Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

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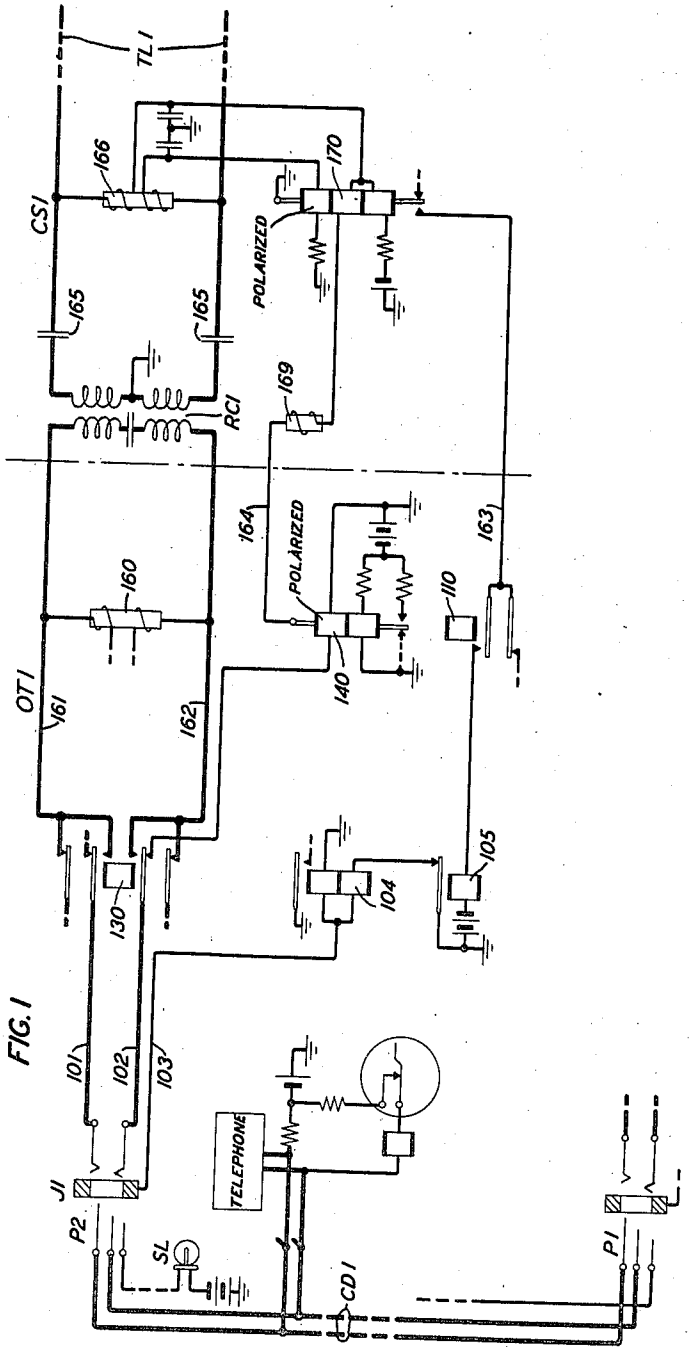

