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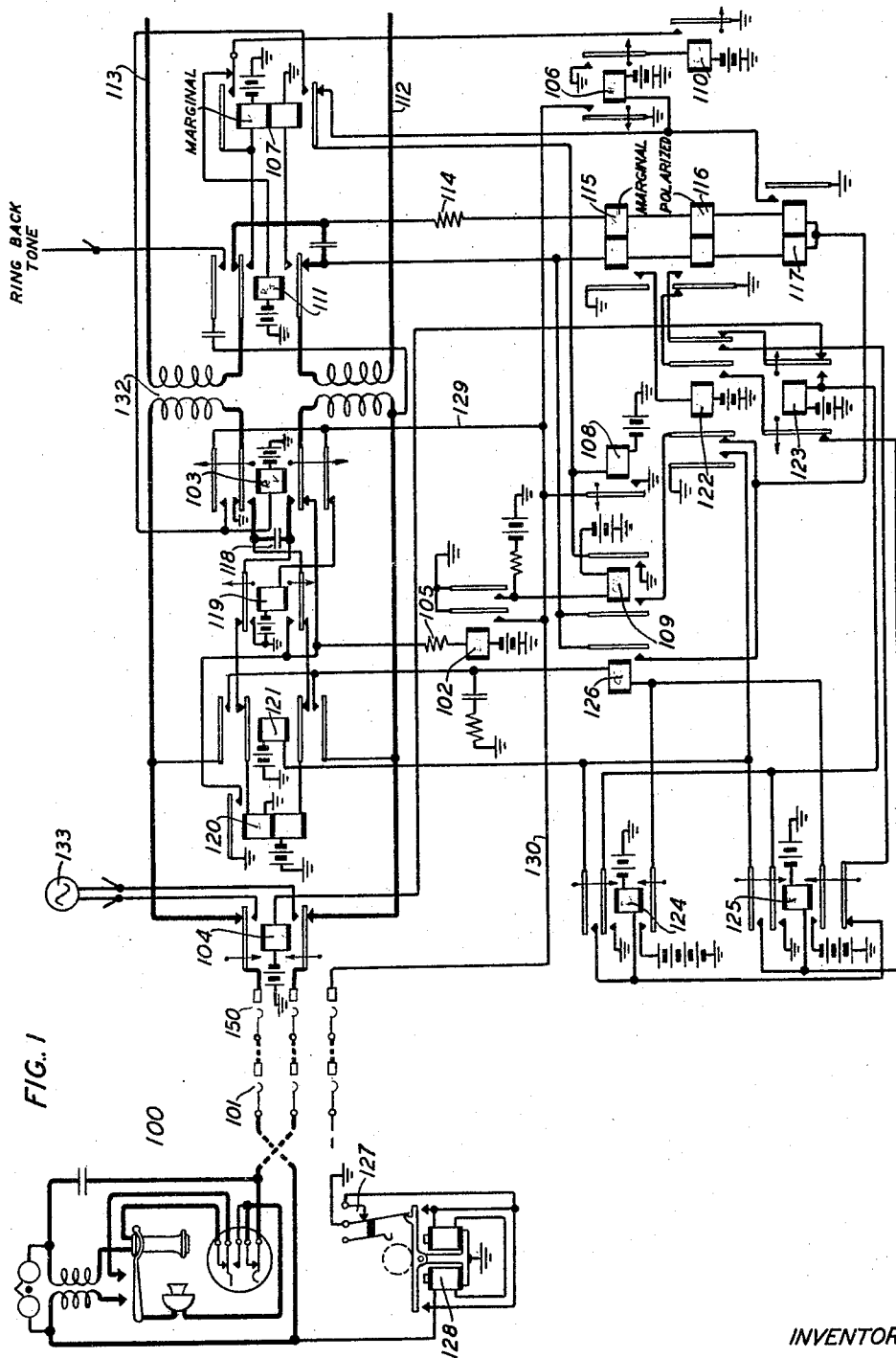
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1,904,252

TELEPHONE SYSTEM

Filed March 18, 1932

5 Sheets-Sheet 1



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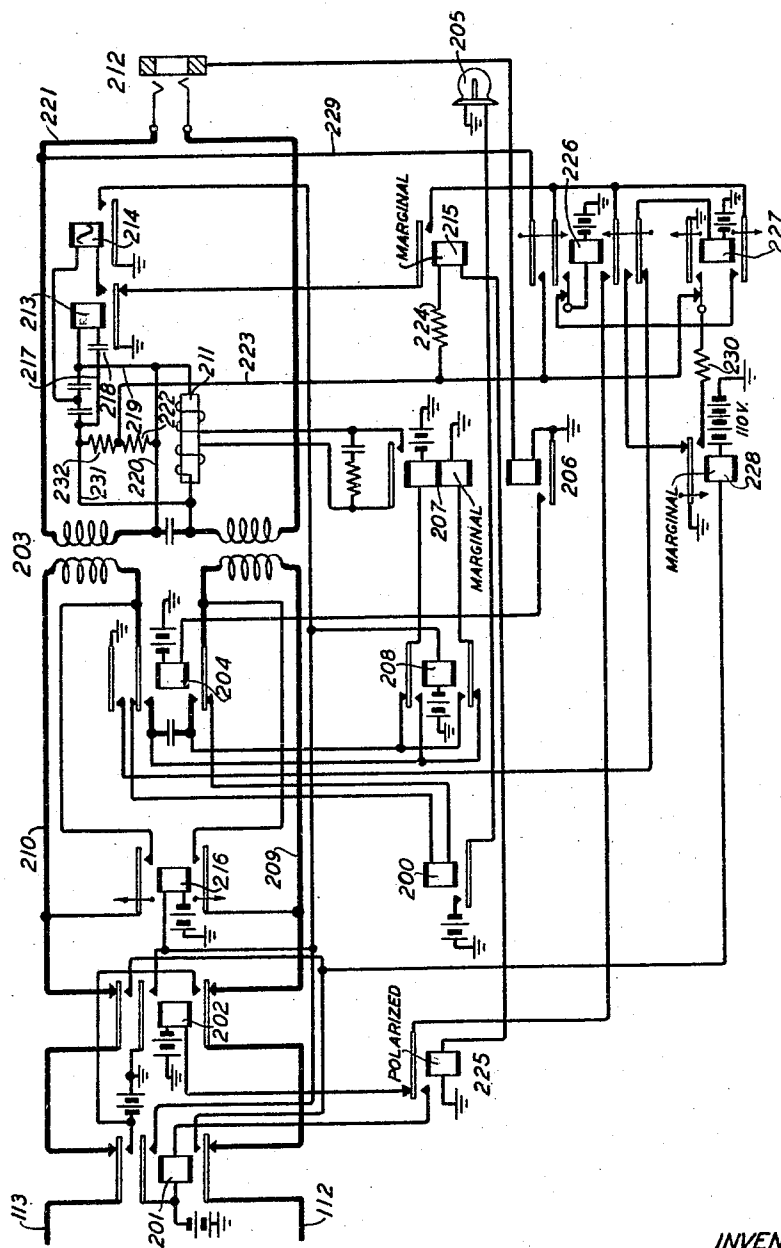
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FIG. 2



