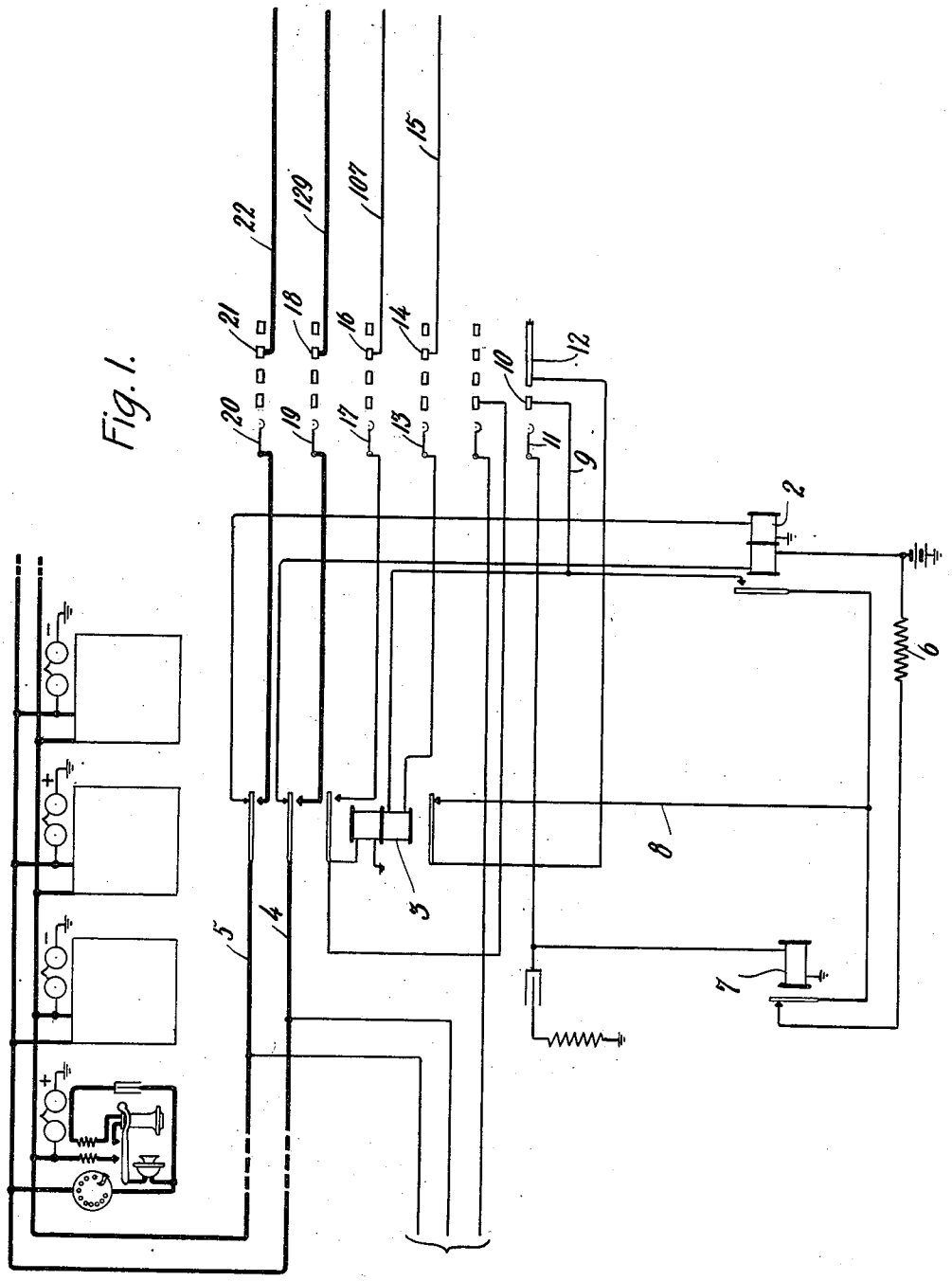
Apr. 3, 1923. 1,450,321

A. E. LUNDELL ET AL

PARTY LINE REVERTIVE RINGING SYSTEM

Filed June 4, 1920 7 sheets-sheet 1

Fig. 1.



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Filed June 4, 1920 7 sheets-sheet 2

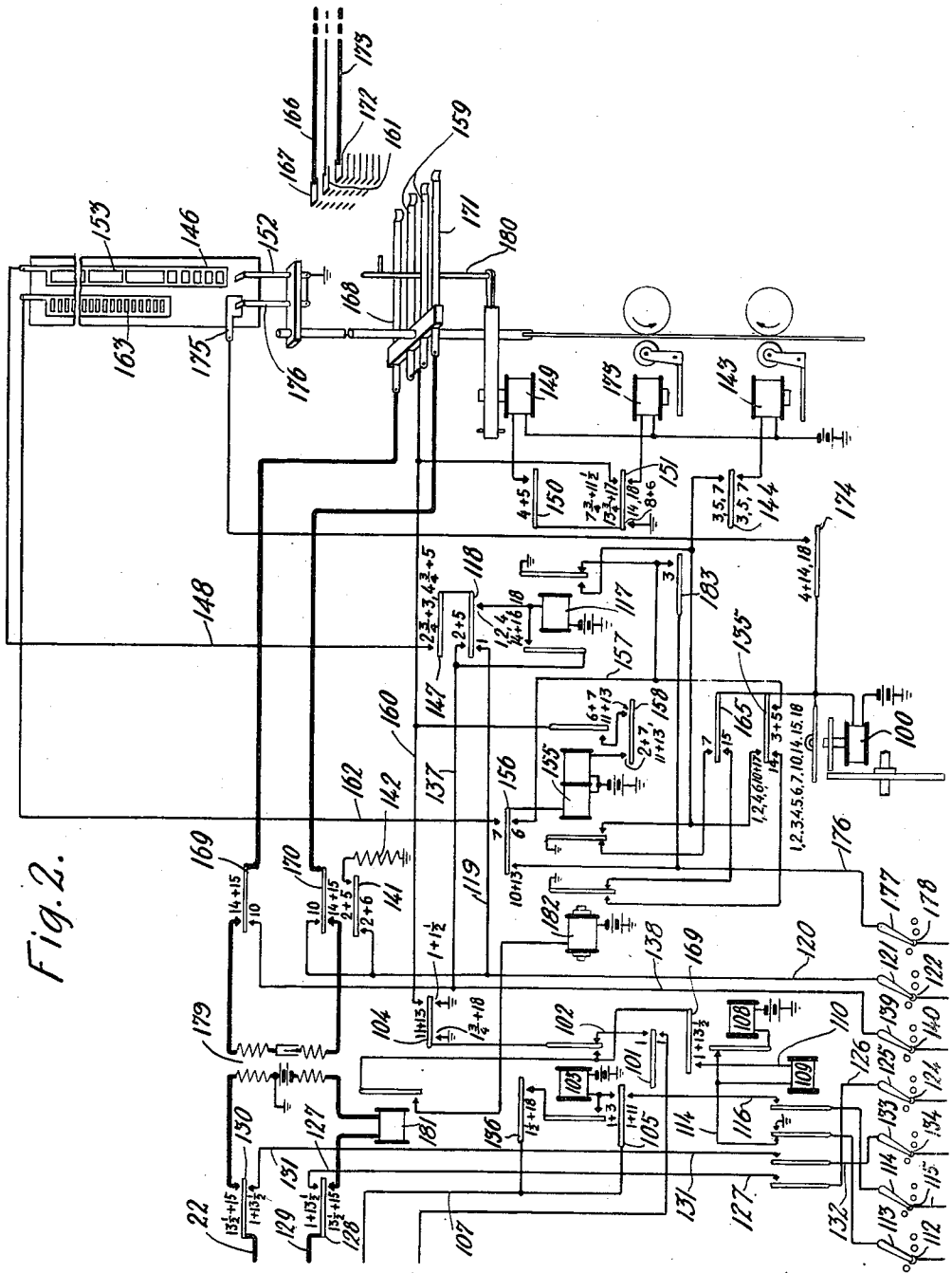

Fig. 2.

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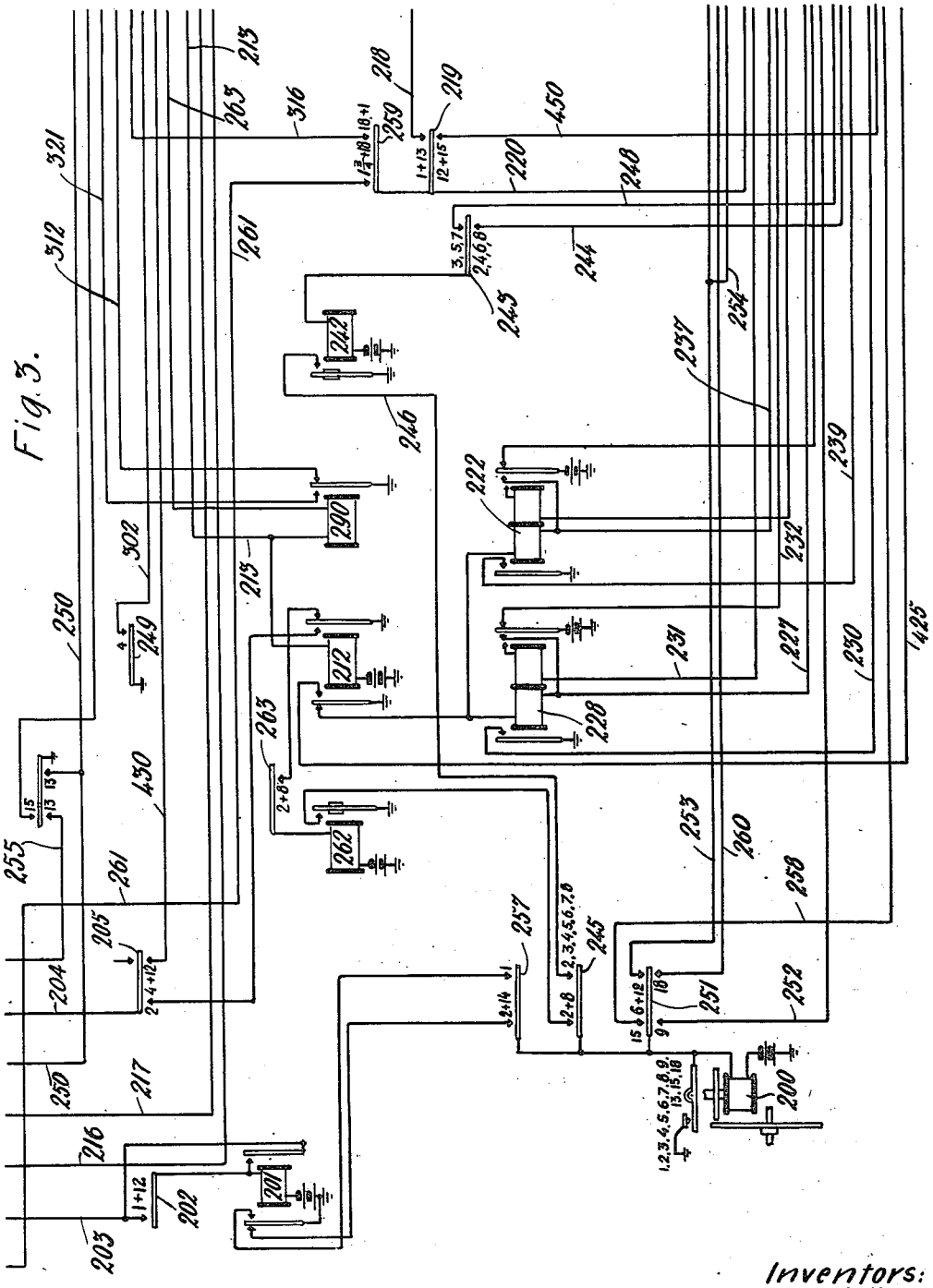
Fig. 3.



