June 24, 1947. N. A. NEWELL 2,422,700

RECIPROCAL SIGNALING TRUNK TELEPHONE SYSTEM

Filed June 15, 1945 4 Sheets-Sheet 1

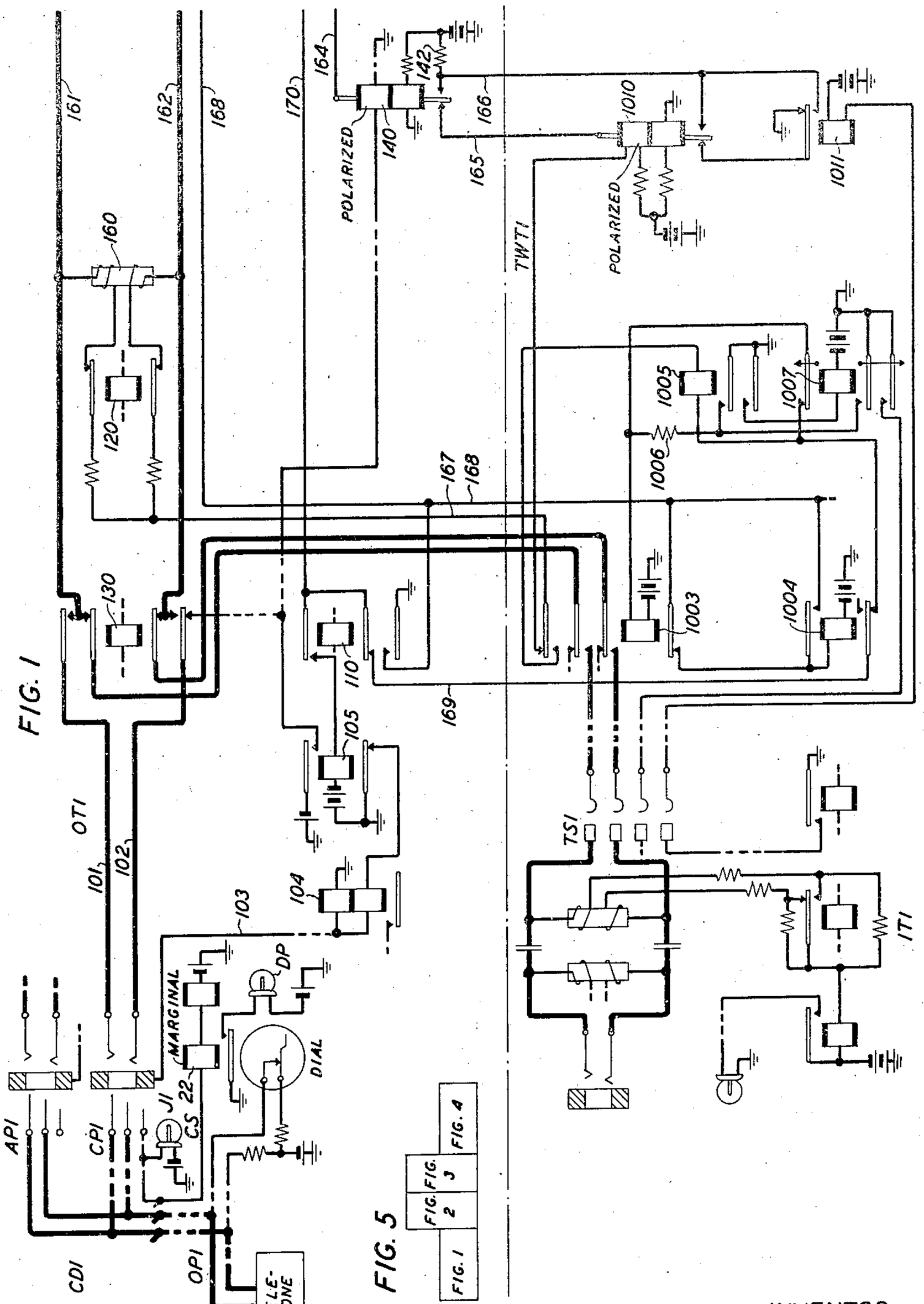

FIG. 1

FIG. 5

		FIG. 4
	FIG. 3	
FIG. 2		
FIG. 1		

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RECIPROCAL SIGNALING TRUNK TELEPHONE SYSTEM

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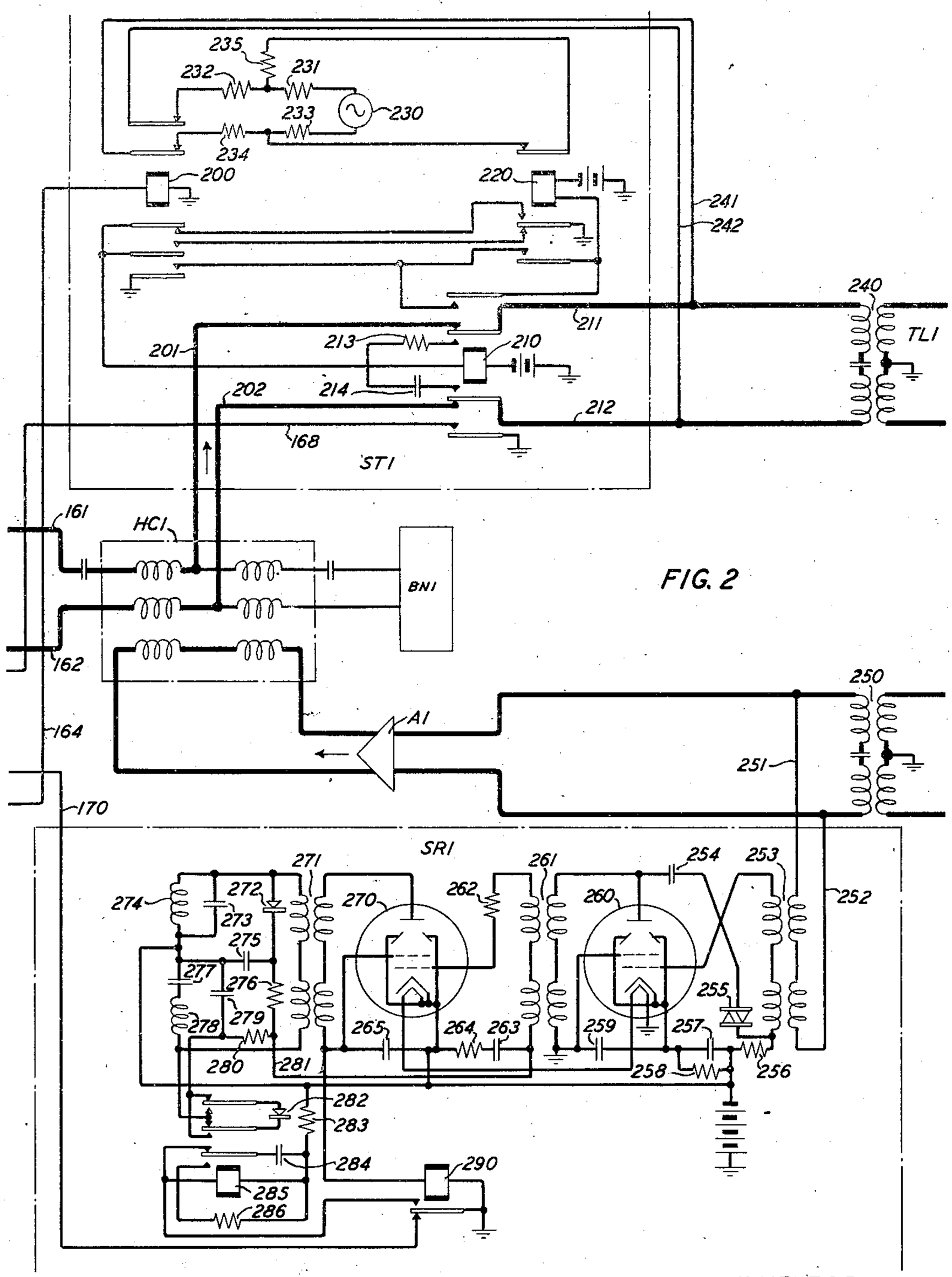

