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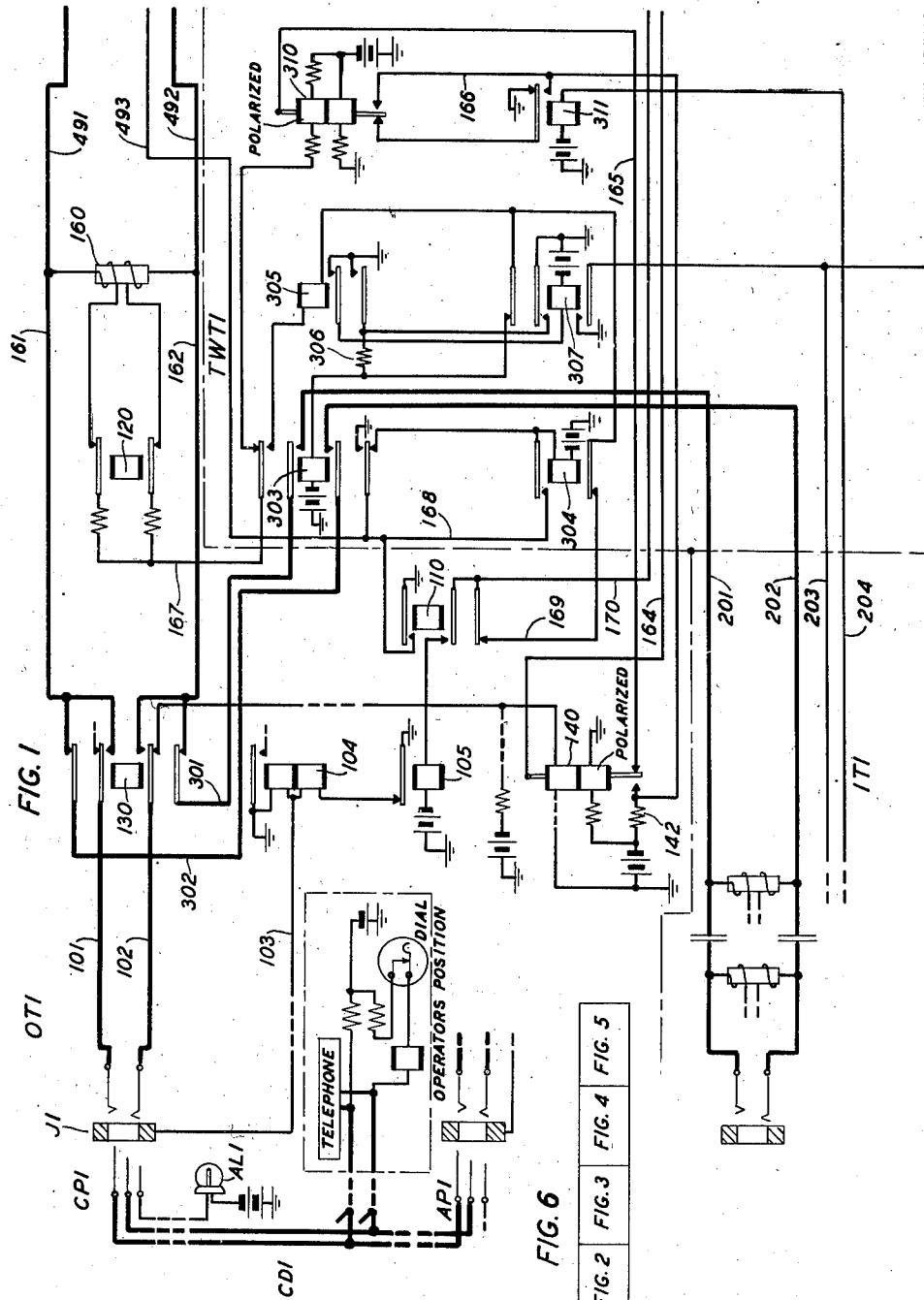
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2,374,884

SIGNALING SYSTEM

Filed Aug. 19, 1943

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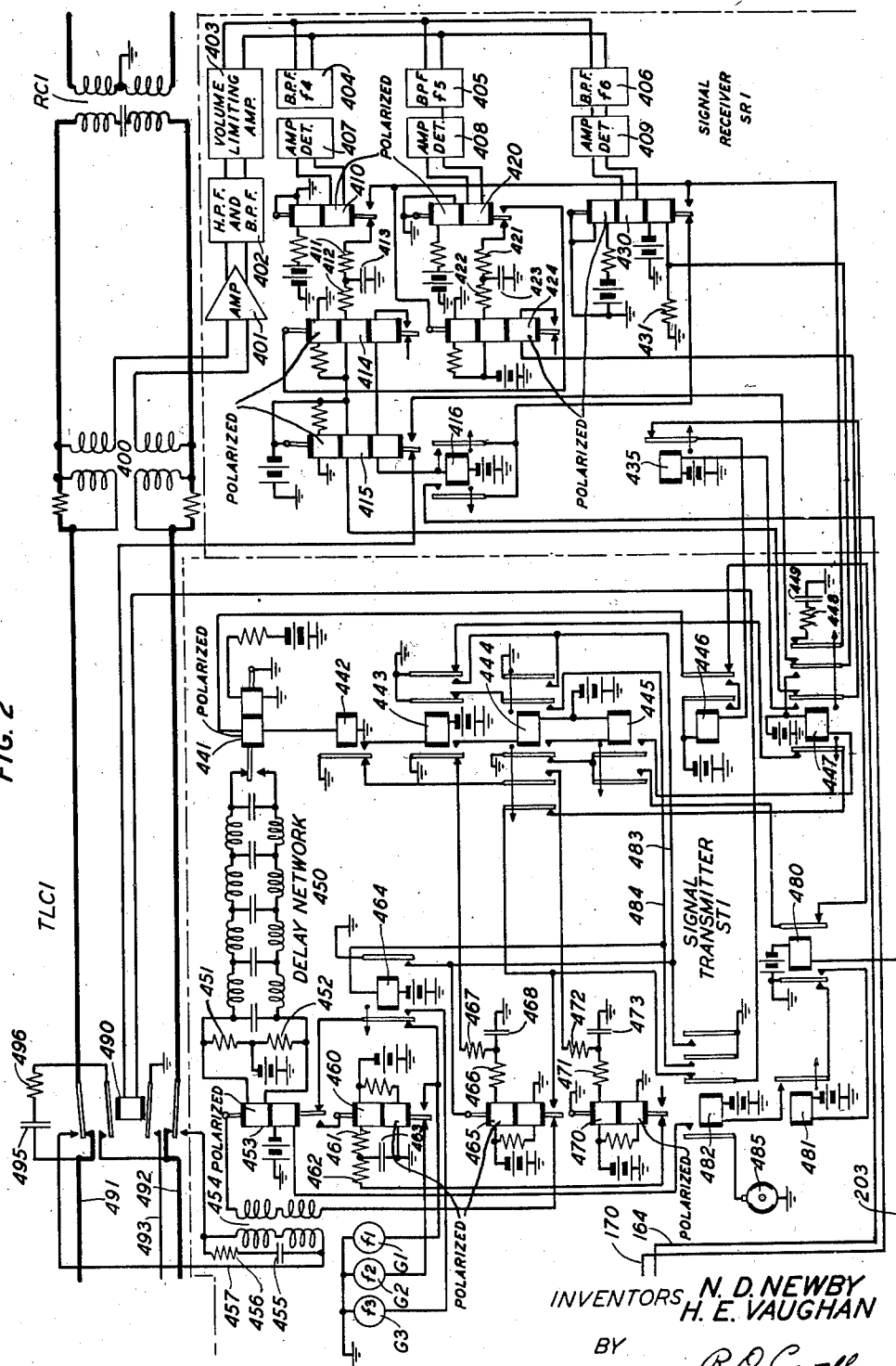
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SIGNALING SYSTEM

