Oct. 20, 1925.

1,557,596

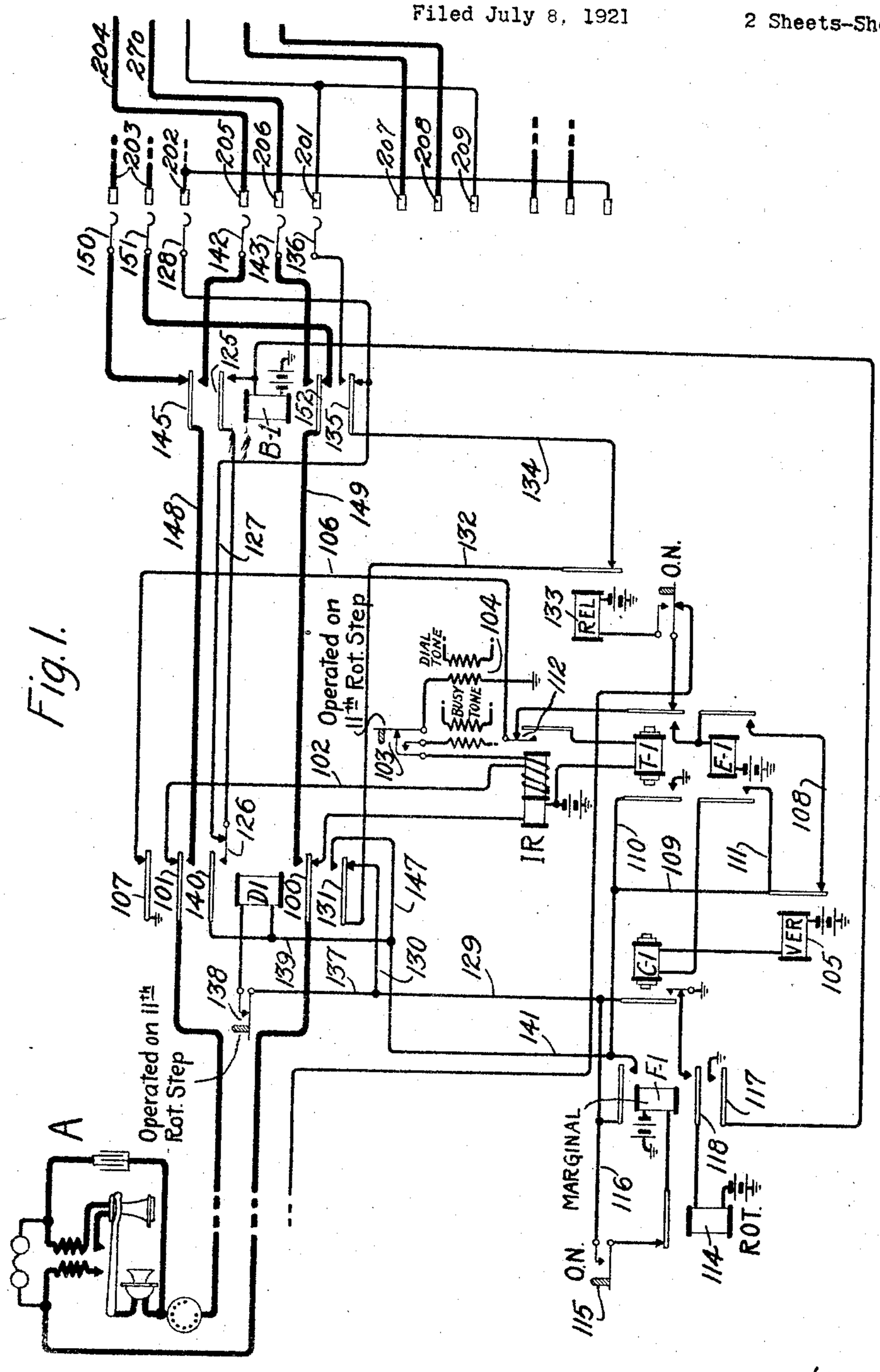
W. E. LAMB ET AL

MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

Filed July 8, 1921

2 Sheets-Sheet 1

Fig. 1.



Inventors

Willis E. Lamb and Ralph W. Mason

by

Atty.

Oct. 20, 1925.

