Jan. 23, 1945. O. J. MURPHY ET AL 2,367,885

SIGNALING SYSTEM

Filed Aug. 19, 1943 3 Sheets-Sheet 1

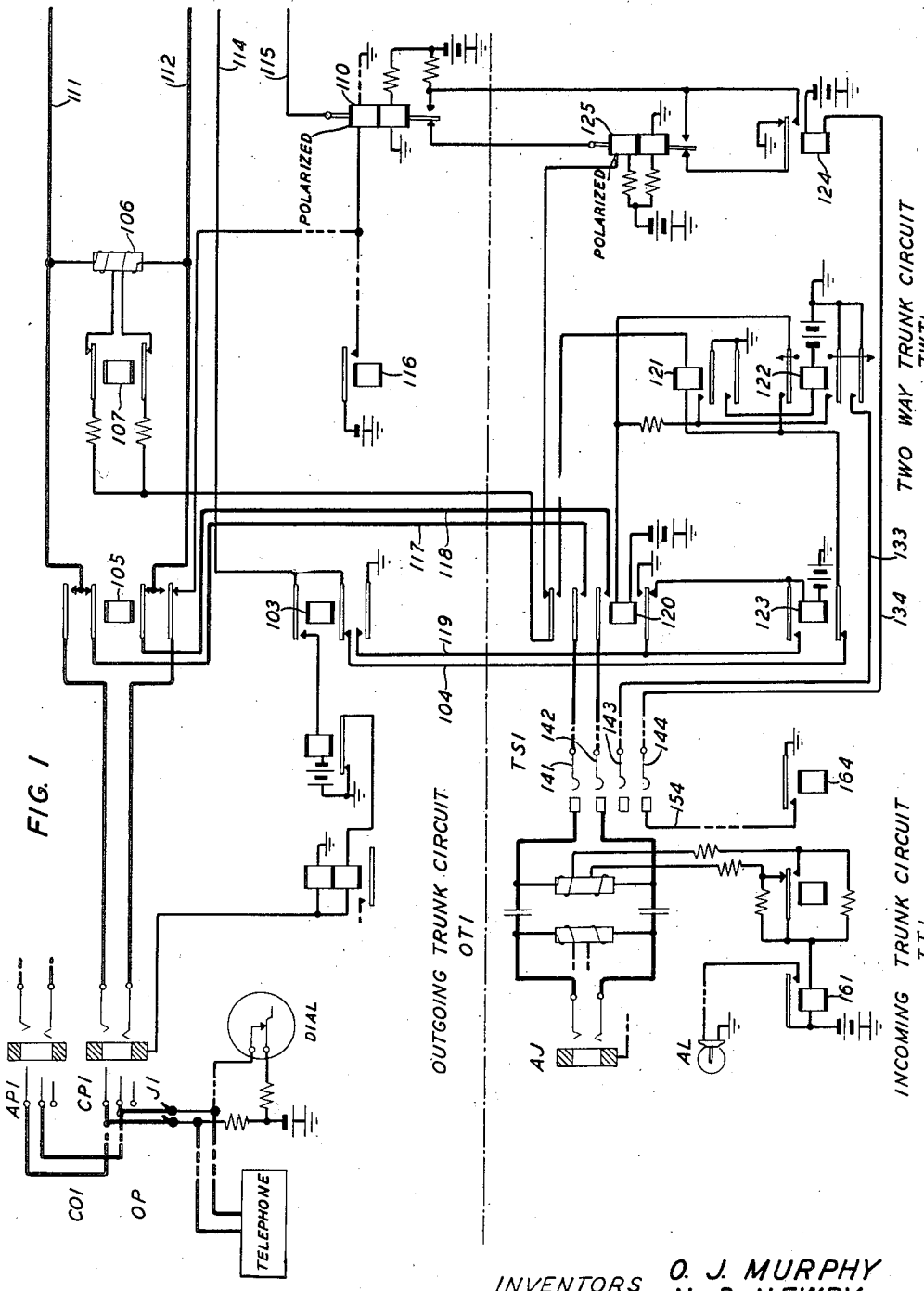

FIG. 1

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SIGNALING SYSTEM

Filed Aug. 19, 1943 3 Sheets-Sheet 2

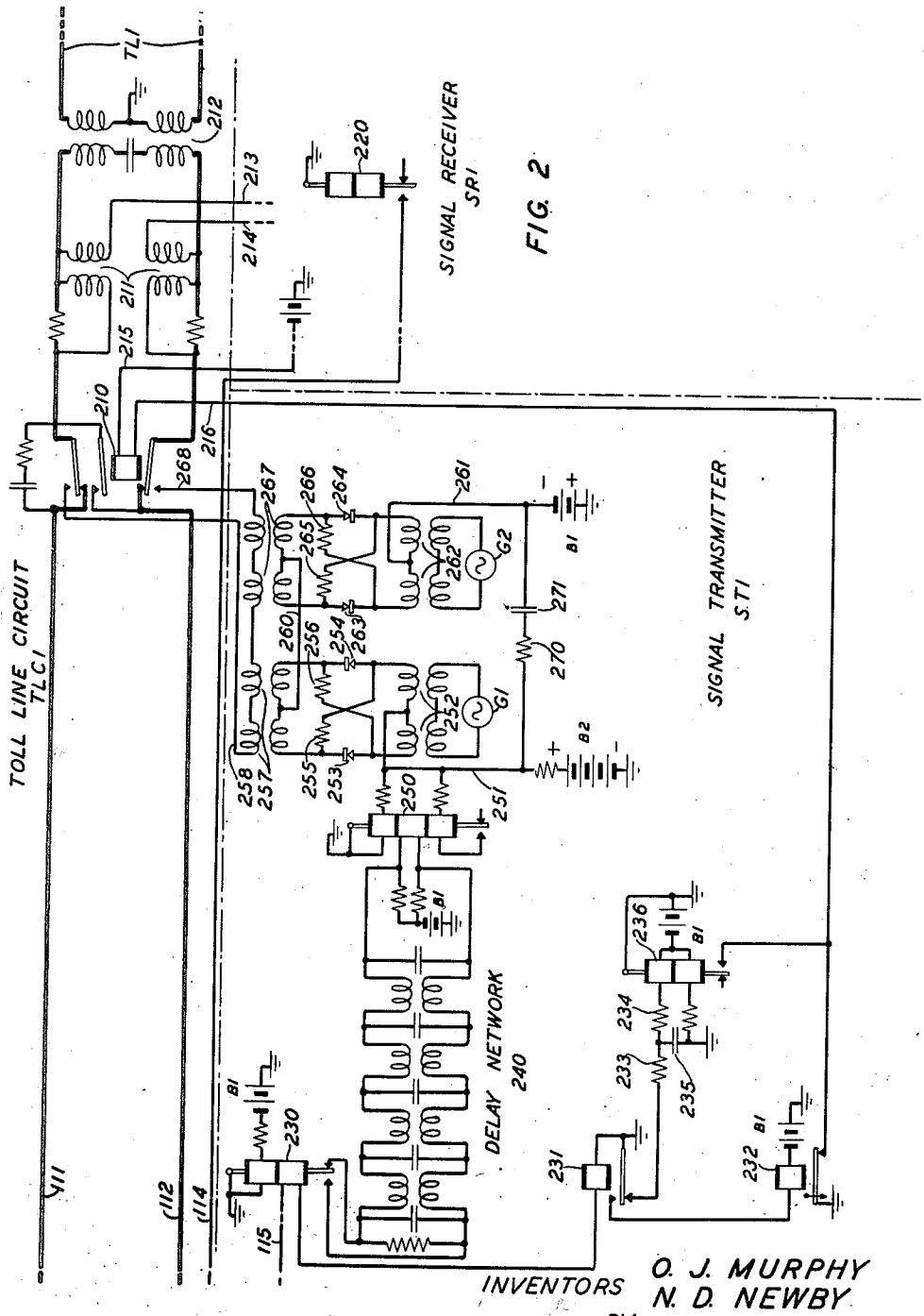

FIG. 2

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SIGNALING SYSTEM

Filed Aug. 19, 1943 3 Sheets-Sheet 3

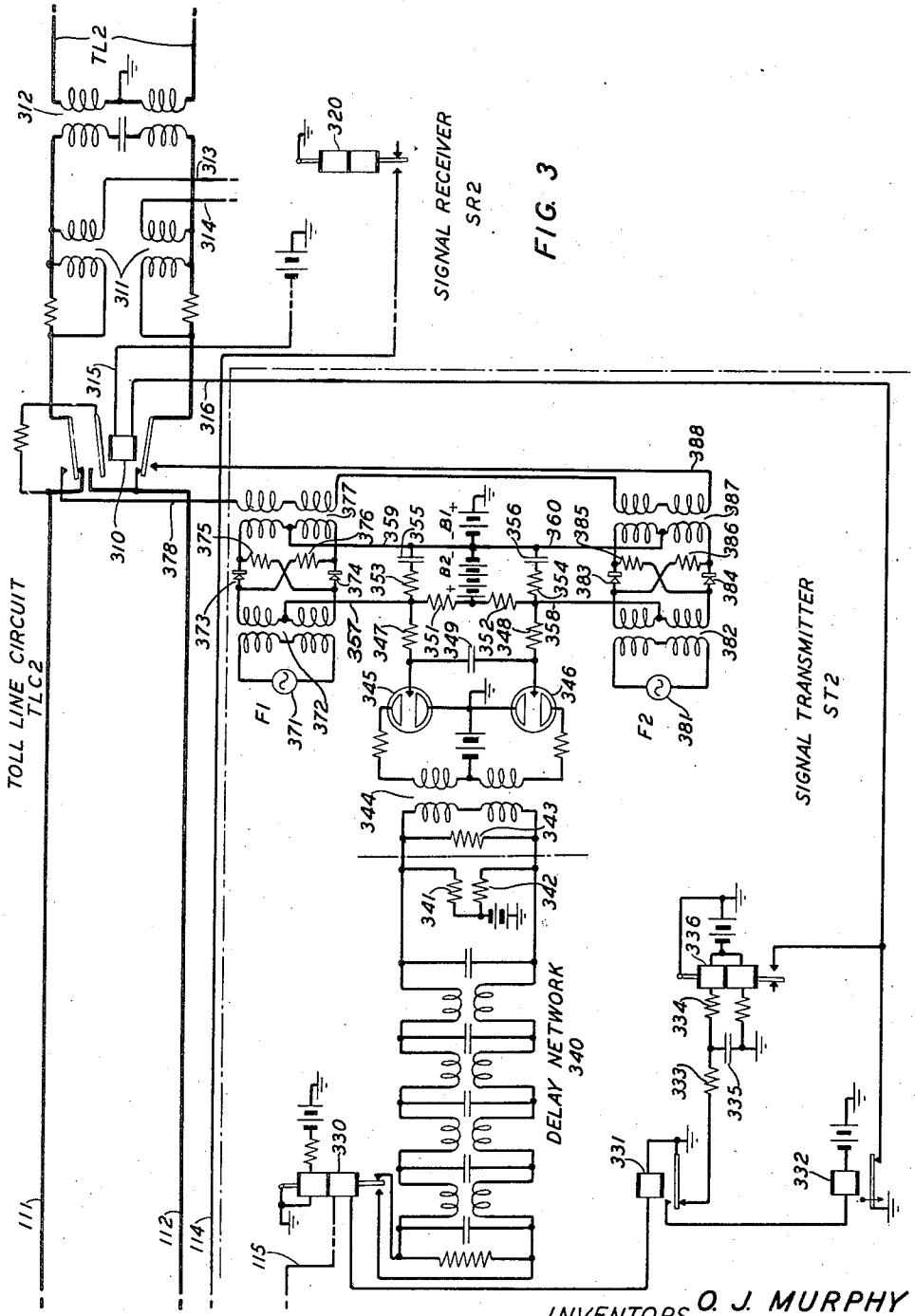

FIG. 3

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2,367,885

SIGNALING SYSTEM

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Application August 19, 1943, Serial No. 499,184

10 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 means in systems employing voice frequency signals and particularly the provision of signal transmitting means arranged to reduce the possibility of false operations.

This invention is an improved signaling system comprising means for transmitting signals each of which consists of a plurality of current impulses in succession, each of a different frequency, the transmission of the impulses being effected by the balancing