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FIG. 2



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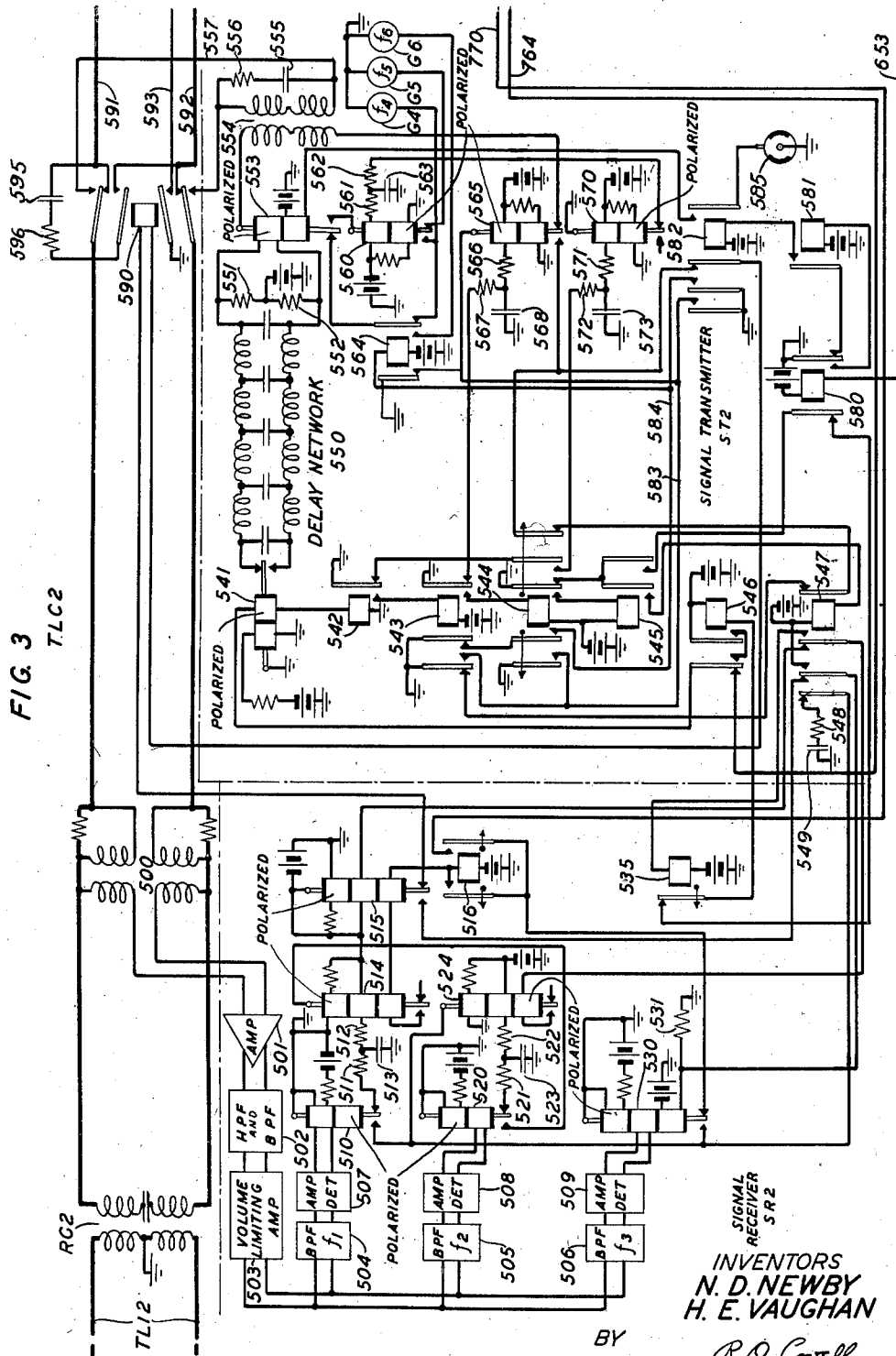
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SIGNALING SYSTEM

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FIG. 3
TLC2



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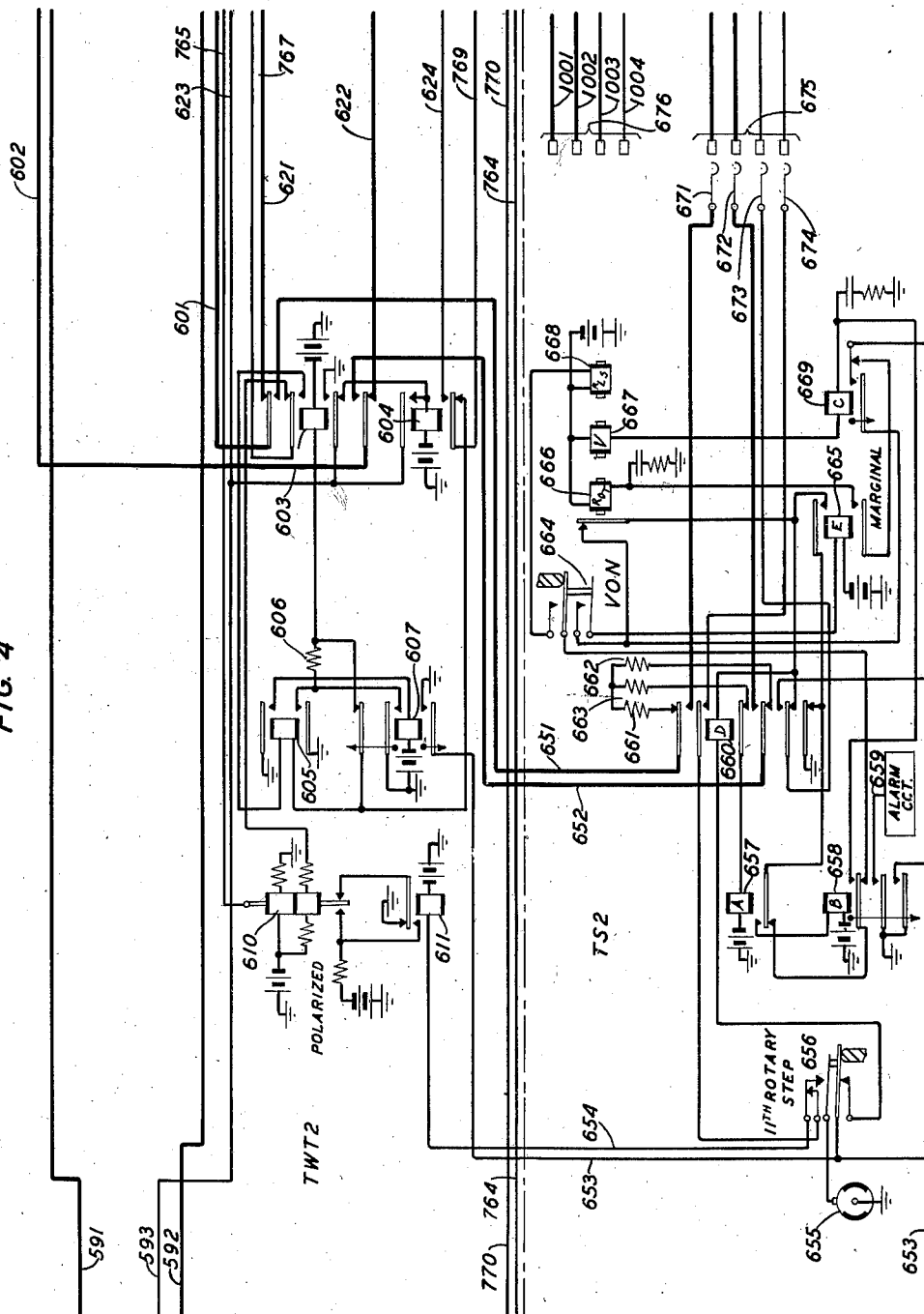
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SIGNALING SYSTEM

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FIG. 4



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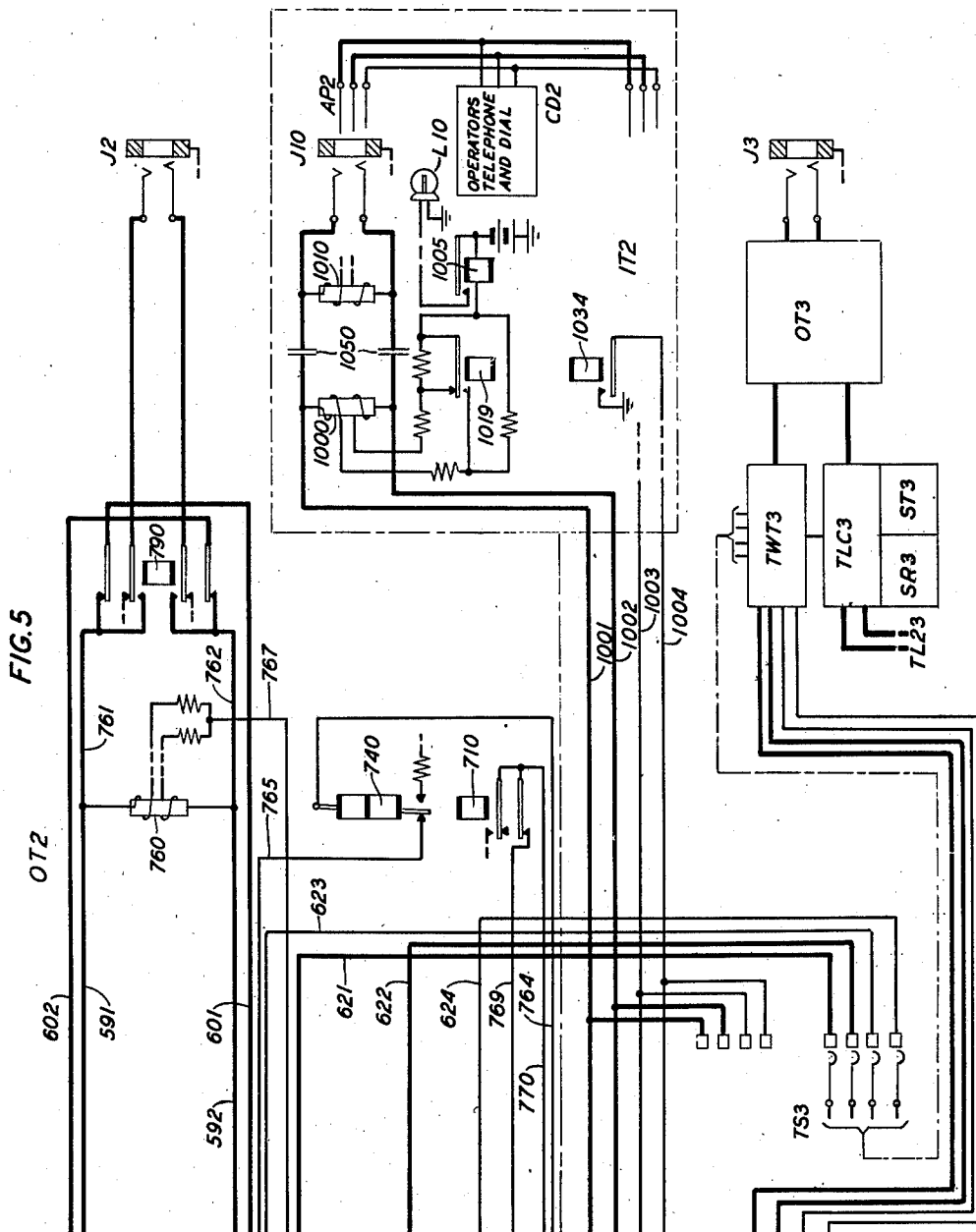
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SIGNALING SYSTEM

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5 Sheets-Sheet 5



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SIGNALING SYSTEM

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19 Claims. (Cl. 179—27)

This invention relates to signaling systems and particularly to telephone systems in which voice frequency currents are used for transmitting signals.