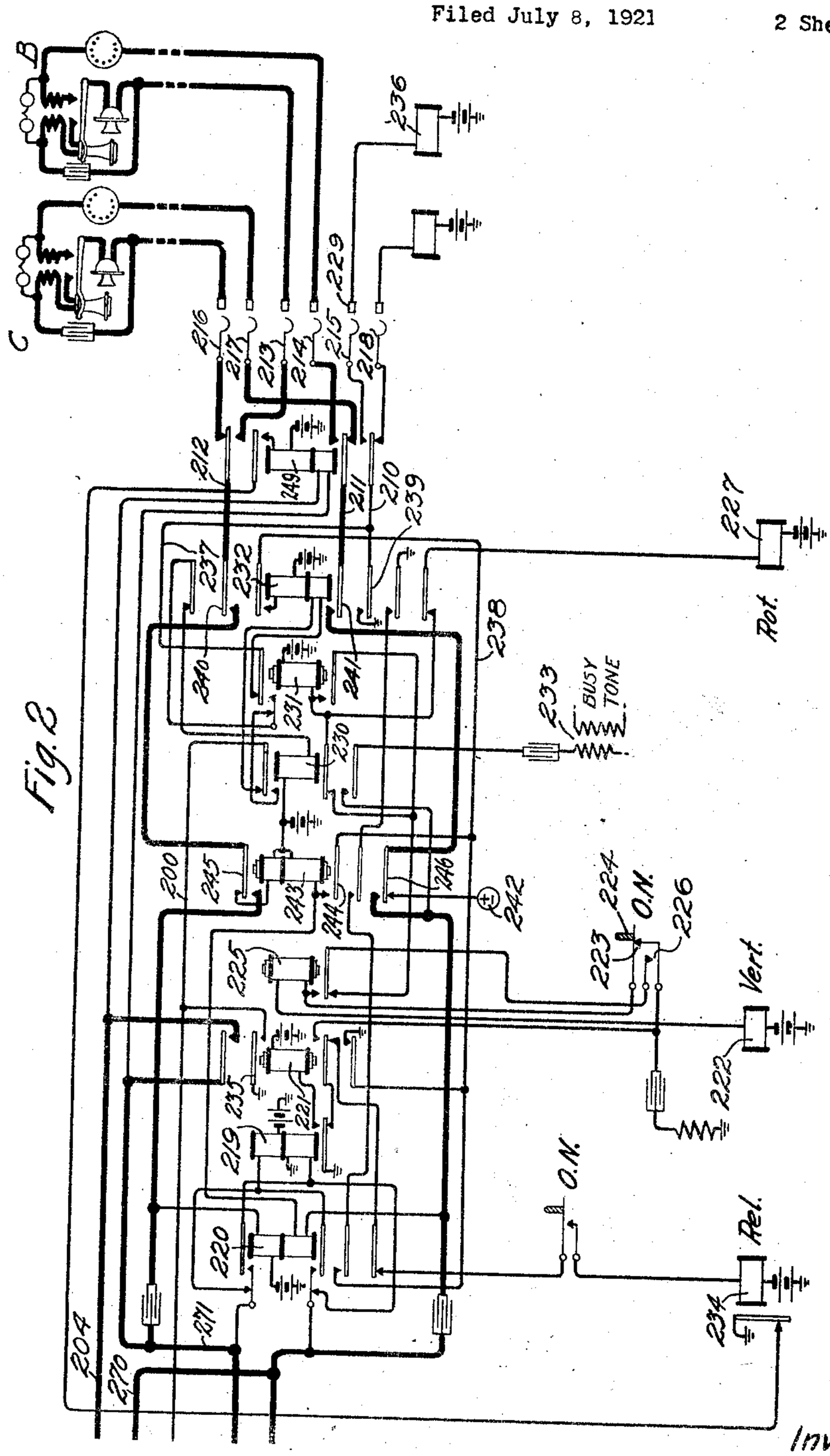
1,557,596

W. E. LAMB ET AL

MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

Filed July 8, 1921

2 Sheets-Sheet 2



Inventors

Willis E. Lamb and Ralph W. Mason

by J. E. Yorke

Atty.

Patented Oct. 20, 1925. 1,557,596

UNITED STATES PATENT OFFICE.

