March 15, 1932. B. G. DUNHAM 1,849,662

TELEPHONE EXCHANGE SYSTEM

Filed May 14, 1930 4 Sheets-Sheet 1

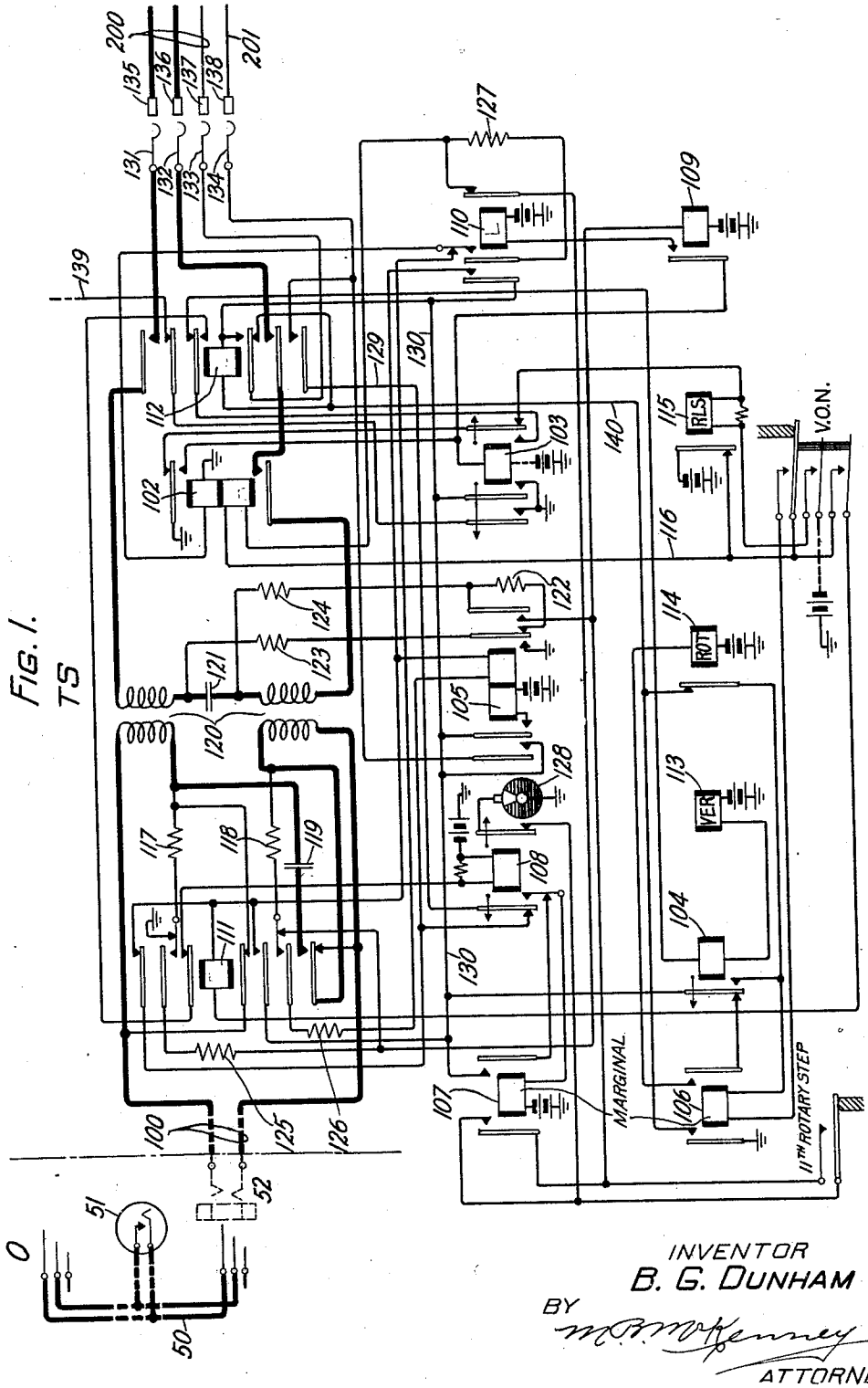

FIG. 1.

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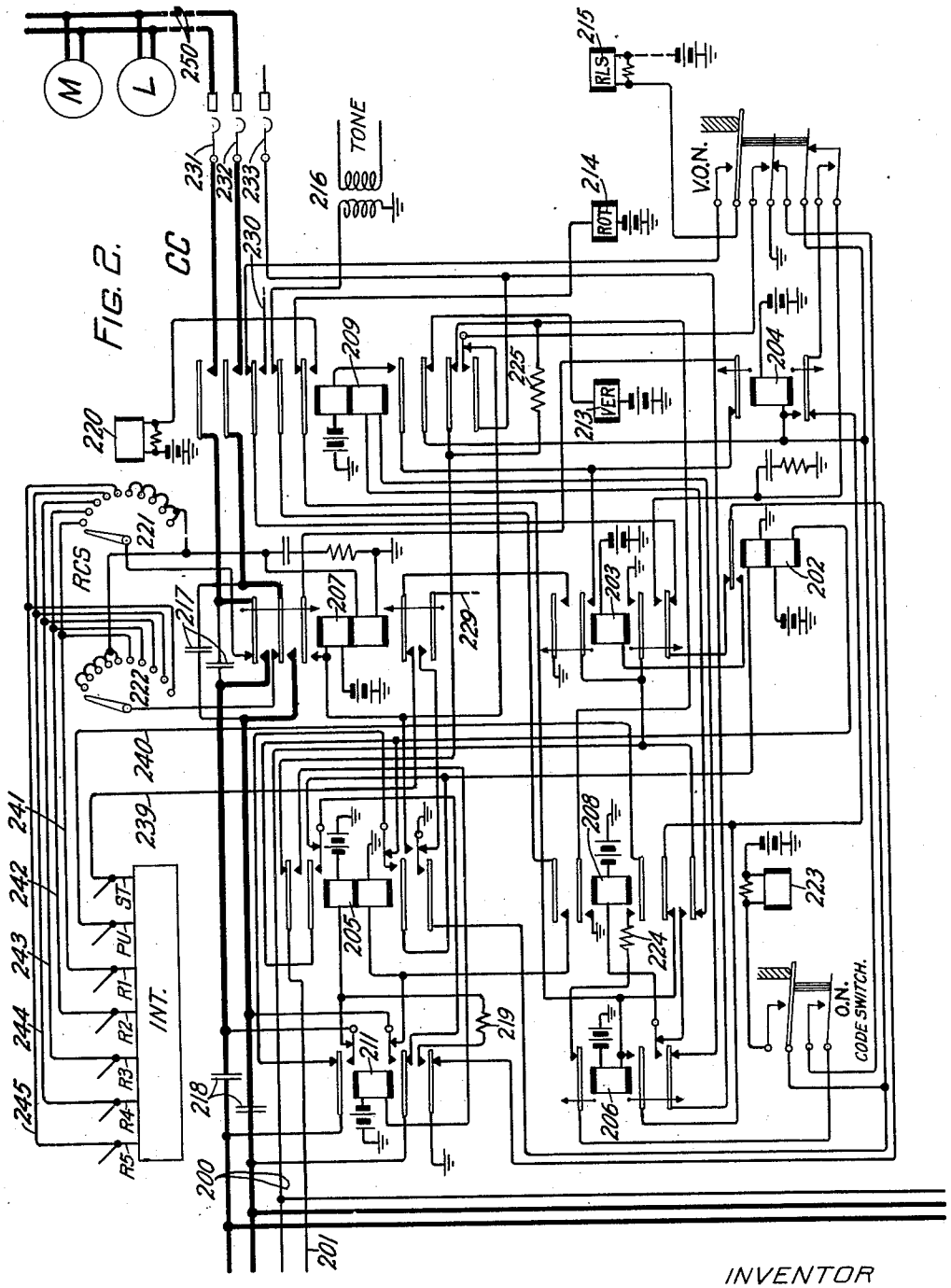

FIG. 2.

