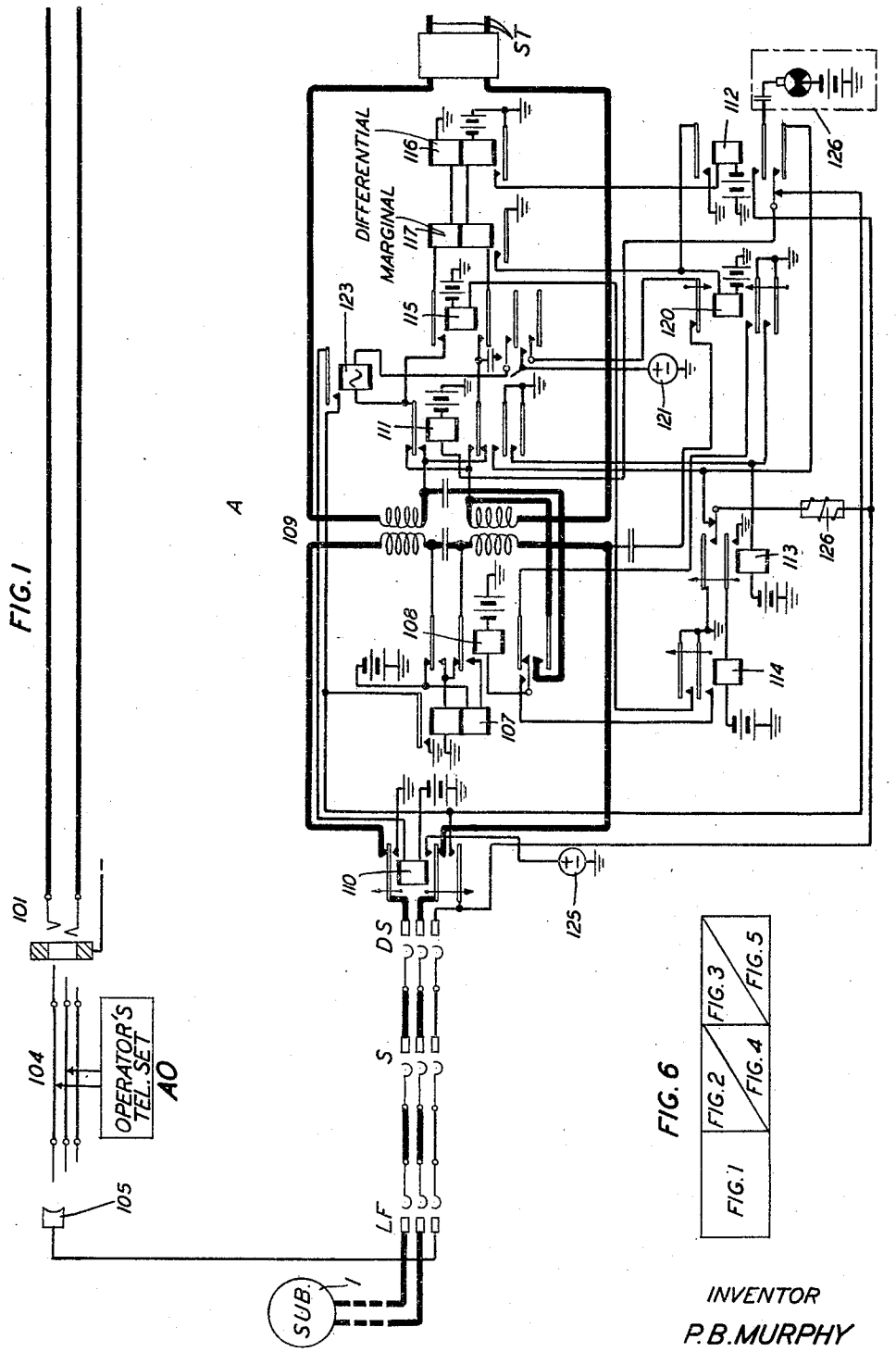
March 14, 1933. P. B. MURPHY 1,901,403

TELEPHONE SYSTEM

Original Filed Dec. 6, 1930 4 Sheets-Sheet 1



INVENTOR
P. B. MURPHY
BY
ATTORNEY

March 14, 1933. P. B. MURPHY 1,901,403

TELEPHONE SYSTEM

Original Filed Dec. 6, 1930 4 Sheets-Sheet 2

