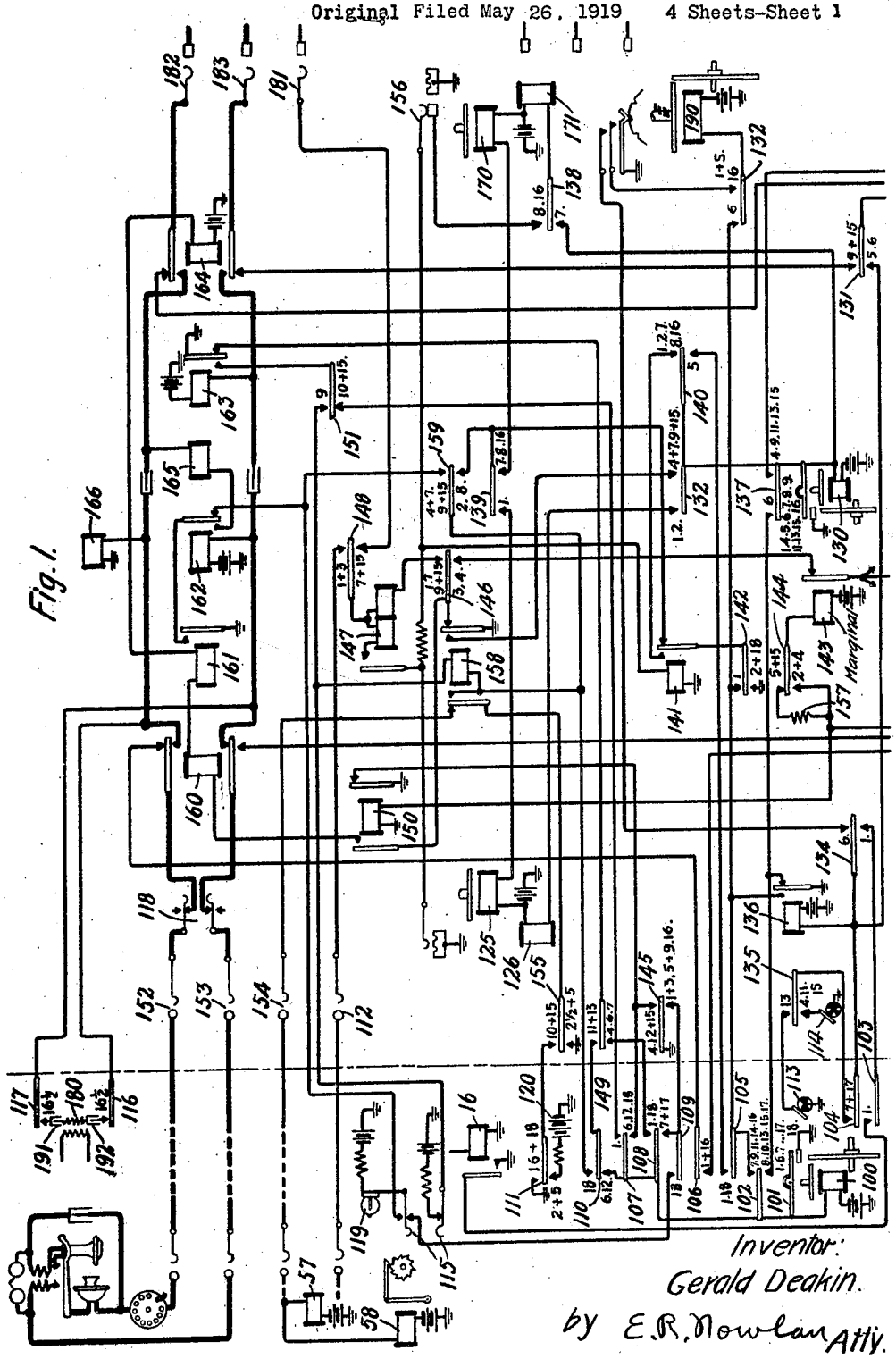
Jan. 8, 1924. 1,479,984

G. DEAKIN

TELEPHONE EXCHANGE SYSTEM

Original Filed May 26, 1919 4 Sheets-Sheet 1



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TELEPHONE EXCHANGE SYSTEM

Original Filed May 26, 1919 4 Sheets-Sheet 2

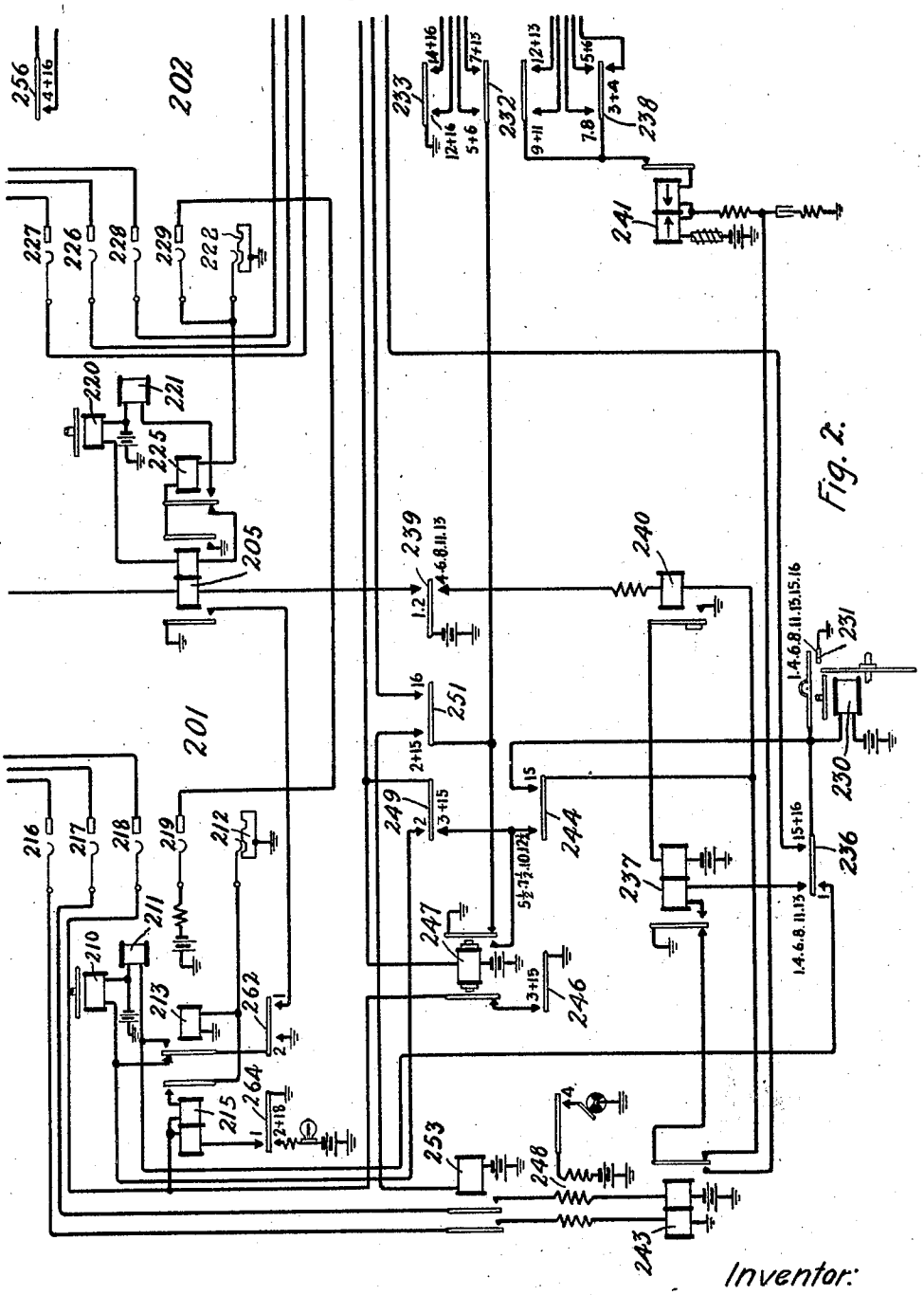

Fig. 2.