FIG. 2

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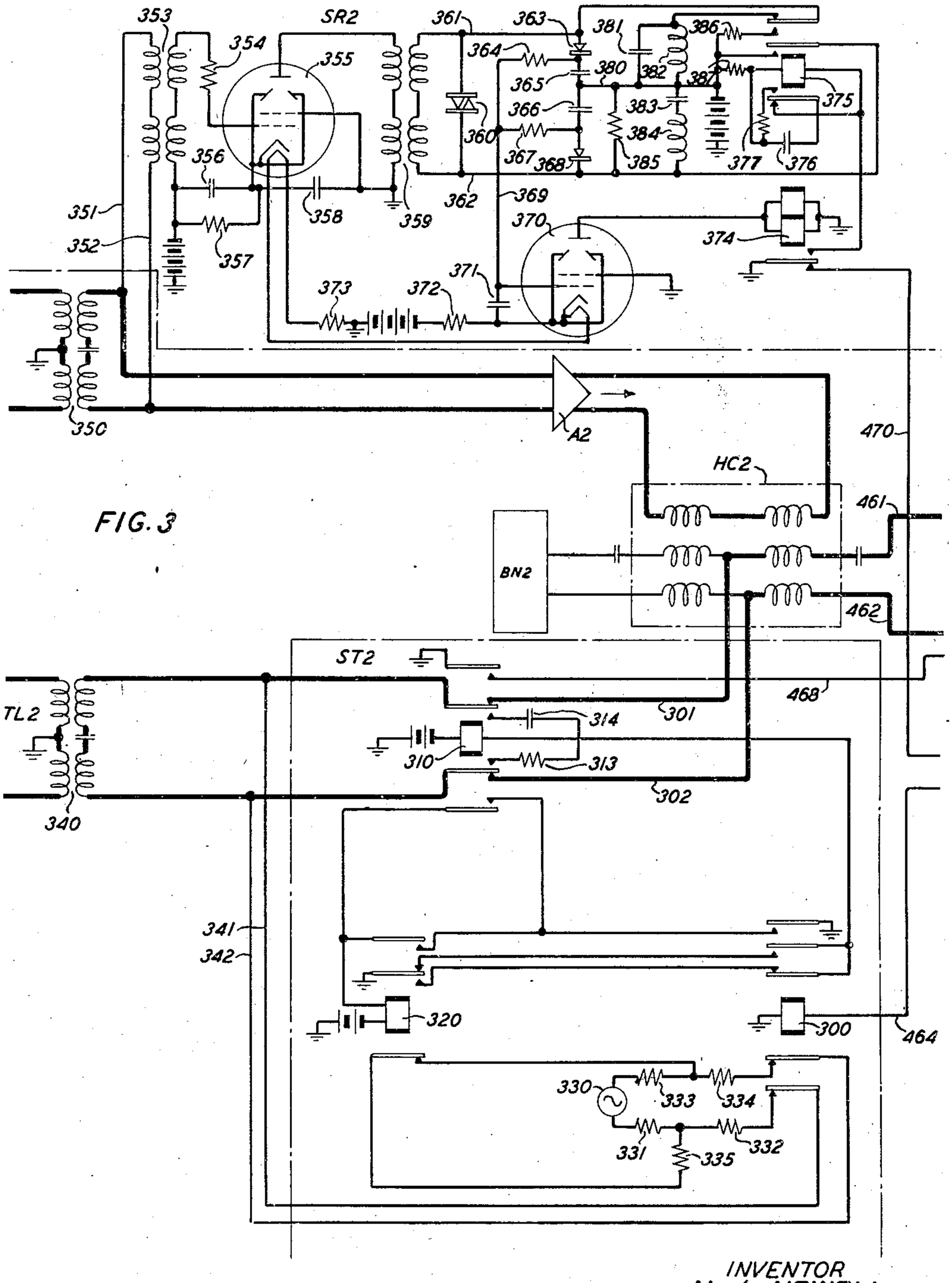