and unbalancing of varistor-resistor bridges, one for each frequency under the control of signal responsive relays. Means comprising a low-pass filter delays the transition from balanced to unbalanced and unbalanced to balanced condition of the bridges responsive to operations of the signal receiving relays.

A feature of the invention is a signaling system comprising a signal transmitter arranged to transmit signals each consisting of an impulse of current of one frequency followed by an impulse of current of a different frequency and arranged to control the initiation and termination of the signal impulses by controlling the balance of varistor-resistor bridges through which the signal sources are individually coupled to the line over which signals are to be transmitted. The production of transients upon transition from one frequency to the other is minimized by a condenser-resistance network connected across the bridges.

A further feature of the invention is a signaling system comprising a signal transmitter arranged to transmit signals consisting of a plurality of current impulses each of different frequency, the transmission of the impulses being controlled by gas-filled tubes in combination with varistor-resistor bridges, the balance of which is controlled by signal responsive relays.

The invention and its various features will be further described by considering the specific embodiments of the invention shown in the drawings which form a part of this specification. The invention is not limited in its application to the partcular system shown but is applicable generally to any telephone or other signaling system employing voice frequency signaling.

Referring to the drawings,

Figs. 1 and 2 show in a toll office, an operator's position OP, an outgoing trunk circuit OT1, a two-way trunk circuit TWT1, a toll selector TS1, a toll line circuit TLC1, a signal transmitter ST1 and a signal receiver SR1; all individually associated with a toll line TL1; Fig. 1 further shows an incoming trunk circuit IT1 connected to a set of terminals in the bank of selector TS1; and

Fig. 3 shows another toll line circuit TLC2, signal transmitter ST2 and signal receiver SR2 adapted for use with the trunk and selector circuits shown in Fig. 1.