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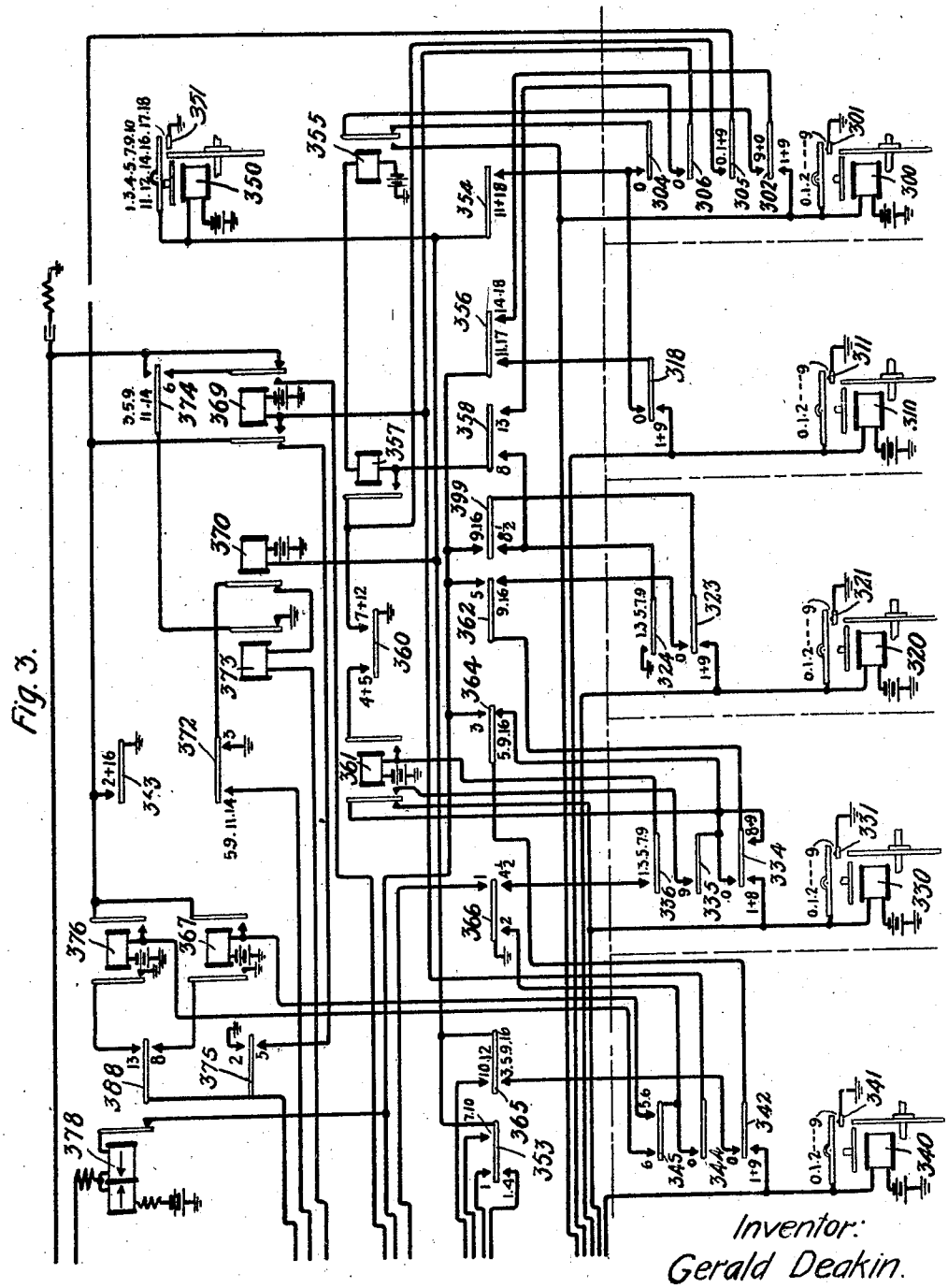

Fig. 3.

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Original Filed May 26, 1919 4 Sheets-Sheet 4

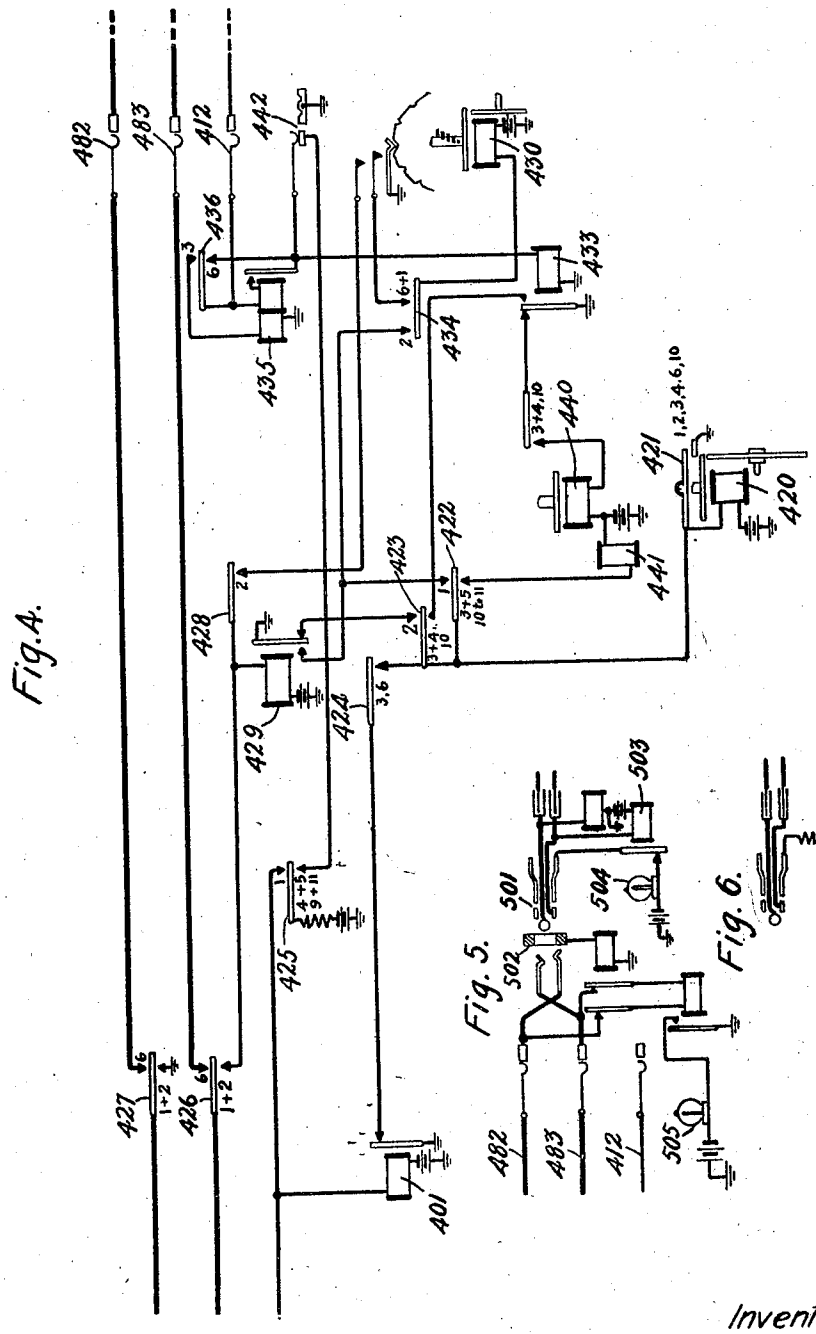

Fig. 4.

Fig. 5.

Fig. 6.

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Patented Jan. 8, 1924. 1,479,984

UNITED STATES PATENT OFFICE.