FIG. 3

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RECIPROCAL SIGNALING TRUNK TELEPHONE SYSTEM

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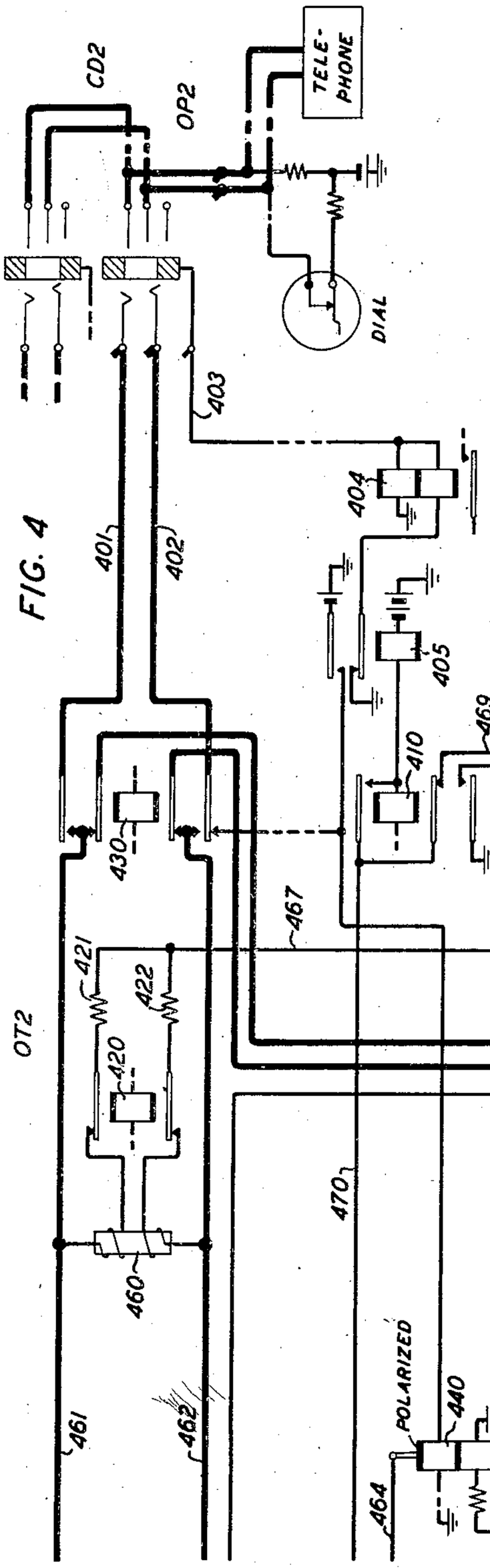

FIG. 4

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UNITED STATES PATENT OFFICE

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RECIPROCAL SIGNALING TRUNK TELEPHONE SYSTEM

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Application June 15, 1945, Serial No. 599,537

17 Claims. (Cl. 179—43)

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This invention relates to signaling systems and particularly to telephone systems in which voice frequency currents are employed in the transmission of selective signals.

Objects of the invention are the provision of more reliable signal transmitting and receiving means in systems employing voice frequency signaling, the provision of such signaling means for the transmission of signals over four-wire lines, and the prevention of false operation in response to voice currents or other interfering currents.

This invention is a signaling system in which the termination of current of a particular frequency normally transmitted over a line constitutes a first signal, in which an impulse of current of said particular frequency constitutes a second signal, and in which the continued transmission of current of said particular frequency constitutes a third signal.

A feature of the invention is a signaling system in which the termination of current of a particular frequency normally transmitted over a line constitutes a first signal, in which the transmission of an impulse of current of said particular frequency and of a particular limited duration constitutes a second signal, in which the continued transmission of current of said particular frequency constitutes a third signal, and in which the current of said particular frequency is reduced in amplitude when continued beyond a predetermined interval of time.

Another feature of the invention is a signaling system in which the termination of current of a particular frequency normally transmitted over a line constitutes a first signal, in which means normally effective to prevent response to current of other frequencies or to current of the signaling frequency in combination with current of other frequencies is disabled by the response to said first signal, in which the transmission of an impulse of current of said particular frequency constitutes a second signal, and in which the continued transmission of current of said particular frequency constitutes a third signal.

Another feature of the invention is a voice frequency signaling system in which current of a particular signaling frequency is continuously transmitted over a line while idle, in which the termination of the transmission of current of this particular frequency constitutes a seizure or supervisory signal, in which short impulses of current of this particular frequency constitute selective or supervisory signals, and in which the continued transmission of current of said particular frequency constitutes a disconnect or supervisory signal.

Another feature of the invention is a telephone and voice frequency signaling system in which the transmission of voice and signaling current is effected over four conductor lines, one pair of

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conductors being used for transmission in one direction and the other pair of conductors for transmission in the other direction, current of a particular frequency being normally transmitted over each pair as long as the line is idle, the termination of the normally transmitted current constituting a seizure or supervisory signal, the transmission of impulses of current of said particular frequency constituting selective or supervisory signals, and the continued transmission of current of said particular frequency constituting a disconnect or supervisory signal.

Another feature of the invention is a telephone and voice frequency signaling system in which voice current and signaling current of a particular frequency are transmitted over a line, in which the talking circuit over the line is normally closed and signaling current of said particular frequency is transmitted over the line while idle, and in which the talking circuit is opened for a predetermined interval of time each time the transmission over said line of current of said particular frequency is initiated or terminated.

Another feature of the invention is a voice frequency signaling system in which voice current and signaling current of a particular frequency are transmitted over a line, in which the talking circuit over the line is normally closed and signaling current of said particular frequency is transmitted over the line while idle, in which termination of the transmission of current of said particular frequency constitutes a seizure or supervisory signal, in which the transmission of an impulse of current of said particular frequency constitutes a selective or supervisory signal, and in which the continued transmission of current of said particular frequency constitutes a disconnect or supervisory signal, the amplitude of the signaling current transmitted over the line while idle being smaller than the amplitude of the signaling current transmitted as selective, supervisory or disconnect signals.

Another feature of the invention is the control of an amplifier by two networks energized by the output of the amplifier, the voltage across the two networks being rectified and applied to the control grid to effect operation of a signal relay responsive to voice frequency signaling current, to prevent operation of the relay responsive to voice current, and to effect release of the relay responsive to termination of the signaling current.

A complete understanding of the invention will be facilitated by considering a system embodying the invention and its features, 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 system.

Referring to the drawings:

Figs. 1 and 2 represent a first toll office comprising an operator's position OP1, an outgoing trunk circuit OT1, a two-way trunk circuit TWT1, a selector TS1, an incoming trunk circuit IT1, a signal transmitting circuit ST1, and a signal receiving circuit SR1;

Figs. 3 and 4 represent another toll office comprising an operator's position OP2, an outgoing trunk circuit OT2, a two-way trunk circuit TWT2, a selector TS2, an incoming trunk circuit IT2, a signal transmitting circuit ST2 and a signal receiving circuit SR2; and

Fig. 5 shows the relative positions of Figs. 1 to 4 inclusive, 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 manual or dial local offices, from toll subscribers' lines, from community dial offices, or from other toll offices; and for connecting calling intertoll trunks with switching trunks leading to called manual or dial local offices, to called toll subscribers' lines, to trunks to community dial offices, and to intertoll trunks to other toll offices. Outgoing jacks are connected to switching trunks, toll subscribers' lines, trunks to community dial offices and intertoll trunks. Answering jacks are connected to recording trunks, toll subscribers' lines, trunks from community dial offices and intertoll trunks. Intertoll first selectors, and intertoll second selectors, if required, are provided for use on calls incoming over intertoll trunks to establish connections with other toll, local or community dial offices. The operators' positions are provided with dials for use in controlling the operation of intertoll selectors in other toll offices and for controlling the operation of selector and connector switches in local or community dial offices.