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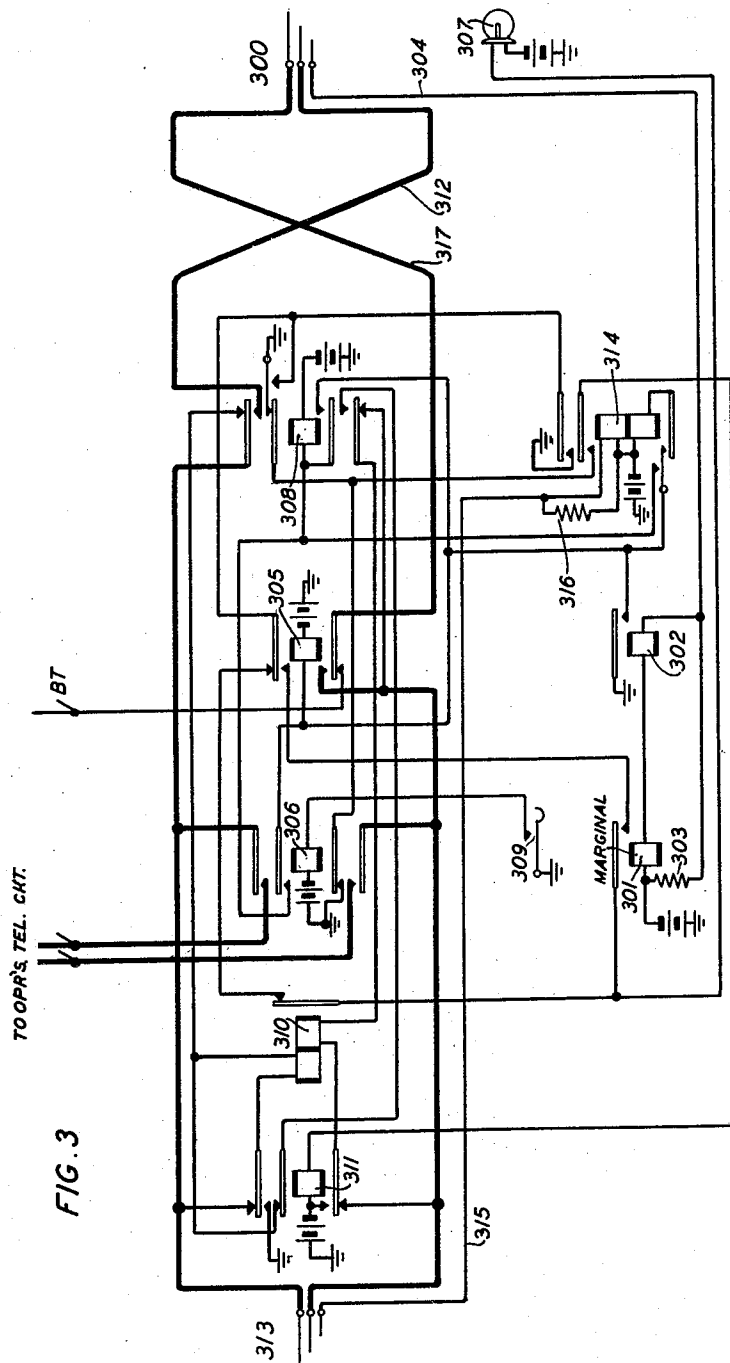
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TELEPHONE SYSTEM

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5 Sheets-Sheet 3



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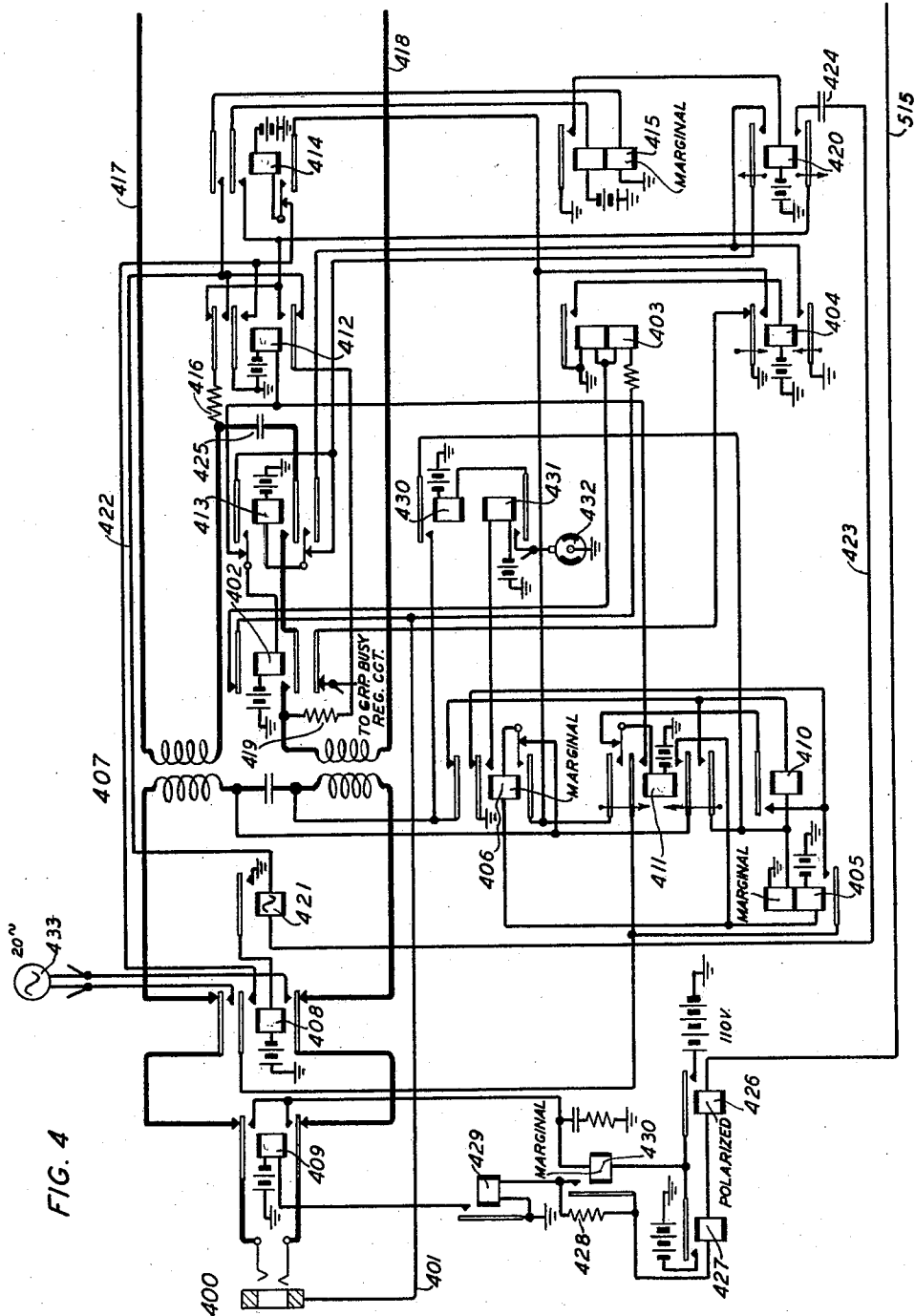
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TELEPHONE SYSTEM

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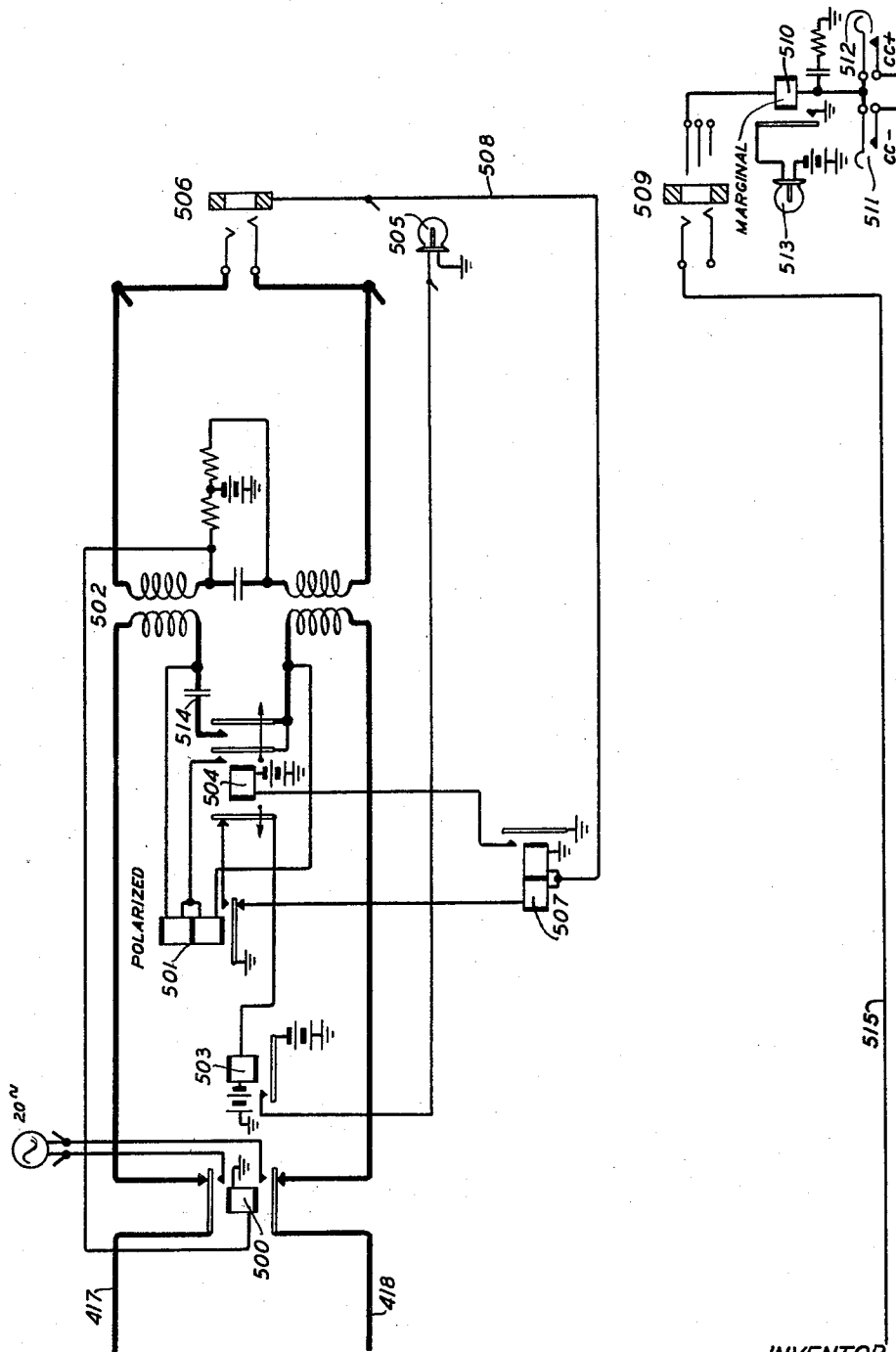
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TELEPHONE SYSTEM