The system represented in the drawings includes a plurality of toll offices each of which comprises a toll board with operator's 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 local manual and dial 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 recording trunks, to toll subscribers' lines, to intertoll trunks and to incoming trunk circuits terminating in the banks of toll route selectors. Toll route selectors and auxiliary toll route selectors are provided for use on calls incoming over intertoll trunks to extend connections to called toll, local or community dial offices.

Reference may be had to the patent to R. E. King et al. 2,209,777, granted July 30, 1940, for a detailed disclosure 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 circuit OT1, incoming trunk circuit IT1, two-way trunk circuit TWT1, and toll selector TS1 are all similar to corresponding circuits in the aforementioned King et al. patent. The operators' positions are provided with dials for use in controlling the operation of incoming and auxiliary toll route selectors in other toll offices and for controlling the operation of selector and connector switches in local or community dial offices.

The signal transmitter ST1 comprises relays 230 and 231 which are operatively controlled by relay 110 of the outgoing trunk circuit OT1 on outgoing calls and controlled by relay 124 of two-way trunk circuit TWT1 on incoming calls. The signal transmitter ST1 further comprises relay 250 controlled by relay 230 and relays 232 and 236 controlled by relay 231. Relay 230 is a polarized relay having a biasing winding which normally maintains closure of the right contact. Relay 250 is a polarized relay having three windings, the top winding being a biasing winding, the bottom winding being a locking and biasing winding and the middle winding being an operating winding which is connected by the delay network 240 to the contacts of relay 230. Normally the middle winding of relay 250 is energized in the same direction as the biasing winding thereby to maintain closure of the right contact of this relay. When relay 230 operates, the current through the middle winding of relay 250 is re-

versed thereby to effect closure of the left contact of relay 250, the reversal being delayed by the network 240 for about .025 second. The signal transmitter ST1 further comprises a source G1 of signaling current of frequency F1, a source G2 of signaling current of frequency F2, transformers 252 and 257 and rectifiers 253 and 254 for transmitting current of frequency F1 to toll line TL1 and transformers 262 and 267 and rectifiers 263 and 264 for transmitting current of frequency F2 to toll line TL1. The rectifiers 253 and 254 and rectifiers 263 and 264 are so poled that there is normally a direct current through all of these rectifiers which reduces their impedance. The circuit for this direct current is traced from the positive pole of battery B2 through a simplex circuit path including both upper windings of transformer 252, rectifiers 253 and 254 and both lower windings of transformer 257 to conductor 260, thence through a simplex circuit path including both lower windings of transformer 267, rectifiers 263 and 264, and both upper windings of transformer 262 to the negative pole of battery B1, the negative pole of battery B2 and the positive pole of battery B1 being connected to ground. With the impedance of rectifiers 253 and 254 reduced, the bridge comprising these rectifiers and the resistors 255 and 256 is unbalanced so as to allow the transmission of current from source G1 through transformers 252 and 257 to line TL1 if and when the cut-off relay 210 of line circuit TLC1 is released. With the impedance of rectifiers 263 and 264 reduced the bridge comprising these rectifiers and resistors 265 and 266 is balanced so as to prevent the transmission of current from source G2 to line TL1. When relay 250 operates as hereinafter described, ground is connected through the top winding of relay 250 to conductor 251 thereby reducing the direct current through rectifiers 253, 254, 263 and 264 below the critical value so as to increase the impedance of these rectifiers. The bridge comprising rectifiers 253 and 254 and resistors 255 and 256 is thereby balanced to prevent the further transmission of current from source G1 and the bridge comprising rectifiers 263 and 264 and resistors 265 and 266 is thereby unbalanced to allow the transmission of current from source G2 to the line TL1 if and when the cut-off relay 210 is released. The energization of the top winding of relay 250 produces an additional bias which, in combination with the energization of the bottom winding, results in the desired percentage break for dial impulse signals. The circuit for operatively energizing the cut-off relay 210 is controlled by relays 232 and 236 as hereinafter described.

The signal receiver SR1 may be similar to that disclosed in the patent to J. G. Walsh, No. 2,306,-236, granted December 22, 1942.