Objects of the invention are the provision of more reliable signal transmitting and receiving means in systems employing voice frequency signals and the provision of voice frequency signal transmitters and receivers arranged to prevent false operations in response to voice currents or other interfering currents.

This invention is an improved signaling system comprising means for transmitting signals each of which consists of current impulses of three different frequencies in succession and to transmit other signals consisting of impulses of current of two of the three frequencies. The system also comprises signal receiving means arranged to respond to said signals without responding to voice currents or other interfering currents. Similar signal transmitting and receiving means are connected to each end of a telephone line, a different set of three frequencies being used for signaling in each direction thereover.

A feature of the invention is a signaling system comprising a signal transmitter arranged to transmit seizure and answering supervisory signals consisting of an impulse of current of a first frequency followed by an impulse of current of the second frequency; to transmit an enablement signal immediately preceding the transmission of selective on-hook and disconnect signals, the enablement signal consisting of an impulse of current of said second frequency followed by an impulse of current of said first frequency, each selective and on-hook signal consisting of an impulse of current of a third frequency for the duration of the signal followed by an impulse of current of said first frequency, and each disconnect signal consisting of an impulse of said third frequency for a relatively long interval; and to transmit a disconnect acknowledgment signal consisting of an impulse of current of said second frequency followed by an impulse of current of said third frequency. The transmitter is further arranged to repeat the transmission of a disconnect signal until an acknowledgment signal is received and to transmit the acknowledgment signal until no further disconnect signals are received.

A further feature of the invention is a signal transmitter arranged to transmit signals consisting of an impulse of each of three frequencies in succession, the first two impulses of which

constitute an enablement signal for preparing the line and signal receiving circuits at the other end of the toll line with which the signal transmitter is associated, the interval of time required for transmission of the enablement signal prior to current of the third frequency being provided by a delay circuit interposed between the signal receiving relay of the signal transmitter and the impulse transmitting relays.

Another feature of the invention is a signaling system comprising a signal receiver arranged to respond to signals of the character described without responding to voice currents or other interfering currents of the same frequencies as those used for signaling.

These and other features of the invention will be further described by considering a system embodying the invention, one such system being represented schematically in the drawings which form a part of this specification. The invention is not limited in its application to the particular system and circuit arrangements shown in the drawings, but is applicable generally to any voice frequency signaling or telephone system.

Referring to the drawings:

Figs. 1 and 2 show, in a first toll office, an operator's position comprising a cord CD1, an outgoing trunk circuit OT1, a two-way trunk circuit TWT1, an incoming trunk circuit IT1, a signal transmitting circuit ST1, a signal receiving circuit SR1 and a toll line circuit TLC1, all of which are associated with a toll line TL12 extending to a second toll office;

Figs. 3, 4 and 5 show, in the second toll office, a toll line circuit TLC2, a signal receiving circuit SR2, a signal transmitting circuit ST2, a two-way trunk circuit TWT2, a selector circuit TS2 and an outgoing trunk circuit OT2, all individual to the toll line TL12. Fig. 5 further shows an incoming trunk circuit IT2 and an operator's position comprising the cord circuit CD2; and shows a toll selector TS3, a two-way trunk circuit TWT3, an outgoing trunk circuit OT3, signal transmitter ST3, signal receiver SR3, and toll line circuit TLC3 all associated with another toll line TL23 extending to a third toll office, and

Fig. 6 shows the relative positions in which Figs. 1 to 5 inclusive, are to be placed to form an operative arrangement.

The system represented in the drawings includes a plurality of toll offices, each of which comprises a toll board with operators' positions and cords for answering calls incoming from local manual and dial offices, from toll subscribers' lines and from other toll offices and for

extending incoming calls to switching trunks leading to called manual and dial local offices, to intertoll trunks and to called toll subscribers' lines. Outgoing jacks are connected to trunks to local offices, to toll subscribers' lines and to intertoll trunks. Answering jacks are directly connected to trunks from local offices, to toll subscribers' lines, to intertoll trunks, and to incoming trunk circuits terminating in the banks of toll route selectors. Toll route selectors are provided for use on calls incoming over intertoll trunks to establish connections with incoming trunk circuits and with trunks to called toll and local offices. The operators' positions are provided with dials for use in controlling the operation of toll route selectors in other toll offices and for controlling the operation of selector and connector switches in local dial offices.

Reference may be had to the patent to R. E. King et al., No. 2,209,777, granted July 30, 1940, for a detailed description of the cord and operator's position circuits provided in each of the toll offices for interconnecting calling and called lines and trunks and controlling the completion of toll calls. The outgoing trunk circuits OT1, OT2 and OT3, incoming trunk circuits IT1 and IT2, the two-way trunk circuits TWT1, TWT2 and TWT3, and the toll route selector circuits TS2 and TS3 are all similar to corresponding circuits in the aforementioned King et al. patent. The toll line circuits TLC1 and TLC2 and the associated signal transmitting and receiving circuits ST1, ST2, SR1 and SR2 are arranged for voice frequency signaling over the associated toll line, whereas in the aforementioned King et al. patent composite signaling circuits are associated with the toll line.

The toll line circuit TLC1 comprises a repeating coil RC1, a directionally selective coil 400 and a cut-off relay 490 for disconnecting the talking conductors 491 and 492 of the associated outgoing trunk circuit OT1 from the toll line TL1 when signals are being transmitted to or received from the second toll office. A repeater termination consisting of condenser 495 and resistor 496 is connected across the talking conductors of trunk circuit OT1 while signals are being transmitted or received over the toll line. The toll line circuit TLC2 is similar to the line circuit TLC1, the reference characters of like elements having the same tens and units digits. The toll line circuit TLC3 may also be similar to the line circuit TLC1.

The signal transmitter ST1 comprises relays 441 and 442 which respond to direct current signals received over conductor 164 from the outgoing trunk circuit OT1 on calls outgoing over toll line TL12 and from two-way trunk circuit TWT1 on calls incoming over toll line TL12. The transmitter ST1 further comprises control relays 443, 444, 445, 446 and 447, a delay network 450, and control relays 453, 456, 465 and 470 for converting the impulses into voice frequency signals. Relay 441 is a polarized relay having a biasing winding which normally maintains closure of the upper contact. Relay 453 is a polarized relay, the upper winding of which is normally energized in the direction which effects closure of its right contact. When relay 441 closes its lower contact due to the energization of its operating winding, the energization of the upper winding of relay 453 is reversed to effect closure of the left contact of this relay. The delay network 450 delays for about .050 second the response of relay 453 to the operation and to

the release of relay 441. Relays 460, 465 and 470 are also polarized relays, each having an operating winding and a biasing winding. Normally the left contact of each of relays 460, 465 and 470 is closed, the upper winding of each of relays 460 and 465 being normally energized and the upper winding of relay 470 being normally deenergized. When the upper winding of either of relays 460 and 465 is deenergized, the biasing winding is effective to open the left contact and close the right contact of the relay in question. When the upper winding of relay 470 is energized, it overcomes the opposing energization of the biasing winding to open the left contact and close the right contact. The network comprising resistors 461 and 462 and condenser 463 associated with the upper winding of relay 460 and the network comprising resistors 471 and 472 and condenser 473 associated with the upper winding of relay 470 render these relays slow in actuating their contacts; so that opening of the left and closure of the right contacts of relay 460 occur about .025 second after the circuit for energizing the upper winding of relay 470 is opened and the opening of the right and closure of the left contacts of relay 460 occur about .050 second after the circuit for energizing the upper winding of relay 470 is closed. The voice frequency signals are transmitted from sources G1, G2 and G3, through transformer 454, back contacts of cut-off relay 490, directional coil 400 and repeating coil RC1 to the conductors of toll line TL12. The transmitter ST1 further comprises relays 480, 481 and 482 and interrupter 485 for effecting the transmission of a disconnect acknowledgment signal on incoming calls. The delay network 450 delays the response of signal control relay 453 to operations of signal receiving relay 441 for about .050 second to allow time for the transmission of the enablement signal preceding dial impulse and similar signals. A seizure signal sent by transmitter ST1 on an outgoing call consists of current of frequency f_1 from source G1 for about .035 second followed by current of frequency f_2 from source G2 for about .050 second. To transmit a train of dial impulses, a preparatory or enablement signal precedes the first dial impulse, the enablement signal consisting of current of frequency f_2 for about .025 second followed by current of frequency f_1 for about .025 second. The enablement signal is immediately followed by current of frequency f_3 for the duration of the dial impulse, current of frequency f_1 being transmitted at the end of each impulse of the train, except the last, until the next impulse begins and at the end of the last impulse of the train for an interval of about .050 second. A ringing or a rering signal transmitted on an outgoing call is similar to a train of dial impulses consisting of a single impulse. An answering supervisory or off-hook signal transmitted by the signal transmitter ST1 on an incoming call is similar to the aforementioned seizure signal. An on-hook supervisory signal transmitted by the signal transmitter ST1 on an incoming call consists of the enablement signal followed by current of frequency f_3 . An all-trunks-busy signal is similar to an answering supervisory signal followed by a succession of on-hook signals similar to dial impulse signals. A disconnect signal transmitted by signal transmitter ST1 on an outgoing call to effect release of the connection at the distant end of toll line TL12 consists of the aforementioned enablement signal followed immedi-

ately by current of frequency f_3 for about .150 second; and this entire disconnect signal is periodically repeated until a disconnect acknowledgment signal is received by the associated signal receiver SR1. A disconnect acknowledgment signal transmitted by the signal transmitter ST1 on an incoming call consists of current of frequency f_2 for about .025 second followed by current of frequency f_3 for about .025 second; and the alternate transmission of impulses of current of these two frequencies continues until the disconnect signal, incoming over the toll line TL12 to the signal receiver SR1, is terminated.

