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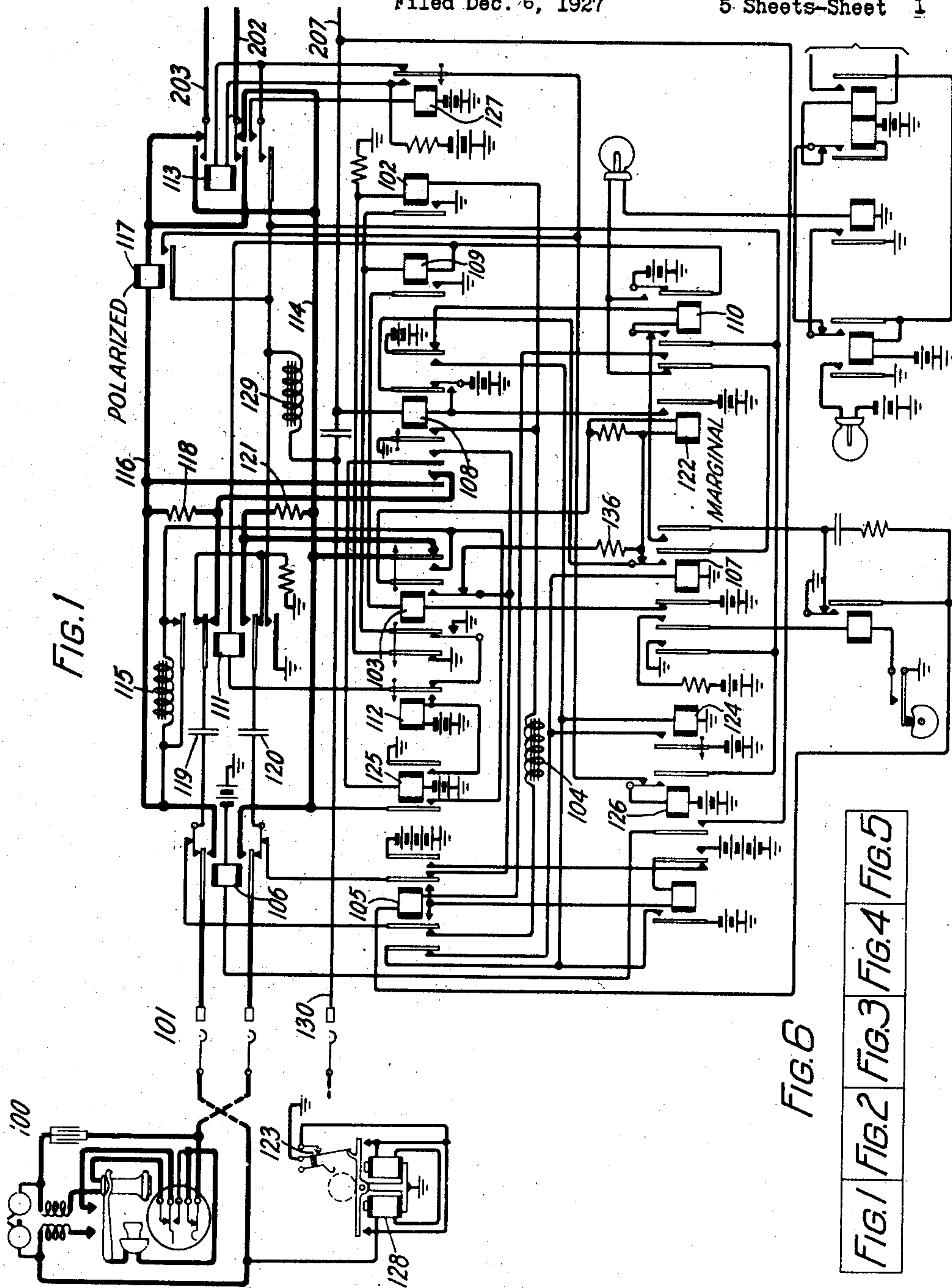
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1,690,234

