6, corresponding to the position to which register 120 was set from the calling substation. The last interruption of the impulse circuit being relatively long, relay 634 energizes and sequence switch 620 moves into position 10.

In position 10, while the transfer sequence switch is completing the remaining portion of its third rotation, relay 625 is energized and a circuit closed from ground, armature and front contact of said relay, armature and front contact of relay 626, contact 706, right-hand winding and armature and contact of relay 629, contact 635, through the winding of the tens register 730 to battery and ground. The tens register 730 moves from position 0 into position 1, where it awaits the first interruption of the impulse circuit on the next series of impulses. As sequence switch 150 again passes position 14, sequence switch 350 is driven into position 6, where it awaits the sending of the tens and units impulses from the calling substation. Assuming the tens and units registers have been set and sequence switch 320 has reached position 14, sequence switch 350 is energized in a circuit including contact 352 (6), and 341 (14) and moves out of position 6 into position 7. In position 7, a circuit is closed over contact 370 to ground at the right-hand armature of relay 382, whereby the transfer sequence switch 150 commences its fourth rotation. The tens register at the satellite during this operation is restored to normal in a circuit including contact 132, contact 366 (7), and thence to ground at contact 156 of sequence switch 150. When register 130 reaches position 0, and thereafter as contact 156 is closed, a circuit is established for relay 357, traceable from battery through the winding of said relay, contact 364 (7), contact 134 (0), contact 366 (7) to ground at the contact 156. In parallel thereto relay 362 is also energized. Relay 357 attracting its armature opens the impulse circuit permitting relays 625 and 629 to deenergize. Relay 362 causes in a well-known manner the deenergization of relay 357 whereupon the relay 625 is energized and register 730 advances to its next position. Register 730 continues to advance under the control of transfer sequence switch 150, coming finally to rest in position 5 corresponding to the position to which register 130 was set. Sequence switch 620 thereupon moves into position 12 to associate the stepping relay 625 with the units register 740, a circuit being closed for said register from ground, armature and front contact of relay 625, armature and front contact of relay 626, contact 706 (0), right-hand winding of armature and contact of relay 629, contact 636 (12), through the winding of register 740 to battery and ground. The register 740 moves out of position 0 and into position 1, where it awaits the first interruption of the impulse circuit of the final series of impulses.

As sequence switch 150 passes through position 14, sequence switch 350 is moved into position 9 in a circuit including contact 157. The transfer sequence switch 150 reaching position 0 now commences its final cycle of operation to restore to normal the units register 140, and thereafter to control the setting of the units register 740 in the exchange. Register 140 is energized in a circuit from battery through the winding thereof, contact 142, contact 367 (9) and thence to ground at contact 156. Register 140 starts from position 7 and moves under the control of the transfer sequence switch into position 0. In this position a circuit is closed for relay 357 from battery through the winding of said relay, contact 364 (9), contact 144 (0), back contact and armature of relay 374, contact 143 to 0, contact 367 (9) to ground at contact 156 of sequence switch 150. Relay 362 is also energized in parallel to relay 357. Relay 357 opens the impulse circuit, relay 625 deenergizes with the deenergization of relay 629. When the impulse circuit again closes, the register 740 advances another position and so on, coming to rest finally in position 7. At the last interruption of the impulse circuit, relay 625 remains deenergized sufficiently long to cause the operation of relay 634, which in turn causes sequence switch 620 to move from position 12 into position 14. As the transfer register passes position 14, sequence switch 350 is driven into position 12.

The register mechanism at the exchange having been positioned under the control of the transfer sequence switch in the satellite, is ready to control the operation of the selector switches through the extension of the connection to the called subscriber is made. When sequence switch 620 reaches position 14, a circuit is completed from battery through the winding of sequence switch 650, contact 669 (1), and back contact and right-hand armature of relay 654 to ground, at contact 641 (14), to drive sequence switch 650 out of position 1 and into position 3. The fundamental circuit is now closed from battery through the winding of relay 522 at the first group selector in the exchange, contact 547 of sequence switch 520, which it will be recalled is in position 3, conductor 695, contact 661 (3) through the winding of stepping relay 655, armature and contact of relay 656, contact 657 (3) to ground. Relays 655 and 522 energize, the latter closing a circuit to drive sequence switch 520 into position 4. This circuit leads from battery, through the winding of