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Filed June 4, 1920 7 sheets-sheet 4

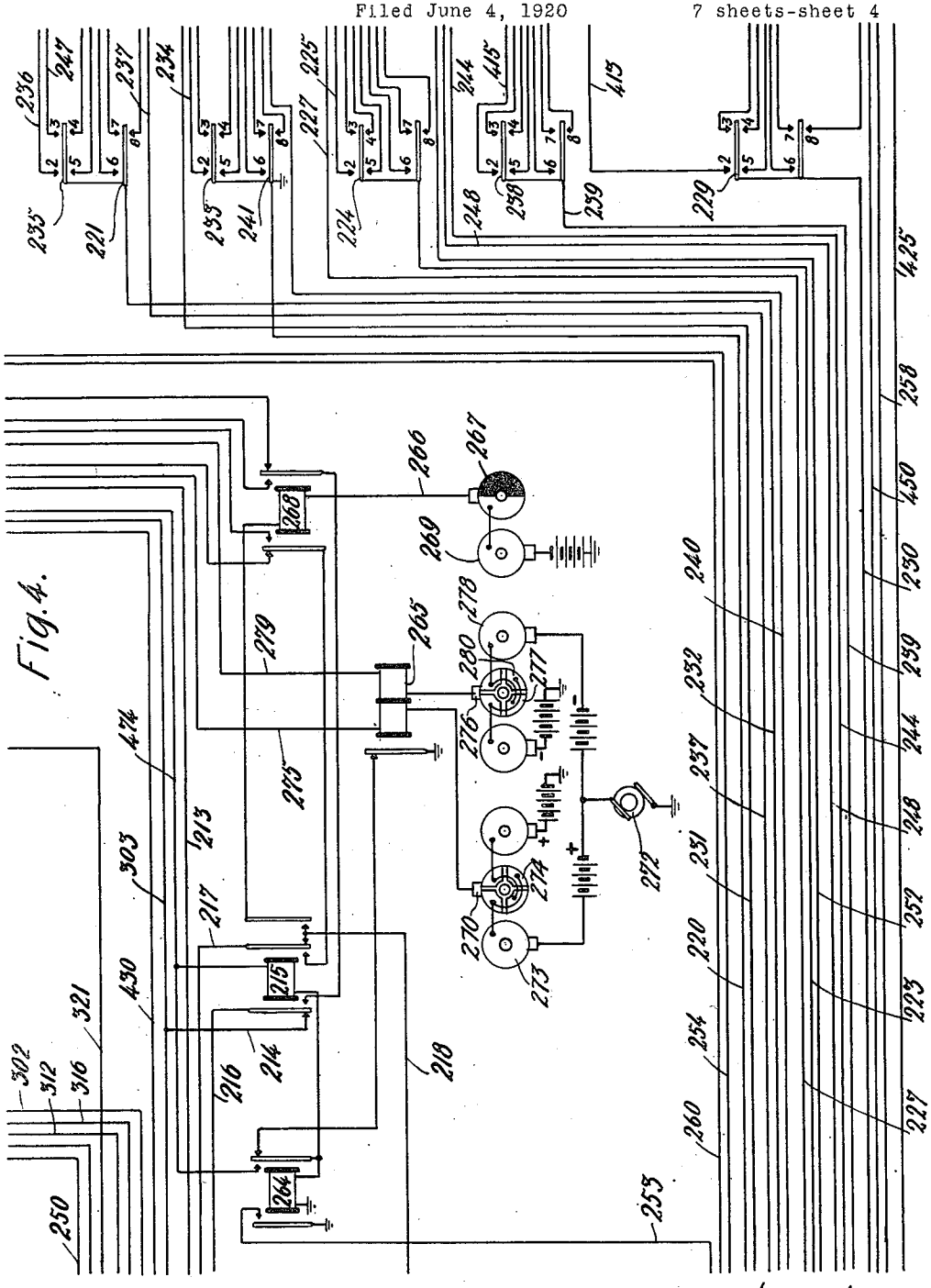

Fig. 4.

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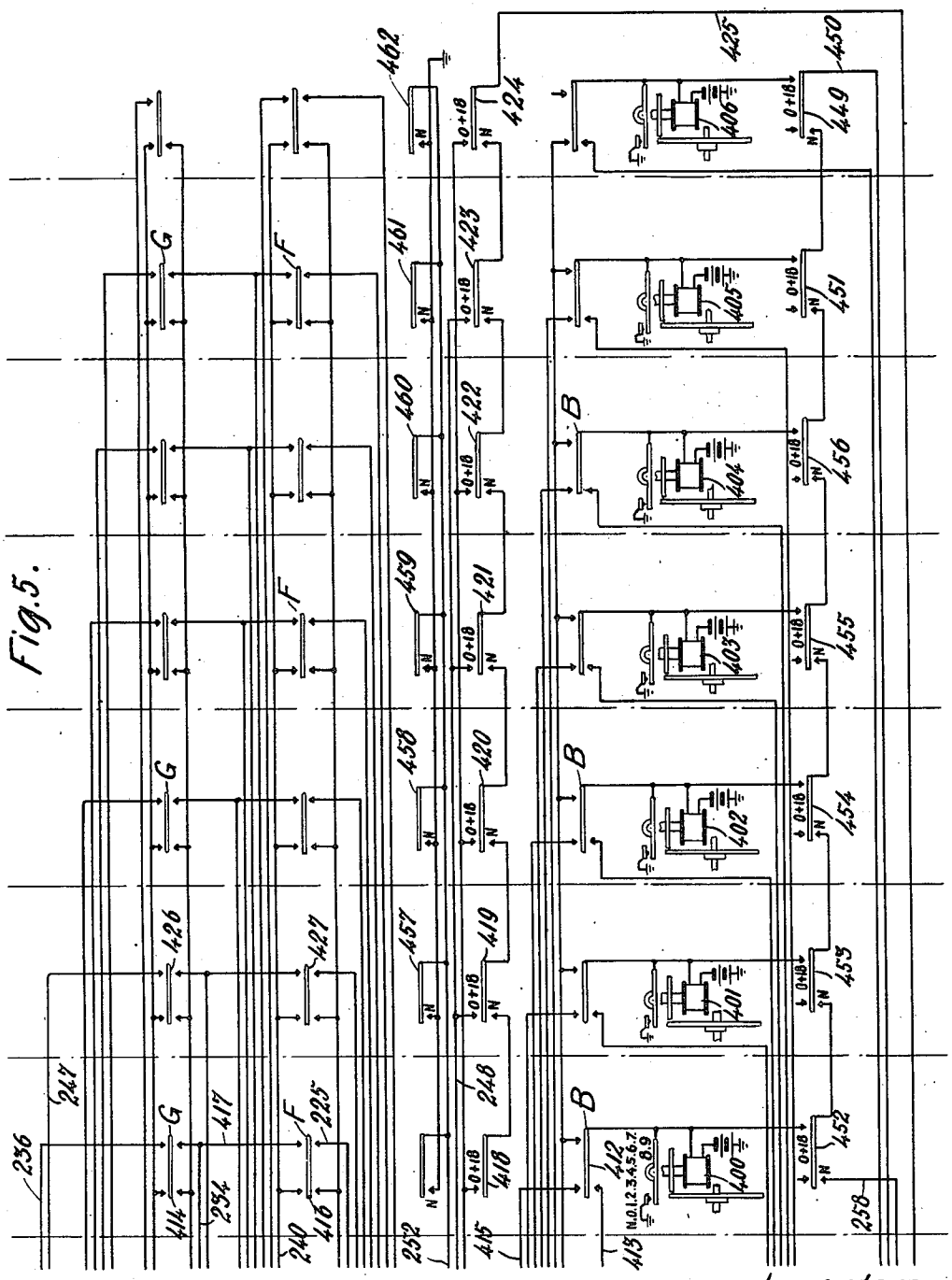

Fig. 5.

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PARTY LINE REVERTIVE RINGING SYSTEM

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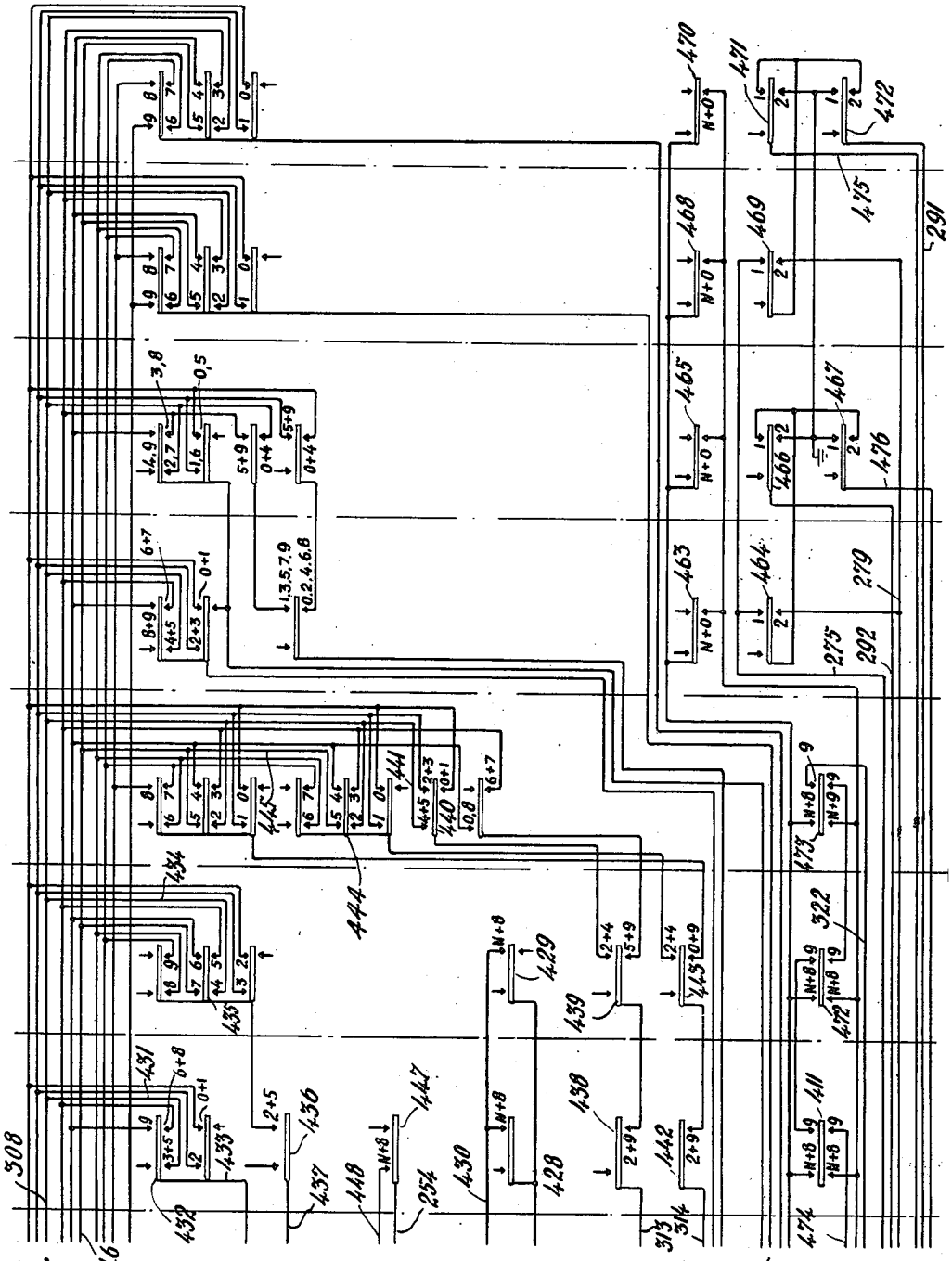

Fig. 6.

