

Sept. 13, 1949.

L. A. KILLE ET AL

2,481,932

SUPERVISORY SIGNALING IN TELEPHONE SYSTEMS

Filed Dec. 27, 1946

3 Sheets-Sheet 1

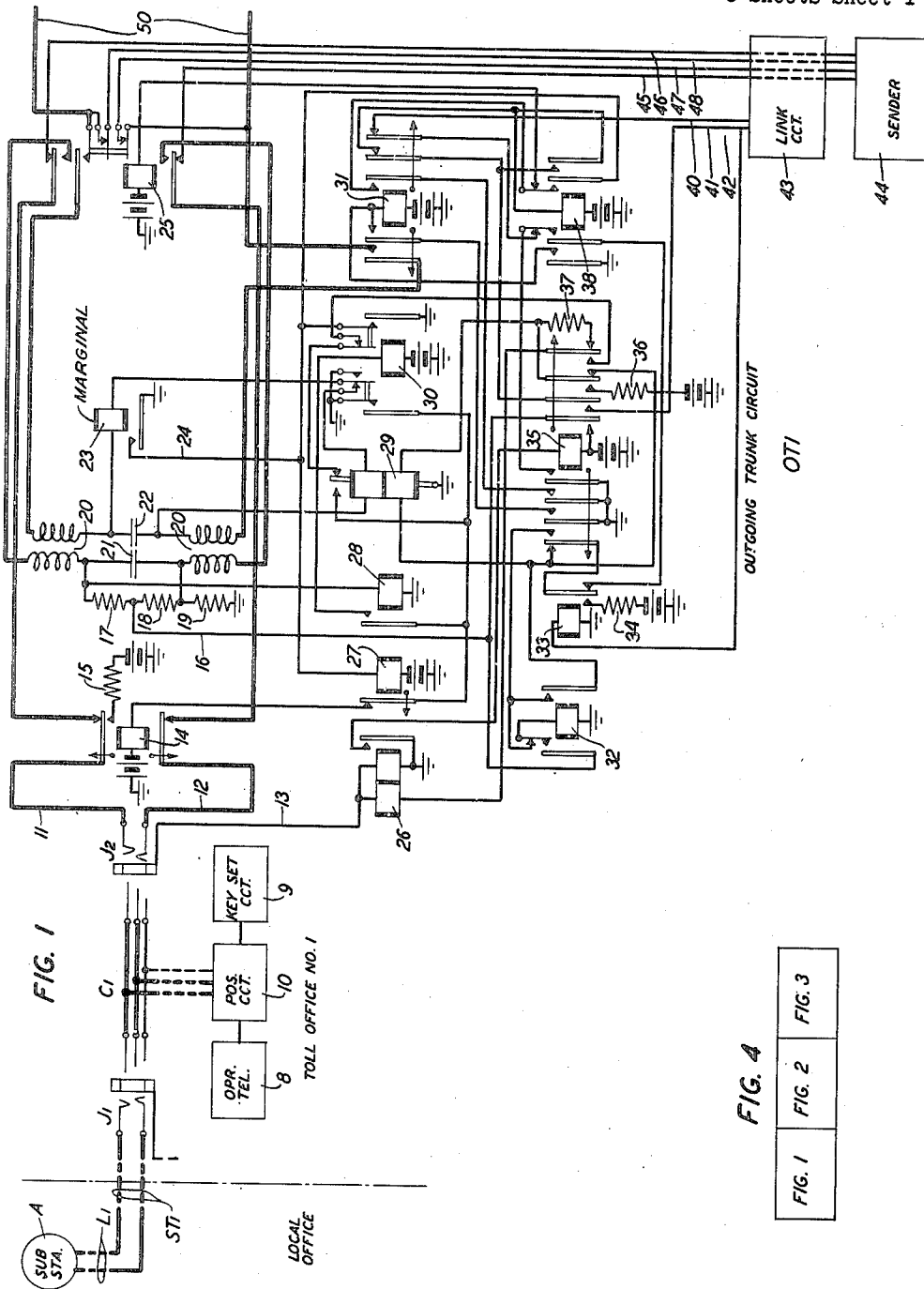


FIG. 4

FIG. 1 FIG. 2 FIG. 3

INVENTORS: L. A. KILLE
T. D. ROBB

BY R. O. Correll
ATTORNEY

Sept. 13, 1949.