WILLIS E. LAMB, OF OAKLAND, AND RALPH W. MASON, OF BERKELEY, CALIFORNIA, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

MACHINE-SWITCHING TELEPHONE EXCHANGE SYSTEM.

Application filed July 8, 1921. Serial No. 483,305.

To all whom it may concern:

Be it known that we, WILLIS E. LAMB and RALPH W. MASON, residing at Oakland and Berkeley, in the county of Alameda and State of California, have invented certain Improvements in Machine-Switching Telephone Exchange Systems, of which the following is a specification.

This invention relates to machine switching telephone exchange systems.

Its object is to provide an improved system employing what are known as two-hundred point switches.

In the system of this invention the selectors and connectors have two sets of talking brushes and two test wipers. The selector is first raised a number of steps corresponding to the first digit and then automatically rotates, testing two trunks at each step, moving on if both are busy and if one is idle, seizing it. The calling line is thus extended to a succeeding link circuit which may be a connector. The set of brushes of this connector rendered operative is determined by the odd or even character of the digit involved in setting the preceding selector. Inasmuch as a given connector takes care of two hundred lines it is reached over either one of two levels of the preceding selector. In order to render the brush set serving the desired hundred of the two hundred lines terminating in the connector operative, one of the talking wires from say the even hundreds level in the preceding selector from which the connector may be reached, includes a switching magnet which operates only when the digit involved in setting the said selector is even and connects the brushes serving the even hundred group to the calling end of the circuit. This magnet in operating locks itself by a circuit through a second winding and short circuits the winding in the talking conductor to remove it from the conversational circuit. The conductor from the odd hundreds level of the selector from which the same connector is reached does not include this switching magnet, and consequently the other set of brushes is left connected to the calling end of the circuit when the connector is seized from this level.

Referring to the drawing, Figure 1 shows the calling line and a selector, and Fig. 2 shows a connector and a pair of substations. Referring to Fig. 1, the removal of the receiver at substation A causes a line switch, not shown, to seize a first selector shown in Fig. 1. The impulse relay IR of this selector is now energized over the following circuit: free pole of battery, left winding of relay IR, Fig. 1, armature 100 and back contact of relay D^1, lower talking conductor, through the loop at the substation A, upper talking conductor, armature 101 and back contact of relay D^1, conductor 102, right non-inductive winding of relay IR, switch 103 operated on the eleventh rotary step of the selector, secondary winding of the induction coil 104 to ground. This induction coil is provided for the purpose of giving a dial tone to the subscriber to inform him when the circuit is ready to receive impulses. When the relay IR operated, it energized the usual first slow relay T^1 over the following circuit: free pole of battery, relay T^1, armature and front contact of relay IR, conductor 106, to ground at the armature 107 and back contact of the relay D^1. Slow relay T^1 holds up over the line circuit interruptions and prepares a circuit for relay E^1. Now upon the first retraction of the impulse relay IR as the finger wheel after being rotated by the party at substation A restores to normal, the relay E^1 operates from ground on the armature 107 of relay D^1, and locks itself over the following circuit: free pole of battery, relay E^1, its right armature and front contact, conductor 108, armature and back contact of the vertical magnet 105, conductors 109 and 110, left armature of relay T^1 to ground. The relay E^1 in attracting its left armature sends an impulse to the vertical magnet 105 over the following circuit: free pole of battery, magnet 105, slow relay C^1, left armature and front contact of relay E^1, con-