GERALD DEAKIN, OF ANTWERP, BELGIUM, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Original application filed May 26, 1919, Serial No. 299,962. Patent No. 1,444,781, dated February 13, 1923. Divided and this application filed June 20, 1921. Serial No. 478,894.

To all whom it may concern:

Be it known that I, GERALD DEAKIN, a citizen of the United States, residing in the city of Antwerp, Belgium, 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 and particularly to those in which machine switching apparatus is employed for the establishment of talking connections between calling and called subscribers' lines.

Where the automatic selective switches used for extending talking connections toward the called lines are arranged to be controlled from the central office, it is customary to provide controlling senders of the register type. A plurality of these senders are located at the central office and receive on their registers the digital records of the called lines. These records may be set up on the controlling registers either by means of an operator's keyboard or by means of impulses transmitted over the calling line from the subscribers' substations, according as the system is semi-automatic or full automatic in character. The sender after taking its setting operates to determine the selective movements of the several switches in the extension of the desired connection.

Since there are a plurality of senders, any one of which may serve any one of a group of connecting circuits or cords, said connecting circuits or cords serving to extend the incoming calling line to the selective switches and thence to the called line, cord finder mechanisms are provided for the attachment of the senders to the proper cord. These finder mechanisms are operated automatically in response to the extension of a calling line to any cord in the group they serve and, upon finding the particular cord concerned, associate an idle register mechanism therewith.

The object of the present invention is the provision of a cord finding mechanism consisting of a plurality of separate switching devices, each having access to all cords in a group, and acting jointly to attach a register sender to any cord.

A feature of the invention relates to the provision of a cord finder consisting of two switches, one of which is operated to extend an impulse circuit from any cord to a register sender for causing the designation to be recorded on the register, and the other of which operates to complete a controlling circuit from the sender to the same cord, whereby the record established on the sender determines the selective operation of the automatic switches.

These and such other features as are contemplated in the present invention will become more clearly understood from a study of the following description and the appended claims.

This application is a division of applicant's copending application filed May 26, 1919, Serial No. 299,962, Patent No. 1,444,781, issued February 13, 1923.

Referring to the drawing, Figs. 1 to 6 disclose parts of a telephone exchange system wherein the features of the invention are embodied. The sheets of the drawing should be arranged with Fig. 2 below Fig. 1, Fig. 4 to the right of Fig. 1, and Fig. 3 to the right of Fig. 2.

Fig. 1 shows a subscriber's line and a first line finder switch, diagrammatically illustrated, for extending such line to the terminals of a second line finder. This figure also shows detailed circuits of the second line finder switch and a first group selector switch. Fig. 2 illustrates the two separate switches of the cord finding mechanism which have access to a plurality of cord circuits, such as the one interconnecting the brushes of the second line finder and the first group selector shown in Fig. 1. Fig. 3 shows the registers of the sender controlling mechanism. Fig. 4 illustrates a second group selector switch to which connections are extended from the first group selector shown in Fig. 1. Fig. 5 illustrates, diagrammatically, a selector switch having access to the terminals of trunks which lead to an operator's position together with a portion of the cord circuit at such position.

Fig. 6 shows a modification of the answering plug of the operator's cord circuit.

The selective switches shown in Figs. 1 and 4 and the two cord finder switches 201 and 202, disclosed in Fig. 2, are of the rotary power driven type, the construction and operation of which are described in detail in the patent to McBerty, No. 1,097,868, issued May 26, 1914.

The sequence switches shown in the several figures of the drawing are similar in structure and operation to the one described in the patent to Reynolds and Baldwin, No. 1,127,808, issued February 9, 1915.

The sequence switch contacts to the left of the vertical broken line in Fig. 1 are part of timing sequence switch 100, and those to the right of this line are controlled by the sequence switch 130. All of the sequence switch contacts in Fig. 2 belong to the sequence switch 230. Likewise all of the sequence switch contacts in Fig. 4 are a part of the sequence switch 420. In Fig. 3 all contacts above the horizontal broken line are controlled by the sequence switch 350, while all contacts located within the broken rectangles at the bottom of the figure are controlled respectively by the registers 340, 330, 320, 310, and 300, correspondingly located.

The operation of the exchange system illustrated, from a description of which the invention will be best understood is as follows:

The extension of a calling line over a first line finder takes place in the manner described in the British patent to Western Electric Company, Limited, No. 143,277, accepted May 27, 1920. The common starting relay 16 having been energized, as therein set forth, a circuit is closed from ground over the front contact of relay 16, contact 103 of sequence switch 100, and contact 134 bottom of sequence switch 130, for the energization of relay 136 of the cord. The power magnet 125 of each second line finder controlled by the relay 136 is energized in a circuit over the front contact of relay 136 and sequence switch contacts 142 top and 139 bottom, and the brush carriages of the second line finders rotate. When the terminal 112 is reached by the test brush of one of the second line finders, its test relays 147 and 141 are energized in a circuit including sequence switch contact 148 top, terminal 112 is made busy, and sequence switch 130 moves from position 1 to position 4. Relay 136 is released as sequence switch contact 134 bottom opens in position 2 and relays 147 and 141 release as sequence switch contact 148 top opens in position 4.

In positions 2 to 4 of sequence switch 130 a circuit is established from ground, relay 150, sequence switch contact 144 bottom and marginal relay 143 to battery. Relay 150 operates, and in turn operates relays 160, 161 and 164. Marginal relay 143 does not operate under these conditions. Relay 160 at its front contacts connects a speech transmission circuit including retardation coil 166 and relay 162 to the calling line. The subscriber having his receiver off the hook, relay 162 is energized and prevents the energization of release relay 158. Before connection has been made to a register, the subscriber may hang up and release the connection by causing the deenergization of relay 162 and the consequent energization of release relay 158.

While sequence switch 130 is passing position 3 and is in position 4, the common starting circuit for the registers, Figs. 2 and 3, is closed from ground, right-hand back contact of relay 158, sequence switch contact 146 bottom, back contact of relay 143, relay 205 of each idle register circuit and contact 239 of register sequence switch 230. At the same time a test potential is placed on the terminals 218 of the finders 201. Each connection circuit is wired to a set of contacts on two associated finders, finder 201 and finder 202. A group of registers have, therefore, access to all connection or cord circuits which may be connected to their arc terminals. The energization of the starting relay 205 closes at its left-hand contact a circuit over sequence switch contact 262 bottom and back contact of relay 213 for the energization of power magnet 210 and the brush carriage of the finder 201 searches for the terminals of the cord circuit. When the cord circuit terminals are found a circuit is established from battery, relay 143, sequence switch contact 144 bottom, terminal 218, high resistance winding of relay 215 and sequence switch contact 264 of sequence switch 230 to ground. Test relay 215 operates and makes the cord circuit busy to all other finders similar to finder 201 by shunting its high resistance winding by its low resistance winding over its front contact to interrupter 212. When the brushes center themselves, the ground at the interrupter is removed and test relay 213 is operated. At its back contact relay 213 opens the circuit of power magnet 210 and at its front contact closes a circuit from ground, left-hand front contact of relay 205, sequence switch contact 262 for the energization of holding magnet 211 and in parallel therewith closes a circuit over sequence switch contact 236 bottom for register sequence switch 230 which advances to position 4. When sequence switch 230 is passing positions 2 and 3 and is in position 4, relay 253 is energized in a circuit from right-hand back contact of relay 247 and over sequence switch contact 251 left. Relay 253 connects the stepping relay 243 to the connection circuit by way of the brushes 216 and 217.