Filed March 18, 1932

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FIG. 5



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TELEPHONE SYSTEM

Application filed March 18, 1932. Serial No. 599,652.

This invention relates to telephone exchange systems and more particularly to dial switching systems in which connections to toll points are established through an operator's position and tolls are assessed against calling subscribers by means of coin boxes associated with the subscribers' lines.

The object of the invention is the provision of improved trunk circuits for extending connections from calling lines to a local operator's position through which the toll connection may be further extended to a toll operator's position and then to the desired toll point, which will enable the toll operator to control coin collection or refund and to ring back on the calling subscriber's line, if necessary, with greater facility and accuracy.

In telephone exchange systems employing dial switching apparatus for extending connections between subscribers' lines it is customary to provide "A" operators' positions for the purpose of aiding subscribers in extending certain types of connections, for example, connection to toll points. In such systems a subscriber desiring a toll connection dials zero and becomes connected over a first selector switch to a trunk circuit terminating at an operator's position on the "A" board. The operator answers the call and, after receiving instructions from the calling subscriber, extends the connection to a toll operator's position, the toll operator then completing the connection to the desired toll point. On such toll connections it is desirable, if the calling subscriber's line is equipped with a coin box, to provide means for enabling the toll operator to collect coins which the calling subscriber has deposited in accordance with instructions if the call is successful or to refund deposited coins if the call is not completed. It is also desirable to enable the toll operator to ring the calling subscriber if he should have restored the receiver upon the switchhook while awaiting the completion of the toll connection.

As has been previously disclosed in Patent No. 1,690,234, granted November 6, 1928, to F. R. Lamberty, two-wire trunks have been provided for extending connections from a dial switching office to an "A" operator's po-

sition over which the collection and refunding of coins could be controlled from the "A" operator's position.

In accordance with the present invention, however, it is proposed to employ a similar two-conductor trunk circuit for extending connections to the "A" operator's position and, in addition, to provide for the control of coin collection and refund from a toll operator's position over a recording and completing trunk circuit extended from the two-wire trunk to the toll operator's position through a recording-completing cord circuit at the "A" operator's position and, further, to make provision in the recording-completing trunk circuit for the repetition of ringing current back to the calling line when the toll operator desires to ring the calling subscriber. In the system disclosed in the patent to Lamberty, coin collection current of 110 volts positive polarity or coin refunding current of 110 volts negative polarity was transmitted over the trunk circuit to the office in which the calling line terminated directly under the control of coin keys associated with the "A" operator's cord circuit.

In accordance with the present invention coin collecting and refunding currents are controlled from the toll operator's position over the established connection to selectively operate relays in the recording-completing trunk for repeating coin-control current of the proper polarity over the two-wire trunk circuit to the originating or outgoing end of said trunk circuit, such repeated currents there being effective as disclosed in the patent to Lamberty to cause the proper operation of the coin box of the calling line.

It has been found that the coin-control current thus repeated over the trunk circuit is more effective if its voltage is higher than 110 volts as heretofore employed. Provision has therefore been made to apply current from a 110-volt source in booster relation to the source of central office operating battery employed for all other operating and supervisory purposes. For this purpose a single source of 110-volt current is provided, in addition to the usual central office battery, which may be connected in series with the

central office battery to transmit current over the trunk loop in one direction in response to a coin collection signal from the toll operator's position and to transmit current over the trunk loop in the opposite direction in response to a coin refund signal from the toll operator's position. In this manner the voltage of the coin-control current transmitted over the trunk may be substantially 134 volts, if a 24-volt central office battery is employed.

The incoming end of the trunk circuit, in addition to the provision of means for receiving coin-control signals from the toll operator's position is also provided with means responsive to ringing current applied from the toll operator's position, which in turn causes the application of ringing current from a ringing source associated with the incoming end of the trunk circuit over the trunk circuit to the calling line in the originating office. Since there is a possibility that ringing current received from the toll operator's position might cause a false operation of the means employed to receive coin-control signals from such operator's position, means have been provided for preventing the application of coin-control current over the trunk during the time that the ring-back responsive means are operating.

In order that the toll operator may be informed when coin collection or coin refunding current has been applied at the originating office to the subscriber's coin box in response to the depression of the coin collect key or the coin refund key at the toll operator's position, a pilot relay is provided at the end of the trunk circuit incoming to the "A" operator's position which relay responds when such coin collection or refunding has been accomplished and which transmits a signal to the toll operator's position to light a coin lamp thereat. Since this pilot relay can be most economically operated in the circuit over which direct or reverse coin-control current is applied to the trunk circuit from the incoming end thereof, by a lowering of the resistance of the trunk loop at the outgoing end thereof, it may happen that the pilot relay will falsely operate due to a surge of current over the trunk circuit when the coin-control current is first applied to the trunk circuit in response to the operation of the coin-control keys and before the apparatus at the outgoing end of the trunk circuit has properly responded to control the coin box. In that event, unless provision were made to guard against it, a premature signal would be transmitted to light the coin lamp at the toll operator's position. Therefore, in accordance with the present invention, a slow releasing relay is provided which is maintained operated during the short operation of the pilot relay which might result from a surge of current over the trunk line

to hold open the signaling circuit temporarily. When, however, the pilot relay is maintained energized for a sufficient interval following a signal from the outgoing end of the trunk circuit that coin-control has been completed thereat, the slow releasing relay deenergizes and, in its deenergized condition with the pilot relay operated, the signal circuit is then completed.

Referring to the drawings,

Fig. 1 shows a calling line terminating in a line switch, and the outgoing portion of a trunk circuit leading from the line switch bank to the "A" operator's position which may be located in the same office as the subscriber or in a distant office;

Fig. 2 shows the terminating end of the trunk disclosed in Fig. 1;

Fig. 3 shows a recording-completing cord at the "A" operator's position; and

Figs. 4 and 5 show a toll recording-completing trunk connecting the special "A" position with a toll position; the latter being located either in the same office as the "A" position or in a distant office.

It is believed that the invention will be best understood through a consideration of the establishment of a connection from the subscriber's substation 100 of Fig. 1 to the toll operator's position of Fig. 5. For this purpose, the several figures of the drawings should be arranged end to end in consecutive order with Fig. 1 at the left and Fig. 5 at the right.