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PARTY LINE REVERTIVE RINGING SYSTEM

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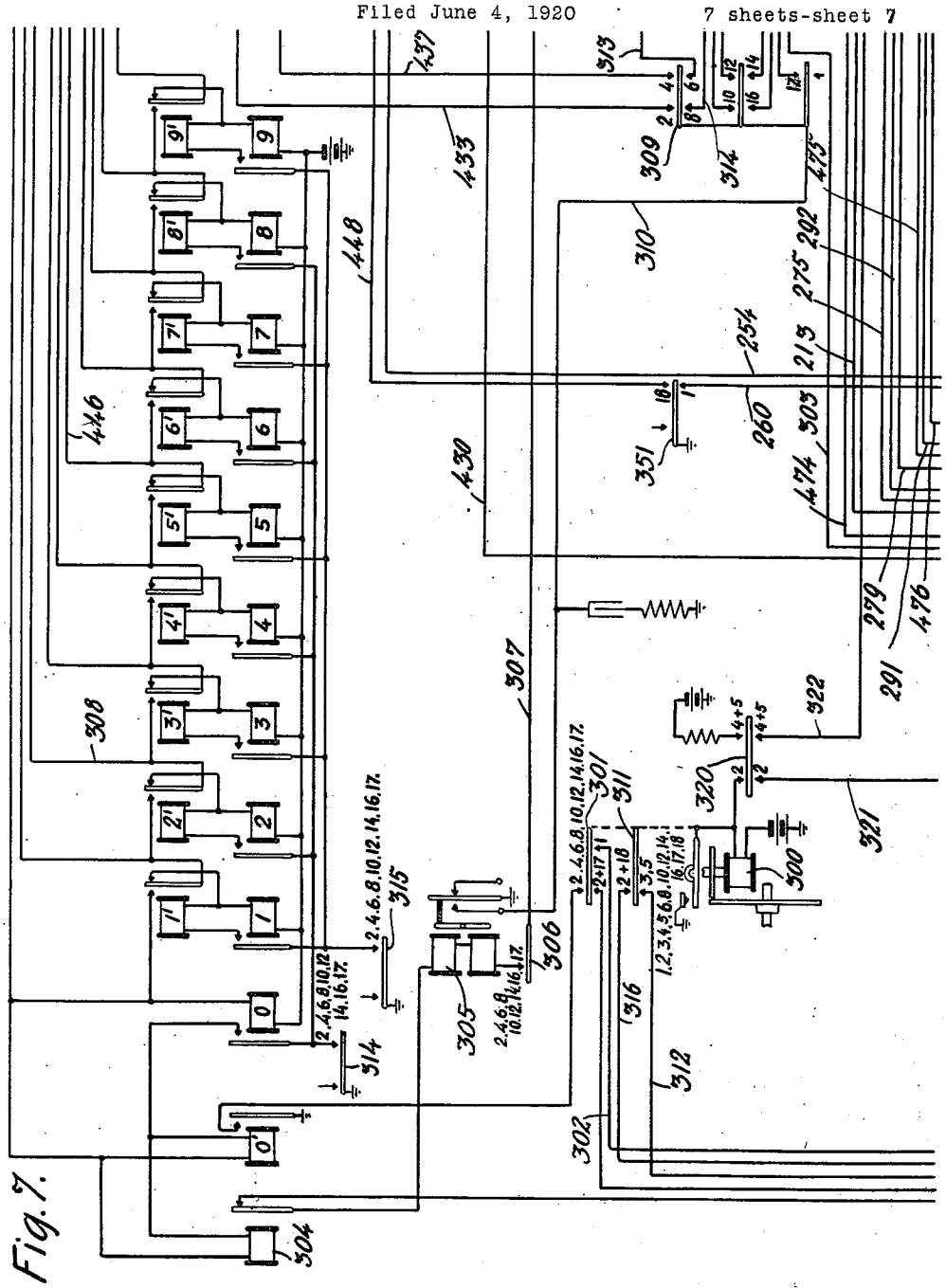

Fig. 7.

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Patented Apr. 3, 1923. 1,450,321

UNITED STATES PATENT OFFICE.

ALBEN E. LUNDELL, OF CHICAGO, ILLINOIS, AND GEORGE THOMPSON, OF MOUNT VERNON, NEW YORK, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PARTY-LINE REVERTIVE RINGING SYSTEM.

Application filed June 4, 1920. Serial No. 386,517.

To all whom it may concern:

Be it known that we, ALBEN E. LUNDELL and GEORGE THOMPSON, citizens of the United States, residing at Chicago, in the county of Cook, State of Illinois, and at Mount Vernon, in the county of Westchester, State of New York, respectively, have invented certain new and useful Improvements in Party-Line Revertive Ringing Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to automatic telephone exchange systems and more particularly to full mechanical systems of large capacity.

It is the object of this invention to provide an improved revertive ringing system.

A feature of the invention is an arrangement whereby a calling subscriber may, under the control of his impulse sending device, establish conditions such that he may signal a subscriber on his own party line without the necessity of obtaining the assistance of an operator.

A further feature of the invention is the provision of an organization such that no selective switches need be positioned in order to accomplish the desired ringing operations, it being merely necessary for the calling subscriber to establish connection to a register sender.

In order to accomplish revertive ringing on a party line it has usually been necessary to provide special apparatus at the calling substations so that extra manipulations by the calling subscriber are required, or else it has been necessary for him to set numerical switches to establish a connection to an operator who then instructs him to replace his receiver, whereupon the desired ringing current is supplied under the control of such operator. An additional scheme which is sometimes used is one wherein certain of the numerical selector switches are provided with a special group of contacts to which ringing generators of varying characteristics are connected, and if these numerical switches are then directively positioned, the proper ringing current is then supplied to the party line.

The present system provides many advantages over any of the above arrangements. The operation of the system in general is as follows. Since the invention has been devised to operate in conjunction with installations of large capacity it will be necessary for each subscriber before dialing the number of a wanted subscriber to dial the designation of the office in which such wanted subscriber's line appears. All the subscribers' line regardless of whether they are party lines or not will appear in the directory under their proper office names and numbers. However, when a revertive call is to be made, the office designation to be dialed is always the same, regardless of what office the party line appears in, and each subscriber on each party line is provided with a list of the names of the subscribers whose stations appear on his line. The numbers and office designations which are given to him individually will, of course, be different from the numbers and office designations which appear in the regular directory.

The subscriber upon initiating a call will seize an idle trunk leading to a numerical switch which normally controls the selection of a desired office. A register sender is then automatically associated with his line and he will dial in the usual manner and position a set of registering devices. If he first dials the code which has been taken for use in connection with revertive calls, the registers which normally control the selection of the desired office will be positioned in such a way that no selections take place but instead ringing apparatus will be connected to the calling line. As soon as the calling subscriber replaces his receiver, which he will be instructed to do when initiating a call which is to be revertive on his own line, this ringing apparatus is put into operation and will alternately signal the substation of the called subscriber and the substation of the subscriber who initiated the call. The selection of the proper kinds of ringing current will be controlled by the numerical registers which would normally operate to control the numerical switches to select the desired line in the selected office.

A complete understanding of the invention may be had from the following detailed description, reference being had to the accompanying drawings.

In the drawings, Fig. 1 shows a calling subscriber's substation and the circuits of a step-by-step trunk selecting switch. Fig. 2

shows the circuits of a district selector switch and a sender selector switch. Fig. 3 shows register controlling equipment and an associated sequence switch. Fig. 4 shows the ringing apparatus. The sequence switch contacts shown at the right of Fig. 4 are controlled by the sequence switch of Fig. 3. Figs. 5 and 6 show the registering devices and the various contacts controlled by them, the contacts controlled by each register appearing vertically above such register in Figs. 5 and 6. Fig. 7 shows the counting relay sending device with its associated stepping relay and controlling sequence switch.

The operation of the system when a non-revertive call is put through will first be described.

The subscriber at substation 1 desiring to initiate a call will remove his receiver from the switch-hook, whereupon a circuit is completed from grounded battery, left-hand winding of line relay 2, upper middle armature and back contact of cut-off relay 3, conductor 4, through the apparatus at the substation, conductor 5, the outermost upper armature and back contact of cut-off relay 3, right-hand winding of line relay 2 to ground. Relay 2 is energized in this circuit and completes a circuit from grounded battery, resistance 6, armature and back contact of stepping magnet 7, armature and front contact of line relay 2, conductor 9, normal contact 10 and its associated brush 11, and the winding of stepping magnet 7 to ground. Magnet 7 is energized in this circuit and advances the line switch wipers one step. As soon as the line switch wipers engage the second set of terminals in the arc served by them, a self interrupting circuit is completed for stepping magnet 7, this circuit extending from grounded battery, resistance 6, armature and back contact of magnet 7, conductor 8, lower armature and back contact of cut-off relay 3, off-normal conducting segment 12, brush 11 and the winding of magnet 7 to ground. Under the influence of this circuit magnet 7 continues to interrupt its own circuit and advances the line switch wipers until an idle trunk is found whereupon the circuit just traced will be broken due to the energization of cut-off relay 3. The test terminals associated with busy trunks leading to district selector switches will be characterized by the absence of potential while the test terminals associated with idle trunks will be characterized by ground potential thereon. As soon, therefore, as test brush 13 engages the terminal of an idle trunk, a circuit is completed from grounded battery, resistance 6, armature and back contact of magnet 7 (which deenergized to cause the advance of the switch), armature and front contact of relay 2, lower winding of relay 3, test brush 13, contact 14, conductor 15, left-hand contacts of sequence switch spring 101, conductor 102, righthand armature and back contact of relay 103, lower right-hand contact of sequence switch spring 104 to ground. Cut-off relay 3 is energized in this circuit and permanently interrupts the circuit of stepping magnet 7. Cut-off relay 3 upon energization also opens the circuit of relay 2 and this relay deenergizes. Relay 3 upon energization also completes a locking circuit for itself extending from grounded battery, winding of relay 103 (Fig. 2), upper right-hand contacts of sequence switch spring 105, conductor 107, terminal 16 and its associated brush 17, innermost upper armature and front contact of relay 3, upper winding of relay 3 to ground.

Relay 103 is energized in the above-traced circuit and by its right-hand armature removes ground from the test terminal of the trunk selected in order to render this trunk non-selectable to other hunting line switches.