The signal transmitter ST2 is similar to the signal transmitter ST1 except that it is arranged to transmit a different set of three frequencies so as to prevent interference with signals being simultaneously transmitted in opposite directions over toll line TL12. Corresponding elements of transmitters ST1 and ST2 are identified by reference characters having like tens and units digits.

The signal receiver SR1 comprises an amplifier 401, high-pass and band-pass filters 402 designed to pass only the signaling frequencies f_4 , f_5 and f_6 which are transmitted by the signal transmitter ST2, a volume limiting amplifier 403, band-pass filters 404, 405 and 406, each designed to pass current of a different one of frequencies f_4 , f_5 and f_6 , amplifier detectors 407, 408 and 409, relay 410 for responding to signaling current of frequency f_4 , relay 420 for responding to signaling current of frequency f_5 , and relay 430 for responding to signaling current of frequency f_6 . The signal receiver SR1 further comprises relays 414, 415, 416 and 424 for converting the incoming voice frequency signals into direct current signals which are transmitted over conductor 170 to trunk circuits OT1, TWT1 and IT1, and comprises a relay 435 which responds to an incoming disconnect acknowledgment signal to end the transmission of a disconnect signal. Relays 410, 420 and 430 are normally released polarized relays, each of which has an operating winding and a biasing winding. Each of relays 414 and 424 is a normally operated polarized relay, which has two operating windings and a biasing winding. Relay 415 is a normally released polarized relay having two operating windings and a biasing winding. The network comprising resistors 411 and 412 and condenser 413 and the network comprising resistors 421 and 422 and condenser 423 are designed to make the associated one of relays 414 and 424 slightly slow in releasing when the circuit through its middle winding is opened and to delay its reoperation for about .030 second when the circuit through this winding is again closed. The network comprising resistor 448 and condenser 449 is designed to delay the response of relays 415 and 424 for about .030 second when the circuit through their lower windings is opened.

The signal receiver SR2 is similar to the signal receiver SR1 except that it is designed to respond to signals consisting of impulses of current of frequencies f_1 , f_2 and f_3 instead of impulses of current of frequencies f_4 , f_5 and f_6 . Corresponding elements of receivers SR1 and SR2 are identified by reference characters having the same tens and units digits.

Assume now that the toll line TL12 is idle and that an operator at the first toll office answers a call with plug AP1 of cord CD1 and then inserts the calling plug CP1 of this cord in jack J1 of outgoing trunk circuit OT1. Relay 104 is operated by the connection of battery to the

sleeve conductor of jack J1 and relays 110 and 140 are operated as described in the aforementioned patent of R. E. King et al. The operation of relay 140 closes a circuit from battery through resistor 142 and conductor 164 for operating relays 441 and 442 of the signal transmitter ST1. The operation of relay 441 closes a circuit from battery through resistor 451 and the upper winding of relay 453 in parallel with resistor 452, thence through the lower inductors of the delay network 450 to ground at the front contact of relay 441. The energization of the upper winding of relay 453 is delayed by the network 450 for about fifty thousandths of a second, during which time a succession of relay operations are effected and an impulse of current of frequency f_1 is transmitted over line TL12. The operation of relay 442 closes a circuit for operating relay 443. The cut-off relay 490 of toll line circuit TLC1 is normally energized in a circuit which is traced from battery through the left contact of relay 415 of signal receiver SR1, winding of relay 490 and back contacts of relays 482, 444, 447 and 443 to ground; and this circuit is opened by the aforementioned operation of relay 443 to cause the release of relay 490 and thereby open the talking connection between trunk circuit OT1 and toll line TL12. Relay 443 also opens the normally closed circuit for energizing the upper winding of relay 465, closes a circuit for operating relay 444, and closes a circuit for starting the transmission of current of frequency f_1 over toll line TL12. The operation of relay 444 opens further the normally closed circuit for energizing the winding of the cut-off relay 490, prepares a circuit for the energization of the upper winding of relay 470, closes a circuit for operating relay 445, prepares a circuit for the operating relay 464, and connects ground to conductor 483 in parallel with the connection of ground to this conductor by the operation of relay 443. The operation of relay 445 prepares circuits for operating relays 446 and 447 when the connection is released by the calling operator. The aforementioned circuit, which is closed by the operation of relay 443 to effect the transmission of current of frequency f_1 , is traced from generator G1, through the back contact of relay 464, back contact of relay 453, right windings of transformer 454, back contact of relay 465, to ground at the right front contact of relay 443. About fifty thousandths of a second after the operation of relay 441 and about .035 second after the impulse of current of frequency f_1 begins, relay 453 operates thereby disconnecting generator G1 from the right windings of transformer 454 and connecting generator G2 to these windings. The impulse of current of frequency f_1 is thus terminated and an impulse of current of frequency f_2 is initiated. About fifty thousandths of a second after relay 453 operates, the deenergization of the upper winding of relay 465 effects the actuation of its contact springs thereby opening the left contact of relay 465 to terminate the impulse of current of frequency f_2 and closing the right contact of relay 455 to reoperate the cut-off relay 490. The circuit for reoperating relay 490 is traced from battery through the left-hand contact of relay 415 of signal receiver SR1, winding of relay 490, back contact of relay 482, right front contact of relay 465 to ground at the right front contacts of relays 443 and 444. Thus a seizure signal has been transmitted through coil 400 and repeating coil RC1 over toll line TL12 to the

second toll office, the signal consisting of current of frequency *f*₁ for about .035 second followed by current of frequency *f*₂ for about .050 second to prepare the signal receiving equipment in the second toll office for selective dial impulses.

The seizure signal thus transmitted by the signal transmitter ST1 over toll line TL12 is further transmitted through repeating coil RC2, directional signaling coil 500, amplifier 501, filters 502, volume limiting amplifier 503 to the input side of band-pass filters 504, 505 and 506. The impulse of current of frequency *f*₁ passes through filter 504 and is rectified by the amplifier detector 507 to effect the operative energization of the lower winding of signal repeating relay 510. The volume limiting amplifier 503 limits the energy level in its output circuit sufficiently to permit the energization of only one of signal receiving relays 510, 520 and 530 at a time thereby reducing the possibility of false operation in response to voice or noise currents. The operation of relay 510 opens the normally closed circuit for energizing the middle winding of relay 514 and closes a circuit for discharging condenser 549. The middle winding of relay 514 remains energized after relay 510 operates while condenser 513 is charging; so that a short impulse of current of frequency *f*₁, such as may occur in speech or noise, is not likely to operatively affect both of relays 510 and 514. When relay 510 releases at the end of the current of frequency *f*₁, the circuit through the middle winding of relay 514 is again closed, the operative energization of this winding being delayed for about .030 second due to the discharge of condenser 513. The current of frequency *f*₂ immediately following the current of frequency *f*₁ effects the operation of relay 520. The operation of relay 520 causes the deenergization of the middle winding of relay 524 to effect closure of the left contact of relay 524, this closure being only slightly delayed due to the charging of condenser 523. The operation of relay 520 also closes a circuit from ground through its left contact, left contact and lower winding of relay 514, lower winding of relay 515 and the winding of relay 516. Relay 516 is operatively energized by the current in this circuit and is locked under the control of relay 530. The energization of the lower winding of relay 515 effects the opening of its right contact to release the cut-off relay 590; and the closing of the left contact of relay 515 short-circuits the lower winding of relay 530, thereby to decrease the bias of relay 530. The energization of the lower winding of relay 514 maintains closure of the left contact of relay 514 until relay 516 has operated and locked. The operation of relay 516 short-circuits the lower windings of relays 515 and 514 and closes a circuit for operating relay 603 of two-way trunk circuit TWT2 as hereinafter described. When the lower windings of relays 514 and 515 are short-circuited by relay 516, the aforementioned energization of the middle winding of relay 514 effects the opening of the left contacts of relay 514; but the short-circuiting of the lower winding of relay 515 is ineffective to restore the contacts of this relay to normal because the middle winding of relay 515 is energized by current charging condenser 549 in a circuit traced from battery through the middle winding of relay 515, a back contact of relay 547, lower winding and left contact of relay 524, through another back contact of relay 547, resistance 548 and condenser 549 to ground. The charging of condenser 549 by the current in this circuit tends to main-

tain the closure of the left contacts of relays 515 and 524; but this is of no utility until dial impulse signals are being received as hereinafter described. When the current of frequency *f*₂ ends, relay 520 releases thereby again closing the circuit for energizing the middle winding of relay 524; but the opening of the left contact of relay 524 is delayed for about .030 second due to the discharge of condenser 523. When relay 515 restores its contacts to normal due to deenergization of its middle winding, the short-circuit across the lower winding of relay 530 is opened and the cut-off relay 590 is reoperated.