Assume now that a call incoming to the operator's position OP has been answered with answering plug AP1 of cord CD1, that the calling plug CP1 of this cord has been inserted in jack J1 of outgoing trunk circuit OT1, the call being one which may be completed through intertoll trunk line TL1. Relay 110 is operated responsive to insertion of plug CP1 in jack J1 in the manner described in the aforementioned patent to King et al. The operation of relay 110 closes a circuit for operating signal relays 230 and 231 of signal transmitter ST1. The operation of relay 230 effects a reversal of the current through the middle winding of relay 250, but this operation of relay 250 is delayed for about .025 second by the delay network 240. The operation of relay 231 opens the normally closed circuit through the upper winding of relay 236, the closing of the right contact of relay 236 being delayed for about .100 second by current charging condenser 235. The operation of relay 231 closes a circuit for operating the slow-to-release relay 232 and relay 232 opens the normally closed circuit through the winding of cut-off relay 210 of toll line circuit TLC2, thereby to effect the release of relay 210. Since the bridge comprising rectifiers 253 and 254 is unbalanced at the time relay 210 releases, current of frequency F1 is transmitted through transformer 257, back contacts of relay 210, directionally selective coils 211 and repeating coil 212 to the conductors of toll trunk line TL1. When relay 250 closes its left contact responsive to the aforementioned reversal of the current through its middle winding, ground is connected through this contact and the bottom winding of relay 250 to conductor 251 thereby reducing the direct current through rectifiers 253, 254, 263 and 264 below the critical value, whereby the resistance of these rectifiers is substantially increased. The bridge comprising rectifiers 253 and 254 is thereby balanced to end the transmission of current of frequency F1 and the bridge comprising rectifiers 263 and 264 is unbalanced to initiate the transmission of current of frequency F2 over toll line TL1. The resistor 270 and condenser 271 bridged across conductors 251 and 261 prevent the change from one frequency to the other from occurring rapidly enough to produce transients which might effect the false operation of signal receiver SR1 or interfere with the operation of receiver SR1 in response to incoming signals. The operation of relay 236, about .075 second after the operation of relay 250, connects ground to conductor 216 to effect the reoperation of cut-off relay 210 and thereby end the transmission of current of frequency F2 to the conductors of toll line TL1. Thus the operation of relays 230 and 231 effects the transmission of a seizure signal over toll line TL1 consisting of current of frequency F1 for about .025 second followed immediately by current of frequency F2 for about .075 second.

When the operator dials the digits of the toll route code, and the local office code and called line number if the called line is a dial office, relay 110 is alternately released and reoperated responsive to each dial impulse in the manner set forth in the aforementioned King et al. patent. Each release and reoperation of relay 110 effects a corresponding release and reoperation of relays 230 and 231. Each release and reoperation of relay 230 effects a corresponding release and reoperation of relay 250, the delay network 240 being effective to delay the response of relay 250 for about .025 second. Each release of relay 231 opens the circuit for operating relay 232; but, being slow in releasing, relay 232 does not release during the response of relay 231 to dial impulses. The release of relay 231 in response to the first dial impulse of a train closes the circuit through the upper winding of relay 236 causing the release of relay 235. The release of relay 236 disconnects ground from conductor 216 thereby releasing the cut-off relay 210. The release of relay 210 again connects the upper winding of transformers 257 and 267 to coils 211 and 212; and, since relay 250 is operated, the bridge comprising rectifiers 253 and 254 is balanced and the bridge comprising rectifiers 263 and 264 is unbalanced so that current of frequency F2 is

transmitted over line TL1 for about .025 second. When relay 250 releases responsive to a dial impulse, ground is disconnected from conductor 251 thereby unbalancing the bridge comprising rectifiers 253 and 254 and balancing the bridge comprising rectifiers 263 and 264 so that the transmission of current of frequency F2 is ended and transmission of current of frequency F1 is initiated. When relay 250 reoperates responsive to the end of each dial impulse, ground is reconnected to conductor 251 thereby balancing the bridge comprising rectifiers 253 and 254 and unbalancing the bridge comprising rectifiers 263 and 264 so that the transmission of current of frequency F1 is ended and the transmission of current of frequency F2 is initiated. After the release of relay 236 in response to the first impulse of a train created by the dialing of one digit, this relay remains normal until all of the impulses in the train have been received. When relay 236 reoperates, about .100 second after the reoperation of relay 231 at the end of the last impulse of a train or dial impulses, it reconnects ground to conductor 216 to effect the reoperation of relay 210 and thus end the transmission of current of frequency F1. In this manner each train of dial impulses is transmitted over toll line TL1.

If the calling operator operates the ringing key (not shown) relay 110 is momentarily released in the manner described in the aforementioned King et al. patent thereby effecting a momentary release of relays 230 and 231 so as to cause the transmission of a ringing signal comprising current of frequency F2 followed by frequency F2, the same as for a single dial impulse representing the digit one.

When the plug CP1 of cord CD1 is removed from jack J1, the release of relay 110 is effected in the manner set forth in the aforementioned King et al. patent. The release of relay 110 causes the release of relays 230 and 231. The release of relay 231 causes the successive release of relays 236 and 210 whereby current of frequency F2 is transmitted to line TL1. When relay 250 releases, about .025 second after the release of relay 230, the bridge comprising rectifiers 253 and 254 is unbalanced and the bridge comprising rectifiers 263 and 264 is balanced thereby to end the transmission of current of frequency F2 and initiate the transmission of current of frequency F1. When relay 232 releases, about .6 second after the release of relay 231, ground is reconnected to conductor 216 thereby reoperating relay 210 to end the transmission of current of frequency F1. Thus a disconnect signal, consisting of current of frequency F2 for about .025 second followed by current of frequency F1 for about .6 second, is transmitted over line TL1.