The calling subscriber at substation 100, to initiate a call, removes his receiver from the switchhook thereby causing the line switch 101 in which the subscriber's line terminates to extend the calling line to the first selector 150. The calling subscriber then dials the digit "0" to control the selector 150 to connect with an idle "A" operator's trunk, such as is shown in Fig. 1. The line switch 101 and selector 150 diagrammatically illustrated herein may be of any well known type such as disclosed respectively, for example, in Patent No. 1,304,369, issued to A. J. Ray on March 20, 1919 and in Patent No. 1,690,234, issued to F. R. Lamberty on November 6, 1928. It will be assumed, therefore, that the trunk line shown in Fig. 1 is idle and becomes connected by the line switch 101 and selector 150 to the substation 100. A circuit is thereupon established for the line relay 102 extending from ground through top inner back contacts of relay 103, left upper winding of repeating coil 132, top back contacts of relay 104, tip brushes of switches 150 and 101, over the substation loop returning over the ring brushes of switches 101 and 150, lower back contacts of relay 104, left lower winding of repeating coil 132, bottom inner back contacts of relay 103, resistance 105, winding of relay 102 to battery. Relay 102 upon en-

5 ergizing connects ground potential through
 its inner contacts and over conductor 130 to
 the sleeve terminal of the trunk to guard the
 trunk from seizure by other selector switches,
 causes the operation of relay 119 by the ex-
 10 tension of this ground to conductor 129 and
 thence through the bottom outer contacts of
 relay 103 to the winding of said relay, and
 further closes a circuit for relay 109 extend-
 15 ing from ground on its outer contacts, wind-
 ing of relay 109 to battery. Relay 109 op-
 erates and, over its right contacts, closes an
 obvious circuit through the winding of re-
 lay 108 and, in parallel therewith, another
 20 circuit for relay 106 extending through the
 bottom back contacts of relay 107, winding
 of relay 106 to battery. Relays 108 and 106
 both operate. Both relays 108 and 106 close
 a supplementary guarding ground to the
 sleeve terminal of the trunk to further guard
 the trunk against false seizure as more par-
 25 ticularly described hereinafter, while relay
 106, in addition, closes an obvious circuit
 through the winding of relay 110 which op-
 erates. Relay 109 through its left contacts
 short circuits the left windings of relays 115,
 116 and 117 although this results in no use-
 30 ful function at this time. Relay 110 closes
 a circuit for relay 111 extending from ground
 on the contacts of relay 110, top normal con-
 tacts of relay 107, winding of relay 111 to
 battery. Relay 111 operates and closes the
 trunk loop through both windings of relay
 35 107 to the two-wire trunk extending to the
 centralized "A" position shown in Fig. 2.
 A circuit is now closed extending from
 ground through the bottom winding of relay
 107, bottom front contacts of relay 111, right
 40 lower winding of repeating coil 132, conduc-
 tor 112, bottom back contacts of relay 201,
 bottom back contacts of relay 202, left lower
 winding of repeating coil 203, bottom back
 contacts of relay 204, winding of relay 200,
 45 top back contacts of relay 204, left upper
 winding of repeating coil 203, top back con-
 tacts of relay 202, top outer back contacts of
 relay 201, conductor 113, right upper wind-
 ing of repeating coil 132, top inner front con-
 50 tacts of relay 111, top winding of relay 107
 to battery. Relay 200 operates in this cir-
 cuit but relay 107, being marginal, does not
 operate because of the high resistance of the
 winding of relay 200. Relay 200 closes an
 obvious circuit for trunk lamp 205 causing
 55 it to light at the operator's position and in-
 dicate that a call is awaiting on the trunk.

60 The "A" operator, noting lighted lamp 205,
 answers the call with the answering plug of
 a regular "A" cord since she has no knowledge
 of the character of the service desired by the
 calling subscriber. The circuit operations of
 an "A" cord, which is not shown in the draw-
 65 ings, are so well known that it is not deemed
 necessary to repeat them here except to ob-
 serve that cord sleeve battery closes a circuit

for trunk sleeve relay 206 which operates.
 Relay 206 closes an obvious circuit through
 the winding of relay 204 which operates. A
 circuit is now closed extending from ground
 70 through the top outer contacts of relay 204,
 bottom outer back contacts of relay 226, wind-
 ing of relay 227 to battery, causing relay 227
 to operate. Relay 204 further disconnects
 relay 200 from the trunk causing it to release
 and extinguish lamp 205 while, through its
 75 top and bottom front contacts, it closes the
 trunk through to the windings of relay 207
 extending from battery through the top
 winding of relay 207, top back contacts of
 relay 208, bottom front contacts of relay 204,
 80 left lower winding of repeating coil 203 to
 conductor 209 on one side of the trunk, and
 from ground through the bottom winding of
 relay 207, bottom back contacts of relay 208,
 top inner front contacts of relay 204, left
 85 upper winding of repeating coil 203, to con-
 ductor 210 on the other side of the trunk.
 The substitution of relay 207 for relay
 200 across the trunk reduces the resis-
 tance of the trunk loop and increases
 the quantity of current flowing through
 the trunk, for it will be observed that
 the grounded winding of relay 207 is now
 in series with the battery winding of relay
 107 while the grounded winding of relay 107
 is in series with the battery winding of relay
 207. The current flowing through both of
 these circuits is now sufficient to cause relay
 107 to operate in series with relay 207, the
 100 latter relay operating also and performing
 functions to be noted hereinafter.

Relay 107 locks in a circuit extending from
 battery through its upper winding and make
 contacts to ground on the contacts of relay
 110, opens the circuit of relay 106 which,
 105 being slow to release does not fall back im-
 mediately, and completes a circuit from ground
 on the right contacts of relay 109, bottom
 front contacts of relay 107, to the winding
 of relay 103 which operates and locks over
 its top outer contacts to ground on con-
 ductor 129. The operation of relay 107 fur-
 110 ther causes the release of relay 111 which,
 through its top and bottom back contacts,
 bridges the trunk with a closed loop compris-
 ing resistance 114, the right windings of mar-
 ginal relay 115 and polarized relay 116 and the
 right winding of relay 117; the left wind-
 115 ing of each of these relays being short-cir-
 cuited through the left contacts of relays 122
 and 109 as previously described. Since relay
 115 is marginal and relay 116 is polarized,
 these relays will not operate but relay 117
 will operate, in turn, closing a holding circuit
 for relay 106 thereby maintaining this re-
 120 lay operated and replacing its original cir-
 cuit which was opened when relay 107 oper-
 ated.

When relay 103 operates as already de-
 125 scribed it opens the circuit of relay 119 and

that of relay 102 both of which release. With relay 103 operated and relay 119 released the talking circuit to the calling line is completed by bridging the left upper and lower windings of repeating coil 132 with condenser 118, and connecting talking battery and ground to the subscriber's line through the windings of relay 120 and through the top and bottom back contacts of relays 121 and 119. Relay 120 operates over the subscriber's loop and closes an obvious circuit for relay 102 which reoperates. The previously described momentary release of relay 102, therefore, had no effect since relay 108, being slow to release, held its operated position during the interval for changing over the circuit of relay 102 from the subscriber's loop to the operated contacts of relay 120.

Mention was hereinbefore made of the fact that relay 207 operated in series with relay 107. Relay 207 connects a bridge comprising retardation coil 211 across the tip and ring of the answering trunk jack 212. This retard coil has the effect of operating the "A" cord answering supervisory relay and retiring the supervisory lamp therein but since this invention is not concerned with the operation of the "A" cord, this feature will be further amplified in the description of the operation of the trunk in cooperation with the toll cord shown in Fig. 3 which the operator subsequently uses to extend the subscriber's connection to the toll position.

The operator, through the "A" cord used to answer the call, learns from the subscriber that the desired connection is to be completed by way of the tollboard. In accordance with regular practice the operator thereupon inserts the calling plug 300 of a recording-completing cord into the jack 400 of an idle recording-completing trunk which terminates in a tollboard either located in the same office or in a distant office first making, however, the usual busy test before establishing the connection. A circuit is now completed from battery through the windings of relays 301 and 302 and, in parallel therewith, resistance 303, conductor 304, sleeve of the cord plug 300 and sleeve of the trunk jack 400, conductor 401, top contacts of relay 402, top winding of relay 403 to ground. Relays 301, 302 in the cord and relay 403 in the trunk operate. Relay 301 performs no useful function at this time. Relay 302 closes a circuit extending from ground on its contacts, winding of relay 305 to battery, operating this relay and disconnecting from the cord thereby the busy test conductor BT connecting with the operator's telephone circuit. Relay 305 also extends the tip of the cord through its bottom front contacts to the bottom outer contacts of relay 306 and further extends the control of cord lamp 307 to relay 308 by way of the contacts of relay 310, top front contacts of relay 305 to the contacts of relay 308.

