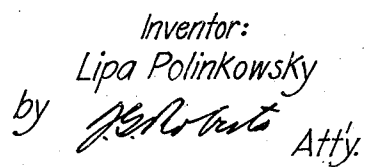


1,435,333.

4 SHEETS--SHEET 1.



L. POLINKOWSKY.
 TELEPHONE EXCHANGE SYSTEM.
 APPLICATION FILED JUNE 14, 1919.

1,435,333.

Patented Nov. 14, 1922.

4 SHEETS—SHEET 2.

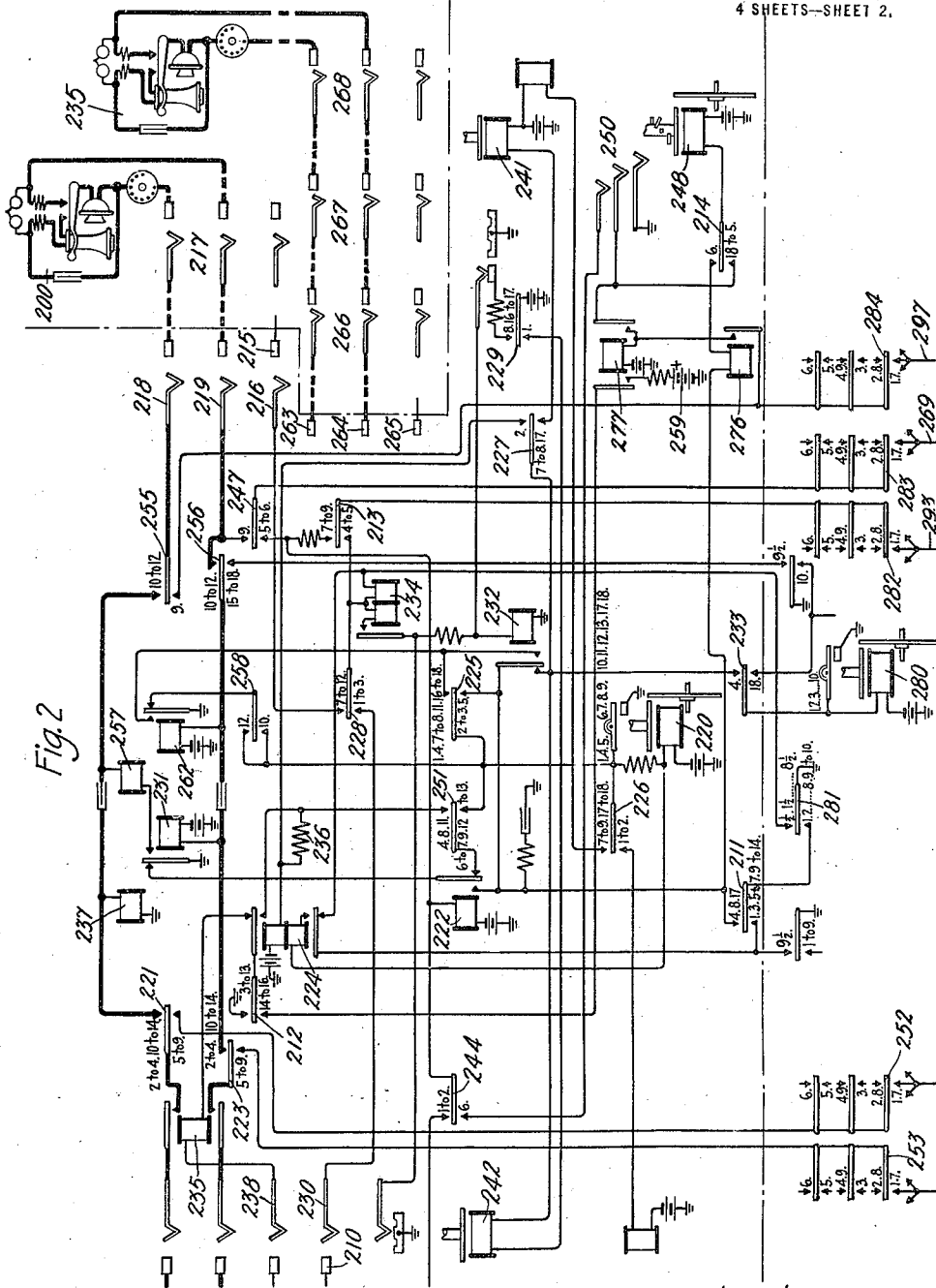


Fig. 2

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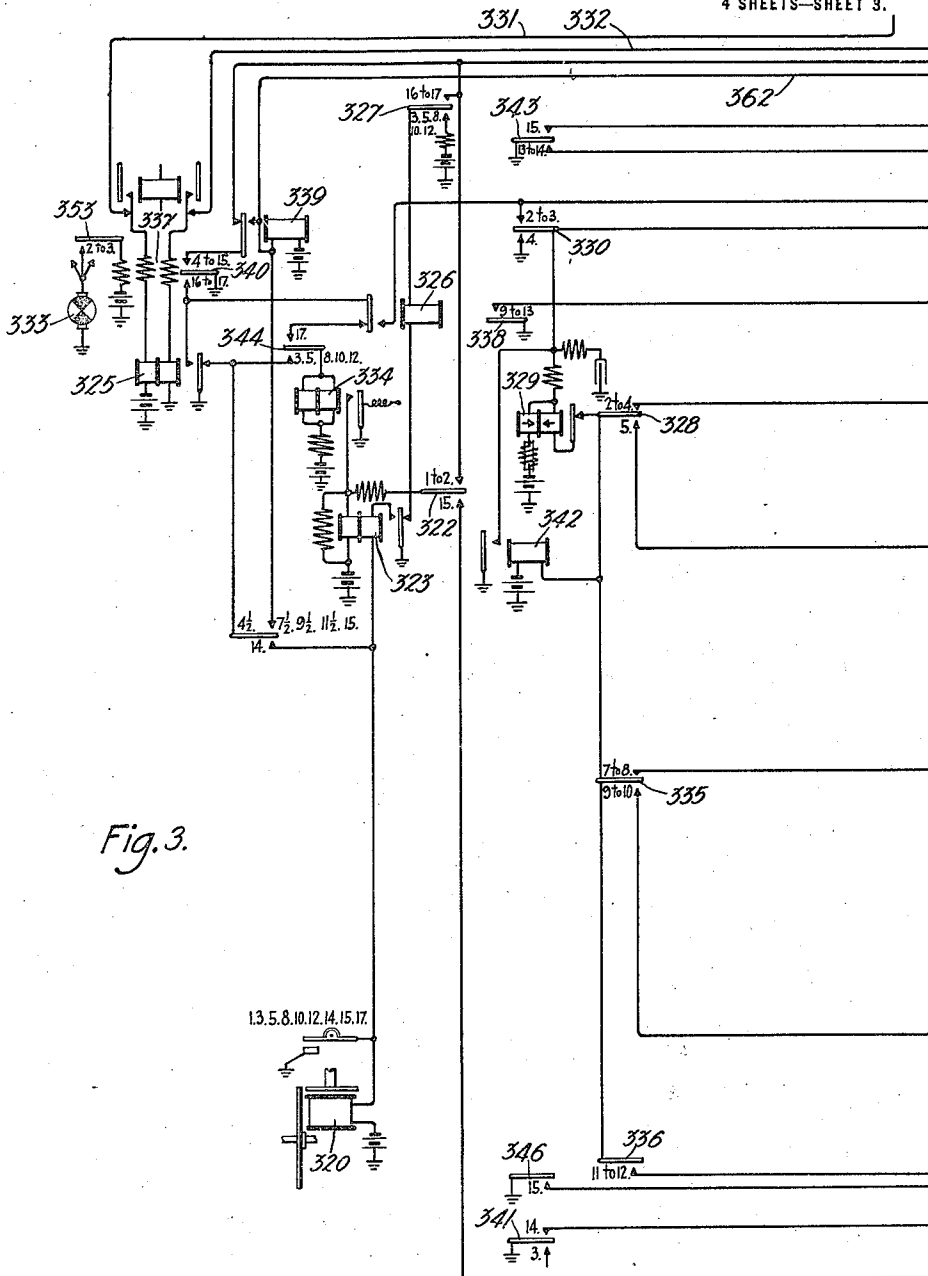