said sequence switch, contact 533 (3) to ground at the front contact and armature of relay 522. In position 4 of sequence switch 520 the trip spindle power magnet 548 of the group selector is energized in a circuit from battery, through the winding of said magnet, contact 549 (4), to ground at the front contact and armature of relay 522. The trip spindle rotates and for each brush tripping position passed over places a short circuit around the stepping relay 655 in the fundamental circuit. At the first deenergization of relay 655, a circuit is closed from battery through the winding of the thousands register 710, contact 712 (8), contact 674 (3), contact and armature and left-hand winding of differential relay 659, contact and armature of relay 655, to ground at contact 658. The register 710 energizes and moves into position 9 and subsequently into position 0, as the brush tripping spindle passes over the next position. In position 0 of register 710 a circuit is closed from battery through the right-hand winding of relay 656, contact 675 (3), contact 703 (0), contact 716 (0), contact 666 (3), contact 674 (3), contact and armature and left-hand winding of relay 659, contact and armature of relay 655, to ground at contact 658. Relay 656 attracts its armature and opens the fundamental circuit to prevent the further advance of the register 710. In parallel of the circuit above traced, sequence switch 650 is also energized and moves from position 3 into position 4. As soon as the interrupter brush 550 opens after register 710 reaches position 0, relay 522 deenergizes and sequence switch 520 is driven into position 5 by means of a circuit including contact 551 (4), and the back contact and armature of relay 522. In position 6 of sequence switch 520, the brush carriage power magnet 541 is energized in a circuit including contact 544 (5), back contact and armature of relay 532, front contact and armature of relay 522 to ground. Relay 522, it will be noted, immediately energizes as soon as sequence switch 520 arrives in position 5 in a circuit from battery to the winding of said relay, contact 523 (5 to 7), conductor 693, back contact and left-hand armature of relay 639, contact 640 to ground. The brush carriage rotates in a well-known manner to select a trunk leading to an idle succeeding selector switch. Upon reaching an idle trunk, which is identified by the presence of a selectable potential, a circuit is closed over the test brush 552, contact 553, right-hand high resistance winding of test relay 528, back contact and left-hand armature of relay 524, contact 527 (5), contact 582 to ground. Test relay 528 energizes in the well-known manner to provide a low resistance circuit through its left-hand winding and the winding of relay 532 to ground. Relay 532 operating opens the power circuit whereby the brush carriage ceases to rotate, and also closes a circuit from battery through the winding of sequence switch 520, contact 529 (5), front contact and armature of relay 532, to ground at the front contact and armature of relay 522. Sequence switch 520 moves over position 6 and into position 7.

In position 7, the fundamental circuit is extended over contacts 547 and 555 to the second group selector 571. The fundamental circuit at the register controlling mechanism is traceable over conductor 697, back contact and right-hand armature of relay 667, contact 657 (6), contact and armature of relay 656, through the winding of the stepping relay 655, contact 661 (6) and thence over conductor 696. The sequence switch 650, it will be observed, has been driven from position 4 into position 6, by means of a circuit including contact 675 (4) and contact 643 (14) of sequence switch 620. The brush tripping operation at the second group selector 571 now takes place under the control of the hundreds register 720. The register 720 energizes in a circuit from battery through the winding thereof, contact 722, contact 671, (6), and thence through the left-hand winding of differential relay 569 to ground at contact 658. When register 720 reaches position 0, a circuit is established for the right-hand winding of relay 656, including contact 675 (6), contact 703, contact 716, contact 666 (6), contact 674 (6), contact 723, contact 671 (6) to ground at contact 658. Relay 656 energizes to open the fundamental circuit. In parallel to the circuit above traced, a circuit is closed for sequence switch 650 to drive the same into position 9. Sequence switch 650 immediately moves into position 10 in a circuit including contact 669 (9), contact and right-hand armature of relay 654 and contact 641 (14). Trunk selection takes place at the group selector 571, and the fundmental circuit is extended through to an idle final selector 572.