CC

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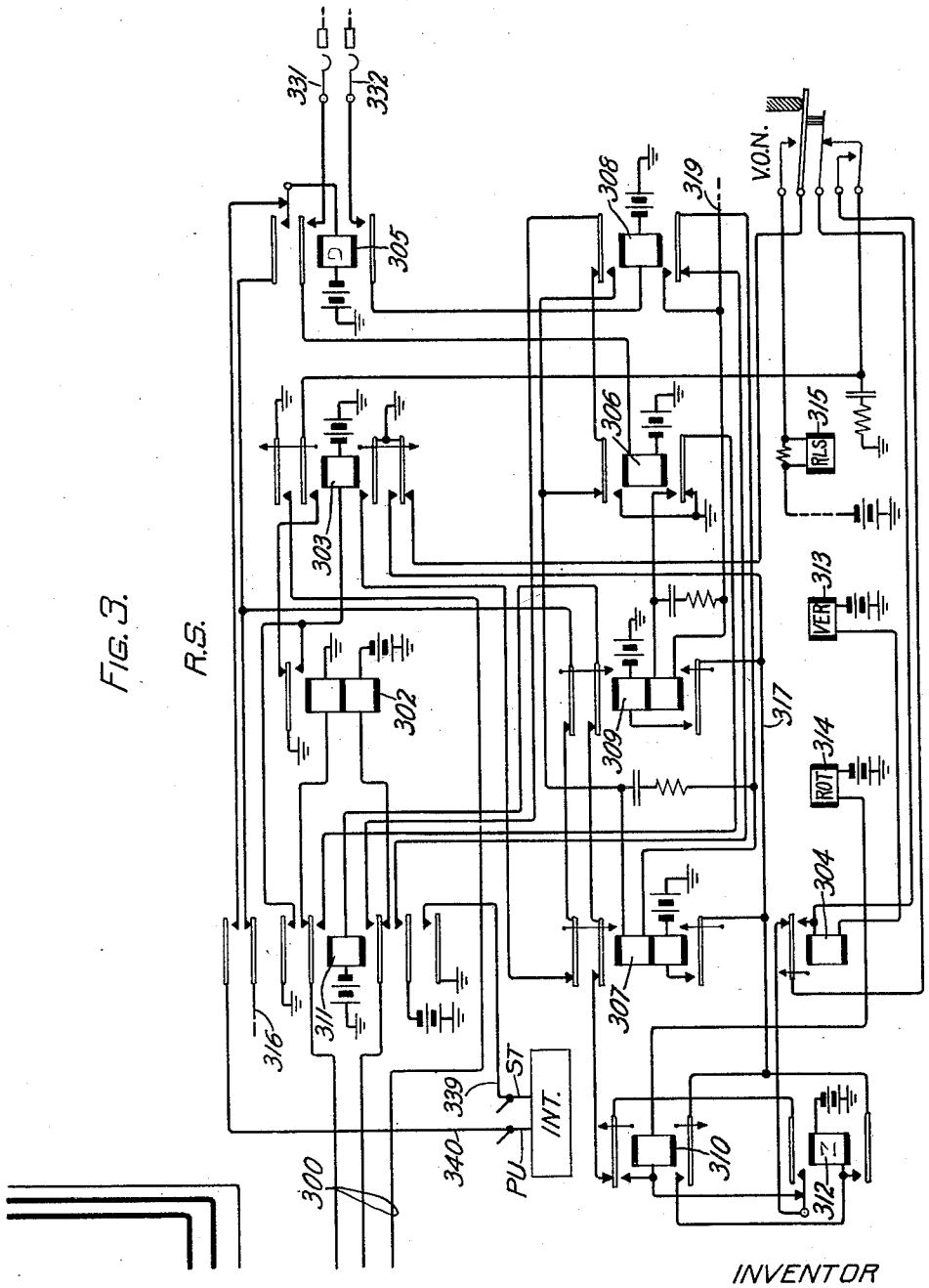

FIG. 3.

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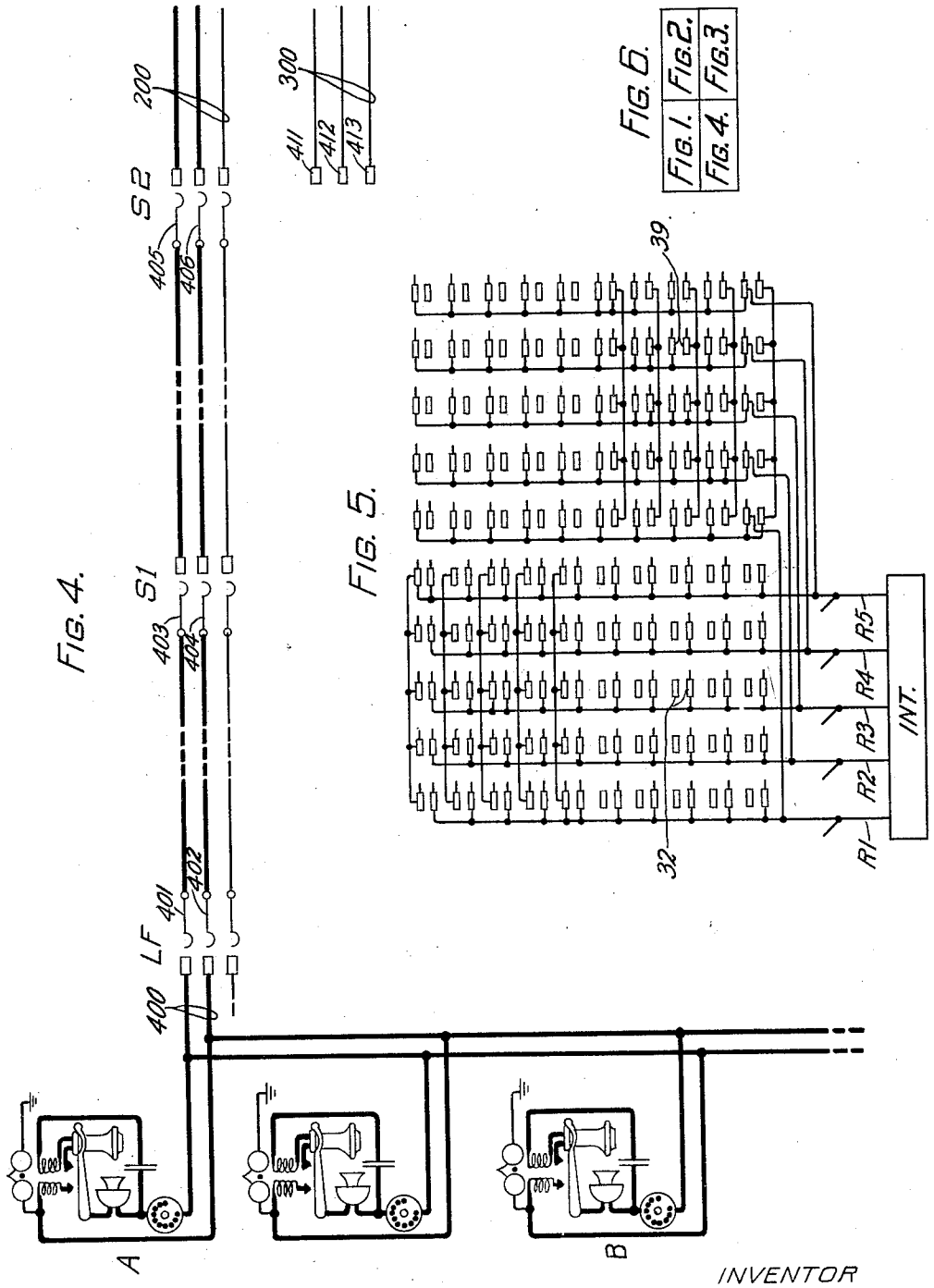

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UNITED STATES PATENT OFFICE

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TELEPHONE EXCHANGE SYSTEM

Application filed May 14, 1930. Serial No. 452,193.