ductors 111, 109, 110 to ground at the left armature and front contact of relay T^1. The vertical magnet 105 at the end of its stroke opens the locking circuit of the relay E^1 which releases. In releasing its left armature, this relay opens the circuit of the magnet 105 which releases. This occurs before the back contact 112 of the impulse relay IR is again closed, as the finger wheel interrupts the line circuit the second time. When this interruption occurs and the contact 112 is again closed, the same operations take place, the relay E^1 initially energizing from ground at the armature 107, locking itself to ground at its right armature and front contact, transmitting an impulse to the vertical magnet 105 and slow relay C^1 in series, the vertical magnet at the end of its stroke opening the locking circuit of the relay E^1, which in releasing again releases the vertical magnet, whereupon the circuit is ready for the next impulse. The relay C^1 being slow remains energized during the transmission of the vertical impulses. When this relay energized at the beginning of the impulses it operated relay F^1 over the following circuits: free pole of battery, relay F^1, armature and back contact of the rotary magnet 114, off-normal switch 115, conductor 116, armature and front contact of relay C^1 to ground. Relay F^1 in attracting its upper armature locked itself to ground over conductor 110 and the left armature and front contact of slow relay T^1 which holds up after the impulses are transmitted. In attracting its armature 117, relay F^1 operates the brush shifting relay B^1. In attracting its armature 118, relay F^1 prepares the circuit of the rotary magnet 114. A short interval after the relay E^1 releases when the vertical magnet interrupts its circuit on the receipt of the last vertical impulse, the relay C^1 releases, closing the circuit of the rotary magnet 114 which thereupon steps the selector brushes 150, 151, 128, 142, 143, 136, onto the first pair of trunks in the selected level. A level is made up of two horizontal rows of ten trunks each. If both of these first trunks are busy, the switch will move on to test the next two trunks. These trunk groups it will be understood are equivalent. If one of the trunks is idle, the switch will stop and seize such trunk.

Assuming that both trunks, first tested, are busy, both test multiples 202, 201, are then grounded. It will be remembered that relay B^1 operated when relay F^1 operated at the beginning of the vertical movement of the selector. Relay F^1 does not release until the end of the stroke of the rotary magnet 114 and consequently relay B^1 will hold up over its armature 125 and front contact, contact 126 of relay D^1, conductor 127, test brush 128 to ground on the test multiple 202 before its original energizing circuit is opened by the retraction of armature 117 of the relay F^1. Ground being also present on the test multiple 201 of the other trunk, an impulse is transmitted to again operate relay F^1 for transmitting another impulse to the rotary magnet to advance the brushes a step onto the next two trunks. The circuit for relay F^1 is as follows: free pole of battery, relay F^1, armature and back contact of magnet 114, off-normal switch 115, conductors 116, 129, 130, armature 131 and back contact of relay D^1, conductor 132, armature and back contact of selector release magnet 133, conductor 134, armature 135 and front contact of relay B^1, test brush 136 to the grounded test terminal 201. The circuit for the rotary magnet 114 includes the armature 118 of the relay F^1 and normal contact of the slow relay C^1.

Assuming now, that when the brushes engage the next two trunks, the trunk shown in full in Fig. 2 is idle. In that event, ground is present on the test multiple 202 of the other trunk and the test multiple 201 is open. The presence of ground on the test multiple 202 of the other trunk causes the switching relay B^1 to remain operated as before, and due to the absence of ground on the test multiple 201, the relay F^1 is not again energized to step the selector ahead. The absence of ground on test multiple 201 also permits the switching relay D^1 to operate over the following circuit: free pole of battery, relay F^1, armature and back contact of the rotary magnet 114, off-normal switch 115, conductors 116, 129, 137, switch 138, operated on the eleventh rotary step, relay D^1, conductor 139, 141, 110 to ground at the left armature and front contact of the slow relay T^1. Relay F^1 is marginal and does not operate in this circuit. Relay D^1 did not operate when the first two trunks were tested and found busy due to the shunt about its winding closed over the conductor 130, armature 131 and back contact of said relay, conductor 132, armature and back contact of the release magnet 133, conductor 134, armature 135 and its front contact brush 136 to the ground on multiple 201. The switching relay D^1 in attracting its armature 140 closes a substitute holding circuit for the relay B^1 as follows: free pole of battery, relay B^1, armature 125 and front contact of said relay, armature 140, and front contact of relay D^1, conductors 139, 141, to ground at the left armature and front contact of relay T^1. Relay D^1 in attracting its armatures 101 and 100 extends the talking conductors through to the impulse relay 219 of the connector which now operates over the calling line circuit. Relay 219 in attracting its armature energizes the usual first slow relay 221 of the connector which in attracting its upper armature grounds

the release wire 200 leading back to the preceding selectors. It will be understood that a number of selectors like that of Fig. 1 are interposed between the first selector and connector before the slow relay of the preceding selector corresponding to slow relay T^1 releases due to its circuit being opened by the release of its impulse relay when the switching relay corresponding to D^1 disconnects it from the calling line. Therefore, the relays similar to D^1 are held up over parallel circuit similar to the following circuit: free pole of battery, relay F^1, armature and back contact of magnet 114, off-normal switch 115, conductors 116, 129, switch 138, relay D^1, conductors 139, 147, armature 131 and front contact of relay D^1, conductor 132, armature and back contact of the release magnet 133, conductor 134, armature 135 and front contact of relay B^1, brush 136, multiple 201 to the grounded sleeve wire 200. This ground also causes the seized trunk shown in Fig. 2 to test busy in both levels in which it appears.