If now a seizure signal is received by signal receiver SR1 responsive to seizure of the line TL1 at its distant end, relay 220 is operated in the manner described in the aforementioned Walsh patent. The operation of relay 220 connects ground to conductor 114 thereby effecting the operation of relays 120, 121 and 122 of two-way trunk circuit TWT1 and the operation of the line relay (not shown) of selector TS1 in the manner set forth in the Walsh patent. The selector TS1 is selectively operated responsive to dial impulse signals received by signal receiver SR1; and on a call to the incoming trunk circuit IT1, relay 161 is operated to light the answering lamp AL in the manner described in the Walsh patent. When the call is answered, the operation of relay 164 connects ground to conductor 154, thereby operating relay 124 of two-way trunk circuit TWT1. The operation of relay 124 closes the circuit for operating relays 230 and 231 of signal transmitter ST1 whereby an answering or off-hook supervisory signal, similar to a seizure signal on an outgoing call, is transmitted over toll line TL1 to the distant office. If the answering operator disconnects, relays 164 and 124 are successively released, causing the release of relays 230 and 231 whereby an on-hook supervisory signal is transmitted over line TL1, this signal being similar to a disconnect signal on an outgoing call.

If an all-trunks-busy or a called line busy condition is encountered on an incoming call, the alternate operation and release of relay 124 is effected in the manner set forth in the aforementioned Walsh patent, thereby causing the alternate transmission of off-hook and on-hook signals over toll line TL1.

The signal transmitter ST1 of Fig. 1 may be modified so as to normally balance both of the varistor-resistor bridges by reversing the polarity of the elements 263 and 264 and reversing the polarity of the battery B1. When so arranged and relay 250 is normal, the voltage impressed across the bridges is equal to the voltage of battery B2 minus the voltage of the battery B1 and is of such a polarity that the resistance of rectifiers 253 and 254 is low and the resistance of rectifiers 263 and 264 is high; whereby the bridge comprising rectifiers 253 and 254 is unbalanced to transmit current of frequency F1 and the bridge comprising rectifiers 263 and 264 is balanced to prevent the transmission of current of frequency F2. When relay 250 operates, the voltage impressed across the bridges is that of the battery B1 and of such a polarity that the resistance of rectifiers 253 and 254 is high and the resistance of rectifiers 263 and 264 is low; whereby the bridge comprising rectifiers 253 and 254 is balanced to prevent the transmission of current of frequency F1 and the bridge comprising rectifiers 263 and 264 is unbalanced to transmit current of frequency F2.

Assume now that the outgoing trunk, two-way trunk and toll route selector circuits of Fig. 1 are associated with the toll line circuit TLC2, signal transmitter ST2, and signal receiver SR2 shown in Fig. 3. Relays 330 and 331 of signal transmitter ST2 are controlled by relay 110 of outgoing trunk circuit OT1 on calls outgoing over the associated toll line TL2 and are controlled by relay 124 of two-way trunk circuit TWT1 on calls incoming over line TL2. Relays 332 and 336 of the signal transmitter ST2, relay 310 of the toll line circuit TLC2 and relay 320 of the signal receiver SR2 are similar to relays 232, 236, 210 and 220 in Fig. 2 and perform like functions. The delay network 340 performs a like function to that of the network 240 of Fig. 2 and the transformer 344 and gas-filled tubes 345 and 346 perform like functions to that of relay 250 of Fig. 2. The transmission of current of frequency F1 from source 371 through transformers 372 and 377 is controlled by the bridge consisting of rectifiers 373 and 374 and resistors 375 and 376, and the transmission of current of frequency F2 from source 381 through transformers 382 and 387 is controlled by the bridge consisting of rectifiers 383 and 384 and resistors 385 and 386. With tube 345 deenergized, the resistance of rectifiers 373 and 374 is reduced by direct current in a cir-