Relay 103 upon energization also completes a circuit extending from grounded battery, winding of stepping magnet 108 of the sender selecting switch, armature and back contact of magnet 108, winding of relay 109, conductor 110, sequence switch spring 169, right-hand armature and front contact of relay 103, lower right-hand contact of sequence switch spring 104 to ground. Relay 109 is energized in this circuit and connects through the various controlling leads to the sender. The resistance of relay 109 is sufficiently high to prevent the operation of stepping magnet 108.

The sender selector switch is a step-by-step rotary switch which is advanced under the control of stepping magnet 108. Magnet 108 maintains this switch with its wipers upon the terminals of an idle sender at all times that the district is not in use. The seizure of the sender is accomplished as soon as relay 109 is energized and any sender selecting switches which are resting on the terminals associated with the sender, which has just been seized are caused to be advanced by means of a circuit extending from grounded battery, windings of magnets corresponding to magnet 108, armatures and back contacts of magnets 108, conductors 114, outer left-hand armatures and back contacts of relays 109, brushes 113 to the grounded terminal 112. The magnets 108 of sender selectors associated with other districts will then be energized and interrupt their own circuits to cause the advance of the sender selector brushes into engagement with the terminals individual to another sender, and will continue in motion until an idle sender has been found at which time they will remain in engagement with the terminals of such sender until it is seized by some district.

Referring to the operation of the circuits

shown, the energization of relay 109 completes a circuit from grounded battery, winding of relay 201 (Fig. 3), upper left-hand contact of sequence switch spring 202, conductor 203, terminal 115 and brush 114 associated therewith, the inner left-hand armature and front contact of relay 109, conductor 116, lower right-hand contact of sequence switch spring 105, conductor 107, terminal 16, brush 17, inner upper armature and front contact of relay 3, upper winding of relay 3 to ground.

Relay 201 is energized in this circuit and completes a circuit from grounded battery, winding of the power magnet of sequence switch 200, upper right-hand contact of sequence switch spring 257, left-hand armature and front contact of relay 201, to ground, for moving this sequence switch out of position 1 and into position 2.

As soon as relay 109 operates, the subscriber's impulse leads are connected through to the line relay by way of the left-hand armatures of relay 109. The line circuit to the substation sender extends from grounded battery, winding of line relay 212, conductor 213, and thence through the left-hand contacts of A register spring 411, which is closed due to the fact that this register is in its normal position, conductors 303 and 214, left-hand armature and back contact of relay 215, conductor 216, terminal 134, brush 133, conductor 132, outer intermediate left-hand armature and front contact of relay 109, conductor 131, lower contact of sequence switch spring 130, conductor 22, terminal 21, brush 20, and thence over the loop of the calling subscriber's line, returning to brush 19, terminal 18, conductor 129, upper contact of sequence switch spring 128, conductor 127, outer left-hand armature and front contact of relay 109, conductor 126, brush 125, terminal 124, conductor 217, inner right-hand armature and back contact of relay 215, conductor 218, upper right-hand contact of sequence switch spring 219, conductor 220, to ground at sequence switch spring 241. Line relay 212 is energized in this circuit.

With sequence switch 200 in position 2 and with relay 109 energized, circuits are completed for advancing sequence switch 100 out of position 1 and into position 2. This is accomplished by energizing relay 117 over a circuit extending from grounded battery, winding of relay 117, lower contacts of sequence switch spring 118, conductors 119 and 120, brush 121, terminal 122, conductor 204, lower left-hand contact of sequence switch spring 205, righ-hand armature and front contact of relay 212 to ground. Relay 117 is energized in this circuit and completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 135, right-hand armature and front contact of relay 117 to ground, for moving this sequence switch out of position 1 and into position 2.

In position 2 of sequence switch 100, relay 103 completes a locking circuit for itself exclusive of the contact of sequence switch spring 105. This circuit extends by way of the left-hand armature and front contact of relay 103, the lower contact of sequence switch spring 136, to grounded conductor 107.

As soon as sequence switch 200 reaches position 2, the subscriber is free to dial the characteristic designation of the wanted line in order to set the registers shown in Fig. 5. It is obvious that the time elapsed before the subscriber is free to dial, is very small, since all that is required is that relay 109 operates to cause the operation of relay 201, which moves sequence switch 200 out of position 1 and into position 2.

The selector switches used in establishing the connection are of the type whose structure and mode of operation is similar to that of the switches shown in Patent No. 1,168,319 issued January 18, 1916, to A. E. Lundell. These switches are each of five-hundred-line capacity. In the present arrangement, registers are provided which will be set in accordance with impulses transmitted on a decimal basis in accordance with the digits of the number of the called subscriber. The registers will then translate these impulses to control the selective operations of the switches on a non-decimal basis. As shown in the present disclosure, provision is made to have a call extended through four switches, each of five-hundred lines capacity. In accordance with the well-known grouping arrangement, by means of the latter two switches of the train 10,000 lines may be served. Therefore, the first two switches of the train will be utilized to select an office of 10,000 line capacity. The first switch of the train will select a district and the second switch of the train will then be operated to select a particular office. By varying the number of trunk lines in a group at the district and office selector switches, an exchange capacity ranging from 4,000,000 to 25,000,000 lines may be obtained. For instance, if each brush of the district selector has access to four groups of twenty-five trunks each, any one of twenty districts may be selected by the district selector with twenty-five lines running to each district. If the grouping arrangement at the office selector is the same, any one of twenty offices may be selected by the office selector. Therefore, connection may be extended by means of a district selector and an office selector to any one of four hundred offices, each one of 10,000 line capacity. This would provide a system of 4,000,000 lines. If each of the

brushes at the district selector has access to ten groups of trunks of ten lines each, a call may be extended to any one of fifty districts, and if the office selector grouping arrangement is the same, the call may then be further extended to any one of fifty offices by means of an office selector, so that a call may be extended by means of a district selector and an office selector to any one of twenty-five hundred offices, each of 10,000 line capacity. As a result, this grouping arrangement would provide an exchange system of 25,000,000 line capacity. The trunk layout would be dependent upon traffic conditions and since the particular number of trunks per group is immaterial in the present arrangement, no specific grouping will be described for the district and office switches. At the incoming switch, which is the third switch in the train, each of the five brushes of the selector has access to four groups of twenty-five trunk lines each, each of these trunk lines terminating in a final connector switch. At the final connector switch each of the five brushes has access to ten groups of ten lines each, each of these leading to a subscriber's station.

In order that the calling subscriber may not have to carry in mind a large number of digits, it is proposed to designate the desired office number by means of letters of the alphabet and three series of impulses will be sent to set three registers to control the first two switches of the train. These three registers will control brush and group selection at the district selector and brush and group selection at the office selector. An impulse-sending device of any well-known type will be used, being arranged merely to cause a desired number of circuit interruption in response to the operation of a finger wheel. The sender dial may be lettered so that in addition to a finger hold for each digit, the hold characterized by the No. 0 which would be arranged to send one impulse, may also bear the letter "A". The No. 1 finger hold may bear the characterizations "B" and 1. In this way the lettering on the dial plate complete would be A—0, B—1, C—2, D—3, E—4, F—5, G—6, H—7, I—8, J—9.

Under the conditions assumed in the present design of the system, the code to be dialed for a revertive call would necessitate an office characterization comprising the three letters J—J—J. Since we are at present not considering a revertive call, it will be assumed that the calling subscriber desires to establish connection with a subscriber whose number is 3456, in an office characterized by the three letters D—E—F. The subscriber will proceed first to operate his impulse dial to send four impulses, then to send five impulses, and then to send six impulses, after which he will proceed to send the digits constituting the desired number in the selected office.

The registers employed in this system are of the well-known power-driven type and are of a mechanical construction similar to that shown in Patent #1,127,808, issued February 9, 1915 to Reynolds and Baldwin. The register 400, which receives the first letter of the office code will be hereinafter designated as the A register; the register 401 will be designated as the B register and receives the second letter of the office code; register 402 will be designated the C register and receives the third letter of the office code. Registers 403, 404, 405 and 406 respectively take up the registrations of the thousands, hundreds, tens and units digits, respectively. The sequence switch springs shown in Figs. 5 and 6 are associated with the various registers, the springs above and below any given register being controlled thereby.

In order that the setting operation of the registers may be understood, it should be noted that all the register contact springs designated by the letters B, F and G are so arranged that in the odd positions of the register switch with which they are associated, the upper contacts will be closed, while in the even positions of the switch the lower contacts will be closed. In each case the normal position of the switch will be considered as an odd position.

In response to the first series of impulses the circuit of line relay 212 is intermittently interrupted. Upon the first deenergization of relay 212 a circuit is completed from grounded battery, right-hand armature and back contact of relay 228, conductor 232, upper left-hand contact of sequence switch spring 235, conductor 236, upper contacts of sequence switch spring 414, which are closed since this is a G spring, conductor 237, left-hand winding of relay 222, left-hand armature and back contact of relay 212, to ground.

Relay 222 is energized in the above traced circuit and completes a circuit from grounded battery, power magnet of register 400, upper contacts of register spring 412, which is closed since this is a B spring, conductor 415, upper left-hand contact of sequence switch spring 238, conductor 239, left-hand armature and front contact of relay 222 to ground, for moving this register out of its normal position and into position 0.

Relay 222, upon energizing, completes two locking circuits for itself by way of its right-hand armature. The first of these extends from grounded battery, right-hand armature and front contact of relay 222, left-hand winding of relay 222, armature and back contact of relay 212 to ground, and

maintains this relay energized until line relay 212 is energized in response to the completion of the first interruption of line circuit. The second locking cicruit for relay 222 extends from grounded battery, right-hand armature and front contact of relay 222, right-hand winding of relay 222, conductor, 240, upper contacts of register spring 416, which are closed in the odd position of the register, conductor 417 upper left-hand contact of sequence switch spring 233, to ground at sequence switch spring 241.

The locking circuit through the right-hand winding of relay 222 is broken as soon as register 400 moves into an even position due to the opening of the circuit at the upper contacts of spring 416. When the line circuit is again completed and relay 212 becomes energized, the circuit through the left-hand winding of relay 222 is broken and the relay deenergizes.

In response to the next deenergization of relay 212, with the register 400 in position 0, a circuit is completed from grounded battery, right-hand armature and back contact of relay 222, conductor 223, upper left-hand contact of sequence switch spring 224, conductor 225, lower contacts of register spring 416, conductor 227, left-hand winding of relay 228, left-hand armature and back contact of relay 212 to ground. Relay 228 is energized and completes a circuit from grounded battery, power magnet of register 400, lower left-hand contact of register spring 412, conductor 413, upper left-hand contact of sequence switch spring 229, conductor 230, left-hand armature and front contact of relay 228 to ground, for moving the register out of position 0 and into position 1.

Relay 228, upon energization, completes two locking circuits for itself through its right-hand armature, one of these circuits extending from grounded battery, right-hand armature and front contact of relay 228, right-hand winding of relay 228, conductor 231, lower contacts of register spring 414, closed in the even position of the register, conductor, conductor 234, upper left-hand contact of sequence switch spring 233, to ground. The other locking circuit extends from grounded battery, right-hand armature and front contact of relay 228, left-hand winding of relay 228, left-hand armature and back contact of relay 212, to ground. As before, when the line circuit is again closed, the resultant energization of relay 212 opens the locking circuit through the left-hand winding of relay 228, and the moving of register 400 out of position 0 and into position 1 opens the circuit through the lower contacts of register spring 414, and relay 228 deenergizes.