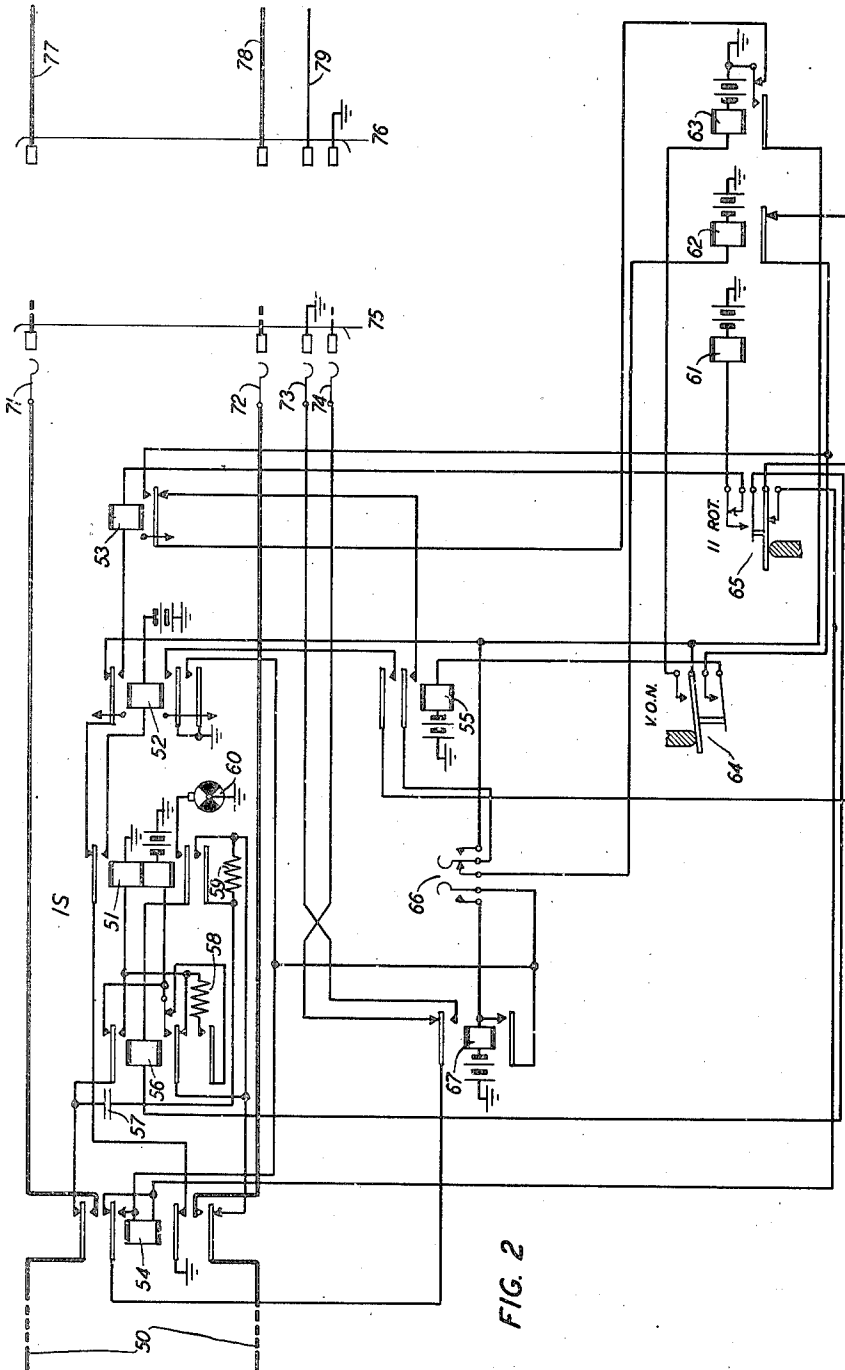
L. A. KILLE ET AL

2,481,932

SUPERVISORY SIGNALING IN TELEPHONE SYSTEMS

Filed Dec. 27, 1946

3 Sheets-Sheet 2



TOLL OFFICE NO. 2

INVENTORS: L. A. KILLE
T. D. ROBB

BY R. O. Covell
ATTORNEY

Sept. 13, 1949.