This invention relates to telephone systems and more particularly to automatic and semi-automatic telephone systems.

The object of this invention is to provide reliable and economical means for completing both toll and local calls to subscribers served by an automatic telephone office.

Heretofore the circuits of connector switches employed in completing both toll and local calls have been provided with switching means for establishing the proper transmission and supervision for each type of call. Various arrangements have been used for distinguishing between toll and local calls. As shown in the patent to Ray L. Stokely #1,464,118 dated August 7, 1923 a control relay which is inserted in the sleeve or release lead of the connector circuit operates when the connector switch is seized by a local selector but does not operate if seized by an incoming selector; the line and sleeve conductors are multipled directly to terminals in the banks of both toll and local selectors. In other circuit arrangements one set of line and sleeve conductors are multipled to the banks of local selectors and another set of line and sleeve conductors are multipled to the banks of toll selectors; a control relay is inserted in one of the line conductors of the connector circuit on toll calls only, and an additional control lead is provided from the banks of toll selectors for facilitating supervision on toll calls.

Circuits arranged according to this invention permit the line and sleeve conductors of a connector switch to be directly multipled to terminals in the banks of both toll and local selector switches without the use of a control relay in the sleeve conductor or in either of the line conductors, a fourth conductor being provided between the toll selectors and each connector switch to facilitate supervision on toll calls.

Another feature of this invention is the provision of a two-motion reverting selector switch for use in completing calls from a calling to a called station on a ten-party line, the selector being arranged so that ringing current may be simultaneously transmitted over both sides of the line whenever the calling and called stations are signaled over opposite sides of the lines, or alternately transmitted if the stations are signaled over the same side of the line.

The drawings which consist of Figures 1 to 6 inclusive represents schematically a portion of a telephone system in which this invention is embodied.

Figure 1 shows an operator's position O in a toll office and an incoming selector circuit TS in a local office for completing calls from the toll office to subscribers in the local office.

Figure 2 shows a combination connector circuit CC, in the local office, which may be seized by an incoming selector on a toll call or by a selector on a call from a subscriber in the same or another local office. This connector circuit is arranged for code ringing on ten-party lines.

Figure 3 shows a reverting selector circuit RS in the local office for use on calls in which one subscriber on a ten-party line is calling another subscriber on the same line.

Figure 4 represents three stations A, B, and C on a ten-party line, a line finder switch LF having access to the line to which stations A, B and C are connected, a first selector switch S1 associated with the line-finder LF, and a second selector S2. The second selector S2 is connected by trunk conductors to terminals in the bank of selector S1 and may be used in extending a call to a connector circuit such as CC (in Figure 2) or to a reverting selector circuit such as RS (in Figure 3).

Figure 5 shows the bank wiring of the reverting selector RS as arranged for ten-party code ringing.

Figure 6 shows how Figures 1 to 4 inclusive are to be asembled to form the system in which this invention is incorporated.

The line-finder switch LF, selector switches S1 and S2, the incoming selector switch TS, reverting selector switch RS, and connector switch CC are all of the well known step-by-step type having both a vertical and a rotary movement. But this invention is not limited to systems employing switches of this particular type and may be applied to systems us-

ing other types of switches. It is understood that one or more additional selectors might be inserted between selector TS and connector CC and between selector S2 and connector CC.

The features of this invention will be described in connection with the establishment of a call from the toll operator's position O to the subscriber at station L in the local office, and in connection with the establishment of calls from the subscriber at station A in the local office to the subscriber at station L in the same or another local office and to the subscriber at station B on the same line as station A. The stations A and B and the stations L and M are served by ten-party lines, five of the stations are signaled over one side of the line, and the other five stations are signaled over the other side of the line. Code ringing is used to distinguish between each of the five stations signaled on the same side of the line. The numbers assigned to stations A, B, L, M etc. are composed of one more digit than the numbers assigned to the line by which they are served, the last digit being used for selecting the proper ringing code.

When the toll operator inserts the plug of a calling cord such as 50 into jack 52 the line relay 102 of toll selector Ts operates in a circuit which may be traced from battery through the back contact of the release magnet 115, conductor 116, lower winding of relay 102, right-hand back contact of relay 110, back contact of the continuity spring of relay 111, resistance 118, outer lower back contact of relay 111, the ring conductor of trunk 100, jack 52, through the cord circuit 50 and dial 51 of the toll operator's position, back over the tip conductor of trunk 100, inner lower back contact of relay 111, and through resistance 117 to ground at the upper continuity spring and back contact of relay 111. Relay 102 closes an obvious circuit for operating slow-to-release relay 103. Relay 103 connects ground through its inner left-hand front contact to conductor 130, this ground being effective to hold the connection after its extension to an idle connector circuit, as hereinafter described. Relay 103 also connects ground through its outer left-hand front contact, and the outer upper back contact of relay 112, over conductor 139 to the permanent signal alarm circuit (not shown); should relay 112 fail to operate in consequence of the selection of a trunk to an idle connector circuit within a predetermined interval of time the alarm is operated.

When the toll operator dials the first digit of the number of the called line, relay 102 alternately releases and reoperates in response to the dial impulses. The release of relay 102 closes a circuit for operating the vertical magnet 113 and the relay 104; this circuit may be traced from battery through the windings of magnet 113 and relay 104 in series, inner upper back contact of relay 112, right-hand front contact of relay 103, and through the back contact of relay 102, to ground. Being slow in releasing relay 103 does not release during receipt of the dial impulses. Relay 104 is also slow in releasing and remains operated until all of the pulses created by the dialing of the first digit have been received. The vertical magnet 113 is operated and released each time relay 102 is released and reoperated thereby advancing the brushes 131, 132, 133 and 134 up to the level corresponding to the first digit dialed. As soon as the shaft and brushes advance from normal position the vertical off-normal springs VON are operated thereby closing a circuit for operating relay 106; this circuit may be traced from battery through the back contact of the release magnet 115, upper contact of the VON springs, winding of relay 106, front contact of relay 104, conductor 130, to ground at relay 103. Relay 106 locks to ground through its left-hand front contact under control of the rotary magnet.

The release of relay 104, after all of the impulses created by the dialing of the first digit have been received, closes a circuit for operating rotary magnet 114; this circuit may be traced from battery through magnet 114, right-hand front contact of relay 106, back contact of relay 104, over conductor 130, to ground at relay 103. The operation of rotary magnet 114 releases relay 106 and the release of relay 106 opens the circuit through the winding of magnet 114. The operation of the rotary magnet advances the brushes of selector TS into contact with the first set of terminals in the previously selected level. If the trunk and connector circuit to which these terminals are connected is idle relay 112 operates; the circuit for operating relay 112 may be traced from battery through the back contact of release magnet 115, upper contact of the VON springs, winding of relay 106, back contact of rotary magnet 114, conductor 140, winding of relay 112, conductor 130, to ground at relay 103. Relay 106 is marginal and does not operate in series with the winding of relay 112.