Assuming, on the other hand, that the trunk 202, 203 was idle and the trunk shown in full in Fig. 2 was busy, the test multiple 202 would be ungrounded, and the test multiple 201 would be grounded. Due to the absence of ground on test multiple 202, relay B^1 would release when its circuit is opened by the retraction of the armature 117 of relay F^1 and shift the trunk talking conductors 148 and 149 to the upper talking brushes 150, 151. Although ground is present on the test multiple 201 when the brush 136 encounters such terminal, relay B^1 releases before this ground is applied long enough to operate the relay F^1 and allow the rotary magnet to magnetize sufficiently to give the selector another step. As soon as the armatures 145 and 152 release, the impulse relay corresponding to 219 of said trunk operates over the calling line energizing slow release corresponding to 221, which supplies ground to the sleeve wire 200 leading back to the test multiple thus providing a substitute circuit for the relay D^1 before the circuit of such relay is opened by the release of the slow relay as before. This ground, also causes the seized trunk to test busy in both levels in which it appears.

Referring to Fig. 2, it will now be necessary to explain how the selection of a given line in a 200 point connector is secured, the finger wheel operating on the decimal basis. The second and third selectors (not shown) but which would be similar to the first selector shown in Fig. 1 are set to the desired levels and have seized trunks. The multiples 205, 206, 201 of the connector appear in an even level and the multiples 207, 208, 209 appear in an odd level of the third selector. A brush shifting magnet 249 is included in circuit with the impulse relay 219 when the connector is seized from the even level and shifts the trunk conductors 210, 211, 212 into connection with the brushes 213, 214, 215 serving the even hundred lines of the connector. This magnet is not operated when the connector is seized from the odd level and allows the trunk conductors to remain in contact with the brushes 216, 217, 218 serving the odd hundred lines in the connector.

Assuming that the hundreds digit is even the following circuit is closed for the impulse relay 219 and relay 249; free pole of battery, upper winding of relay 219, normal contact of relay 220, conductor 271, lower winding of relay 249, conductor 204, multiple 205, brush 142, armature 145 of relay B^1, conductor 148, armature 101 of relay D^1, through the substation loop, armature 100 of relay D^1, conductor 149, armature 152 of relay B^1, brush 143, multiple 206, conductor 270, normal contact of relay 220, lower winding of relay 219 to ground. Relay 219 operates slow relay 221, preparing the circuit of the vertical magnet 222. Relay 221 in attracting its upper armature grounds multiples 201 and 209 to render this connector busy in both levels in which it appears. The calling party now transmits the tens impulses. Each time the relay 219 closes its back contact an impulse is transmitted to the vertical magnet 222 over a circuit, including contact 223 of off-normal switch 224 and the slow relay 225, which holds itself operated during the transmission of the impulses. Contact 223 opens on the first step of the switch and contact 226 closes so that the impulses after the first, pass by way of the armature and front contact of relay 225. When the impulses cease, slow relay 225 releases and connects the rotary magnet to the back contact of the impulse relay and upon the transmission of the units impulses the rotary magnet 227 steps the brushes around a number of steps corresponding to the number of the units impulses. Slow relay 231 holds up during these impulses and releases when they cease. It having been assumed that the hundredths digit was even the relay 249 which operated when the connector was seized, locked itself over its upper winding to ground under control of the release magnet 234. Therefore the brushes 213, 214 and 215 serving the even hundreds, are in circuit with the trunk conductors 210, 211, 212, and an even hundreds line, which we will assume to be the one, designated B, has been selected. A test of the line now takes place.