Reference may be had to the patent to R. E. King and Ohmer R. Miller No. 2,209,777, granted July 30, 1940, and to the patent to J. G. Walsh No. 2,306,236, granted December 22, 1942, for a complete disclosure of the cord and operator's position circuits provided in each of the two toll offices for interconnecting calling and called lines and trunks and controlling the completion of toll calls. The outgoing trunk circuits OT1 and OT2, incoming trunk circuits IT1 and IT2, two-way trunk circuits TWT1 and TWT2, and the toll route selector circuits TS1 and TS2 are all similar to corresponding circuits of the aforementioned King-Miller and Walsh patents.

The two toll offices shown in the drawings are interconnected by four-wire lines, one being shown in the drawings as consisting of two two-wire lines TL1 and TL2 associated with trunk circuits OT1 and TWT1 in the first toll office and with trunk circuits OT2 and TWT2 in the second toll office. The line TL1 is used to transmit voice and voice frequency signaling current from the first toll office to the second and the line TL2 is used to transmit voice and voice frequency signaling current from the second toll office to the first. A hybrid coil HC1 individual to trunk circuits OT1 and TWT1 is arranged to transmit voice current from these trunk circuits over toll line TL1 to the second toll office and to receive and transmit voice current incoming over toll line TL2 to these trunk circuits. A like hybrid coil HC2 individual to trunk circuits OT2 and TWT2 is arranged to transmit voice current from these trunk circuits over toll line TL2 to the first toll office and to receive and transmit voice current incoming over toll line TL1 to these trunk circuits. Balancing networks BN1 and BN2 are connected to hybrid coils HC1 and HC2 in usual and well-known manner.

The signal transmitter ST1 comprises a generator 230 of alternating current of a particular voice frequency, for instance 3,200 cycles per second, a relay 200 responsive to seizure, selective, supervisory and disconnect signals which are to be transmitted over the toll line TL1, an auxiliary relay 220 and a cut-off relay 210 for disconnecting the toll line TL1 from the hybrid coil HC1 during the transmission of signals outgoing over toll line TL1. The generator 230 is normally connected through resistors 231 and 233, resistors 232 and 234, back contacts of relay 200, conductors 241 and 242 and repeating coil 240 to the conductors of toll line TL1, the continued presence of a tone of 3,200 cycles on the toll line indicating that the line is idle. A one-way amplifier A1, connecting toll line TL2 to the hybrid coil HC1, prevents the transmission of signaling current from signal transmitter ST1 over toll line TL2.

The signal transmitter ST2 associated with toll line TL2 in the second toll office is similar to the signal transmitter ST1, corresponding elements having reference characters with the same tens and units digits. Thus signaling current from generator 330 is normally transmitted over toll line TL2; and the amplifier A2 is effective to prevent the transmission of signaling current from generator 330 over toll line TL1.

The signal receiver SR1 comprises an input transformer 253 which is connected by conductors 251 and 252 to the repeating coil 250 of toll line TL2 in parallel with the input side of amplifier A1 through which voice currents are transmitted to the hybrid coil HC1. The signal receiver SR1 further comprises a thermionic amplifier 260, an output transformer 261, a detector 270, an output transformer 271, two tuned circuits connected in series across the output of transformer 271, a signal relay 290 connected in the plate circuit of tube 270 and an auxiliary relay 285. The amplifier 260 is arranged for negative feedback from the plate circuit through condenser 254 and varistor 255 so as to limit the level of signal applied through transformer 261 to the detector 270. One of the aforementioned tuned circuits consists of an inductance coil 274 connected in parallel with condenser 273 and the other tuned circuit consists of the condenser 277 connected in series with the inductance coil 278. Both of these tuned circuits are tuned to the signaling frequency so that the parallel tuned circuit has a very high impedance at the signaling frequency and a low impedance at other frequencies whereas the series tuned circuit has a low impedance at the signaling frequency and a very high impedance at other frequencies. The detector 270 is biased substantially to cut-off and the alternating component in its output circuit is applied through transformer 271 across the two tuned circuits. The voltage thus developed across the parallel tuned circuit is rectified by rectifier 272 and applied through resistor 276 to the grid of tube 270 to produce a positive reaction. The voltage developed across the series tuned circuit is rectified by rectifier 282 and applied through resistor 280 to the grid of tube 270 to produce a negative reaction. Since the voltage across the parallel resonant circuit is a maximum at signaling frequencies, the plate current of tube 270 is increased by the positive reaction in response to

signaling current to effect the operation of relay 290; and since the voltage across the series resonant circuit is a maximum at frequencies other than the signaling frequency, the negative reaction guards against the operation of relay 290 in case voice or interference current incoming over line TL2 has a component of the signaling frequency. Relay 290 requires about .010 second for operation thereby affording additional protection against false operation in response to a signaling frequency component in speech. When relay 290 operates, it closes a circuit for operating auxiliary relay 285. Relay 285 connects rectifier 282 into the grid circuit of tube 270 in the reverse direction thereby disabling the guard against false release of relay 290. The disabling of the guard is necessary to prevent release of relay 290 on connections routed to an intercept operator, since on such a call the negative reaction might otherwise release relay 290 and cause false charging for the call. Condenser 284 renders relay 285 slow in operating and this condenser is discharged through resistor 286 when relay 285 operates. Relay 290 controls the connection of ground to signaling conductor 170.