At the same time the register test relays 215 and 213 and relay 150 are short-circuited by a circuit from ground, sequence switch contact 246, left-hand armature and back contact of relay 247, brush 218, sequence switch contact 144 bottom and winding of relay 143 to battery. Relays 213, 215 and 150 release. Marginal relay 143 operates and opens the common cord finder starting circuit thereby causing the remaining finders to cease hunting. The deenergization of relay 150 releases relays 160, 161 and 164. Relay 160 at its back contacts connects the calling line with the register terminals 216 and 217, thus closing the circuit of the stepping relay 243. When the sequence switch 230 reaches position 4, relay 253 having been energized as explained, relay 243 is energized in a circuit from ground, one winding of relay 243, one winding of dialing tone coil 248, outer front contact of relay 253, brush 216, sequence switch contact 106 of sequence switch 100, upper back contact of relay 160, brush 152 of the second line finder and thence through the telephone circuit and dial contacts over the other side of the line to brush 153 of the second line finder, lower back contact of relay 160, brush 217, inner front contact of relay 253, other winding of dialing tone coil 248, other winding of relay 243 to battery.

As soon as the finder 201 moves, the corresponding finder 202 automatically follows. The circuit of power magnet 220 is closed from ground, right-hand front contact of relay 205, back contact of relay 225, the second winding of relay 205, power magnet 220 to battery. When the brushes of finder 202 come in contact with the terminals 226 to 229, corresponding to the terminals 216 to 219, selected by finder 201, a circuit is established from battery, over terminal 219, terminal 229 to ground at interrupter 222. When the brushes of finder 202 center themselves this ground is removed and the circuit continues to ground through relay 225 and the right-hand front contact of relay 205. Relay 225 operates and causes the energization of holding magnet 221 and the deenergization of power magnet 220 and of relay 205. Under normal conditions the finders 201 and 202 will always come to rest on corresponding terminals. Should, however, one of these finders be moved by hand or otherwise, while idle, it is possible that the finder 201 may select the cord circuit some time in advance of the finder 202, in which case, sequence switch 230 may be stepped out of position 2 and the common starting circuit for the register be opened at sequence switch contact 239. Relay 205, remains energized, however, by virtue of its second winding until the finder 202 reaches the proper terminals. Should the finder 201 be in contact with the terminals of the cord circuit at the moment the common starting circuit is closed, the terminals will be immediately seized and made busy by the energization of its test relays 215 and 213. This condition will often be met with.

When sequence switch 130 reaches position 4, the combined timed metering and monitoring sequence switch 100 is energized in a circuit from ground, back contact of relay 163, contact 149 bottom of sequence switch 130 and contact 108 top of sequence switch 100. Sequence switch 100 advances to position 6 and then to position 7 by means of a circuit from ground, contact 145 top of sequence switch 130 and contact 107 bottom of sequence switch 100.

Premature release.—If the calling subscriber fails to dial within a predetermined time, or in the case of a false call, i. e., a call due to a ground, crossed wires, or the like, sequence switch 130 of the cord circuit and sequence switch 230 of the register circuit will remain in position 4. In such circumstances timing sequence switch 100 passes through the following sequence of operation. Sequence switch 100 being in position 7, as above described, the constantly rotating interrupter 114 alternately closes and opens, for equal periods, a circuit from ground, interrupter 114, contact 135 bottom of sequence switch 130, timing sequence switch contact 104 and relay 136 to battery. When the interrupter 114 closes, relay 136 energizes and closes a circuit at contact 102 top for moving sequence switch 100 into position 8. When interrupter 114 opens this circuit, relay 136 is released and at its back contact closes a circuit over contact 102 bottom of sequence switch 100 for the energization of sequence switch 100 which advances to position 9. This cycle of operations continues until sequence switch 100 reaches position 12, from which position it advances to position 13 by means of a circuit from ground, contact 145 top of sequence switch 130 and contact 107 bottom of sequence switch 100. From this point sequence switch 100 continues under the control of interrupter 114 as above described until it has advanced into position 17.

The exact time required to step sequence switch 100 from position 7 to position 17 will, of course, depend upon the position of interrupter 114 at the moment when the circuit of relay 136 is closed at contact 135 bottom.

When sequence switch 100 reaches position 17, the circuit of stepping relay 243 is opened at contact 106 of sequence switch 100. Relay 243 deenergizes and causes the energization of relay 240 in positions 4, 6, 8, 11 and 13 of sequence switch 230. The energization of relay 240 causes the energization of relay 237. In each of these positions a circuit is established from ground, front

contact of relay 237, sequence switch contact 236 and sequence switch 230 to battery. By this circuit and the circuit over its local contact 231, sequence switch 230 is advanced from position 4 to position 15, in which position a circuit is closed from ground, contact 366 of sequence switch 350, and contact 236 of sequence switch 230 for the energization of sequence switch 230, which moves into position 1. As sequence switch 230 leaves position 15, relay 253 is released.

In positions 5 and 6 of sequence switch 230, a circuit is established from ground, right-hand back contact of relay 247, sequence switch contact 232 top and contact 353 top for the energization of sequence switch 350, which advances to position 3. In this position it is again energized in a circuit from ground, back contact of relay 373, sequence switch contact 374, contact 256 of sequence switch 230, one winding and back contact of relay 378, (also in parallel through the other winding of this relay) sequence switch contact 364, contact 342 top of register 340, and sequence switch contact 365, and advances to position 4. In this position sequence switch 350 is energized in a circuit including its contact 353 and contact 232 of sequence switch 230, in positions 7 to 13, and advances to position 5. In position 5 of sequence switch 350 a circuit is established from battery to the winding of said sequence switch, lower contact 365, contact 342 of register 340, lower contact 364, contact 334 of register 330, upper contact 362, contact and armature and right-hand winding of relay 378, contact 256, upper contact 374 to ground at the armature and contact of relay 373. Sequence switch 350 advances from position 5 into position 7. A circuit is then established from ground, contact 233 of sequence switch 230 and sequence switch contact 353 top of sequence switch 350; sequence switch 350 moves into position 9, in which its energizing circuit is closed as in position 3, except that instead of passing through sequence switch contact 364 top, etc., it passes through sequence switch contact 399, register contact 323 top, sequence switch contact 362, register contact 334, sequence switch contact 364 bottom, register contact 342, and sequence switch contact 365. Sequence switch 350 goes to position 10 in which its circuit is closed over its contact 353 and contact 233 of sequence switch 230, or over its contact 365 top and contact 233 of sequence switch 230. In position 11 of sequence switch 350 its energizing circuit is closed over sequence switch contact 354, register contact 318, sequence switch contact 356 and thence over the back contact and winding of relay 378, contact 256, upper contact 374 to ground at the armature of relay 373, or over contact 251 of sequence switch 230 and back contact of relay 247. In position 12, the circuit is over sequence switch contact 365 top and contact 233 of sequence switch 230; in position 14, over sequence switch contacts 354, register contact 304, back contact of relay 355, register contact 302, sequence switch contact 356 bottom, and back contact of relay 378, etc., or contact 233 of sequence switch 230; in position 16, the same as for position 9; in position 17, the same as for position 11; in position 18, the same as for position 11. Sequence switch 350 therefore returns to normal position.

As sequence switch 350 passes position 2, a circuit is momentarily closed from ground, sequence switch contact 375, brush and terminal 228, and contact 137 of sequence switch 130, sequence switch 130 to battery. Sequence switch 130 moves into position 5, in which position the circuit of relay 136 is opened at sequence switch contact 135 bottom. At the same time sequence switch 100 is advanced to position 18, the energizing circuit extending from ground over sequence switch contact 145 bottom and sequence switch contact 108 bottom. In position 18 of sequence switch 100 the circuit of the monitoring lamp 119 is closed from ground, sequence switch contact 145 bottom, timing sequence switch contact 109, holding key 115, lamp 119 to battery. Sequence switch 130 remains in position 5 and sequence switch 100 in position 18 until they are released by the subscriber or operator. When the register circuit is released, a short-circuit around relay 150 through brush and terminal 218 is removed and relay 150 becomes reenergized in a circuit from ground, winding of relay 150, resistance 157, sequence switch contact 144 top, winding of marginal relay 143 to battery; relays 160, 161 and 164 are therefore also reenergized.