FIG. 1

FIG. 15

			FIG. 8
FIG. 14	FIG. 5	FIG. 6	FIG. 7
FIG. 13	FIG. 11	FIG. 4	
FIG. 12	FIG. 10	FIG. 3	FIG. 9
		FIG. 2	
	FIG. 1		

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 2

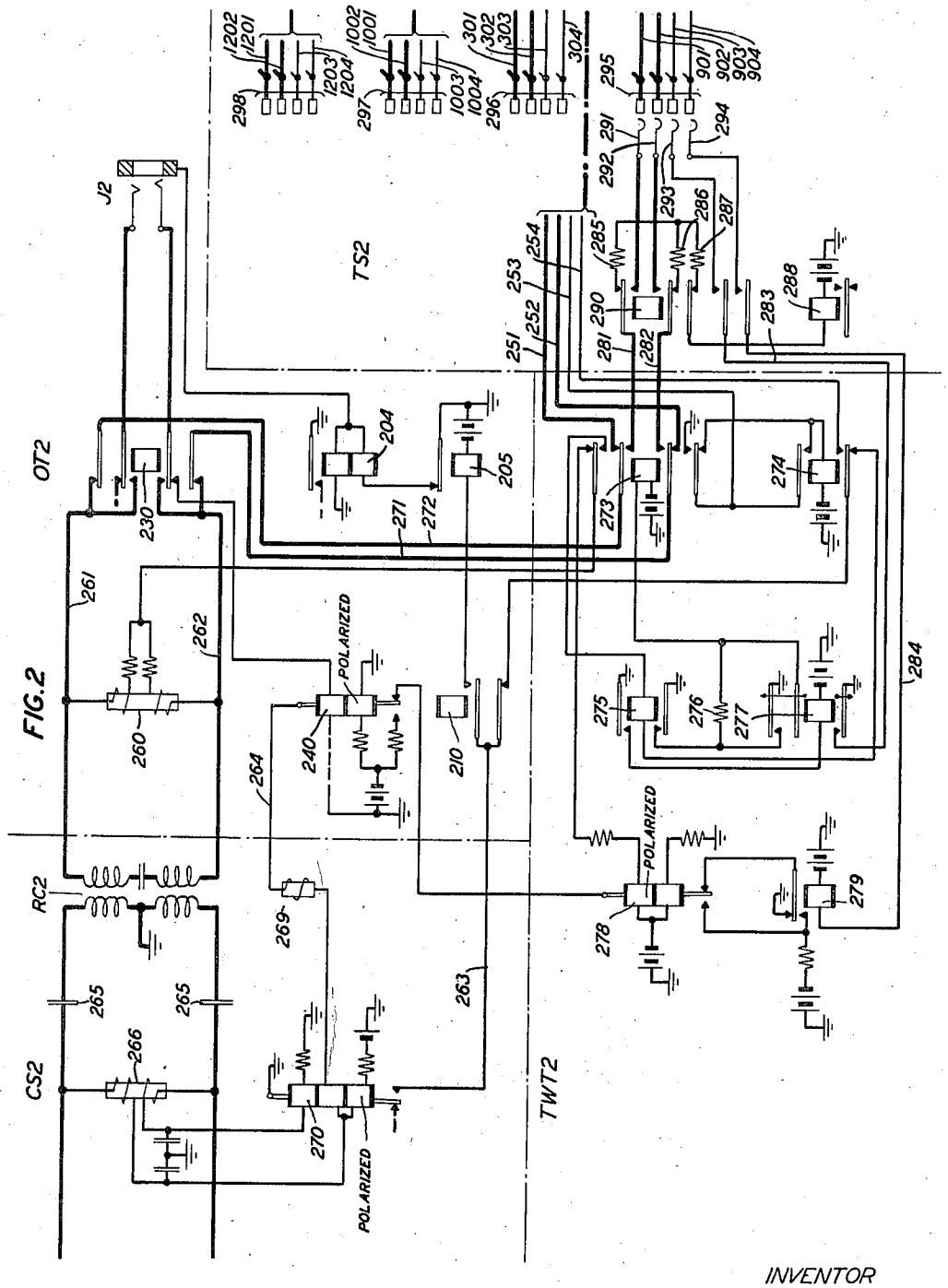

FIG. 2

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 3

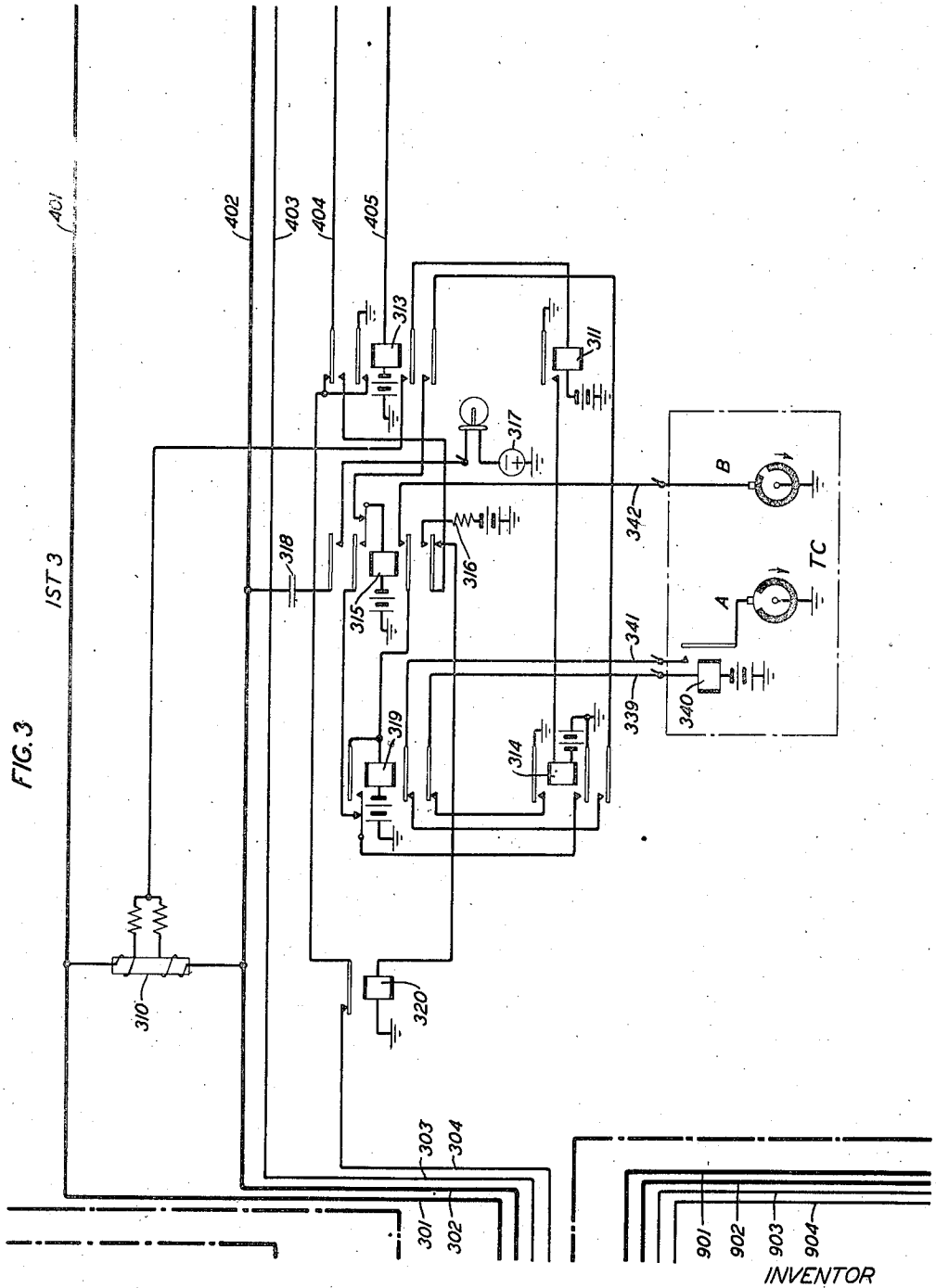

FIG. 3

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 4

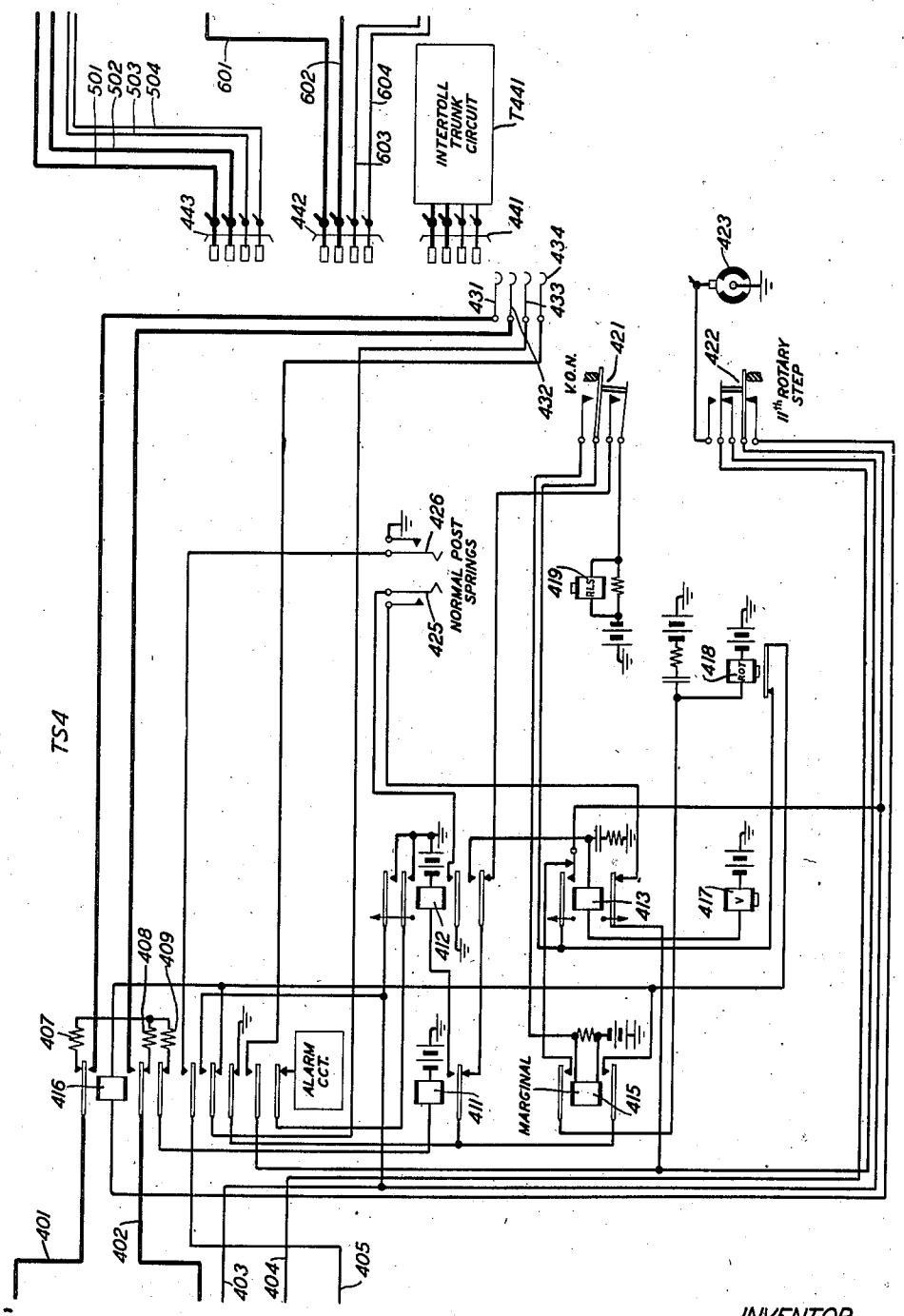

FIG. 4

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 5

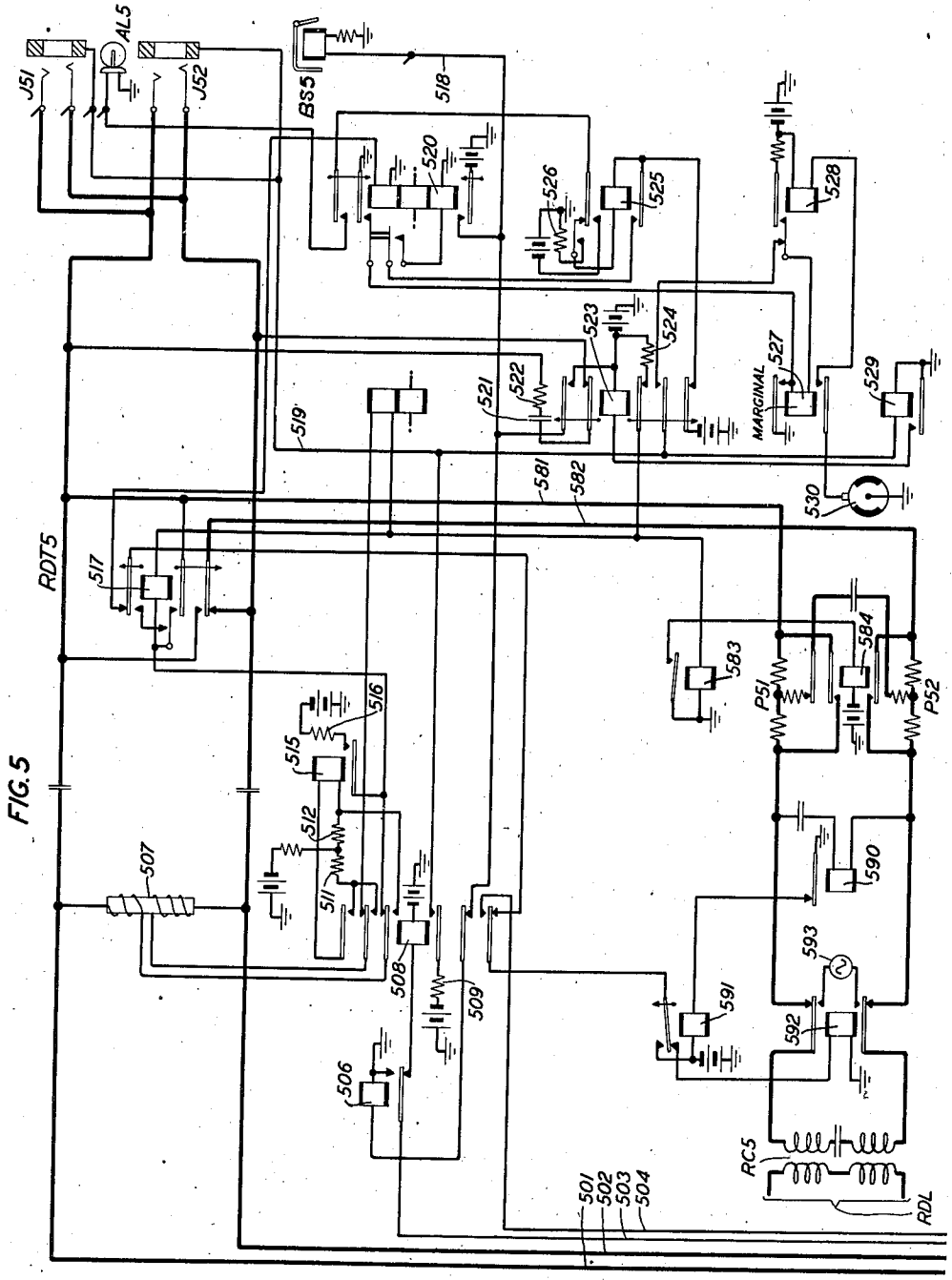

FIG. 5

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 6

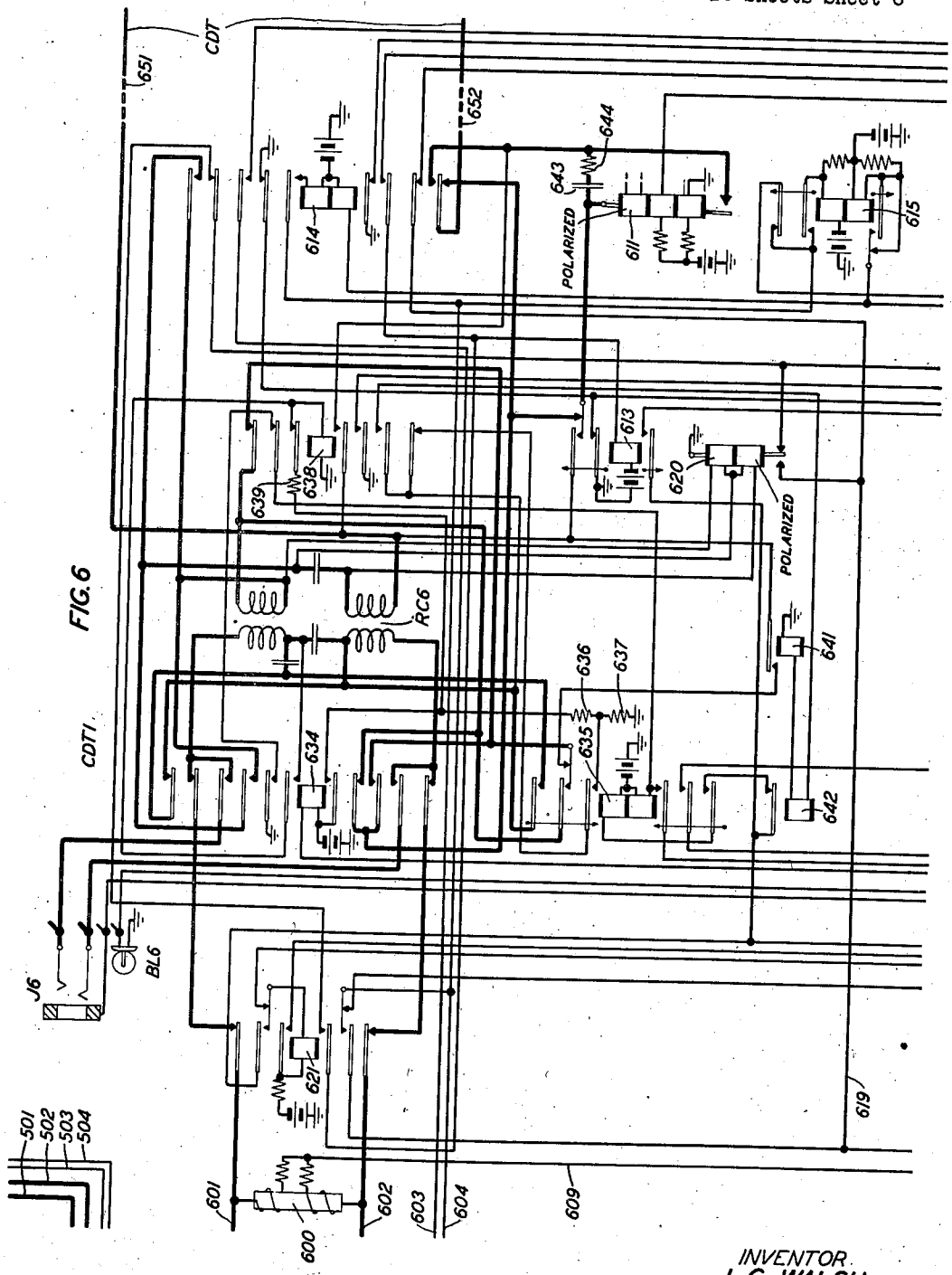

FIG. 6

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 7

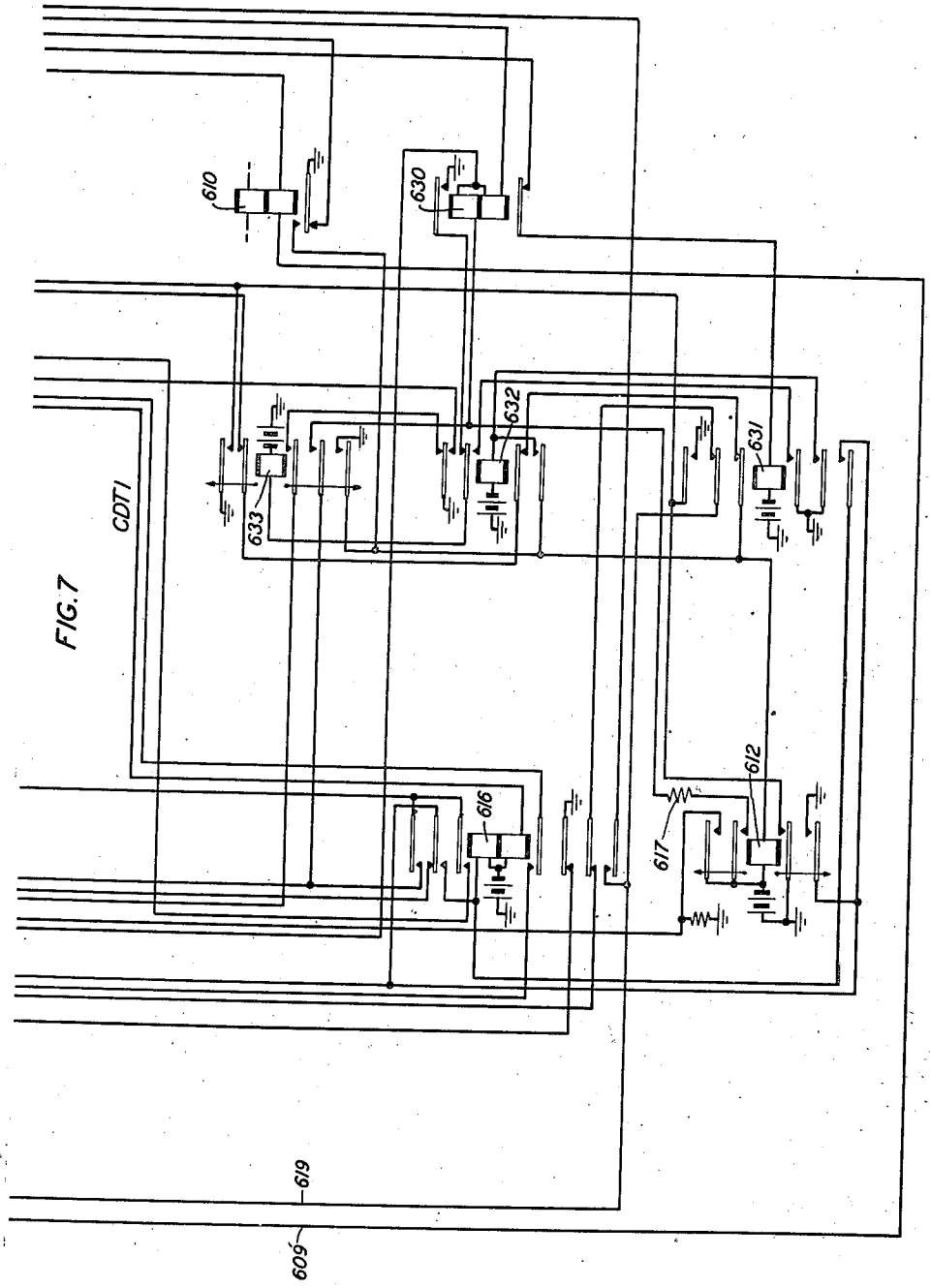

FIG. 7

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 8

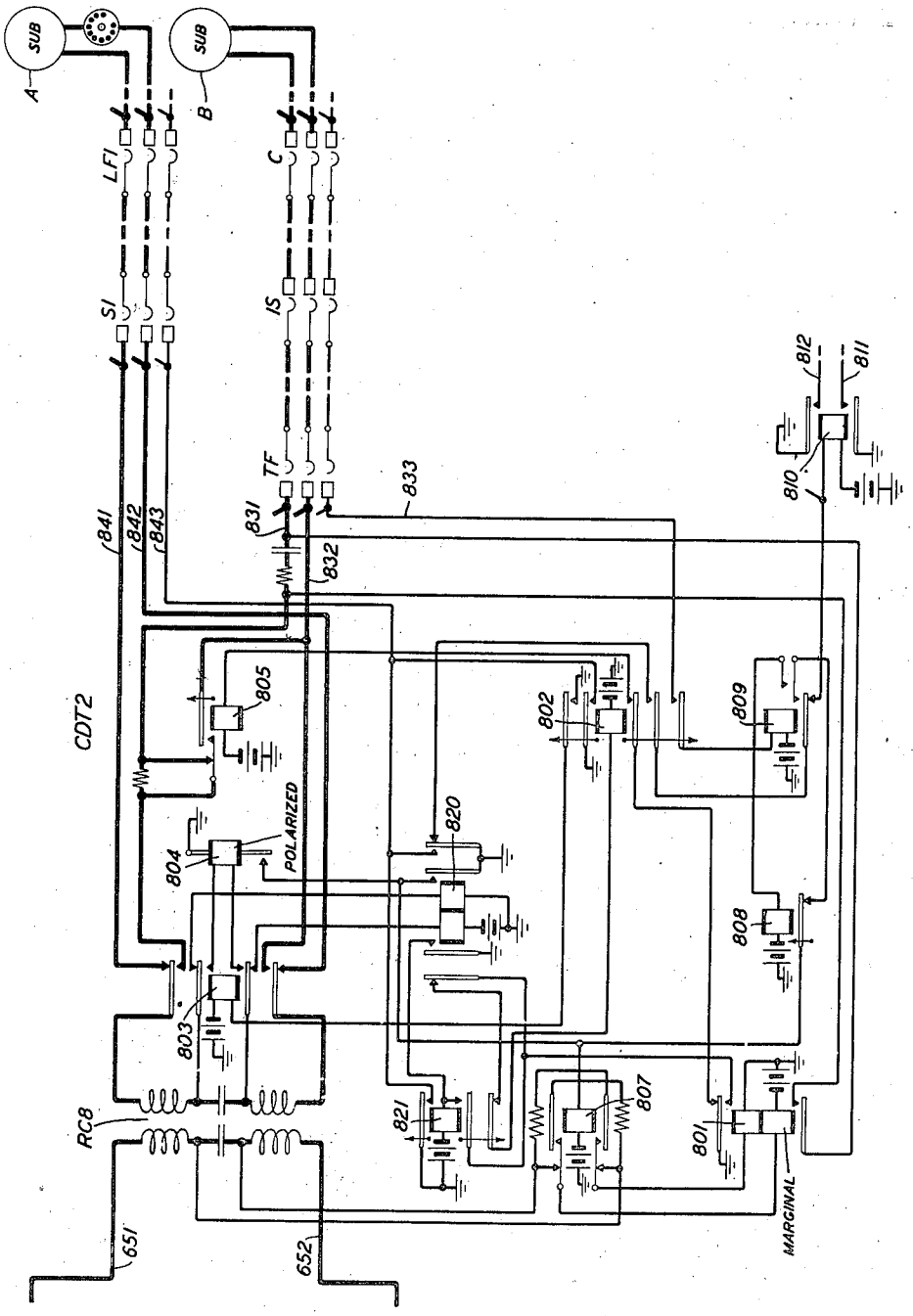

FIG. 8

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Dec. 21, 1943. J. G. WALSH 2,337,433

TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 9

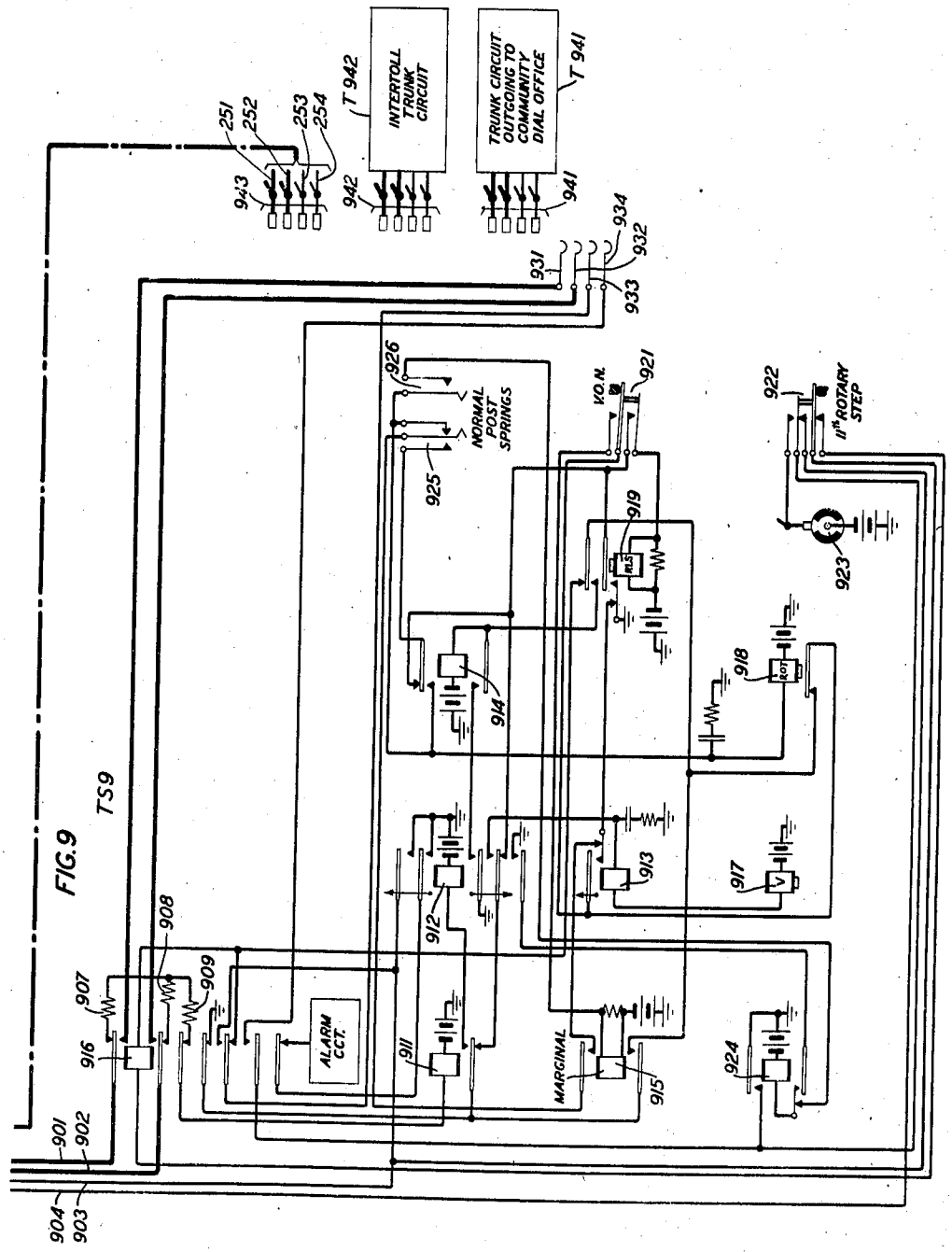

FIG. 9

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 10

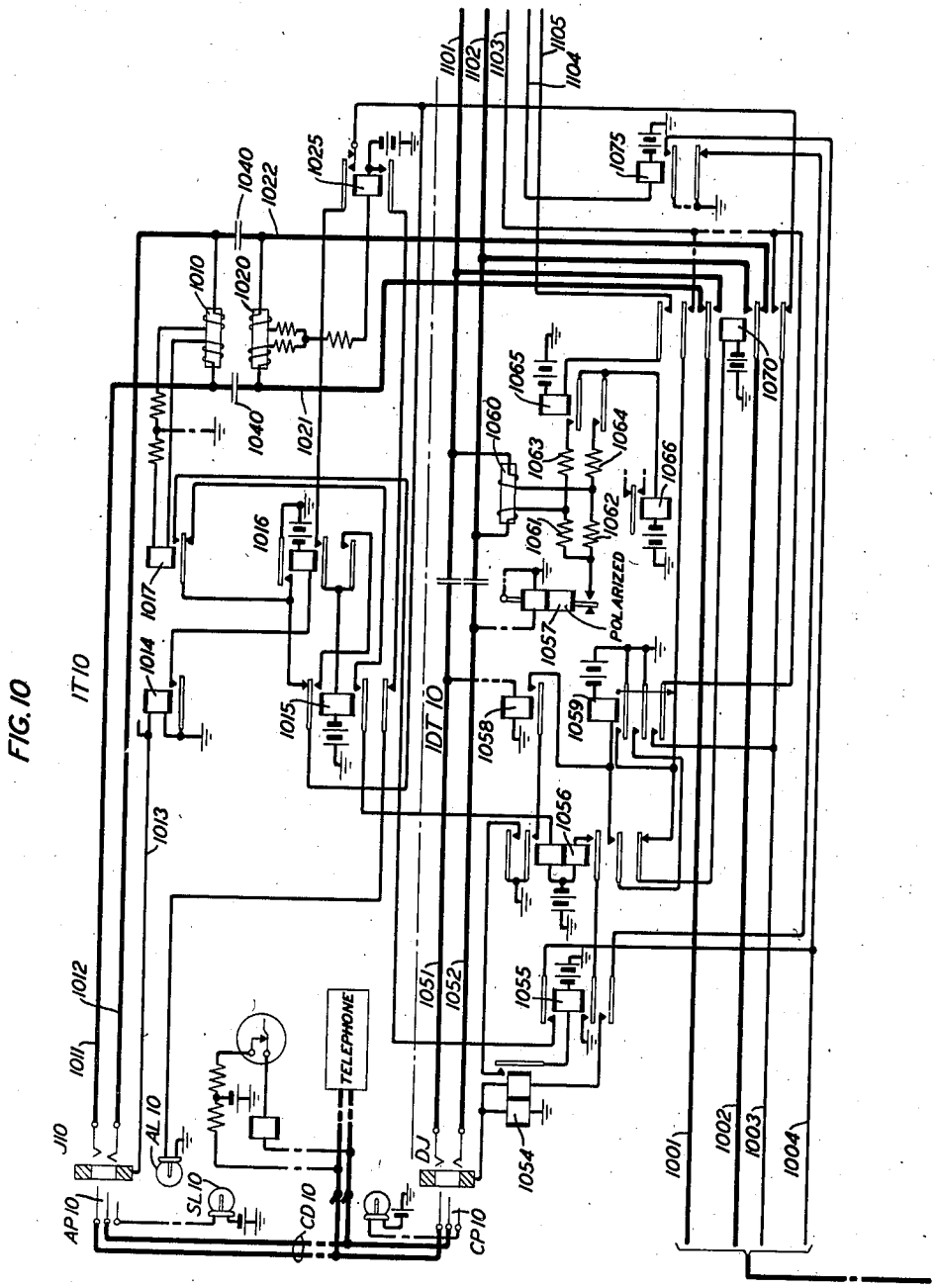

FIG. 10

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 11

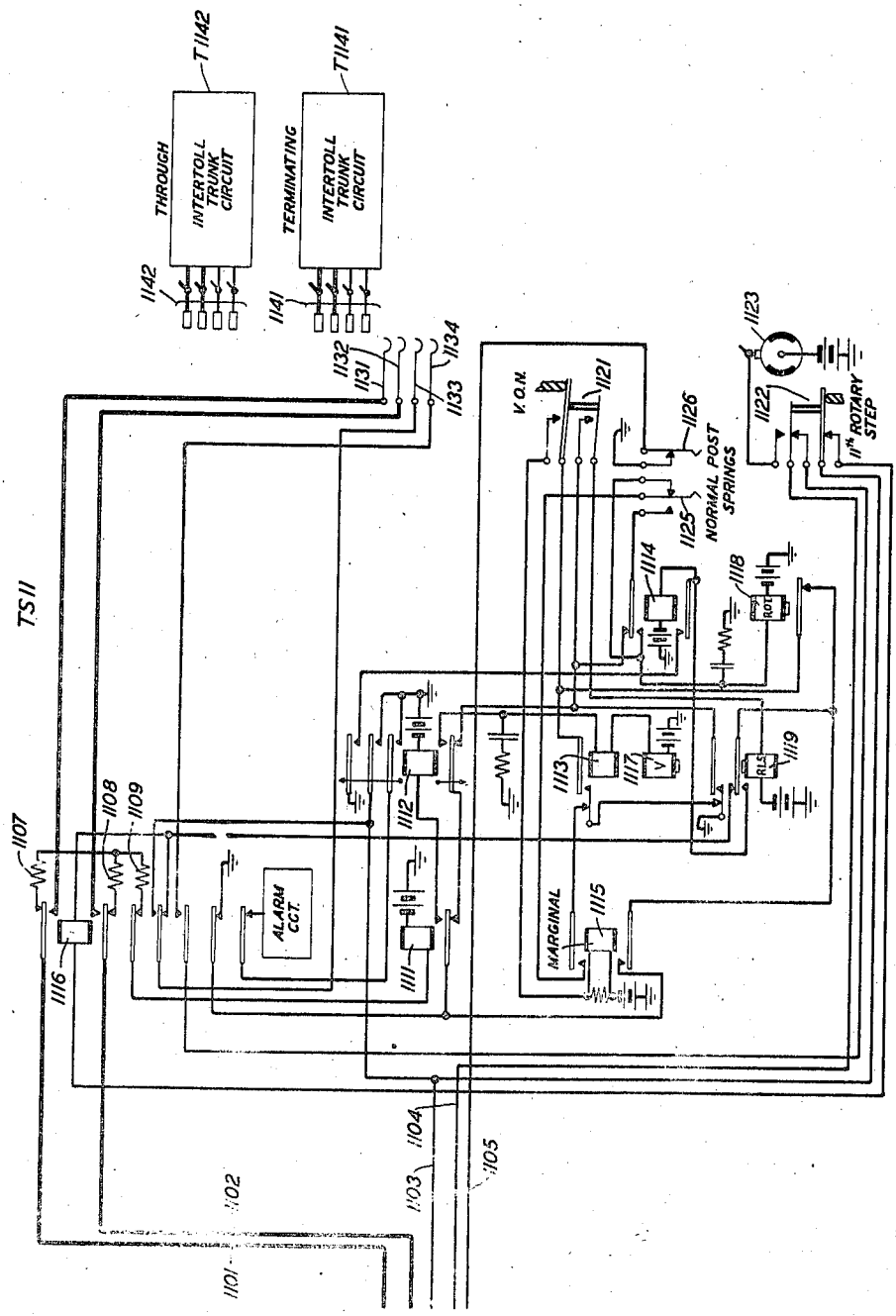

FIG. 11

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 12

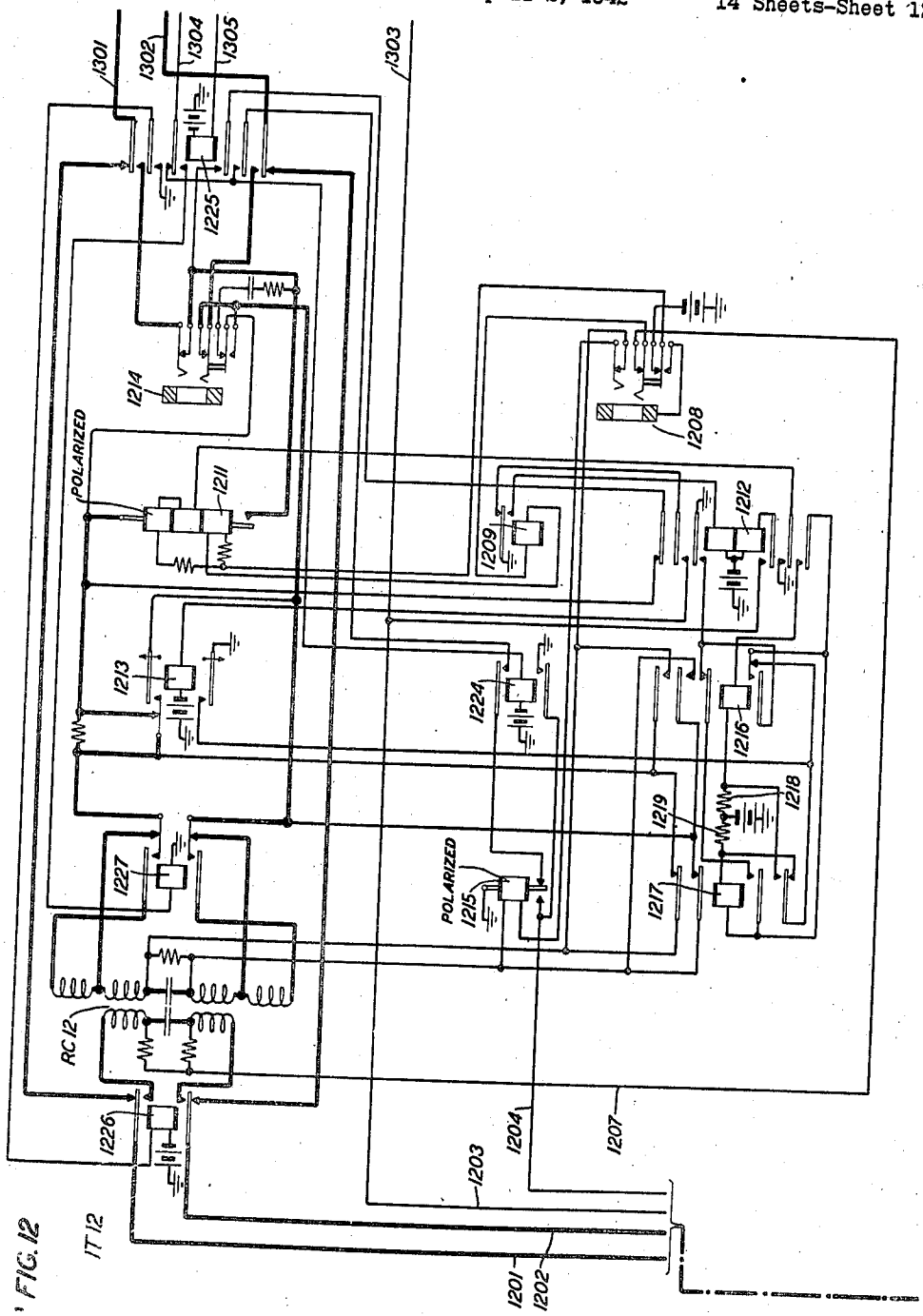

FIG. 12

IT 12

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 13

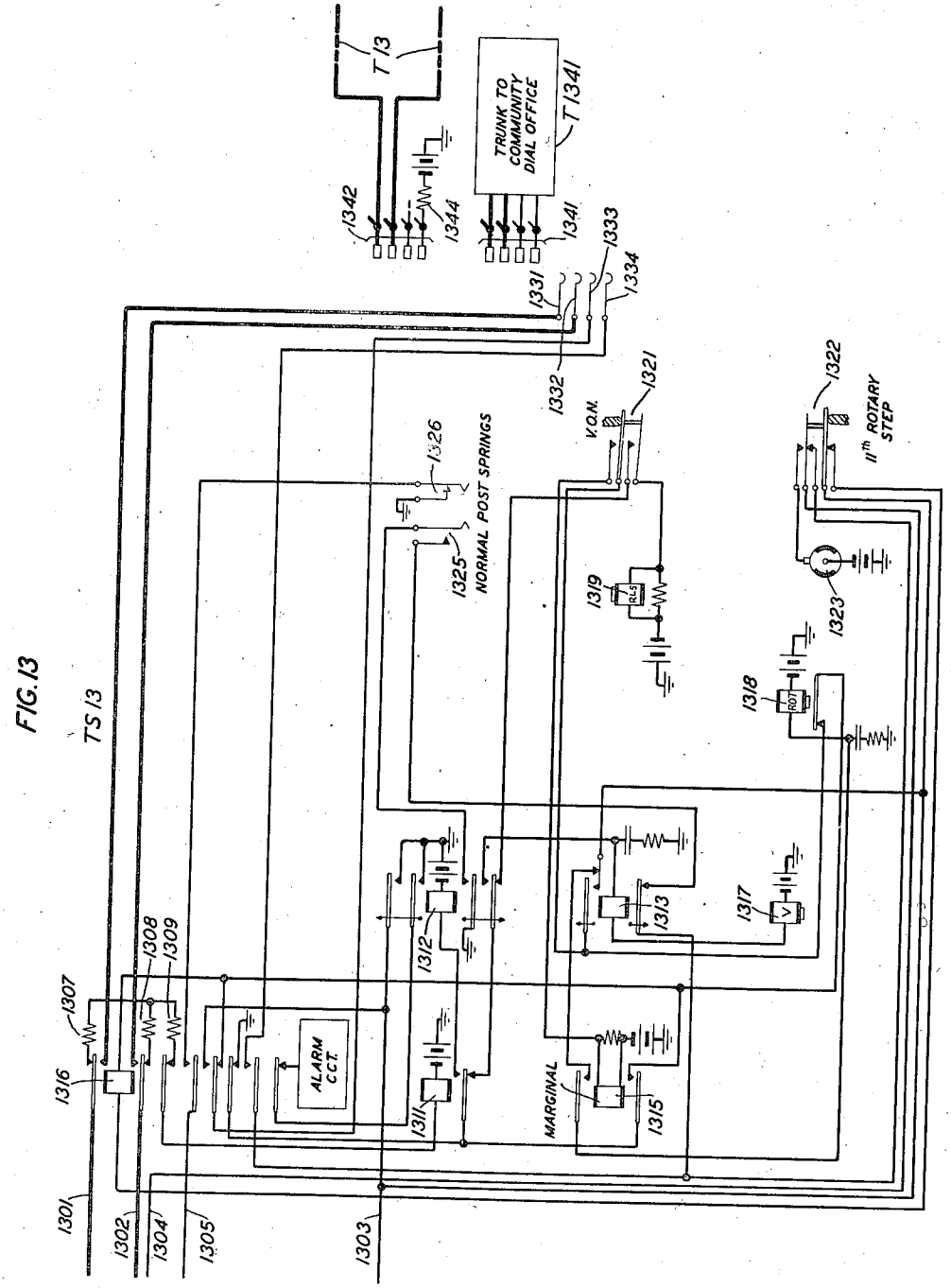

FIG. 13

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TELEPHONE SYSTEM

Filed April 2, 1942 14 Sheets-Sheet 14

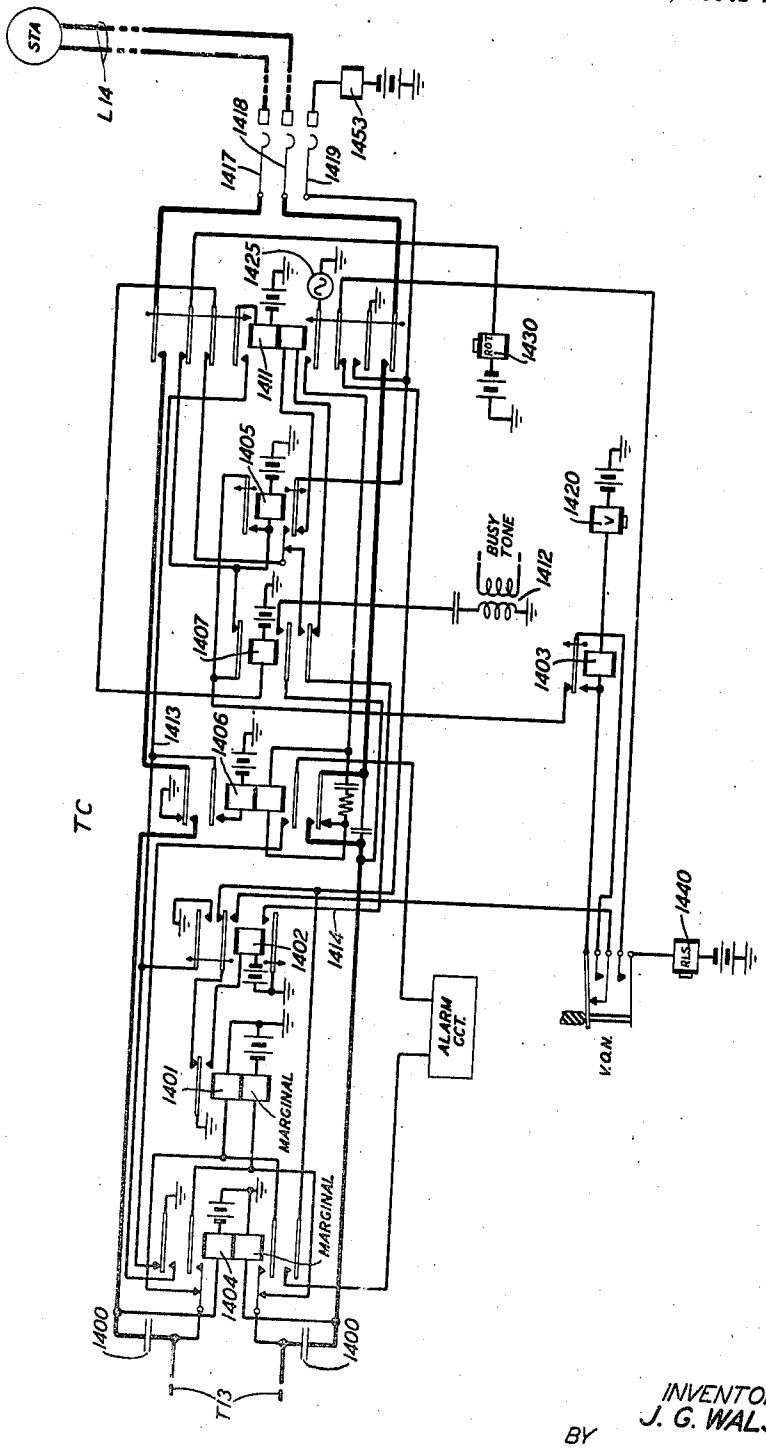

FIG. 14

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Patented Dec. 21, 1943

2,337,433

UNITED STATES PATENT OFFICE

2,337,433

TELEPHONE SYSTEM

John G. Walsh, Newark, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application April 2, 1942, Serial No. 437,398

12 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems comprising impulse controlled selector switches for establishing connections between calling and called lines.

Objects of the invention are an increase in the efficiency of the switching apparatus and trunking arrangements of automatic and semiautomatic telephone systems and particularly an increase in the capability and efficiency of selector switches used in establishing intertoll connections.

This invention is a selector switch adapted for use in establishing connections under the control of directive impulses and having access to trunk circuits of different kinds, normal post springs being provided for operation on the various levels according to the character of the trunks connected to the terminals in a selected level to control the operation of a preceding trunk circuit and to enable the transmission of stop and start dial signals if the character of the trunks connected to terminals in the selected level is of a character requiring the transmission of such signals.