TRUNKING CIRCUIT TO CENTRALIZED OPERATOR'S POSITION

Filed Dec. 6, 1927

5 Sheets-Sheet 1



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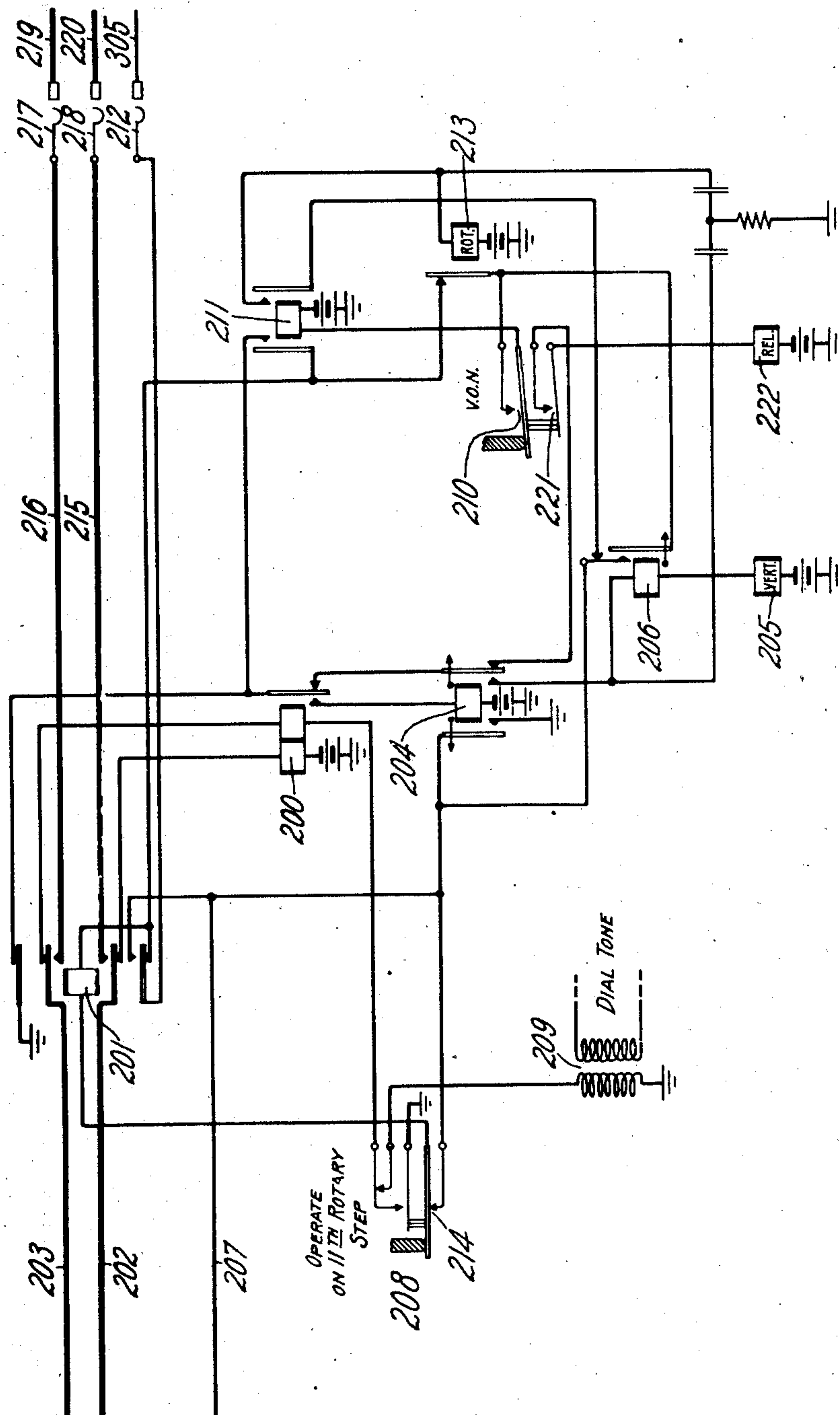
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FIG 2