Should the first set of terminals be busy, ground on the sleeve terminal is connected through brush 133 and the lower back contact of relay 112 to short circuit the winding of relay 112 and thereby prevent its operation. In this event relay 106 is reoperated by the ground on the sleeve terminal of the busy trunk, thus causing the reoperation of the rotary magnet 114. The magnet 114 and relay 106 are thus effective to advance the brushes of selector switch TS until an idle set of terminals is engaged and relay 112 operated. Should all of the trunks on the selected level be busy, the brushes are advanced beyond the tenth set of terminals to

operate the 11th rotary step springs and connect the interrupter 128 to the winding of relay 109; and relay 109 operates as soon as the interrupter connects ground to its winding. In operating, relay 109 closes an obvious circuit for operating relay 110. Relay 110 closes a circuit for operating relay 111; this circuit may be traced from battery through the back contact of release magnet 115, lower contacts of the VON springs, winding of relay 111, outer left-hand front contact of relay 110, conductor 130, to ground at relay 103. In operating, relay 111 closes a locking circuit through its inner lower front contact and over conductor 130 to ground at relay 103; relay 111 also reverses the conductors of trunk 100 with respect to the windings of line relay 102, so as to reverse the current over trunk 100. This reversal of current is effective at the toll operator's position to substitute a supervisory bridge across the trunk conductors in place of the dial 51. Relay 109 operates and releases under control of interrupter 128 thereby causing the alternate operation and release of relay 110. Each operation of relay 110 opens the circuit which includes the lower winding of line relay 102 and the toll operator's cord circuit, but relay 102 is held operated in a circuit from battery through the back contact of release magnet 115, lower winding of relay 102, resistance 127, inner left-hand front contact of relay 110, upper winding of relay 102, to ground. At each release of relay 110 the tip conductor of trunk 100 is connected through the upper left-hand winding of repeating coil 120, resistance 117, front contact of the upper continuity spring of relay 111, resistance 125, right-hand back contact of relay 110, lower winding of relay 102, back contact of release magnet 115, to battery; and the ring conductor of trunk 100 is connected through the lower left-hand winding of repeating coil 120, resistance 118, front contact of the lower continuity spring of relay 111, resistance 126, left-hand back contact of relay 110, upper winding of relay 102, to ground. The alternate opening and closing of this circuit by relay 110 flashes the supervisory lamp of the toll cord circuit as on all-trunks busy signal.

Assume trunk 200 to have been idle when the brushes 131, 132, 133 and 134 came into contact with the terminals 135, 136, 137 and 138; the operation of relay 112 as hereinbefore described connects the ground at relay 103 over conductor 130, through the inner lower front contact of relay 112 and brush 133 to terminal 137, to guard the selected trunk and associated connector CC from seizure by any other hunting selector. Relay 112 also closes a bridge across the tip and ring conductors of the selected trunk to operate the line relay 202 of the connector circuit CC. The circuit for operating relay 202 may be traced from battery through the lower winding of relay 202, inner lower back contact of relay 205, outer upper back contact of relay 211, tip conductor of trunk 200, terminal 135 and brush 131, outer upper front contact of relay 112, upper right-hand winding of repeating coil 120, resistance 123, right-hand back contact of relay 105, resistances 122 and 124, lower right-hand winding of repeating coil 120, lower front contact of relay 102, middle lower front contact of relay 112, brush 132, terminal 136, ring conductor of trunk 200, middle lower back contact of relay 211, inner upper back contact of relay 205, and through the upper winding of relay 202, to ground. In operating, relay 202 closes an obvious circuit for operating the slow-to-release relay 203. Relay 203 connects ground through its inner lower front contact over the sleeve conductor of trunk 200 to the sleeve terminals of all selectors having access thereto as a guarding potential. This ground is also effective on local calls to hold the preceding switches involved in the connection.

When the toll operator dials the next digit of the called number relay 102 of the toll selector circuit is alternately released and reoperated thereby opening and closing the circuit for the line relay 202 of the connector circuit. The first release of relay 102 closes a circuit for operating the slow-to-release relay 108; this circuit may be traced from battery through the winding of relay 108, inner upper back contact of relay 111, inner upper front contact of relay 112, right-hand front contact of relay 103 to ground at the back contact of relay 102. Relay 112 holds until all of the pulses in each train repeated by relay 102 have been received.

The first release of relay 202 closes a circuit for operating vertical magnet 213 and relay 204; this circuit may be traced from battery through the winding of vertical magnet 213 and the next-to-the-outer lower back contact of relay 209, in parallel with the winding of relay 204, through the normally closed contacts of the VON springs, outer lower front contact of relay 203, back contact of relay 202, to ground at the back contact of relay 211. The circuit through the windings of magnet 213 and relay 204 is closed and opened each time relay 202 releases and reoperates. The vertical magnet 213 is thereby operated and released in response to each of the impulses to advance the brushes 231, 232 and 233 up to the corresponding level in the associated bank of terminals. As soon as the shaft and brushes are moved out of their normal position the VON springs are operated, thereby closing a circuit from battery through the upper winding of relay 207, outer lower back contact of relay 209, to ground at the VON springs. Relay 207 operates; and, when relay 204 releases, as hereinafter described, relay 207 is locked through

its inner upper front contact under control of relay 204 to ground at the inner front contacts of relay 203. Relay 204 is slow-to-release and remains operated until all of these impulses have been received. After the VON springs have been operated the circuit for operating the vertical magnet and for holding relay 204 is traced through the lower front contact of relay 204, the lower front contact of the VON springs, outer lower front contact of relay 203, and through the back contact of relay 202, to ground at the back contact of relay 211.

Relay 204 releases, when all of the impulses in the train have been received, to transfer the pulsing contacts of line relay 202 from the vertical magnet 213 to the rotary magnet 214. When the toll operator dials the next digit of the called stations number relay 102 of the toll selector is again alternately released and reoperated to repeat the impulses to the line relay 202 of the connector CC. The first release of relay 202 closes a circuit for operating relay 206 and the rotary magnet 214; this circuit may be traced from battery through the winding of rotary magnet 214 and inner upper back contact of relay 209, in parallel with the winding of relay 206, through the inner lower back contact of relay 208, lower back contact of relay 204, lower front contact of the VON springs, outer lower front contact of relay 203 and through the back contact of relay 202 to ground at the back contact of relay 211. With relay 206 operated, this circuit is also closed through the inner lower front contact of relay 206 so as to be independent of relay 208. Relay 206 is slow to release and it holds during receipt of the entire train of impulses; but the rotary magnet releases each time relay 202 reoperates. The brushes 231, 232 and 233 are thus advanced, one step each time the rotary magnet operates, into contact with the set of terminals which correspond to the next to the last digit of the called station's number. After all of this train of impulses have been received by relay 102 and repeated to relay 202, but before relay 108 of the selector TS and relay 206 of the connector CC have released, a testing relay 208 is connected to the sleeve terminal of the called line to determine whether or not the called line is busy; this connection may be traced from battery through the winding of relay 208, outer lower front contact of relay 206, through brush 233 to the sleeve terminal of the called line. If the called line is idle relay 208 does not operate, but if the called line is busy the sleeve terminal is at ground potential and relay 208 operates.