Tens selection is proceeded with at the final selector under the control of the tens register 730, and the circuit for the energization of register 730 leads from battery to the winding of said register, contact 732, contact 670 (10) through the left-hand winding of relay 659 to ground at contact 658. When register 730 reaches its 0 position, relay 656 is energized, to open the fundamental circuit, in a circuit including contact 669, contact 733, contact 670 (10) and contact 658. The sequence switch 650 is also energized as above described and moves from position 10 into position 12, where a circuit is completed for the operation of the units register from battery through the

winding of the units register 740, contact 742, contact 670 (12), and thence to ground at contact 658. The units register is returned to its 0 position, and the brushes of the final selector are set upon the terminals of the called line 610. In position 0 of register 740, relay 656, and in parallel therewith sequence switch 650 is energized over a circuit including contact 669, contact 744, (0), back contact and armature of relay 681, contact 743 (0), contact 670 (12) to ground at contact 658, whereby sequence switch 650 moves from position 12 into position 15.

The switches having been set to complete the desired connection, the register mechanisms at the exchange and satellite may now be disconnected and restored to their normal condition. As sequence switch 650 passes position 13, a circuit is closed from battery through the winding of relay 639, contact 665 (13), back contact and left-hand armature of relay 667, to ground at contact 668. Relay 639 energizes, and at its left-hand armature and back contact opens the circuit which, up to this time, has been maintaining the energization of relay 522 at the group selector. Relay 522 closes a circuit to drive sequence switch 520 into position 12, including contact 551 (7). Position 12 of sequence switch 520 is the talking position. The register mechanism at the exchange being disassociated from the cord circuit at sequence switch contacts 542 and 543, relays 625 and 384 deenergize. As soon as relay 384 releases its armature, a circuit is closed from battery through the winding of relay 339, contact 376 (12), back contact and armature of relay 384, contact 154 (0) of transfer sequence switch 150, back contact and left-hand armature of relay 383 to ground at contact 369. Relay 339 opens the circuit, which, up to this time, has been holding relay 222 at the cord circuit of the group selector in the satellite energized. Relay 222, releasing its armature, closes a circuit to drive sequence switch 220 out of position 9 and into position 10. This circuit includes contact 251 (9), and back contact and armature of relay 222 and the armature of relay 231. In position 10, sequence switch 220 is energized in a circuit including contact 258 (10) and the back contact and armature of supervisory relay 262 and advances into position 11.

The register set in the satellite now being released at contacts 236 and 239 is restored to its normal condition in the manner hereinbefore described.

The calling line is extended to the cord circuit in Fig. 2 over contacts 239 and 236, whereby relay 231 and retardation coil 237 energize. Relay 231 closes a circuit from ground over its armature and front contact through the winding of relay 257, contact 255 (11), brush 268, contact 543 (12), back contact and right-hand armature of relay 524, through the winding of relay 531, to battery and ground. Relay 531 energizes and closes a circuit from ground over its armature and front contact, through the winding of coil 557, contact 555 (12), thence over the loop of the called subscriber's line and returning by way of contact 556 (12), through the winding of relay 562, to battery and ground. Relay 562 attracts its armature to close a circuit from ground over its armature and contact through the winding of relay 537, sequence switch 542 (12), brush 267, contact 256 (11), through the winding of relay 262 to battery and ground. Relay 262, energizing, closes a circuit including contact 517 to drive sequence switch 220 into position 12, which is the talking position thereof.

At the time the relay 625 deenergizes when the register controlling mechanism in the exchange is disconnected from the cord circuit, sequence switch 620 moves into position 15 by means of a circuit including contact 684 (14), and the back contact and armature of relay 625. In position 15 of sequence switch 620, sequence switch 650 is energized by means of a circuit including contact 675 (15), contact 703, contact 716, contacts 666 and 674 (15), contact 723, contact 671 (15) to ground at contact 664 (15). Sequence switch 650 advances into position 16 where it is energized in a circuit including contact 669, contact 733 of register 730, contact 670 (16) to ground at contact 643, and moves into position 17. Sequence switch 650 is now driven into its home position by means of a circuit, contact 659, contact 744, back contact and armature of relay 681, contact 743, contact 670 (17) and contact 644. In position 1 of sequence switch 650, relay 623 is energized by means of the circuit through its left-hand winding, contact 622 (15) to ground at contact 668 (1). Relay 623 energizes and closes a circuit to drive sequence switch 620 into position 17. In this position relay 634 is energized in a circuit including contact 642, back contact and armature of relay 626 and contact 640. Relay 634 causes the energization of relay 623, which in turn closes a circuit to drive sequence switch 620 into its home position 1.