The aforementioned circuit for operating relay 603 of two-way trunk circuit TWT2 is traced from ground through the right contact of relay 530, the right front contact of relay 516, conductor 770, a back contact of relay 710 of outgoing trunk circuit OT1, conductor 769, back contacts of relays 604 and 607 of two-way trunk circuit TWT2, and through the winding of relay 603 to battery. The operation of relay 603 connects ground to conductor 623 to mark the trunk TL12 busy in the banks of selectors TS3 and closes a circuit for operating relay 605 of trunk circuit TWT2 in series with the line relay 657 of the selector TS2. This circuit is traced from ground at the right contact of relay 530 through the right front contact of relay 516, conductor 770, back contact of relay 710, conductor 769, back contact of relay 604, winding of relay 605, a front contact of relay 603, conductor 767, thence in simplex through both windings of retard coil 760, conductors 761 and 762, back contacts of relay 790, conductors 601 and 602, front contacts of relay 603, conductors 651 and 652, back contacts of relay 660, resistors 661 and 662, to and through resistor 663, thence through a back contact of relay 660 and the winding of relay 657 to battery. The operation of relay 605 closes a circuit for holding relay 603 and a circuit for operating slow-to-release relay 607. Relay 607 closes a circuit for holding relay 603 and connects ground to conductor 653 to operate relay 580. Relay 580 disconnects the outer front contact of relay 545 from the winding of relay 546 to prevent the operation of relay 546 when a disconnect acknowledgment signal is transmitted as hereinafter described; closes a circuit for operating relay 581 of signal transmitter ST2; and disconnects ground from the contact of relay 581 to prevent the operation of relay 582. The aforementioned operation of line relay 657 of selector TS2 closes a circuit for operating slow-to-release relay 658. Relay 658 connects ground to conductor 653 and connects ground to conductor 659 leading to an alarm circuit to initiate a timing operation for effecting an alarm in case the selective operation of selector TS2 is not completed within a predetermined interval of time. No further operations occur until the calling operator dials the first digit of the code of the called toll route or local exchange in which the called subscriber's line terminates. The calling operator in the first toll office now dials the toll route code and also the local office code of numerical digits of the called subscriber's number in case the call is for a subscriber in an automatic local office, relay 140 being alternately released and reoperated in response to each dial impulse thus created. Each release and reoperation of relay 140 effects a corresponding release and reoperation of relays 441 and 442 of the signal transmitter ST1. The release of relay 441 effects the reversal of current through the upper winding of relay 453 to cause the release of

relay 453 about .050 second after relay 441 releases. The release of relay 442 causes the release of relay 443 and the energization of the upper winding of relay 470, thereby effecting the opening of the left contact of relay 470. The release of relay 443 effects the release of cut-off relay 490, the operation of relay 464 and the energization of the upper winding of relay 465. The energization of the upper winding of relay 465 effects closure of the left contact of relay 465 thus completing a circuit from generator G2 through the left contacts of relays 460 and 453, right windings of transformer 454, left contact of relay 465, and conductor 483 to ground at the outer right front contact of relay 444. The transmission of an impulse of current of frequency f_2 over toll line TL12 is thereby initiated. Since relay 444 is slow in releasing, it remains operated during the transmission of dial impulses. The aforementioned opening of the left contact of relay 470 causes the deenergization of the upper winding of relay 460 to effect the opening of the left contact and closing of the right contact of relay 460, thereby to end the current of frequency f_2 and initiate the transmission of current of frequency f_1 over line TL12. Due to the delay effect of the resistor condenser networks associated with relays 470 and 460, the opening of the left contact and the closure of the right contact of relay 460 resulting from the opening of the left contact of relay 470 occur about .025 second after the closure of the left contacts of relay 465; so that the impulse of current of frequency f_2 endures for about .025 second. When relay 453 releases about .050 second after the release of relay 441, it disconnects generator G1 from the right windings of transformer 454 and connects generator G3 to these windings, thereby ending the impulse of current of frequency f_1 and initiating the transmission of current of frequency f_3 over line TL12, the current of frequency f_3 representing the dial impulse which has effected the release of relays 441 and 442. The current of frequency f_3 continues until relay 453 again operates due to the reoperation of relay 441 at the end of the dial impulse. When relay 453 reoperates, the transmission of current of frequency f_3 ends and the transmission of current of frequency f_1 is resumed. Each release and reoperation of relay 453, under the control of relay 441 in response to succeeding impulses of the train created by the dialing of the first digit, effects the transmission of an impulse of current of frequency f_3 followed by an impulse of current of frequency f_1 . Since relay 464 is slow to release, it remains operated during the transmission of a train of dial impulse signals; since the response of relay 465 to the closure of the circuit through its upper winding is delayed by the associated resistor condenser network, the closure of the left contact of relay 465 is maintained during the transmission of the train of dial impulse signals; and since the operative response of each of relays 470 and 460 is delayed by the associated resistor condenser network, relay 460 does not open its right contact during the transmission of a train of dial impulse signals. After receiving the last impulse of a train, relays 441, 442 and 443 remain operated. About .100 second after the reoperation of relay 443 at the end of the last impulse of the train, relay 465 opens its left contact and closes its right contact thereby ending the transmission of current of frequency f_1 . The reoperation of relay 442 causes the deenergization of the upper winding of relay

470 to effect the closing of the left contact of relay 470; and the closing of the left contact of relay 470 causes the reenergization of the upper winding of relay 460 to effect the opening of the right contact and closure of the left contact of relay 460. The opening of the left contact and closure of the right contact of relay 460 is effective to open the circuit through the right windings of transformer 454 and to reoperate the cut-off relay 490. Thus the dialing of the first digit by the calling operator effects the transmission of an enablement or preparatory signal consisting of current of frequency f_2 for about .025 second followed by current of frequency f_1 for about .025 second, followed by dial impulse signals, each dial impulse signal consisting of current of frequency f_3 for the duration of the impulse followed by current of frequency f_1 during the interval between impulses and following the last impulse of the train. The dialing of each additional digit by the calling operator effects the transmission of the enablement signal and a train of dial impulses over toll line TL12 in the above-described manner. When dialing is completed, the release of the dial key (not shown) effects the operation of relay 130 in the manner described in the aforementioned King et al. patent, thereby to close the talking connection between cord CD1 and toll line TL12.

The signal receiver SR2 receives the enablement signal and train of dial impulses corresponding to each digit dialed, the first digit being effective to selectively operate the selector TS2 to select a group of trunks corresponding to this digit. Relays 520 and 510 are successively operated by the enablement signal and relays 530 and 510 are thereafter successively operated responsive to each dial impulse signal. The operation of relay 520, in response to current of frequency f_2 , opens the circuit through the middle winding of relay 524 to effect the closing of the left contact of relay 524, the delay network comprising resistors 521 and 522 and condenser 523 being effective to maintain closure of this contact for about .030 second after relay 520 releases at the end of the impulse of current of frequency f_2 . The operation of relay 510 in response to the current of frequency f_1 causes the deenergization of the middle winding of relay 514 to effect closure of the left contact of relay 514 and closes a circuit through the left contact and lower winding of relay 524, a back contact of relay 547 and middle winding of relay 515. The energization of the lower winding of relay 524, by the current in this circuit, maintains closure of the left contact of relay 524; and the energization of the middle winding of relay 515 effects the opening of the right contact of relay 515, to release the cut-off relay 590, and effects the closing of the left contact of relay 515 to short-circuit the lower winding of relay 530 and thereby reduce the bias of relay 530 to render it responsive to dial impulses. The delay network, comprising resistors 511 and 512 and condenser 513, maintains closure of the left contact of relay 514 after relay 510 releases at the end of the current of frequency f_1 . The operation of relay 530 in response to the current of frequency f_3 , representing the open period of the first dial impulse cycle, closes a circuit for discharging condenser 549 and closes a circuit for energizing the lower winding of relay 524 in series with the middle winding of relay 515 so as to maintain the closure of the left contact of relay 524 and to maintain closure of the left contact of relay 515. The operation

of relay 530 opens the holding circuit of relay 516 and disconnects ground from conductor 770 thereby to repeat the dial impulse to relay 605 of two-way trunk circuit TWT2 and line relay 657 of selector TS2. When relay 530 releases at the end of the impulse of current of frequency f_3 , the holding circuit for relay 516 is again closed and ground is reconnected to conductor 770. Being slow in releasing, relay 516 remains operated during the response of relay 530 to dial impulse signals. After relay 530 releases, the closure of the left contact of relay 524 is maintained by current through the lower winding of relay 524 charging condenser 549, this current also being effective to maintain the energization of the middle winding of relay 515 and thereby maintain closure of the left contact of relay 515. When relay 510 is reoperated by the current of frequency f_1 representing reclosure of the dialing circuit, the circuit through the middle winding of relay 514 is opened so as to maintain the closure of the left contact of relay 514. Succeeding alternate operations of relays 530 and 510, in response to alternate currents of frequencies f_3 and f_1 , maintain the closure of the left contacts of relays 514, 515 and 524 and effects the alternate disconnection and reconnection of ground to conductor 770. About .030 second after relay 510 releases, at the end of the impulse of current of frequency f_1 representing closure of the dialing circuit following the last impulse of the train, the contacts of relays 514, 515 and 524 are restored to normal and the cut-off relay 590 is reoperated.