If relay 208 operates, the continuity contacts of relay 206 close a locking circuit for relay 208 when relay 206 releases; this circuit may be traced from battery through the winding of relay 208, the continuity spring and back contact of relay 206 and the outer lower front contact of relay 208, to ground at the front contact of relay 203. Relay 208 closes a connection from ground through the secondary winding of the busy tone transformer 216, next-to-the-inner upper back contact of relay 209, outer upper front contact of relay 208, inner lower back contact of relay 211, to the ring conductor of trunk 200. Relay 208 also connects ground through its inner upper front contact, next-to-the-outer lower back contact of relay 209, outer upper back contact of relay 205, over control conductor 201, terminal 138 and brush 134 of selector TS, outer lower front contact of relay 112, conductor 129, left-hand front contact of relay 108, and through the winding of relay 107, to battery. Relay 107 operates; and as soon as the continuity spring of slow-to-release relay 108 closes its back contact, relay 107 is held operated through this back contact and its own right-hand front contact, over conductor 130, to ground at relay 103. With relay 107 operated, the release of relay 108 connects the winding of relay 109 through the left-hand front contact of relay 107 and through the right-hand back contact of relay 108, to the interrupter 128. The release of relay 108 also extends the connection from ground in the connector circuit CC over control conductor 201 and conductor 129, through the left-hand back contact of relay 108, outer upper back contact and winding of relay 111, and through the lowest contact of the VON springs, to battery at the back contact of release magnet 115. Relay 111 operates to reverse the flow of current over trunk 100 and thereby cause the conductors of trunk 100 to be transferred from the dial at the toll operator's position to a supervisory bridge (not shown) in the associated outgoing trunk circuit. The interrupter 128, relay 109 and relay 110 now function as hereinbefore described to interrupt the current over the trunk and thus to flash the supervisory lamp (not shown) of the toll cord as a line busy signal. The tone hereinbefore described as being connected to the ring conductor of trunk 200 is also transmitted through repeating coil 120 and trunk 100 to the toll operator.

Assuming the called line to be idle, relay 208 does not operate; and, when relay 206 releases, a circuit is closed from battery through the winding of the cut-off relay (not shown) of the called line, through the sleeve terminal and brush 233, outer lower back contact of relay 206, lower winding of relay 209, outer lower back contact of relay 208, to ground at relay 203. Relay 209 is partially operated in this circuit to close a locking circuit from battery through its upper winding and inner lower front contact, to ground at relay 203. Relay 209, being fully operated by the closure of this locking circuit,

connects ground through the next-to-the upper front contact of the VON springs and through the front contact of the continuity spring of relay 209, through brush 233, to the sleeve terminal of the called line to hold the cut-off relay operated and prevent seizure of this line by any other connector switch.

When the toll operator dials the last digit (the ringing code digit) of the number of the called station L, the line relay 102 of selector TS repeats the impulses to the line relay 202 of the connector CC in the manner hereinbefore described. The first release of relay 202 closes a circuit for operating relay 206 and the stepping magnet 220 of the rotary code-ringing switch RCS; this circuit may be traced from battery through the winding of magnet 220 and the inner upper front contact of relay 209, in parallel with the winding of relay 206, through the inner lower back contact of relay 208, lower back contact of relay 204, lowest contact of the VON springs, outer lower make contact of relay 203, back contact of relay 202, to ground at the back contact of relay 211. With relay 206 operated, the circuit through its winding and the winding of magnet 220 is also closed through the inner lower contact of relay 206 so as to be independent of relay 208. Relay 206 holds until all of these impulses have been received; but the stepping magnet 220 operates and releases each time relay 202 releases and reoperates, thereby advancing the brushes 221 and 222 of switch RCS into the required ringing position. The operation of relay 206 also closes a circuit for operating relay 208; this circuit may be traced from battery through the winding of relay 208, outer lower front contact of relay 206, outer lower front contact of relay 209, to ground at the VON springs. When relay 206 releases after all of the impulses have been received, relay 208 is held operated in the circuit through its winding and the back contact of the continuity spring of relay 206 and through the outer lower front contact of relay 208, to ground at relay 203. Relay 208 connects ground through its inner upper front contact, resistance 225, outer upper back contact of relay 205, control conductor 201, terminal 138 and brush 134 of selector TS, outer lower front contact of relay 112, conductor 129, left-hand front contact of relay 108, winding of relay 107 to battery; but relay 107 is marginal and does not operate with resistance 225 included in this circuit. When relay 108 releases after all of the impulses corresponding to the last digit of the called station's number have been received, the connection from the ground in the connector circuit CC, over control conductor 201 to conductor 129 (as hereinbefore traced) is extended through the left-hand back contact of relay 108, the outer upper back contact and winding of relay 111, lowest contact of the VON springs, to battery at the back contact of release magnet 115. The reversing relay 111 operates in this circuit to reverse the current over trunk 100 and thereby cause the conductors of trunk 100 to be transferred from the dial at the toll operators position to a supervisory bridge (not shown) in the associated outgoing trunk circuit; this bridge is effective to hold relay 102 operated, the connections from the conductors of trunk 100 through the windings of relay 102 to battery and ground having been hereinbefore described.

The advance of the code switch RCS from its normal position operates its off-normal springs ON and when relay 206 releases, after all of the last train of impulses have been received, the winding of relay 204 is connected through the lower contacts of the ON springs, upper back contact of relay 206, resistance 224, inner lower front contact of relay 208, over conductor 240, to the pick-up lead PU of the ringing current interrupter INT. The ringing interrupter is arranged to remain in a normal position until one or more connector switches are ready to signal a called station. In the normal position of the interrupter, the PU lead is connected to ground so that relay 204 operates as soon as the interrupter reaches its normal position, if not already in this position when relay 206 releases. The operation of relay 204 opens the circuit through the upper winding of relay 207 so that relay 207 releases. The release of relay 207 connects ground from the outer upper front contact of relay 203, through the lower back contact of relay 207, over conductor 239 to the start lead ST of the ringing interrupter INT. With the ST lead grounded by any one or more of the connector switches such as CC, the ringing interrupter circuit is effective to intermittently connect ringing and tripping potentials to the ringing leads R1, R2, R3, R4, and R5, so as to supply ringing current of five different codes. Relay 204 releases as soon as the interrupter mechanism moves off-normal.

Assuming the brushes of code switch RCS to have been advanced to position 3, the ringing circuit for signalling the called party may be traced from ringing current lead R3, brush 221 in pisition 3, outer upper back contact of relay 207, outer upper front contact of relay 209, brush 231, tip-side of the subscriber's line 250, through the ringers of five subscriber's to ground. Ringing tone is transmitted through one or the other of condensers 217 (depending upon which side of the called line is being used to transmit ringing current) to one of the talking conductors of trunk 200, this tone being repeated by selector TS over the trunk 101 to the toll cord. Upon answer of the called party relay 207 operates in a circuit which may be traced from the ringing or tripping potential over

lead R3 and over the tip-side of the called line as traced above, through the answering subscriber's telephone set, back over the ring-side of the called line, brush 232, next-to-the-outer upper front contact of relay 209, inner upper back contact of relay 207, brush 222 in position 3, lower winding of tripping relay 207, to ground. Relay 207 operates thereby transferring the called line from brushes 221 and 222 of the code switch, through the two outer upper front contacts of relay 207 through the inner back contacts of relay 211, and through the windings of relay 205 to battery and ground, thereby causing the operation of relay 205. The called line is also extended through the contacts of relay 207 and through the talking condensers 218 to the tip and ring conductors of trunk 200.

The operation of relay 205 reverses the connections between the tip and ring conductors of trunk 200 and the windings of line relay 202, closes a holding circuit through the upper winding of relay 207, and closes a circuit for operating the release magnet 223 of the code switch RCS thereby causing this switch to restore to normal. Upon reaching its normal position the ON contacts of the code switch are restored to their normal position thus opening the circuit through the winding of magnet 223. Relay 205 also opens the connection from control conductor 201 to ground as hereinbefore traced, and closes a circuit over this conductor for operating relay 211 of the connector circuit CC and for partially operating relay 105 of toll selector circuit TS; this circuit may be traced from battery through the winding of relay 211, outer upper front contact of relay 205, conductor 201, terminal 138 and brush 134, outer lower front contact of relay 112, left-hand back contact of relay 108, right-hand winding of relay 105, the inner lower front contact of relay 111, over conductor 130 to ground at relay 103. The operation of relay 211 causes the release of relays 202 and 203, closes a holding circuit through the upper winding of relay 205 and resistance 219, and short circuits the talking condensers 218. Relay 105 is operated sufficiently to close its inner lefthand front contact thus causing the energization of its right-hand winding and thus insure complete operation. When fully operated, relay 105 connects the control conductor from brush 134 directly to conductor 130 to hold relay 211 operated, opens the bridge (through resistance 122) across the outgoing trunk, transfers the connection from the tip conductor of trunk 200 to ground at the inner right-hand front contact of relay 105, and transfers the connection from the ring conductor of trunk 200 through the outer-right-hand front contact of relay 105 to battery through the winding of relay 109. Thus, after the operation of relays 211 and 105, talking battery is supplied to the called line from the toll selector TS instead of from the connector CC. Relay 109 operates in the circuit which includes the loop of the called line, thereby closing the circuit for operating relay 110. Relay 110 disconnects the windings of relay 102 from the conductors of trunk 100, thereby extinguishing the supervisory lamp of the toll cord. Relay 110 also closes a holding circuit for relay 102 as hereinbefore described. Although the release of relay 203 disconnected the ground at its inner lower front contact from the sleeve conductor of trunk 200, this conductor remains connected to ground at relay 103 of the toll selector TS.