cuit from the positive pole of battery B2, through resistor 351, conductor 357, right windings of transformer 372, rectifiers 373 and 374, left windings of transformer 377, conductor 359, to the negative pole of battery B1. The bridge comprising rectifiers 373 and 374 is thereby balanced to block the transmission of current from source 371. When the equipment is placed in service and thereafter upon closure of the right contact of relay 330, an electromotive force is induced in the right windings of transformer 344, which becomes effective about .025 second after closure of this contact, to energize tube 345. The energization of tube 345 connects ground through resistance 347, to conductor 357 to reduce the direct current through rectifiers 373 and 374. By reducing the current through rectifiers 373 and 374, their resistance is increased to unbalance the bridge and thus render the bridge effective to transmit current of frequency F1 to the toll line T12 if and when the cut-off relay 310 is released. With tube 346 deenergized, the resistance of rectifiers 383 and 384 is reduced by direct current in a circuit from the positive pole of battery B2, through resistor 352, conductor 358, right windings of transformer 382, rectifiers 383 and 384, left windings of transformer 387, and conductor 360 to the negative pole of battery B1. The bridge comprising rectifiers 383 and 384 is thereby balanced to block the transmission of current from source 381. When tube 346 is energized by an electromotive force induced in the input windings of transformer 344 responsive to the reversal of current through the left windings of this transformer about .025 second after the operation of relay 330, ground is connected to conductor 358 through resistor 348, to reduce the current through rectifiers 383 and 384. By reducing the current through the rectifiers 383 and 384, their resistance is increased to unbalance the bridge and thus render the bridge effective to transmit current of frequency F2 to the toll line TL2 if and when relay 310 is released. Condenser 349 is bridged across the anodes of tubes 345 and 346 to effect the deenergization of tube 345 when tube 346 becomes energized and to effect the deenergization of tube 346 when tube 345 becomes energized. Resistor 353 and condenser 355 and resistor 354 and condenser 356 serve a similar purpose to that of resistor 270 and condenser 271 of Fig. 2. Thus the transmitter ST2 effects the transmission of seizure, selective, supervisory, ringing and disconnect signals similar to those above described as being transmitted by the signal transmitter ST1.

What is claimed is:

1. In a signaling system, a line and a signal transmitter associated with said line, said transmitter comprising a signal responsive relay, a source of current of one frequency, means including a varistor-resistor bridge connecting said source to said line, another source of current, the frequency of said other source being different from said one frequency, means including a varistor-resistor bridge connecting said other source to said line, each of said bridges being effective only when unbalanced to transmit current from the associated source to said line, means including a relay controlling the balance of said bridges, and means including said signal responsive relay for operating the last-mentioned relay to effect the transmission over said line of signals consisting of impulses of current from said sources.

2. In a signaling system, a line and a signal transmitter associated with said line, said transmitter comprising a signal responsive relay, a source of current of one frequency, means including a varistor-resistor bridge connecting said source to said line, another source of current, the frequency of said other source being different from said one frequency, means including a varistor-resistor bridge connecting said other source to said line, each of said bridges being effective when unbalanced to transmit current from the associated source to said line and effective when balanced to prevent the transmission of current from the associated source to said line, means including a relay controlling the balance of said bridges, and means including a low-pass network connecting the contacts of said signal responsive relay to the winding of the last-mentioned relay for controlling the operation of said last-mentioned relay, thereby to effect the transmission of signals consisting of impulses of current from said sources corresponding to the signals received by said signal responsive relay, said network being effective to delay the response of said last-mentioned relay to operations of said signal responsive relay for a predetermined interval of time.

3. In combination in a signaling system, an incoming signaling circuit, a signal responsive relay in said circuit, an outgoing signaling circuit, a source of current of one frequency, a source of current of another frequency, means including a normally unbalanced varistor-resistor bridge connecting one of said sources to said outgoing circuit, means including a normally balanced varistor-resistor bridge connecting the other of said sources to said outgoing circuit, each of said bridges being effective to transmit current from the associated source to said outgoing circuit when said bridge is unbalanced and to prevent the transmission of current from the associated source to said outgoing circuit when said bridge is balanced, means including a relay controlling the balance of said bridges, and means including said signal responsive relay for operating and releasing said last-mentioned relay thereby to effect the transmission of signals consisting of impulses of current from said sources through said outgoing circuit.

4. In a signaling system, a line over which signals are to be transmitted and a signal transmitter associated with said line and adapted to transmit over said line signals consisting of a plurality of impulses of current in succession, each impulse consisting of current of only one of two signaling frequencies, said transmitter comprising a signal relay responsive to signals to be transmitted over said line, a source of current of one of said frequencies, a source of current of the other of said frequencies, a normally balanced varistor-resistor bridge connecting one of said sources to said line, a normally unbalanced varistor-resistor bridge connecting the other of said sources to said line, each of said bridges being effective when balanced to prevent the transmission of current from the associated source to said line and effective when unbalanced to transmit current from the associated source to said line, a relay controlling the balance of said bridges, and means including said signal relay controlling said last-mentioned relay to effect the transmission of signals over said line.