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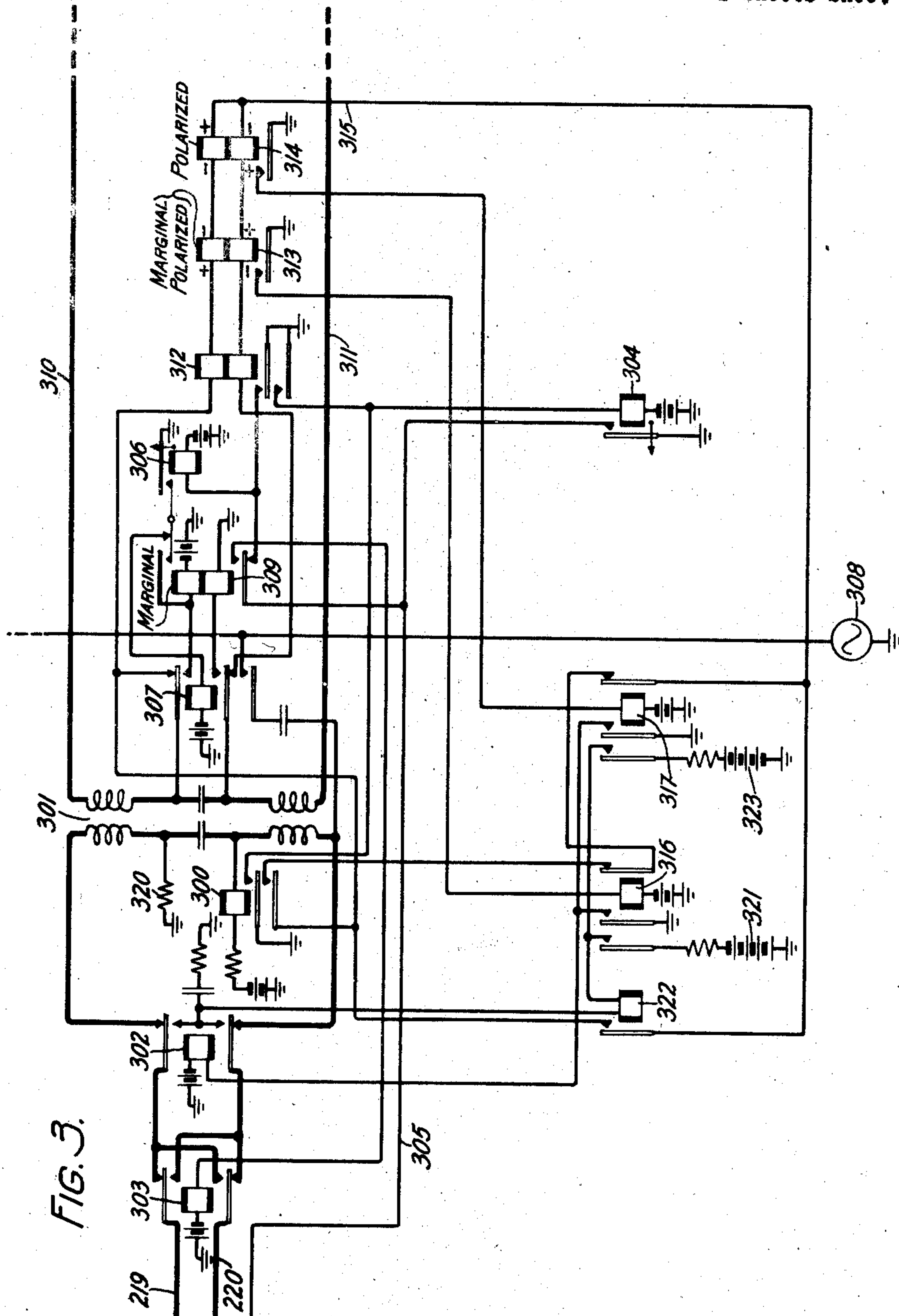
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5 Sheets-Sheet 3