Fig. 3.

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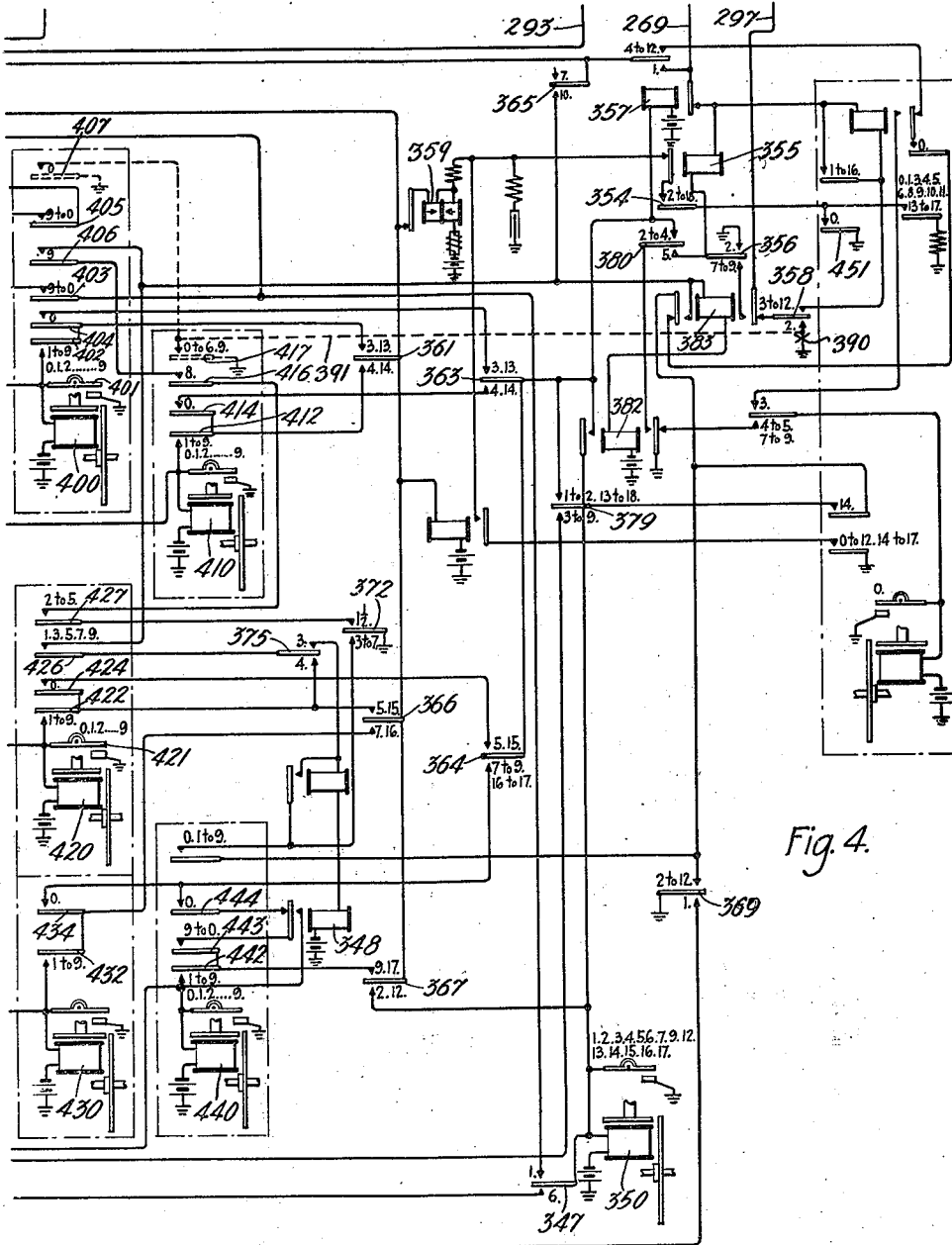


Fig. 4.

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UNITED STATES PATENT OFFICE.

LIPA POLINKOWSKY, OF NEW YORK, N. Y., ASSIGNOR 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. 304,144.

To all whom it may concern:

Be it known that I, LIPA POLINKOWSKY, a citizen of Russia, residing at New York, in the county of New York and State of New York, 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 employing machine switching apparatus for setting up connections between subscribers' lines.

More particularly it relates to a system in which means are provided for establishing connections with lines of different character, such as subscribers' lines local to a given exchange or satellite and subscribers' lines belonging to a distant exchange.

An object of the invention is to provide for message registration in a system of this type with means for discriminating between different classes of calls, whereby if a connection is extended to a line of one character, the call is charged to the calling line but is not charged if a connection is established with a line of a different class.