Until the holding key 115 is thrown, the subscriber may release switches 100 and 130 at any time by hanging up his receiver, thereby closing a circuit from ground, front contact of relay 161, back contact of relay 162, sequence switch contact 159 top, release relay 158, holding key 115 to battery. Release relay 158 is energized and locks up over its left-hand front contact and sequence switch contact 155 bottom, and freeing the calling subscriber's line by opening at its left-hand back contact the circuit of the wire to terminal 154. At its right-hand front contact relay 158 closes an energizing circuit over sequence switch contact 132 top for sequence switch 130 which is returned to normal. Sequence switch 130 passes positions 8 and 16 since relay 141 is energized in these positions over the home contact of interrupter 156, sequence switch contact 138 and magnet 171 to battery; the circuit for sequence switch 130 is closed in these positions from ground, sequence switch contact

142 bottom, front contact of relay 141 and sequence switch contact 140 top.

The operator upon noting the burning of monitoring lamp 119 may throw holding key 115. This transfers the circuit of the monitoring lamp to the back contact of the calling supervisory relay 162 and opens the circuit of the release relay 158, so that should the line become free the lamp will again burn but the connection circuit will not be released. While the connection circuit is thus held, the operator may make connection through the key 118 and apply the usual test to the line and when desirable may apply a howler. In the case of a false call the operator will, after a predetermined period, turn the fault over to the wire chief for attention. It will be noted that if the circuit is not in its normal condition, either the monitoring lamp will burn or else the holding key 115 must be in an off normal and conspicuous position; either one of these conditions indicates a fault.

Local call.—The capacity of the exchange is assumed to be 100,000, the designation of each subscriber's line containing five digits, and five registers being employed; one for each digit of a designation. The subscriber's lines accessible over switches controlled by the registers at an exchange are divided into three zones. Subscribers in the first zone e. g., those which may be reached without going through another exchange are designated by numbers, the first or ten thousands digit of which is 1, 2, 3, 4, 7, 8 or 9, those in the second zone are designated by numbers whose first digit is 5; and those in the third zone by numbers whose first digit is 6.

With register sequence switch 230 in position 4, a circuit is established from ground, over back contact of relay 237, front contact of relay 243, to differentially wound relay 241 and thence in one direction through the high resistance winding of relay 241 and retardation coil to battery, and in the other direction through the low resistance winding and back contact of relay 241, sequence switch contact 238 bottom, ten thousands register 340 to battery. As register 340 advances from position 0 to position 1 the differential windings of relay 241 are unbalanced by the ground placed on the back contact of relay 241 at contact 341 of register 340. Relay 241 breaks its back contact and remains energized over its high resistance winding as long as relay 243 remains energized.

Let it be assumed that the first of the five digits of the designation of the wanted subscriber's line is 4, which corresponds to a train of four openings in the line circuit at the dial, the last opening, as in the case of each digit, being relatively long. Upon each short opening of the line circuit relay 243 releases and in turn, releases relay 241. When the line circuit again closes following each short opening, relay 243 is reenergized and register 340 advances one step. When the long opening is reached relay 243 remains deenergized long enough to cause the energization of relay 240, by a circuit from ground, back contacts of relays 237 and 243, relay 240, and sequence switch contact 239 to battery. Relay 240, which is slow to energize, operates and closes an energizing circuit for relay 237, which locks up over its front contact and closes an energizing circuit over sequence switch contact 236 top for sequence switch 230; the latter advances to position 6, releasing relays 240 and 237 by opening contacts 239 and 236. By the time position 6 is reached the line circuit is again closed and relay 243 reenergized. In positions 6, 8, 11 and 13 of sequence switch 230, thousands register 330, hundreds register 320, tens register 310 and units register 300 are, in like manner successively energized and advanced to positions determined by the corresponding digits of the designation of the wanted line. When the dialing is completed, sequence switch 230 is advanced to position 16, being first energized in a circuit from ground, front contact of relay 237 and sequence switch contact 236, and then in a circuit over local contact 231. When sequence switch 230 leaves position 15 by means of a circuit closed over contact 244 and back contacts of relays 243 and 237, the circuit of relay 253 is opened at sequence switch contact 251 and this relay releases.

To extend the call to the desired line, first, second and third group selectors and final selectors are provided. A first selector is shown at the right of Fig. 1 and a second group selector for extending calls to lines terminating in the same exchange is shown in Fig. 4; a second group selector as arranged for extending calls received in another exchange is shown in Fig. 3 of the drawings forming part of British Patent No. 143,277 above referred to, Figs. 6 and 7 of said drawings illustrating a third group selector and a final selector.

When sequence switch 230 has reached position 5 a circuit is closed from ground, right-hand back contact of relay 247, sequence switch contact 232, and contact 363 of sequence switch 350 for the energization of sequence switch 350 which advances from position 1 to position 3. In position 2 of switch 350, a circuit is closed from ground, sequence switch contact 375 top, terminal 228, contact 137 of sequence switch 130, for the energization of sequence switch 130, which moves from position 4 into position 5.

The timing sequence switch 100, having been advanced to position 7 as above described, is returned to position 1, the energizing circuit being first from ground, con-

tact 145 of sequence switch 130, contact 108 of sequence switch 100, and sequence switch 100 to battery; then in position 18 of the latter sequence switch, from ground, right-hand back contact of relay 150, contact 107 bottom of sequence switch 100, and sequence switch 100 to battery.

When sequence switch 350 reaches position 3, the fundamental circuit is established from ground, sequence switch contact 372 bottom, back contact of relay 370, relay 373, brush and terminal 227, contact 131 bottom of sequence switch 130 and relay 136 to battery. Relays 373 and 136 are operated; at its front contact relay 136 closes a circuit over contact 105 of sequence switch 100, and contact 140 bottom of sequence switch 130, for the energization of sequence switch 130 which advances to position 6. In this position a circuit is closed from ground, front contact of relay 136, sequence switch contact 132 and trip spindle magnet 190 to battery. As the trip spindle rotates, it short-circuits at the top contact of its interrupter, the winding of relay 373 once for each position reached. Each time relay 373 is short-circuited, a circuit is established from ground, back contact of relay 373, sequence switch contact 374 top, contact 256 of sequence switch 230, to differentially wound relay 378, and from there in one direction through one winding of relay 378, to battery, and in the other direction through the other winding and back contact of relay 378, sequence switch contact 364 top, contact 342 of ten thousands register 340; winding of register 340 to battery; register 340 is therefore moved forward one step toward normal position for each step taken by the trip spindle, relay 378 functioning in the same way as relay 241 of the stepping in circuit. When register 340 reaches its home or zero position and when relay 373 is short-circuited, the usual stepping circuit is established to the register, but instead of passing through the register winding it passes over register contact 342 top, contact 365 bottom of sequence switch 350, and to battery through relay 370 and sequence switch 350 in multiple. The fundamental circuit is opened at the back contact of relay 370 and sequence switch 350 goes to position 4. When the trip spindle completes the step through which it is passing, and ground at the top contact of its interrupter is removed, relay 136 releases since its alternate circuit is open at the back of relay 370. A circuit is established from ground, back of relay 136, and sequence switch contact 137 top, for the energization of sequence switch 130, which advances to position 7. The trip spindle comes to rest since its energizing circuit is opened at the front contact of relay 136.

In position 7 of sequence switch 130, the energizing circuit for the brush carriage power magnet 170 is established from ground, over sequence switch contact 142 bottom, back contact of relay 141 and sequence switch contact 139, and the brush carriage searches for an idle trunk line to a second group selector in the well-known manner. When an idle trunk is found a circuit is established from battery, (Fig. 4) contact 425 of sequence switch 420, terminal and brush 181, contact 148 of sequence switch 130, high resistance winding of test relay 147, sequence switch contact 146, and right-hand back contact of relay 158 to ground. Relay 147 operates and causes the energization of test relay 141, thus bringing the brush carriage to rest in the well-known manner, by deenergizing the power magnet 170 and energizing holding magnet 171; a circuit is also established from ground, sequence switch contact 142, front contact of relay 141 and sequence switch contact 140 top, for the energization of sequence switch 130 which advances to position 9.