According to a feature of the invention a group selector which is operatively controlled by directive impulses to select a desired trunk group is provided with normal post springs for operation on any level in which the terminals are connected to trunks over which reverse battery supervisory signals are transmitted, thereby to effect the insertion of a repeating coil in the talking connection and enable response to reverse battery signals. A further feature is the provision of means for varying the impedance of the repeating coil thus inserted in a talking connection according to the impedance of the trunk through which the connection is extended.

According to another feature of the invention a two-motion group selector switch adapted for use in establishing connections under the control of directive impulses is provided with normal post springs for operation on desired levels according to the character of the trunks connected to the terminals in a selected level to control the operation of a preceding trunk circuit and with normal post springs for operation on desired levels to effect the absorbing of a digit.

According to another feature of the invention a two-motion group selector switch adapted for use in establishing connections under the control of directive impulses is provided with normal post springs for operation on various levels according to the character of the trunks connected to a selected level to control the operation of a preceding trunk circuit and to effect the absorbing of a digit, the selection of one or more of the levels in which the terminals are connected to trunks requiring the transmission of stop and start dial signals being effective to restore the brushes of the selector to normal if selected responsive to a first train of impulses incoming to the selector.

A clear and complete understanding of the invention will be facilitated by considering a system in which the various features of the invention are embodied, one such system being shown in the drawings which form a part of this specification. The invention is, however, not limited in its application to the particular system shown but is generally applicable to systems comprising impulse controlled switches.

Referring to the drawings:

Fig. 1 shows, in a first toll office, an operator's position comprising a cord CD1, telephone and dial, a jack J1 terminating an outgoing trunk circuit OT1 and a signaling circuit CS1 connecting the outgoing trunk circuit OT1 with a toll line TL1;

Fig. 2 shows a signal circuit CS2, an associated outgoing trunk circuit OT2 terminating in a jack J2, a two-way trunk circuit TWT2, and a toll selector TS2 all associated with the toll line TL1 in a second toll office;

Fig. 3 shows an interswitch trunk circuit IST3 connected to a set of terminals in the bank of the intertoll first selector TS2;

Fig. 4 shows an intertoll selector TS4 associated with the trunk IST3;

Fig. 5 shows a trunk circuit RDT5 associated with a ring-down toll line RDL and connected to a set of terminals in the bank of the intertoll selector TS4;

Figs. 6 and 7 show a trunk circuit CDT1, associated with a trunk CDT to a community dial office and connected to a set of terminals in the bank of intertoll selector TS4;

Fig. 8 shows a trunk circuit CDT2 in a community dial office associated with the trunk CDT; shows a line finder LF1 and selector S1 for use in connecting a calling line to a trunk circuit CDT2 on a call to the toll office; and shows a trunk finder TF, incoming selector IS and connector C for use in completing calls incoming over a trunk CDT from the toll office;

Fig. 9 shows an intertoll second selector circuit TS9 associated with a set of terminals in the bank of intertoll first selector TS2;

Fig. 10 shows an intermediate toll operator's position comprising a cord CD10, telephone and dial, an incoming trunk circuit IT10 terminating

in a jack J10 and an intermediate dialing trunk circuit IDT10 terminating in a dialing jack DJ;

Fig. 11 shows an intertoll second selector TS11 associated with the trunk circuit IDT10;

Fig. 12 shows an intertoll trunk circuit IT12 connected to a set of terminals in the bank of intertoll first selector TS2;

Fig. 13 shows an intertoll second selector TS13 associated with the intertoll trunk circuit IT12;

Fig. 14 shows a connector circuit LC in a local step-by-step dial office; and

Fig. 15 shows the relative position in which Figs. 1 to 14, inclusive, are to be placed to form an operative arrangement.

The system represented in the drawings includes a plurality of tool offices, each of which comprises a toll board with operators' positions and cords for answering calls incoming from local manual or dial offices, from toll subscribers' lines, from community dial offices or from other toll offices; and for connecting calling intertoll trunks with switching trunks leading to called manual or dial local offices, to called toll subscribers' lines, to trunks to community dial offices, and to intertoll trunks to other toll offices. Outgoing jacks are connected to switching trunks, toll lines, trunks to community dial offices and intertoll trunks; answering jacks are connected to recording trunks, toll subscribers' lines, trunks from community dial offices and intertoll trunks. Intertoll first selectors and intertoll second selectors are provided for use on calls incoming over intertoll trunks to establish connections with other toll, local or community dial offices. The operators' positions are provided with dials for use in controlling the operation of intertoll selectors in other toll offices and for controlling the operation of selector and connector switches in local or community dial offices. While not shown in the drawings, the operators' positions may be provided with key-sets in place of dials, in which case senders are associated with the outgoing trunks to register the key-set impulses and control the selectors.

Reference may be had to the patent to R. E. King et al. 2,208,765, granted July 23, 1940, for a detailed disclosure of the cord and operator's position circuits provided in each of the two toll offices for interconnecting calling and called lines and trunks and for controlling the completion of toll calls. The outgoing trunk circuits OT1 and OT2, signaling circuits CS1 and CS2, two-way trunk circuit TWT2, intertoll first selector circuit TS2, interswitch trunk circuit IST3, ring-down trunk circuit RDT5, and community dial trunk circuits CDT1 and CDT2 are all similar to corresponding circuits disclosed in the aforementioned King et al. patent or in the King et al. Patent 2,209,777, granted July 30, 1940. The intertoll trunk circuits T441, T942, T1141, and T1142 may also be two-way trunk circuits, similar to two-way trunk circuit TWT2. The trunk circuits T941 and T1341 may be similar to trunk circuit CDT1. The toll connector circuit TC is similar to the toll connector disclosed in the patent to E. D. Butz, No. 2,021,286, granted November 19, 1935. Although not shown in the drawings, one or more intermediate selectors may be provided in the step-by-step office for establishing connections with called lines.

The incoming trunk circuit IT10 is similar to the trunk circuit IT2 shown and described in detail in the aforementioned King et al. patent. The intermediate dialing trunk circuit IDT10 is similar to the intermediate dialing trunk circuit IDT shown and described in detail in the copending application of J. Baumfalk, Ser. No. 437,397, filed April 2, 1942.

The intertoll dialing trunk circuit IT12 comprises a repeating coil RC12, line relays 1209 and 1211, release relay 1212, supervisory relays 1215 and 1224, relays 1225 and 1226 for operation when the associated selector TS13 selects a trunk T13 leading to a local step-by-step office, supervisory relay 1215 being polarized for response to reverse battery supervisory signals. The repeating coil RC12 has a plurality of windings and relay 1227 controls the impedance ratio of the repeating coil to be connected in the talking circuit, the operation of relay 1227 depending upon the character of the trunk selected by the associated selector TS13.

The intertoll selector TS4, associated with trunk circuit IST3, is of the well-known two-motion, step-by-step type and comprises a set of brushes 431, 432, 433 and 434, a terminal bank which is represented by three sets of terminals 441, 442 and 443, a line relay 411, a release relay 412, a switching relay 416, vertical stepping magnet 417, rotary stepping magnet 418, release magnet 419, vertical off-normal springs 421 and eleventh-rotary-step springs 422. The selector TS4 also includes normal post-springs 425 and 426 which are independently actuated on desired levels. The springs 426 are actuated when the brushes are on a level in which the terminals are connected to ring-down intertoll trunks, such a level being represented by the terminals 443 connected to trunk circuit RDT5. When a ring-down trunk circuit RDT5 is seized by switch TS4, the trunk circuit IST3 operates to close a ringing control circuit for two seconds to operate the ringing relay in the seized trunk circuit to effect the transmission of a ring-down signal over the associated ring-down intertoll trunk RDL. The normal post springs 425 are actuated upon selection of a level in which the terminals are connected to trunks to a community dial office and it is necessary to give the calling operator a start dialing signal when the switching apparatus in the community dial office is ready to receive directive impulses, such a level being represented by the terminals 442 connected to trunk circuit CDT1.

Each of the intertoll selectors TS9, TS11 and TS13 is similar to the intertoll selector TS4, like elements having reference characters with the same tens and units digits. Each of selectors TS9 and TS11 includes an additional relay 914 or 1114, for controlling the absorbing of the first train of dial impulses received if this digit is of such a numerical value as to indicate that the first digit is to be absorbed; in such a case the left-hand set of normal post springs are actuated to operate the release magnet of the selector. The right-hand set of normal post springs of selector TS9 are actuated upon selection of a level giving access to trunks requiring the transmission of a stop dial signal to the calling operator, such a level being represented by the terminals 941 connected to trunk circuit T941 associated with a trunk to a community dial office. The right-hand set of normal post springs of selector TS11 are actuated upon selection of a level in which the terminals are connected to through trunks to render a rering signal from the calling operator ineffective to cause the release of selector TS11, a level giving access to through trunks being represented by terminals 1142 connected to two-way trunk circuit T1142 and a level giving access to

terminating trunks being represented by terminals 1141 connected to two-way trunk circuit T1141. The right-hand set of normal post springs of selector TS13 are actuated on levels in which the terminals are connected to trunks over which reverse battery supervisory signals are received, such a level being represented by terminals 1342 connected to a trunk T13 to a local selector or connector in a step-by-step dial office; and the left-hand set of normal post springs are actuated on levels in which the terminals are connected to trunks requiring the transmission of a stop dial signal to the calling operator, such a level being represented by the terminals 1341 connected to a trunk T1341 to a community dial office.

Assume now that the plug P2 of the cord CD1 is inserted in jack J1 of the outgoing trunk circuit OT1 thereby closing a circuit for operating relay 104. Relay 104 effects the operation of relay 110 as described in the aforementioned King et al patent and closes a circuit for operatively energizing the upper winding of signaling relay 140. The operation of relay 140 connects signaling battery through conductor 164, retard coil 169, middle winding of composite signaling relay 170, upper winding of retard coil 166, upper conductor of toll line TL1, upper winding of retard coil 266 of signaling circuit CS2 in the second toll office, to the windings of composite signaling relay 270. Relay 270 operates, closing a circuit through conductor 263, back contact of relay 210 of outgoing trunk circuit OT2, back contact of relay 274 of two-way trunk circuit TWT2, back contact of relay 277, through the winding of relay 273. Relay 273 operates, connecting ground to conductor 253 to guard the toll line TL1 from seizure in the second toll office. Relay 273 closes a circuit for operating relay 275, from ground through the front contact of signaling relay 270, conductor 263, back contact of relay 210, back contact of relay 274, winding of relay 275, a front contact of relay 273, thence in simplex through both windings of retard coil 260, back contacts of relay 230, conductors 271 and 272, inner front contacts of relay 273, conductors 281 and 282, back contacts of relay 290, resistors 285, 286 and 287, and through the winding of relay 288 to battery. The line relay 288 of toll selector TS2 is thereby operated in series with relay 275 of the two-way trunk circuit TWT2. Relay 275 closes a circuit through resistor 276 for holding relay 273 and closes a circuit for operating the slow-to-release relay 277. Relay 277 also closes a holding circuit for relay 273 and connects ground potential to conductor 283 to hold the selector TS2 and any succeeding switches or trunks through which a connection may be established. When the calling operator operates the dialing key (not shown) the upper winding of relay 140 is controlled by the impulse contact of the dial. Each release and reoperation of relay 140 in response to the dialing of the first digit of the called number opens and closes the circuit through conductor 164 and the upper conductor of toll line TL1, causing a corresponding release and reoperation of relay 270 of signaling circuit TS2. Relay 270 repeats these dial impulses to relay 275 of two-way trunk circuit TWT2 and to relay 288 of selector TS2. Each release of relay 275 opens the operating circuit of relay 277; but since this relay is slow in releasing, it maintains the connection of ground to conductor 283 during the response of relays 275 and 288 to dial impulses. The alternate release and reoperation of relay 288 causes the brushes of selector TS2 to be stepped up to the level corresponding to the digit dialed. At the end of the train of impulses, the brushes 291, 292, 293 and 294 are advanced step-by-step in the selected level to hunt for and seize a set of terminals connected to an idle trunk. When an unguarded set of terminals is found, relay 290 is operated to disconnect relay 288 and connect toll line TL1, through brushes 291 and 292 and the engaged terminals, to the next line, trunk or selector through which the desired connection is being established. For a detailed description of the operation of selector TS2, reference may be had to the aforementioned patents to King et al.

Calls completed through selector TS4

Assume first that the level selected by the brushes of switch TS2 is a level in which the terminals are connected to interswitch trunk circuits, such a level being represented by the terminals 296. Assume further that the switch TS2 selects the terminals 296 to which the interswitch trunk circuit IST3 is connected. When relay 290 operates, it closes a circuit from ground at the contact of relay 270, through conductor 263, back contact of relay 210, back contact of relay 274, winding of relay 275, uppermost front contact of relay 273, thence in simplex through both windings of retard coil 260, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 290, through brushes 291 and 292 and engaged terminals of terminal set 296, through conductors 301 and 302 of trunk circuit IST3, conductors 401 and 402 of selector TS4, back contacts of relay 416, through resistors 407, 408 and 409 and the winding of relay 411 to battery. Relay 411 is thereby energized in series with relay 275 of the two-way trunk circuit TWT2. The operation of relay 411 closes a circuit for operating the slow-to-release relay 412. Relay 412 connects ground through a back contact of relay 416 to the alarm circuit 409 to initiate an alarm operation in case the selector TS4 is seized but no directive impulses are received within a predetermined interval of time. Relay 412 also connects ground to conductor 403, this being without effect since conductor 403 is connected through conductor 303 and brush 293 of switch TS2 to ground at a front contact of relay 277 of two-way trunk circuit TWT2. No further operation takes place until the calling operator dials the next digit of the called toll route code number. Each release and reoperation of relay 270, in response to the impulses transmitted by the dialing of the next digit, causes a corresponding release and reoperation of relays 275 and 411. The first release of relay 411 closes a circuit from ground at the back contact of relay 416, through the back contact of relay 411, a front contact of relay 412, winding of relay 413 and through the winding of vertical stepping magnet 417 to battery. Relay 413 and stepping magnet 417 are thereby operated, the operation of magnet 417 being effective to step the brushes of selector TS4 up to the first level of the terminal bank. The release of relay 411 at the end of the first impulse causes the release of vertical stepping magnet 417; but relay 413 is slow to release and remains operated until all of the impulses in the train have been received by relay 411. Relay 412 is also slow to release and remains operated while relay 411 is re-

sponding to dial impulses. The vertical off-normal springs 421 are actuated as soon as the shaft on which the brushes are mounted moves out of normal position thereby closing a circuit from battery through the winding of relay 415 upper contact of vertical off-normal springs 421, front contact of relay 413 to ground at a front contact of release relay 412. The release and re-operation of relay 411 in response to each succeeding impulse of the train effects a corresponding operation and release of the vertical stepping magnet 417 thereby advancing the brushes of switch TS4 to the level corresponding to the digit dialed. When relay 413 releases at the end of the train of impulses, it opens the operating circuit of relay 415, but relay 415 is held operated under control of springs 421 and rotary stepping magnet 418. The release of relay 413 closes a circuit for operating the rotary stepping magnet 418, this circuit being traced through the upper front contact of relay 415 and the upper back contact of relay 413, to ground at the uppermost front contact of relay 412. The operation of stepping magnet 418 advances the brushes of switch TS4 into engagement with the first set of terminals in the selected level. The operation of stepping magnet 418 also causes the release of relay 415; and the release of relay 415 causes the release of stepping magnet 418. When stepping magnet 418 releases, it closes a circuit from battery through the winding of relay 415 through the upper front contact of vertical off-normal springs 421, back contact of stepping magnet 418, middle lower back contact of relay 416, through test brush 433 to the test terminal engaged thereby. If the selector or trunk circuit connected to the engaged set of terminals is busy, brush 433 encounters a busy ground potential which causes the reoperation of relay 415. The reoperation of relay 415 causes the reoperation of stepping magnet 418 to advance the brushes of selector TS4 into engagement with the next set of terminals in the selected level. If the test terminal of this next set of terminals is also connected to ground, relay 415 is again operated to continue the advance of the brushes of selector TS4. When the brushes engage a set of terminals connected to an idle trunk or selector, relay 415 does not reoperate since the terminal engaged by brush 433 is free of ground potential; and relay 416 is operated by the current in a circuit traced from battery through the winding of relay 415, upper contact of vertical off-normal springs 421, back contact of rotary stepping magnet 418, winding of relay 416, lower contacts of the eleventh-rotary-step springs 422, to ground at the uppermost front contact of relay 412. Relay 415 is marginal and does not reoperate in series with the winding of relay 416. Relay 416 disconnects the winding of relay 411 from conductors 401 and 402 and connects these conductors through the brushes 431 and 432 to the talking conductors of the trunk connected to the engaged set of terminals. The release of relay 411, when its winding is disconnected from conductors 401 and 402, causes the release of relay 412. Relay 412 disconnects ground from conductor 403 but relay 416 is held operated since conductor 403 is connected through conductor 303 of interswitch trunk circuit IST3, the terminal engaged by brush 293 of selector TS2, and through conductor 283 to ground at the front contact of relay 277 of two-way trunk circuit TWT2.