After the conversation is completed, the calling subscriber restores his receiver to the switchhook and the apparatus in the satellite is released to its normal position and in the manner hereinbefore described. At the exchange, relays 531 and 537 are deenergized as soon as sequence switch contacts 252 and 256 move out of position 12. Relay 531, releasing its armature, closes a circuit from battery through the left-hand winding of relay 524, contact 558 (12), armature and contact of relay 537, back con-

tact and armature of relay 531 to ground. Relay 524 energizes and closes a circuit through the winding of sequence switch 520, front contact and left-hand armature of relay 524, contact 527 (12) to ground at contact 582. Sequence switch 520 moves into position 17 where the brush carriage of the group selector is restored to normal, by means of a circuit through the winding of power magnet 541, contact 544 (17), and back contact and armature of relay 532, contact 527 (17) to ground and contact 582. On reaching its home position the interrupter brush 569 completes a circuit from battery through the winding of relay 562, contact 556, brush 569 through the winding of relay 532 to ground. Relay 532 opens the circuit of the brush carriage power magnet and also closes a circuit from battery through the winding of sequence switch 520, contact 529 (17), front contact and armature of relay 532, contact 527 (17) to ground at contact 582 to drive sequence switch 520 out of position 17 and into position 1. Release of the succeeding selector switches 571 and 572 takes place in any well-known manner.

What is claimed is:

1. In a telephone exchange system, automatic switches for establishing telephone connections, a register controlling mechanism, a second register controlling mechanism, means for setting said first controlling mechanism to establish the registration of a wanted designation thereon, means operated under the control of said first mechanism in accordance with the setting thereof for controlling said automatic switches, and means under the control of said first mechanism for setting the second register controlling mechanism in correspondence with the setting of said first mechanism.

2. In a telephone exchange system, automatic switches for establishing telephone connections, a register controlling mechanism for controlling said automatic switches, other automatic switches for establishing telephone connections, a second register controlling mechanism for controlling said other automatic switches, and means for setting said first controlling mechanism to establish the registration of a wanted designation thereon, said first mechanism being effective either to control said first automatic switches or to set said second controlling mechanism.

3. In a telephone exchange system, automatic switches for establishing telephone connections, a register controlling mechanism for controlling said switches, other automatic switches for establishing telephone connections, a second register controlling mechanism for controlling said other automatic switches, means for setting said first controlling mechanism to establish the registration of a wanted designation thereon, and means dependent upon the setting of said first mechanism for rendering such mechanism effective either to control the operation of said first automatic switches or to control the setting of said second controlling mechanism.

4. In a telephone exchange system, automatic switches for establishing telephone connections, a register controlling mechanism for controlling said automatic switches, other automatic switches for establishing telephone connections, a second register controlling mechanism for controlling said other automatic switches, means for setting said first controlling mechanism to establish a registration thereon in accordance with a desired designation, and means dependent upon the designation for rendering such controlling mechanism effective either to control said first automatic switches or to control the setting of said second controlling mechanism in correspondence with the setting of said first mechanism.

5. In a telephone exchange system, a switching station, automatic switches therein for establishing telephone connections, a register controlling mechanism at said station for controlling said switches, a distant station, automatic switches therein for establishing telephone connections, a controlling mechanism in the distant station for controlling the switches therein, means for setting said first mechanism to establish the registration of a wanted designation thereon, and means dependent upon the setting of such mechanism and operative under the control thereof for setting the controlling mechanism at the distant station in correspondence with the setting of said first mechanism.

6. In a telephone exchange system, a switching station, automatic switches therein for establishing telephone connections, a register set at said station for controlling said switches, a distant station, automatic switches therein for establishing telephone connections, a register set at said distant station for controlling the switches therein, means for positioning the registers of said first set, means dependent upon a certain positioning of such set for rendering the same operative to control the automatic switches in the first station, a transfer device, means dependent upon another positioning of said first register set for rendering said transfer device operative, and means operated by the transfer device to position the registers in the distant station in correspondence with the positioning of the registers in said first station.

7. In a telephone exchange system, automatic switches for establishing telephone connections, a set of registers for controlling

said automatic switches, other automatic switches for establishing telephone connnections, a second set of registers for controlling said other automatic switches, means for positioning the registers of said first set, and means dependent upon the position of such registers for rendering the first register set effective either to control said first automatic switches or to position the registers of said second register set in correspondence with the position of said first register set.