In response to the third interruption of the line circuit, relay 222 is energized to advance register 400 out of position 1 and into position 2 over circuits identical with those circuits previously traced for moving the register out of its normal position and into position 0. Locking circuits of relay 222, identical with those previously described in the description of the operation of this relay, are also completed and interrupted in the same manner.

In response to the fourth interruption of the line circuit, relay 228 is again energized to move register 400 from position 2 to position 3, in the same manner as described for moving it from position 0 to position 1, the cycle of operation of relay 228 in this case being the same as when it was previously brought into use.

It will thus be seen that for each interruption of the line circuit the register 400 will be advanced one position. At the termination of the first series of impulses, at which time four interruptions of the line circuit will have occurred, the register 400 will have advanced four steps into position 3. Relay 228 is energized in response to the last deenergization of line relay 212.

It is to be observed that as soon as register 400 left its normal position, a circuit was completed for relay 242 (Fig. 3), this circuit extending from grounded battery, winding of relay 242, lower contact of sequence switch spring 243, conductor 244, upper right-hand contact of sequence switch spring 418, lower contacts of register springs 419, 420, 421, 422, 423, and 424 in series, conductor 425, left-hand armature and front contact of relay 212 to ground. This circuit is completed momentarily each time relay 212 is energized during the sending of the first series of impulses. Relay 242 is, however, designed to be slow to attract its armature and, therefore, these momentary circuit closures will not allow its armature to close its contact. However, after register 400 has been positioned and during the interval between the sending of the first and second series of impulses, relay 212 remains energized for a relatively long time and as a result, relay 242 attracts its armature, thus completing a circuit from grounded battery, power magnet of sequence switch 200, upper right-hand contact of sequence switch spring 245, conductor 246 to ground, for moving this sequence switch out of position 2 and into position 3. When sequence switch 200 leaves position 2, the energizing circuit of relay 242 is broken at the lower contact of sequence switch spring 243, and relay 242 deenergized.

In position 3 of sequence switch 200 the second series of impulses may be received. Five impulses will be sent to advance register 401 five steps into position 4. At this time, relays 222 and 228 function to control

the advance of register 401 in a manner substantially similar to that previously described. At this time, however, the energizing circuit for relay 222 extends through the upper right-hand contact of sequence switch spring 235, conductor 247, upper contacts of register spring 426, conductor 237, and thence to ground as previously described. The energizing circuit of relay 228 extends by way of the upper right-hand contact of sequence switch spring 224, the lower contacts of register spring 427 and conductor 227, to ground as previously described. The operation of setting register 401 is fundamentally similar to that of setting register 400 and it is thought need not be described in detail.

After the second series of impulses has been sent, relay 212 will remain energized a comparatively long time and will complete a circuit for relay 242 from grounded battery, winding of relay 242, upper contact of sequence switch spring 243, conductor 248, upper contact of register spring 419, and thence through the lower contacts of register springs 420, 421, 422, 423 and 424 in series, and conductor 425 to ground as described. This circuit has been intermittently closed upon each short actuation of relay 212 but does not become effective until after the sending of the series of impulses. When relay 242 is energized, a circuit is completed from grounded battery, power magnet of sequence switch 200, upper right-hand contact of sequence switch spring 245, conductor 246, armature and front contact of relay 242, to ground for moving this sequence switch out of position 3 and into position 4.

The subscriber continues sending series of impulses, and as a result register 402 will be set in position 5, register 403 will be set in position 3, register 404 will be set in position 4, register 405 will be set in position 5, and register 406 will be set in position 6.

Upon the completion of the setting of register 402, the energization of relay 242 will advance sequence switch 200 from position 4 to position 5, the completion of the setting of register 403 will advance sequence switch 200 into position 6; the completion of the setting of register 404 will advance sequence switch 200 into position 7; the completion of the setting of register 405 will advance sequence switch 200 in position 8, and when the last register 406 is positioned, sequence switch 200 will be advanced out of position 8 and into position 9.

When sequence switch 200 reaches position 4, at which time registers 400 and 401 will have been positioned, these being the registers which control the district selector switch shown in Fig. 2, a circuit is completed from grounded battery, power magnet of sequence switch 300 (Fig. 7), lower right-hand contact of sequence switch spring 301, conductor 302, contact of sequence switch spring 249 to ground, for moving this sequence switch out of position 1 and into position 2.

In position 2 of sequence switch 300 the fundamental circuit is completed to control selection at the district switch. A circuit is completed from grounded battery, winding of relay 117 (Fig. 2) upper contacts of sequence switch spring 118, conductors 137 and 138, brush 139, terminal 140, conductor 250, armature and back contact of relay 304, which is in parallel with the 0′ counting relay, winding of stepping magnet 305, upper contact of sequence switch spring 306, conductor 307, through the contacts of register springs 428 and 429 in parallel, conductor 430, lower right-hand contact of sequence switch spring 205, conductor 204, terminal 122, brush 121, conductor 120, upper right-hand and lower left-hand contacts of sequence switch spring 141, resistance 142 to ground. Relay 117 is energized in this circuit and locks up to conductor 137 through its left-hand armature and front contact.

It is to be observed that, if both registers 400 and 401 are in position 9, which corresponds to the sender designation J, the fundamental circuit would not have been completed, since both register springs 428 and 429 would have been open. It is therefore obvious that in case the revertive ringing office code has been sent, which comprises the letters JJJ, the relay 117 would not have been energized and would not have advanced the district as will now be described. The operation of the system in connection with a revertive call will be hereinafter described.

Relay 117 upon energization completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 135, right-hand armature and front contact of relay 117 to ground, for moving this sequence switch out of position 2 into position 3.

Stepping relay 305 is also energized upon the completion of the fundamental circuit and completes a circuit from grounded battery, winding of the No. 2 counting relay, armature and back contact of the No. 2′ counting relay, conductors 308 and 431, lower left-hand contact of sequence switch spring 432, conductor 433, upper left-hand contact of sequence switch spring 309, conductor 310 to ground at the armature and front contact of stepping relay 305. The No. 2 counting relay is energized in this circuit and prepares a circuit for the No. 2′ counting relay which does not become effective until the stepping relay is deenergized to remove the shunt about the winding of the No. 2′ counting relay.

In position 3 of sequence switch 100, a circuit is completed from grounded battery, winding of up-drive magnet 143, right-hand contacts of sequence switch springs 144,

right-hand armature and front contact of relay 117 to ground. Magnet 143 is energized and causes the brush shaft to be moved upward in a brush selecting movement. As soon as commutator brush 152 engages a conducting segment of commutator 146 the holding circuit of relay 117 is extended directly to ground at the district selector, this circuit extending from grounded battery, winding of relay 117, left-hand armature and front contact of relay 117, upper left-hand contact of sequence switch spring 118, upper left-hand contact of sequence switch spring 147, conductor 148, commutator 146 and brush 152 to ground. Stepping relay 305 is shunted down in this circuit and allows the No. 2′ counting relay to become energized. When brush 152 engages an insulating segment of commutator 146, relay 305 again becomes energized and causes the energization of the No. 1 counting relay. Stepping relay 305 is intermittently actuated as the brush shaft moves upwardly until, on its third deenergization, the 0′ counting relay and relay 304 are energized. Relay 304 opens the lower branch of the locking circuit of relay 117 and when, a moment later, brush 152 engages an insulating portion of commutator 146, at which time the brush shaft will be properly positioned to trip the third set of brushes, the locking circuit for relay 117 is completely broken and this relay deenergizes and opens the circuit of the up-drive magnet, thus bringing the brush shaft to rest. The deenergization of relay 117 also completes a circuit from grounded battery, power magnet of sequence switch 100, lower right-hand contact of sequence switch spring 135, right-hand armature and back contact of relay 117, to ground, for moving this sequence switch out of position 3 and into position 4.

In the sender, the energization of the 0′ counting relay completes a circuit from grounded battery, power magnet of sequence switch 300, upper left-hand contact of sequence switch spring 301, armature and front contact of the 0′ counting relay to ground, for moving this switch out of position 2 and into position 3. Since relay 290 (Fig. 3) is not energized at this time, due to conditions which will be subsequently described, sequence switch 300 is immediately moved out of position 3 and into position 4, due to the completion of a circuit extending from grounded battery, power magnet of sequence switch 300, lower left-hand contact of sequence switch spring 311, conductor 312, armature and back contact of relay 290 to ground.

With sequence switch 100 in position 4 and sequence switch 300 in position 4, the fundamental circuit is again completed to advance sequence switch 100 out of position 4 and into position 5 by means of circuits identical with those previously traced for moving this sequence switch out of position 2 and into position 3.

In position 5 of sequence switch 100 the district brush shaft is moved upward in a group selecting movement due to the closure of a circuit from grounded battery, winding of up-drive magnet 143, left-hand contacts of sequence switch spring 144, right-hand armature and front contact of relay 117 to ground. It is to be observed that as soon as sequence switch 100 reaches position 4, a circuit is completed from grounded battery, winding of trip magnet 149, contact of sequence switch spring 150, lower left-hand contact of sequence switch spring 151 to ground. The resultant energization of magnet 149 operates the trip rod 180 so that upon subsequent upward movement of the brush shaft the third set of brushes will be released into engagement with the terminals served by them.

The first energization of stepping relay 305 completes a circuit from grounded battery, winding of the No. 2 counting relay, armature and back contact of the No. 2′ counting relay, conductors 308 and 434, lower left-hand contact of sequence switch spring 435, upper contact of sequence switch spring 436, conductor 437, upper right-hand contact of sequence switch spring 309, conductor 310, armature and front contact of relay 305 to ground. Stepping relay 305 is intermittently shunted down as the brush moves upwardly due to the engagement of commutator brush 152 with commutator 153 which supplies holding ground directly to relay 117 by way of the upper left-hand contact of sequence switch spring 147 and conductor 148. Upon the third shunting down of the stepping relay the 0′ counting relay and relay 304 are energized in parallel. Relay 304 permanently opens the lower branch of the locking circuit of relay 117 and when, a moment later, the brush 152 engages an insulating segment of commutator 153, relay 117 deenergizes and completes a circuit from grounded battery, lower right-hand contact of sequence switch 135, right-hand armature and back contact of relay 117 to ground for moving this switch out of position 5 and into position 6. The deenergization of relay 117 opens the circuit of up-drive magnet 143, and brings the brush shaft to rest with the selected set of brushes in operative relation to the selected group of trunk lines.

In the sender, the energization of the 0′ counting relay completes a circuit from grounded battery, winding of the power magnet of sequence switch 300, upper left-hand contact of sequence switch spring 301, armature and front contact of the 0′ counting relay to ground, for moving this sequence switch out of position 4 and into position 5. Sequence switch 300 is then moved

out of position 5 and into position 6 due to the closure of a circuit for its power magnet extending from the lower left-hand contact of sequence switch spring 311 by way of conductor 312 to ground at the armature and back contact of relay 290.

In position 6 of sequence switch 100, a circuit is completed from grounded battery, left-hand winding of test relay 155, lower right-hand contact of sequence switch spring 156, conductor 157 to ground, at the right-hand armature and back contact of relay 117. Relay 155 is energized in this circuit and locks up through its right-hand winding over a circuit extending from grounded battery, right-hand winding of relay 155, upper contacts of sequence switch spring 158, right-hand armature and front contact of relay 155, conductor 160, test brush 159 and its associated terminal 161 to ground, provided that the first trunk in the selected group is busy, it being understood that busy trunks will be characterized by the presence of ground potential on their test terminals, while no potential will be found on the terminals of idle trunks.