If the selector TS4 finds all of the terminals in the selected level busy, the brushes 431 to 434, inclusive, are advanced to the eleventh rotary position in which position springs 422 are actuated to disconnect the winding of relay 416 from conductor 403 and to connect the interrupter 423 to conductor 404, thence through a back contact of relay 313 of interswitch trunk circuit IST3, back contact of relay 320, through conductor 304, terminal and brush 294 of switch TS2, lowermost front contact of relay 290, to the winding of relay 279 of two-way trunk circuit TWT2. Each time that ground is connected to the brush of interrupter 423, relay 279 is operated thereby closing a circuit from signaling battery through the front contact of relay 279, back contact of relay 278, back contact of relay 240 of outgoing trunk circuit OT2, through retard coil 269, middle winding of relay 270, upper winding of retard coil 266, upper conductor of toll line TL1, thence through the upper winding of retard coil 166 and windings of signaling relay 170 to effect the operation of signal relay 170. The alternate operation and release of relay 170, under control of relay 279 and interrupter 423, causes the intermittent operation of relay 105 thereby alternately opening and closing a circuit through the lower, low resistance winding of relay 104 to flash the lamp SL associated with plug P2 of the calling operator's cord CD1 to indicate an all-trunks-busy condition. When the plug P2 is disconnected from jack J1, relays 104 and 140 are released thereby disconnecting signaling battery from conductor 164 to cause the release of relay 270 of signaling circuit CS2. The release of relay 270 disconnects ground from conductor 263 to cause the release of relays 275 and 411. The release of relay 411 causes the release of relay 412; and the release of relay 275 causes the release of relay 277. With both of relays 277 and 412 released, ground is disconnected from conductors 403 and 283 thereby causing the release of relay 290 of selector circuit TS2 to cause this selector to be restored to normal in the manner described in the aforementioned patent to R. E. King et al. With both of relays 411 and 412 released, a circuit is closed from battery through the winding of release magnet 419 of selector TS4, lower front contact of vertical off-normal springs 421, through back contacts of relays 412 and 411, to ground at the back contact of relay 416. The operation of release magnet 419 causes the return of the shaft and brushes of switch TS4 to normal. When the shaft reaches normal position, the vertical off-normal springs 421 are restored to normal thereby opening the circuit for operating the release magnet 419.

Assume now that the selector TS4 has selected the level represented by terminals 442, the terminals in this level being connected to trunks to a community dial office, and that the trunk circuit CDT1 which is connected to terminals 442 is the first idle trunk circuit in the group. When relay 416 operates, a circuit is closed for operatively energizing the line relays 610 and 611 of trunk circuit CDT1. This circuit is traced from ground, through the front contact of relay 270 of signaling circuit TS2, conductor 263, back contact of relay 210, back contact of relay 274, winding of relay 275, uppermost front contact of relay 273, thence in simplex through both windings of retard coil 260 of outgoing trunk circuit OT2, back contacts of relay 230, conductors 271 and 272, inner front contacts of relay 273, conductors 281 and 282, front contacts of relay 290 of selector TS2, through brushes 291 and 292 and

engaged terminals of terminal set 296, through conductors 301 and 302 of trunk circuit IST3, conductors 401 and 402 of selector TS4, front contacts of relay 416, brushes 431 and 432 of selector TS4, through conductors 601 and 602 of trunk circuit CDT1, both windings of retard coil 600, thence through conductor 609, a winding of relay 610 and a winding of relay 611 to battery. Since the trunk circuit CDT1 is associated with the trunk CDT to a community dial office in which it is necessary to connect the trunk circuit to an idle selector before the calling operator dials the next digit of the called subscriber's number, the left-hand normal post springs 425 of selector TS4 are actuated upon selection of the level in which the terminals 442 are located to connect ground to conductor 404 as a stop dial signal. This connection is traced from ground at a front contact of relay 412, through the front contact of normal post springs 425, lower back contact of relay 413, upper back contact of the eleventh-rotary-step springs 422, through conductor 404, back contacts of relays 313 and 320 of interswitch trunk circuit IST3, conductor 304, through brush 294 of selector TS2, front contact of relay 290, and through conductor 284 to the winding of relay 279 of two-way trunk circuit TWT2. Relay 279 is thereby operated to connect signaling battery through back contacts of relays 278 and 240, conductor 264, retard coil 269, middle winding of relay 270, upper winding of retard coil 266, to the upper conductor of toll line TL1 to effect the operation of relay 170 of signaling circuit CS1 in the toll office at which the calling operator is located. The operation of relay 170 causes the operation of supervisory relay 105 thereby disconnecting ground from the lower, low resistance winding of relay 104 to extinguish the dial pilot lamp (not shown) at the calling operator's position, in the manner set forth in aforementioned King et al patent. Since the calling operator has not completed dialing of the called number, the extinguishing of the dial pilot lamp indicates that no further digits should be dialed until this lamp is again lighted as a start dial signal. After relay 412 releases due to the operation of relay 416, conductor 404 is connected through the upper back contact of springs 422, a front contact of relay 416, through brush 434 to conductor 604 of trunk circuit CDT1, thence through a back contact of relay 621 to ground at the back contact of relay 616. The aforementioned operation of relay 610 closes circuits for operating relays 612, 614 and 615. Relay 612 closes a circuit for lighting the busy lamps, such as BL6, associated with outgoing jacks to which trunk circuit CDT1 is connected and connects battery through resistor 617 and the upper winding of relay 630 to the sleeve of the associated jacks at the toll board to mark the trunk CDT1 busy. Relay 614 locks through its upper winding, conductor 603, brush 433 of selector TS4, a front contact of relay 416, conductor 403, conductor 303 of trunk circuit IST3, brush 293 of selector TS2, a front contact of relay 290, and through conductor 283 to ground at a front contact of relay 277 of two-way trunk circuit TWT2. Relay 614 disconnects ground from the lower winding of relay 630 to prevent operation of this relay if an operator should disregard the busy indication and plug into a jack to which trunk circuit CDT1 is connected. Relay 614 also disconnects the winding of relay 631 from conductor 619, so as to prevent false operation of relay 631; and short circuits the upper winding of relay 620, thereby causing the operation of marginal line relay 801 in the community dial office at the distant end of the trunk CDT. Relay 615 locks through its upper winding to ground on sleeve conductor 603 and disconnects this conductor from the contacts of relays 612, 631 and 633. The lower contacts of relay 615 facilitate testing of this relay.

While the trunk CDT between the toll office and the community dial office is idle, there is a closed circuit through the windings of line relay 801 of trunk circuit CDT2 in the community dial office in series with the left windings of repeating coil RC8, conductors 651 and 652 of trunk CDT, right windings of repeating coil RC6 of trunk circuit CDT1 in the toll office and both windings of relay 629. Relay 629 is polarized and does not operate since the current in this normally closed circuit is in the non-operating direction. Relay 801 is marginal and does not operate since the upper winding of relay 620 has a high resistance. When the upper winding of relay 620 is short circuited by the above-mentioned operation of relay 614, the current through trunk conductors 651 and 652 is increased sufficiently to cause the operation of relay 801 in the community dial office. Relay 801 closes a circuit for operating the slow-to-release relay 802. Relay 802 closes a circuit for operating relay 803, connects ground to conductor 843 to mark trunk circuit CDT2 as busy in the banks of selectors S1 having access thereto, connects the winding of relay 809 to conductor 833 to mark the terminals of trunk CDT2 in the banks of trunk finders TF having access thereto, and closes a circuit for operating group relay 810. With relays 801 and 803 operated, the winding of polarized relay 804 is bridged across conductors 831 and 832. The operation of group relay 810, which is common to the lines connected to one level of terminals in the banks of a group of trunk finders TF, connects ground to the start conductor 811 to start the first idle finder in the group, and connects ground to conductor 812 to mark the level of the banks in which the terminals of trunk circuit CDT2 are located. For a disclosure of a finder circuit and its operation resulting from connection of ground to the start conductor, reference may be had to the patent to R. L. Stokely, No. 1,799,654, granted April 7, 1931. When the brushes of the trunk finder TF engage the terminals to which conductors 831, 832, and 833 are connected, a circuit is closed through conductor 833 for operating relay 809 and for operating a relay in the trunk finder circuit to stop the finder switch TF. Relay 809 closes circuits for operating relays 807 and 808. The operation of relay 807 causes a reversal of the current over trunk CDT and through the windings of polarized relay 620. Relay 808 opens the circuit for operating relay 807 but relay 808 is slow in operating so that relay 807 remains operated for an interval long enough to cause the operation of polarized relay 620 of trunk circuit CDT1 to indicate that a finder has connected the trunk CDT to a selector IS. Relay 804 is thereby connected through the upper brushes of finder TF to the windings of the line relay, not shown, of the associated incoming selector IS. Relay 804 does not operate since it is polarized and the current is in the non-operating direction. The selector S1 and IS and connector C may be two-motion step-by-step switches and reference may be had to pages 53 to 65 of the second edition Automatic Telephony by Smith and Campbell for a com-

plete description of the structure and operation of such switches when used as selectors and connectors. The operation of relay 620 causes the operation of relay 621. Relay 621 locks under control of relay 612, disconnects conductors 601 and 602 from the repeating coil RC6 to prevent the transmission of dial tone from selector IS in the community dial office to the calling operator, disconnects conductor 604 from the ground at the back contact of relay 616 and connects this conductor to ground at the front contact of relay 620. Since calls to trunk circuit CDT may come from intertoll trunks arranged for voice frequency signaling, the dial tone is not transmitted because it would interfere with the receiving of dial impulses. When relay 620 releases due to the release of relay 807, it disconnects ground from conductor 604 causing the release of relay 279; and the release of relay 279 causes the successive reelase of relays 170 and 105 thereby again connecting ground to the low resistance winding of relay 104 to cause the lighting of the dial pilot lamp at the calling operator's position as a signal to the calling operator that dialing may be resumed.

The calling operator now dials the digits of the called subscriber's number, the dial impulses being successively repeated by relays 140 and 270 to cause the alternate release of relays 610 and 611 of trunk circuit CDT1. The release of relay 610 in response to the first impulse of a digit operates relay 613. Relay 613 being slow in releasing remains operated until all of the impulses of a digit have been received by relay 610; and, during each such interval, relay 613 short circuits the windings of relay 620 and the right windings of repeating coil RC. The operation of relay 613 upon receipt of the first dial impulse of the first digit also closes a circuit through the lower winding of relay 616. Relay 616 operates and it locks through its upper winding under the sole control of relay 612. When relay 613 releases at the end of the first digit it closes a short circuit around the winding of relay 621, causing the release of relay 621. Since relay 616 is operated, the release of relay 621 does not reconnect ground to conductor 604. Being slow in releasing, relay 612 remains operated during the response of relay 610 to dial impulses. Relay 611 repeats the dial impulses over trunk circuit CDT, to relay 801 of trunk circuit CDT2. The release of relay 801 in response to the first impulse of each digit closes a circuit for operating relay 805. Being slow in releasing, relay 805 remains operated until all of the impulses of the digit have been received; and, during this interval, relay 805 short circuits the winding of relay 804 and the windings of repeating coil RC8. Relay 801 repeats the impulses through conductors 831 and 832, the first train being effective to directively operate the selector IS. The last two trains of impulses control the operation of a connector C to establish connection with the called line. Ringing is automatically started by the connector; and, when the called subscriber answers, a relay in the connector (which relay is not shown in the drawings) is operated to reverse the current through conductors 831 and 832 to cause the operation of polarized relay 804. Relay 804 closes a circuit for operating relay 807; and relay 807 reverses the current over trunk CDT to operelay 620. The operation of relay 620 connects ground to conductor 619, thence through the lowermost front contact of relay 616, and middle upper front contact of relay 614, to conductor 604 to reoperate relay 279 of two-way trunk circuit TWT2. The operation of relay 279 causes the successive operation of relays 170 and 105. The opening of the circuit through the low resistance winding of relay 140 causes the lamp SL to be extinguished; and, since dialing has been completed, this indicates to the calling operator that the call has been answered by the called subscriber.

When the called subscriber replaces the receiver, the reversal of current from connector C causes the release of relay 804 and the release of relay 804 causes the successive release of relays 807, 620, 279, 170 and 105 to light the supervisory lamp SL associated with plug P2 as a disconnect signal. When the calling operator disconnects plug P2 from jack J1, the outgoing trunk circuit OT2 is restored to normal as described in the aforementioned King et al. patent. The release of relay 140 causes the release of signaling relay 270 of signaling circuit TS2; and the release of relay 270 causes the successive release of relays 275 and 277 of the two-way trunk circuit TWT2 and the successive release of relays 610, 611 and 612 of trunk circuit CDT1. Relays 416, 614 and 615 are held operated through conductors 603, 403, 303 and 283 until relay 277 of two-way trunk circuit TWT2 releases. The selector TS2 is restored to normal as described in the aforementioned King et al. patent. The selector TS4 is restored to normal due to the release of relay 416 when ground is disconnected from conductor 403, in the manner hereinbefore described. The release of relays 614 and 615 restores trunk circuit CDT1 to normal. The aforementioned release of relay 611 causes the release of relay 801 of trunk circuit CDT2. The release of relay 801 causes the release of relays 802, 803, 808 and 809. The release of relay 801 opens the loop across conductors 831 and 832 releasing the finder, selector and connector switches in the community dial office in the usual and well-known manner.

Assume next that the selector TS4 is operated under the control of the impulses created by the dialing of the second digit by the calling operator in the first toll office to select the level represented by the terminal 443, the terminals in this level being connected to ringdown trunk circuits associated with ringdown lines to another toll office. Assume further that the terminals selected in this level are connected to the ringdown trunk circuit RDT5 shown in Fig. 5. Upon selection of such a level, the right-hand normal post springs 426 are actuated to prepare for the connection of ground to conductor 405. When relay 416 operates to extend the connection from conductors 401, 402 through brushes 431 and 432 to conductors 501 and 502 of the selected trunk circuit RDT5, ground is connected through the front contact of normal post springs 426 and a front contact of relay 416 to conductor 405 to operate relay 313 of interswitch trunk circuit IST3. Relay 313 connects conductor 404 to the winding of relay 320 and connects the winding of relay 311 to the windings of retard coil 310, thence through conductors 301 and 302 thence to ground at the front contact of signaling relay 270 as hereinbefore described. Relay 311 operates, closing a circuit for operating relay 314. Relay 314 closes a circuit through conductor 339 for operating the start relay 340 of the common timing circuit TC. As soon thereafter as ground is connected through interrupter A to conductor 341, relay 315 operates. Relay 315 locks under con-

trol of relays 319 and 314; connects battery through resistor 316 and a front contact of relay 313 to conductor 404; and connects ringing current source 317 through condenser 318 to conductor 302, thereby transmitting a ringing tone to the calling operator. Two seconds after interrupter A closes the circuit for operating relay 315, interrupter B connects ground to conductor 342 operating relay 319. Relay 319 locks to ground at relay 314, releases relay 315, disconnects ground from conductor 339, and disconnects conductor 341 from the contact of relay 314 to prevent the reoperation of relay 315. The release of relay 315 opens the ringing tone circuit, disconnects battery from conductor 404 and reconnects this conductor to the winding of relay 320. With relay 313 operated and relay 320 non-operated, ground is connected to conductor 304 to cause the operation of relay 279 of two-way trunk circuit TWT2. The operation of relay 279 causes the operation of relays 270 and 105 of two-way trunk circuit TWT1 to extinguish the supervisory lamp SL to indicate that the called toll line is being signaled. With relay 416 of selector TS4 operated and relays 411 and 412 released, the ground at the front contact of relay 277 of two-way trunk circuit TWT2 is extended through conductor 283, front contact of relay 290, brush 293, conductor 303 of trunk circuit IST3, conductor 403 of selector TS4, a front contact of relay 416, brush 433, conductor 503 of trunk circuit RDT5, through a back contact of relay 506, to the winding of relay 508 of ringdown trunk circuit RDT5. Relay 508 operates and connects battery through resistor 509 to the sleeve of jacks J51 and J52 to mark the line RDL as busy; and connects battery to the winding of relay 529. Relay 529 operates, closing a circuit for operating relay 523. Relay 523 opens the repeater termination comprising condenser 521 and resistor 522 normally bridged across conductors 501 and 502, closes a circuit for operating busy signals BS5, and opens the normally closed circuit through resistor 524 for holding relay 503 operated. With relay 508 operated and with relays 313 and 315 of interswitch trunk circuit IST3 operated, battery is connected through resistor 316, conductor 404, upper back contact of the eleventh-rotary-step springs 422, front contact of relay 416, brush 434, conductor 504, front contact of relay 508, front contact of the normally operated relay 591, to the winding of relay 592. Relay 592 operates, connecting the ringing current source 593 to the repeating coil RC5, thereby transmitting ringing current over the ringdown line RDL to signal an operator at the distant toll office. When relay 315 reelases at the end of a two-second ringing interval, battery is disconnected from conductor 404, releasing relay 592 to disconnect ringing source 593 from repeating coil RC5. With relays 416 and 508 operated, the simplex circuit path from ground at the front contact of relay 279 is extended through conductors 301 and 302, brushes 431 and 432, conductors 501 and 502, windings of retard coil 507, front contacts of relay 508, through resistors 511 and 512 to battery. Resistors 511 and 512 are equal in resistance since the associated ringdown line is equipped with pads. Relay 515, bridged across the simplex, does not operate if the simplex is balanced; and in this case relay 503 releases and relay 534 operates to short circuit pads P51 and P52. If and when a ringing signal is received from the distant toll office, relay 590 operates causing the release of relay 591. The release of relay 591 connects battery through conductors 504 and 404 to operate relay 320 of the interswitch trunk circuit IST3. Relay 320 disconnects the ground at a front contact of relay 313 from conductor 304, thereby causing the release of relay 279. When the ringing signal ends, relay 590 releases, relay 591 operates, relay 320 releases and relay 279 reoperates. The release and reoperation of relay 279 causes the release and reoperation of relays 170 and 105 thereby lighting and extinguishing the supervisory lamp SL associated with plug P2. When the calling operator removes plug P2 from jack J1, relays 104 and 140 are released. The release of relay 140 causes the release of signaling relay 270 of signaling circuit CS2; and the release of relay 270 causes the successive release of relays 275 and 277 of two-way trunk circuit TWT2. The release of relay 277 disconnects holding ground potential from conductor 283 thereby causing the release of relay 416 of selector TS4 and the release of relay 508 of trunk circuit RDT5. The release of relay 508 disconnects busy potential from the jacks J5 and J6 and causes the release of relays 529 and 523.