The talking connection is now completely established from the toll cord at the toll operator's position, over trunk 100, through the windings of repeating coil 120 of toll selector TS, over trunk 200, and through connector circuit CC, to the called line; this connection is under the joint control of the toll operator and the called station. If the receiver at the called station is replaced upon the receiver hook the circuit through the winding of relay 109 is opened thereby causing the release of relays 109 and 110. The release of relay 110 reconnects the windings of relay 102 to the conductors of trunk 100 thereby causing the toll cord supervisory lamp to light; by slowly moving the receiver hook up and down the supervisory lamp is caused to flash and thus to attract the attention of the toll operator. When the toll operator removes the plug of the toll cord from jack 52, and the receiver is on the hook at the called station, the release of relay 110 causes the release of relay 102. The release of relay 102 causes the release of relay 103 and the holding ground is thereby disconnected from the conductor 130 to cause the release of relays 105, 111 and 112 of selector TS and relay 208 of connector CC. The release of relay 103 also causes the operation of release magnet 115 thereby causing the shaft and brushes of switch TS to be restored to normal. The circuit for operating magnet 115 is opened at the contact of the VON springs when the shaft reaches normal position.

The aforementioned release of relay 105 also opens the circuit through brush 134 of switch TS and over control conductor 201 so as to cause the release of relay 211. The release of relay 211 causes the release of relay 205, and the release of relay 205 causes the release of relays 207 and 209. The release of relay 209 closes a circuit from battery through the winding of release magnet 215, upper contacts of the VON springs, outer upper back contact of relay 209, back contacts of relays 203 and 202, to ground at the outer lower back contact of relay 211. The release magnet 215 operates thereby restoring the shaft and brushes of switch CC to their normal position. When the shaft

reaches its normal position the VON springs are restored to normal thereby opening the circuit through the release magnet 215.

Consider now the establishment of a connection from the subscriber at station A to the subscriber at station L and assume that the calling line 400 has been extended through the brushes 401 and 402 of line finder switch LF, through brushes 403 and 404 of first selector S1, and through brushes 405 and 406 of selector S2, over the conductors of trunk 200 to the connector circuit CC. It is to be noted that the control conductor 201 does not connect to a terminal in the bank of the second selector S2 but is only connected to the banks of toll selectors. The line relay 202 of connector C operates in a circuit which may be traced from battery through the lower winding of relay 202, inner lower back contact of relay 205, outer upper back contact of relay 211, tip conductor of trunk 200, terminal and brush 405 of selector S2, terminal and brush 403 of selector S1, brush 401 and terminal of line finder LF, line 400 and instrument at station A, terminal and brush 402 of line finder LF, brush 404 and terminal of selector S1, brush 406 and terminal of selector S2, over the ring conductor of trunk 200, middle lower back contact of relay 211, inner upper back contact of relay 205, upper winding of relay 202, to ground. The operation of relay 202 closes the circuit for operating relay 203. Relay 203 connects the ground at its inner lower front contact to the sleeve conductor of trunk 200 so as to hold the connection through the preceding switches as long as the receiver is off the hook at the calling station. The operation of the connector CC is similar to that hereinbefore described on a call incoming through the toll selector TS except that those operations involving control conductor 201 do not take place, (since this conductor is connected only to the banks of toll selectors). The operation of relay 205 after the called subscriber has answered does not, therefore, cause the operation of relay 211. Relay 205 does, however, reverse the connections from the tip and ring conductors of trunk 200 with respect to the windings of relay 202, thereby reversing the direction of current over these conductors in the usual manner for supervisory purposes. Thus talking battery is supplied to the called station through the winding of relay 205 and to the calling station through the windings of relays 202. (If an inter-office outgoing trunk repeater were included in the connection, the talking battery for the calling station would be supplied from the repeater and a supervisory bridge would be connected across the trunk in the usual manner to hold relay 202 operated). Since relay 211 is normal the talking circuit includes the talking condensers 218. The connection is under the sole control of the calling subscriber and when the receiver is replaced on the receiver hook at the calling station relay 202 releases. Relay 203 then releases and, if the receiver at the called station has been replaced, the connector switch is restored to normal in the manner hereinbefore described. If the receiver at the called station is not replaced relay 205 is held operated, thus holding relays 207 and 209 operated; in this case ground is connected from the outer lower back contact of relay 211, through back contacts of relays 202 and 203, and through the upper middle spring and front contact of relay 209, over conductor 230 to a trouble alarm circuit to operate an alarm after a predetermined interval. When relay 203 releases it disconnects the holding ground from the sleeve conductor of trunk 200 thereby causing the preceding switches in the connection to be released and returned to normal in the usual manner.

Should the called subscriber delay in replacing the receiver on the receiver hook, relay 205 remains operated to hold relays 207 and 209 operated even though relay 203 has released. The connector circuit is thus protected from seizure by another selector, either toll or local, by a guarding potential connected to the sleeve conductor of trunk 200; this connection may be traced from ground at the next-to-the-upper front contact of the VON springs, through the outer lower front contact of relay 209, outer lower back contact of relay 206, lower winding of relay 209, outer lower back contact of relay 208, to the sleeve conductor of trunk 200. When the called subscriber does replace the receiver on the hook, relay 205 releases thereby causing the release of relays 207 and 209. The connector switch is then restored to normal as hereinbefore described. Should the called subscriber be the first to replace the receiver on the hook, relay 205 releases but relays 207, 208 and 209 are held operated as long as relay 203 remains operated. In this case relay 205 connects ground at its outer lower back contact and through the outer lower front contact of relay 207 to conductor 229 for the purpose of operating a maintenance signal in case this condition endures beyond a certain interval. When the connection is also released by the calling subscriber, relays 202 and 203 release and the connector switch is restored to normal.

Having described the operation of the toll selector TS and the operation of the connector CC in completing both toll and local calls we will now proceed to consider a call from one station on a ten-party line to another station on the same line. To establish a talking connection between these stations it is necessary to use a reverting call selector circuit such as RS shown schematically in Figure 3. The subscriber at the calling sta-

tion dials an assigned number for extending the line to the reverting call selector; in the system disclosed in the drawings this number would consist of two digits, one for selectively operating a first selector switch and the other for selectively operating a second selector switch. In addition, the calling subscriber dials the last digit of his own station number followed by the last digit of the called station's number. The calling subscriber then hangs up the receiver to permit signaling of the called station. As hereinbefore mentioned, the ringers of 5 stations are connected to the tip conductor of the line and the ringers of the other 5 stations are connected to the ring conductor of the line. The stations signaled over the ring conductor are numbered from 1 to 5 inclusive and the stations signaled over the tip conductor are numbered from 6 to 0 inclusive. Thus stations 1 and 6 are signaled by ringing code 1 but over opposite sides of the line; stations 2 and 7, by ringing code 2; stations 3 and 8, by ringing code 3; stations 4 and 9, by ringing code 4; and stations 5 and 0, by ringing code 5. If the ringers of both the calling and called stations are connected to the same conductor, only the code of the called station is transmitted but both ringers are operated. If the ringers of the calling and called stations are not connected to the same conductor of the line, the codes of both stations are transmitted. When the subscriber at the called station answers, the ringing ceases and the calling subscriber again removes the receiver to converse with the called station.