When relay 530 of signal receiver SR2 disconnects ground from and reconnects ground to conductor 770 in response to each dial impulse of the first digit dialed by the calling operator, relays 605 and 657 are alternately released and reoperated a corresponding number of times. Being slow in releasing, relays 607 and 658 remain operated during the response of relays 605 and 657 to dial impulses. The release of relay 657 in response to the first dial impulse closes a circuit for operating the vertical stepping magnet 667 and relay 669 in series. This circuit is traced from battery through the winding of stepping magnet 667, winding of relay 669, a front contact of relay 658, back contact of relay 657 to ground at a back contact of relay 660. The operation of stepping magnet 667 steps the brushes 671, 672, 673 and 674 up to the first level of the terminal bank, the vertical off-normal springs 664 being actuated as soon as the shaft on which the brushes are mounted moves out of normal position. The operation of relay 669 and actuation of springs 664 close a circuit for operating relay 665. Relay 665 locks in a circuit traced from its winding through the lower contact of springs 664, back contact of rotary stepping magnet 666, upper contact of relay 665, to ground at a back contact of relay 660. When relay 657 reoperates at the end of the first dial impulse, the stepping magnet 667 releases. Being slow in releasing, relay 669 remains operated until all of the impulses in the train corresponding to the first digit dialed have been received. Each succeeding release and reoperation of relay 657 causes a corresponding operation and release of stepping magnet 667, the brushes of selector TS2 being thereby stepped up to the level corresponding to the digit dialed. When relay 669 releases following the reoperation of relay 657 at the end of the last impulse of the train, it closes a circuit for operating the rotary stepping magnet 666, this circuit being traced from the winding of stepping magnet 666, 75

lower front contact of relay 665, and back contact of relay 669 to grounded conductor 653. The operation of stepping magnet 666 steps the brushes into engagement with the first set of terminals in the selected level. The operation of stepping magnet 666 causes the release of relay 665; and the release of relay 665 causes the release of stepping magnet 666. The release of stepping magnet 666 closes a test path from battery through the winding of relay 665, lower contact of springs 664, back contact of stepping magnet 666, a back contact of relay 660, and test brush 673 to the terminal engaged thereby. If the first set of terminals is connected to a busy trunk or selector circuit, the terminal engaged by test brush 673 is marked by the connection of ground potential thereto; in which case, relay 665 is reoperated to again close the circuit for operating stepping magnet 666. The brushes are thereby advanced to the next set of terminals, the test circuit being again closed when stepping magnet 666 releases. The brushes are in this manner advanced step by step in the selected level until they engage a set of terminals, the test terminal of which is not marked with ground potential connected thereto. Whereupon relay 660 is operated by the current in a circuit from battery through the winding of relay 665, lower contact of springs 664, back contact of stepping magnet 666, winding of relay 660, lower back contact of the 11th rotary step springs 656, to grounded conductor 653. Being marginal, relay 665 is not operatively energized in series with the winding of relay 660. The operation of relay 660 disconnects the winding of line relay 657 from conductors 651 and 652 and connects these conductors through its front contacts and brushes 671 and 672 to the conductors of the selected trunk which may be connected to an incoming trunk circuit such as IT2, to an auxiliary selector, to a switching trunk to a local manual or dial office, or to a trunk to another toll office, depending upon the particular call which is in question. Relay 657 releases, when it is disconnected from conductors 651 and 652, causing the release of relay 658. Relay 658 disconnects ground from conductor 659 to stop the alarm circuit operation and disconnects ground from conductor 653, this conductor continuing, however, to be connected to ground at the lower front contact of relay 607 of two-way trunk circuit TWT2.

Assume now that the call is one which is routed to a toll operator in the second toll office for completion through a cord at the answering toll operator's position. In this case, the selected set of terminals 676 are connected to an incoming trunk circuit IT2. Reference may be had to the aforementioned patent to King et al. for a complete disclosure of the incoming trunk circuit IT2. Upon selection of this trunk circuit, the line relay 1005 is operated in series with relay 605 of two-way trunk circuit TWT2 in a circuit traced from ground at the right contact of relay 530, right front contact of relay 510, conductor 770, back contact of relay 710, conductor 769, back contact of relay 604, winding of relay 605, a front contact of relay 603, conductor 767, both windings of retard coil 760, conductors 761 and 762, back contacts of relay 780, conductors 691 and 692, front contacts of relay 603, conductors 651 and 652, front contacts of relay 660, brushes 671 and 672, conductors 1001 and 1002, both windings of retard coil 1000 of trunk circuit IT2, to and through the winding of line relay 1005 to battery. Relay 1005 closes a circuit for lighting the answering

lamp L10 to signal an operator. When the call is answered by the insertion of the answering plug AP2 of a cord CD2 in jack J10, relay 1034 is operated in the manner described in the aforementioned King et al. patent, thereby connecting ground to conductor 1004, through the lowest terminal of set 676, brush 674, a front contact of relay 660, upper back contact of springs 656, conductor 654, and through the winding of relay 611 of two-way trunk circuit TWT2 to battery. Relay 611 operates, closing a circuit from battery through the front contact of relay 611, right contact of relay 610, conductor 765, left contact of relay 740, conductor 764, back contact of relay 546 of signal transmitter ST2, and windings of relays 541 and 542 to ground. The operation of relay 541 effects the reversal of current through the upper winding of relay 553 thereby to effect the operation of relay 553, the operation of relay 553 being delayed for about .050 second by the delay network 550. The operation of relay 542 causes the operation of relay 543. The operation of relay 543 causes the operation of relay 544 and the release of cut-off relay 590, and connects ground to conductor 583 to start the transmission of current of frequency /4 through transformer 554, directional coil 500 and repeating coil RC2 over toll line TL12 to the first toll office. The operation of relay 543 also opens the normally closed circuit through the upper winding of relay 565, the opening of the right contact and closing of the left contact of relay 565 being delayed for about .100 second by current charging condenser 568. The operation of relay 544 connects ground to conductor 583, holds open the circuit through the winding of cut-off relay 590 and closes a circuit for operating relay 545. The operation of relay 545 prepares a circuit for operating relay 547. The operation of relay 553, about .050 second after the operation of relay 541, ends the transmission of current of frequency /4 and initiates the transmission of current of frequency /5. When relay 565 opens its right contact, it ends the transmission of current of frequency /5 and closes a circuit for reoperating the cut-off relay 590. Thus an answering supervisory or off-hook signal is transmitted by the signal transmitter ST2 over line TL12 in response to the answering of the call by an operator in the second toll office. After the transmission of this signal, relays 541, 542, 543, 544, 545, 560 and 581 remain operated, relay 553 maintains closure of its right contact, relay 560 maintains closure of its right contact, relay 565 maintains closure of its left contact, and relay 570 maintains closure of its right contact.

The answering supervisory signal thus transmitted from signal transmitter ST2 over line TL12 operates signal receiver SR1, in similar manner to that in which the signal receiver SR2 is operated responsive to a seizure signal as hereinbefore described, to connect ground to conductor 170 to cause the operation of supervisory relay 105. The operation of relay 105 opens the circuit through the lower, low-resistance winding of relay 104 to extinguish the calling cord supervisory lamp AL1.

If the answering operator disconnects before the calling operator, relay 1034 of incoming trunk circuit IT2 releases, in turn causing the release of relay 611 of two-way trunk circuit TWT2. The release of relay 611 causes the release of relays 541 and 542 thereby to effect the transmission of an enablement signal, consisting of current of frequency /5 followed by current of frequency /4, followed by an on-hook signal consisting of current of frequency /6. The release

of relay 541 causes a reversal of the energization of the upper winding of relay 543, the response of relay 543 being delayed for about .050 second by network 550. The release of relay 542 causes the release of relay 543 and closes the circuit for energizing the upper winding of relay 570, the opening of the left contact of relay 570 being delayed for about .025 second. The release of relay 543 reenergizes the upper winding of relay 565, operates relay 564 and opens the circuit through the winding of relay 544. The energization of the upper winding of relay 565 effects the opening of the left contact of this relay to release cut-off relay 590 and the closing of the right contact to start the transmission of current of frequency /5 over line TL12. The opening of the right contact of relay 570 causes the deenergization of the upper winding of relay 560 to effect the opening of the right contact and closure of the left contact of this relay, whereby the transmission of current of frequency /5 is ended and the transmission of current of frequency /4 started. When relay 553 releases, the transmission of current of frequency /4 is ended and the transmission of current of frequency /6 started. If the on-hook condition continues to exist until relay 544 releases, the release of relay 544 disconnects ground from conductor 583 thus ending the transmission of current of frequency /6. The release of relay 544 also effects the reoperation of relay 590, the operation of relay 547, the release of relay 545 and the deenergization of the upper winding of relay 570, thereby to effect the closing of the right contact of relay 570. The closing of the right contact of relay 570 effects the reenergization of the upper winding of relay 560 thereby to cause the opening of the right contact and closure of the left contact of relay 560. The release of relay 545 causes the release of relay 547. The on-hook signal thus sent from transmitter ST2 over line TL12 operates signal receiver SR1 in similar manner to that in which the signal receiver SR2 operates in response to a single dial impulse except that, since the current of frequency /6 continues for about .150 second, relay 430 is operated long enough to cause the release of relay 416 and thereby disconnect ground from conductor 170. The disconnection of ground from conductor 170 causes the release of relay 105 to light the calling cord supervisory lamp AL1. If the answering operator again inserts the plug of a cord in jack J10 before the calling operator disconnects, an off-hook signal is again transmitted to the calling operator in the manner hereinbefore described.