The signal receiver SR2 is similar to the signal receiver SR1 in that it responds to the same signals but constitutes an alternative arrangement. Both of the signal receivers connected to lines TL1 and TL2 may be arranged the same as receiver SR1 in Fig. 2 or both may be arranged the same as receiver SR2 in Fig. 3. Signal receiver SR2 comprises an input transformer 353 which is connected by conductors 351 and 352 to the repeating coil 350 of toll line TL1 in parallel with the input side of amplifier A2 through which voice currents are transmitted to the hybrid coil HC2. The signal receiver SR2 further comprises a thermionic volume limiting amplifier 355, an output transformer 359, a thermionic detector 370, a signal relay 374, an auxiliary relay 375, a voltage dividing network and two tuned networks normally connected in series across the output of transformer 359 to control the bias of the grid of detector 370. Resistor 354 included in the grid circuit of amplifier 355 limits the level of signal transmitted through transformer 359; and the varistor 360 connected across one side of this transformer also limits the voltage applied to the voltage dividing network and tuned networks aforementioned. The voltage dividing network comprises rectifier 363, resistor 364, condensers 365 and 366, resistor 367 and rectifier 368. One of the tuned networks consists of condenser 381 and induction coil 382 in parallel and the other consists of condenser 383 and coil 384 connected in series. The voltages developed across the tuned circuits are applied through the voltage dividing network and conductor 369 to the grid of detector 370, which is normally biased by the voltage drop in resistor 372. The rectifiers 363 and 368 are poled so that the grid of tube 370 becomes more positive when signaling current is being received and becomes more negative when current of a frequency other than the signaling frequency is being received over line TL1, the impedance of the parallel tuned circuit being a maximum at the signaling frequency and the impedance of the series tuned circuit being a maximum at other frequencies. Condenser 371 delays a change in the grid bias of tube 370 thereby giving further protection against response to voice current having a signaling frequency component. Resistor 385 connected in parallel with the series tuned circuit limits the voltage developed thereacross.

Condenser 376 delays the operation of relay 375 and resistor 377 discharges condenser 376 when relay 375 operates. Relay 374 controls the connection of ground to signaling conductor 470; and the auxiliary relay 375, when operated, short-circuits the series tuned circuit so that voice or interference current is ineffective to cause the release of relay 374 on calls routed to an intercept operator.

Assume now that the plug AP1 of the cord CD1 at the position OP1 in the first toll office is inserted in an answering jack to answer a call incoming over a recording trunk or an intertoll trunk or a trunk from a community dial office, that the operator has determined the destination of the call and that the plug CP1 of this cord is inserted in a jack associated with an outgoing trunk circuit over which the call may be extended, and that the trunk OT1 is associated with the jack J1 into which the plug CP1 is inserted. The insertion of plug CP1 in jack J1 closes a circuit for operating relay 104, thereby causing the operation of relay 110 as described in the aforementioned King et al. patent, and closes a circuit including conductor 102 for operatively energizing the upper winding of signaling relay 140. The operation of relay 110 disconnects the signaling conductor 170 from conductor 169 thereby to prevent the operation of relay 1003 of two-way trunk circuit TWT1 when ground is connected to signaling conductor 170, connects answering supervisory relay 105 of the trunk circuit OT1 to conductor 170 and connects ground to conductor 168 to operate relay 1004 of two-way trunk circuit TWT1. Relay 1004 locks to conductor 168 independent of relay 1003 and further opens the connection between the winding of relay 1003 and the signaling conductor 170. The operation of relay 140 connects signaling battery to conductor 164 to operate the signal relay 200 of the signal transmitter ST1. The operation of relay 200 of signal transmitter ST1 terminates the transmission of signaling current of 3200 cycles per second from the generator 230 over toll line TL1 thereby causing the release of the normally operated relay 374 of signal receiver SR2. Relay 200 also closes a circuit through its inner lower front contact for operating cut-off relay 210. Relay 210 disconnects the repeating coil 240 of toll line TL1 from conductors 201 and 202 leading to the hybrid coil HC1, connects the repeater termination comprising resistor 213 in series with condenser 214 across the repeating coil 240, connects ground to conductor 168 to hold relay 1004 operated independent of relay 110, and closes a circuit for operating relay 220. Relay 220 locks under the sole control of relay 200, opens the operating circuit of relay 210 and opens a shunt circuit through resistor 235 across the generator 230 thereby to increase the voltage applied to conductors 241 and 242 when relay 200 releases as hereinafter described. The release of relay 210 disconnects the repeater termination and closes the talking connection between coil 240 and hybrid coil HC1.

The termination of the signaling current normally transmitted over toll line TL1 effects the release of relay 374 of signal receiver SR1, thereby connecting ground to signaling conductor 470 to cause the operation of relay 503 of trunk circuit TWT2. The circuit for operating relay 503 is traced from ground at the back contact of relay 374, through conductor 470, lower back contact of relay 410 of trunk circuit OT2, conductor 469, back contact of relay 504 of trunk circuit TWT2,

back contact of relay 507 and the winding of relay 503. Relay 503 connects ground to conductor 468 to guard the outgoing trunk circuit OT2 from being seized on an outgoing call. Relay 503 closes a circuit for operating relay 505, this circuit being traced from ground at the back contact of relay 374, through conductor 470, lower back contact of relay 410 of outgoing trunk circuit OT2, conductor 469, back contact of relay 504 of two-way trunk circuit TWT2, winding of relay 505, uppermost front contact of relay 503, conductor 467, thence in simplex through resistors 421 and 422, back contacts of relay 420 of outgoing trunk circuit OT2, windings of retard coil 460, conductors 461 and 462, inner back contacts of relay 430, conductors 501 and 502, front contacts of relay 503, back contacts of relay 560 of selector TS2, resistors 561, 562 and 563, lowermost back contact of relay 560 and the winding of line relay 557. The line relay 557 of toll selector TS2 is thereby operated and so also is relay 505 of the two-way trunk circuit TWT2. Relay 505 closes a circuit through resistor 506 for holding relay 503 operated and closes a circuit for operating the slow-to-release relay 507. Relay 507 also closes a circuit through resistor 506 for holding relay 503 operated, opens the operating circuit of relay 503 and connects ground to conductor 553 of selector TS2 to hold the selector TS2 and any additional selector through which the connection is extended in the second toll office until the connection is released at the first toll office.