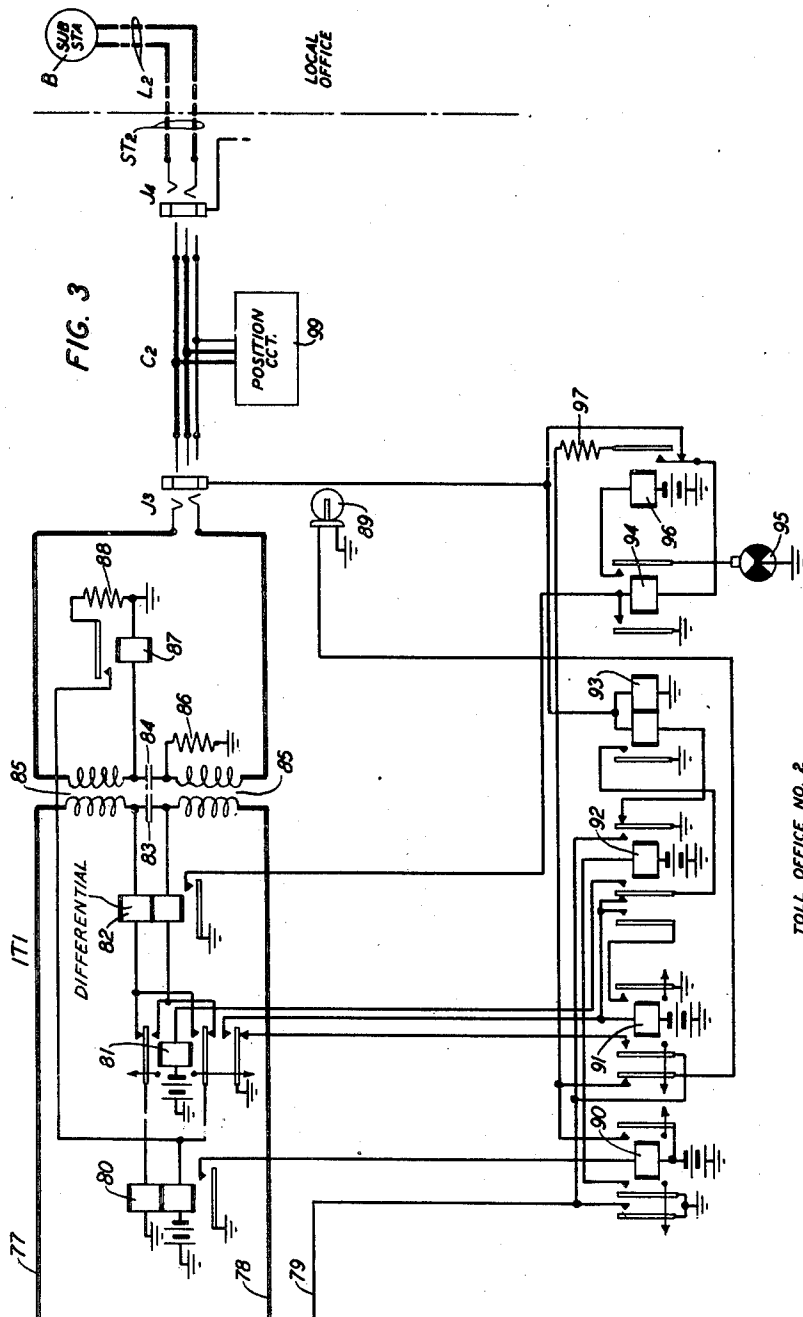
L. A. KILLE ET AL

2,481,932

SUPERVISORY SIGNALING IN TELEPHONE SYSTEMS

Filed Dec. 27, 1946

3 Sheets-Sheet 3



INVENTORS: L. A. KILLE
T. D. ROBB
BY

R. O. Correll

ATTORNEY

UNITED STATES PATENT OFFICE

2,481,932

SUPERVISORY SIGNALING IN TELEPHONE SYSTEMS

Lindley A. Kille, Morristown, and Theodore D. Robb, Ridgewood, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 27, 1946, Serial No. 718,780

3 Claims. (Cl. 179—18)

1

This invention relates to telephone systems and particularly to systems including automatic switches for completing connections between calling and called subscriber and operator stations.

Objects of the invention are the provision of means for facilitating the completion of delayed toll calls in areas in which the toll board is decentralized, the provision of means for giving an inward toll operator access to a plurality of delayed-call operators, and in general the provision of means for decentralizing toll switchboards.

This invention is a telephone system in which an outgoing trunk circuit in one toll office and an incoming trunk circuit at a delayed-call operator position in another toll office are arranged to give the operator in the first toll office answering supervision responsive to the reversal of the current in a loop circuit over the interconnecting intertoll trunk, in which ringing of the delayed-call operator is effected by operation of a differential relay in the incoming trunk circuit responsive to the opening of the loop circuit and connection of ground to a single conductor of the intertoll trunk, and in which ring-back of the operator in the first toll office is effected by the release of a marginal relay in the outgoing trunk circuit responsive to a reduction of the voltage applied to the intertoll trunk in the incoming trunk circuit associated with the delayed-call operator position in the other toll office.

The invention and its features will be further explained by describing in detail a telephone system in which the invention is embodied, such a system being represented schematically in the drawing which forms a part of this specification and consists of three figures.

Referring to the drawing:

Fig. 1 shows a local office and a first toll office, the local office being represented by the subscriber station A, line L1 and a switching trunk ST1. The toll office is represented by a cord C1, jacks J1 and J2, operator telephone set 8, position circuit 10, key-set circuit 9, outgoing trunk circuit OT1, link circuit 43 and sender circuit 44;

Figs. 2 and 3 show a second toll office comprising an incoming selector IS, an incoming trunk circuit IT1 connected to jack J3, a cord circuit C2, a toll operator position circuit 99, and a switching trunk ST2 connected to jack J4. Fig. 3 further shows a local office terminating the switching trunk ST2, a subscriber line L2 and subscriber station B.

The subscriber stations A and B may be of the usual common battery type and the connections between subscriber lines L1 and L2 and switching trunks ST1 and ST2 may be established either by manually operated or dial controlled switching means. Reference may be had to the patent to Carpenter and Hersey 1,780,906, November 11,

2

1930 and to the patent to Henry 1,916,760, July 4, 1933 for disclosure of cord, position and key-set circuits arranged for key pulsing and the associated trunk, link and sender circuits. The switching trunks ST1 and ST2, cord circuits C1 and C2, position circuits 10 and 99 and the associated operator telephone and key-set circuits may be similar to those disclosed in the Carpenter-Hersey and Henry patents. The link circuit 43 and sender circuit 44 are similar to link and sender circuits disclosed in the aforementioned Henry patent. The position circuit 99 in the second toll office includes similar operator's telephone and key-set circuits.