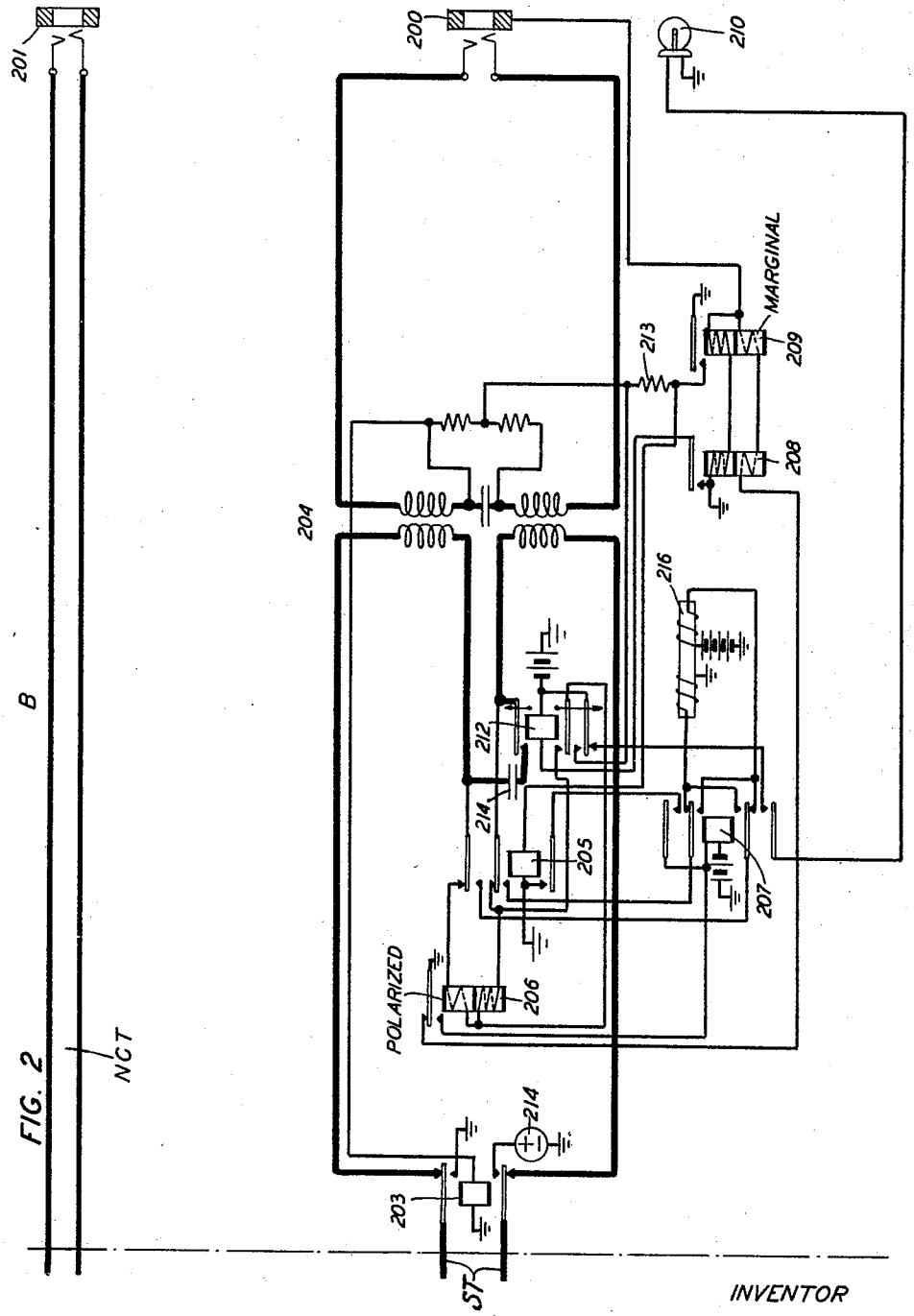


FIG. 2

INVENTOR
P.B.MURPHY
BY M.A.McKenney
ATTORNEY

March 14, 1933. P. B. MURPHY 1,901,403

TELEPHONE SYSTEM

Original Filed Dec. 6, 1930 4 Sheets-Sheet 3

FIG. 3

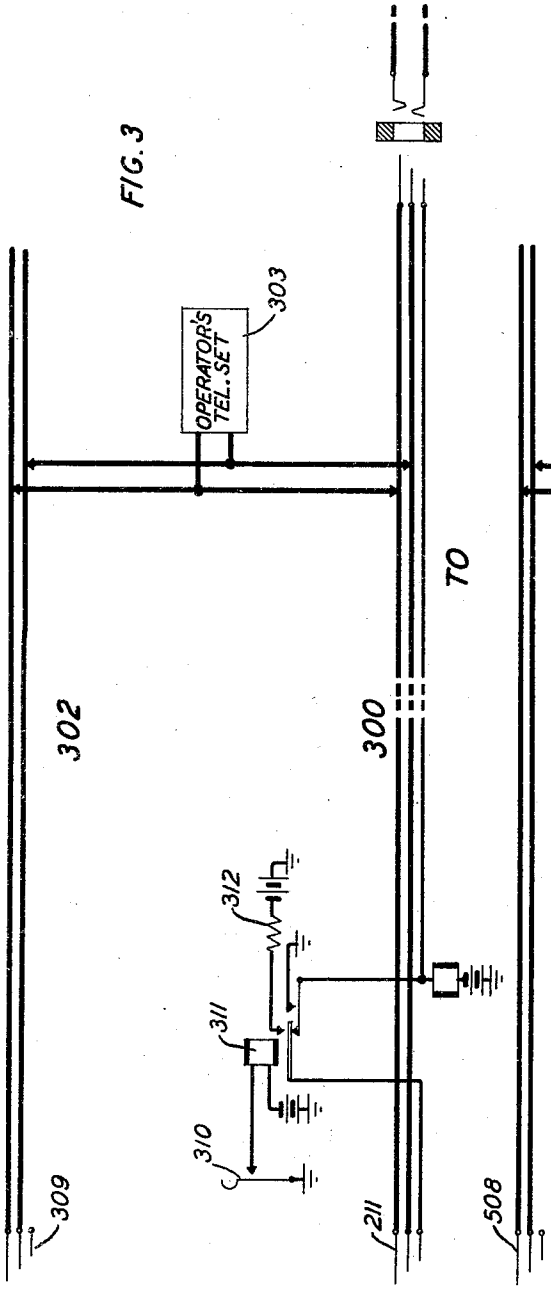
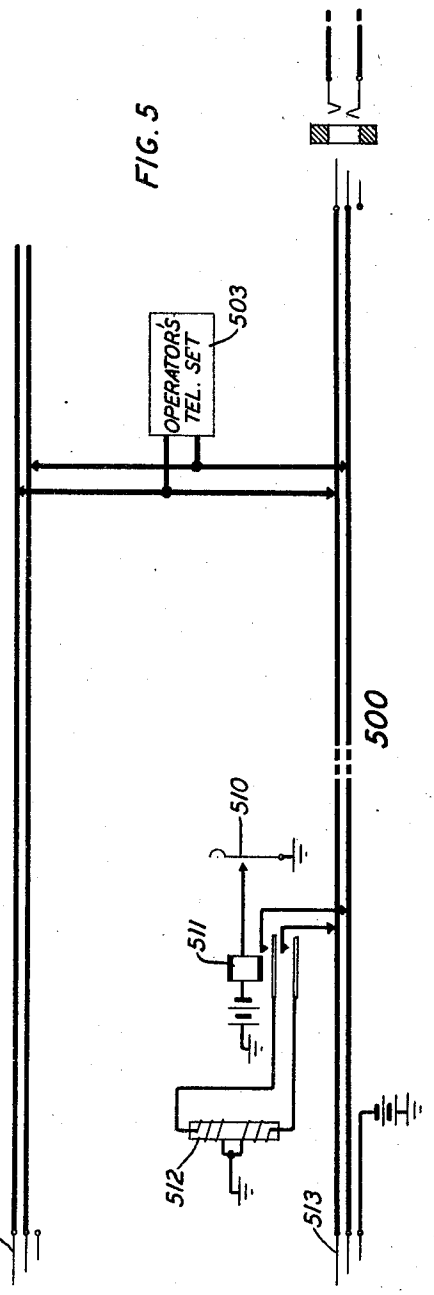