The operator now operates talking key 309 and causes the operation of relay 306 over an obvious circuit. The operation of relay 306 bridges the operator's telephone circuit to the cord in the well known manner and further closes a circuit extending from battery through the winding of relay 308, top inner contacts of relay 306 to ground at relay 302. Relay 308 operates, locks to ground at relay 302 through its bottom inner contacts, bridges both windings of bridge relay 310 across the tip and ring conductors of the cord by way of ring conductor, the top outer back contacts of relay 311, left winding of relay 310, top inner back contacts of relay 311, bottom outer front contacts of relay 308, right winding of relay 310, bottom back contacts of relay 311 to the tip conductor of the cord, and further connects ground over its top inner front contacts to an aforetraced circuit for lamp 307. This lamp, however, will light momentarily, if at all, because, due to the operation of the trunk circuit as a result of the connection of the cord thereto described hereinafter, the resistance of the trunk sleeve circuit connected to conductor 304 will have been increased. Since relay 301 is marginal, the corresponding decrease in current through its winding will not be sufficient to cause it to remain operated, and will therefore release and open the circuit of lamp 307.

In the meanwhile, the operation of relay 403 of the trunk, as already described, causes the operation of relay 404 over an obvious circuit which prepares operating grounds to various parts of the trunk circuit for performing functions hereinafter described. The operation of relay 308 and the subsequent connection of bridge relay 310 across the cord as already described causes a circuit to be closed extending from battery through the lower winding of relay 405, winding of relay 406, bottom normally made contacts of relay 406, left upper winding of repeating coil 407, top outer back contacts of relay 408, top back contacts of relay 409, tip of the trunk jack and trunk cord, conductor 317, bottom front contacts of relay 305, bottom back contacts of relay 311, right winding of relay 310, bottom outer front contacts of relay 308, top inner back contacts of relay 311, left winding of relay 310, top outer back contacts of relay 311, top outer front contacts of relay 308, conductor 312, rings of the cord plug and trunk jack, bottom back contacts of relay 409, bottom back contacts of relay 408, left bottom winding of repeating coil 407, top outer contacts of relay 406, winding of relay 410, top winding of relay 405 to ground. Relays 410, and 310 operate in this circuit, relays 406 and 405 not operating because they are marginal. Relay 410 closes a circuit extending from ground on the top inner back contacts of relay 406, contacts of

relay 410, top outer normally made contacts of relay 411, winding of relay 411 to battery. Relay 411 operates, locks to ground on the top front contacts of relay 404 and, by closing its bottom contacts, short-circuits relay 410 and by closing its inner bottom contacts short-circuits relay 406, causing thereby the release of relay 410. The short-circuiting of relay 410 now causes the operation of relay 405.

Relay 405 now closes circuits extending from ground through the top inner back contacts of relay 406, contacts of relay 405, top inner contacts of relay 411, winding of relay 412 to battery, and, in parallel therewith, through the top normally made contacts of relay 413, winding of relay 402 to battery. Both relays 412 and 402 operate. Relay 412 closes a circuit for relay 414 from ground on the top inner contacts of relay 412, bottom normally made contacts of relay 414, winding of relay 414, to battery, causing this relay to operate and lock to ground under the control of the top front contacts of relay 404. Relay 402 opens the short circuit around the bottom high resistance winding of relay 403 thereby increasing the resistance of the sleeve circuit of the trunk and cord to cause the release of marginal relay 301 in the cord thus extinguishing the cord lamp 307, as already described. Relay 402 further partially prepares the circuit through the right lower winding of repeating coil 407 while, by opening its bottom outer contact opens the circuit to the group busy register circuit which is not shown since it forms no part of this invention. Relay 414, in operating, closes a circuit extending from ground through the lower winding of marginal relay 415, top outer contacts of relay 414, top outer front contacts of relay 412, resistance 416, right upper winding of repeating coil 407, trunk conductor 417, top back contacts of relay 500, left upper winding of repeating coil 502, both windings in series of polarized relay 501, left lower winding of repeating coil 502, bottom back contacts of relay 500, conductor 418, right lower winding of repeating coil 407, resistance 419, bottom front contacts of relay 412, top inner contacts of relay 414, top winding of marginal relay 415 to battery. Relay 501 operates in this circuit but relay 415 does not because of the high resistance of both windings of relay 501.

A circuit is now closed for relay 503 extending from ground on the front contacts of relay 501, back contacts of relay 504, winding of relay 503 to battery. Relay 503 operates and closes a circuit to light trunk lamp 505 in each toll position to which the trunk is multiplied. The toll operator now answers the call by inserting the plug of a regular toll cord circuit in the answering jack 506 of the trunk associated with the lighted

trunk lamp 505 and causes thereby the operation of relay 507 in a circuit including and extending from a sleeve battery of the toll cord (not shown), conductor 508 to the right winding of relay 507, the left winding having been opened at the back contacts of relay 501 when this relay operated. Relay 507 operates and closes thereby an obvious circuit for relay 504 which also operates. Relay 504 releases relay 503 which thereby opens the circuit of trunk lamp 505 causing it to be extinguished. Relay 504, over its right outer contacts connects both left windings of repeating coil 502 together through condenser 514 while, by the closure of its right inner contacts, it short-circuits the high resistance lower winding of relay 501. The elimination of this winding from the previously described circuit including the winding relays 501 and 415 increases the current flowing through said circuit and allows relay 415 to operate. Relay 415 now closes an obvious circuit for relay 420 which likewise operates. Relay 420 closes a circuit extending from ground on the bottom contacts of relay 404, top contacts of relay 420, bottom outer normally made contacts of relay 413, winding of relay 413 to battery, causing relay 413 to operate and lock over its bottom outer contacts to ground on the bottom contacts of relay 404. Relay 420 further connects ringing relay 421 across the tip and ring conductors of the trunk in a path extending from tip conductor 417, right upper winding of repeating coil 407, resistance 416, top outer front contacts of relay 412, conductor 422, winding of relay 421, conductor 423, condenser 424, bottom contacts of relay 420, bottom front contacts of relay 412, resistance 419, right lower winding of repeating coil 407, to ring conductor 418. Relay 413, when it operated, completed the talking circuit by closing the upper and lower right windings of repeating coil 407 through condenser 425 by way of the bottom inner contacts of said relay and the bottom front contact of relay 402 and transfers the control of holding ground for relay 402 from relay 405 to the bottom contacts of relay 404 by way of the top contacts of relay 420.

The talking circuit being thus completed, the "A" operator transmits to the toll operator the necessary information for completing the call, restores talking key 309, withdraws the plug of the regular subscriber's answering "A" cord from the trunk and replaces it with answering plug 313 of the completing cord shown in Fig. 3.

When the answering plug 313 is exchanged for the answering end of the regular subscriber's cord originally used in answering the call, a circuit for operating relay 314 is closed, extending from ground through the winding of relay 206, trunk and cord sleeves, conductor 315, upper winding of relay 314 in

parallel with resistance 316, to battery. Relay 314 locks through its lower winding and contacts to ground at relay 302 and connects ground through its top outer contacts to the top contact of relay 305. If now, at the time the substitution is made, talking key 309 is not operated and hence relay 306 is not operated, a circuit is closed extending from ground on the bottom inner contacts of relay 306, top inner contacts of relay 314, winding of relay 311 to battery. Relay 311 operates and disconnects the bridge relay 310 from the tip and ring conductors of the cord thereby transferring the control of the call-recording trunk supervisory bridge comprising relays 405, 410 and 406 through to retard coil 211 over the contacts of relay 207 which relay, in turn, is controlled over the subscriber's loop as already described. Switchhook flashing or the restoration of the calling subscriber's receiver therefore, will be ineffective at the "A" board with talking key 309 released and relay 306 unoperated as the bridge-through relay 310 will not be connected to the cord and the supervisory bridge in the toll recording-completing trunk will then be directly responsive to the opening and closure of the trunk loop through the contacts of relay 207. In this event subscriber supervision is under the control of the toll operator. If, however, talking key 309 is operated relay 310 is connected across the cord, relay 310 alone will be responsive to the opening and closure of the contacts of relay 207 while the supervisory bridge in the toll recording-completing trunk will have a steady circuit through the windings of relay 310. In this event relay 310 responds to flashes but lamp 307 will not light since its circuit is cut off at the top contacts of relay 305. The "A" operator, however, is listening in on the cord and will be able to supervise the connection.