The incoming selector IS comprises a switch of the well-known two-motion, step-by-step type arranged to give access to 16 delayed-call operator positions. A four-conductor terminal bank is provided and the selector has two sleeve brushes, thereby permitting the ten sets of terminals in each level to be divided into two groups of five sets each. To enable the selection of trunks in a desired one of the two groups on a selected level, relay 67 is provided for transferring the trunk testing circuit from one sleeve brush to the other. In one group, the terminals which are engageable by the normally connected one of the sleeve brushes are grounded; and in the other group the terminals which are engageable by the other sleeve brush are grounded. A set of level springs 66 are provided for operation on particular levels. If the brushes are stepped up to the fifth level, only the right contacts of springs 66 are actuated to effect the release of the brushes to normal; and if the brushes are stepped up to the tenth level, all of the contacts of springs 66 are actuated to effect the return of the brushes to normal and also to effect the operation of brush switching relay 67. When operated, relay 67 locks and causes the brushes to be restored to normal. While only two-digit numbers are required for selecting any desired one of these operators, the controlling sender in the first toll office may be arranged to transmit a larger number of digits for instance 4. The delayed-call operator's trunk groups will, in such a case be numbered NNNX and NNOX where N is a particular digit, for instance 5, O is the digit used for operating relay 67, and X is any digit other than 5 or O. Thus, the levels corresponding to these particular two digits, O and 5, cannot be used for giving access to delayed-call operators and only eight levels of the switch are available for trunks to different delayed-call operators, two groups of trunks per level.

Assume now that the subscriber at station B initiates a toll call to station A and that at the time the call is initiated it is not possible for the call to be completed immediately, either because the called station is busy or because the call is

3

not answered. In such a case, the calling subscriber is requested to replace the receiver and the call is referred to a delayed-call operator in the calling toll office, and the number of this delayed-coil operator is given to the toll operator in the called toll office.

As soon as the toll operator in the called toll office is successful in extending a connection, through a cord C1 and a switching trunk ST1, to the called subscriber station and the call is answered thereat, the calling plug of cord C1 is inserted in jack J2 of an outgoing trunk circuit OT1 associated with an idle trunk to toll office No. 2. A circuit is closed from battery (not shown) in the position circuit 10, through the sleeve conductors of the calling plug and jack J2, conductor 13, and the high resistance right winding of relay 26, to ground. Relay 26 operates, closing a circuit for operating relay 35. The operation of relay 35 connects ground through its inner left front contact, continuity back contact of relay 38 and the outer right back contact of relay 31 to start conductor 40 leading to the link circuit 43, thereby causing the link to hunt for and connect with the trunk circuit OT1 and causing the link to hunt for and connect with an idle sender circuit 44. The operation of relay 35 closes a connection from battery through the winding of relay 38, inner right back contact of relay 31, and front contact of relay 35, to conductor 41 leading to the link circuit 43; and closes a connection from ground through the normally closed contact of relay 29, a back contact of relay 30, the outer right front contact of relay 35 and the left winding of relay 26 to conductor 13. The left winding of relay 26 is a low-resistance winding so that the current through conductor 13 is increased sufficiently to cause the operation of a marginal relay in the position circuit 10 and the lighting of a supervisory lamp (not shown) associated with the calling plug of cord C1. When the link circuit 43 connects with the trunk circuit OT1, ground (not shown) in the link circuit, is connected to conductor 41 to operate relay 38 in the trunk circuit. The operation of relay 38 disconnects ground from the start conductor 40; and relay 38 locks through its outer right front contact to the operating ground independent of relay 31. The operation of relay 38 also closes a circuit for operating relay 31. The operation of relay 31 closes a locking circuit through its inner left front contact, to ground at a front contact of relay 35. Relay 31 opens the operating circuit for relay 38; prepares a circuit for operating relay 25 when relay 38 releases; connects the lower conductor of trunk 50, to the lower left winding of repeating coil 20; and closes a circuit for operating relay 27, this circuit being traced from the winding of relay 27 through the inner right front contact of relay 38, inner right front contact of relay 31, to ground at a front contact of relay 35. When the link circuit 43 finds and connects with an idle sender 44, battery is connected through a 10,000-ohm resistance (not shown) to conductor 42, operating relay 33 of the outgoing trunk circuit. The operation of relay 33 closes a circuit from battery through resistor 34, front contact of relay 33, front contact of relay 35; and through the continuity back contact and winding of relay 32 to ground. Relay 32 is thereby operated, closing a locking circuit from ground through its winding and front contact of its continuity spring through the inner right front contact of relay 35 to battery. With an idle sender 44 connected through link 43 to

4

conductors 45, 46, 47 and 48, a signal is transmitted from sender 44, through conductors 45 and 46, back contacts of relay 25 of outgoing trunk circuit OT1, back contacts of relay 14, conductors 11 and 12, through the tip and ring conductors of jack J2 and plug of cord C1 to the key-set circuit 9, thereby to effect the lighting of a sender lamp in the key circuit as an indication that the keying of the delayed-call operator's number may be started. At the same time a loop connection is closed in the sender through conductors 47 and 48 and back contacts of relay 25, conductors of trunk 50, back contacts of relays 54 and 56 of selector IS in toll office No. 2 and the windings of line relay 51 of this selector. Relay 51 operates, closing a circuit for operating slow-to-release relay 52. The further operation of selector IS occurs when a train of impulses is received over trunk 50 as hereinafter described.