FIG. 5



INVENTOR
P B MURPHY

BY W. M. McKenney
ATTORNEY

March 14, 1933. P. B. MURPHY 1,901,403

TELEPHONE SYSTEM

Original Filed Dec. 6, 1930 4 Sheets-Sheet 4

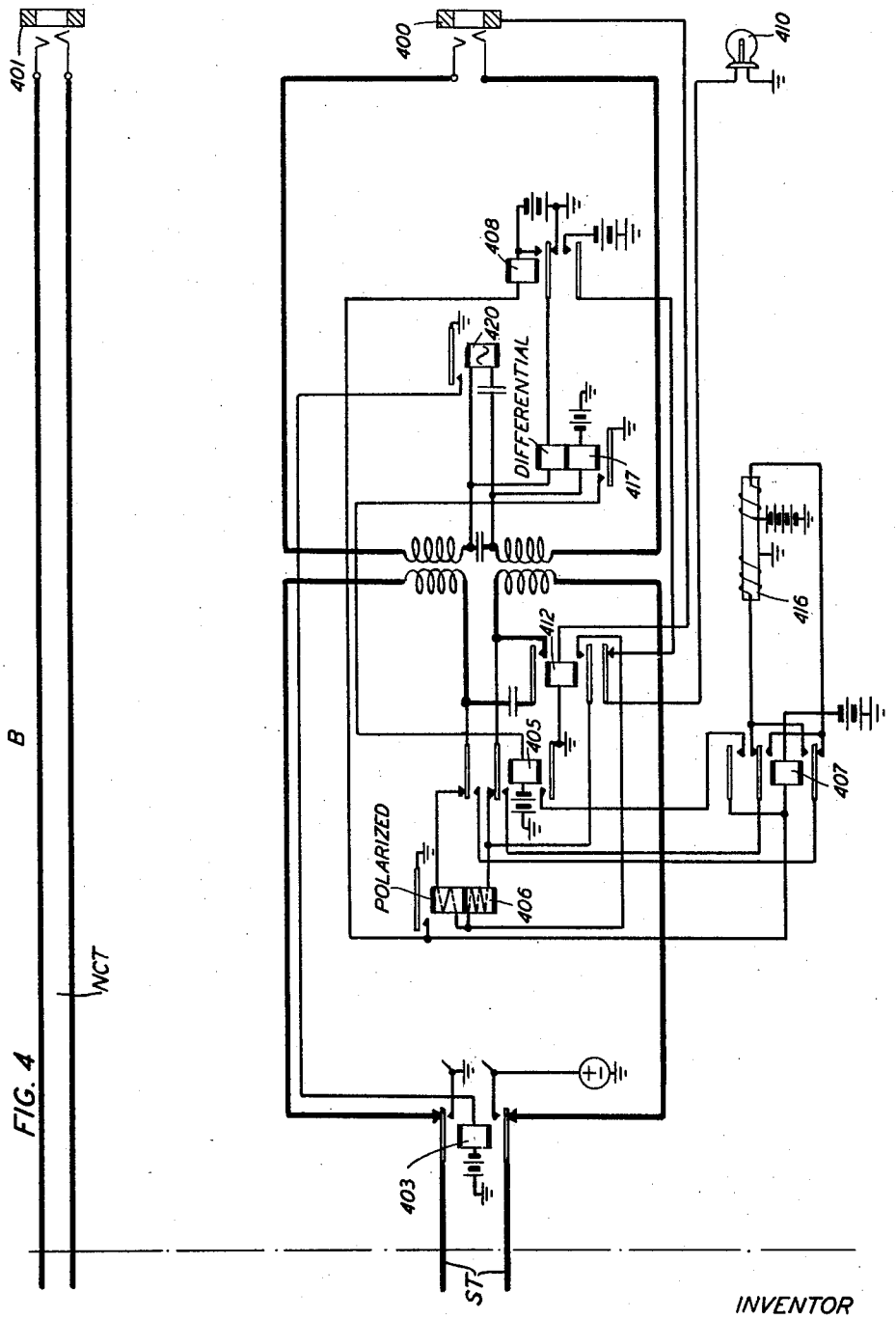


FIG. 4

INVENTOR
P.B. MURPHY
BY M.B. McKenney
ATTORNEY

Patented Mar. 14, 1933 1,901,403

UNITED STATES PATENT OFFICE

PAUL B. MURPHY, OF NYACK, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

Application filed December 6, 1930, Serial No. 500,517. Renewed April 15, 1932.

This invention relates to telephone systems and particularly to means for checking calling subscribers' numbers and the object of the invention is to simplify and improve the checking of numbers when applied to automatic systems.

Heretofore systems have been proposed in which an operator at one office may check the number given by a calling subscriber at another office who has established automatically a connection to said operator over a trunk between said offices by establishing a separate connection to the calling subscriber's line and causing the application of an alternating current signal through the automatic connection for detection by this operator if the calling subscriber gave the correct number. A system of this character has been disclosed in the copending application of R. L. Quass, Serial No. 500,492, filed on the same date with this application. In the Quass system this alternating current signal is applied from means in the second connection.

A feature of the present invention is an arrangement in systems of this kind whereby the operator at the second office causes the alternating current signal to be applied to the automatic connection by transmission of a direct current signal over the trunk line of the automatic connection from the second office to the first office and by having this direct current signal, when received at the first office, translated into the alternating current signal for transmission over a portion of the automatic connection at the first office. A specific feature of this arrangement for applying the alternating current signal is the means for applying the direct current signal over the trunk when this trunk is of the type in which the usual supervisory signaling is done in one direction by reversal of battery and ground connections over the tip and ring conductors and in the other direction by the reduction of resistance of this battery and ground connection over the tip and ring conductors. This direct current signal may be applied regardless of whether or not the battery and ground connections have been reversed. A differentially wound relay is provided at the first office for the application of the alternating current signal. This relay is provided with two windings connected in a series opposing direction from