Relay 155 upon energization also completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 135, left-hand armature and front contact of relay 155 to ground, for moving this sequencet switch out of position 6 and into position 7.

In position 7 of sequence switch 100 the selected set of brushes is moved upward in a trunk selecting movement due to the closure of a circuit from grounded battery, winding of up-drive magnet 143, right-hand contacts of sequence switch spring 144, left-hand armature and front contact of relay 155 to ground.

As soon as test brush 159 encounters the terminal of an idle trunk the locking circuit through the right-hand winding of relay 155 is opened. Relay 155 does not immediately deenergize, however, due to the existence of a circuit from grounded battery, left-hand winding of relay 155, upper right-hand contact of sequence switch spring 156, conductor 162, commutator 163, commutator brush 176 to ground. When, an instant later, brush 176 engages an insulating segment of commutator 163, at which time the brush set will be accurately centered on the terminals of the selected trunk, relay 155 deenergizes and opens the circuit of up-drive magnet 143 to bring the selected brush set to rest on the terminals of an idle trunk leading to the office selector. The deenergization of relay 155 also completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 165, left-hand armature and back contact of relay 155 to ground, for moving this switch out of position 7 and into position 10.

The fundamental circuit is now completed from grounded battery at the office selector associated with the seized trunk, over conductor 166, terminal 167, brush 168, upper contact of sequence switch spring 169, conductor 138, brush 139, terminal 140, conductor 250, armature and back contact of relay 304, winding of stepping relay 305, upper contact of sequence switch spring 306, through the upper contacts of register springs 428 and 429 in parallel, conductor 430, lower right-hand contact of sequence switch spring 205, conductor 204, terminal 122, brush 121, conductor 120, upper contact of sequence switch spring 170, brush 171, terminal 172, conductor 173, to ground at the office selector through the usual switching devices at the office selector. The up-drive magnet at the office selector is then brought into service and brush selection takes place in substantially the same manner as described in connection with the district selector. The office selector in this movement will cause interruptions of the flow of current to the stepping relay 305 by means of an interrupting commutator corresponding to commutator 146 and brush 152 at the district selector.

The closure of the fundamental circuit causes the energization of relay 305. Upon the energization of stepping relay 305 a circuit is completed from ground, armature and front contact of relay 305, conductor 310, lower right-hand contact of sequence switch spring 309, conductor 313, contact of register spring 438, upper contact of register spring 439, upper left-hand contact of register spring 440, conductors 441 and 308, armature and back contact of the No. 2′ counting relay, and the winding of the No. 2 counting relay to grounded battery. The No. 2 counting relay prepares a circuit for the No. 2′ counting relay in the well known manner. The movement of the office selector operates the counting relays until the 0′ counting relay and relay 304 are energized. Relay 304 opens the fundamental circuit, thus opening one branch of the circuit of the relay which controls the office selector and causing the subsequent stopping of the office selector in a position to trip the third set of brushes.

The energization of the 0′ counting relay closes a circuit from grounded battery, power magnet of sequence switch 300, upper left-hand contact of sequence switch spring 301, armature and front contact of 0′ counting relay to ground, for moving this sequence switch out of position 6 and into position 8. In passing from position 6 to position 8, the holding circuits of the counting

relays are opened at sequence switch springs 314 and 315 and the counting relays are deenergized.

In position 8 of sequence switch 300, the fundamental circuit is again closed through to the office selector and again causes the energization of the up-drive magnet at the office selector. Group selection will now take place. As the switch shaft, is elevated relay 305 is again intermittently shunted by means of a circuit from a commutator similar to commutator 153 at the district selector. The first energization of stepping relay 305 completes a circuit from ground, armature and front contact of relay 305, conductor 310, lower left-hand contact of sequence switch spring 309, conductor 314, contact of register spring 442, upper contact of register spring 443, upper left-hand contact of register spring 444, conductors 445, and 446, armature and back contact of No. 5′ counting relay and the winding of the No. 5 counting relay to grounded battery.

As the office selector switch moves upward in the group selecting movement the counting relays will be successively actuated in the same manner as above described. As soon as relay 304 is energized the fundamental circuit is opened, thus stopping the selected set of brushes of the office selector at the bottom of the fourth group of terminals served thereby. The energization of the 0′ counting relay completes the above traced circuit for moving sequence switch 300 out of position 8 and into position 10.

Meanwhile trunk hunting takes place at the office selector in a manner substantially like that described in connection with the district switch, and upon completion of trunk hunting, the office selector will have seized a set of terminals leading to an idle incoming switch in the desired office.

Since the operation of the incoming and final switches are well known in the art, it is not believed to be necessary to describe the operation of the sender in connection with the setting of these switches. In positions 10 and 12 of sequence switch 300, brush selection and group selection, respectively, at the incoming switch will be controlled. The incoming switch will then trunk hunt to pick an idle final switch, whereupon the fundamental circuit will be again completed and in position 14 of sequence switch 300, final brush selection will be accomplished. In position 16 of sequence switch 300, group selection of the final will take place, and in position 17 of sequence switch 300 final line selection will take place. The called line will be tested and if idle will be signaled in the well known manner.

Since the number of the line wanted was 3 4 5 6, the second brush and third group of the incoming switch will have been selected, and at the final, the fifth brush, sixth group and seventh line will have been selected. An inspection of Figs. 7 and 6 will show that in the proper positions of sequence switch 300, counting relays 1, 2, 4, 5 and 6 will be energized at the start of each selective operation to control these selections.

Upon the completion of units selection at the final switch, the energization of the 0′ counting relay operates to advance sequence switch 300 out of position 17 and into position 18, in the usual manner.

As soon as sequence switch 300 reaches position 18, a circuit is completed from grounded battery, power magnet of sequence switch 200, Fig. 3, upper right contact of sequence switch spring 251, conductors 253 and 254, closed contacts of register spring 447, conductor 448, upper right-hand contact of sequence switch spring 351 to ground, for moving sequence switch 200 out of position 9 and into position 13.

In position 13 of sequence switch 200, a circuit is completed from grounded battery, left-hand winding of relay 155, (Fig. 2) lower left-hand contact of sequence switch spring 156, conductor 176, brush 177, terminal 178, conductor 255, lower left-hand contact of sequence switch spring 256 to ground. Relay 155 is energized in this circuit and completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 135, left-hand armature and front contact of relay 155 to ground, for moving this sequence switch out of position 10 and into position 14. It is to be observed that relay 155 upon energization locks up through its right-hand winding and the upper contacts of sequence switch spring 158, the left-hand armature and front contact of relay 155 and the upper right-hand and lower left-hand contacts of sequence switch spring 104, until sequence switch 100 leaves position 13. Relay 155 is then deenergized and allows the sequence switch to come to rest in position 14.

As soon as sequence switch 100 leaves position 13½, the impulse leads into the sender are opened at sequence switch springs 128 and 130, and line relay 212 is allowed to deenergize. At the same time the circuit of relay 109 is opened at sequence switch spring 169 and this relay deenergizes to open the various controlling leads to the sender. The sender is then restored to its normal position in a manner to be subsequently described.

As soon as sequence switch 100 reaches position 13½, the tip and ring conductors of the subscriber's line are supplied with battery by way of the left-hand windings of a repeating coil 179, and the lower contacts of

sequence switch springs 128 and 130 respectively. Current flow over the subscriber's line causes the energization of relay 181 which becomes energized and causes in turn the energization of relay 182 over a circuit extending from grounded battery, winding of relay 182, armature and front contact of relay 181, right-hand armature and front contact of relay 103 to ground, at the lower left-hand contact of sequence switch spring 104. The energization of relay 182 completes a circuit from grounded battery, power magnet of sequence switch 100, lower left-hand contact of sequence switch spring 135, armature and front contact of relay 182 to ground, for moving this sequence switch out of position 14 and into position 15.

Referring now to the register controlling circuit shown in Fig. 3, it will be noted that when sequence switch 100 left position 11, the upper branch of the locking circuit of relay 201 was broken at sequence switch spring 105, and when sequence switch 100 leaves position 13½ to cause the deenergization of relay 109, the subsequent deenergization of line relay 212 opens the lower branch of the locking circuit of relay 201. Relay 201 thereupon deenergizes and completes a circuit from grounded battery, power magnet of sequence switch 200, upper left-hand contact of sequence switch spring 257, left-hand armature and back contact of relay 201 to ground, for moving this sequence switch out of position 13 and into position 15.

In position 15 of sequence switch 200, the various registers shown in Fig. 5 are restored. The first register to be restored is register 406, by means of a circuit extending from grounded battery, power magnet of register 406, upper right-hand contact of register spring 449, conductor 450, lower left-hand contact of sequence switch spring 219, conductor 220 to ground at sequence switch spring 241. Register 406 rotates until it reaches its normal position at which time the driving circuit just traced will be opened at the upper contact of register spring 449. As soon as register 406 reaches its normal position, a circuit is completed for restoring register 405, extending from grounded battery, power magnet of register 405, upper contact of register spring 451, lower left-hand contact of register spring 449, conductor 450 to ground over the path described. Register 405 is then advanced into its normal position where it is brought to rest and at the same time completes the circuit for restoring register 404. In this manner the restoration of the registers continues until all the registers have returned to their normal position whereupon a circuit is completed from grounded battery, power magnet of sequence switch 200, upper left-hand contact of sequence switch spring 251, conductor 258 and thence through register springs 452, 453, 454, 455, 456, 451 and 449 respectively, as soon as the lower contacts of these register springs are closed in the normal positions of the registers, and thence to ground over conductor 450 over the path described. The completion of this circuit advances sequence switch 200 out of position 15 and into position 18.

As soon as sequence switch 200 reaches position 18, a circuit is completed from grounded battery, power magnet of sequence switch 300, upper left-hand contact of sequence switch spring 311, conductor 316, upper right-hand contact of sequence switch spring 259, conductor 220 to ground at sequence switch spring 241. Completion of this circuit advances sequence switch 300 out of position 18 and into position 1.

When sequence switch 300 reaches position 1, a circuit is completed from grounded battery, power magnet of sequence switch 200, lower right-hand contact of sequence switch spring 251, conductor 260, lower right-hand contact of sequence switch spring 351 to ground, for moving this sequence switch out of position 18 and into position 1. The various registers, the sender and the register controlling equipment have now all been restored to their normal condition and are ready for reuse. It is to be noted that after relay 109 releases and removes from its outer left-hand armature the ground which was maintaining the sender busy, the sender is protected against seizure until it is fully restored by means of ground supplied to test terminal 112, from sequence switch spring 241, Fig. 4, by way of conductor 220, the upper left-hand contact of sequence switch spring 259 and conductor 261. When sequence switch 200 reaches position 1, this ground is removed and the sender may again be selected for reuse.

Conversation takes place in position 15 of sequence switch 100. Upon completion of the conversation the calling subscriber replaces his receiver upon the switchhook, thus opening the line circuit. Relay 181 deenergizes and causes the release of slow release relay 182. Relay 182 upon deenergization completes a circuit from grounded battery, power magnet of sequence switch 100, lower left-hand contact of sequence switch spring 165, armature and back contact of relay 182 to ground for moving this sequence switch out of position 15 and into position 18.