If an abnormal condition occurs in the sender 44 while the link and sender are attached to the trunk circuit OT1, ground is intermittently connected to conductor 42 in place of a battery through 10,000 ohms resistance. Each connection of ground to conductor 42 causes the release of relay 33, thereby closing a circuit for operating relay 29, this circuit being traced from ground through the inner left front contact of relay 35, inner left front contact of relay 38, back contact of relay 33, outer left front contact of relay 35, right front contact of relay 32, lower winding of relay 29, a front contact of relay 35, and through resistor 36 to battery. Each time that relay 29 operates, ground is disconnected from the left-hand winding of relay 26, thereby increasing the resistance in the circuit through conductor 13 and the sleeve conductor of cord C1 to extinguish the calling cord supervisory lamp. This lamp is thus flashed until the cord is disconnected from jack J2; whereupon relays 26, 35, 38, 31 and 32 release, restoring the outgoing trunk circuit to normal.

Assume that the operator completes the keying of the delayed-call operator's number and that the start key in the key circuit is depressed to effect the transmission of a start signal to the sender in the manner described in the aforementioned Henry patent, to indicate that keying has been completed. The sender now transmits the digits registered therein, which digits are the digits of the number of the delayed-call operator in toll office No. 2 having the ticket of the delayed call from station B to station A. These impulses are transmitted through the link circuit 43 and conductors 47 and 48, back contacts of relay 25, over the conductors of trunk 50 to operate incoming selector IS as hereinafter described. When all of the digits have been transmitted, the sender is released and the link returns to normal, in the manner described in the aforementioned Henry patent, thereby disconnecting ground from conductor 41 to release relay 38 in the outgoing trunk circuit. The release of relay 33 completes a circuit, for operating relay 25, from the winding of relay 25 through the continuity back contact of relay 38, right inner front contact of relay 31 to ground at a front contact of relay 35. The release of relay 38 also opens the operating circuit of relay 27. The operation of relay 25 opens the connection between cord C1 and sender 44; connects the left windings of repeating coil 20 through its outer front contacts, back contacts of relay 14; and conductors 11 and 12, to the talking conductors of cord C1; disconnects the conductors 47 and 48

5

from the conductors of trunk 50 and closes a supervisory bridge across the conductors of trunk 50. This bridge is traced from the lower conductor of trunk 50, outer left front contact of relay 31, lower right winding of repeating coil 29, upper winding of polarized supervisory relay 29, a back contact of relay 30, winding of marginal supervisory relay 23, upper right winding of repeating coil 20 and through a front contact of relay 25 to the upper conductor of trunk 50.

Returning now to the transmission of the trains of impulses corresponding to the four digits of the delayed-call operator's number, each impulse is transmitted from the sender by opening the loop across the conductors of trunk 50. The line relay 51 of the incoming selector releases responsive to each impulse, but relay 52 is slow to release and remains operated during the receipt of digit impulses. Each release of relay 51 closes a circuit from ground through the inner lower back contact of relay 54, upper back contact of relay 51, upper front contact of relay 52, winding of relay 53, upper normally closed contact of the eleventh-rotary-step springs 65, through the winding of vertical stepping magnet 61 to battery. Stepping magnet 61 and relay 53 are thereby energized, the operation of stepping magnet 61 being effective to step the brushes 71, 72, 73 and 74 up to the first level of the bank. Each time that relay 51 releases and reoperates, the circuit through the winding of vertical stepping magnet 61 and relay 53 is closed and opened, thereby causing the operation and release of stepping magnet 61. Being slow to release, relay 53 remains operated until relay 51 reoperates at the end of each train of impulses. The brushes of selector IS are thus stepped up to the level corresponding to the first train of impulses transmitted by the sender 44. The vertical off-normal springs 64 are actuated as soon as the shaft of the switch moves out of normal position closing a circuit from battery through the winding of relay 55, lower contact of springs 64, front contact of relay 53, to ground at the back contact of the release magnet 63. Relay 55 is thereby operated; and it locks independent of relay 53, the locking circuit being traced from the winding of relay 55 through the lower contact of springs 64, back contact of rotary stepping magnet 62, outer front contact of relay 55, to ground at the inner lower front contact of relay 52. Since the first two digits of the delayed-call operator's number are to be absorbed, the brushes are advanced to the fifth level responsive to each of these digits thereby actuating only the right-hand contacts of level springs 66. When relay 53 releases at the end of each of these digits, a circuit is closed from battery through the winding of release magnet 63, upper front contact of vertical off-normal springs 64, right front contact of level springs 66, inner front contact of relay 55, back contact of relay 53, to ground at the continuity back contact of release magnet 63. The operation of release magnet 63 causes the return of the shaft and brushes to normal position. The release magnet locks under control of springs 64. When the switch shaft reaches normal, springs 64 return to normal and the release magnet 63 is deenergized. If the third digit transmitted over trunk 50 from the sender 44 is the digit 5, this digit is absorbed in like manner. If the third digit received over trunk 50 from sender 44 is the digit 0, the actuation of the left contacts of level springs 66 closes a circuit for operating relay 67; and relay 67 locks to ground at the lower front contact of relay 52.