battery to ground through the tip and ring conductors to prevent said relay from operating in said circuit regardless of the current reversals, and a circuit arrangement is provided whereby regardless of the current reversals a connection is made at the first office from a battery of a higher voltage than the normal battery in opposition to said normal battery to cause the direct current signal therefrom to operate said relay to apply the alternating current signal.

This invention has been illustrated in the accompanying drawings in which

Figs. 1 to 5 may be arranged as shown in Fig. 6;

Figs. 1, 2 and 3 show a complete system for number checking; while

Figs. 4 and 5 taken in connection with Fig. 1 show a modified number checking system.

Referring now to Figs. 1, 2 and 3 a subscriber 1 at office A may extend an automatic connection to a toll operator's position TO at office B over a line finder LF, a selector S and a district selector DS and a trunk ST. The circuits at the call-originating end of trunk ST have been shown in Fig. 1 in detail to illustrate certain features of the invention and the circuits for this trunk at the toll office B have also been shown in detail in Fig. 2 to illustrate other features of the invention. Trunk ST terminates in jack 200 at the toll operator's position TO and a toll cord 300 which has been shown in diagrammatic form. This cord may be used for answering calls incoming over trunk ST to jack 200 and for the extension of this call to a subscriber over jack 301 to a desired line. A number checking cord 302 has also been shown in Fig. 3 in diagrammatic form. This cord may be used for checking a calling subscriber's number over the number checking trunk NCT that terminates at the toll office B in jack 201. This number checking trunk NCT termi-

nates at the call originating office A and at an A operator's position AO in jack 101. An A operator's cord 104 has been shown in diagrammatic form and this cord may be used by the A operator for checking the calling subscriber's number over the checking terminal 105 which is connected to the sleeve conductor of the calling subscriber's line. The circuit details of the number checking cord 302 and trunk NCT and the A operator's cord have not been shown as these details do not appear to be necessary for the clear understanding of the present invention and in fact any well-known means may be employed for communication between the toll operator and the A operator in regard to number checking. The modified form of the invention as shown in Figs. 4 and 5 shows a modification of the circuits of trunk ST at the terminating end in the toll office B and a modification of the means at the toll operator's position for causing the number checking signal to be effected.