A feature of the invention relates to an arrangement in which a register controlling mechanism, adapted to control the operation of selective switches, is capable of discriminating between different classes of calls, whereby message registers associated with the calling lines are operated when lines of certain character are called whereas said registers are not operated when lines of different character are called.

A further feature of the invention relates to an arrangement in which the register controlling mechanism is capable of discriminating between calls of different character such that when a call is made to a certain class of lines, means are operated which later become effective to charge the call during release of the connection.

A still further feature of the invention is the provision, in a system where a register controlling mechanism in a switching station is adapted to control both the switches in said station and also the switches in a distant exchange, of means whereby said controlling mechanism is arranged to distinguish between local calls and calls to the distant exchange for the purpose of causing

the operation of the message registers of calling lines when connections are extended to the exchange lines.

Such other and further features as are contemplated by the present invention, will become apparent from a consideration of the following description and the appended claims.

In the drawings, Fig. 1 shows a subscriber's line terminating in the multiple terminals of a first line finder switch in a satellite and the circuits for operating said finder switch.

Fig. 2 illustrates in detail the circuit arrangement of a second line finder switch and a first group selector switch in the satellite, together with means for associating a register controlling mechanism with the circuits of the group selector. This figure also shows diagrammatically a final selector switch having access to called lines local to the satellite, and a first group selector, second group selector, a final selector switch in a distant exchange with a subscriber's line of the exchange terminating in said final selector switch.

Figures 3 and 4 illustrate in detail the circuits and apparatus of a register controlling mechanism for controlling the operation of the selector switches both in the satellite and in the distant exchange.

In accordance with the principles of the present invention, a message registering arrangement is provided whereby a calling subscriber in a satellite may extend his line into connection with the lines of other subscribers belonging to the same satellite, free of charge. If, however, a subscriber in the satellite desires to hold a conversation with a subscriber whose line belongs to a distant exchange, means in the satellite are provided for distinguishing a call of this nature so that upon release of the connection, the message register associated with the calling subscriber's line is operated to charge the call. To accomplish the end generally outlined above, the register controlling mechanism in the satellite, the function of which is to control the selective operation of the switches, is so designed as to be able to distinguish between calls local to the satellite and calls outgoing to distant exchanges, either to withhold the application of a special

source of metering current for operating the message register during the release of the connection or to prepare circuits for the connection of such source to the message register, as the case may be.

Since the discrimination by the register controlling mechanism is made to depend upon the particular positioning of the individual registers of such mechanism under the control of the calling subscriber's dial, or, in other words, dependent upon the character of the digits transmitted, for causing message registration in one case and for preventing it in another, it is apparent that by suitable modifications, calls to any desired class of lines may be charged, whereas calls of other classes may be made without charge.

The first line finder switches shown in Fig. 1 and the second line finder switches shown in Fig. 2, are of the rotary power-driven type arranged to be driven by a continuously operating source of power, and are in general the same as those disclosed in the patent to Polinkowsky 1,193,053, issued August 1, 1916. The selector switches shown in Fig. 2 are likewise designed to be operated by a continuous source of power and controlled in accordance with the well-known principle of reverting impulses in a manner similar to the operation of the switches shown in said patent.

The register controlling equipment disclosed in Figures 3 and 4 comprises a plurality of sequence switch registers, each having a series of 10 controlling positions. These registers are arranged to be advanced from their normal or zero position under the control of impulses transmitted from the calling subscriber's dial to positions corresponding to the number of impulses contained in each series. Having thus been positioned, the registers are then adapted to run through the remaining positions in their cycle, which number of positions it will be observed is the complement of the impulses sent from the calling substation to control the selective operation of the several selector switches. Accordingly, it is apparent that in order to control the selector switches through a number of selecting steps corresponding to the digit of the called number concerned, it is necessary to provide means for setting the registers up to positions corresponding to the complements of the digits rather than to position them in accordance with the actual digits of the called number. This is readily accomplished by arranging the calling subscriber's dial so as to send out series of impulses corresponding to the complements of the digits of called numbers as they are listed in the telephone directory. The operation of a register controlling mechanism of this character and the construction of

the calling subscriber's dials for cooperating therewith, has been described in detail in the British patent issued to Western Electric Company, Limited, No. 146,517, accepted October 5, 1921.

It is believed that a more thorough understanding may be had of this invention from a detailed description of the operation of the system in which it is embodied.

It will first be considered that a subscriber, such as the subscriber of line 100 in the satellite, wishes to complete a talking connection with another subscriber's line in the same satellite, as for example, line 200. On removing his receiver from the switchhook, a circuit is completed from battery through the left-hand winding of line relay 101, contact and armature of cut-off relay 120 over the loop of the calling line inner armature and contact of relay 120, through the right-hand winding of relay 101 to ground. Relay 101 attracting its armature, places a selectable potential upon the multiple terminals, such as 109, in all first line finders having access to the calling line. The circuit over which this potential is placed upon terminals 109 leads through the inner windings of the starting relays 102. Relays 102 are at the same time energized by means of a circuit from battery through their inner windings, armature and contact of relay 101, through the outer windings of relays 102 to ground. The starting relays 102, by attracting their armatures, complete a circuit from ground through the winding of relay 103, and thence in parallel to the windings of the motor magnets such as 114, of all idle first line finder switches in the group, back contact and armature of relay 116, to battery over the back contact and armature of relay 119. The motor magnets 114 cause, in the well-known manner, the rotation of the brushes 110, 111, 112, 113, of such idle first line finder switches. On coming in contact with the terminal 109 of the calling line, upon which a selectable potential exists, a circuit is closed from battery through the inner windings of relays 102, armature and contact of relay 101, test terminal 109, brush 113, through the right-hand high resistance winding of test relay 115 to ground. Relay 115 energizes and closes a low resistance circuit to ground through its left-hand low resistance winding and contact and armature and the winding of relay 116. This low resistance path decreases the potential on the test terminals of other line finder switches to render the calling line non-selectable. Relay 116 energizing, at the same time opens the circuit of power magnet 114 to bring the brush carriage to rest with the brushes 110, 111, 112, 113, upon terminals 106, 107, 108, 109, and also closes a circuit from battery, armature and back contact

of relay 19, armature and front contact of relay 116, through the winding of the holding magnet 123, through the windings of starting relays 117, to ground. The holding magnet 123 serves to accurately position the brushes 110, 111, 112, 113. Relay 116 also closes a circuit from battery, armature and back contact of relay 119, armature and front contact of relay 116, through the resistance 124, to the multiple terminals, such as 210, of all second line finder switches having access to the connecting circuit of the calling first line finder, thus placing a selectable potential thereon.