Calls completed through selector TS9

Assume next that the first digit dialed by the calling operator operates the selector TS2 to select the level represented by terminals 295 and that the selector TS9 is connected to the selected set of terminals in this level. When relay 290 of selector TS2 operates to extend the connection from the calling operator, a circuit path is closed from ground at the front contact of signaling relay 279, through conductor 263, back contacts of relays 210 and 274, winding of relay 275, uppermost front contact of relay 273, thence in simplex through both windings of retard coil 260, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 290, brushes 291 and 292, conductors 901 and 902, back contacts of relay 916 of selector TS9, through resistors 907 and 908 in parallel, thence through resistor 909 and a back contact of relay 916, to the winding of relay 911. Relay 911 operates, closing a circuit for operating slow-to-release relay 912. Relay 912 connects ground to conductor 903 and connects ground through the lowermost back contact of relay 916 to initiate the operation of an alarm circuit to operate an alarm in case the selective operation of switch TS9 is not completed before a predetermined interval of time has expired.

When the calling operator dials the next digit of the called toll route number, the impulses thus created are repeated by relay 140 to relay 270. Each release and reoperation of relay 270 causes a corresponding release and reoperation of relays 275 and 911. The first release of relay 911 closes a circuit from ground at a back contact of relay 916, through the back contact of relay 911, a front contact of relay 912, winding of relay 913, and through the winding of vertical stepping magnet 917 to battery. The stepping magnet 917 is thereby operated to step the brushes 931, 932, 933 and 934 up to the first level of the associated terminal bank. Vertical off-normal springs 921 are actuated when the brush shaft moves out of normal position. Relay 913 is operated in series with the magnet 917 in response to the first impulse of the train; and, when springs 921 are

actuated, a circuit is closed from battery through the winding of relay 915, upper contact of springs 921, front contact of relay 913, to ground at a back contact of release magnet 919. Relay 915 is operated by the current in this circuit and is locked through the back contact of rotary stepping magnet 918 and lower front contact of relay 915 to ground at a back contact of relay 916. When relay 911 reoperates at the end of the first dial impulse, the vertical stepping magnet 917 releases; but relay 913 is slow in releasing and remains operated until relay 911 has reoperated after the last impulse of the train. Relay 912 is also slow in releasing and remains operated during the response of relay 911 to dial impulses. The release and reoperation of relay 911 in response to each succeeding impulse in the train created by the dialing of the next digit after seizure of selector TS9, causes a corresponding operation and release of the vertical stepping magnet 917, thereby advancing the brushes of switch TS9 to the level corresponding to the digit dialed. When relay 913 releases at the end of this train of impulses, it opens the operating circuit of relay 915; but relay 915 is held operated under control of springs 921 and rotary stepping magnet 918.

The selector TS9 is arranged to absorb the first digit if the first digit is of a value which causes the operation of the left-hand normal post springs 925; but, if the selected level is one which does not require the absorbing of the first digit, these springs are not operated and trunk hunting is effective as hereinafter described. If the first digit dialed after seizure of selector TS9 is to be absorbed, the release of relay 913 at the end of the train of impulses closes a circuit from battery through the winding of release magnet 919, lower contact of vertical off-normal springs 921, upper back contact of relay 914, front contact of the left-hand normal post springs 925, upper front contact of relay 915, back contact of relay 913, to ground at the continuity back contact of release magnet 919. The operation of magnet 919 causes the shaft and brushes of switch TS9 to be restored to normal, the release magnet 919 being held operated through the lower contact of vertical off-normal springs 921 until the shaft reaches normal position. While magnet 919 is operated, a circuit is closed from battery through the winding of relay 914, upper outer front contact of release magnet 919, lower front contact of relay 915 to ground at a back contact of relay 916. Relay 914 is operated by the current in this circuit and is locked through its lower front contact to ground at the inner lower front contact of relay 912. Relay 914 disconnects the winding of release magnet 919 from the front contact of normal post springs 925 and connects this contact to the winding of rotary stepping magnet 918. When the vertical off-normal springs 921 are restored to normal position, relay 915 and release magnet 919 release. When the calling operator dials the next digit of the called route number, the impulses received by relay 911 effect the operation of the vertical stepping magnet 917 and relay 913 as above described, thereby advancing the brushes 931, 932, 933 and 934 up to the corresponding level of the terminal bank. Relay 915 is again operated as soon as the vertical off-normal springs 921 are actuated and is locked under control of rotary stepping magnet 918.

When relay 913 releases at the end of the last impulse of the digit which determines the level on which a trunk is to be selected, it closes a circuit for operating the rotary stepping magnet 918. If the selected level is one the selection of which actuates the left-hand normal post springs 925, the circuit for operating magnet 918 is traced through the upper front contact of relay 914, front contact of normal post springs 925, upper front contact of relay 915, back contact of relay 913, to ground at the inner back contact of release magnet 919. If the selected level is one on which the right-hand normal post springs 926 are actuated but the left-hand normal post springs 925 are not actuated, the circuit for operating the rotary stepping magnet 918 includes the back contact of the normal post springs 925. In either case the operation of relay 918 advances the brushes of selector TS9 into engagement with the first set of terminals in the selected level. If the trunk circuit connected to this first set of terminals is busy, the terminal engaged by test brush 933 is connected to ground potential and this ground potential is connected through brush 933, middle lower back contact of relay 916, upper back contact of release magnet 919, back contact of rotary stepping magnet 918, upper contact of vertical off-normal springs 921, to the winding of relay 915. Relay 915 is thereby reoperated to cause the reoperation of rotary stepping magnet 918 to advance the brush to the next set of terminals. Relay 915 and rotary magnet 918 are in this manner cooperative to advance the brushes step by step until the brushes encounter a set of terminals connected to an idle trunk; whereupon relay 916 is operated in a circuit traced from battery through the winding of relay 915, upper front contact of vertical off-normal springs 921, back contact of rotary stepping magnet 918, uppermost back contact of release magnet 919, winding of relay 916, lower back contact of eleventh-rotary-step springs 922, to ground at the uppermost front contact of relay 912. Being marginal, relay 915 does not reoperate in series with the winding of relay 916. The operation of relay 916 connects the grounded conductor 903 through its middle lower front contact and through brush 933 to the engaged terminal, thereby to guard the selected trunk circuit against selection by any other selector which has access thereto. The operation of relay 916 disconnects the winding of relay 911 from conductors 901 and 902 and connects these conductors through brushes 931 and 932 to the talking conductors of the selected trunk circuit. The release of relay 911 causes the release of 912 and the release of 912 causes the release of relay 914 if operated. After relay 912 releases, relay 916 is held through conductors 903, brush 293 of selector TS2, a front contact of relay 290, and through conductor 283 to ground at a front contact of relay 277 of two-way trunk circuit TWT2.

If the level selected in response to a first digit which is not absorbed, or in response to a second digit after the absorbing of the first digit, is the level represented by the terminals 941 in which level the trunk circuits are associated with trunks outgoing to a community dial office, the right-hand normal post springs 926 are actuated upon selection of the level. In this case the release of relay 913 closes a circuit for operating relay 924, from ground at the continuity back contact of release magnet 919, through the continuity back contact of relay 913, upper front contact of relay 915, back contact of normal post

springs 925, front contact normal post springs 926 and through the winding of relay 924. Relay 924 locks through its lower front contact to ground at a front contact of relay 912. The operation of relay 924 connects ground through the upper back contact of springs 922 and conductor 904 to the terminal engaged by brush 294 of selector TS2, to operate relay 279 of two-way trunk circuit TWT2 thereby to effect the extinguishing of the dial pilot lamp at the calling operator's position in the manner hereinbefore described to indicate that no further digits are to be dialed until the lamp is again lighted. If the level, on which the trunks outgoing to the community dial office are located, is one corresponding to a digit which is absorbed if it is the first digit dialed after seizure of selector TS9, the left-hand normal post springs 925 are actuated as well as the right-hand springs 926; and in this case the first digit was absorbed, relay 914 is operated and the circuit for operating relay 924 is traced from the winding of this relay through the front contact of springs 926, upper front contact of relay 914, and front contact of normal post springs 925, thence to ground at the continuity back contact of release magnet 919 as above described. After the trunk-hunting operation has been completed and relay 916 has operated to extend the connection from the calling operator through brushes 931 and 932 to the conductors of the selected trunk, ground is connected to the terminal engaged by brush 934, in similar manner to that hereinbefore described on a call through trunk circuit CDT1 and selector TS4, thereby to hold relay 279 of two-way trunk circuit TWT2 until the switches in the community dial office are ready to receive dial impulses. When the connection has been extended in the community dial office to an incoming selector, the ground potential is disconnected from the terminal engaged by trunk 934 to cause the release of relay 279 and thereby effect the lighting of the calling operator's dial pilot lamp, as a start dial signal, as hereinbefore described.

If the brushes of selector TS9 are advanced to a level which indicates that the first digit is not to be absorbed and also that the trunks are such as not to require the transmission of a stop dial signal, neither the left-hand normal post springs 925 nor the right-hand normal post springs 926 are actuated; and in this case, when relay 913 releases at the end of the digit, the rotary stepping magnet 918 is operated in a circuit traced from its winding through the back contact of normal post springs 925, upper front contact of relay 915, continuity back contact of relay 913 to ground at the continuity back contact of release magnet 919. If the selector TS9 finds all of the trunks busy in the selected level, the brushes are advanced to the eleventh rotary position in which springs 922 are actuated to connect interrupter 923 to conductor 904 to cause the alternate operation and release of relay 279 of two-way trunk circuit TWT2 and thereby cause the flashing of a supervisory lamp at the calling operator's position.

When a connection through selector TS9 is released, the release of relay 277 of two-way trunk circuit TWT2 disconnects ground potential from conductor 283, thereby causing the release of relay 916 of selector TS9 and the release of relay 290 of selector TS2. The release of relay 916 connects ground through the back contact of relays 911 and 912 and the lower front contact of the vertical off-normal springs 921 to operate release magnet 919. Release magnet 919 locks through the vertical off-normal springs and causes the return of the shaft and brushes to normal. When the shaft reaches normal the vertical off-normal springs are restored to normal position to open the circuit through release magnet 919. The selector TS2 and other circuit units involved in the connection are restored to normal as hereinbefore described.

Calls through intertoll selector TS11

Assume next that the first digit dialed by the calling operator operates the selector TS2 to select the level represented by terminal 297 and that the intermediate dialing trunk circuit IDT10 and associated incoming trunk circuit IT10 are connected to the selected set of terminals in this level. Upon selection of the terminals 297 and operation of relay 290 of selector TS2 a circuit is closed from ground through the front contact of relay 270, conductor 263, back contact of relay 210, back contact of relay 274, winding of relay 275, a front contact of relay 273, both windings of retard coil 260, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 290, brushes 291 and 292, conductors 1001 and 1002, back contacts of relay 1010, conductors 1021 and 1022, both windings of retard coil 1020, thence through the winding of relay 1025 to battery. Relay 1025 is thereby operated in series with relay 275 of two-way trunk circuit TWT2 under control of relay 270 of the signaling circuit CS2. Relay 1025 closes a circuit for lighting the answering lamp AL10 associated with jack J10 of the incoming trunk circuit IT10. When the call is answered by the insertion of a plug AP10 of a cord CD10 in jack J10, battery is connected through the sleeve conductors of plug AP10 and jack J10 to conductor 1013 to operate relay 1014. Relay 1014 closes a circuit for operating relay 1016. Relay 1016 closes a circuit for operating relay 1015, this circuit being traced from the winding of relay 1015 through front contacts of relays 1016 and 1025, a back contact of relay 1070, conductor 1003, brush 293, a front contact of relay 290, and through conductor 283 to ground at the lower front contact of relay 277 of two-way trunk circuit TWT2. Relay 1015 locks to conductor 1003 under control of relay 1016 but independent of relay 1025, closes a circuit for operatively energizing the upper winding of relay 1056 of intermediate dialing trunk circuit IDT10 and extinguishes lamp AL10. When the dial key at the calling operator's position is restored to normal, relay 130 of outgoing trunk circuit OT1 is operated and relay 140 is held under control of relay 104 in the manner described in the aforementioned King et al. patent. The talking circuit between the calling operator in the first toll office and the answering operator in the second toll office includes conductors 101 and 102, front contacts of relay 130, conductors 161 and 162, repeating coil RC1, condensers 165, toll line TL1, condensers 265, repeating coil RC2, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 290, brushes 291 and 292, conductors 1001 and 1002, back contacts of relay 1070, conductors 1021 and 1022, condensers 1040 and conductors 1011 and 1012.

To complete the desired connection, the answering operator inserts the calling plug CP10 of cord CD10 in the dial jack DJ of the intermediate dialing trunk circuit IDT10 thereby causing the operative energization of the left winding of relay 1054. Relay 1054 closes a circuit for operating relay 1055. Relay 1055 closes a circuit through the right, low resistance winding of relay 1054 and closes a locking circuit for relay 1056. When the answering operator actuates the dial key, not shown, battery is connected through the impulse contact of the dial, the ring conductor of plug CP10 and conductor 1052 to operate relay 1057; and battery is connected through the tip conductor of plug CP10 and conductor 1051 to operate relay 1058. Relay 1058 closes a circuit for operating relay 1059; and relay 1059 locks under the sole control of relay 1056. Relay 1057 closes a simplex circuit from ground through resistors 1061 and 1062, both windings of retard coil 1060, conductors 1101 and 1102, back contacts of relay 1116, resistors 1107 and 1108, thence through resistor 1109 and a back contact of relay 1116 to the winding of relay 1111. Relay 1111 closes a circuit for operating relay 1112. Relay 1112 connects ground through its inner upper front contact and a back contact of relay 1016 to the alarm circuit to cause a maintenance alarm in usual manner in case no dial impulses are received within a predetermined interval of time.

When the intermediate answering operator dials the first digit of the called toll route or local office code and subscriber's number, relay 1057 is alternately released and reoperated to repeat the dial impulses to relay 1111. The release of relay 1111 in response to the first dial impulse closes a circuit from ground at a back contact of relay 1116, through the back contact of relay 1111, a front contact of relay 1112, winding of relay 1113 and through the winding of vertical stepping magnet 1117 to battery. The stepping magnet 1117 is thereby operated to step the brushes up to the first level of the terminal bank. The vertical off-normal springs 1121 are actuated when the brush shaft moves out of normal position. Relay 1113 is operated in series with magnet 1117; and, when springs 1121 are actuated, a circuit is closed from battery through the winding of relay 1115, upper contact of springs 1121, front contact of relay 1113 to ground at a back contact of release magnet 1119. Relay 1115 locks through the back contact of the rotary stepping magnet 1118 independent of relay 1113. When relay 1111 reoperates at the end of the first dial impulse, stepping magnet 1117 releases; but relay 1113 is slow in releasing and remains operated until after all of the impulses in the train have been received by relay 1111. Relay 1112 is also slow in releasing and remains operated during the response of relay 1111 to dial impulses. The release and reoperation of relay 1111 to each succeeding impulse in the train created by the dialing of the first digit by the answering operator causes a corresponding operation and release of the vertical stepping magnet 1117, thereby advancing the brushes to the level corresponding to the digit dialed. When the relay 1113 releases at the end of this train of impulses, it opens the operating circuit of relay 1115 but relay 1115 is held operated under control of springs 1121 and magnet 1118.

If the level selected in response to the dialing of the first digit by the intermediate operator is one in which selection of a trunk is desired without the dialing of a second digit, normal post springs 1125 are not actuated; and, when relay 1113 releases, a circuit is closed for operating rotary stepping magnet 1118 as hereinafter described. If, however, the first digit dialed by the intermediate operator is one which is to be absorbed, the stepping of the brushes to the corresponding level is effective to actuate normal post springs 1125 without actuating normal post springs 1126. The actuation of the springs 1125 closes a circuit for operating release magnet 1119, this circuit being traced through the lower contact of vertical off-normal springs 1121, back contact of relay 1114, front contact of normal post springs 1125, upper front contact of relay 1115, continuity back contact of relay 1113 to ground at a back contact of release magnet 1119. The release magnet 1119 locks under control of the vertical off-normal springs, causes the return of the shaft and brushes to normal, and closes a circuit for operating relay 1114, this circuit being traced from battery through the winding of relay 1114, upper front contact of release magnet 1119, lower front contact of relay 1115, to ground at a back contact of relay 1116. Relay 1114 locks through its lower front contact under control of relay 1112. When the vertical off-normal springs 1121 are restored to normal, the release magnet 1119 releases and relay 1115 releases. When the calling operator dials the next digit of the called toll route number, relay 1111 again releases and reoperates in response to each impulse of the train causing a corresponding operation and release of the vertical stepping magnet 1117. The release of relay 1111 in response to the first impulse also causes the operation of relay 1113; and the actuation of vertical off-normal springs 1121 again causes the operation of relay 1115. The brushes of switch TS11 are thus stepped up to the level corresponding to the second digit dialed.