If the calling operator wishes to recall the answering operator, the operation of the ringing key (not shown) effects the momentary release of relay 140, thereby effecting the momentary release of relays 441 and 442; whereby a signal is transmitted over toll line TL12, which signal is the same as that for a train of dial impulses consisting of a single impulse. In response to this signal, the signal receiver SR1 momentarily disconnects ground from conductor 170, causing the release and reoperation of relay 1005 of incoming trunk circuit IT2. The response of relay 1005 causes a flashing recall signal to be given to the answering operator in the manner disclosed in the aforementioned King et al. patent.

When the calling operator releases the connection by withdrawing plug CP1 from jack J1, each of relays 104, 110, 120 and 140 is released. If operated, relay 105 also releases. The release of relay 140 causes the successive release of re-

lays 441, 442, 443 and 444, thereby effecting the transmission of the enablement signal in the manner hereinbefore described. When relay 453 releases, responsive to the release of relay 441, it ends the transmission of current of frequency /1 and initiates the transmission of current of frequency /3. The release of relay 444 causes the operation of relays 446 and 447. Relay 445 is sufficiently slow in releasing so that it remains operated while the disconnect signal is being transmitted. The operation of relay 447 prevents the reoperation of the cut-off relay 490, short-circuits the lower winding of relay 430 of signal receiver SR1 to render relay 430 operative in response to current of frequency /6 incoming over line TL12, and connects the winding of relay 435 of the signal receiver in series with the locking winding of relay 424 in preparation for response to a disconnect acknowledgment signal incoming over line TL12 from the second toll office. The operation of relay 446 closes a circuit for reoperating relays 441 and 442 thereby causing the successive reoperation of relays 443 and 444 and the delayed operation of relay 453. The reoperation of relay 444 causes the release of relays 446 and 447. The release of relay 446 causes the successive release of relays 441, 442, 443 and 444 and the delayed release of relay 453. Thus relays 441, 442, 443, 444 and 453 are released and reoperated and relays 446 and 447 are operated and released in a repeated cycle until a disconnect acknowledgment signal is received by the signal receiver SR1. The interval of time during which relay 443 is operated during each cycle of these disconnect signal operations, is not long enough to cause the opening of the left contact of relay 465 and the interval of time during which relay 444 is released or relay 443 operated is not long enough to cause the release of relay 464; so that the current of frequency /3 continues until relay 453 reoperates in response to the reoperation of relay 441. While the interval of time during which relay 442 is released and relay 444 is operated is long enough to effect the successive operation of relays 470 and 460, these relays are again released due to the next succeeding reoperation of relay 442, before the reoperation of relay 453 occurs; and each operation of relay 453 is thus effective to end the current of frequency /3 and to initiate the transmission of current of frequency /2. The reoperation of relays 470 and 460 resulting from each release of relay 442 ends each impulse of current of frequency /2 and initiates an impulse of current of frequency /1; and each impulse of current of frequency /1 is ended when relay 453 releases. Thus the disconnect signal cycle continues until a disconnect acknowledgment signal is received by the signal receiver SR1 as herein-after described.

When the enablement portion of a disconnect signal, transmitted by signal transmitter ST1, reaches the signal receiver SR2, relays 520 and 510 are operated in succession thereby effecting the operation of relays 524, 514, 515 and 516 in the manner hereinbefore described. The current of frequency /3 following the enablement signal operates relay 530, thereby to disconnect ground from conductor 770 and to hold relays 515 and 524. Since the impulse of current of frequency /3 continues for about .150 second, relay 530 remains operated long enough to cause the release of relay 516. Since the reoperation of relay 516 can be effected only by receiving an impulse of current of frequency /1 followed by an

impulse of current of frequency /2, the repeating of the disconnect signal does not effect the reoperation of relay 516.

When ground is disconnected from conductor 770, due to the operation of relay 530 and release of relay 516, relay 605 of two-way trunk circuit TWT2 and relay 1005 of incoming trunk circuit IT2 release. The continued release of relay 605 causes the successive release of relays 607 and 603. A disconnect signal is given to the answering operator and the return to normal of trunk circuit IT2 is effected in the manner described in the above-mentioned patent to King et al. The release of relay 607 disconnects ground from conductor 653 thereby causing the release of relay 660 of selector TS2 and the release of relay 580 of signal transmitter ST2. The release of relay 660 effects the return of selector TS2 to normal in the usual and well-known manner. The release of relay 580 opens the circuit through the winding of slow-to-release relay 581, and causes the operation of relay 582 until relay 581 releases. The operation of relay 582 causes the release of cut-off relay 590, closes a circuit for operating relay 564, connects ground to conductor 583 and connects the lower winding of relay 553 to the brush of interrupter 583. Relay 553 is thereby alternately operated and released under the control of interrupter 583, impulses of current of frequencies /5 and /6 being alternately transmitted over line TL12 under the control of relay 553 as long as relay 582 is operated. When relay 582 releases, relay 553 remains normal, relay 564 releases, and cut-off relay 590 reoperates.

When the disconnect acknowledgment signal is received by the signal receiver SR1, relay 420 responds to each impulse of current of frequency /5 and relay 430 responds to each impulse of current of frequency /6. The operation of relay 420 causes the operation of relay 424; and the operation of relay 430 immediately following the operation of relays 420 and 424 closes a circuit from ground through the right contact of relay 430, right contact and lower winding of relay 424, inner front contact of relay 447 and winding of relay 435. Relay 435 is thereby operated to end the cyclic operation of relay 446 and thereby prevent the reoperation of relays 441, 442, 443, 444 and 453. Relay 464 now releases to end the transmission of current from any of sources G1, G2 and G3 and the cut-off relay 490 is reoperated.

If the selector TS2 encounters an all-trunks-busy condition or if the all-trunks-busy or line-busy condition is encountered in a called local dial office, off-hook and on-hook supervisory signals are alternately transmitted over the toll line TL12 in the manner hereinbefore described.

On calls outgoing from the second toll office over toll line TL12, the signal transmitter ST2 and signal receiver SR2 operate in similar manner to that in which the transmitter ST1 and receiver SR1 operate as above described, and the signal transmitter ST1 and signal receiver SR1 operate in similar manner to that in which the transmitter ST2 and receiver SR2 operate as above described.

On a call from the first toll office to a third toll office, the selector TS1 in the second toll office is selectively operated responsive to the first toll route digit to select a set of terminals 675 connected to the trunk and line circuits TWT3 and TLC3 associated with an intertoll trunk line TL23 leading to the third toll office. If the toll line TL23 is arranged for voice frequency signaling, a signal transmitter similar to the transmitter

ST1 and signal receiver similar to the receiver SR1 are associated with the line circuit TLC3 and a seizure signal is transmitted by the signal transmitter ST3 over line TL23 to the third toll office responsive to seizure of terminals 675. After the seizure signal has been transmitted over toll line TL23, selective and supervisory signals incoming over line TL12 from the first office are repeated by signal receiver SR2 to the signal transmitter ST3 associated with toll line TL23 and are transmitted thereover in similar manner to that in which these signals are transmitted by the transmitter ST1 in the first toll office. Since the cut-off relay 590 of line circuit TLC2 is operated at the time the first part of any incoming signal is received by signal receiver SR2, a part of the signal is transmitted through to toll line TL23 and thereover to the third toll office before relay 590 releases. The use of a two impulse enablement signal preceding selective and supervisory signals minimizes the probability of false or premature signal operations in the third toll office due to the transmission of part of a voice frequency signal, incoming over toll line TL23 to signal receiver SR2 before relay 590 releases. False signal operations are thus prevented in built-up connections without providing means for delaying the response to signals for an interval long enough to prevent a signal operation by that portion of a signal which is transmitted before the cut-off relay opens the talking connection at the intermediate switching point. Although it is not possible to introduce sufficient delay to prevent such false operations when selective impulses are being transmitted by a high-speed dial, the use of a two-frequency enablement signal is effective to prevent false operations in built-up connections without limiting the selective impulse rate. The further operations of the signal transmitter ST3 and signal receiver SR3 are similar to corresponding operations of the signal transmitters ST1 and ST2 and signal receivers SR1 and SR2 as hereinbefore described.

What is claimed is:

1. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means comprising signal relays responsive to signals to be transmitted over said line, means responsive to the operation of said signal relays for transmitting a signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, means responsive to the release of said signal relays for transmitting an enablement signal consisting of an impulse of current of said second frequency followed immediately by an impulse of current of said first frequency and for transmitting current of a third frequency immediately following the enablement signal, means responsive to the reoperation of said signal relays within a predetermined interval of time after their release for ending the current of said third frequency and for transmitting an impulse of current of said first frequency immediately following the current of said third frequency, and means effective in case said signal relays are not reoperated within said predetermined interval of time for ending the current of said third frequency.

2. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means

comprising signal relays responsive to signals to be transmitted over said line, means responsive to the operation of said signal relays for transmitting a signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, means responsive to the release of said signal relays for transmitting an enablement signal consisting of an impulse of current of said second frequency followed immediately by an impulse of current of said first frequency and for transmitting current of a third frequency immediately following the enablement signals, means responsive to the reoperation of said signal relays within a predetermined interval of time after their release for ending the current of said third frequency and for transmitting an impulse of current of said first frequency immediately following the current of said third frequency, means effective in case said signal relays are not reoperated within said predetermined interval of time for ending the current of said third frequency, and a delay network effective to delay the transmission of impulses of current of said third and first frequencies corresponding to the release and the reoperation of said signal relays for an interval equal to the interval required for the transmission of said enablement signal preceding the impulse of current of said third frequency.

3. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means comprising signal relays responsive to a train of dial impulses to be transmitted over said line, means including relays controlled by the release of one of said signal relays for effecting the transmission over said line of an enablement signal consisting of an impulse of current of a first frequency immediately following an impulse of current of a second frequency, a relay operatively responsive to each release and each reoperation of another of said signal relays, the release of the last-mentioned relay being effective to end the transmission of current of said first frequency and cause the transmission of an impulse of current of a third frequency and the reoperation of said last-mentioned relay being effective to end the transmission of current of said third frequency and initiate the transmission of current of said first frequency.

4. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means comprising signal relays responsive to a train of dial impulses to be transmitted over said line, means including relays controlled by the release of one of said signal relays for effecting the transmission over said line of an enablement signal consisting of an impulse of current of a first frequency immediately following an impulse of current of a second frequency, a relay operatively responsive to each release and each reoperation of another of said signal relays, the release of the last-mentioned relay being effective to end the transmission of current of said first frequency and cause the transmission of an impulse of current of a third frequency and the reoperation of said last-mentioned relay being effective to end the transmission of current of said third frequency and initiate the transmission of current of said first frequency, and means comprising a delay network for delaying the re-

sponse of said last-mentioned relay to each release and reoperation of said other of said signal relays for an interval sufficient for the transmission of said enablement signal prior to the transmission of current of said third frequency.

5. In a signaling system according to claim 3, signal receiving means connected to said line to receive signals from said signal transmitting means, said signal receiving means comprising a first relay means for responding to impulses of current of said third and first frequencies representing dial impulses, and comprising relay means operatively responsive to said enablement signal for rendering said first relay means operatively responsive to the impulses of current representing dial impulses.

6. In a signaling system according to claim 4, signal receiving means connected to said line to receive signals from said signal transmitting means, said signal receiving means comprising a first relay means for responding to impulses of current of said third and first frequencies representing dial impulses, and comprising relay means operatively responsive to said enablement signal for rendering said first relay means operatively responsive to the impulses of current representing dial impulses.

7. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means comprising relay means for transmitting a signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, relay means for transmitting trains of signals, each train consisting of any desired number of signals and each signal consisting of current of an impulse of current of a third frequency followed immediately by an impulse of current of said first frequency, relay means for transmitting an enablement signal preceding each said train of signals, said enablement signal consisting of an impulse of current of said second frequency followed immediately by an impulse of current of said first frequency, and relay means for transmitting a signal consisting of said enablement signal followed immediately by an impulse of current of said third frequency.

8. In a signaling system, signal receiving means comprising relay means operatively responsive to a signal consisting of an impulse of current of a first frequency followed within a predetermined interval of time by an impulse of current of a second frequency, relay means operatively responsive to trains of signals, each train consisting of any desired number of signals and each signal consisting of an impulse of current of a third frequency followed within a predetermined interval of time by an impulse of current of said first frequency, relay means operatively responsive to an enablement signal preceding each said train of signals, said enablement signal consisting of an impulse of current of said second frequency followed within a predetermined interval of time by an impulse of current of said first frequency, and relay means operatively responsive to a signal consisting of said enablement signal followed by an impulse of current of said third frequency.

9. In a signaling system according to claim 7, signal receiving means connected to said line to receive signals from said signal transmitting means, said signal receiving means comprising relay means operatively responsive to a signal

consisting of an impulse of current of said first frequency followed within a predetermined interval of time by an impulse of current of said second frequency, relay means rendered operative by said enablement signal for responding to said signals corresponding to a train of any desired number of signals, and relay means rendered operative by said enablement signal for operatively responding to an impulse of current of said third frequency.

10. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, and signal transmitting means associated with said line, said signal transmitting means comprising relay means for transmitting a signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, relay means for transmitting trains of signals, each train consisting of any desired number of signals and each signal consisting of an impulse of current of a third frequency followed immediately by an impulse of current of said first frequency, relay means for transmitting an enablement signal preceding each said train of signals, said enablement signal consisting of an impulse of current of said second frequency followed immediately by an impulse of current of said first frequency, relay means for transmitting a signal consisting of said enablement signal followed immediately by an impulse of current of said third frequency, and relay means for transmitting a signal consisting of an impulse of current of said second frequency followed immediately by an impulse of current of said third frequency.

11. In a signaling system, signal receiving means comprising relay means operatively responsive to a signal consisting of an impulse of current of a first frequency followed within a predetermined interval of time by an impulse of current of a second frequency, relay means operative responsive to trains of signals, each train consisting of any desired number of signals and each signal consisting of an impulse of current of a third frequency followed within a predetermined interval of time by an impulse of current of said first frequency, relay means operatively responsive to an enablement signal preceding each said train of signals, said enabling signal consisting of an impulse of current of said second frequency followed within a predetermined interval of time by an impulse of current of said first frequency, relay means operatively responsive to a signal consisting of said enablement signal followed by an impulse of current of said third frequency, and relay means operatively responsive to a signal consisting of an impulse of current of said second frequency followed within a predetermined interval of time by an impulse of current of said third frequency.

12. In a signaling system according to claim 10, signal receiving means connected to said line to receive signals from said signal transmitting means, said signal receiving means comprising relay means operatively responsive to a signal consisting of an impulse of current of said first frequency followed within a predetermined interval of time by an impulse of current of said second frequency, relay means rendered operative by said enablement signal for responding to said signals corresponding to a train of any desired number of signals, relay means rendered operative by said enablement signal for operatively responding to an impulse of current of said third frequency, and relay means operatively responsive to

by an impulse of current of said fourth frequency, relay means operatively responsive to a signal consisting of said enablement signal followed by an impulse of current of said sixth frequency, and relay means operatively responsive to a signal consisting of an impulse of current of said fifth frequency followed within a predetermined interval of time by an impulse of current of said sixth frequency, and the signal receiving means at said other end of the line comprising relay means operatively responsive to a signal consisting of an impulse of current of said first frequency followed within a predetermined interval of time by an impulse of current of said second frequency, relay means operatively responsive to trains of signals, each train consisting of any desired number of signals and each signal consisting of an impulse of current of said third frequency followed within a predetermined interval of time by an impulse of current of said first frequency, relay means operatively responsive to an enablement signal preceding each said train of signals, said enablement signal consisting of an impulse of current of said second frequency followed within a predetermined interval of time by an impulse of current of said first frequency, relay means operatively responsive to a signal consisting of said enablement signal followed by an impulse of current of said third frequency, and relay means operatively responsive to a signal consisting of an impulse of current of said second frequency followed within a predetermined interval of time by an impulse of current of said third frequency.

15. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, signal transmitting means connected to one end of said line, said signal transmitting means comprising signal relay means responsive to signals to be transmitted over said line, and means controlled by said signal relay means responsive to a train of selective signals for transmitting a preparatory signal preceding the first selective signal, said preparatory signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, and for transmitting an impulse of current of a third frequency immediately following the current of said second frequency and an impulse of current of said second frequency immediately following the current of said third frequency, and for transmitting an impulse of current of said third frequency followed by current of said second frequency for each succeeding selective signal of the train

16. In a signaling system, a plurality of sources of current, each source of a different frequency, a line, signal transmitting means connected to one end of said line, said signal transmitting means comprising signal relay means responsive to signals to be transmitted over said line, means controlled by said signal relay means responsive to a train of selective signals for transmitting a preparatory signal preceding the first selective signal, said preparatory signal consisting of an impulse of current of a first frequency followed immediately by an impulse of current of a second frequency, and for transmitting an impulse of current of a third frequency immediately following the current of said second frequency and

an impulse of current of said second frequency immediately following the current of said third frequency, and for transmitting an impulse of current of said third frequency followed by current of said second frequency for each succeeding selective signal of the train, and means comprising a delay network for delaying the transmission of each selective signal of a train for an interval of time equal to that during which said preparatory signal is transmitted preceding the transmission of the signal corresponding to the first selective signal of the train.

17. In a signaling system according to claim 15, signal receiving means connected to the other end of said line to receive the signals transmitted over the line from said signal transmitting means, said signal receiving means comprising relay means operatively responsive to a preparatory signal consisting of an impulse of current of said first frequency followed within a predetermined interval of time by an impulse of current of said second frequency, and relay means rendered operative by the operation of the relay means which is responsive to the preparatory signal for responding to a train of selective signals each of which consists of current of said third frequency followed by current of said second frequency.

18. In a multioffice signaling system, a first trunk line interconnecting a first and a second of said offices, another trunk line interconnecting said second and a third of said offices, a signal transmitter in said first office and a signal receiver in said second office associated with said first trunk line, means in said second office connecting said first line to said second line for the transmission of voice currents therebetween, said signal transmitter comprising means for transmitting a preparatory signal consisting of an impulse of current of a first signaling frequency followed immediately by an impulse of current of a second signaling frequency and for immediately thereafter transmitting an impulse of current of a third signaling frequency, said signal receiving means comprising means responsive to said preparatory signal for enabling a signal response to said impulse of current of the third signaling frequency, and means responsive to said preparatory signal for opening said connection between said first and second lines, thereby to prevent the transmission of the impulse of current of said third signaling frequency over said second line.

19. In a signaling system according to claim 16, signal receiving means connected to the other end of said line to receive the signals transmitted over the line from said signal transmitting means, said signal receiving means comprising relay means operatively responsive to a preparatory signal consisting of an impulse of current of said first frequency followed within a predetermined interval of time by an impulse of current of said second frequency, and relay means rendered operative by the operation of the relay means which is responsive to the preparatory signal for responding to a train of selective signals each of which consists of current of said third frequency followed by current of said second frequency.

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