The starting relays 117, by attracting their armatures, close a circuit from ground through the winding of relay 118, conductor 125, and thence in parallel over sequence switch contacts 244, of the second line finder switches having access to the calling group, through the winding of relay 222 to battery and ground. Relay 222 closes a circuit 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 power magnet 242 of the second line finder, contact 229 (1) of sequence switch 220, to battery and ground. The power magnet 242 energizing in this circuit, operates to rotate the brush carriage of the second line finder switch. When the test brush 230 of the rotating brush carriage reaches test terminal 210, a selectable potential, being found thereon, relay 234 is energized. The circuit for relay 234 extends from terminal 210 by way of brush 230, contact 228 (1), through the right-hand high resistance winding of relay 234, back contact and lower armature of relay 224, contact 211 (1), contact 281 of sequence switch 280, closed in positions 1 to 10 to ground. Test relay 234 closes a low resistance path through its left-hand winding, contact and armature and winding of relay 232 to ground, in parallel with its high resistance winding. This serves to reduce the potential on multiple terminals 210 to render the calling circuit non-selectable to other second line finder switches. Relay 232 which also energizes, opens the circuit of the power magnet 242 to discontinue the rotation of the finder brush carriage and closes a circuit to drive sequence switch 220 out of position 1 and into position 4. This circuit may be traced from battery through the winding of sequence switch 220, contact 225 (1), front contact and armature of relay 232, front contact and armature of relay 222 to ground at back contact and armature of relay 231.

As sequence switch 220 reaches position 3, and in the positions thereafter up to position 13, a circuit is closed from ground, contact 212, upper armature of relay 224, through the winding of relay 235, brush 238, through the winding of relay 119, brush 112, terminal 108, through the winding of cut-off relay 120 to battery and ground. Relay 120 opens the circuit of line relay 101, which in turn permits the deenergization of the common starting relays 102, thereby causing all other hunting first line finder switches to cease their rotation. Relay 119 energizing in the above circuit, opens the circuit of the common starting relays 117, which remove the ground from conductor 125, thus preventing the hunting of other second line finder switches. In parallel with the circuit traced for cut-off relay 120, a circuit is also completed through the winding of the message register magnet 121, which is individual to the calling line 104, 105. This magnet, however, being of the marginal type, does not receive sufficient current in this circuit to energize. On leaving position 2, sequence switch contact 244 opens to permit the deenergization of relay 222. In position 3 of sequence switch 220, the above traced circuit for relays 235, 119 and 120, is closed and relay 235 energizing, closes the calling line over conductors 126, and 127 through to the cord circuit of the second line finder switch in Fig. 2. Relay 231 is, therefore, energized in series with the calling line and retardation coil 237, in position 3 of sequence switch 220. Relay 231 being energized when sequence switch 220 reaches position 4, the meter hindering relay 224 remains deenergized. Relay 224 would otherwise energize in a circuit through its upper winding, contact 251 (4), back contact and armature of relay 222 to ground, at back contact and armature of relay 231. The object of this circuit is to permit the energization of relay 224, to prevent the registration of a call in the event that the calling subscriber abandons the call when sequence switch 220 is in position 4.

In position 4 of sequence switch 220, the selection of an idle register controlling mechanism, such as the one shown in Figs. 3 and 4, 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, to associate the same with the circuits shown in Fig. 2. The circuit for initiating the testing operation of sequence switch 280 extends from battery through the winding of said sequence switch, contact 233 (4), back contact and armature of relay 232, contact 211 (4) to ground at contact 281 of sequence switch 280. It will be noted that relays 234 and 232 are deenergized upon the opening of contact 228 as sequence switch 220 passes out of position 3. The circuits of the register mechanisms, such as the one shown in Figures 3 and 4, are multiplied to corresponding contacts, as contacts 282, 283 and 284, of a plurality of testing sequence 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 a 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, (approaching position 1) contact 213 (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 the 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. The details of this operation are shown and described in the patent to Polinkowsky No. 1,160,447, granted November 16, 1915. Relay 234 energizes and closes the 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 so as to prevent another sequence switch 280 from seizing the selected register mechanism. Relay 232 energizes and opens the circuit of sequence switch 280, causing the same to cease its rotation. Relay 232 also closes a circuit from battery through the winding of sequence switch 220, contact 225 (4), front contact and armature of relay 232, contact 211 (4), to ground at contact 281 closed in either position 1 or 7. The sequence switch 220 leaves position 4 and moves into position 5. When sequence switch 220 passes out of position 4, it opens at contacts 221 and 223 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 221 and 223, closed in position 5, to the stepping relay 325 of the selected register mechanism, ready for the transmission of impulses to register the designation of the called line. The impulse circuit including stepping relay 325 is traceable from battery through the left-hand winding of said relay, conductor 331, contact 253 (1 or 7), of sequence switch 280, contact 223 (5), contact and lower armature of relay 235, conductor 127, brush 111, terminal 107, conductor 105 over the loop of the calling line conductor 104, terminal 106, brush 110, conductor 126, upper armature and contact of relay 235, contact 221 (5), contact 252 (1 or 7) of sequence switch 280, conductor 332, through the winding of relay 325 to ground.

At the time the registering mechanism

was selected the relay 323 was energized in series with test relay 234. A circuit was thereupon closed from ground, over the armature and front contact of relay 323, through the right-hand winding thereof, through the winding of sequence switch 320 to battery and ground. Sequence switch 320 moves out of position 1. In leaving position 2, sequence switch 320 opens the original energizing circuit of relay 323 at its contact 322, permitting said relay to be deenergized before sequence switch 320 reaches position 3. Sequence switch 320 therefore, comes to rest in position 3 and at its contact 353 closes a circuit for the interrupter 333, in series with the primary winding of a dialing tone coil 337. 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 400 to battery and ground. A parallel circuit to the one just traced is also completed from battery through the 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 400, however, is energized and moves out of position zero. Between positions zero and 1 of register 400 a direct circuit to ground is closed in the well-known manner, by its local contact 401, thus shunting the right-hand winding of the differential relay 329. This relay now attracts its armature and register 400, under the control of its local contact, advances into position 1. Relay 342 also energizes in a circuit over contacts 328 (3) to ground at the local contact 401 of register 400. Relay 342 remains energized while register 400 is passing from one position to another, and at its armature and contact closes a holding circuit for relay 329, to insure that this relay will not deenergize until register 400 has reached its full position.