When the toll operator has completed the extension of the calling line to the wanted subscriber, if the calling subscriber is still on the line, talking may proceed as soon as the called subscriber removes his receiver. It often happens, however, that the calling subscriber may have restored his receiver during the time that the connection is being set up in which event the toll operator has to ring him back. Should the calling subscriber restore his receiver, then relay 120 releases, in turn releasing relay 102, followed by the release of relays 109 and 108. Relay 109 opens the shunt around the left windings of relays 115, 116 and 117. The resistance of the loop circuit including all the windings of these relays, as well as the windings of relay 207, is now increased, causing a decrease in current and a release of relay 207. Relay 207 opens the trunk bridge circuit including retardation coil 211 and functions to light the cord supervisory lamp at the toll board as an in-

dication that the calling subscriber has restored. Relay 117, however, will not release and relay 106 is maintained operated thereby maintaining ground on conductor 130 which holds selector 150 connected to the trunk notwithstanding the disconnection by the subscriber.

When the operator wishes to ring back the subscriber, she operates the ringing key in the connected toll cord circuit which connects battery to the tip side of the recording-completing trunk in the well known manner and causes the operation of relay 500. Relay 500 opens the trunk to the repeating coil 502 and connects ringing current to the recording-completing trunk conductors 417 and 418 through the winding of ringing relay 421 over a previously described path. Relay 421 operates and closes an obvious circuit to operate relay 408 which opens the trunk to repeating coil 407 and connects ringing current through its front contacts to the local trunk over the toll cord through which the calling line has been extended. A circuit is now completed from one side of ringing current source 433, top outer front contacts of relay 408, top back contacts of relay 409, tips of trunk jack 400 and cord plug 300, conductor 317, bottom front contacts of relay 305, ring of cord plug 313 and ring of trunk jack 212, right bottom winding of repeating coil 203, conductor 231, conductor 217, condenser 218, winding of ringing relay 213, conductor 219, conductor 220, right upper winding of repeating coil 203, conductor 221, tips of trunk jack 212 and cord plug 313, top outer front contacts of relay 308, conductor 312, rings of cord plug 300 and trunk jack 400, bottom back contacts of relay 409, bottom front contacts of relay 408 to the other side of ringing current source 433. Relay 213 operates and connects ground to the winding of relay 214 while removing ground from the contacts of relay 215. Now relay 215 is one of the relays which controls coin operations and it is possible that when ringing current is transmitted through the above described circuit, relay 215 may falsely operate when relay 213 operates. The ground which is effective on the contacts of relay 215 therefore is controlled through the normal contacts of relay 213 so that if relay 215 does falsely operate, the ground will be removed from its contacts so as to make these contacts ineffective at this time. Relay 214 now operates from the same ringing current and closes a circuit extending from ground on its contacts, winding of relay 208 to battery and, in parallel therewith, winding of relay 216 to battery. Relays 208 and 216 operate, the former reversing the direction of current flowing through the circuit of relay 207, while the latter shunts the left windings of the repeating coil 203 to prevent ringing induction through the repeating coil when

ringing current is finally transmitted through the subscriber's loop from the local end of the trunk. The circuit of relay 207 includes, as already described, windings of relays 115, 116 and 117. Of these, relay 115 is marginal and relay 116 is polarized and the reversal of current is in a direction to operate relay 116. Relay 117 remains operated, while relay 115 does not operate at this time. Relay 116 closes a circuit extending from ground on its front contacts, right back contacts of relay 122, right back contacts of relay 123, winding of relay 104 to battery. Relay 104 operates, disconnects the calling line from repeating coil 132 and, through its front contacts, applies ringing current from source 133 over selector 150 and line switch 101 to the subscriber's line. This ringing current is maintained on the line so long as the toll operator maintains the cord ringing key operated. When the ringing key is released, relays 500, 421, 408, 213 and 214 are released in succession. The release of relay 214 causes the release of relays 208 and 216. Relay 208 reverses the direction of current flowing through the circuit including relays 207 and 116 and causes the release of relay 116. Relay 104 releases in consequence disconnecting the ringing current source 133 and reestablishing the subscriber's connection to the talking circuit.

When the subscriber responds by removing his receiver from the hook, relays 120, 102 and 109 operate as already described, the latter short-circuiting the left windings of relays 115, 116 and 117. The resistance of the trunk bridge is thereby reduced to increase the current flowing over the trunk circuit including the windings of relay 207. Relay 207 operates and closes through the bridge circuit including retard coil 211, and eventually causes previously described circuits to function to extinguish the toll supervisory lamp.

The toll operator may collect or refund the coin deposited by the calling subscriber or ask for the deposit of additional coins before the subscribers may be permitted to talk. In the case of coin lines, however, it is necessary in some systems to deposit a coin before the switches can operate to extend the line to the "A" operator's position. When the "A" operator learns that the subscriber desires a connection which can be extended only from the toll board, the original coin is refunded, the line is extended to the toll position as already described, and the toll operator then tells the subscriber how many coins to deposit.

The regular subscriber's cord with which the "A" operator originally answered the call is equipped with coin collect and coin refund facilities in the well known manner comprising means for connecting a negative potential to the tip side of the trunk through

a coin refund key and means for connecting a positive potential to the tip side of the trunk through a coin collect key. These features, like the regular subscriber's cord into which they are incorporated, are so well known that it is not thought necessary to describe them herein in detail. It is sufficient for the purpose of this description to note that when the "A" operator wishes to refund the original coin deposited, negative coin refunding battery is connected to the tip conductor of the trunk, that is, conductor 221 and a circuit is thereby closed from said battery over conductor 221, right upper winding of repeating coil 203, conductor 220, resistance 222, conductor 223, resistance 224, winding of relay 215, winding of relay 225 to ground. Relay 215 operates but relay 225 does not as it is polarized and will not respond to current of negative potential. The operation of relay 215 causes a circuit to be closed extending from ground at the back contacts of relay 213, contacts of relay 215, bottom contacts of relay 227, top inner normally made contacts of relay 226, winding of relay 226 to battery. Relay 226 operates and locks to the same operating ground. A circuit is now closed extending from battery through the winding of relay 202, back contacts of relay 225, bottom inner contacts of relay 226, contacts of relay 215, back contacts of relay 213 to ground. Relay 202 operates in this circuit and, at its top and bottom outer back contacts, opens the circuit of relay 207 which releases. With the operation of relay 226, relay 227, which was previously held operated from ground on the top outer contacts of relay 204, is now held operated from ground on the top back contacts of relay 228 by way of the bottom outer front contacts of relay 226. Relay 226 further connects the tip of trunk jack 212 to resistance 224 by way of conductor 229 and the top outer contacts of relay 226. Relay 226 is made slow to operate so as to insure that relay 225 in the case of collection will be operated before ground is connected to the contacts of relay 225, thereby preventing a false operation of relay 202. This slow operate feature of relay 226 and the fact that the ground for operating relay 226 and relay 201 or 202 is taken from the back contacts of relay 213 both prevent a false operation of either relay 201 or 202 in case relay 215 or 225 should falsely operate on ringing current. The operation of relay 202 closes an obvious circuit for relay 216 which operates and short-circuits the left windings of repeating coil 203. Relay 202 also closes a parallel circuit extending to the winding of relay 208 causing this relay to operate, but which performs no useful function at the present time. A battery of positive polarity is now connected through the winding of relay 228, top front contacts of relay 202, top outer back contacts of relay

201, conductor 113, right upper winding of repeating coil 132, top inner back contacts of relay 111, resistance 114, through the closed loop consisting of the right windings of relays 115, 116 and 117, left back contacts of relay 122, left contacts of relay 109, bottom back contacts of relay 111, right lower winding of repeating coil 132, conductor 112, bottom back contacts of relay 201, bottom outer front contacts of relay 202 to negative battery. The coin battery is thus connected over this circuit in booster relation to the regular office battery, giving a higher voltage and providing better operating margins for the relays of the circuit. Relay 115 operates in this circuit but the current flowing is not in the proper direction to operate polarized relay 116, while relay 117 remains operated. Relay 115 causes the operation of relay 122 over an obvious circuit and relay 122 at its left inner contacts opens the short circuit around the left winding of each of the relays 115, 116 and 117, thereby increasing the resistance of the loop circuit just traced and including the winding of relay 228. Relay 228, being marginal, does not receive sufficient current to operate at this time due to the increased resistance through both windings of each of the bridge relays 115, 116 and 117. Relay 228 is further made slow to operate in order to allow for sufficient time to operate relay 122.