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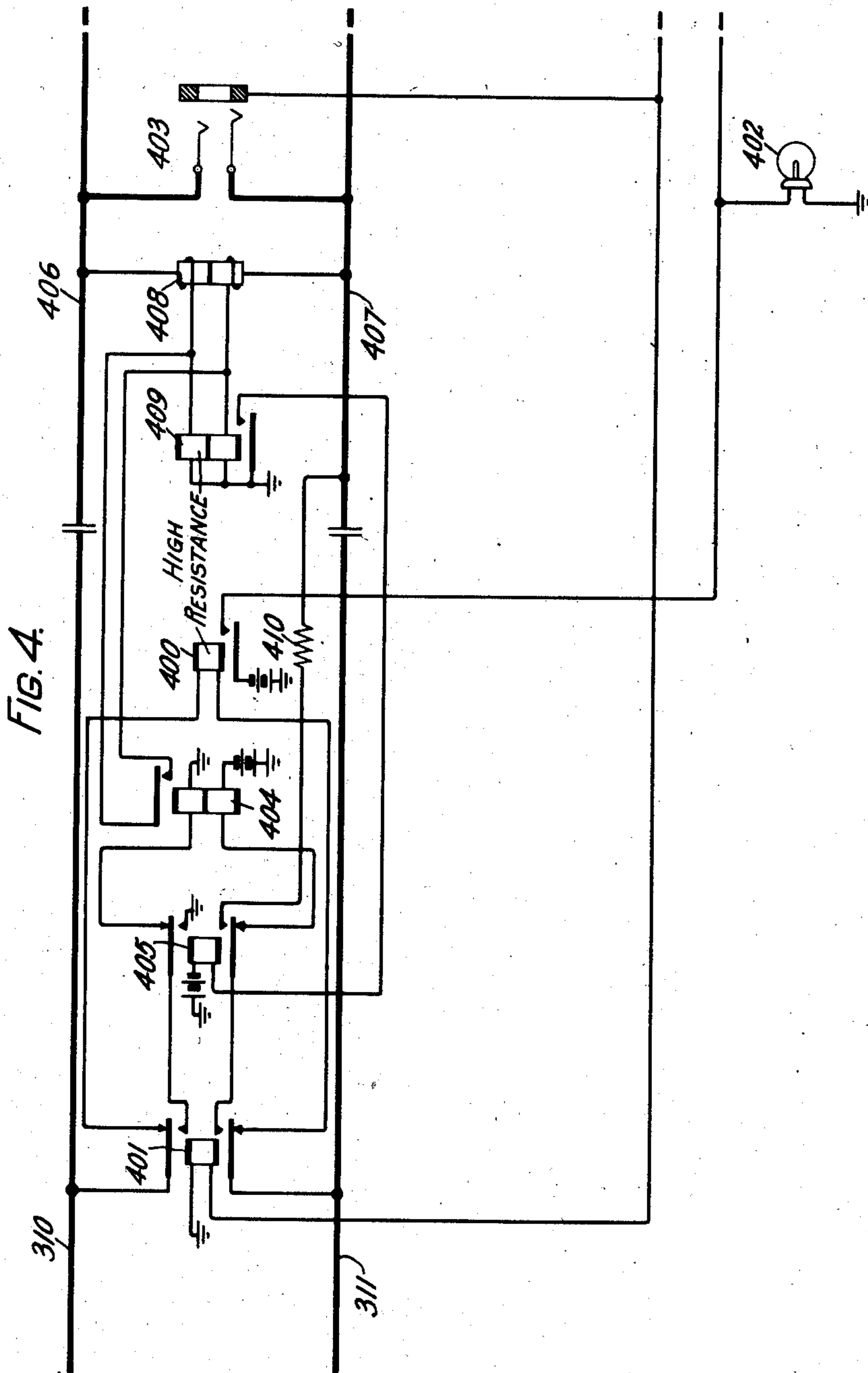
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5 Sheets-Sheet 4



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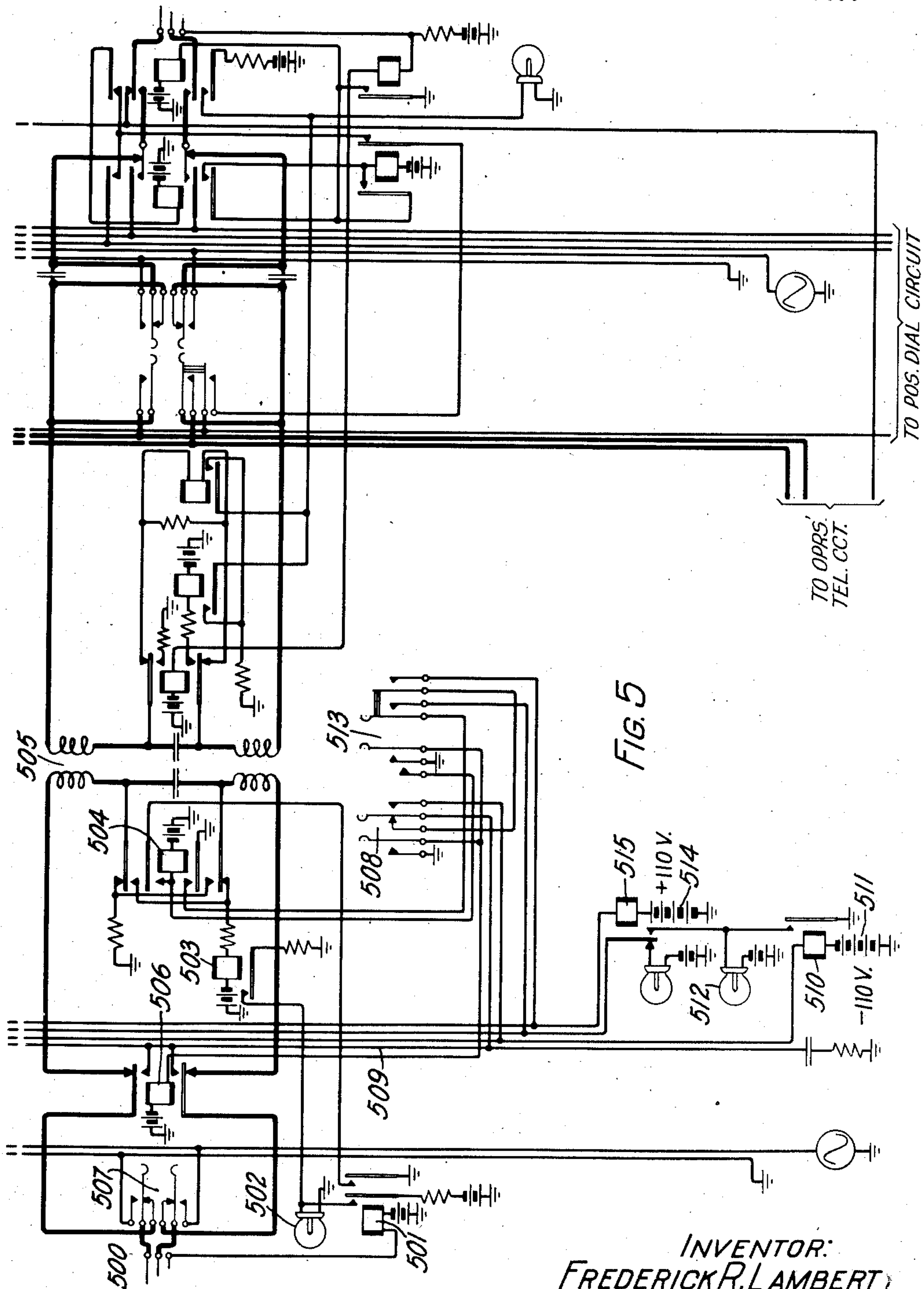
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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