When the calling operator at the first toll office operates the dialing key (not shown) the upper winding of relay 140 is controlled by the impulse contacts of the dial at position OP1. Each release and reoperation of relay 140 in response to the dialing of the first digit of the called number opens and closes the circuit through conductor 164 and the winding of relay 200, causing a corresponding release and reoperation of relay 200. When relay 200 releases responsive to the first impulse of a digit, generator 230 is reconnected through resistors 231, 232, 233 and 234, back contacts of relay 200 and conductors 241 and 242 to the repeating coil 240, whereby an impulse of 3200-cycle current is transmitted over toll line TL1 during the interval that relay 200 is released. This impulse of current is amplified by tube 355 of signal receiver SR2 and effects the operation of relay 374. When relay 200 reoperates at the end of the first impulse, generator 230 is disconnected from conductors 241 and 242 thereby terminating the impulse of current of the signaling frequency to effect the release of relay 374. Each release and reoperation of relay 140 in response to the dialing of the first digit of the called number opens and closes the circuit through conductor 164 to cause a corresponding release and reoperation of relay 200, whereby a series of impulses of current of signaling frequency is transmitted over toll line TL1, each impulse causing the momentary operation of relay 374. Accordingly, relay 374 momentarily disconnects ground from conductor 470 as many times as there are impulses in the series received over toll line TL1, and relay 505 of trunk circuit TWT2 and line relay 557 of selector TS2 are thereby alternately released and reoperated a like number of times. Since relay 507 is slow in releasing, the response of relay 505 to dial impulses is ineffective to cause the release of relay 507. Each release of relay 557 causes the operation of the vertical stepping magnet (not shown) of selector TS2

whereby the brushes 571, 572, 573 and 574 are stepped up to the level corresponding to the digit dialed. At the end of this train of impulses, the brushes are advanced step by step in the selected level until a set of terminals connected to an idle trunk or succeeding selector are encountered; whereupon relay 560 is operated to extend the connection to the selected switch or trunk, all in usual and well-known manner.

Each succeeding train of dial impulses created by operation of the calling operator's dial is repeated by relay 140 to relay 200 and a corresponding train of impulses of voice frequency signaling current is transmitted over toll line TL1 to operate relay 374; and the operation of relay 374 effects the transmission of corresponding trains of impulses, through brushes 571 and 572 and the selected terminals of selector TS2, to operate succeeding switches through which the connection is extended or to operate digit registers. When dialing is completed, the dial key (not shown) is restored to normal and relay 130 is operated in the manner described in the aforementioned King-Miller and Walsh patents to complete the talking connection between cord CD1 and hybrid coil HC1.

Assume that the call in question is one which is routed through selector TS2 and a selected idle incoming trunk circuit to a toll operator's position in the second toll office and that the selected trunk circuit is the trunk circuit IT2 terminating at jack J8. In this case the operation of relay 560 of selector TS2 closes a circuit for operating the line relay 605 of trunk circuit IT2. This circuit is traced from ground at the back contact of relay 374, through conductor 470, lower back contact of relay 410 of outgoing trunk circuit OT2, conductor 469, back contact of relay 504, winding of relay 505, outer upper front contact of relay 503, conductor 467, thence in simplex through resistors 421 and 422, back contacts of relay 420, windings of retard coil 460, conductors 461 and 462, back contacts of relay 430, conductors 501 and 502, front contacts of relays 503 and 560, brushes 571 and 572 of selector TS2, conductors 601 and 602 of trunk circuit IT2, windings of retard coil 600, resistors 615, 616 and 617, and the winding of line relay 605. Relay 505 is operated by the current in this circuit, thereby to hold relay 507 and thus maintain the connection of ground to conductor 553. Relay 605 closes a circuit for lighting lamp L8. When the plug of a cord CD2 at a position OP2 is inserted in jack J8 to answer the call, the lamp L8 is extinguished and a talking connection is completed through condensers 650 and 651. Relay 634 is operated in the manner described in the aforementioned patent to J. G. Walsh and closes a circuit from ground through conductor 604, brush 574 of selector TS2, a front contact of relay 560, and the winding of relay 511 of two-way trunk circuit TWT2. The operation of relay 511 closes a circuit for operating relay 300 of signal transmitter ST2. This circuit is traced from battery through conductor 466, front contact of relay 511, back contact of relay 510, conductor 465, back contact of relay 440, conductor 464 and the winding of relay 300. The operation of relay 300 disconnects generator 330 from conductors 341 and 342 to terminate the transmission of signaling current over toll line TL2 and thereby cause the release of relay 290 of signal receiver SR1. The operation of relay 300 also closes a circuit for operating cut-off relay 310. Relay 310 opens the talking connection between repeating coil 340 and

hybrid coil HC2, connects the repeater termination comprising resistor 313 and condenser 314 across coil 340, connects ground to conductor 468 to maintain a busy indication for trunk circuits OT2 and TWT2 while a signal is being transmitted over line TL2, and closes a circuit for operating relay 320. The operation of relay 320 opens the operating circuit of relay 310 and opens the normally closed shunt circuit through resistor 335 across generator 330, thereby to increase the voltage applied across conductors 341 and 342 when relay 300 releases to transmit a signal, for instance an on-hook or busy signal. The release of relay 310 transfers coil 340 from the repeater termination to coil HC2 and opens the operating circuit of relay 320; and relay 320 is then held operated under the sole control of relay 300.

The release of relay 290 responsive to the termination of signaling current over toll line TL2 causes the release of relay 285 and connects ground to conductor 170, thereby operating supervisory relay 105 of trunk circuit OT2. Relay 105 disconnects ground from the low resistance winding of sleeve relay 104, thereby causing the calling supervisory lamp CS to be extinguished to indicate that the call has been answered in the called toll office. When the answering operator disconnects from jack J8, relay 634 releases and disconnects ground from conductor 604, causing the successive release of relay 511 of trunk circuit TWT2 and relay 300 of signal transmitter ST2. The release of relay 300 reconnects generator 330 to coil 340, thereby transmitting signaling current over line TL2 to cause the reoperation of relay 290 of signal receiver SR1. The operation of relay 290 disconnects ground from conductor 170, releasing relay 105 and thereby causing the lighting of lamp CS to give the calling operator an on-hook signal. The aforementioned release of relay 300 also causes the operation of relay 310 and the release of relay 320. The release of relay 320 causes the release of relay 310 and again closes the shunt circuit through resistor 335 across generator 330, whereby the voltage applied across conductors 341 and 342 is reduced and the signaling current transmitted over line TL2 is reduced to the normal, idle condition.

If a busy condition is encountered in extending the connection, for instance if selector TS2 finds all trunks busy in the selected level, relay 511 of two-way trunk circuit TWT2 is alternately operated and released under the control of an interrupter (not shown) thereby causing the alternate operation and release of relay 300 of signal transmitter ST2. Relay 300 alternately disconnects and reconnects generator 330 to coil 340, whereby signaling current is intermittently transmitted over line TL2 to cause the alternate release and reoperation of relay 290 of signal receiver SR1. The alternate release and reoperation of relay 300 causes the alternate operation and release of supervisory relay 105 of trunk circuit OT1 whereby the supervisory lamp CS of cord CD1 is intermittently extinguished and lighted, thus giving the calling operator a busy signal.