Assuming the calling subscriber to be at station A, the line 400 is extended through the line finder LF, the first selector S1, and the second selector S2 to an idle trunk, such as 300, connecting to a reverting call selector, such as RS. When the trunk 300 is seized a circuit may be traced from battery through the lower winding of relay 302, inner lower back contact of relay 311, ring conductor of trunk 300, terminal 412 and brush 406 of selector S2, terminal and brush 404 of selector S1, brush 402 and terminal of line finder LF, over line 400 and through the calling subscriber's telephone instrument, terminal and brush 401 of line finder LF, brush 403 and terminal of selector S1, brush 405 and terminal 411 of selector S2, over the tip conductor of trunk 300, inner upper back contact of relay 311, and through the upper winding of relay 302, to ground. Relay 302 operates thereby closing a circuit for operating relay 303. Relay 303 connects ground to the sleeve conductor of trunk 300 to hold the connection through the preceding switches and to guard this trunk from selection by any other selector. Relay 303 also connects ground through its inner lower front contact, and through back contacts of relays 307, 309 and 311, over conductor 316 to a permanent signal alarm which is operated if relay 311 does not operate and open this connection within a certain interval.

When the calling subscriber dials the last digit of his own station number relay 302 alternately releases and reoperates in response to the impulses thus created. The first release of relay 302 closes a circuit from ground through its back contact, front contact of relay 303, normally closed contacts of the VON springs, winding of relay 304, and through the winding of vertical magnet 313 to battery. Relay 304 and vertical magnet 313 operate; and when relay 302 reoperates the vertical magnet 303 releases, thereby stepping the shaft and brushes of the selector switch up one step. As soon as the shaft moves off-normal, the VON springs are actuated thereby transferring the operating circuit for the vertical magnet from the normally closed to the lower front contact of the VON springs, thence to the locking contact of relay 304. Relay 304 is slow in releasing and remains operated until all of this train of impulses have been received but the vertical magnet operates and releases each time relay 302 releases and reoperates. The shaft and brushes of switch RS are thus stepped up to the level corresponding to the last digit of the calling subscriber's number.

The release of relay 304 prepares the circuit for the next train of impulses which are created by the dialing of the last digit of the called station's number. When relay 302 releases, in response to the first pulse of this train a circuit is closed from battery through the winding of the rotary magnet 314, winding of relay 310, back contacts of relays 312 and 304, lower front contact of the VON springs, front contact of relay 303, and through the back contact of relay 302 to ground. Relay 310 and rotary magnet 314 operate; and when relay 302 reoperates the rotary magnet releases, thereby advancing the brushes 331 and 332 into engagement with the first set of terminals in the previously selected level. Relay 310 closes a circuit from battery through the winding of relay 312, lower front contact of relay 310, conductor 317, to ground at the outer lower front contact of relay 303. Relay 312 operates in this circuit and locks through its lower front contact to the same ground. Relay 312 also changes the circuit for operating the rotary magnet 314, so that this circuit may now be traced from the back contact of relay 304, upper front contacts of relay 312, upper front contact and winding of relay 310, winding of magnet 314, to battery. The rotary magnet 314 reoperates and releases each time relay 302 releases and reoperates, thereby advancing brushes 331 and 332 into engagement with the set of terminals which correspond to the digit dialed. Relay 310 is slow-in-re-

leasing and remains operated until all of the impulses have been received.

The calling subscriber now places the receiver on the hook thereby causing the release of relay 302. Relay 302 closes a circuit from battery through the winding of relay 311, back contacts of relays 309, 307 and 310, upper front contact of relay 312, back contact of relay 304, lower front contact of the VON springs, inner upper front contact of relay 303, to ground at the back contact of relay 302. Since relay 303 is slow to release, relay 311 operates in this circuit before relay 303 releases. Relay 311 thus prevents the release of relay 303, disconnects ground from the permanent signal alarm conductor 316, and connects ground over conductor 339 to the start lead ST of the ringing interrupter INT. As soon as the ringing interrupter reaches normal position, if not standing in normal position at the time relay 311 operates, a circuit is closed from battery through the winding and normally closed contacts of relay 305, through the outer upper front contact of relay 311, over conductor 340, to ground on the pick-up lead PU of the ringing interrupter. Relay 305 operates and locks through its outer upper front contact, under the control of relays 309 and 307, to ground at the inner lower front contact of relay 303. Relay 311 also disconnects the tip and ring conductors of trunk 300 from the windings of relay 302 and prepares connections from these conductors for signaling the called station.

In operating, relay 305 connects the windings of ringing control relays 306 and 308 through brushes 331 and 332 to the selected set of terminals. The set of terminals in the bank of selector RS are connected to the ringing code leads of interrupter INT as shown in Figure 5 so as to cause such operation of relays 306 and 308 as will transmit the proper ringing code over the calling line on each call. Each set of terminals is numbered to correspond with the two digits required to advance the brushes into contact therewith. Assuming the last digit of the calling station's number to be 3 and the last digit of the called station's number to be 2, the brushes 331 and 332 will be in engagement with the second set of terminals on the third level. This set of terminals is designated 32 and, since both the calling and called stations are signaled over the same side of the line, the ring terminal only of this set is connected to a ringing lead of interrupter INT, in this case to lead R2, for transmitting the proper code to signal the called station. The ringing current thus transmitted is effective to operate control relay 308. When operated relay 308 closes a circuit from ringing-current supply conductor 319, through the lower front contact of relay 308, upper winding of relay 307, upper front contact of relay 308, inner lower front contact of relay 311, over the ring conductors of trunk 300, selector circuits S2 and S1, and of line finder circuit LF, over the ring conductor of line 400 and through the ringers of five stations including stations A and B, to ground. All five ringers are operated, but the code indicates that station B is the called station. When the receiver is removed from the switchhook at station B relay 307 is operated by the ringing current; or if the receiver is removed during a silent period relay 307 is operated in a circuit from battery at the middle lower front contact of relay 311, lower back contact of relay 308, upper winding of relay 307, upper back contacts of relays 306 and 308, inner lower front contact of relay 311, thence over the ring conductors of trunk 300, selectors S2, S1, line finder LF, and line 400, through the subscriber's instrument at station B, back over the tip conductors of line 400, line finder LF, selectors S1 and S2, and of trunk 300, through the inner upper front contact of relay 311, to ground at the lower back contact of relay 306. The operation of relay 307, in either case, is sufficient to close its lower contacts and lock through its lower winding to ground on conductor 317. The energization of the locking winding insures the complete operation of relay 307 so as to cause the release of relays 305 and 311 and to disconnect ground from the permanent signal alarm conductor 316. The release of relay 305 prevents further ringing and the release of relay 311 reconnects the tip and ring conductors of trunk 300 through the windings of relay 302, to battery and ground. When the ringer of station A ceases to operate, the calling subscriber thereat recognizes that the called station has answered and upon removing the receiver at station A the calling and called subscribers may converse, talking battery being supplied through the windings of relay 302.

When both subscribers replace the receivers on the receiver hooks relay, 302 releases thereby causing the release of relay 303. Relay 303 disconnects the holding ground from the sleeve conductor of trunk 300 thereby causing the release of selectors S2 and S1 and of line finder LF in the usual manner.