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TRUNKING CIRCUIT TO CENTRALIZED OPERATOR'S POSITION.

Application filed December 6, 1927. Serial No. 238,007.

This invention relates to telephone exchange systems and more particularly to dial systems in which the connections to toll points are established through an operator's position and toll is assessed against calling subscribers by means of coin boxes associated with their lines. The object of the invention is the provision of improved trunk circuits for extending connections from calling lines to an operator's position which will enable the operator to control coin collection or refund from the usual coin keys of her cord circuit with greater facility and over the connection established to the operator's position by the calling subscriber.

In telephone exchange systems employing machine switching apparatus for extending connections between subscribers' lines, it is customary to provide so-called "machine switching A" operators' positions for the purpose of aiding subscribers in extending certain types of connections, particularly connections 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 the desired toll point. On such toll connections it is desirable, if the calling subscriber's line is equipped with a coin box, to require the subscriber to deposit the number of coins which the operator tells him is necessary, before the desired connection is completed. After the coins have been deposited provision must then be made to collect them if the call is successful or to refund any deposited coins if the call is unsuccessful. The present invention relates to a two-wire trunk for connecting a machine switching office to a centralized machine switching "A" board which is arranged to enable the control of the usual switchhook supervision between the subscribers' lines and the answering cord circuit at the "A" board, and to enable the operator to control the coin box to collect or refund deposited coins by means of the coin keys of her cord circuit. Provision is also made for operating a coin

pilot lamp at the operator's position when coin collecting or refunding current is transmitted to the coin box. Provision is also made for relighting the trunk lamp at the "A" board if the operator disconnects before the calling subscriber hangs up.

In the embodiment of the invention chosen for the purpose of illustration, the calling subscriber whose line is equipped with a coin box, upon initiating a call becomes connected over the usual switching equipment with a trunk circuit terminating in a first selector switch. This selector trunk circuit is provided with the usual equipment for controlling the coin box equipment. The subscriber, to obtain a toll connection, then dials zero setting the first selector on an idle trunk of a group extending to the machine switching "A" board which is made common to a plurality of offices in the exchange area. The trunk circuits of this group and in which the present invention centers are of the character of interoffice trunks and are, therefore, of the two-conductor type.

Each trunk, at either end thereof, is provided with a high resistance bridge and with line relays for reducing the resistance of each bridge for controlling supervision. When the trunk is seized at its outgoing end by a selector and the "A" operator has responded by plugging into the jack in which the incoming end of the trunk terminates, both bridges become effective. Since the calling subscriber's receiver is off the switchhook, the line relay at the outgoing end of the trunk reduces the resistance of the bridge thereat, thereby causing the line relay at the incoming end of the trunk to also reduce the resistance of the bridge thereat. The reduction of the resistance of the second bridge permits the operation of the answering cord supervisory relay to extinguish the answering supervisory lamp.