The calling subscriber on hearing the distinctive dialing 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 relay becomes deenergized, the relay 342 having in the meantime deenergized, since register 400 has opened its local contact 401, to open the substituted circuit for the left-hand winding of relay 329. As the line circuit again closes register 400 is energized once more and moves out of position 1, relay 329 energizes, the register passes to position 2 and at the next interruption of the line circuit relay 329 becomes deenergized. This operation 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 closed for the windings of relay 334 over sequence switch contact 344. Relay 334, however, is made slow to energize and does not attract its armature on short closures of its operating circuit. At the last interruption of the line circuit, which due to the construction of the subscriber's transmitter is made comparatively long, the circuit of relay 334 is closed for a sufficient interval to permit said relay 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 344, 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. As sequence switch 320 passes through position 4, the register 400 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 400 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 400 to the thousands register 410. As soon as relay 326 energizes upon the arrival of sequence switch 320 to position 5, a circuit is established from ground, armature and contact of relay 325, armature and front contact of relay 326, contact 405 of register 400, which, as will be hereinafter explained, is closed in either position 9 or position 0, right-hand winding and armature and contact of relay 329, contact 328 (5), through the winding of register 410 to battery. In a similar manner to that described, a parallel circuit is closed through the left-hand winding of relay 329, to prevent this relay from attracting its armature. The register 410 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 deenergization of relay 329. The register 410 advances under the control of its local contact to position 1. After each succeeding interruption of the line circuit, register 410 moves forward one position and at the last interruption relay 334 energizes to cause the operation of relay 323. The relay 323 then closes a circuit over its armature and front contact and drives sequence switch 320 out of position 5. While sequence switch 320 is moving 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. 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 405 of register 400, right-hand winding and armature and contact of relay 329, sequence switch contact 335 (8), through the winding of the hundreds register 420 to battery and ground.

The calling subscriber operating his dial in accordance with the third digit of the desired number, causes the register 420 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 a circuit for driving sequence switch 320 out of position 8 and 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 405, right-hand winding and armature and contact of relay 329, sequence switch contact 335 (10) through the winding of the tens register 430 to battery and ground. The interruption of the line circuit during the sending of the fourth series of impulses, causes the advance of register 430 under the control of 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 440 is completed from ground, armature and front contact of relay 325, armature and front contact of relay 326, contact 405, right-hand windings and armature of contact of relay 329, sequence switch contact 336 (12), through the winding of units register 440 to 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 440. The last interruption of the line being of 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 the first three registers advanced to their corresponding set positions group selection is proceeded with, without waiting for the tens and units registers to be set. The first three registers 400, 410 and 420 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.

The capacity of the present system is taken for example to be 20,000 lines. These lines are numbered from 10,000 to 29,999, whereby the tens thousand register 400 is utilized in only 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, the register 400 is advanced under the control of the calling dial to its ninth position, the complement of the desired digit, and thereafter advanced into its 0 position by means of the circuit over contact 330 (4), 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 400 is first advanced to the complementary position 8 and thereafter moved an additional step into its ninth position. Hence the contact 405 of the register 400 will always be closed in either the ninth or the 0 position of the tens thousand register.

The subscriber's lines belonging to the satellite of which, for the purpose of illustration, there will be considered to be 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 10,000 group, which corresponds to the eighth position of register 410, and comprise the 8th, 7th, 6th and 5th groups of 100 lines in the second thousand, which correspond to the second, third, fourth and fifth positions of register 420. Therefore, when a call is made to a line belonging to the satellite the register 400 is set to its ninth position, the register 410 to its eighth position and the register 420 to either its second, third, fourth or fifth 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 of the positioned registers during the selective movement of the switches. This circuit may

be traced from battery through the winding of sequence switch magnet 350, contact 347 (1), contact 403 to ground at contact 338. 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 406 (9), contact 416 (8), contact 427, closed in one of its positions from 2 to 5, contact 372 to ground. Relays 382 and 383 energize and lock up in a circuit from battery, through the windings of these relays and front contact and left-hand armature of relay 383, to ground at contact 369 closed in positions 2 to 12. Sequence switch 350, therefore, 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, to ground at the front contact and right-hand armature of relay 382. 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 451 to ground. Relay 359 by attracting its armature insures that the registers remain 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 at the group selector in the satellite, contact 247 (5), contact 283, conductor 269, 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 220, contact 225 (5), front contact and armature of relay 222, to ground over the back contact and armature of relay 231. Sequence switch 220 moves 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 214 (6), winding of relay 276, front contact and armature of relay 222, to ground at back contact and armature of relay 231.

The trip spindle rotates in the well-known manner, causing a short circuit for the step-

ping 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 5 250, a circuit is established from battery through the winding of the hundred register 420, contact 422, contact 366 (5), contact and armature and left-hand winding of relay 359, contact and armature of relay 355, 10 contact 354 to ground at contact 451. In parallel thereto a circuit is also closed through the right-hand winding of relay 359, to ground at contact 451. The relay 359 is made differential and, therefore, does not attract its armature when both windings are energized. The register 420, however, is energized and moves out of the position to which it was set from the calling subscriber's station. As soon as the local contact 421 20 is closed between positions, a direct circuit is closed to ground, thus short circuiting the left-hand winding of the differential relay 359, permitting this relay to become energized. The register 420 continues to move 25 under control of its local contact, into the next position.

As the brush tripping spindle reaches its first tripping position, the short circuit is removed at contact 250 and relay 355 once 30 more energizes. Relay 355 opens the circuit for the right-hand winding of relay 359, which relay thereupon deenergizes. Register 420 is again energized in the circuit above described including the left-hand 35 winding of relay 359, contact and armature of stepping relay 355 and contact 451. Register 420 advances through another position, relay 355 is short-circuited a second time by the interrupter 250 and relay 359 becomes 40 deenergized. This operation continues until the register 420 is fully restored to its 0 position. On the next deenergization of relay 355 after register 420 has reached position 0, a circuit is closed from battery 45 through the winding of sequence switch magnet 350, left-hand armature and front contact of relay 382, contact 364 (5), contact 424, contact 366 (5), contact and armature and left-hand winding of relay 50 359, contact and armature of relay 355 contact 354 to ground at contact 451. In parallel to the circuit just traced 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 60 of sequence switch 220, contact 251 (6), back contact and armature of relay 222 to ground at back contact and armature of relay 231. Sequence switch 220 passes into position 7. The relay 222 is now energized in a circuit 65 from battery through the winding of this