6

With relay 67 operated, the test circuit of the selector is transferred from test brush 74 to test brush 73. As soon as relay 53 releases at the end of the train of impulses, release magnet 63 is operated thereby causing the brushes to be again restored to normal. When the fourth digit is transmitted by the sender over the conductors of trunk 50, relay 51 controls the operation of stepping magnet 61 to advance the brushes of the selector to the particular level in which trunk hunting is to take place. When relay 53 releases at the end of the fourth train of impulses incoming to selector IS, a circuit is closed from battery through the winding of rotary stepping magnet 62, back contact of the level spring 66, inner front contact of relay 55, back contact of relay 53 to ground at the continuity back contact of release magnet 63. The operation of the rotary stepping magnet advances the brushes into engagement with the first set of terminals in the selected level and opens the locking circuit of relay 55 causing the release of this relay. The release of relay 55 causes the release of the rotary stepping magnet 62, thereby closing the busy testing circuit which includes brush 74 if relay 67 is not operated and includes brush 73 if relay 67 is operated. If the first set of terminals is in the desired trunk group but the associated trunk is busy or if this set of terminals is not connected to a trunk in the desired group, the terminal engaged by the connected one of test brushes 73 and 74 will encounter ground potential, and this ground is connected through the test brush and contact of relay 67, through the inner upper back contact of relay 54, lower normally closed contact of the eleventh-rotary-step springs 65, back contact of the rotary stepping magnet 62, lower contact of the vertical-off-normal springs 64, and through the winding of relay 55 to battery. Relay 55 is reoperated in this circuit thereby reclosing the circuit for operating the rotary stepping magnet 62. The reoperation of stepping magnet 62 opens the operating circuit of relay 55 and steps the brushes of the switch to the next set of terminals. When the connected one of test brushes 73 and 74, encounters a test terminal which is not connected to ground, relay 54 is operatively energized in a circuit traced from battery through the winding of relay 55, lower contact of vertical-off-normal springs 64, back contact of rotary stepping magnet 62, lower contact of the eleventh-rotary-step springs 65, winding of relay 54, to ground at a front contact of relay 52. Being marginal, relay 55 does not operate in series with relay 54, so that no further stepping of the switch occurs. Relay 54 closes a connection from ground through the lower front contact of relay 52, inner upper front contact of relay 54, contact of relay 67 and test brush 73 or 74, to the test terminal of the trunk thereby guarding the trunk against seizure of any other hunting selector. The operation of relay 54 disconnects the conductors of trunk 50 from the windings of relay 51 and extends these conductors through brushes 71 and 72 to the tip and ring conductors of the trunk which is connected to the selected set of terminals. The release of relay 51 causes the release of relay 52. Relay 54 is held operated, after relay 52 releases, by ground supplied over the sleeve conductor of the selected trunk circuit, as hereinafter described.

Assume now that the selected terminals in the bank of switch IS are connected to the trunk IT1, shown in Fig. 3. When relay 54 operates, a circuit is closed for operating relay 80 of the incoming trunk circuit IT1 and relay 23 of the outgoing

trunk circuit OT1. This circuit is traced from battery through the lower winding of relay 80, a back contact of relay 81, lower winding of relay 82, lower left winding of repeating coil 85, conductor 78, brush 72, a front contact of relay 54, lower conductor of trunk 50, a front contact of relay 31, lower right winding of repeating coil 29, upper winding of polarized supervisory relay 29, a back contact of relay 30, winding of marginal supervisory relay 23, upper right winding of repeating coil 29, a front contact of relay 25, upper conductor of trunk 50, upper front contact of relay 54, brush 71, conductor 77, upper left winding of repeating coil 85, upper winding of relay 82, a back contact of relay 81, and through the upper winding of relay 80 to ground. Relay 82 does not operate at this time since its windings are differentially energized and relay 29 does not operate because the current through its upper winding is in the non-operate direction. The operation of relay 80 closes a circuit for operating the slow-to-release relay 90 and the operation of relay 23 closes a circuit for operating relay 27. Relay 90 connects ground to conductor 79 to maintain the energization of relay 54 of the incoming selector IS, closes a circuit for operating relay 92, and closes a circuit for lighting the answering lamp 89 associated with jack J3. The operation of relay 92 connects ground to conductor 79, and disconnects ground from the low resistance left-hand winding of relay 93. Relay 90 is slow-to-release in order to maintain the operation of relay 54 of the incoming selector in case relay 80 is momentarily released due to a ringing key operation or some other disturbance over the trunk.