The bridge at the outgoing end of the trunk comprises three double wound relays, one of which serves as a trunk holding relay, and is responsive to the office battery current, and the two remaining relays being responsive only to 110 volt coin box current applied by the coin keys at the "A" board. One of these

latter relays is negatively polarized for response to negative 110 volt current and the other is positively polarized and responsive to positive 110 volt current. When the "A" operator desires to either refund or collect a coin in the calling line coin box, she operates the proper coin key at her position thereby applying either 110 volt positive or 110 volt negative current to both the tip and ring conductors of her cord circuit and thence to ground through both windings of a relay in the bridge at the incoming end of the trunk. This relay, which is not responsive to current from the office battery, does respond to 110 volt current applied by either of the operator's coin keys, and in turn causes the tip conductor of the interoffice trunk to become grounded and the ring conductor to be connected around the trunk condenser, so that the 110 volt current applied to the ring of the cord circuit may pass directly to the outgoing end of the trunk circuit and to the polarized relays in bridge thereof.

At the outgoing end of the trunk circuit the 110 volt current flows serially through all of the windings of the bridged relays. If negative 110 volt current has been applied to refund the coin, the negatively polarized relay of the bridge operates and in turn causes the application of 110 volt refunding current from a source local to the trunk circuit to be transmitted to the coin box of the calling line. Similarly if positive 110 volt current has been applied to collect the coin, the positively polarized relay of the bridge operates and in turn causes the application of 110 volt collecting current to be transmitted. In either case when current is thus applied to the coin box, means is provided at the outgoing end of the trunk circuit to short-circuit one winding of each of the bridged relays to reduce the resistance of the bridge, whereby a pilot lamp is lighted at the operator's position to indicate that current has been applied to the coin box.

At the termination of the call, when the calling subscriber returns his receiver to the switchhook, the bridge at the outgoing end of the trunk circuit is, under the control of the associated line relay, increased in resistance and thereby the bridge at the incoming end of the trunk circuit is also increased in resistance. The cord supervisory relay can not remain operated in series with the high resistance bridge at the incoming end of the trunk circuit and thus releases causing the illumination of the answering cord lamp as a disconnect signal.

Referring to the drawings, Fig. 1 shows a calling line terminating in a line switch, and a coin box controlling trunk circuit;

Fig. 2 shows a first selector circuit in which the trunk circuit of Fig. 1 terminates;

Fig. 3 shows the outgoing end of a trunk

circuit extending to a centralized "A" operator's position;

Fig. 4 shows the incoming end of the trunk circuit shown in Fig. 3; and

Fig. 5 shows one cord circuit at an "A" operator's position.

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 "A" operator's position of Fig. 5. For this purpose the several figures of the drawing should be arranged end to end in consecutive order with Fig. 1 at the left and Fig. 5 at the right.

Establishing connection.

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 connect with an idle trunk such as is shown in Fig. 1. The line switch 101 has been diagrammatically illustrated herein but may be of a well-known type such as is disclosed for example in Patent 1,304,369, issued to A. J. Ray on March 20, 1919. It will be assumed that the trunk line shown in Fig. 1 is idle and becomes connected by the line switch 101 to the substation 100. A circuit is thereupon established for the line relay 102 extending from ground through the outer left back contact of relay 103, winding of relay 102, coil 104, inner left back contact of relay 105, upper normal contacts of relay 106, tip brush of switch 101, over the substation loop returning over the ring brush of switch 101, lower normal contacts of relay 106, right back contact of relay 105, inner right normal contacts of relay 103, resistance 136, right normal contacts of relay 107, to battery 108. Relay 102 upon energizing, closes a circuit for relay 109 extending from battery at the right back contact of relay 110, winding of relay 109 to ground at the front contact of relay 102, and a circuit for relay 111 extending from battery at the right back contact of relay 110 through the winding of relay 111, the right back contact of relay 112, the inner left back contact of relay 103, to ground at the contact of relay 102. Relay 109, upon energizing, in turn closes a circuit for relay 103, extending from battery at the left back contact of relay 107, winding of relay 103 to ground at the contact of relay 109. With relay 109 energized the circuit of relay 111 is connected directly to ground at the inner left alternate contact of relay 103.

Relay 103, upon energizing, establishes a circuit for the line relay 200 of the first selector extending from battery, left winding of relay 200, uppermost lower back contact of relay 201, conductor 202, lower normal contacts of relay 113, conductor 114, right

front contact of relay 103, retard coil 115, conductor 116, winding of polarized relay 117, upper normal contacts of relay 113, conductor 203, inner upper back contact of relay 201, through the right winding of relay 200, the normally closed contacts of the 11th rotary step springs 208 to ground through the dialing tone coil 209. Relay 200 energizes, closing a circuit for slow release relay 204 extending from battery through the winding of relay 204, the front contact of relay 200 to ground at the uppermost back contact of relay 201. Relay 204 at its right front contact prepares a stepping circuit for the vertical magnet 205 in series with the slow-to-release relay 206 and at its left front contact places a busy holding ground on the sleeve conductor 207. Relay 103 upon attracting its inner right armature substitutes relay 122 for resistance 136 in the ring side of the calling line circuit but relay 122 being marginal does not operate at this time.