When relay 1113 releases, after selection of a level in which selection of a trunk is desired responsive either to the first digit alone or in response to a second digit after the first digit has been absorbed, it closes a circuit for operating the rotary stepping magnet 1118. If the selected level is one on which the left-hand normal post springs 1125 are not actuated, the circuit for operating the rotary stepping magnet 1118 is traced from the winding of this magnet through the back contact of normal post springs 1125, upper front contact of relay 1115, and back contact of relay 1113, to ground at a back contact of release magnet 1119. If the selected level is one on which the normal post springs 1125 are actuated, relay 1114 was operated upon release of the switch to absorb a first digit and the circuit for operating the rotary stepping magnet 1118 is traced from the winding of this magnet through the upper front contact of relay 1114 and front contact of normal post springs 1125 and thence to ground at a back contact of release magnet 1119 as above described. In either case the operation of the rotary stepping magnet 1118, after selection of a desired level, effects the advance of the brushes 1131, 1132, 1133 and 1134 to the first set of terminals in the selected level. The operation of magnet 1118 also causes the release of relay 1115 and the release of relay 1115 causes the release of stepping magnet 1118. When the stepping magnet 1118 releases, a circuit is closed from battery through the winding of relay 1115 through the upper front contact of vertical off-normal springs 1121, back contact of rotary magnet 1118, back contact of release magnet 1119, through the

middle lower back contact of relay 1116 and test brush 1133 to the engaged terminal. If a busy ground potential is connected to this terminal due to the fact that the trunk connected to the first set of terminals is busy, relay 1115 reoperates thereby closing the circuit for reoperating the rotary stepping magnet 1118 to step the brushes to the next set of terminals. Relay 1115 and stepping magnet 1118 are thus effective to advance the brushes step by step in the selected level until the test brush 1133 encounters a terminal which is not connected to ground potential; whereupon relay 1116 is operated in a circuit traced from battery through the winding of relay 1115, upper front contact of the vertical off-normal springs 1121, back contact of rotary stepping magnet 1118, back contact of release magnet 1119, winding of relay 1116, lower back contact of eleventh rotary step springs 1122 to ground at a front contact of relay 1112. Being marginal, relay 1115 does not reoperate in series with the winding of relay 1116. The operation of relay 1116 connects the grounded conductor 1103 through brush 1133 to the engaged terminal to mark the selected trunk busy. Relay 1116 disconnects the winding of relay 1111 from conductors 1101 and 1102 and extends these conductors through its front contacts and brushes 1131 and 1132 to the talking conductors of the selected trunk circuit.

Assume now that the level in which the trunk hunting occurs is one in which the terminals are connected to trunks leading directly to the called toll office, such a level being represented by the terminals 1141 in the bank of switch TS11. When such a level is selected the right-hand normal post springs 1126 are not actuated; and in this case, ground is connected through the back contact of springs 1126 to conductor 1105 to operate relay 1065 of intermediate dialing trunk circuit IDT10, when dialing is completed. The dialing of the remaining digits of the called toll route, and called subscriber's number if the calling line is in a local dial office, causes the alternate release and reoperation of relay 1057 to repeat these impulses over conductors 1101 and 1102 through brushes 1131 and 1132 to the selected intertoll trunk circuit to effect the desired operations in the called toll office. The intertoll trunk circuit T1141 connected to terminals 1141 may be similar to two-way trunk circuit TWT2 and reference may be had to the aforementioned King et al. patent for a complete description of its operation. When the call is answered by an operator in the terminating toll office or by a called subscriber in the called local dial office, ground potential is connected to the conductor engaged by brush 1134, thence through a front contact of relay 1118 and a back contact of eleventh-rotary-step springs 1122 to conductor 1104 to operate the supervisory relay 1075 of the intermediate dialing trunk circuit IDT10. Relay 1075 opens the circuit through the low resistance right winding of relay 1054 to extinguish the supervisory lamp associated with the calling plug CP10 of cord CD10 but does not connect ground to conductor 1094 until the intermediate operator disconnects cord CD10 from both of jacks J10 and DJ. When plug AP10 is disconnected from jack J10, relays 1014, 1016 and 1015 release in succession. When plug CP10 is disconnected from jack DJ, relays 1054, 1057 and 1058 release. The release of relay 1054 causes the release of relays 1055 and 1056 in succession. The release of relays 1056 and 1058 cause the release of relay 1059. Relay 1059 is slow in releasing and, before relay 1059 releases, a circuit is closed from ground through the inner lower front contact of relay 1059 and lower back contact of relay 1056 for operating relay 1070. Relay 1070 locks to conductor 1003, disconnects conductors 1001 and 1002 from the winding of relay 1025 and connects these conductors, through conductors 1101 and 1102, front contacts of relay 1116 and brushes 1131 and 1132, to the windings of the line relay (not shown) in the selected intertoll trunk circuit T1141. Since the normal post springs 1126 are not actuated, the operation of relay 1070 completes the circuit path from ground at the back contact of springs 1126, through conductor 1105, and a front contact of relay 1070, to the winding of relay 1065 of intermediate dialing trunk circuit IDT10. Relay 1065 operates, connecting the winding of supervisory relay 1066 through resistors 1063 and 1064 and both windings of retard coil 1060, conductors 1101 and 1102, front contacts of relay 1070, conductors 1001 and 1002, brushes 291 and 292 of selector TS2, thence to ground at the front contact of relay 270 in signaling circuit CS2. Thus relay 1066 is connected in parallel with the line relay of the selected trunk circuit T1141. After relays 1056 and 1059 have released, ground is connected through a front contact of relay 1075, conductor 1004, brush 294 and a front contact of relay 296 to conductor 284 to operate relay 279 of two-way trunk circuit TWT2. Relay 279 connects signaling battery to the upper conductor of toll line TL1 to operate relay 170 of signaling circuit CS1 and thereby effect the extinguishing of the supervisory lamp SL associated with the calling operator's cord CD1. The aforementioned operation of relay 1070 also connects conductor 1003 to conductor 1103 thereby extending the ground potential at the front contact of relay 277 of trunk circuit TWT2 through conductor 1103, a front contact of relay 1116 and brush 1133 to the holding conductor of the selected intertoll trunk circuit. Supervisory signals from the called toll office are repeated by relays 1075, 279, 170 and 105 to the calling operator.

If the calling operator, operates the ringing key (not shown) to transmit a rering signal, the release and reoperation of relay 140, which is thereby effected in the manner set forth in the aforementioned King et al. patent, causes a like release and reoperation of relay 270 of signaling circuit CS2. The release of relay 270 causes the release of relay 275 of two-way trunk circuit TWT2, the release of relay 1066 of trunk circuit IDT10 and the release of the line relay of trunk circuit T1141. If supervisory relay 1075 is operated at the time relay 1066 releases, the rering signal does not further affect the trunk circuit IDT10; but, if relay 1075 is not operated at the time relay 1066 releases, the release of relay 1066 causes the release of cut-through relay 1070 in the manner described in the aforementioned copending application of J. Baumfalk. The release of relay 1070 disconnects conductors 1001, 1002 and 1003 from conductors 1101, 1102 and 1103 thereby causing the release of relay 1116 of selector TS11 and the return of this selector to normal. The release of relay 1070 reconnects conductors 1001 and 1002 to the winding of relay 1025 of trunk circuit IT10 to again light the lamp AL10 as a calling signal.

When the calling operator disconnects, relays 104, 110, 130, 140 and 270 are released. The release of relay 270 causes the release of relays 275 of two-way trunk circuit TWT2, the release of re-

lay 1066 of intermediate dialing trunk circuit IDT10 and the release of the line relay of the trunk circuit T1141. The release of relay 275 causes the release of relay 277, thereby disconnecting holding ground potential from conductor 283 to cause the return of selector TS2 to normal and causing the release of relays 1070 and 1116. The release of relay 1116 closes the circuit for operating the release magnet 1119 thereby causing the shaft and brushes of selector TS11 to be restored to normal. When the vertical off-normal springs are restored to normal the release magnet 1119 is released.

Assume next that the level in which trunk hunting is desired, is a level in which the trunks accessible therethrough are used for through calls, that is, calls which do not terminate in the toll office to which the trunks extend, such a level being represented by terminals 1142 connected to trunk circuit T1142. In this case, the normal post springs 1126 are actuated when the level is selected. When relay 1116 operates, upon selection of an idle trunk in the selected level, the conductors 1101 and 1102 are connected through brushes 1131 and 1132 to the line relay (not shown) of the selected intertoll trunk circuit T1142. The impulses created by the dialing of the succeeding digits of the call toll route subscriber's number are repeated by relay 1057 through conductors 1101 and 1102 and brushes 1131 and 1132 to the selected intertoll trunk circuit to effect completion of the desired connection. When the intermediate dialing operator disconnects the cord CD10 from jacks J10 and DJ, relays 1014, 1015, 1016, 1054, 1055, 1056, 1057, 1058, and 1059 are released and relay 1070 is operated in the manner hereinbefore described. The operation of relay 1070 releases relay 1025 and completes the talking connection between toll line TL1 and the selected intertoll trunk. Since normal post springs 1126 are actuated, relay 1065 is not operated and relay 1066 is not connected to conductors 1101 and 1102 as above described on a terminating call through trunk circuit T1141. Supervisory signals are transmitted from the seized intertoll trunk through brush 1134 and a front contact of relay 1116 to relay 1075 of the intermediate dialing trunk circuit IDT10. Relay 1075 repeats the supervisory signals through conductor 1004, brush 294 and conductor 284 to relay 279 by two-way trunk circuit TWT2; and relay 279 repeats these signals over toll line TL1 to control the supervisory lamp of the calling operator's cord CD1 in the manner hereinbefore described. If the calling operator operates a ringing key to transmit a rering signal on the call, the momentary release of relay 140 causes a like release of relay 270 of signal circuit CS2. The momentary release of relay 270 causes the release of the line relay of the intertoll trunk circuit T1142. Since relay 1065 is not operated on a through call, relay 1066 is not controlled by the rering signal. When the calling operator releases the connection by disconnecting plug P2 from jack J1, all of the circuit units involved in the connection are restored to normal as above described.

Calls completed through selector TS13

Assume next that the first digit dialed by the calling operator operates the selector TS2 to select the level represented by terminals 298 and that the intertoll trunk circuit IT12 is connected to the selected set of terminals in this level. The trunk circuit IT12 is normally in a cut-through condition and simplexed impulses received over the tip and ring are transmitted directly to the associated selector TS13. Upon selection of the terminals 298 and operation of relay 299 of selector TS2, a circuit is closed from ground through the front contact of relay 270, through conductor 283, back contact of relay 210, back contact of relay 274, winding of relay 275, a front contact of relay 273, both windings of retard coil 269, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 233, brushes 291 and 292, conductors 1201 and 1202, back contacts of relays 1226 and 1225, conductors 1301 and 1302, back contacts of relay 1316, resistors 1307 and 1308, thence through resistor 1309, a back contact of relay 1316, through the winding of relay 1311 to battery. Relay 1311 is thereby operated in series with relay 275 of two-way trunk circuit TWT2 under control of relay 270 of the signaling circuit CS2. Relay 1311 closes a circuit for operating the slow-to-release relay 1312. Relay 1312 connects ground to conductor 1303 and connects ground to the lowermost back contact of relay 1316 to initiate the operation of an alarm circuit to operate an alarm in case the selective operation of switch TS13 is not completed before a predetermined interval of time has expired.

When the calling operator dials the next digit of the called toll route number, the impulses thus created are repeated by relay 140 of outgoing trunk circuit OT1, over intertoll trunk TL1, to relay 270 of signaling circuit CS2. Each release and reoperation of relay 270 causes a corresponding release and reoperation of relays 275 and 1311. The first release of relay 1311 closes a circuit from ground at the back contact of relay 1316, through the back contact of relay 1311, a front contact of relay 1312, winding of relay 1313, and through the winding of vertical stepping magnet 1317 to battery. The stepping magnet 1317 is thereby operated to step the brushes up to the first level of the terminal bank. Vertical off-normal springs 1321 are actuated when the brush shaft moves out of normal position. Relay 1313 is operated in series with the magnet 1317 in response to the first impulse of the train; and, when springs 1321 are actuated, a circuit is closed from battery through the winding of relay 1315, upper contact of springs 1321, front contact of relay 1313, to ground at a front contact of release relay 1312. Relay 1315 is operated by the current in this circuit; and it locks through the back contact of rotary stepping magnet 1318, through its own lower front contact, to ground at a back contact of relay 1316. When relay 1311 reoperates at the end of the first dial impulse, the vertical stepping magnet 1317 releases; but relay 1313 is slow in releasing and remains operated until relay 1311 has reoperated after receiving the last impulse of the trains. Relay 1312 is also slow in releasing and remains operated during the response of relay 1311 to dial impulses. The release and reoperation of relay 1311 in response to each succeeding impulse in the train causes a corresponding operation and release of the vertical stepping magnet 1317, thereby advancing the brushes of switch TS13 to the level corresponding to the digit dialed. When relay 1313 releases at the end of the train of impulses, it opens the operating circuit of relay 1315; but relay 1315 is held operated under control of springs

1321 and rotary stepping magnet 1318. When relay 1313 releases, the rotary stepping magnet 1318 is operated in a circuit traced from its winding through the upper front contact of relay 1315, upper back contact of relay 1313, to ground at a front contact of relay 1312. The operation of stepping magnet 1318 advances the brushes of switch TS13 into engagement with the first set of terminals in the selected level, and causes the release of relay 1315. The release of relay 1315 causes the release of stepping magnet 1318, thereby closing a circuit from battery through the winding of relay 1315, upper front contact of vertical off-normal springs 1321, back contact of stepping magnet 1318, middle lower back contact of relay 1316, through test brush 1333 to the engaged test terminal. If the selector or trunk circuit connected to the engaged set of terminals is busy, brush 1333 encounters a busy ground potential which causes the reoperation of relay 1315. The reoperation of relay 1315 causes the reoperation of stepping magnet 1318 to advance the brushes of selector TS13 into engagement with the next set of terminals in the selected level. If the test terminal of this next set of terminals is also connected to ground, relay 1315 is again operated to continue the advance of the brushes of selector TS13. When the brushes engage a set of terminals connected to an idle trunk or selector, relay 1315 does not reoperate since the terminal engaged by brush 1333 is free of ground potential; and relay 1316 is operated by the current in a circuit traced from battery through the winding of relay 1315, through the upper contact of vertical off-normal spring 1321, back contact of rotary stepping magnet 1318, winding of relay 1316, lower contact of the eleventh rotary step springs 1322, to ground at the uppermost front contact of relay 1312. Relay 1315 is marginal and does not reoperate in series with the winding of relay 1316. Relay 1316 disconnects the winding of relay 1311 from conductors 1301 and 1302 and connects these conductors, through brushes 1331 and 1332, to the talking conductors of the trunk connected to the engaged set of terminals. The release of relay 1311 when its winding is disconnected from conductors 1301 and 1302 causes the release of relay 1312. Relay 1312 disconnects ground from conductor 1303 but relay 1316 is held operated, since conductor 1303 is connected, through conductor 1203 of trunk circuit IT12 to ground at the front contact of relay 277 of two-way trunk circuit TWT2.

Assume now that the selector TS13 selects the level represented by terminals 1342, the terminals in this level being connected to trunks to a local step-by-step dial office which is represented by the toll connector TC shown in Fig. 14. Upon selection of such a level, neither the normal post springs 1325 nor the normal post springs 1326 are actuated; and, when relay 316 operates upon selection of an idle trunk in the level, ground is connected through the back contact of springs 1326, and a front contact of relay 1316, to conductor 1305 to operate relay 1225 of trunk circuit IT12. Relay 1225 closes a circuit for operating relay 1226; and closes a circuit for operating the line relay 1401 of connector TC. The circuit for operating relay 1401 is traced from battery through the lower winding of relay 1401, lower back contact of relay 1404, lower conductor of trunk T13, brush 1332 of switch TS13, inner lower front contact of relay 1316, conductor 1302, outer lower front contact of relay 1225, back contact of jack 1214, inner upper back contact of relay 1217, winding of relay 1215, upper back contact of jack 1208, outer upper back contact of relay 1217, back contact of relay 1213, back contact of relay 1212, inner lower front contact of relay 1225, upper back contact of jack 1214, uppermost front contact of relay 1225, conductor 1301, front contact of relay 1316, brush 1331, upper conductor of trunk T13, inner upper back contact of relay 1404, through the upper winding of relay 1401 to ground. This circuit is immediately closed by the operation of relay 1225, prior to the operation of relay 1211 of trunk circuit IT12, in order to prepare the connector TC for response to dial impulses. The operation of relay 1226 closes a circuit for operating relays 1209 and 1211. This circuit is traced from ground at the front contact of relay 270 of signaling circuit CS2 through conductor 263, back contact of relay 210, back contact of relay 274, winding of relay 275, a front contact of relay 273, both windings of retard coil 260, conductors 261 and 262, back contacts of relay 230, conductors 271 and 272, front contacts of relay 273, conductors 281 and 282, front contacts of relay 290, brushes 291 and 292 of switch TS2, conductors 1201 and 1202, front contacts of relay 1226, and left windings of repeating coil RC12 to conductor 1207, thence through a back contact of jack 1208, winding of relay 1209 and through the lower winding of relay 1211, to battery at a back contact of jack 1208. Relay 1209 closes a circuit for operatively energizing the upper winding of relay 1212. Relay 1212 locks through its lower winding and inner lower front contact, through conductor 1203 to ground at a front contact of relay 277 of two-way trunk circuit TWT2. Relay 1212 closes a circuit for operatively energizing the middle and upper, biasing windings of relay 1211 and opens the short circuit across the contact of relay 1211 so that the circuit for operating relay 1401 of connector TC now includes the front contact of relay 1211 instead of the upper back contact of relay 1212. The aforementioned operation of relay 1225 also connects the winding of relay 1227, through the inner upper front contact of relay 1225 to conductor 1304, thence through a back contact of the eleventh-rotary-step springs 1322, a front contact of relay 1316, through brush 1334 to the terminal engaged thereby. If the trunk T13 to the step-by-step office has an impedance in excess of 1200 ohms, the terminal engaged by brush 1334 is connected to battery through a resistor 1344, thereby causing operation of relay 1227 in trunk circuit IT12. Relay 1227 connects the outer windings of repeating coil 1312 in series with the inner windings to increase the impedance of the repeating coil to match that of the trunk circuit T13. If the trunk to the step-by-step office has an impedance less than 1200 ohms, the terminal engaged by brush 1334 will not be connected to battery; and in this case relay 1227 remains normal so that only the inner right windings of repeating coil RC12 are included in the talking connection over the trunk selected by switch TS13. While the trunk T13 is shown as connecting directly to the connector TC, the trunk may connect to an incoming selector and intermediate selectors may also be provided in the local dial office, the number of stages of selection depending on the number of lines in the office.