A description will now be made using Figs. 1, 2 and 3 of a connection established by the subscriber at 1 to the toll operator at TO and the establishing of another connection from the toll operator TO to the A operator AO for the checking of the calling subscriber's number.

After the calling subscriber at 1 has established a connection over line finder LF, selector S and district selector DS to trunk ST of any well-known automatic system, a circuit is established for the operation of relay 107 as follows: battery, upper outer armature and back contact of relay 108, repeating coil 109, upper armature and back contact of relay 110 over the tip conductor through a loop connection in the district selector DS, back over the ring conductor, lower inner armature and back contact of relay 110, repeating coil 109, upper inner armature and back contact of relay 108, upper winding of relay 107 to ground. Relay 107 in operating closes a circuit for the operation of relay 111 from battery, winding of relay 111, make-before-break contacts of relay 112, armature and front contact of relay 107 to ground. Relay 111 in operating partially prepares a supervisory signaling circuit over trunk ST. It also establishes a connection to ground over its lower middle armature and front contact, make-before-break contacts of relay 113, coil 126, to the sleeve conductor of the district selector to maintain it busy. An obvious circuit is also prepared for the operation of relay 113. This relay, in operating, supplies another connection to ground for the sleeve conductor to maintain it busy and to prevent the connection from releasing. Relay 113 closes an obvious circuit for the operation of relay 114 and this relay in turn closes an obvious circuit for the operation of relay 115. This relay closes a ringing induction connection from the ringing source 121 to the calling subscriber's line. This relay also extends a connection from battery and ground through windings of relays 116 and 117, armatures of relays 115 and 111, repeating coil 109, trunk ST, armatures and back contacts of relay 203, repeating coil 204, armatures and back contacts of relay 205 through a loop over the windings of relay 206. Relay 116 does not operate in this circuit as it is differentially wound and provided for number checking purposes as will be hereinafter described. Neither does relay 117 operate in this circuit due to the high resistance of the lower winding of relay 206 and the marginal characteristics of relay 117. Relay 206, however, operates and closes a circuit for the operation of relay 207. Ground is disconnected from the low resistance windings of relays 208 and 209 by the operation of relay 206 and the purpose of this will be described in a connection recalling the toll operator from the subscriber's station. The operation of relay 207 closes an obvious circuit for the operation of the line lamp 210 associated with jack 200.

The toll operator at TO answers this signal by inserting the answering plug 211 of cord 300 into jack 200. The immediate effect of this connection will be the operation of relays 208 and 209 from a battery supplied over the sleeve of cord 300 to the upper windings of these relays to ground. Relay 208, in operating, closes an obvious circuit for the operation of relay 212. Relay 212, in operating, opens the circuit for the line lamp 210 at its lower outer armature and back contact. Relay 212 also completes a circuit for the winding of relay 205 and resistance 213 to battery at the lower outer armature and front contact of relay 212. The operation of relay 205 is, however, prevented due to the ground shunt connection at the armature and front contact of relay 209. The tip and ring conductors of the trunk ST are now connected through the condenser 214 at the upper armature and front contact of relay 212 to provide a talking circuit. Relay 212 also shunts at its lower inner armature and front contact the lower high resistance winding of relay 206. Relay 206, however, remains operated. At the call-originating end of trunk ST, the marginal relay 117 now operates due to the shunting of the high resistance winding of relay 206. Relay 117 in operating closes an obvious circuit for the operation of relay 120. Relay 120, in operating, opens the ringing induction connection from the ringing source 121 to the calling subscriber's line at its upper armature and back contact. Relay 120 also closes an obvious circuit for relay 113 to hold this relay operated to

maintain the connection to the calling subscriber's line under control of the toll operator. Relay 120 also closes an obvious circuit for the operation of relay 108. This relay provides a locking circuit for itself under control of relay 114 and reverses the battery and ground connections over the tip and ring conductor to the district selector DS to cut through by means in the district selector (not shown), the tip and ring connection from the calling subscriber's line to the relay 107. It will be noted that the talking connection from the calling subscriber's line now extends through both windings of relay 107 and that relay 108 has closed at its lower outer armature and front contact the talking connection through the outgoing coil of the repeating coil 109. The circuits are now in condition for conversation between the subscriber at 1 and the toll operator at TO.