Dialing tone now passes from the coil 209 as traced over the tip trunk conductor 203, through the winding of relay 117, conductor 116, resistance 118, inner upper front contact of relay 111, condenser 119, upper normal contacts of relay 106, thence over the calling line returning through the lower normal contacts of relay 106, condenser 120, inner lower front contact of relay 111, resistance 121 conductor 114, thence to battery through the left winding of relay 200 as previously traced.

The subscriber hearing the tone proceeds to deposit a coin in the coin box chute preparatory to dialing. The coin box may be of the type shown and described in Patent 1,043,219, of November 5, 1912, issued to O. F. Forsberg. As shown and described in detail in said patent the deposited coin causes the closure of contact 123 to ground the tip side of the line and since the receiver is now removed from its hook this ground is also connected to the ring side of the line. The application of this ground closes a shunt about relay 102 and causes its deenergization, whereupon the marginal relay 122 operates over a circuit including the ring side of the line, the calling substation receiver hook and the ground closed at contact 123 of the coin box.

Relay 122 in operating closes a circuit for relay 108 extending from battery, contact of relay 122, winding of relay 108 to ground on conductor 207. The relay 102 releases when its winding is shunted through the deposit of the coin, in turn opening the circuit of relay 109, thereby releasing relays 103 and 111. Relay 122 releases following the release of relay 103. With relay 108 energized ground is connected over its inner left contact in shunt of relay 102, and an obvious circuit is closed from battery over its outer right front contact for relay 124 and from battery

over the same front contact, the outer left back contact of relay 105 to ground through the winding of relay 107. Relay 124 upon operating also closes an obvious circuit for operating relay 107 independent of the contacts of relay 105. At its outer left front contact relay 108 closes a shunt around resistance 118, a shunt about resistance 121 being closed at the right back contact of relay 103 upon the deenergization of the latter relay. At its intermediate left front contact relay 108 also establishes a circuit for relay 125 extending from battery, winding of relay 125, intermediate left front contact of relay 108, right back contact of relay 105, lower normal contacts of relay 106 to ground at the coin box contacts 123, thereby energizing relay 125.

Relay 125 operates before relay 103 which is slow to release has completely released, so that the bridge previously traced across trunk conductors 114 and 116 is maintained closed at the left contacts of relay 125 to prevent the relay 200 of the first selector from releasing. At its right contact relay 125 closes an obvious circuit for slow releasing relay 112 which, in turn, extends operating ground from the right front contact of relay 125 through the front contact of relay 112, winding of relay 111 to battery at the right normal contact of relay 110. The circuit is now ready for the calling subscriber to dial.

In response to dial impulses relay 125 follows the impulses, but relay 112 being slow to release does not deenergize during impulsing. Upon each deenergization of relay 125 in response to each dialing impulse, the bridge previously traced across trunk conductors 114 and 116 is opened at its left contacts, thereby permitting relay 200 of the first selector to release. Upon each release of relay 200 a circuit is closed from ground at the upper back contact of relay 201, back contact of relay 200, right front contact of relay 204, which relay being slow to release does not deenergize between impulses, winding of relay 206 to battery through the winding of vertical magnet 205. Magnet 205 operates to step the switch brushes vertically one step each time that relay 200 deenergizes in response to an impulse from the calling dial and relay 206 being slow to release remains energized until the series of impulses is terminated.

Upon the initial vertical step of the switch shaft the off-normal contacts 210 close and with relay 204 energized, a circuit is closed for relay 211 extending from battery, winding of relay 211, off-normal contacts 210, front contact of relay 206, to ground at the left contact of relay 204. Relay 211 prepares the circuit of the rotary magnet and locks over the off-normal contacts 210, back contact of rotary magnet 213, left contacts of relay 211 to ground at the upper contact of relay 201.

Since a connection to the "A" operator's position is under consideration, it will be assumed that the calling subscriber dialed the digit zero and that therefore the first selector
 5 was operated to position its brushes opposite the tenth level of its bank.