relay, contact 213 (7), contact 282, 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 70 power magnet 241 is energized by means of a circuit completed from battery through the winding of said magnet, contact 227 (7), back contact and armature of relay 232, front contact and armature of relay 222, to 75 ground at the back contact and armature of relay 231. The power magnet 241 operates to cause the rotation of the group selector brush carriage, which advances its brushes over the terminals of the selected level of 80 terminals. In reaching the test terminal such as terminal 215, of an idle trunk, a selectable potential is found thereon and a circuit is closed over terminal 215, brush 216, 85 contact 228 (7), through the right-hand high resistance winding of test relay 234, back contact and lower armature of relay 224, contact 211 (7), to ground at contact 281. The test relay 234 energizes and closes a low resistance circuit through its left-hand 90 winding, contact and armature and the winding of relay 232 to ground in parallel to the circuit, through the right-hand winding of relay 234. This low resistance circuit so reduces the potential on the test terminals 95 215 as to render the selected trunk busy to other group selectors. Relay 232 also energizes and establishes a circuit from battery through the winding of sequence switch 220, contact 225 (7), front contact and armature 100 of relay 332, front contact of relay 222 to ground at back contact and armature of relay 231. Sequence switch 220 moves over position 8 and into position 9, in which the register controlling equipment is connected 105 over contacts 255 and 247 through to the final selector of the satellite, diagrammatically illustrated at 217. The energization of relay 232 also opens the above traced circuit for power magnet 241 to discontinue the operation of the group selector brush carriage. 110

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 115 into position 7, which only takes place after the tens and units registers 430 and 440 have been positioned from the calling subscriber's substation. After the units register has been set, it will be recalled, sequence switch 320 120 advances into position 14. In this position, a circuit is completed from battery through the winding of sequence switch 350, contact 347 (6), to ground at contact 341 (14), to advance sequence switch 350 out of 125 position 6 and into position 7. The fundamental circuit is thereby completed for the final selector 217. This fundamental circuit includes, as is well known, a relay corresponding to relay 222, at the final selector 130

217 and extends over the brush 218 of the group selector, contact 255 (9), contact 284, conductor 297, right-hand armature and front contact of relay 383, contact 356 (7), through the winding of stepping relay 355, contact and armature of relay 357, conductor 269, contact 283, contact 247 (9), brush 219, and thence to ground at the final selector 217.

Brush selection at the final selector 217 takes place, the stepping relay 355 being short-circuited by the interrupter contacts on the trip spindle to control the return of the tens register 430 to its 0 position. On reaching position 0, register 430 closes a circuit from battery through the winding of sequence switch 350, left-hand armature and contact of relay 382, contact 364 (7), contact 434 (0), contact 366 (7), contact and armature and left-hand winding of relay 359, contact and armature of relay 355, contact 354 to ground at contact 451. Relay 357 is also energized in parallel to the circuit just traced. The sequence switch 350 moves from position 7 into position 9. Units selection now takes place at the final selector, the stepping relay 355 in the fundamental circuit being shortcircuited to intermittently release and attract its armature to control the return of the units register 440 to its 0 position. When the brushes of the final selector 217 have reached the terminals of the called line 200, the register 440 being now in its 0 position, a circuit is completed from battery through the winding of sequence switch 350, left-hand armature and contact of relay 382, contact 364 (9), contact 444 (0), back contact and armature of relay 348, contact 443 (0), contact 367 (9) and thence to ground at contact 451. Sequence switch 350 moves out of position 9 and into position 12.

The manner in which the final selector 217 in the satellite is operated to select the called line under the control of the tens and units registers 420 and 440 and to thereupon test the idle condition of such line, is described in detail in the above mentioned British Patent No. 146,517, accepted October 5, 1921.

When sequence switch 350 passes through position 10, a circuit is completed from battery through the winding of relay 339, conductor 362, contact 365 (10), front contact and left-hand armature of relay 383, to ground at contact 369. Relay 339 attracts its armature and opens the above traced circuit for relay 222. Relay 222 deenergizes and closes a circuit from battery through the winding of sequence switch 220, contact 251 (9), back contact and armature of relay 222 to ground at back contact and armature of relay 231. Sequence switch 220 moves into position 10, where a circuit is completed to drive it into position 11. This circuit leads from battery through the wind-

ing of said sequence switch, contact 258 (10) to ground at the back contact and armature of supervisory relay 262. When sequence switch 220 reaches position 10, the calling subscriber's line is disconnected from the register controlling equipment and is extended over contacts 221 and 223 through to the cord circuit of the group selector. Relay 231 and retardation coil 237 are therefore energized in series with the calling line. The register controlling equipment being disconnected, is now restored to its normal position ready to be taken for use in connection with a subsequent call in the manner described in the above-mentioned British Patent No. 146,517, accepted October 5, 1921.

If the called line is found idle and the called subscriber responds, relay 262 is energized in series with the line. By attracting its armature this relay closes a circuit over contact 225 (11) to drive sequence switch 220 into position 12, which is the talking position thereof.

At the termination of the conversation the calling subscriber replaces the receiver on the switchhook, which opens the circuit of relay 231. Relay 231 deenergizing, closes a circuit from battery through the winding of sequence switch 220, contact 251 (12), back contact and armature of relay 222 to ground at the back contact and armature of relay 231. Sequence switch 220 moves out of position 12, over position 13 and into position 17. A circuit is then closed from battery through the winding of the brush carriage power magnet 241, contact 227 (17), back contact and armature of relay 232, contact 211 (17) to ground at contact 281. The brush carriage is rotated back to its normal position where a circuit is closed from battery, contact 229 (17), through the winding of relay 232 to ground. The relay 232 energizing, opens the circuit of power magnet 241, bringing the brush carriage to rest and also closes a circuit from battery through the winding of sequence switch 220, contact 225 (17), front contact and armature of relay 232, contact 211 (17) to ground at contact 281. Sequence switch 220 thereupon moves out of position 17. When sequence switch 220 leaves position 13, it opens at contact 212 the hereinbefore traced circuit for relays 120, 119 and 235, and the register magnet 121. Since the call is a local one, this circuit is not closed at any other point and relays 120, 119 and 235 deenergize. As explained, the magnet 121 is marginal and, therefore, is not operated to charge the call.

It will now be assumed that the subscriber of substation 100 wishes to obtain a connection with a line belonging to a distant exchange, such as line 235. In this case the designation of the desired line is registered, in the manner described, on the register controlling equipment in the satellite. The

group selector at the satellite shown in Figure 2 operates to extend the calling subscriber's line over an idle trunk circuit leading to the distant exchange whereupon the satellite register mechanism may be operated to directively control the group and final selectors in such exchange to complete the establishment of the connection. In the present arrangement, however, the controlling mechanism is so designed that in the case of an outgoing call, the several registers are first restored to their normal positions to control the setting of similar registers at the called exchange to corresponding positions. Thereafter the register set at the exchange becomes effective to control the operation of the selective switches therein to complete the connection to the called line. Since the specific method by which setting of the satellite register set is transferred to the register set at the distant exchange, is not concerned with the present invention, it is not considered necessary to go into a detailed description of the same. For a more specific description, reference is made to the above-mentioned British Patent No. 146,517, accepted October 5, 1921.