If the calling subscriber decides to recall the toll operator at TO he will operate the switchhook in the usual manner. This causes the alternate operation and release of relay 107. Relay 111 being under control of relay 107 will follow these operations and cause the battery and ground connections over trunk ST to be alternately reversed. This causes the alternate release and operation of relay 206. Relay 206, in turn, will alternately connect and disconnect the ground from the lower windings of relays 208 and 209. This will have the effect of alternately lowering the resistance in the sleeve circuit for cord 300 and thereby cause in any well-known manner the flashing of a supervisory lamp in this cord to notify the operator at TO that the calling subscriber desires further attention.

If the toll operator at TO desires to recall the calling subscriber she will operate the usual ringing key in cord 300 (not shown) and thereby cause the ringing relay 203 to be operated and apply ringing current from source 214 over the tip and ring conductors of trunk ST to actuate the ringing responsive relay 123. Ringing relay 123 will operate relay 110 over an obvious circuit, the ground connection for which is supplied through the armature and front contact of relay 107. Relay 110, in operating, provides a locking circuit for itself under control of relay 114 independent of relay 107 and supplies ringing current to the calling subscriber's line from source 125 and the ground return at the upper armature and front contact of relay 110. It will be noted that on the operation of relay 110 relay 107 will release but relay 111 will now be maintained operated under control of relay 114 over a circuit through the lower outer armature and front contact of relay 110. When the operator at TO discontinues the ringing relay 203 will release to cause the release of relays 123 and 110. Relay 110 in releasing again closes a circuit for the operation of relay 107.

After the calling subscriber has instructed the toll operator at TO to extend a connection to a desired subscriber's line and this connection has been made and conversation completed the calling subscriber may disconnect by replacing his receiver on the hook. This causes the release of relay 107 which in turn causes the release of relay 111. Relay 111, in releasing, releases relay 206 to continuously light the supervisory lamp in the cord 300 as a disconnect signal. The operator at TO will now disconnect by removing plug 211 from jack 200 thereby causing the release of relays 208 and 209. Relay 208, in releasing, causes the release of relay 212 and this relay in turn removes the short circuit from the lower high resistance winding of relay 206 thereby causing the release of relay 117 which, in turn, causes the release of relay 120. Relay 120, in releasing, opens the circuit for relay 113 which, in releasing, releases relay 114. The release of these relays opens the connection to ground for the sleeve circuit to the district selector and causes the release of this selector and the preceding switches in the connection to the calling subscriber. Relay 114 releases relays 108 and 115 and the circuits shown in these figures are thereby returned to normal condition. If the toll operator at TO should disconnect before the calling subscriber, relays 208, 209 and 212 will release and thereby cause the lighting of the line lamp 210.

The operation of these circuits while checking the calling subscriber's number will now be described. The toll operator will first, by operating her talking key in cord 300, (not shown) connect her telephone set 303 through cord 300 to the calling subscriber's line and secure the number of this subscriber for the purpose of checking it as well as for the securing of the information for extending the connection of the desired subscriber's line. When the operator has received the number of the calling subscriber, she will actuate a talking key (not shown) in the number checking cord 302. The operation of this key, connects the telephone operator's set 303 with plug 309 for number checking. The toll operator will now insert plug 309 into jack 201 of a number checking trunk NCT and operate key 310. The operation of this key causes the operation of relay 311. Relay 311 in operating its armature opens the sleeve circuit for the cord 300 and establishes a connection from a battery through this armature and its front contact to the sleeve of cord 300 leading through plug 211 to trunk ST and also at the make-before-break contacts controlled by this armature closes a circuit to ground for the sleeve circuit to a relay to keep the telephone circuit connected to the toll cord 300. It

will be noted that the circuit from battery for the sleeve circuit to the trunk ST passes through a resistance 312. During the operation of relay 311, the sleeve circuit to the trunk was momentarily interrupted which caused the release of relays 208 and 209 momentarily. When the above-mentioned circuit through resistance 312 is closed, relay 208 will again operate, while relay 209 which is marginal will remain released due to the high resistance 312, in the sleeve circuit. During the momentary release of relay 208, the circuit for relay 212 was opened but this relay is slow in releasing so that it will remain operated during this period. As relay 209 is now released the circuit hereinbefore mentioned for relay 205 through resistance 213 causes the operation of this relay. Relay 205, in operating, disconnects the relay 206 from the trunk ST and thereby causes it to release. If relay 207 is operated at this time, it will be held operated by the operation of relay 205 through a locking circuit provided at the lower armature and front contact to ground of relay 205. Under these circumstances when relay 205 operates, high voltage battery and ground will be supplied to the line as follows: from battery and ground through the windings of retardation coil 216, armatures and front contacts of relay 207, armatures and front contacts of relay 205, transformer 204, armatures and back contact of relay 203, tip and ring conductors of trunk ST. The high voltage battery will be connected in this case over the ring conductor of trunk ST to the battery through a winding of relay 116 to ground, while ground at 216 will be connected to the tip conductor to ground at relay 116. If relay 207 had not been operated at this time, the high voltage battery would have been connected over the tip conductor and in this case the relay 111 would not have been operated so the connection would have been made to the same battery at relay 116. This arrangement is for the purpose of insuring the operation of relay 116 regardless of whether supervision is being carried on during this time or not. That is, regardless how the tip and ring conductors are connected for supervisory signaling as hereinbefore described the battery at 216 will always be switched to oppose the battery at 116 when number checking signaling takes place. In either case, therefore, relay 116 will be operated as it is differentially wound and the high voltage battery causes current to flow through a winding of relay 116 in the opposite direction to that ordinarily flowing from the low voltage battery. Relay 116, in operating, closes an obvious circuit for the operation of relay 112 and this relay in operating provides a holding circuit for relay 120 if it has been operated by relay 117 during supervision. If relay 117 was not operated, relay 120 will now be operated by relay 112 to maintain the circuit connections established regardless of whether relays 117 and 111 are operated or released during the number checking period. Relay 112, in operating, provides a connection from an alternating current source 126 to the sleeve of the connection to the calling subscriber and the extension sleeve of the calling subscriber to number checking terminal 105.