If station A were calling station C and the last digit of the number of station C were 9, the brushes 331 and 332 would have been advanced to the set of terminals designated 39. Since station A is signaled over the ring conductor and station C is signaled over the tip conductor of line 400, the ring terminal of set 39 is connected to ringing code lead R4 and the tip terminal of set 39 is connected to ringing code lead R3. Relay 308 is operated under control of the ringing current over code conductor R4 to connect ringing-current-supply conductor 319 to the ring conductor of trunk 300 as hereinbefore described; and re-

lay 306 is operated to connect conductor 319 through the lower winding of relay 309, lower front contact of relay 306, and through the inner upper front contact of relay 311, to the tip conductor of trunk 301. Thus the ringers of the 5 stations signaled over the tip conductor of line 400 are operated in accordance with code 3 and at the same time the ringers of the 5 stations signaled over the ring conductor of line 400 are operated in accordance with code 4. When the subscriber at station C removes the receiver from the hook, relay 309 is operated sufficiently to close its lower contacts and thus be fully operated by current through its upper winding to the ground on conductor 317. The complete operation of relay 309 releases relay 305 and 311 thereby preventing further operation of the ringers on both sides of the line. When the subscriber at station A again removes the receiver, conversation may take place, talking battery being furnished through the windings of relay 302 as hereinbefore described. When both subscribers replace the receivers on their hooks the connection is released.

Calls between other stations on the same party line will be completed in a similar manner, the proper ringing code being transmitted through the selected set of terminals in the bank of a reverting selector from the ringing-code-leads R1, R2, R3, R4 and R5 to operate the ringing control relays in the reverting selector.

The invention is not limited in its application to the particular system hereinbefore described and it may be applied to any system in which its features are desirable.

What is claimed is:

1. In a telephone system, selector switches employed in completing incoming tool calls, selector switches employed in completing local calls, a connector for completing both toll and local calls, line and holding conductors leading to said connector from terminals in the banks of said toll and local selector switches, a control conductor individual to said toll selector switches and said connector, means in said connector for supplying a called line with talking battery on local calls, talking battery in said toll selector and means for supplying a called line with talking battery from the toll selector on toll calls controllable over said control conductor.

2. In a telephone system, a toll operator's cord, subscriber's lines, a connector for extending connections to a called one of said lines, toll selectors for extending connections from said cord to said connector, local selectors for extending local connections to said connector, line and holding conductors leading to said connector from terminals in the banks of said toll and local selectors, a control conductor individual to said toll selectors and said connector, a marginal relay in each of said toll selectors, means effective upon operation of said marginal relay for periodically interrupting the connection from said toll cord, and means in said connector for closing a circuit over said control conductor to operate said marginal relay if said called line is busy.

3. In a telephone system, a toll operator's cord, subscriber's lines, a connector for extending connections to said lines, toll selectors for extending connections from said cord to said connector, local selectors for extending local connections to said connector, line and holding conductors leading to said connector from terminals in the banks of said toll and local selectors, a control conductor individual to said toll selectors and said connector, a reversing relay in each of said toll selectors for reversing the current to said toll cord when a connection has been extended to a called line, a marginal relay in each of said toll selectors for operation if said called line is busy, and means in said connector for closing a circuit over said control conductor to operate said reversing relay if said called line is idle, said circuit closure being ineffective to operate said marginal relay.

4. In a telephone system, a toll operator's cord, subscriber's lines, a connector for extending connections to said lines, toll selectors for extending connections from said cord to said connector, local selectors for extending local connections to said connector, line and holding conductors leading to said connector from terminals in the banks of said toll and local selectors, a control conductor individual to said toll selectors and said connector, means in said connector for supplying a called line with talking battery on local calls, means in said toll selector for supplying a called line with talking battery on toll calls, a control relay in said connector for transfering said called line from talking battery in said connector to talking battery in said toll selector, and means in said toll selector for closing a circuit over said control conductor to operate said control relay.

5. In a telephone system, a toll operator's cord, subscriber's lines, a connector for extending connections to said lines, toll selectors for extending connections from said cord to said connector, local selectors for extending local connections to said connector, line and holding conductors leading to said connector from terminals in the banks of said toll and local selectors, a control conductor individual to said toll selectors and said connector, a reversing relay in each of said toll selectors for reversing the current to said toll cord when a connection has been extended to a called line, a marginal relay in each of said toll selectors, means effective upon operation of said marginal relay for periodically interrupting the connection from said toll cord, means in said connector for closing a cir-

cuit over said control conductor to operate said marginal relay if said called line is busy, means in said connector for closing a circuit over said control conductor for operating said reversing relay without operating said marginal relay if said called line is idle, means in said toll selector for supplying said called line with talking battery on toll calls, means in said connector for supplying said called line with talking battery on local calls, a control relay in said connector for transferring said called line from talking battery in said connector to talking battery in said toll selector, and means in said toll selector for closing a circuit over said control conductor to operate said control relay.

6. In a telephone system subscribers' lines, a plurality of stations permanently connected to each of said lines, a selector switch for use in signalling a called station on the same line with said calling station, means for extending said line to said selector switch, terminals in the bank of said switch individual to said calling and called stations, and means for transmitting ringing current of the proper codes to simultaneously signal said calling and called stations.

7. In a telephone system, a line, a plurality of stations permanently connected to said line, the ringers of certain stations being connected from one side of said line to ground and the ringers of the other stations being connected from the other side of said line to ground, each of the stations whose ringers are connected to the same side of the line being signaled by a different code, a reverting selector employed on calls from one station on said line to another station on said line, means for extending said line to said selector, a source of ringing current, a control relay for connecting said source to one side of the line, another control relay for connecting said source to the other side of the line, terminals in the bank of said selector individual to the ringing codes of said calling and called stations, means under the control of the calling station for directively, advancing the brushes of said selector into contact with said terminals, and means including the selected terminals and an interrupter for operating said control relays in accordance with the codes for signaling the calling and called stations.

8. In a telephone system, a line, a plurality of stations permanently connected to said line, some of said stations being signaled by different ringing codes over the tip conductor of said line, the others of said stations being signaled by said different codes over the ring conductor of said line, a reverting selector employed on calls from one station on said line to another station on said line, means for extending said line to said selector, means under the control of the calling station for directively advancing the brushes of said selector to a group corresponding to the ringing code of the calling station, means under control of the calling station for directively advancing the brushes of said selector to the set of terminals in said group corresponding to the ringing code of said called station, a source of ringing current, control relays, one for connecting said source to the tip conductor of said line and the other for connecting said source to the ring conductor of said line, and an interrupter for simultaneously operating said control relays in accordance with the ringing codes of the calling and called stations.

9. In a telephone system, a line, a plurality of stations permanently connected to said line, the ringers of certain stations being connected from the tip conductor of the line to ground and the ringers of the remaining stations being connected from the ring conductor of the line to ground, each of the stations whose ringers are connected to the same conductor being signaled by a different code, a reverting selector employed on calls from one station to another station on said line, means for extending said line to said selector, means under control of the calling station for directively advancing the brushes of said selector into engagement with a set of terminals which correspond to the ringing codes of said calling and called stations, a source of ringing current, one control relay for connecting said source to the tip conductor of said line, another control relay for connecting said source to the ring conductor of said line, and an interrupter for transmitting ringing code impulses to operate said control relays, said terminals in the bank of said selector being connected to the code conductors of said interrupter so that only the called station is signaled if the ringers of both of said calling and called stations are connected to one conductor of said line and so that both of said calling and called stations are signaled if the ringer of said calling station is connected to one conductor and the ringer of the called station is connected to the other conductor of said line.

In witness whereof, I hereunto subscribe my name this 12th day of May, 1930.

BERT G. DUNHAM.