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 already described. When the register mechanism is connected to the cord circuit shown in Figure 2 and the impulse circuit established from the calling line of the stepping relay 325 of the register mechanism, the dialing tone is placed upon the called 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 wanted exchange number, which, in effect, results in the transmission of series of impulses corresponding to the complements of the digits of such numbers. In response to these impulses the registers 400, 410, 420, 430 and 440 are positioned.

Since the called number is one belonging to the distant exchange and since, as already explained, the first three registers 400, 410 and 420 are designed to discriminate between satellite lines and exchange lines, the preliminary energizing circuit of relays 382 and 383 above traced, will be held open either at one or more of the contacts 406, 416 and 427, when sequence switch 350 passes position 14. Hence, when the first three digits have been sent, and sequence switch 320 passes out of position 8 and sequence switch 350 consequently leaves position 1 and moves through position 11, the discriminating relays 382 and 383 remained deenergized. The sequence switch 350 now comes to rest in po-

sition 2 instead of moving on to position 5 as in the case of a local call.

In position 2 of sequence switch 350, the relay 222 is energized in a circuit from battery through the winding thereof, contact 247 (5), contact 283, conductor 269, armature and contact of relay 357, through the winding of stepping relay 355, contact 356 (2) to ground. Relay 355 also energizes in this circuit. Relay 222 closes a circuit from battery through the winding of sequence switch 220, contact 225 (5), front contact and armature of relay 222 to ground at back contact and armature of relay 231 to drive sequence switch 220 into position 6. In position 6 the trip spindle magnet 248 is energized in a circuit from battery through the winding thereof, contact 214 (6), winding of relay 276, front contact and armature of relay 222 to ground, at back contact and armature of relay 231. The trip spindle rotates and in passing through the first brush tripping position the interrupter contacts 250 are momentarily closed to short-circuit the stepping relay 355 in the fundamental circuit. Relay 355 retracts its armature and closes a circuit from battery to the winding of sequence switch 350, contact 367 (2), contact and armature and left-hand winding of relay 359, back contact and armature of relay 355, contact 354, to ground at contact 451. The sequence switch 350 immediately passes out of position 2 and into position 3. As soon as the trip spindle reaches its first brush tripping position the contacts 250 are opened and relay 222 is deenergized by reason of the fundamental circuit being opened at contact 356. The relay 222 releasing its armature, opens the circuit of the trip spindle power magnet 248 and also closes a circuit to drive sequence switch 220 into position 7. This latter circuit may be traced from battery through the winding of sequence switch 220, contact 251, back contact and armature of relay 222, back contact and armature of relay 231 to ground. In position 7 of sequence switch 220, relay 222 is energized in a circuit including contact 213 (7), contact 282, conductor 293, back contact and armature of relay 339 to ground at contact 340 of sequence switch 320. In position 7 of sequence switch 220 the brush carriage power magnet 241 is also energized in a circuit from battery to the winding of said magnet contact 227 (7), back contact and armature of relay 232, front contact and armature of relay 222 to back contact and armature of relay 231. The brush carriage of the group selector rotates and the selected set of brushes 218, 219, and 216 are trailed over the terminals of trunks, such as terminals 263, 264, 265, leading to the distant exchange.

When an idle trunk is found upon the test terminal 265 of which exists a selectable potential, as is well understood, a circuit is closed over test brush 216, contact 228 (7), through the right-hand winding of the test relay 234, back contact and lower armature of relay 224, contact 211 (7), contact 281 to ground. Relay 234 energizes and closes a low resistance circuit for its left-hand winding and the relay 232, as hereinbefore described. Relay 232 attracts its armature and closes a circuit including contact 225 (7), front contact and armature of relay 232, front contact and armature of relay 222 and back contact and armature of relay 231 to drive sequence switch 220 over position 8 and into position 9. The operation of relay 232 also opens the circuit of the power magnet 241 to bring the brush carriage to rest with the brushes 218, 219 and 216 in engagement with terminals 263, 264 and 265.

The fundamental circuit is now extended over contacts 255 and 247 to a register set, not shown, and associated with the first group selector 266 in the distant exchange. In the manner described in the above-mentioned British patent, the exchange register set is positioned in accordance with the setting of the register set shown in the satellite, and later operates to control the selective movement of the group selectors 266 and 267 and final selector 268 to extend the calling line into connection with the desired line 235. If the called line is idle and the called subscriber responds, sequence switch 220 is driven into talking position 12, in the manner above described.

Returning to the point where brush selection takes place at the group selector in the satellite, it will be remembered that relay 276 is included in the circuit of the brush spindle magnet 248. The relay 276 energizes and closes a circuit from battery through the winding of relay 277, contact and armature of relay 276, contact 284, conductor 297, right-hand armature and back contact of relay 383, which relay remains deenergized on outgoing calls, sequence switch contact 353 (2) to ground. Relay 277 energizes and locks up in a circuit from battery through its winding, contact and right-hand armature to ground over the two lower contacts indicated at 250. The interrupter contacts shown at 250 are arranged such that the lower two contacts remain permanently closed during the time the brush tripping spindle is away from its normal position, whereas the upper two contacts make temporary closures as the brush tripping spindle passes from one brush tripping position to another.

At the end of the conversation, when the calling subscriber hangs up his receiver, the line circuit is opened and relay 231 releases its armature. A circuit is then

closed from battery, through the winding of sequence switch 220, contact 251 (12), back contact and armature of relay 222, back contact and armature of relay 231 to ground. Sequence switch 220 passes from position 12 into position 17. In moving through positions 14, 15 and 16, the sequence switch 220 closes at its contact 212 the following circuit: positive pole of battery 259, contact and left-hand armature of relay 277, contact 212, upper armature and back contact of relay 224, through the windings of relays 235 and 119, brush 112, terminal 108, through the winding of the marginal register magnet 121, to the negative pole of battery and ground. The source of current 259 being of the proper polarity, adds to the source of current already in series with the register magnet 121, whereby said magnet operates to charge the call against the calling line. From this point on the restoration of the apparatus takes place in exactly the same manner as has hereinbefore been described.