When the called delayed-call operator inserts a plug of a cord C2 in jack J3 to answer the call, battery in the position circuit 99 is connected through the sleeve conductor of the plug and jack to operatively energize the right winding of relay 93. The operation of relay 93 closes a circuit for operating relay 81. The operation of relay 81 closes a circuit for operating relay 91 and interchanges the connections between the windings of relay 80 and conductors 77 and 78, thereby reversing the current over trunk 50 to cause the operation of relay 29 of outgoing trunk circuit OT1. Relay 23 releases momentarily when the current over trunk 50 is reversed but not long enough to release relay 27. The operation of relay 29 disconnects ground from the low resistance winding of relay 26, thereby to effect the extinguishing of the cord supervisory lamp in usual and well-known manner. Relay 91 of the incoming trunk circuit locks under control of relay 92, and opens the circuit for lighting lamp 89. The delayed-call operator is now informed that the toll operator in toll office No. 1 has a connection established with the called station A. The delayed-call operator thereupon extends a connection over switching trunk ST2, through the local office and line L2 to the calling station B.

If the operator in toll office No. 1 wishes to signal the delayed-call operator after the delayed-call operator has restored the talking key of cord C2 to normal, the ringing key of cord C1 is operated thereby connecting battery of a high enough voltage to the tip conductor of the calling plug to effect the operation of relay 28 of outgoing trunk circuit OT1. The operation of relay 28 closes a circuit, including the front contact of relay 29, for operating relay 30. Relay 30 locks under control of relay 28 but independent of relay 29, closes a circuit for holding relay 27 operated

to prevent false ring-back, opens the connection between the left winding of relay 26 and the back contact of relay 29 to prevent false supervision to the toll operator in toll office No. 1, opens the supervisory bridge across trunk 50 and connects ground to and through the winding of relay 23, upper right winding of repeating coil 29, front contact of relay 25, upper conductor of trunk 50, a front contact of relay 54 of selector IS, brush 71, conductor 77, upper left winding of repeating coil 85 of incoming trunk circuit IT1 in toll office No. 2, upper winding of relay 82, inner lower front contact of relay 81 and through the lower winding of relay 80 to battery. Relay 23 of trunk circuit OT1 may or may not remain operated in this circuit, relay 80 of incoming trunk circuit IT1 is held operated by its lower winding and relay 82 is operated by the energization of its upper winding alone. The operation of relay 82 closes a connection from ground through its front contact, winding of relay 94, continuity back contact of relay 95, and sleeve conductor of jack J3 and cord C2 to battery in the cord circuit, thereby effecting the operation of relay 94. The resistance of the winding of relay 94 is approximately the same as that of the low resistance winding of relay 93 so as to cause the lighting of the supervisory lamp associated with the plug connected to jack J3. When the ringing key of cord C1 is released relays 28 and 30 release and so also does relay 82; but relay 94 is locked independent of relay 82 and connects the winding of relay 95 to interrupter 95. Relay 96 is alternately operated and released under the control of interrupter 95 to intermittently open the operating circuit of relay 94 through the sleeve conductor. Each time relay 96 operates, the cord supervisory lamp is extinguished but relay 94 is held operated in a circuit from ground through its own left front contact and winding, front contact of relay 96, resistor 97, and right front contact of relay 99 to battery. The cord supervisory lamp is thus flashed to recall the delayed-call operator. When the talking key of cord C2 is again operated, the resistance in the sleeve conductor circuit is increased to cause the release of relay 94; and the release of relay 94 disconnects the winding of relay 96 from the interrupter.

If the delayed-call operator wishes to signal the inward toll operator in toll office No. 1, operation of the ringing key of cord C2 connects battery of high enough voltage to the tip conductor of the cord to cause the operation of relay 87. With relay 87 operated ground is connected through resistor 88 and the front contact of relay 87 to the lower winding of relay 80 thereby holding relay 80 operated; and this ground is further connected through the inner lower front contact of relay 81 to the upper winding of relay 82, whereby the voltage applied through this winding to the loop circuit over trunk 50 is reduced and the current thereover is insufficient to maintain the operation of marginal supervisory relay 23 of outgoing trunk circuit OT1. Relay 29 remains operated since the current is maintained in the operate direction. The release of relay 23 causes the release of relay 27 thereby closing a circuit from ground through the left contact of relay 29, back contact of relay 27 and winding of relay 14. Relay 14 is operated connecting battery through resistor 15 and conductor 11 to the tip conductor of cord C1. If the connection with station A includes another toll office, this battery operates a relay in the intertoll trunk circuit associated with the other end of cord C1 to effect

the transmission of a ring-back signal to the toll operator in the other toll office. When the delayed-call operator in toll office No. 2 releases the ringing key of cord C2, relay 87 of incoming trunk circuit IT1 releases, relay 23 of outgoing trunk circuit OT1 reoperates, and relays 27 and 14 release thereby terminating the transmission of the ring-back signal.