Relay 122, at its right inner contacts, closes an operating path for relay 125 extending from ground on the back contacts of relay 116, right inner contacts of relay 122, left contacts of relay 123, winding of relay 125 to battery. Over its left outer contacts relay 122 closes an obvious circuit through the winding of relay 121 and in parallel therewith connects ground to the locking contacts of relays 125 and 124. Relay 125 locks and closes the coin return battery circuit to the coin box which may be traced as follows: negative battery through the bottom inner contacts of relay 125, winding of relay 126, top and bottom outer contacts of relay 121, top and bottom back contacts of relay 104, tip and ring terminals and connecting brushes of switches 150 and 101 to ground through coin magnet 128 regardless of whether the receiver is restored on the switchhook or not. The return magnet operates and, in the well known manner, returns the original coin deposited. The operation of relay 125 opens at its bottom contacts the operating path of relay 124, so as to prevent any possible connection of positive battery to the line at the same time negative battery is connected thereto. In the meanwhile, relay 126 operates in series with the coin box magnet 128 and re-establishes the short circuit around the left windings of relays 115, 116 and 117. The resistance of the trunk loop being thus reduced, relay 228 receives sufficient current to operate

and, in turn, causes the release of relay 227 and connects ground through resistance 230 by way of the top normally made contacts of relay 227 over conductor 229, conductor 221 to the tip of the trunk jack and thence through the associated coin pilot relay in the cord circuit which operates and lights a coin lamp to indicate that the coin was properly returned. Relay 227 is slow to release so that any momentary operation of relay 228 due to a current surge over the local trunk when coin-control current is applied thereover will not cause a false operation of the coin pilot relay in the cord.

When the coin refund key is released relay 215 releases, in turn releasing relays 226 and 202. Relay 202 removes coin battery from the trunk and also releases relays 216 and 208, the former removing the short circuits around the left windings of repeating coil 203 and the latter restoring the proper direction of current flow over the trunk through the windings of relay 207. The release of relay 226 permits relay 227 to reoperate over its previously described path. Relay 216 is made slow in releasing to provide an interval between the time battery and ground are again connected to the trunk and the removal of the shunts from the repeating coil windings.

The release of relay 202 further opens the coin battery circuit through the windings of the bridge relays 115, 116 and 117 and replaces it with the low potential circuit through the windings of relay 207 causing thereby the release of bridge relay 115 which, in turn, releases relay 122 and causes the reoperation of relay 207. Relay 122 releases which, in turn, causes the release of relays 121 and 125, the former restoring the talking circuit and the latter opening the coin battery circuit to the coin box magnet 128 at the subscriber's line. The trunk is now restored to the condition existing before the coin key was operated.

The "A" operator, having by the operation described above, refunded the subscriber's coin and having in the meanwhile extended the subscriber's connection to the toll position, any further coin collecting or refunding will take place from the said position. The toll operator will require the subscriber to deposit the proper number of coins causing the coin box contacts 123 to close again. It will be assumed for the purposes of this description that the call has been successfully completed and that, at the end of the conversation, the toll operator will collect the deposited coins. Now, with each toll incoming trunk from the special "A" board there is associated a special jack 509 into which the operator plugs a coin-control cord, the tip of which is wired to the winding of relay 510. This cord has associated with it two coin-control keys, one of which 511, connects nega-

tive coin potential and the other 512, connects positive coin potential to the cord.

When, therefore, the toll operator desires to collect the coin or coins, she inserts the
 5 cord plug into jack 509 and key 512 is depressed which thereupon closes a circuit extending from the source of positive coin battery, contacts of key 512, winding of relay
 10 510, tip of cord, tip of jack 509, conductor 515, windings of polarized relays 426 and 427, resistance 428, winding of relay 429 to ground. Now relay 426 is positively polarized and relay 427 is negatively polarized so that, on the closure of the aforementioned circuit imposing positive potential upon the
 15 winding of relay 426, this relay will operate while relay 427 will not. Relay 429 likewise operates in the above circuit, but due to the high resistance of resistance element 428, relay 510 does not get sufficient current to operate. Relay 429 closes an obvious circuit for relay 409 which disconnects the trunk
 20 tip and ring contacts of jack 400 from repeating coil 407 and connects them to the winding of relay 430. The operation of relays 426 and 409 causes a circuit to be closed extending from positive battery, contacts of relay 426, winding of relay 430, front
 25 contacts of relay 409, tip of trunk jack 400, tip of cord plug 300, conductor 317, bottom front contacts of relay 305, ring of cord plug 313, ring of trunk jack 212, right lower winding of repeating coil 203, conductor 231, resistance 222, conductor 223, resistance 224, wind-
 30 ing of relay 215, winding of polarized relay 225 to ground. Another parallel circuit exists over the bottom front contacts of relay 409, ring of trunk jack 400, ring of cord plug 300, conductor 312, top outer front contacts of relay 308, tip of cord plug 313, tip of trunk
 35 jack 212, right upper winding of repeating coil 203, conductor 220, resistance 232 to conductor 223. The direction of current flow in both of these currents is such, in this case, that not only does relay 215 operate but relay
 40 225, which is polarized, operates as well. Relay 430 does not operate in the above circuit as the resistance of resistance elements 224, 222, 232 and the resistances of relays 215 and 225 are too high to permit sufficient current for operating relay 430 which is marginal. Relay 215, in operating closes a circuit for operating relay 226 as previously
 45 described. In this case, however, instead of operating relay 202 through the back contacts of relay 225, a circuit is closed for operating relay 201 which extends from battery through the winding of relay 201, front
 50 contacts of relay 225, bottom inner contacts of relay 226, contacts of relay 215, back contacts of relay 213 to ground. Relay 201 operates and connects positive coin battery through the winding of relay 228 to the bottom front
 55 contacts of relay 201 and thence to the ring of the trunk over a previously described loop

including the windings of bridge relays 115, 116 and 117 to negative low voltage battery over the top outer front contacts of relay 201 as previously described. The direction
 50 of current flowing is now opposite to what it was at the time the original coin was returned from the "A" board so that not only relay 115 operates in this case but polarized relay 116 also operates. Relay 122 now operates to perform functions which have been previously
 55 described while the operated condition of relay 116 causes a circuit to be closed extending from ground on its front contacts, right outer front contacts of relay 122, bottom contacts of relay 125, winding of relay
 60 124 to battery. Relay 124 operates, locks over its top outer contacts to ground on the left outer contacts of relay 122, and closes a coin collect positive battery circuit to the subscriber's coin box over a previously described
 65 circuit from positive battery on the bottom inner front contacts of relay 124, the only difference between said other circuit and the present one being the substitution of said positive battery from the contacts of relay
 70 124 to the winding of relay 126 for negative battery on the bottom inner contacts of relay 125 to the winding of relay 126. The coin is collected due to the closure of this circuit instead of returned as previously described.

When the coin is collected and relay 228 operates as previously described, in turn releasing relay 227 which, after an interval, connects resistance 230 to the tip conductor
 75 221 as previously described thereby increasing the quantity of current flowing through the previously described circuit including the winding of relay 430. The current is now sufficient to operate relay 430 which, in operating, short-circuits resistance 428 and thereby
 80 increases the current flowing through the previously described circuit including the winding of relay 510. This relay now operates and closes an obvious circuit for lighting coin pilot relay 513 which indicates to the toll operator that the coin or coins have been
 85 collected. The operator restores coin key 512 and removes positive coin battery from relay 426 and releases said relay. With the release of relay 426, positive coin battery is removed from the trunk, thereby releasing
 90 relay 430. Relay 409 also releases with the release of key 512, thereby restoring the toll completing trunk to the condition in which it was prior to the depression of key 512.
 95 The removal of positive battery from the trunk causes the release of relays 215 and 225 which then close circuits controlling the restoration of the incoming connection to the condition in which it was before the
 100 operation of the coin key 512 and which has already been previously described in connection with coin refund operations from the "A" board.

Had the operator desired to refund the 130

coins, key 511 would have been operated which would have resulted in the operation of relay 427 and the consequent operation of relay 215 only and not relay 225. Since the operations following this would be the same as those following the application of coin refund battery from the "A" board, it is not necessary to describe them again.