8. In a telephone exchange system, automatic switches for establishing telephone connections, a register set for controlling said switches, other automatic switches for establishing telephone connections, a second register set for controlling said other automatic switches, means for positioning the registers of said first set, a transfer device, means for associating said transfer device with said first register set, and means operated by the transfer device for positioning the registers of said second register set in correspondence with the positioning of the first register set.

9. In a telephone exchange system, autonatic switches for establishing telephone connections, a register set for controlling said switches, other automatic switches for establishing telephone connections, a second register set for controlling said other automatic switches, means for positioning the registers of said first set, a transfer device, means for associating said transfer device successively with the registers of said first set, and means operated by said device for successively positioning the registers of said second register set in correspondence with the positioning of the registers of the first set.

10. In a telephone exchange system, automatic switches for establishing telephone connections, a register set for controlling said switches, other automatic switches for establishing telephone connections, a second register set for controlling said other automatic switches, means for positioning the registers of said first set, means dependent on a certain positioning of said first register set to render such set operative to control said first automatic switches, a transfer device, and means dependent on another positioning of said first register set for rendering said transfer device operative to position the registers of said second register set in correspondence with the positioning of the first set.

11. In a telephone exchange system, automatic switches for establishing telephone connections, a switch controlling mechanism for controlling said switches, other automatic switches for establishing telephone connections, a second controlling mechanism for controlling said other automatic switches, a sender for setting said first controlling mechanism, and means dependent upon the setting of said first mechanism for rendering the same effective either to control the operation of said first automatic switches, or to control the setting of said second switch controlling mechanism.

12. In a telephone exchange system, a subscriber's line, automatic switches for extending said line, a switch controlling mechanism for controlling said switches, other automatic switches for further extending said line, a second controlling mechanism for controlling said other automatic switches, a sender associated with said line for setting said first controlling mechanism, and means dependent upon the setting of said first mechanism for rendering the same effective either to control the operation of said first automatic switches or to set said second controlling mechanism to control the operation of said second automatic switches.

13. In a telephone exchange system, a calling line, a first called line and a second called line, an automatic switch for extending the calling line to said first called line, a controlling mechanism for controlling said switch, a second automatic switch for extending the calling line to said second called line, a controlling mechanism for controlling said second automatic switch, means for setting said first controlling mechanism, means for rendering the first controlling mechanism effective to control the operation of said first automatic switch when a call is made to the said first called line, and means for rendering said first mechanism effective to set said second mechanism to control said second automatic switch when a call is made to the second called line.

14. In a telephone exchange system, a calling line, a first called line and a second called line, an automatic switch for extending the calling line to said first called line, a register set for controlling said switch, a second automatic switch for extending the calling line to said second called line, a register set for controlling said second automatic switch, a sender for setting said first register set according to the called line designation, means for rendering the first register set effective to control said first switch when a call is made to the first called line, means for operating said first switch automatically to extend the calling line to said second switch when a call is made to the second called line, and means for rendering said first register set effective to set said second register set to control the operation of said second automatic switch.

15. In a telephone exchange system, a calling line, a first called line and a second called line, an automatic switch for extending the calling line to said first called line,

a register set for controlling said switch, a second automatic switch for extending the calling line to said second called line, a register set for controlling said second automatic switch, a sender for setting said first register set according to the called line designation, means for rendering the first register set effective to control said first switch when a call is made to the first called line, means for operating said first switch independently of said first register set to extend the calling line to said second switch when a call is made to the second called line, and means for rendering said first register set effective to set said second register set to control the operation of said second automatic switch.

16. In a telephone exchange system, a satellite, a calling line at said satellite, an exchange, a switch in the satellite for extending the calling line to a called line in said satellite, a register set for controlling said switch, a switch in the exchange for extending the calling line to a called line in said exchange, a register set in the exchange for controlling said second switch, means for registering the designations of both satellite and exchange lines on said first register set, means for rendering said first register set operative to control the switch in the satellite when a satellite line designation is registered, means for operating the satellite switch independent of said first register set to extend the calling line to the exchange switch when an exchange line designation is registered, and means for rendering said first register set operative to register the exchange line designation on said second register set.