5. In a signaling system, a line over which signals are to be transmitted and a signal transmitter associated with said line and adapted to

transmit over said line signals consisting of a plurality of impulses of current in succession, each impulse consisting of current of only one of two signaling frequencies, said transmitter comprising a signal relay responsive to signals to be transmitted over said line, a source of current of one of said frequencies, a source of current of the other of said frequencies, a normally balanced varistor-resistor bridge connecting one of said sources to said line, a normally unbalanced varistor-resistor bridge connecting the other of said sources to said line, each of said bridges being effective when balanced to prevent the transmission of current from the associated source to said line and effective when unbalanced to transmit current from the associated source to said line, a relay controlling the balance of said bridges, means including said signal relay controlling said last-mentioned relay to effect the transmission of signals over said line, and means comprising a condenser-resistance network bridged across said varistor-resistor bridges for delaying the transition from one frequency to the other thereby to minimize the production of transients.

6. In a signaling system, a line and a signal transmitter associated with said line, said transmitter comprising a signal responsive relay, a source of current of one frequency, means including a varistor-resistor bridge connecting said source to said line, another source of current, the frequency of said other source being different from the frequency of said one frequency, means including a varistor-resistor bridge connecting said other source to said line, each of said bridges being effective when unbalanced to transmit current from the associated source to said line and effective when balanced to prevent the transmission of current from the associated source to said line, means comprising two gas-filled tubes controlling the balance of said bridges, and means connecting the contacts of said signal responsive relay to said tubes to render one of the tubes conductive when said relay is operated and the other of said tubes conductive when said relay is released.

7. In a signaling system, a line and a signal transmitter associated with said line, said transmitter comprising a signal responsive relay, a source of current of one frequency, means including a varistor-resistor bridge connecting said source to said line, another source of current, the frequency of said other source being different from the frequency of said one frequency, means including a varistor-resistor bridge connecting said other source to said line, each of said bridges being effective when unbalanced to transmit current from the associated source to said line and effective when balanced to prevent the transmission of current from the associated source to said line, means comprising two gas-filled tubes controlling the balance of said bridges, means connecting the contacts of said signal responsive relay to said tubes to render one of the tubes conductive when said relay is operated and the other of said tubes conductive when said relay is released, and means effective upon energization of either of said tubes to deenergize the other of said tubes.

8. In a signaling system, a line and a signal transmitter associated with said line, said transmitter comprising a signal responsive relay, a source of current of one frequency, means including a varistor-resistor bridge connecting said source to said line, another source of current, the frequency of said other source being different from the frequency of said one frequency, means including a varistor-resistor bridge connecting said other source to said line, each of said bridges being effective when unbalanced to transmit current from the associated source to said line and effective when balanced to prevent the transmission of current from the associated source to said line, means comprising two gas-filled tubes controlling the balance of said bridges, and means comprising a low-pass network connecting the contacts of said signal responsive relay to said tubes to render one of the tubes conductive when said relay is operated and the other of said tubes conductive when said relay is released, said network being effective to delay for a predetermined interval of time the energization of said tubes responsive to operations of said signal relay.

9. In a signaling system, a line over which signals are to be transmitted and a signal transmitter associated with said line and adapted to transmit over said line signals consisting of a plurality of impulses of current in succession, each impulse consisting of current of only one of two signaling frequencies, said transmitter comprising a signal relay responsive to signals to be transmitted over said line, a source of current of one of said frequencies, a source of current of the other of said frequencies, a normally balanced varistor-resistor bridge connecting one of said sources to said line, a normally unbalanced varistor-resistor bridge connecting the other of said sources to said line, each of said bridges being effective when balanced to prevent the transmission of current from the associated source to said line and effective when unbalanced to transmit current from the associated source to said line, means comprising one gas-filled tube for controlling the balance of one of said bridges, means comprising another gas-filled tube for controlling the balance of the other of said bridges, and means including said signal relay for effecting the energization and deenergization of said tubes.

10. In a signaling system, a line over which signals are to be transmitted and a signal transmitter associated with said line and adapted to transmit over said line signals consisting of a plurality of impulses of current in succession, each impulse consisting of current of only one of two signaling frequencies, said transmitter comprising a signal relay responsive to signals to be transmitted over said line, a source of current of one of said frequencies, a source of current of the other of said frequencies, a normally balanced varistor-resistor bridge connecting one of said sources to said line, a normally unbalanced varistor-resistor bridge connecting the other of said sources to said line, each of said bridges being effective when balanced to prevent the transmission of current from the associated source to said line and effective when unbalanced to transmit current from the associated source to said line, means comprising one gas-filled tube for controlling the balance of one of said bridges, means comprising another gas-filled tube for controlling the balance of the other of said bridges, means including said signal relay for effecting the energization and deenergization of said tubes, and means comprising a low-pass network connecting the contacts of said signal relay to said tubes to delay for a predetermined interval of time the energization of each of said tubes responsive to operation or release of said signal relay.

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