Sequence switch 350 remains in position 4 until after the thousands digit has been registered and sequence switch 230 has been advanced to position 7. A circuit is then established from ground, right-hand back contact of relay 247, contact 232 of sequence switch 230 and contact 353 of sequence switch 350 for the energization of sequence switch 350 which advances to position 5. The fundamental circuit is established from ground, contact 427 of second group selector sequence switch 420, terminal and brush 182, upper back contact of relay 164, terminal and brush 226, sequence switch contact 372, back contact of relay 370, relay 373, terminal and brush 227, sequence switch contact 131 top, lower back contact of relay 164, terminal and brush 183, sequence switch contact 426 bottom and relay 429 to battery. Relays 373 and 429 are energized. A circuit is established from ground, front contact of relay 429 and sequence switch contact 422 top, for the energization of sequence switch 420, which advances to position 2. In this position, trip spindle power magnet 430 is energized in a circuit from ground over the front contact of relay 429 and sequence switch contact 434. The trip spindle 430 and thousands register 330 are advanced together step-by-step, in the well-known manner, until the register reaches its home position. Relay 370 is then energized, in a circuit over sequence switch contact 365 bottom, contact 342 top of register 340, sequence switch contact 364 bottom, contact 334 top of register 330, sequence switch contact 362 top, back contact of relay 378, contact 256 of sequence switch 230, sequence switch contact 374 top and back contact of relay 373 to ground; sequence switch 350 is energized in a circuit in parallel with relay 370 and advances to position

7. The fundamental circuit is opened at the back contact of relay 370, and relay 429 is released, establishing over its back contact a circuit for sequence switch 420 which advances to position 3. In this position the brush carriage power magnet 440 is energized and the second selector searches for an idle line to the third selector, in the usual manner. In a similar manner, as described more fully in the British Patent No. 143,277, above referred to, the hundreds register 320 is returned to normal in connection with the third group selector with sequence switch 350 in position 9, and the tens register 310 and the units register 300 are returned to normal in connection with the final selector, sequence switch 350 being in positions 11 and 14 respectively.

Since register 340 is not in its normal position when sequence switch 350 passes position 2, the circuit of relay 369 is open and this relay remains unenergized; therefore when sequence switch 350 passes position 5 after the operation of the thousands register 330, a circuit is established from ground, contact 363 top of sequence switch 350, left-hand back contact of relay 369, sequence switch contact 375, brush and terminal 228, contact 137 of sequence switch 130, and sequence switch 130 to battery. Sequence switch 130 goes to position 11, in which it remains. After the selection is complete, sequence switch 350 of the register is energized in a circuit from ground, (Fig. 2) right-hand back contact of relay 247, contact 251 of sequence switch 230, (which has advanced to position 16 as above described) contact 356 of sequence switch 350, contact 302 top of units register 300, back contact of relay 355, contact 304 of register 300, contact 354 of sequence switch 350; sequence switch 350 advances to position 16, and a circuit is established from ground, right-hand back contact of relay 247, sequence switch contact 251, sequence switch contact 399, contact 323 top of register 320, sequence switch contact 362 bottom, contact 334 top of register 330, sequence switch contact 364 bottom, contact 342 top of register 340, sequence switch contact 365 bottom and sequence switch 350 to battery; sequence switch 350 advances to position 17 in which a similar circuit is established over sequence switch contact 356, contact 318 top of register 310, and sequence switch contact 354 for the energization of sequence switch 350 which advances to position 18; in this position a similar circuit is established over the sequence switch contact 356, register contact 302 top, back contact of relay 355, register contact 304 and sequence switch contact 354. Sequence switch 350 moves into position 1, and a circuit is established from ground, contact 366 top of sequence switch 350, contact 236 top of sequence switch 230, and sequence switch 230 to ground. Sequence switch 230 moves into position 1.

When the sequence switch 230 leaves position 15, the short-circuit of relay 150 at sequence switch contact 246 is removed, and relay 150, and consequently relays 160, 161 and 164 are again energized.

When the called party answers, relay 163 is energized in a circuit completed over the called subscriber's line. A circuit is established from ground, front contact of relay 163, contact 151 bottom of sequence switch 130, timing sequence switch contact 107 top, timing sequence switch 100 to battery. Sequence switch 100 advances to position 6, and in passing through positions 2 to 5 inclusive, establishes a circuit from the metering booster battery 120, timing sequence switch contact 111 bottom, contact 155 top of sequence switch 130, left-hand back contact of relay 158, second line finder brush and terminal 154, corresponding first line finder brush, and cut off relay 57 and service meter 58 of the calling line, to the exchange battery. The service meter records one count. The timing sequence switch 100 remains in position 6.

If the calling subscriber hangs up, relay 162 releases and a circuit is established from ground, front contact of relay 161, back contact of relay 162, release relay 158, holding key 115 to battery. Relay 158 operates and establishes a circuit from ground over its right-hand front contact and sequence switch contact 132 top for the energization of sequence switch 130 which advances into position 15, from which point the release of the connection proceeds in the well-known manner.

Should, however, the called subscriber, but not the calling subscriber hang up, a circuit is established from ground, back contact of relay 163, sequence switch contact 149 top, timing sequence switch contact 110 bottom and timing sequence switch 100 to battery. Sequence switch 100 advances to position 7 and in this position comes under the control of interrupter 114 and is advanced to position 18, as in the case of a false call, described above.

Should the calling subscriber fail to hang up before the expiration of the timed period, as determined by interrupter 114 and sequence switch 100, a circuit is established from ground, back contact of relay 163, sequence switch contact 149 top, contact 110 top, winding of release relay 158, holding key 115 to battery. Relay 158 releases the connection and frees the calling and called lines. The calling line being closed is selected by another connection circuit and if it is not opened in the prescribed time appears as a false call, as described above.

Should the called subscriber during conversation only momentarily open the line

circuit relay 163 releases and starts timing sequence switch 100 on its way to position 18. This sequence switch however, does not pass position 12 since its energizing circuit, by way of its contact 110 bottom, is open in this position, relay 163 having been only momentarily released.

If the called subscriber's line is found busy or if the called subscriber does not answer, relay 163 is not energized, and when the calling subscriber abandons the call and restores his receiver to its hook, release relay 158 is energized and restores the connection without metering. This arrangement also permits operators, when tandem trunking, to answer with a condenser circuit or other non-direct current circuit to obtain the required information from the calling subscriber and to extend the connection to the wanted line so as to permit metering to commence only when the called party answers.

By omitting the connection between timing sequence switch springs 107 and 110, the circuit may be changed so as to prevent release when the called party hangs up his receiver, that is, so as to place the release of the connection entirely under the control of the calling subscriber.

Distant call.—The general method of extending a call to subscribers' lines terminating in a distant exchange is described in the British Patent No. 143,277, above referred to. As stated above, the first or ten thousands digit of such line, if it is in the second zone, is assumed to be 5. When any number commencing with this digit is dialed, the ten thousands register 340 is stepped to position 5, in the manner before set forth. As sequence switch 350 passes position 2 a circuit is established from ground, sequence switch contact 366, contact 345 of register 340, relay 367 to battery. Relay 367 locks up over its right-hand front contact, and sequence switch contact 363 to ground. As sequence switch 350 passes into position 5 when the trip spindle of the second group selector has been set, sequence switch 130 is advanced to position 11 as in the case of a call for the first zone. As sequence switch 350 passes position 8, a circuit is established from ground, left-hand front contact of relay 367, sequence switch contact 388 bottom, brush and terminal 228, contact 137 of sequence switch 130, for the energization of sequence switch 130, which advances to position 13, in which position it remains during the rest of the connection.