If the called line is busy or if the called subscriber fails to answer the sequence switch 220 remains in position 11. When, therefore, the calling subscriber restores his receiver to the switchhook and relay 231 deenergizes, a circuit is closed from battery through the upper winding of relay 224, resistance 236, contact 251 (11), back contact and armature of relay 222, back contact and armature of relay 231 to ground. Relay 224 closes a circuit from battery through the winding of sequence switch 220, lower winding and front contact and armature of relay 224, contact 211 to ground at contact 281. The relay 224 remains energized in this circuit and sequence switch 220 is driven from position 11 into position 17. Since relay 224 has its upper armature attracted while sequence switch 220 is passing over position 14 to 16, the above traced circuit for the application of the meter battery 259, is maintained open and the message register magnet 221 is not operated. From here on, release of the apparatus takes place as described.

It may be desirable in some instances to provide for the charging of calls only when certain classes of connections are extended to the exchange. For example, all calls to lines local to the satellite and all calls to lines belonging to the exchange may be made without charge, while calls extending to the exchange and thence to a subscriber's line in a second or distant exchange are registered against the calling line. Here, as in the two classes of calls already considered, the setting of the registers in the satellite discriminates as to the class of the connection desired and determines whether the message register should be operated. In order to make provision

for the registration of this class of calls, the lower contact 358 is disconnected from the direct ground, shown at the cross 390, in Fig. 4, and connected by way of the dotted conductor 391 to contacts 407 and 417 of registers 400 and 410 respectively. The closing positions of contacts 407 and 417 may be selected to correspond with the digits of the numbers of lines of the class for which a charge should be made, namely, lines reached by connections extended through the first exchange and to a distant exchange. On all other calls however, such as those made to lines local to the satellite and lines local to the first exchange, contacts 407 and 417 remain open to prevent the operation of the message register.

What is claimed is:

1. In a telephone exchange system, a line, a message register associated with said line, selective switches for extending said line, a register mechanism for controlling the operation of said switches, means responsive to current impulses for variably setting said register mechanism, and means dependent upon the setting of said mechanism for operating said message register.

2. In a telephone exchange system, a line, a message register associated with said line, selective switches for extending said line, a register mechanism for controlling the operation of said switches, means for variably setting said register mechanism, and means dependent upon the setting of said mechanism for operating said message register during the release of said selective switches.

3. In a telephone exchange system, a line, a message register associated with said line, a plurality of selective switches, means for operating said switches to extend said line, a register controlling mechanism for controlling the selective operation of said switches, a sender for variably setting said controlling mechanism, and means dependent upon the setting of said mechanism for operating said message register.

4. In a telephone exchange system, a line, a message register associated with said line, a sender associated with said line, selective switches for extending said line, a register controlling mechanism for controlling the operation of said switches, said mechanism comprising a plurality of registers, means under the control of said sender for variably setting the registers of said controlling mechanism, and means dependent upon the setting of said controlling registers for operating said message register.

5. In a telephone exchange system, a line, a message register associated with said line, a sender associated with said line, selective switches for extending said line, a register controlling mechanism for controlling the operation of said switches, said mechanism comprising a plurality of registers, means

under the control of said sender for variably setting the registers of said controlling mechanism, and means dependent upon the setting of certain of said controlling registers for operating said message register.

6. In a telephone exchange system, a line, a message register associated with said line, a plurality of selective switches for extending said line, a register mechanism comprising a plurality of controlling registers for controlling the operation of said switches, means for variably setting each of said controlling registers, means for releasing said switches, and means dependent upon the setting of said controlling registers for operating said message register during the release of the selective switches.

7. In a telephone exchange system, a line, a message register associated with said line, an operating circuit for said message register, selective switches for extending said line, a register controlling mechanism for controlling the operation of said switches, means for variably setting said mechanism, means dependent upon the particular setting of said controlling mechanism for preparing said operating circuit, and means for completing said operating circuit to cause the operation of said message register.

8. In a telephone exchange system, a line, a message register associated with said line, an operating circuit for said message register, selective switches for extending said line, a register controlling mechanism for controlling the operation of said switches, means for variably setting said mechanism, means dependent upon the particular setting of said controlling mechanism for preparing said operating circuit, and means operative during the release of said switches for completing said operating circuit to cause the operation of said message register.

9. In a telephone exchange system, a calling line, called lines divided into different classes, a message register for said calling line, selective switches for establishing connections between the calling line and said called lines, a register controlling mechanism for controlling the operation of said switches, means for variably setting said mechanism, means dependent upon the particular setting of said mechanism for distinguishing between the different classes of said called lines, and means controlled by said last named means for operating said message register.

10. In a telephone exchange system, a calling line, called lines divided into different classes, a message register for said calling line, selective switches for establishing connections between the calling line and said called lines, a register controlling mechanism for controlling the operation of said switches, means for variably setting said

mechanism, means dependent upon the particular setting of said mechanism for distinguishing between the different classes of said called lines, and means controlled by said last named means for operating said message register during the release of an established connection.

11. In a telephone exchange system, a switching station, a calling and a called line terminating in said station, a distant switching station, a second called line therein, a message register for said calling line, selective switches for extending the calling line to either of said called lines, a register controlling mechanism for controlling said switches, means for variably setting said mechanism, means dependent upon the setting of said mechanism for distinguishing between a call made to said first called line and a call made to said second called line, and means controlled by said last named means for operating said message register when a call is made to said second called line.

12. In a telephone exchange system, a switching station, a calling and a called line terminating in said station, a distant switching station, a second called line therein, a message register for said calling line, selective switches for extending the calling line to either of said called lines, a register controlling mechanism for controlling said switches, means for variably setting

said mechanism, means dependent upon the setting of said mechanism for distinguishing between a call made to said first called line and a call made to said second called line, and means controlled by said last named means for operating said message register during the release of said switches.

13. In a telephone exchange system, a line, a message register associated with said line, selective switches for extending said line, a register controlling mechanism for controlling the operation of said switches, said mechanism comprising a plurality of registers, and means dependent on the joint setting of said registers for operating said message register.

14. In a telephone exchange system, a line, a message register associated with said line, selective switches for extending said line, a register controlling mechanism comprising a plurality of registers, means for variably setting said registers, an operating circuit for said message register, means dependent on the joint setting of said controlling registers for preparing said circuit, means controlled by said registers for operating said switches, and means for completing said circuit to cause the operation of said message register.

In witness whereof, I hereunto subscribe my name this 12th day of June A. D., 1919.

LIPA POLINKOWSKY.