In position 18 of sequence switch 100, a circuit is completed from grounded battery, winding of down-drive magnet 173, and the lower contacts of sequence switch spring 151 to ground. Magnet 173 is energized and causes the restoration of the district selector. When the brush shaft is fully returned to its normal position, a circuit is completed

from grounded battery, winding of power magnet of sequence switch 100, lower contact of sequence switch spring 174, commutator segment 175, brush 176 to ground, for moving sequence switch 100 out of position 18 and into position 1.

As soon as the district selector brushes 168, 171 and 159 leave the terminals of the trunk leading to the office selector, restoration of the office selector is started. The office selector, incoming, and final switches are restored in the usual manner.

When the sequence switch 100 leaves position 18, the holding circuit of the cut-off relay 3 is broken and this relay deenergizes and causes the restoration of the subscriber's individual line switch, by completing a circuit from grounded battery, resistance 6, armature and back contact of stepping magnet 7, conductor 8, lower armature and back contact of cut-off relay 3, off normal segment 12, brush 11 and the winding of stepping magnet 7 to ground. Stepping magnet 7 interrupts its own circuit and continues to do so until the switch has been advanced through a complete revolution and back to its normal position, at which time brush 11 will leave segment 12 and permanently open the circuit of magnet 7. During the return of the switch, the wipers will pass over busy and idle trunks without stopping, since line relay 2 is not energized at this time. All of the apparatus has now been restored to its normal condition and is ready for reuse.

The conditions which arise in case the calling subscriber abandons the call, either before dialing to set any of the registers or after he has dialed to set some of the registers but not all of them will now be described.

It will first be assumed that a subscriber abandons the call without operating his dial at all. In this case his initial removal of the receiver will cause his line switch to pick an idle district as previously described. A preselected sender will then be connected to the district and advanced into position 2 as described. The district sequence switch will also be advanced into position 2. Assuming now that the calling subscriber replaces his receiver at this time, line relay 212 will be deenergized and will cause register 400 to be advanced one step into its 0 position. Line relay 212 will now remain deenergized and will allow relay 262 to become energized over a circuit extending from grounded battery, winding of relay 262, lower contact of sequence switch spring 263, right-hand armature and back contact of relay 212 to ground. This circuit is normally completed upon each interruption of the line circuit during the sending of the series of impulses. Relay 262 is however designed so as to be slow to attract its armature and therefore does not become energized during the normal operation of the system. In case of an abandoned call however, relay 262 becomes deenergized and completes a circuit from grounded battery, power magnet of sequence switch 200, upper left-hand contact of sequence switch spring 245, armature and front contact of relay 262 to ground, for moving this sequence switch out of position 2 and into position 9. Since only one of the registers has been advanced out of its normal position, a circuit is then at once effective to advance sequence switch 200 out of position 9 and into position 13. This circuit extends from grounded battery, power magnet of sequence switch 200, lower left-hand contact of sequence switch spring 251, conductor 252 through the lower contacts of register springs 457, 458, 459, 460, 461 and 462 in parallel to ground. Since sequence swich 200 does not come to rest in position 4 at this time, but passes directly through it, sequence switch 300 is not moved out of position 1, since ground is closed to lead 302 for an insufficient period of time to allow this sequence switch to advance.

When sequence switch 200 reaches position 13, a circuit is completed from grounded battery, winding of relay 117, Fig. 2, lower right-hand and upper left-hand contacts of sequence switch spring 118, conductors 137 and 138, brush 139, terminal 140, conductor 250, right-hand contact of sequence switch spring 256 to ground. Relay 117 is energized in this circuit and completes a circuit from grounded battery, power magnet of sequence switch 100, upper left-hand contact of sequence switch spring 135, right-hand armature and front contact of relay 117 to ground, for moving this sequence switch out of position 2 and into position 3.

Since sequence switch 200 is in position 13, sequence switch 100 is immediately moved out of position 3 and into position 4 by means of a circuit extending from grounded battery, power magnet of sequence switch 100, lower right-hand contact of sequence switch spring 135, contact of sequence switch spring 183, conductor 176, brush 177, terminal 178, conductor 255, lower left-hand contact of sequence switch spring 256 to ground. When sequence switch 100 reaches position 4, since the district selector has not been put into operation, a circuit is completed from grounded battery, power magnet of sequence switch 100, contact of sequence switch spring 174, normal commutator segment 175 and brush 176 to ground, for moving this sequence switch out of position 4 and into position 15. Since the call was abandoned, relay 182 will not have been energized and therefore a circuit it at once completed from grounded battery, power magnet of sequence switch 100, lower left-hand contact of sequence switch spring 165, armature and back contact of relay 182

to ground, for moving sequence switch 100 out of position 15 and into position 18 from which position it is at once moved into 1 by means of the previously traced circuit extending through the contact of sequence switch spring 174 and normal commutator segment 175 and its associated commutator brush 176 to ground.

The release of the district selector causes the release of relay 201, Fig. 3, which advances sequence switch 200 out of position 13 and into position 15, wherein register 400 is restored to its normal position. With all the registers in their normal positions, circuits identical with those previously traced are completed to advance sequence switch 200 into position 18, from which position it is advanced into position 1 as previously described.

If the subscriber abandons the call after dialing a number of series of impulses, but without completing the full registration, the restoration of the registers and various controlling apparatus is substantially similar. In case the first three registers have been set, the fundamental circuit will have been completed and the various selective operations will have been started at the time the call is abandoned. The continued deenergization of relay 212 at this time will cause the energization of relay 262 and sequence switch 200 will be advanced into position 9 as previously described. Since some one, or perhaps several, of the registers are in their normal positions at the time sequence switch 200 reaches position 9, a circuit will again be completed for advancing sequence switch 200 by way of the lower left-hand contact of sequence switch spring 251 and conductor 252.

Meanwhile the district switch will complete its selective operations and sequence switch 100 will come to rest in position 10. A circuit is then completed from grounded battery, left-hand winding of relay 155, lower left-hand contact of sequence switch spring 156, conductor 176, brush 177, terminal 178, conductor 255, lower left-hand contact of sequence switch spring 256 to ground. Relay 155 is energized and at its left-hand armature and front contact completes a circuit for moving sequence switch 100 out of position 10 and into position 14.

A circuit is then completed from grounded battery, winding of down-drive magnet 173, lower contacts of sequence switch spring 151 to ground. Magnet 173 is energized and causes the restoration of the district selector brush shaft. When the district brush shaft reaches its normal position sequence switch 100 is advanced out of position 14 and into position 15, and thence into position 1 as previously described in connection with an abandoned call.

As soon as the district selector brush set leaves the terminals of the trunk leading to the office selector, the incoming selector and any succeeding switches in the train are released in the well known manner. Under the conditions assumed, sequence switch 200 is advanced into position 18 as previously described whereupon a circuit is completed from grounded battery, power magnet of sequence switch 300, upper left-hand contact of sequence switch spring 311, conductor 316, upper right-hand contact of sequence switch spring 259, conductor 220 to ground at sequence switch spring 241. The completion of this circuit advances the sender sequence switch 300 out of whatever position it happens to be in, into position 1, whereupon sequence switch 200 is advanced out of position 18 and into position 1. The apparatus is now all in its normal condition.

The operation of the system when used by a subscriber on a party line in making a revertive call to a station on the same line will now be described.

The invention has been shown applied to a system in which revertive ringing may be accomplished on a four-party line of the type in which a desired one of the four stations may be selectively rung by applying ringing current superimposed on plus or minus battery to either the tip or the ring side of the line. Since the system could easily be adapted to operate with any type of party line ringing system, whether arranged for two or four party lines, it is not to be restricted to the specific embodiment shown, which merely illustrates one form of carrying out the principles involved.

As previously stated any party line subscriber in the system, regardless of which office he is in will dial a characteristic office code when he desires to make a revertive call. To accomplish this, each party line subscribed will be supplied with the names of the subscribers who are on his own party line, since these numbers will have no relation to the numbers appearing in the regular directory. The directory numbers will, of course, be used by any other subscribers who desire to converse with a subscriber on a given party line, provided that they are not on the same line.

As just stated by first dialing impulses corresponding to the letters JJJ the sender registers will be set in positions to accomplish revertive ringing. The thousands, hundreds, tens and units registers will then be positioned and determine which substation on the party line will be rung.

Briefly the general operation is as follows: The subscriber initiating a call will dial JJJ and then dial the number which corresponds to the particular party line station on his own line which he desires to signal. He will then replace his receiver

on the switch-hook. The sender and special revertive ringing apparatus will then be operated to ring first the called subscriber's station and then the station of the originating subscriber. The ringing of the bell at the originating subscriber's station informs him that the system is operating satisfactorily and that the called subscriber has not yet answered. When the called subscriber removes his receiver from the switchhook ringing current is disconnected, and the bell at the originating station ceases to ring, thus informing the calling subscriber that the called party has answered. He will then remove his receiver from the switchhook and may converse with the called subscriber. Battery for the conversation is supplied from the district switch which is held by the calling subscriber's line switch. The district switch, however, does not advance out of its normal position.

Referring now to Fig. 6, thousands register spring 464, hundreds register springs 466 and 467, tens register spring 469 and units register springs 471 and 472 are the springs which determine which two parties shall be signaled in the case of a revertive call. In the case of all of these four registers the digits 2 and 1 are the only ones which are used to control the ringing selections.

It will be assumed that the subscriber whose substation is signaled by ringing current superimposed on plus battery applied to the ring side of the line desires to talk with a subscriber on the same party line whose substation may be signaled by ringing current superimposed on minus battery applied to the tip side of the line. He will consult his individual card showing the substations on his own party line and will learn that the number he must dial is JJJ 1221.

The calling subscriber thereupon removes his receiver from the switchhook and his individual line switch selects an idle trunk to a district switch in a manner identical with that described in connection with a non-revertive call. He will then dial JJJ 1221 to set the A register in position 9, the B register in position 9, the C register in position 9, the thousands register in position 1, the hundreds register in position 2, the tens register in position 2 and the units register in position 1. The operation of the district circuits and the register controlling circuits in Fig. 3 is identical with that previously described and it is thought that no further description is necessary.

After the registers have all been set the district sequence switch 100 will be in position 2, the register controlling sequence switch 200 will be in position 9 and the sender sequence switch 300 will have been advanced into position 2 in the usual manner.

It is to be observed that when sequence switch 200 reaches position 4, however, the fundamental circuit including line relay 117 (Fig. 2) is not completed. This circuit extends from grounded battery, winding of relay 117, lower right-hand and upper left-hand contacts of sequence switch spring 118, conductors 137 and 138, brush 139, terminal 140, conductor 250, armature and back contact of relay 304, winding of stepping relay 305, contact of sequence switch spring 306, conductor 307 to register springs 428 and 429 in parallel. Since the A and B registers are both in position 9, in the case of a revertive call, springs 428 and 429 are both open and the fundamental circuit is not completed to start selection at the district switch. The district sequence switch therefore remains in position 2.

After all the registers have been set, at which time sequence switch 200 is in position 9 and sequence switch 300 is in position 2, the shunt path about relay 290 is removed since this shunt is now open at each of the register springs 411, 472, 473, 463, 465, 468 and 470, at any one of which it would normally be in existence provided any designation other than JJJ had first been dialed or in case any one of the numerical registers has not been advanced beyond its zero position. The relay 290 is now included in the line circuit which extends from grounded battery, winding of relay 212, winding of relay 290, conductors 263 and 214 left-hand armature and back contact of relay 215, conductor 216 and thence through the calling substation to ground as previously described.