If the line is busy ground is present on its multiple 229 which operates relay 230 over the following circuit; free pole of battery, relay 230, uppermost armature and

back contact of relay 232, upper armature and front contact of slow relay 231, conductors 237, 210, brush 215 to ground on the test multiple 229. Upon the release of slow relay 231, relay 230 locks itself to ground on conductor 200. Relay 230 in attracting its upper armature prevents relay 232 from operating and applying ringing current to the line, and in attracting its lowermost armature applies busy tone from source 233 to the calling line. When the calling party replaces his receiver relay 219 releases, releasing relay 221; the inert condition of these relays operating the connector release magnet 234. The retraction of armature 235 of relay 221 removes ground from release wire 200, deenergizing relay D^1 of the first selector, and similar relays of the other selectors in the switch train and also releases the line switch. The retraction of armature 107 of relay D^1 closes the circuit of release magnet 133 of the first selector.

Assuming however that the called line is idle, full potential is present on multiple 229 and relay 232 operates over the following circuit: free pole of battery, relay 236, multiple 229, brush 215, conductors 210, 237, upper armature and back contact of relay 231, lower winding of relay 232, upper armature and back contact of relay 230 to grounded release wire 200. Relay 232 in attracting its upper armature locks itself to conductor 238, grounded at the lowermost armature of relay 221. In attracting its armature 239 relay 232 grounds the test multiple 229 to render the selected line busy. In attracting its armatures 240, 241, relay 232 connects ringing current to the called line from source 242, this circuit including the upper winding of the ringing cutoff relay 243. When the called party answers, this relay operates removing the ringing current and in attracting its armature 244, locks itself to grounded conductor 238. In attracting its armatures 245 and 246, relay 243 completes the conversational circuit. Relay 220 energizes in series with the called line and reverses the direction of current flow in the calling line for metering purposes in the well-known manner.

Upon the replacement of the receiver by the calling party after the termination of the conversation the connection is released as described in the case of a busy line.

If the connector had been seized from the odd level at multiples 207, 208, 209; that is to say if the hundreds digit was odd, the relay 249 would not have been operated and the brushes 216, 217, 218 would remain in connection with the trunk conductors 210, 211, 212 and at the end of the rotary movement of the connector these brushes would extend the calling line to substation C, the corresponding line in the odd hundreds. The other operations would be the same as those described in detail.

While only one selector is shown it will be understood that in actual practice a second and third selector would also be used, the connector shown being accessible from levels in the third selectors.

What is claimed it:

1. In a telephone system, a connector switch having a pair of bush sets, groups of called lines to which said switch has access, terminal banks leading to said connector, a brush shifting relay in said connector for rendering operative the proper connector brush set, a circuit including said brush shifting relay closed over the talking conductors of said connector switch via certain of said terminal banks for operating said brush shifting relay, a release magnet in said connector switch, and a locking circuit for said brush shifting relay including a contact of said release magnet.

2. In a telephone system, a calling line, a connector switch having a pair of brush sets, groups of called lines to which said switch has access, terminal banks leading to said connector, a brush shifting relay in said connector for rendering operative the proper connector brush set, a circuit including a winding of said brush shifting relay closed over the talking conductors of said connector switch via certain of said terminal banks for operating said brush shifting relay, a slow relay, means responsive to the extension of said calling line to said connector for operating said slow relay to remove the winding of said brush shifting relay from the talking circuit, a release magnet in said connector, and a locking circuit for said brush shifting relay including a contact of said release magnet.

3. In a telephone system, a switch, a plurality of sets of correspondingly positioned brushes on said switch, a series of sets of contacts for each of said sets of brushes, a connecting circuit extending to said switch, multiple terminal contacts for said connecting circuit, a relay to the back contacts of which one of said brush sets is connected, the other brush set being connected to the front contacts of said relay, a circuit for said relay automatically completed when connection is made to certain of said multiple terminal sets, a release magnet in said switch, and a locking circuit for said relay including an armature thereof and a contact of said release magnet.

4. In a telephone system, a switch, a plurality of sets of correspondingly positioned brushes on said switch, a series of sets of contacts for each of said sets of brushes, a connecting circuit extending to said switch, multiple terminal contacts for said connecting circuit, a relay arranged to render one

of said brush sets operative when said relay is deenergized, the other brush set being rendered operative when said relay is energized, a circuit for said relay automatically completed when connection is made to certain of said multiple terminal contacts, a release magnet in said switch, and a locking circuit for said relay including an armature thereof and a normal contact of said release magnet.

In testimony whereof, we have signed our names to this specification this 28th day of June 1921.

WILLIS E. LAMB.
RALPH W. MASON