When the called subscriber answers, relay 163 is energized and timing sequence switch 100 advances to position 6, connecting the metering booster battery 120 to the calling subscriber's meter, all as in the case of a call in the first zone. In position 6, a circuit is established from ground, contact 145 top of sequence switch 130 and timing sequence switch contact 107 bottom for the energization of sequence switch 100, which advances to position 7. In this position the timing sequence switch 100 comes under the control of interrupter 113. This interrupter closes and opens for equal periods the circuit from ground for relay 136, and timing sequence switch 100 is advanced to position 12 as in the case of a call to the first zone. In position 12 a circuit is established from ground, contact 145 top of sequence switch 130, timing sequence switch contact 107 bottom, timing sequence switch 100 to battery; sequence switch 100 advances to position 13, and then to position 17 under control of the interupter 113. In position 18 the same circuit is closed as in position 12 and the timing sequence switch advances to position 1, and begins a new rotation. The timing sequence switch continues to rotate as long as both the calling and called subscribers' receivers are off their hooks, the calling subscriber's meter being operated once for each rotation of the timing switch.

When the calling subscriber hangs up, release relay 158 is energized and effects the release of the connection, as before described. Timing sequence switch 100 is returned to normal regardless of its position, its energizing circuit in positions 7 to 17 inclusive, and 1 extending from ground, contact 145 of sequence switch 130, timing sequence switch contact 108 bottom, and timing sequence switch 100 to battery, and in position 18 from ground, right-hand back contact of relay 150, timing sequence switch contact 107 bottom and timing sequence switch 100 to battery.

Should the called subscriber, but not the calling subscriber, hang up, the connection will remain undisturbed until timing sequence switch 100 reaches position 18, in which position a circuit is established from ground, back contact of supervisory relay 163, sequence switch contact 149 top, timing sequence switch contact 110 top and release relay 158 to battery. Relay 158 is operated. The calling line when freed originates another call and if, in the prescribed time, the calling circuit is not opened, by the calling subscriber hanging up, the false call will come to the attention of the operator, as previously described.

With the above arrangement the calling subscriber is not further charged after the conversation is broken by either party, and the calling party may not tie up a long important junction after the called party has hung up.

As timing sequence switch 100 passes position 16½, a circuit is established including the secondary winding of the transformer 180, through condenser 191 and timing sequence switch contact 117 to one side of

the line, and through a condenser 192 and timing sequence switch contact 116 to the other side of the line, and a tone or buzz is momentarily applied to the line, indicating to the calling subscriber that another charge is about to be recorded. It is obvious that the time interval may be increased by having the contacts 116 and 117 closed in an earlier position, as 15½.

As previously stated, the numbers of subscribers' lines in the third zone are assumed to have 6 for their first digit. When this digit is dialed at the beginning of a number, ten thousands register 340 is stepped into position 6 and when register sequence switch 350 passes position 2, a circuit is established from ground, sequence switch contact 366, register contact 345, and relays 367 and 376 in multiple to battery. Relays 367 and 376 are energized and lock up over their right-hand front contacts. By the energization of relay 367, sequence switch 130 is advanced to position 13 as in the case of a call in the second zone. As sequence switch 350 passes position 13, a circuit is established from ground, left-hand front contact of relay 376, sequence switch contact 388, brush and terminal 228, and sequence switch contact 137, for the energization of sequence switch 130 which advances to position 15 and remains in this position until the connection is released.

When the called subscriber answers, supervisory relay 163 is energized and the timing sequence switch 100 is placed under the control of interrupter 114, the circuit being from ground, interrupter 114, contact 135 bottom of sequence switch 130, timing sequence switch contact 104, and relay 136 to battery; at its front and back contacts relay 136 closes alternate circuits over timing sequence switch contact 102 top or bottom, for the energization of the timing sequence switch 100. The interrupter 113 is shown with two circuit making contacts while interrupter 114 is provided with four circuit making contacts. Assuming the speed of rotation of the interrupters to be the same, it is evident that the interrupter 114 closes and opens the energizing circuit of relay 136 approximately twice as many times as the interrupter 113 in a given period. Therefore, the total charge for a conversation of given length will be greater for calls in the third zone. The mode of release and so forth is the same as in the case of calls to the second zone.

There is thus provided an arrangement by which for a call in the first zone, one unit of charge is made for an unlimited period, while for a call in the second or third zones one unit of charge is made for each fixed limited period, this period being longer in the case of calls to the second zone.

Special call.—It is desirable that calls for special services, such as for the "information" operator, shall not be metered. In making such calls, the calling subscriber dials a number beginning with 0, for instance 01. Register 340 advances to position 0 and register 330 to position 1. Register sequence switch 230 advances to position 8 and register sequence switch 350 to position 7, in the manner referred to above. As sequence switch 350 passes position 2, a circuit is established from ground, contact 366 of sequence switch 350, register contact 344 and relay 369 to battery. Relay 369 locks up over its left-hand front contact in series with sequence switch contact 363. As sequence switch 350 passes position 2, circuit is also established from ground, contact 375 of sequence switch 350, brush and terminal 228 and sequence switch contact 137 for the energization of sequence switch 130, which advances from position 4 to position 5. The first group selector (Fig. 1) now selects the level corresponding to the digit 0, after which the second group switch (Fig. 4) under control of register 330 selects the level corresponding to the digit 1. Sequence switch 130 during this selection advances to position 9, as in the case of a call to the first zone. In Fig. 5 the brushes 482, 483, 412, of the second group selector are shown in operative relation to the terminals of a trunk leading to the operator's position. A suitable signal, 505 at the special operator's position, is operated to inform her of the call.

As sequence switch 350 passes position 6, a circuit is established from ground, back contact of relay 373, sequence switch contact 374 bottom, right-hand front contact of relay 369, winding of relay 247 to battery. Relay 247 is energized and locks up over its right-hand front contact and sequence switch contact 249 bottom. At the right-hand back contact of relay 247, an energizing circuit for relay 253 is opened; this relay releases and opens the energizing circuit of stepping relay 243, which also releases. The release of relay 243 energizes relay 240 in positions 4, 6, 8, 11 and 13 and in these positions relay 240 effects energization of relay 237, and sequence switch 230 advances to position 15, as previously described. In this position, a circuit is established from ground, back contacts of relays 237 and 243, sequence switch contact 244 and sequence switch 230 to battery. Sequence switch 230 advances to position 16 in which a circuit is established from ground, sequence switch contact 233 left, contact 353 top of sequence switch 350, and sequence switch 350 to battery. Sequence switch 350 advances to position 9, in which a circuit is established from ground, right-hand back contact of relay 247 (which has been released when its energizing circuit

was opened at sequence switch contact 249 bottom as sequence switch 230 left position 15), sequence switch contact 251, contact 399 of sequence switch 230, register contact 323 top, sequence switch contact 362 bottom, register contacts 334 bottom left, register 330 to battery. Register 330 is then returned to its normal position 0, after which the circuit from sequence switch contact 362 bottom continues by way of register contact 334 to sequence switch contact 364 bottom, and, as register 340 is held in position 0, by way of register contact 342 top, sequence switch contact 365 bottom and sequence switch 350 to battery. Sequence switch 350 advances to position 10, in which a circuit is established from ground, sequence switch contact 233, sequence switch contact 365 top and sequence switch 350 to battery. Sequence switch 350 advances to position 11, from which it is driven by a circuit from ground, back contact of relay 373, sequence switch contact 374 top, sequence switch contact 256, winding and back contact of relay 378, sequence switch contact 356, register contact 318 top, sequence switch contact 354, sequence switch 350 to battery. Sequence switch 350 is driven through position 12 by a circuit from ground, sequence switch contact 233, right, sequence switch contact 365 and sequence switch 350 to battery. Sequence switch 350 is then returned to position 1 as described in connection with its release after the extension of a call to a subscriber's line in the zero zone.