The aforementioned operation of relay 1401, upon seizure of trunk T13, closes a circuit for operating the slow-to-release relay 1402. Relay

1402 connects ground to conductors 1413 and 1414 and connects the windings of vertical stepping magnet 1420 and relay 1403 to the back contact of relay 1401 in preparation for response to dial impulses. When the calling operator dials the first numerical digit of the called subscriber's number after seizure of switch TC, the impulses are repeated by relays 140 and 270 to relays 1209 and 1211 of trunk circuit IT12. Each release of relay 1211 opens the bridge across conductors 1301 and 1302 to cause the release of relay 1401 of connector TC. The release of relay 1209 in response to the first impulse closes a circuit for operating slow-to-release relay 1213 to short circuit the winding of polarized relay 1215 while the train of impulses is being received and repeated over trunk T13 to connector TC. Being slow in releasing relay 1213 remains operated until all of the impulses in the train have been received. When relay 1213 operates at the beginning of the first train of impulses transmitted over the trunk T13 to the step-by-step office, it closes a circuit for operating relay 1216, this circuit being traced from battery through resistor 1218, winding of relay 1216, lowermost front contact of relay 1212, continuity back contact of relay 1216, to ground at the lower front contact of relay 1213. Relay 1217 does not operate at this time since its winding is normally short-circuited. Relay 1216 locks under the control of relay 1212; and, when relay 1213 releases at the end of the train of impulses, relay 1217 is operated in a circuit from battery through resistor 1219, winding of relay 1217, lower front contact of relay 1216, to ground at the inner upper front contact of relay 1212. When relay 1213 operates, in response to the first impulse of the second digit dialed after selection of trunk T13, it closes a short circuit across the winding of relay 1216 to cause the release of this relay; but relay 1217 is held operated in a circuit from battery through resistor 1219, winding of relay 1217, inner front contact of relay 1217, through the inner upper back contact of relay 1216 to ground at the inner upper front contact of relay 1212. While relay 1217 is normal, the windings of repeating coil RC12 are short-circuited at the upper back contacts of relay 1217. After relay 1217 operates and while relay 1216 is operated, the windings of repeating coil RC12 are short-circuited at the upper front contacts of relay 1216; but, after relay 1216 has released and while relay 1217 is operated, the short circuiting of the windings of repeating coil RC12 is controlled solely by relay 1213. After the release of relay 1213, at the end of the second train of impulses, the winding of polarized relay 1215 is connected in series with the right windings of repeating coil RC12 across the conductors of trunk T13. This feature of short circuiting the right windings of repeating coil RC12 until after two digits have been dialed prevents the transmission of dial tone from the step-by-step office through repeating coil RC12 to the originating operator, thereby preventing interference with signaling over a preceding intertoll trunk which is arranged for voice frequency dialing in case the trunk circuit IT12 is accessible to intertoll selectors preceded by such a trunk circuit.

The dial impulses repeated by relay 1211 over conductor T13 to the line relay 1401 of connector TC causes the alternate release and reoperation of relay 1401. The first release of relay 1401 closes a circuit from ground at its back contact, through the inner upper front contact of relay 1402, normally closed contact of the vertical off-normal springs VON, winding of relay 1403, and through the winding of vertical stepping magnet 1420 to battery. Relay 1403 and magnet 1420 both operate, the operation of the magnet stepping the shaft and brushes of switch TC up to the first level of the terminal bank. When relay 1401 reoperates at the end of the first impulse, the stepping magnet 1420 releases but relay 1403 is slow in releasing and remains operated until all of the impulses of the train have been received. Relay 1402 is also slow in releasing and remains operated until the connection is released by the calling subscriber. Each succeeding release of relay 1401 causes the reoperation of stepping magnet 1420 thereby advancing the brushes 1417, 1418, and 1419 to the level corresponding to the digit dialed. After the switch is advanced from its normal position in response to the first impulse, the circuit for holding relay 1403 and reoperating magnet 1420 is traced through the upper front contact of the vertical off-normal springs VON and the front contact of relay 1403 instead of through the normally closed contact of the VON springs.

When relay 1401 releases in response to the first impulse created by the dialing of the last digit of the called subscriber's number a circuit is closed for operating relay 1405 and the rotary stepping magnet 1430 in parallel. This circuit is traced from battery through the winding of magnet 1430 and outer upper back contact of relay 1411, in parallel with battery through the winding of relay 1405, then through the upper back contact of relay 1407, back contact of relay 1403, upper front contact of the VON springs, inner upper front contact of relay 1402, to ground at the back contact of relay 1401. The operation of relay 1405 renders the energization of this relay and magnet 1430 independent of relay 1407, the upper front contact of relay 1405 being in parallel with the upper back contact of relay 1407. The operation of magnet 1430 advances the brushes 1417, 1418, and 1419 into contact with the first set of terminals in the selected level. The reoperation of relay 1401, at the end of the first impulse of the last digit, causes the release of magnet 1430. Each succeeding release of relay 1401 causes the reoperation of magnet 1430, thereby advancing the brushes of switch TC into engagement with the set of terminals connected to the line of the called subscriber. Relay 1405 is slow in releasing and remains operated until all of the impulses in the train have been received. Before relay 1405 releases, a busy test is made. The test circuit is traced from battery through the winding of relay 1407, inner upper back contact of relay 1411, lower front contact of relay 1405, through sleeve brush 1419 to the sleeve terminal of the selected line. If the line is busy, the terminal engaged by brush 1419 is connected to ground and in this case relay 1407 operates. If relay 1407 operates, it remains operated after relay 1405 releases, the holding circuit being traced through the inner back contact of relay 1405, front contact of relay 1407, and conductor 1414, to ground at the lower front contact of relay 1402. A busy tone is transmitted to the calling station by connecting the left-hand winding of the tone source 1412, through the inner lower front contact of relay 1407, to the lower one of talking condensers 1490.

Assuming that the called line is the line L14 and that this line is idle, relay 1407 does not operate; and the release of relay 1405 closes a

circuit from battery through the winding of the cut-off relay 1453 of line L4, through brush 1419, outer back contact of relay 1405, lower winding of relay 1411, lower back contact of relay 1407 to ground at relay 1402. Relay 1411 is sufficiently energized by the current through its lower winding to close its inner upper front contact. Whereupon the operation of relay 1411 is completed by the energization of its upper winding, through conductor 1413 to ground at the uppermost front contact of relay 1402. With relay 1411 completely operated, ground is connected through the next-to-the-outer lower front contact to sleeve brush 1419 as a line busy condition; and a signaling circuit is closed from the ringing current source 1425, through the inner lower front contact of relay 1411, lower winding and lower back contact of relay 1406, lowermost front contact of relay 1411, brush 1418, through the talking conductors of line L14 and ringer, not shown, at the subscriber's station, brush 1417, uppermost front contact of relay 1411, to ground at the outer upper back contact of relay 1406. When the subscriber at the called station removes the receiver, relay 1406 is energized sufficiently by the current through its lower winding to operate its inner upper front contact, thereby closing a circuit from battery through the upper winding and inner upper front contact of this relay to ground on conductor 1413. The operation of relay 1406 connects a source of talking current to the line L14 in series with the windings of supervisory relay 1404. With the receiver removed from the receiver hook at the called station, relay 1404 is operated thereby reversing the connections between the windings of relay 1401 and the conductors of trunk T13. The resulting reversal of current through the winding of polarized relay 1215 of trunk circuit IT12 causes the operation of this relay. The operation of relay 1215 connects ground to conductor 1204 thereby causing the operation of relay 279 of two-way trunk circuit TWT2 to transmit an answering supervisory signal over the toll line TL1 to the calling operator, as hereinbefore described.

When the called subscriber restores the telephone to normal, relay 1404 releases, causing the successive release of relays 1215 and 279 to effect the transmission of an On Hook signal to the calling operator. When the calling operator disconnects plug P2 from jack J1, relay 140 of outgoing trunk circuit OT1 releases, causing the release of relay 270 of signaling circuit CS2. The release of relay 270 causes the successive release of relays 275 and 277 of two-way trunk circuit TWT2 and causes the release of relays 1209 and 1211 of trunk circuit IT12. The release of relay 277 disconnects holding ground potential from conductors 283 and 1203, causing the return of selector TS2 to normal and causing the release of relay 1212 of trunk circuit IT12 and release of relay 1316 of selector TS13. The release of either of relays 1211 and 1212 causes the successive release of relays 1401 and 1402 of connector TC. The release of relay 1316 of selector TS13 closes the circuit for operating release magnet 1319 to restore this selector to normal. The release of relays 1402 and 1404 causes the release of relays 1406 and 1411. The release of relay 1411 closes the circuit for operating release magnet 1440 to restore connector TC to normal.

If the selector TS13 selects a level represented by terminals 1341 on a call to a community dial office, the left-hand normal post springs 1325 are actuated, to initiate a stop-dial signal which is transmitted to the calling toll operator in the manner hereinbefore described upon selection of a trunk to a community dial office by the selector TS4. The right-hand normal post springs 1326 are also actuated on such a level to prevent the operation of relay 1225 of trunk circuit IT12 when a trunk is selected in the level. The further operations of the various circuit units included in such a connection are similar to those hereinbefore described on a call completed through selector TS4 and community dial trunk circuits CDT1 and CDT2.

If selector TS13 selects a level in which the trunks are arranged for reverse battery supervision and it is also necessary to give the calling operator a signal to prevent further dialing until the equipment at the distant end of the selected trunk is ready to receive dial impulses, the normal post springs 1325 are actuated to initiate a stop-dial signal; but the normal post spring 1326 are not actuated. Relay 1224 is operated as soon as relay 1313 of selector TS13 releases, the operating circuit being traced from the winding of relay 1224, through a back contact of relay 1225, conductor 1304, back contact of springs 1322, lower back contact of relay 1313, front contact of springs 1325, to ground at a front contact of relay 1312. As soon as the trunk is selected, the operation of relay 1316 closes the circuit for operating relay 1225. Relay 1225 opens the operating circuit of relay 1224 but relay 1224 locks through the middle lower front contact of relay 1225 and its own upper front contact, to ground at the back contact of relay 1215. The operation of relay 1225 closes the circuit for operating relay 1226, thereby inserting the repeating coil RC12 in the connection between intertoll trunk TL1 and the selected trunk circuit, and closes the impulse repeating bridge across the conductors of the selected trunk under the control of relays 1209 and 1211, as above described. Relay 1215 will be immediately operated in response to a stop dial signal, which is similar to an off-hook signal transmitted from the distant end of the trunk, until the equipment in the distant office is ready to receive dial impulses. The operation of relay 1215 causes the release of relay 1224 and connects ground to conductor 1204 to continue the stop dial signal after relay 1224 releases. When the distant equipment is ready to receive dial impulses, the off-hook signal ends and relay 1215 releases, thereby disconnecting ground from conductor 1204 to release relay 279 of two-way trunk circuit and thereby transmit a start dial signal over toll line TL1 to the calling operator. The dial impulses are then repeated by relay 1211 as above described and supervisory signals are transmitted as above described.

What is claimed is:

1. In combination in a telephone system, a trunk circuit, a selector individual to said trunk circuit and comprising a set of brushes, a bank of terminals divided into levels and means for advancing the brushes to select any level and any set of terminals in a selected level, groups of trunks, the trunks of each group being connected to terminals in a different level of the bank, said groups of trunks varying in character, and means comprising contact springs actuated upon selection of a particular level for indicating to the associated trunk circuit the character of the trunks connected to the selected level.

2. In combination in a telephone system, a

trunk circuit, a selector individual to said trunk circuit and comprising a set of brushes, a bank of terminals divided into levels and means for advancing the brushes to select any level and any set of terminals in a selected level, groups of trunks, the trunks of each group being connected to terminals in a different level of the bank, said groups of trunks varying in character, means comprising contact springs actuated upon selection of a particular level for effecting the return of the brushes to normal, and means comprising other contact springs actuated upon selection of a particular level for indicating to the associated trunk circuit the character of the trunks connected to the selected level.

3. In combination in a telephone system, a trunk circuit, a selector individual to said trunk circuit and comprising a set of brushes, a bank of terminals divided into levels and means for advancing the brushes to select any level and any set of terminals in a selected level, groups of trunks, the trunks of each group being connected to terminals in a different level of the bank, said groups of trunks varying in character, means comprising contact springs actuated upon selection of a particular level for effecting the return of the brushes to normal, means rendered effective upon return of the brushes to normal responsive to the operation of said contact springs for rendering said contact springs ineffective to cause the return of said brushes to normal, and means comprising other contact springs actuated upon selection of a particular level for indicating to the associated trunk circuit the character of the trunks connected to the selected level.

4. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising normally inoperative impulse receiving and repeating means, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, the terminals in another of said levels being connected to trunks terminating in an office comprising means for receiving impulses in a loop circuit over the conductors of a trunk, means in in said selector responsive to a train of dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, and means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to repeat the trains of dial impulses incoming over said intertoll trunk in a loop circuit over the selected one of the trunks to said other level.

5. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising normally inoperative means for receiving reverse battery supervisory signals, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, the terminals in another of said levels being connected to trunks terminating in an office comprising means for transmitting reverse battery supervisory signals over the conductors of a trunk, means in said selector responsive to a train of dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, and means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to respond to reverse battery supervisory signals incoming over the trunk selected by said selector.

6. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising normally inoperative impulse receiving and repeating means and normally inoperative means for receiving reverse battery supervisory signals, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is assoicated with a trunk responsive to its seizure by said selector, the terminals in another of said levels being connected to trunks terminating in an office comprising means for receiving impulses in a loop circuit over the conductors of a trunk and means for transmitting reverse battery supervisory signals over the conductors of a trunk, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, and means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to repeat the trains of dial impulses incoming over said intertoll trunk in a loop circuit over the conductors of the selected trunk in said other level and for rendering said trunk circuit effective to respond to reverse battery supervisory signals incoming over the selected trunk in said other level.

7. In combination in a telephone system comprising lines and trunks, a trunk circuit, a selector individual thereto, said selector comprising

a set of brushes and a terminal bank divided into levels and means for advancing the brushes to select any level and any set of terminals in a selected level, a calling line connected to said trunk circuit, groups of trunks connected to the levels of said bank, some of said trunks having an impedance within certain limiting values and others having an impedance outside of said limiting values, a repeating coil in said trunk circuit for connecting said calling line to the trunk selected by said selector, and means including means individual to a selected one of said other trunks for changing the effective impedance ratio of said repeating coil to more closely match the impedance of the selected ttrunk.

8. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising a normally by-passed repeating coil and normally inoperative impulse receiving and repeating means, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, the terminals in another level being connected to trunks terminating in an office comprising means for receiving impulses in a loop circuit over the conductors of a trunk, some of said last-mentioned trunks having an impedance within certain limiting values and others having an impedance outside of said limiting values, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to repeat the trains of dial impulses incoming over said intertoll trunk in a loop circuit over the conductors of the selected trunk in said other level, and means including means individual to a selected one of the trunks having an impedance outside of said limiting values for changing the effective impedance of said repeating coil to more closely match the impedance of the selected trunk.

9. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising a normally by-passed repeating coil and normally inoperative means for receiving reverse battery supervisory signals, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, the terminals in another level being connected to trunks terminating in an office comprising means for transmitting reverse battery supervisory signals over the conductors of a trunk, some of said last-mentioned trunks having an impedance within certain limiting values and others having an impedance outside of said limiting values, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to respond to reverse battery supervisory signals incoming over the selected trunk in said other level, and means including means individual to a selected one of the trunks having an impedance outside of said limiting values for changing the effective impedance of said repeating coil to more closely match the impedance of the selected trunk.

10. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said trunk circuit comprising a normally by-passed repeating coil and normally inoperative impulse receiving and repeating means and normally inoperative means for receiving reverse battery supervisory signals, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, the terminals in another level being connected to trunks terminating in an office comprising means for receiving impulses in a loop circuit over the conductors of a trunk and means for transmitting reverse battery supervisory signals over the conductors of a trunk, some of said last-mentioned trunks having an impedance within certain limiting values and others having an impedance outside of said limiting values, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to said operator's position to indicate that the operator shall stop dialing, means comprising another set of contact springs actuated upon selection of said other level for rendering said trunk circuit effective to repeat the trains of dial impulses incoming over said intertoll trunk in a loop circuit over the conductors of the selected trunk in said other level and for rendering said trunk circuit effective to respond to reverse battery supervisory signals incoming over the selected trunk in said other level, and means including means individual to a selected one of the trunks having an impedance

outside of said limiting values for changing the effective impedance of said repeating coil to more closely match the impedance of the selected trunk.

11. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of a particular level for restoring the brushes to normal, and means comprising another set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to the calling operator to indicate that the operator shall stop dialing.

12. In a multioffice telephone system, an intertoll trunk, a calling operator's position comprising an impulse dial for transmitting trains of selective impulses corresponding to the digits of toll route, local office code and called subscriber's numbers, a trunk circuit and a selector individual thereto, means including said intertoll trunk connecting said operator's position to said trunk circuit, said selector comprising a set of brushes and a bank of terminals divided into levels, groups of trunks connected to the terminals of said bank, the terminals in one of said levels being connected to trunks terminating in an office in which impulse receiving means is associated with a trunk responsive to its seizure by said selector, means in said selector responsive to dial impulses transmitted over said intertoll trunk for selecting a corresponding level and a set of terminals connected to an idle trunk, means comprising a set of contact springs actuated upon selection of a particular level for restoring the brushes to normal, means rendered effective upon return of the brushes to normal responsive to the operation of said set of contact springs for rendering said springs ineffective to cause the return of said brushes to normal, and means comprising another set of contact springs actuated upon selection of said one level for initiating the transmission of a signal to the calling operator to indicate that the operator shall stop dialing.

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