When the delayed-call operator disconnects cord C2 from jack J3, relay 93 releases. Relays 80, 90, 91 and 92 remain operated until trunk 50 is released in toll office No. 1. The release of relay 93 while relay 92 is operated causes the release of relay 81 thereby reversing the current over trunk 50 to cause the release of relay 29 of outgoing trunk circuit OT1. The release of relay 29 connects ground to the low resistance winding of relay 26 to light the cord supervisory lamp. When the inward toll operator in toll office No. 1 disconnects cord C1 from jack J2, relay 26 releases causing the release of relays 35, 31 and 25. The release of relays 31 and 25 opens the supervisory bridge across trunk 50 causing the release of relay 80 of incoming trunk circuit IT1. The release of relay 80 causes the release of relays 90, 92 and 91. If the cord C2 has not yet been disconnected from jack J3 when relay 92 releases, the cord supervisory lamp is lighted as a disconnect signal. With cords C1 and C2 both disconnected from jacks J2 and J3, trunk circuits OT1 and IT1 are restored to normal. The aforementioned release of relays 90 and 92 of trunk circuit IT1 disconnects ground from conductor 79 thereby causing the release of relay 54 of selector IS. The release of relay 54 closes the circuit for operating release magnet 63 and the shaft and brushes of selector IS are thus restored to normal.

What is claimed is:

1. In a telephone system, an outgoing trunk circuit, an incoming trunk circuit, means comprising a two-conductor trunk interconnecting said circuits, a loop signaling circuit including in series a battery one pole of which is connected to ground, both windings of a line relay and both windings of a differential relay in said incoming trunk circuit, the conductors of said trunk and the windings of marginal and polarized relays in said outgoing trunk circuit, said marginal and line relays only being operatively energized in said loop circuit, means in said incoming trunk circuit for reversing the current in said loop signaling circuit to effect the operation of said polarized relay, means in said outgoing trunk circuit for opening the loop signaling circuit and connecting ground potential to one conductor of said trunk to effect the operation of said differential relay and to hold operated said line relay in said incoming trunk circuit, and means in said incoming trunk circuit for decreasing the voltage applied through one winding of the line relay and one winding of the differential relay to effect the release of the marginal relay in said outgoing trunk circuit without releasing the polarized relay therein.

2. In a telephone system, an outgoing trunk circuit, an incoming trunk circuit, means including a two-conductor trunk for interconnecting said trunk circuits, a marginal relay and a polarized relay in said outgoing trunk circuit, a line relay and a differential relay in said incoming trunk circuit, each of said relays having two windings, a battery one pole of which is connected to ground, means bridging said battery and both windings of said line and differential

relays across the conductors of said trunk, means in said outgoing trunk for connecting the windings of said marginal and polarized relays in series across the conductors of said trunk thereby to effect the operation of only the marginal relay in said outgoing trunk circuit and only the line relay in said incoming trunk circuit, means in said incoming trunk circuit for interchanging the connections between the windings of the line relay and the windings of the differential relay to reverse the current through the conductors of said trunk and thereby effect the operation of the polarized relay in said outgoing trunk circuit, means in said outgoing trunk circuit for opening the series connection through said marginal and polarized relays and for connecting ground potential through the winding of said marginal relay to a single conductor of said trunk to effect the operation of the differential relay in said incoming trunk circuit without releasing said line relay, and means in said incoming trunk circuit for decreasing the current through the conductors of said trunk and the windings of said marginal and polarized relays in said incoming trunk circuit to cause the release of said marginal relay.

3. In a telephone system, an outgoing trunk circuit, an incoming trunk circuit, means including a two-conductor trunk for interconnecting said trunk circuits, a marginal relay and a polarized relay in said outgoing trunk circuit, a line relay and a differential relay in said incoming trunk circuit, each of said relays having two windings, a battery one pole of which is connected to ground, means bridging said battery and both windings of said line and differential relays across the conductors of said trunk, means in said outgoing trunk for connecting the windings of said marginal and polarized relays in series across the conductors of said trunk thereby to effect the operation of only the marginal relay in said outgoing trunk circuit and only the line relay in said incoming trunk circuit, means in said incoming trunk circuit for interchanging the connections between the windings of the line relay and the windings of the differential relay to reverse the current through the conductors of said trunk and thereby effect the operation of the polarized relay in said outgoing trunk circuit, means in said outgoing trunk circuit for opening the series connection through said marginal and polarized relays and for connecting ground potential through the winding of said marginal relay to a single conductor of said trunk to effect the operation of the differential relay in said incoming trunk circuit without releasing said line relay, and means in said incoming trunk circuit for shunting the loop through the conductors of said trunk and the windings of the marginal and polarized relays in said incoming trunk circuit thereby to cause the release of the marginal relay without releasing the polarized relay.

LINDLEY A. KILLE.
THEODORE D. ROBB.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,990,437	Moody	Feb. 5, 1935
2,298,751	Crocker	Oct. 13, 1942