The energization of relay 247, as above described, removes at its left-hand contact, the short circuit from relay 150, which latter relay, however, is energized in series with resistance 157, sequence switch contact 144, marginal relay 143 to battery. The introduction of the resistance 157 into the circuit of the test potential placed on the register terminals 218, prevents another selection of this connection circuit by another register should one happen to make contact with the finder arc terminals. By the energization of relay 150, a circuit is closed over its left-hand front contact and the right-hand back contact of release relay 158, for the energization of relays 160, 161 and 164; the energization of these three relays extends the talking circuit from the second line finder brushes 152 and 153 to the first group switch brushes 182 and 183, and also frees the talking circuit from connection with the register finder terminals.

Should the special operator's answering circuit include a closed circuit for direct current such as is shown in Fig. 5, relay 163 will be energized when the operator answers by inserting her plug 501 in jack 502, thus short-circuiting the winding of the release relay 158 over the front contact of relay 163 and sequence switch contact 151 top. The calling subscriber may signal the operator and in so doing deenergizes supervisory relay 162 without fear of releasing the connection. The opening of a called line transmission circuit at the front contact of relay 162, causes the deenergization of relay 503 in the operator's circuit, and the circuit of lamp 504 is established over the sleeve contacts of jack 502 and plug 501, back contact of relay 503, lamp 504 to battery, and lamp 504 is illuminated. In this way the calling subscriber is placed under the full control of the answering operator.

Should the answering subscriber's circuit include condensers such as shown in Fig. 6, supervisory relay 163 will not be energized and the calling subscriber may release at any time before, during or after the operator's answer. The act of hanging up by the calling subscriber, releases supervisory relay 162 and thereby establishes a circuit from ground, front contact of relay 161, back contact of relay 162, sequence switch contact 159 top, release relay 158, holding key 115 to battery. Sequence switch 130 is energized in a circuit from ground, right-hand front contact of relay 158 and sequence switch contact 132 top, and advances to position 16. In this position the brush carriage is restored, circuit from ground, back contact of relay 141, sequence switch contact 139 bottom, brush carriage 170 to battery. Relay 141 is energized when the home contact at interrupter 156 is closed. Sequence switch 130 is energized in a circuit from ground, sequence switch contact 142, front contact of relay 141, sequence switch contact 140 and sequence switch 130 to battery and returns to position 1. The trip spindle is also returned to normal, circuit from ground, trip spindle interrupter, sequence switch contact 132, power magnet 190 to battery.

It is to be noted that on connections of this character the metering sequence switch is not brought into service.

It is important that when two finders 201 simultaneously make connection with the cord circuit, the sender should not be disturbed; that is, some other finder should be able to select the cord circuit immediately afterward. In such case, relays 215 and 213 of both finders are energized in position 1 of the associated sequence switches 230, as described above. As each sequence switch 230 passes position 2, the high resistance of relay 215 is opened at sequence switch contact 264, whereupon relays 213 and 215 release, since the current flowing through the test relay at both finders is not sufficient to maintain their energization. In position 2 of sequence switch 230 a circuit is established from ground, sequence switch contact 262, back contact of relay 213, sequence switch contact 249, winding of relay

247 to battery. Relay 247 locks up over its front contact in a circuit from ground, front contact of relay 247, sequence switch contact 249, winding of relay 247 to battery. This relay is sluggish in releasing so that it does not fall away during the momentary opening of its circuit as sequence switch contact 249 passes from position 2 to position 3. The energization of relay 247 prevents the energization of relay 253 and consequently also prevents the energization of stepping relay 243. Relay 247 also removes the short-circuit to ground over brush and terminal 218, thereby preventing the deenergization of relay 150 of the cord circuit. Relay 240 is energized over the back contact of relay 243 in positions 4, 6, 8, 11 and 13 of sequence switch 230, and therefore in these positions sequence switch 230 is energized over the front contact of relay 237 and advances to position 15. In position 15 a circuit is established from ground, contact 266 of sequence switch 350 in position 1, contact 236 of sequence switch 230, sequence switch 230 to battery. Sequence switch 230 returns to position 1. Sequence switch 350 is not disturbed.

What is claimed is:

1. In a telephone system, a cord circuit, selective switches for extending said cord circuit to establish talking connections, a register sender for controlling the selective movement of said switches, a finder mechanism consisting of a plurality of separately movable finder switches, and means for operating all of said finder switches simultaneously to associate the register sender with said cord circuit.

2. In a telephone system, a cord circuit, selective switches for extending said cord circuit to establish talking connections, a register sender for controlling the selective movement of said switches, a finder mechanism individual to the register sender and consisting of a plurality of separately movable finder switches, and means for operating said finder switches simultaneously to associate the register sender with said cord circuit.

3. In a telephone system, a plurality of cord circuits, selective switches for extending said cord circuits to establish telephone connections, a register sender for controlling the selective movement of said switches, a finder mechanism consisting of a plurality of separately movable finder switches, and means for operating said finder switches simultaneously to find a particular one of said cord circuits and to associate said register sender therewith.

4. In a telephone system, a plurality of cord circuits, selective switches for extending said cord circuits to establish talking connections, a register sender for controlling the selective movement of said switches, a finder mechanism consisting of two separately operable finder switches, and means for starting said finder switches in operation simultaneously, the first finder operating to find a particular one of said cords and to connect said register sender with such cord, the second finder operating to find the same cord circuit and to connect said sender therewith.

5. In a telephone system, a plurality of cord circuits, selective switches for extending said cord circuits to establish talking connections, a register sender for controlling the selective movement of said switches, a finder mechanism consisting of two separate finder switches, means for starting said finders in operation simultaneously, both of said finder switches operating to find the same particular cord circuit and to associate the register sender therewith, and means dependent upon one of said finders having found the cord circuit for enabling the other of said finders to subsequently find the same cord circuit.

6. In a telephone system, a plurality of cord circuits, selective switches for extending said cord circuits to establish talking connections, a register sender for controlling the selective movement of said switches, a finder mechanism consisting of a plurality of separately movable finder switches, each of said finder switches having sets of terminals representing said cord circuits, means for starting said finder switches in operation simultaneously, and means for stopping each finder switch when it reaches the terminals identifying a particular one of said cord circuits, said finders serving jointly to associate the register sender with such cord circuit.

7. In a telephone system, a plurality of cord circuits, selective switches for extending said cord circuits to establish talking connections, a plurality of register senders for controlling the selective movement of said switches, a plurality of finder mechanisms one for each of said senders and each mechanism consisting of a plurality of separately movable finder switches, means for starting in operation the finder switches of each finder mechanism to search for a particular one of said cord circuits, and means operated when the finder switches of any one of said mechanisms finds the desired cord circuit for discontinuing the operation of the finder switches of the remaining mechanisms and for associating the corresponding register sender with said cord circuit.

8. In a telephone system, a calling line and a called line, a plurality of cord circuits, means for extending the calling line to one of said cord circuits, selective switches for extending said cord circuit to the called line, a register sender for recording the des-

ignation of the called line and for controlling the operation of said selective switches in accordance therewith, and a finding mechanism consisting of two separately movable finder switches, the first finder switch serving to connect the register sender to said cord circuit to receive the record of the called line, the second finder switch being operable simultaneously for connecting the register sender to the cord circuit to enable the register sender to selectively control said selective switches.

9. In a telephone system, a calling line and a called line, a plurality of cord circuits, means for extending the calling line to one of said cord circuits, selective switches for extending said cord circuit to the called line, a register sender, a finder switch operable to find said cord circuit to complete an impulse circuit from such cord circuit to the register sender, means operated over the impulse circuit for setting the registers of said sender, a second finder switch operable to associate the register sender with the same cord circuit to complete a control circuit from the sender to said cord circuit, and means operated over the control circuit for controlling the selective switches in accordance with the setting of the register sender.

In witness whereof I hereunto subscribe my name this 24th day of May, A. D. 1921.

GERALD DEAKIN.