17. In a telephone exchange system, selective switches for establishing telephone connections, a register set comprising registers each having a plurality of positions for controlling said switches, other selective switches, a second register set for controlling said other selective switches, means for variably positioning the registers of said first set, and means for restoring said positioned registers to normal, said registers being operative during their restoration either to control the operation of said first switches or to control the positioning of the registers of said second set in correspondence to the positioning of the first register set.

18. In a telephone exchange system, a register set comprising a plurality of multi-position registers, a second register set having registers corresponding to the registers of said first set, means for moving the registers of said first set into positions corresponding to the complements of the digits of a wanted designation, means for restoring said positioned registers to normal, and means controlled by said registers on restoration for moving the registers of said second set into positions corresponding to the positions taken by the registers of said first set.

19. In a telephone exchange system, selective switches for establishing telephone connections, a register set comprising a plurality of multi-position registers, a second register set having registers corresponding to the registers of said first set, means for moving the registers of said first set into positions corresponding to the complement of the digits of a wanted designation, and means for restoring such positioned registers to normal, said positioned registers being operative on restoration either to control the operation of said selective switches or to control the movement of the registers of said second register set to positions corresponding to the positioning of the first register set.

20. In a telephone exchange system, a selector switch for establishing telephone connections, a register set comprising a plurality of multi-position registers, a second register set having registers corresponding to the registers of said first set, an impulse sender for moving the registers of said first set into positions corresponding to the complements of the digits of a wanted designation, and means for restoring such positioned registers to normal, said positioned registers being operative on restoration either to control the operation of said selective switches or to control the moving of the registers of said second register set to positions corresponding to the positioning of the first register set.

21. In a telephone exchange system, selective switches for establishing telephone connections, a register set comprising a plurality of multi-position registers, a second register set having registers corresponding to the registers of said first set, means for moving the registers of said first set into positions corresponding to the complements of the digits of a wanted designation, and means for restoring such positioned registers to normal, said positioned registers being operative on restoration either to control the operation of said selective switches or to control the movement of the registers of said second register set to positions corresponding to the positioning of the first register set dependent upon the character of said wanted designation.

22. In a telephone system, an automatic switch for establishing telephone connections, a set of registers, a second set of registers, means for setting said first registers, means operated under the control of said lrst registers in accordance with the setting thereof for controlling said automatic switch, and means under the control of said first registers for setting said second registers in correspondence with the setting of said first registers.

23. In a telephone system, automatic

switches for establishing connections, a plurality of registers for controlling said switches, other automatic switches for establishing connections, a plurality of other registers for controlling said last switches, and means for variably setting the said first registers, said first registers being effective either to control said first automatic switches or to set said second registers.

24. In a telephone system, automatic switches for establishing connections, a plurality of registers, a second plurality of registers, means for variably setting said first registers to establish a wanted designation thereon, means for setting said second registers in accordance with the setting of said first registers to reestablish the wanted designation, and means for operating said automatic switches in accordance with said designation.

25. In a telephone system, automatic switches for establishing telephone connections, a set of variably operable registers, a second set of variably operable registers, impulse means for setting said first registers in accordance with a desired designation, means dependent upon the setting of said first registers for setting said second registers in accordance with said designation, and means controlled in accordance with the setting of said registers for operating said automatic switches.

26. In a telephone system, automatic switches for establishing connections, a controlling mechanism common to said automatic switches and arranged to control the operation thereof, a second controlling mechanism, means for variably setting said first controlling mechanism, means controlled by said first mechanism in accordance with the setting thereof for operating one of said automatic switches, and means under the control of said first mechanism for setting said second controlling mechanism in correspondence with the setting of said first mechanism.

27. In a telephone system, a plurality of automatic switches for establishing connections, a switch controlling mechanism common to said automatic switches and arranged to control the operation thereof, a second switch controlling mechanism, means for associating said first mechanism with any one of said automatic switches, means for variably setting said first mechanism in accordance with a wanted designation, means controlled by said first mechanism in accordance with the setting thereof for operating the associated automatic switch, and means under the control of said first mechanism for setting said second controlling mechanism in accordance with the setting of said first mechanism.

In witness whereof, we hereunto subscribe our names this 12th day of June, A. D. 1919.

LIPA POLINKOWSKY.
WILLIAM H. MATTHIES.