While this number checking signal is being transmitted, the toll operator will inform the A operator at position AO of the number of the calling subscriber. The number checking trunk may be any well-known communicating circuit in which the insertion of plug 309 into jack 201 causes the operator at AO to be called and when this operator answers the call by inserting the answering plug of cord 104 into jack 101 a talking connection is established between the two operators. The A operator will then receive the number of the subscriber whose number has to be checked. She will then touch the checking terminal 105 which is marked with the number of the calling subscriber with the tip of the calling plug of cord 104. This terminal may be mounted on the A operator's board for number checking purposes in connection with similar terminals of other lines that may be checked in this manner by the operator. If an alternating current signal is detected on the sleeve connection from source 126 the A operator will know that the number given by the calling subscriber was correct. The A operator will then communicate with the toll operator and inform her that the number given by the calling subscriber was the correct number. If, however, the A operator does not receive an alternating current signal on terminal 105 she will know that the calling subscriber gave the wrong number as the terminal 105 would in that case be associated with another subscriber's sleeve. In this case the A operator will inform the toll operator that the calling subscriber has given a wrong number.

Referring now to the modifications as shown in Figs. 4 and 5 the operation of these circuits are the same as the circuits shown in Figs. 2 and 3 with a few exceptions in regard to the passing of supervisory signals over the connection established between the toll operator and the calling subscriber and in regard to the passing of the alternating current signal to the calling subscriber's sleeve.

In signaling from the calling subscriber's line over trunk ST relay 406 operates through both windings being included in the tip and ring connection. Relay 407 is then operated over an obvious circuit to prepare the circuits for number checking. Re-

lay 406, in operating, also closes an obvious circuit for the operation of relay 408. This relay, in operating, closes a circuit for the operation of the line lamp 410 to signal the toll operator. The toll operator inserts the plug 513 into jack 400 and connects her telephone set 503 to cord 500 for conversation with the calling subscriber and to receive his number. After receiving his number, the operator proceeds to number check by operating a key (not shown) to cause the telephone set 503 to be connected to plug 508 for number checking. When cord 500 was connected to jack 400 relay 412 was operated from battery over the sleeve of the cord to extinguish lamp 410, to establish a talking circuit and to short circuit the high resistance winding of relay 406. This causes the operation of the relay 117, Fig. 1, and the operation of the circuit in Fig. 1 is the same as hereinbefore described in connection with Figs. 2 and 3.

If the calling subscriber desires to recall the toll operator at TO, he will proceed as hereinbefore described to cause the alternate operation and release of relay 406 which, in turn, causes the alternate operation and release of relay 408. Battery and ground are thereby alternately connected to the tip conductor to flash the supervisory lamp in the cord 500. Relay 417 is not operated during supervision regardless of whether relay 408 is operated or not as it is differentially wound.

If the toll operator wishes to recall the calling subscriber, she causes alternating current to be applied from the cord 500 to operate the alternating current responsive relay 420 and thereby cause the operation of relay 403 to apply ringing current over the trunk ST and thereby call the calling subscriber in the same manner as hereinbefore described in connection with Fig. 1.

The toll operator, in number checking, inserts plug 508 into jack 401 and operates a key (not shown) to connect her telephone set 503 with trunk NCT. She then notifies the A operator that number checking is desired and operates key 510. The operation of this key causes the operation of relay 511. Relay 511, in operating applies a ground connection through a retardation coil 512 to the tip and ring conductors of the cord 500. This is the essential difference from the signaling caused by the operation of relay 311, Fig. 3. This ground connection on the two conductors causes the operation of relay 417 regardless of whether relay 408 is operated or not. If ground is connected to the upper winding of relay 417 when number checking, this winding is shunted and thereby permits current through the lower winding to cause the operation of this relay, while if battery is connected when number checking, the current in both windings aid each other to cause the operation of this relay. Thus number checking operations are not interfered with by supervisory signaling. Relay 417, in operating, closes a circuit for the operation of relay 405 to apply battery and ground through the retardation coil 416 and contacts of relays 407 and 405 to the distant end of the trunk ST to cause the operation of relay 116. In this case, it depends upon the operation of relay 407 whether battery or ground should be connected in one way or another to the tip and ring conductors. Relay 116 applies the alternating current signal to the sleeve conductor of the calling subscriber as hereinbefore described. When the number checking has been completed and lamp 516 has been lighted steadily or flashed depending upon whether the subscriber gave the right number or not, the toll operator removes plug 508 from jack 401 and proceeds with the setting up of the connection.