Relay 290 responds in series with line relay 212 since the line circuit is closed immediately following the termination of the last series of impulses. Relay 290 upon energization completes a circuit from grounded battery, power magnet of sequence switch 300, left-hand contacts of sequence switch spring 320, conductor 321, armature and front contact of relay 290 to ground, for moving sequence switch 300 out of position 2 and into position 3.

The calling subscriber will then replace his receiver and await the ringing of the called subscriber. The resultant interruption of the line circuit allows relays 212 and 290 to be deenergized. The deenergization of relay 290 completes a circuit from grounded battery, power magnet of sequence switch 300, lower left-hand contact of sequence switch spring 311, conductor 312, armature and back contact of relay 290 to ground for moving this sequence switch out of position 3 and into position 4.

In position 4 of sequence switch 300 a circuit is completed from grounded battery, right-hand contacts of sequence switch spring 320, conductor 322, right-hand contacts of register spring 473, right-hand contacts of register spring 472, right-hand contacts of registers spring 411, conductor 474, winding of relay 215, armature and back contact of relay 264, armature and back contact of relay 265 to ground. Relay 215 is energized in this circuit and connects through the tip and ring conductors 216 and 217 respectively, to the ringing apparatus. If brush 266 is at this time resting on a conducting segment of interrupter drum 267, relay 268 will be energized by means of a circuit extending from grounded battery, interrupter drum 269, conducting portion of drum 267, brush 266, winding of relay 268, outer righthand armature and front contact of relay 215, conductor 218, upper right-hand contact of sequence switch spring 219, and conductor 220 to ground at sequence switch spring 241. At this time brush 276 is in engagement with segment 277 of its associated drum and a circuit is therefore completed from ground through a source of alternating current ringing potential indicated at 272, through negative battery, interrupter drum 278 and its associated brush and thence to segment 277, brush 276, right-hand winding of relay 265, conductor 279, lower contact of tens register spring 469, upper contact of units register spring 471, conductor 475, left-hand armature and front contact of relay 268, inner right-hand armature and front contact of relay 215 and then over the tip side of the line to ground through the bell at the called substation. The ringing current causes the called subscriber to be signaled. As soon as the interrupter has revolved through 90 degrees, segment 280 is brought into contact with brush 276 and supplies negative battery to the tip side of the line to trip the ringing relay in case the called subscriber answers during the interval, in which no ringing current is being supplied to the line.

As soon as the interrupter has revolved through 180 degrees brush 266 engages an insulating segment of drum 267 and relay 268 is deenergized. At the same time brush 270 will engage segment 274 of the drum served by it. A circuit is then completed from ground through the ringing generator 272, plus battery, drum 273 and its associated brush, segment 274, brush 270, left-hand winding of relay 268, conductor 275, upper contact of thousands register 464, lower contact of hundreds register 467, conductor 476, right-hand armature and back contact of relay 268, right-hand armature and front contact of relay 215, conductor 216, and thence over the ring side of the line, thus supplying negative ringing current to the substation of the calling subscriber and thereby causing his bell to ring to inform him that ringing is now taking place at the called substation.

The bells at the calling and called substations are alternately rung until the called subscriber answers. In case he fails to answer the calling subscriber may answer and restore the connection by setting up conditions which will be hereinafter described. It will be assumed, however, that the called subscriber answers.

The response of the called subscriber completes a low resistance bridge at the substation and allows sufficient currents to flow through relay 265 to cause the energization of this relay. The circuit of relay 265 at this time extends to the called substation over the tip side of the line, and returns over the ring conductor to conductor 216, left-hand armature and front contact of relay 215, right-hand armature and front contact of relay 268, conductor 291, upper right-hand contact of register spring 472, to ground. When relay 268 deenergizes in response to the operation of interrupter drum 267, a substitute holding circuit for relay 265 is established over the ring side of the line and returns by way of the tip conductor to conductor 217, inner right-hand armature and front contact of relay 215, left-hand armature and back contact of relay 268, conductor 292, lower contact of register spring 466 to ground. The energization of relay 265 removes the holding ground for relay 215. Relay 215, is however, supplied with ground through the winding of relay 264. Relay 264 was previously included in series with relay 215 from ground, but could not operate due to the shunting ground at the back contact of relay 265. Relay 265 upon energization, however, allows relay 264 to energize and lock up to conductor 474, thus shunting down relay 215. Relay 215 upon deenergization opens the circuits to the ringing apparatus. Relay 264 upon energization also completes a circuit from grounded battery, power magnet of sequence switch 200, upper right-hand contact of sequence switch spring 251, conductor 253, left-hand armature and front contact of relay 264 to ground, for moving sequence switch 200 out of position 9 and into position 13.

In position 13 of sequence switch 200, the district switch sequence switch 100 is advanced into position 15 in a manner identical with that described for moving it into this position in case a subscriber abandons a call without dialing. As soon as sequence switch 100 reaches position 13½ battery is supplied to the line through the left-hand windings of repeating coil 179 by way of the lower contacts of sequence switch springs 130, and 128

respectively. Relay 181 is energized and causes in turn the energization of slow release relay 182 in the manner previously described. The sender, the various registers and the register and sender controlling equipment are restored in the usual manner.

When the bell at the calling station ceases to ring the calling subscriber will know that the called subscriber has responded and will therefore remove his receiver from the switchhook and may then proceed with his conversation. When the connection is no longer desired and after both parties have replaced their receivers, the circuit of relay 181 is interrupted and this relay deenergizes, causing in turn the deenergization of relay 182 which completes a previously traced circuit for advancing sequence switch 100 out of position 15 and into position 18. Since the district brush shaft is in its normal position, sequence switch 100 is then immediately moved out of position 18 and into position 1 by means of a circuit completed through normal commutator segment 175 and its associated brush 176. The apparatus has now all been restored to its normal condition and is ready for reuse.

In the case just assumed the calling subscriber is equipped with a station which may be signaled by applying plus ringing current to the ring side of the line, while the called subscriber's station bells are arranged to respond to negative ringing current applied to the tip side of the line. It is obvious therefore that if the subscriber who in this case was the called subscriber wishes to initiate a call and signal the subscriber who has just called him, he may dial the same number which was just used, that is JJJ 1221. Inspection of the drawings will show, however, that the setting JJJ 2112 would give the same results except that the bells are alternately rung in different positions of the relay 268 from the case just assumed. That is, the setting 1—2 is characteristic of a plus ring on the ring side of the line. If the setting 1—2 is found on the thousands and hundreds registers the ring side of the line will receive plus ringing current when relay 268 is deenergized. However, if the setting 1—2 occurs on the tens and units registers, the ring side of the line will receive plus ringing current when relay 268 is energized. It is therefore apparent that one pair of registers controls the conditions which determine the type of current to be applied and to which line it is to be applied. From this it follows that the designation for plus ringing current on the ring side of the line is 1—2, that the setting for causing application of negative ringing current to the ring side of the line is 2—2, the setting which controls the application of plus ringing current to the tip side of the line is 1—1 and the setting which controls the application of negative ringing current to the tip side of the line is 2—1. The following chart, which should be self-explanatory in view of the above, shows the various settings necessary in order that any two subscribers on a four-party line may be alternately signaled by means of the apparatus just described.

Register setting code for revertive ringing.

R+ wants R− must dial J—J—J— 1—2—2—2 or J—J—J—2—2—1—2
R+ wants T+ must dial J—J—J— 1—2—1—1 or J—J—J—1—1—1—2
R+ wants T− must dial J—J—J— 1—2—2—1 or J—J—J—2—1—1—2
R− wants T+ must dial J—J—J— 1—1—2—2 or J—J—J—2—2—1—1
R− wants T− must dial J—J—J— 2—1—2—2 or J—J—J—2—2—2—1
T+ wants T− must dial J—J—J— 2—1—1—1 or J—J—J—1—1—2—1

That is T+ takes 1—1 on Th and H or T and U
T− takes 2—1 on Th and H or T and U
R+ takes 1—2 on Th and H or T and U
R− takes 2—2 on Th and H or T and U

What is claimed is:

1. In an automatic telephone exchange system, calling and called subscribers' lines, including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, means to operate said automatic switches to establish an interconnection when the line called is not on the same party line with the subscriber who initiates a call, and means determined solely by the positions assumed by said registering devices to operate said ringing apparatus, to accomplish revertive ringing without operation of said automatic switches when a subscriber on a party line calls another subscriber on the same line.

2. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices, variably operable ringing apparatus, means to variably position said registering devices, means to operate said automatic switches in

accordance with certain settings of said registering devices, and means operative in accordance with other settings of said registering devices to prevent operation of said automatic switches and to put into operation said ringing apparatus to accomplish revertive ringing.

3. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, and means determined solely by the positions assumed by said registering devices to operate said ringing apparatus to accomplish revertive ringing when a subscriber on a party line calls another subscriber on the same line.

4. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, and means operative when a calling subscriber replaces his receiver to put into operation said ringing apparatus to accomplish revertive ringing when said registering devices have been set in certain positions.

5. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, and means operative when the calling subscriber replaces his receiver for actuating said ringing apparatus to accomplish revertive ringing by alternately signaling the calling and called subscribers respectively when said subscribers are on the same party line, without operating any of said automatic switches.

6. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, means to operate said automatic switches under the control of said sending device to establish a connection between a calling and a called subscriber when the called subscriber is not on the same party line with the calling subscriber, means to prevent the operation of said automatic switches and means to accomplish revertive ringing when the called subscriber is on the same party line as the calling subscriber, said last mentioned means being controlled in direct accordance with the positions assumed by said registering devices.

7. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, and discriminating means controlled by the setting of certain ones of said registering devices to determine whether said automatic switches shall be put into operation or whether said ringing apparatus shall be put into operation to accomplish signaling on the calling line.

8. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, a substation controlling apparatus, means to position said registering devices under the control of said substation apparatus, variably operable ringing apparatus, and means determined solely by the positions, assumed by said registering devices to operate said ringing apparatus to accomplish revertive ringing when a subscriber on a party line calls another subscriber on the same line.

9. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices for controlling the operation of said switches, means to variably position said registering devices, variably operable ringing apparatus, discriminating means controlled by the setting of certain ones of said registering devices to determine whether said automatic switches shall be put into operation or whether said ringing apparatus shall be put into operation to accomplish signalling on the calling line, and means controlled by the setting of other of said registers for variably operating said ringing apparatus.

10. In an automatic telephone exchange system, calling and called subscribers' lines including party lines, automatic switches for interconnecting said lines, a sending device including a plurality of registering devices, for controlling the operation of said switches, means to variably position said registering devices variably operable ringing apparatus, discriminating means controlled by the setting

of certain ones of said registering devices to determine whether said automatic switches shall be put into operation or whether said ringing apparatus shall be put into operation to accomplish signaling on the calling line, and means selectively controlled by the setting of other of said registers for variably operating said ringing apparatus to alternately signal the calling and called subscribers on the calling line.

In witness whereof, I hereunto subscribe my name this 18th day of June, A. D. 1920.

ALBEN E. LUNDELL.

In witness whereof, I hereunto subscribe my name this 2nd day of June, A. D. 1920.

GEORGE THOMPSON.