When the subscribers have completed their conversation and the calling subscriber restores his receiver, the loop circuit holding relay 120 operated is broken and relay 120 releases, in turn causing the release of relay 102. Relay 102 releases relay 109 and this relay releases relay 108. By the opening of its left contacts, relay 109 removes the short circuit around the left windings of bridge relays 115, 116 and 117, while the release of relay 108 removes a guard ground from sleeve conductor 130. The resistance of the trunk loop is thereby increased and relay 207 releases which opens the retard coil bridge across the trunk and connecting cord at the "A" position, releasing relay 405 which in turn releases relay 412. Relay 412, in releasing, reverses the direction of current flowing through the loop circuit including relay 415 and polarized relay 501. Since relay 501 is polarized, the reversal of current causes its release. Relay 501 connects ground through its back contact to the left winding of relay 507 thereby placing both windings of this relay in parallel and decreasing the resistance of the sleeve circuit to the toll connecting cord. This decrease in resistance increases the current through the sleeve circuit thereby operating the sleeve supervisory relay of the cord and lighting the supervisory and disconnect lamp of the cord as an indication that the call is terminated. It is obvious that if the calling subscriber should flash instead of restoring, the effect of the opening and closing of the above circuits would result in a corresponding flashing response of relay 501 which, by alternately reducing and increasing the sleeve resistance, would alternately cause the lighting and extinguishing of the cord supervisory lamp. The operator removes the cord from trunk jack 506 and relay 507 releases in turn releasing relay 504. Relay 504 recloses the circuit of the trunk lamp 505 causing it to light and further removes the short circuit around the lower winding of relay 501 placing both of its windings in series. The current flowing through the circuit previously traced through the windings of relay 415 is decreased and relay 415 releases, and in turn releases relay 420. Relay 420 in turn releases relay 402. The release of relay 402 short-circuits the high resistance winding of sleeve relay 403 and thereby increases the current through the sleeve circuit including relays 301 and 302. Relay 301 now reoperates and closes a previously described path to the cord lamp 307 causing it

to light as a disconnect signal. The "A" operator removes the cord plugs, opens the loop to relay 405 and causes the release of relay 412 which now reverses the flow of current through the trunk loop including relays 415 and 501. Due to this reversal, relay 501 releases and opens the circuit of relay 503 which, in turn, extinguishes the trunk lamp 505.

The removal of the cord further opens the circuit of relay 403 which, in turn, causes the release of relay 404. Relay 414 is unlocked in consequence and opens the trunk loop. Relay 413 releases in consequence of the release of relay 404, which also causes the release of relay 411. The toll recording-completing trunk is now normal.

When cord sleeve relay 314 releases, it releases all operated relays of the cord thereby restoring the cord to normal. Relay 206 in the local trunk also releases thereby releasing relay 204 which in turn releases relay 227. Relay 200 is now placed again across the trunk and since the loop is now dry, relay 117 releases, thereby causing the release of relay 106. Relay 106 removes the last guard ground to conductor 130 thereby causing the selector switch to restore. Relay 106 further releases relay 110 which unlocks relay 107 causing it to restore to normal. The outgoing part of the trunk is now fully restored to normal.

In the foregoing description only the main operations of the supervisory signals at the two boards have been described. There are minor variations of the sequence of signals of which the disclosed circuits are capable, such as the necessary signals between the two boards if the "A" operator were to connect a regular "A" cord in error into jack 400 of a toll recording trunk and involving the operations of relays 406, 430 and 431 and interrupter 432. Since, however, these features do not form a part of this invention, it is not thought necessary to describe them.

What is claimed is:

1. In a telephone exchange system, a calling line, a coin box thereon; an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, said trunk circuit being inductively divided into a plurality of sections, a coin box control key at said operator's position, a first relay controlled over the incoming section of said trunk circuit from said key, a second relay in the outgoing section of said trunk circuit, means controlled by said second relay for applying coin box operating current to said coin box, a source of booster current and a source of operating current at the incoming end of said trunk circuit and means controlled by said first relay for applying said sources of current accumulatively over the outgoing section of said trunk circuit for operating said second relay.

2. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit, for extending a connection from said line to said operator's position, said trunk circuit being inductively divided into a plurality of sections, a coin collect key and a coin refund key at said operator's position, serially connected relays associated with the incoming section of said trunk circuit variously responsive to the operation of said keys, a marginal relay and polarized relay bridged across the outgoing section of said trunk circuit, means under the control of either of said relays for applying operating current to said line for collecting or refunding, respectively, coins deposited in said coin box, a source of booster current and a source of operating current at the incoming end of said trunk circuit, and means controlled by said serially connected relays for applying said sources of current cumulatively over the outgoing section of said trunk circuit in either direction for selectively operating said polarized and said marginal relays.

3. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, said trunk circuit being inductively divided into a plurality of sections, a coin collect key and a coin refund key at said operator's position, a marginal relay and a polarized relay associated with the incoming section of said trunk circuit and controllable from said keys over a simplex circuit, said relays both being responsive to the operation of said collect key and said marginal relay only responsive to said refund key, a marginal and a polarized relay bridged across the outgoing section of said trunk circuit, means under the control of said latter relays for applying operating current to said line for collecting or refunding coins deposited in said coin box, a source of booster current and a source of operating current at the incoming end of said trunk circuit, a relay controlled in the operated condition of said first polarized relay and of said first marginal relay for applying said sources of current cumulatively over the outgoing section of said trunk circuit for operating said second marginal and polarized relays for causing the application of coin collection current to said line, and another relay controlled in the unoperated condition of said first polarized relay and in the operated condition of said first marginal relay for applying said sources of current cumulatively in the opposite direction over the outgoing section of said trunk circuit for operating said marginal relay in the outgoing section of said trunk for causing the application of coin refunding current to said line.

4. In a telephone exchange system, a calling

line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, coin-control keys at said operator's position, relays in said trunk circuit controllable from said keys for causing the connection of current to said coin box for collecting or refunding coins deposited therein, means in said trunk circuit controllable from said operator's position for applying ringing current over said trunk circuit for ringing back the calling subscriber and means controlled by said latter means for rendering said relays ineffective during the application of ringing current.

5. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, coin-control keys at said operator's position, first relays controlled by said keys over the incoming section of said trunk circuit, relays in the outgoing section of said trunk circuit, means controlled by said latter relays for applying operating current to said line for collecting or refunding coins deposited in said coin box, means controlled by said first relays for operating said latter relays, means in the incoming section of said trunk circuit controllable from said operator's position for applying ringing current to the outgoing section of said trunk circuit for ringing back the calling subscriber and means controlled by said latter means for preventing the control of said latter relays by said first relays during the application of ringing current to the outgoing section of said trunk circuit.

6. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, coin-control keys at said operator's position, first relays in said trunk circuit controllable from said keys, second relays controllable by said first relays for transmitting a coin collection or a coin refunding signal over said trunk circuit toward said calling line, relay means in said trunk circuit controllable from said operator's position for applying ringing current over said trunk circuit to ring back the calling subscriber, and means controlled by said relay means for removing said second relays from the control of said first relays during the application of ringing current over said trunk circuit.

7. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, coin collect and refund keys at said position, first relays at the incoming end of said trunk circuit controllable from said keys for applying operating cur-

rent of opposite polarities to said trunk circuit, a pilot lamp associated with said keys, a pilot relay for lighting said lamp, a high resistance bridge across the outgoing end of said trunk circuit comprising a polarized relay and a marginal relay, each of said relays being controlled respectively by one of said first relays, means under the control of said polarized and marginal relays for applying
10 operating current to said line for collecting or refunding coins deposited in said coin box, means operative upon the application of said current to said line to reduce the resistance of said bridge to operate said pilot
15 relay, and means for preventing the lighting of said lamp upon a momentary operation of said pilot relay due to a surge of current when operating current is first applied to said trunk circuit by said first relays.

20 8. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, means including a trunk circuit for extending a connection from said line to said operator's position, coin-control keys at said
25 operator's position, first relays at the incoming end of said trunk circuit under the control of said keys for applying operating current of opposite polarities to the outgoing end of said trunk circuit, a high resistance
30 bridge across the outgoing end of said trunk circuit comprising a polarized and a marginal relay, each of said relays being controlled respectively by one of said first relays, means under the control of said polarized
35 and marginal relays for applying operating current to said line for collecting or refunding coins deposited in said coin box, a pilot relay at the incoming end of said trunk circuit, a slow releasing relay operable over a
40 back contact of said pilot relay, means operative upon the application of said operating current to said line to operate said pilot relay to reduce the resistance of said bridge, a lamp associated with said keys and a circuit
45 for said lamp controlled upon the operation of said pilot relay and the subsequent release of said slow releasing relay, said slow releasing relay preventing the lighting of said lamp should said pilot relay
50 momentarily operate due to a surge of current when operating current is first applied to said trunk circuit by said first relays.

In witness whereof, I hereunto subscribe my name this 14th day of March, 1932.

55 THEODORE D. ROBB.