While this invention has only been described in connection with two systems it should be understood that it can readily be applied to other systems without departing from the spirit thereof and that the present disclosures are merely illustrative of the invention.

What is claimed is:

1. In a telephone system, a first office, a second office, a subscriber's line at the first office, an operator's position at the second office, means for establishing a connection from the subscriber's line to the operator's position, means for establishing a second connection from the operator's position to the subscriber's line, means for transmitting a direct current signal from the operator's position toward the subscriber's line, and means for translating said direct current signal into an alternating current signal for transmission over said connections.

2. In a telephone system, a first office, a second office, a subscriber's line at the first office, an operator's position at the second office, means for establishing a connection from the subscriber's line to the operator's position, said connection including a sleeve conductor for that portion thereof that is located at the first office, means for establishing a second connection from the operator's position to the subscriber's line, means for transmitting a direct current signal from the operator's position over the first connection toward the first office, means for translating said direct current signal into an alternating current signal, and means for transmitting said alternating current signal over the sleeve conductor of said first connection to the second connection.

3. In a telephone system, a first office, a second office, a subscriber's line at the first office, an operator's position at the second

office, a trunk between said offices, means for establishing a connection from the subscriber's line over said trunk to said operator's position, means for establishing a second connection from the operator's position to the subscriber's line, a direct current source associated with said trunk while engaged in said first connection, means for signaling in either direction over said trunk while engaged in said first connection through reversal of the direct current from said source and changes in the resistance of said trunk, means for transmitting from said operator's position a direct current signal over said trunk of a higher voltage than the direct current from the source associated with said trunk regardless of the direction of said direct current from said source, means including a relay at the first office responsive to the high voltage direct current signal, and means responsive to the operation of said relay for transmitting an alternating current signal over said connections at the first office.

4. In a signaling system, a line, a source of current for said line, means for signaling in either direction over said line with the current reversed from the normal direction of said current on said line, another source of current of a higher voltage than the normal current on said line, and means for signaling in one direction over said line with said increased current regardless of whether the direction of the normal current has been reversed or not.

5. In a signaling system, a line, a source of current for said line, a series connection over the tip and ring conductors of said line from said source to ground, means for signaling over said line in one direction by reversing the current flow through said conductors from said source, means for signaling over said line in the opposite direction by reversing the current from said source, and reducing the resistance of said connection, a relay in said connection, means for preventing the operation of said relay regardless of the direction of the current from said source in said connection, a source of current of a higher voltage than the current from the first mentioned source on said line, means for actuating said relay on the connection of said second source of current to said line regardless of the direction of the original current from the first mentioned source through said connection.

6. In a signaling system, two offices, a line between said offices having a sleeve conductor at one office, a source of current at one office for said line, means for signaling in either direction over the tip and ring conductors of said line with the current reversed from the normal direction of said current on the said line, a polarized relay in said line at one office, means for maintaining said relay in non-operated condition regardless of the direction of the current on said line, means including a source of current of a higher voltage than the normal source of current at the other office for actuating said relay regardless of the direction of the normal current on said line, a source of alternating current, and means responsive to the actuation of said relay for connecting said source of alternating current to said sleeve conductor for the transmission of a signal from said source over said sleeve conductor.

7. In a signaling system, a line, means for signaling in either direction over said line in response to a current impulse, and means for signaling in one direction of said line in response to a current impulse of higher voltage.

8. In a signaling system, a line, means for signaling in one direction over said line in response to a current impulse of a certain voltage, means for signaling in the opposite direction over said line in response to a current impulse of the same voltage and reduced resistance of the line, and means for signaling in one direction over the line in response to a current impulse of another voltage.

9. In a signaling system, a line, means for signaling in either direction over said line in response to a current impulse, and means for signaling in one direction over said line in response to a current impulse of a higher voltage regardless of the presence at the time when this last mentioned signaling is initiated of either of the other signals on the line.

10. In a signaling system, a line, means for signaling in either direction over said line in response to a current impulse, and means for disabling said signaling in either direction for signaling in one direction over said line in response to another current impulse.

11. In a signaling system, a line, a source of current normally connected to said line, means for signaling in one direction over said line in response to an impulse from said current source of a certain polarity, means for signaling in the opposite direction over said line in response to a current impulse from said source of said certain polarity and to the reduction of the resistance in said line, another current source normally disconnected from said line, and means for signaling in one direction over said line in response to the connection of said second mentioned current source to said line.

In witness whereof, I hereunto subscribe my name, this 1st day of December, 1930.

PAUL B. MURPHY.