When the calling operator disconnects plug CP1 from jack J1, relay 104 releases; but if relay 105 is operated at this time, relays 110 and 140 are held operated. With relay 105 released, or as soon after the release of relay 104 as relay 105 releases, relays 110 and 140 are also released. The release of relay 140 causes the release of relay 200 whereby generator 230 is reconnected across conductors 241 and 242 thereby to effect the transmission of signaling current over line TL1 to

effect the reoperation of relay 374 of signal receiver SR2. The release of relay 200 also causes the operation of relay 210 and the release of relay 220. The operation of relay 220 causes the release of relay 210 and closes the shunt circuit through resistor 235 across generator 230 whereby the voltage applied to conductors 241 and 242 is reduced to the normal level. The operation of relay 374 disconnects ground from conductor 470 causing the release of relay 505 of trunk circuit TWT2 and line relay 605 of trunk circuit IT2. The continued release of relay 505 causes the release of relays 507 and 503 of trunk circuit TWT2 and the release of relay 560 of selector TS2 whereby selector TS2 is restored to normal in usual and well-known manner. The release of relay 503 also disconnects ground from conductor 468, thereby terminating the busy marking of trunk circuits OT2 and TWT2.

What is claimed is:

1. In a signaling system, a line, a first means normally effective to transmit current of a particular frequency and amplitude over said line, means for terminating the transmission of said current as a first signal, means for transmitting an impulse of current of said particular frequency and of greater amplitude than that normally transmitted as a second signal, and means for transmitting current of said particular frequency for a predetermined interval of time and of said greater amplitude as a third signal.

2. In a signaling system, a line, a first means normally effective to transmit current of a particular frequency and amplitude over said line, means for terminating the transmission of said current as a first signal, means for transmitting an impulse of current of said particular frequency and of greater amplitude than that normally transmitted as a second signal, and means for transmitting current of said particular frequency for a predetermined interval of time and of said greater amplitude as a third signal and for continuing the transmission of current of said particular frequency and normal amplitude.

3. In a signaling system, a line, a first means operated responsive to current of a particular frequency normally transmitted over said line, means normally effective to prevent the operation of said first means responsive to current of frequencies other than said particular frequency or to current of said particular frequency and other frequencies, means operated responsive to the release of said first means upon the termination of current of said particular frequency and effective to disable said preventing means, means responsive to the reoperation of said first means by an impulse of current of said particular frequency, and means responsive to the operation of said first means by current of said particular frequency for more than a predetermined interval of time.

4. In a signaling system, a line, signal transmitting means at one end of said line comprising a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, a trunk circuit comprising talking conductors over which voice current is transmitted, means normally connecting said line to said talking conductors and to said generator, means effective to disconnect said generator from said line as a seizure signal, and signal receiving means at the other end of said line comprising a relay operated by current of said particular frequency, means for preventing the operation of said relay responsive to current other than sig-

naling current transmitted over said line which includes a component of said particular frequency, means rendered effective by the operation of said relay to disable said preventing means, and other means controlled by said relay.

5. In a signaling system comprising a line for transmitting voice current and signaling current of a particular frequency in the voice frequency range, signal receiving means connected to said line, said signal receiving means comprising a relay, means for operating said relay responsive to current of said particular frequency, means responsive to current of frequencies other than said particular frequency for preventing the operation of said relay when voice or interference current which has a component of said particular frequency is transmitted over said line and means rendered effective by the operation of said relay for disabling said preventing means, and signal means controlled by said relay.

6. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltages of a particular frequency for use in transmitting signals over said line, means normally connecting said generator to said one end of said line, signal receiving means connected to the other end of said line comprising a signal relay, means responsive to current of said particular frequency for operating said relay, means responsive to current of frequencies other than said particular frequency for preventing the operation of said relay in response to voice or interfering current which includes a component of said particular frequency, means rendered effective by the operation of said relay to disable said preventing means, and means responsive to seizure of said trunk circuit for momentarily disconnecting said talking conductors from said line and for disconnecting said generator from said line to cause the release of said signal relay.

7. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, means comprising contacts of a signal transmitting relay connecting said generator to said one end of said line, signal receiving means connected to the other end of said line comprising a signal receiving relay, means responsive to current of said particular frequency for operating said signal receiving relay, means responsive to current of frequencies other than said particular frequency for preventing the operation of said relay in response to voice or interfering current which includes a component of said particular frequency, means rendered effective by the operation of said relay to disable said preventing means, means responsive to seizure of said trunk circuit for operating said signal transmitting relay to disconnect said generator from said line thereby to effect the release of said signal receiving relay, means for momentarily releasing said signal transmitting relay to effect the operation and release of said signal receiving relay, means for releasing said signal transmitting relay to effect only the operation of said signal receiving relay, and means controlled by said signal receiving relay.

8. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, means comprising contacts of a signal transmitting relay

connecting said generator to said one end of said line, signal receiving means connected to the other end of said line comprising a signal receiving relay, means responsive to current of said particular frequency for operating said signal receiving relay, means responsive to current of frequencies other than said particular frequency for preventing the operation of said relay in response to voice or interfering current which includes a component of said particular frequency, means rendered effective by the operation of said relay to disable said preventing means, means for operating said signal transmitting relay to disconnect said generator from said line thereby to effect the release of said signal receiving relay, means for momentarily releasing said signal transmitting relay to effect the operation and release of said signal receiving relay, means for releasing said signal transmitting relay to effect only the operation of said signal receiving relay, means rendered effective by each operation and each release of said signal transmitting relay to open the connection between the talking conductors of said trunk circuit and said line, and means controlled by said signal receiving relay.

9. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, means comprising contacts of a signal transmitting relay connecting said generator to said one end of said line, signal receiving means connected to the other end of said line comprising a signal receiving relay, means responsive to current of said particular frequency for operating said signal receiving relay, means responsive to current of frequencies other than said particular frequency for preventing the operation of said relay in response to voice or interfering current which includes a component of said particular frequency, means rendered effective by the operation of said relay to disable said preventing means, switching means, means responsive to seizure of said trunk circuit for operating said signal transmitting relay to disconnect said generator from said line thereby to effect the release of said signal receiving relay to prepare said switching means for operation, means for momentarily releasing said signal transmitting relay to effect the operation and release of said signal receiving relay to selectively operate said switching means, means for releasing said signal transmitting relay to effect only the operation of said signal receiving relay to release said switching means, and means controlled by said signal receiving relay.

10. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, means comprising contacts of a signal transmitting relay connecting said generator to said one end of said line, means for operating said signal transmitting relay to terminate the transmission of current of said particular frequency over said line, means for momentarily releasing said signal transmitting relay to effect the transmission of impulses of current of said particular frequency over said line, means for releasing said signal transmitting relay thereby to continuously transmit current of said particular frequency over said line, and means rendered effective by each operation and each release of said signal transmitting relay to

open the connection between the talking conductors of said trunk circuit and said line.

11. In a signaling system, a line, a trunk circuit comprising talking conductors normally connected to one end of said line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, means comprising contacts of a signal transmitting relay connecting said generator to said one end of said line, means for operating said signal transmitting relay to terminate the transmission of current of said particular frequency over said line, and means rendered effective by the operation of said signal transmitting relay to momentarily open the connection between the talking conductors of said trunk circuit and said line.

12. In a signaling system, a line for transmitting voice current and signaling current of a particular frequency in the voice frequency band and signal receiving means connected to said line, said means comprising a thermionic amplifier, first and second tuned networks coupled to the output of said amplifier, said first network parallel resonant at the signal frequency and said second network series resonant at the signal frequency, means comprising said first network and a unidirectional device for applying a positive bias to the grid of said amplifier responsive to current of the signal frequency incoming over said line, means comprising said second network and a unidirectional device for applying a negative bias to the grid of said amplifier responsive to current of frequencies other than the signal frequency incoming over said line, and a signal relay operatively controlled by said amplifier.

13. In a signaling system, a four-conductor line, one pair of the conductors for transmitting voice and signaling current in one direction and the other pair of conductors for transmitting voice and signaling current in the other direction, a trunk circuit at one end of said line having a pair of talking conductors for transmitting voice current in both directions, means comprising a hybrid coil connecting said talking conductors to both pairs of conductors of said line, signal transmitting means associated with the pair of conductors of said line used to transmit voice current from the talking conductors of said trunk circuit and signal receiving means associated with the pair of conductors of said line used to transmit voice current to the talking conductors of said trunk circuit, said signal transmitting means comprising a generator of alternating voltage of a particular frequency used for signaling, means normally connecting the generator to the pair of conductors used to transmit voice currents from the talking conductors of said trunk circuit and a signal transmitting relay controlling the connection between said generator and pair of conductors, the operation of said signal transmitting relay being effective to terminate the transmission of current of said particular frequency as a signal of a first character, the momentary release of said signal transmitting relay effecting the transmission of an impulse of current of said particular frequency as a signal of a second character, and the continued release of said signal transmitting relay effecting the transmission of current of said particular frequency as a signal of a third character, said signal receiving means comprising a signal receiving relay, means responsive to current of said particular frequency for effecting the operation of said signal receiving relay, means responsive to current of other frequencies for preventing the operation of said signal receiving relay in response to voice or interfering current which has a component of said particular frequency and means rendered effective by the operation of said signal receiving relay to disable said preventing means.

14. In a signaling system, a four-conductor line, one pair of the conductors for transmitting voice and signaling current in one direction and the other pair of conductors for transmitting voice and signaling current in the other direction, current of the same particular frequency being used for transmitting signals in both directions, trunk circuits, one at each end of said line, each of said trunk circuits having a pair of talking conductors for transmitting voice current in both directions, means at each end of said line comprising a hybrid coil connecting the talking conductors of the associated trunk circuit to both pairs of conductors of said line, and signal transmitting means and signal receiving means at each end of said line, the signal transmitting means at each end being associated with the pair of conductors of said line which transmits voice and signaling current to the other end and the signal receiving means at each end being associated with the pair of conductors of said line which receives voice and signaling current from the other end, each of said signal transmitting means comprising a generator of alternating voltage of a particular frequency for use in transmitting signals over the associated pair of conductors, means normally connecting the generator to the associated pair of conductors of said line and a signal transmitting relay controlling the connection between said generator and pair of conductors, the operation of said signal transmitting relay being effective to terminate the transmission of current of said particular frequency as a seizure or supervisory signal, the momentary release of said signal transmitting relay effecting the transmission of an impulse of current of said particular frequency as a selective or supervisory signal, and the continued release of said signal transmitting relay effecting the transmission of current of said particular frequency as a disconnect and idle signal, each of said signal receiving means comprising a signal receiving relay, means responsive to current of said particular frequency for effecting the operation of said signal receiving relay, means responsive to current of other frequencies for preventing the operation of said signal receiving relay in response to voice or interfering current which has a component of said particular frequency and means rendered effective by the operation of said signal receiving relay to disable said preventing means.

15. In a signaling system comprising a line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, a signal relay for controlling the transmission of signals over said line, means including contacts of said relay normally connecting said generator to said line thereby to transmit current of said particular frequency over said line while idle, means for limiting the amplitude of the current transmitted over the line while idle, the operation of said signal relay being effective to terminate the transmission of current of said particular frequency as a seizure signal, each momentary release of said relay being effective to transmit an impulse of current of said particular frequency as a selective or supervisory signal, and the continued release of said relay being effective to initiate the continued

transmission of current of said particular frequency as a disconnect signal, and means for disabling said amplitude limiting means during the transmission of selective, supervisory and disconnect signals.

16. In a signaling system comprising a line, a generator of alternating voltage of a particular frequency for use in transmitting signals over said line, a signal relay controlling the transmission of signals over said line, means including contacts of said relay normally connecting said generator to said line thereby to transmit current of said particular frequency over said line while idle, the operation of said signal relay being effective to terminate the transmission of current of said particular frequency as a seizure or supervisory signal, each momentary release of said relay being effective to transmit an impulse of current of said particular frequency as a selective or supervisory signal and the continued release of said relay being effective to initiate the continued transmission of current of said particular frequency as a disconnect signal, and means effective to increase the amplitude of the current of said particular frequency transmitted as selective, supervisory and disconnect signals as compared with the current normally transmitted over the trunk when idle.

17. In a signaling system, a trunk line, a generator of alternating voltage of a particular signaling frequency used in transmitting signals over said line, means normally connecting said generator to said line thereby to transmit current of said signaling frequency over said line

while idle, means comprising a signal relay controlling the connection of said generator to said line, the operation of said relay being effective to terminate the transmission of signaling current over said line as a seizure or supervisory signal, each momentary release of said relay effecting the transmission of an impulse of signaling current as a selective or supervisory signal, and the continued release of said relay effecting the transmission of signaling current as a disconnect signal, means for limiting the amplitude of the signaling current transmitted over the line while idle, means for increasing the amplitude of the signaling current transmitted as selective, supervisory and disconnect signals and means effective a predetermined interval of time after the release of said relay to reduce the amplitude of the signaling current transmitted as a disconnect signal over said line to that of the signaling current transmitted over said line while idle.

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