Following the termination of the impulse series, relays 200 and 204 remain energized and after an interval relay 206 deenergizes.
 10 A circuit is now closed for the rotary magnet 213 extending from battery, winding of magnet 213, right front contact of relay 211, normal contacts of relay 206 to ground at the left contact of relay 204. Magnet 213, upon operating, opens the locking circuit of relay
 15 211, whereupon relay 211 deenergizes in turn opening the operating circuit of magnet 213. The switch brushes are thus advanced in a rotary direction into engagement with the first
 20 set of trunk terminals in the tenth level. If the trunk in which this set of terminals terminates is busy, there will be ground potential on the sleeve terminal engaged by brush 212 and relay 211 will be again op-
 25 erated from ground on the brush 212, over the lower back contact of relay 201, the back contact of magnet 213, off-normal terminals 210 to battery through the winding of relay 211. Relay 211 will again close the
 30 circuit of magnet 213 which will operate again, opening the circuit of relay 211, thus advancing the switch brushes to the next set of trunk terminals. In this manner the switch brushes are advanced until an idle
 35 trunk is encountered, which trunk will be assumed to be the one disclosed in Figs. 3 and 4.

Relay 201 which has been shunted as long as the brush 212 encountered grounded sleeve terminals of busy trunks now energizes in a
 40 circuit from battery, through the winding of relay 211, off-normal terminals 210, the back contact of rotary magnet 213, winding of relay 201, normally closed contacts 214 of the eleventh rotary step springs 208 to ground at the left contact of relay 204. Relay 201 be-
 45 ing of high resistance relay 211 does not operate in series with relay 201. Relay 201 at its inner front contacts connects the trunk conductors 203 and 202 over conductors 216 and 215, brushes 217 and 218 to trunk con-
 50 ductors 219 and 220, respectively, disconnects the windings of relay 200 from conductors 202 and 203 at its inner back contacts thereby releasing relays 200 and 204, disconnects
 55 operating ground at its uppermost back contact and at its lowermost front contact, connects the sleeve conductor 207 directly through to sleeve brush 212, thence to the sleeve conductor 305 of the selected trunk circuit. Ground is applied to conductor 305
 60 as will be presently described before slow-to-release relay 204 has time to completely release so that ground is supplied to conductor 207 without interruption and relay 201 is
 65 maintained energized over the circuit previ-

ously traced through its winding, thence through contacts 214, the lower front contact of relay 201 to ground on conductor 305.

Upon the seizure of the trunk 219, 220 a circuit is established for the relay 300 which ex-
 70 tends from battery, winding of relay 300, lower left winding of repeating coil 301, lower back contacts of relays 302 and 303, conductor 220, brush 218, conductor 215, innermost lower front contact of relay 201, conductor 202,
 75 lower normal contact of relay 113, conductor 114, left front contact of relay 125, retard coil 115, conductor 116, winding of relay 117, upper normal contact of relay 113, conductor 203, upper front contact of relay 201, con-
 80 ductor 216, brush 217, conductor 219, upper back contacts of relays 303 and 302, upper left winding of repeating coil 301, resistance 320 to ground. Relay 300 energizes, closing an obvious circuit for relay 304. Relay 304
 85 places ground on the sleeve conductor 305 to hold the preceding selector from releasing. Relay 304 also closes a circuit to operate relay 306 which may be traced from battery, through
 90 the winding of relay 306, the lower back contact of relay 309 to ground at the contact of relay 304.

Relay 306, upon energizing, closes a circuit for operating relay 307 which extends from
 95 battery through the winding of relay 307, the upper normal contacts of relay 309 to ground at the armature of relay 306. Relay 307, upon operating, establishes a circuit over the two conductors 310 and 311 of the trunk ex-
 100 tending to the "A" operator's position for operating the relay 400 in a circuit which may be traced from battery, upper winding of relay 309, upper front contact of relay 307, upper right winding of repeating coil 301, conductor
 105 310, upper back contact of relay 401, winding of high resistance relay 400, lower back contact of relay 401, conductor 311, lower right winding of repeating coil 301, lower front contact of relay 307 to ground through the
 110 lower winding of relay 309. Relay 400 energizes in this circuit, but relay 309 being marginal does not operate due to the high resistance of relay 400. Relay 400 closes an obvious circuit for the trunk lamp 402.

In order that the calling subscriber may be
 115 apprised of the fact that the operator is being signaled, relay 307, upon operating, connects the source of ringing current 308, over its lower front contact, the lower back contacts of relays 302 and 303, thence as traced to con-
 120 ductor 114, right back contact of relay 103, innermost lower front contact of relay 111, condenser 120, lower normal contacts of relay 106, thence over the calling line, returning over the upper normal contacts of relay 106,
 125 condenser 119, upper front contact of relay 111, left front contact of relay 108, conductor 116, thence as traced to ground through the resistance 320.

In response to the lighting of trunk lamp 130

402, the "A" operator inserts the answering plug 500 of a cord circuit at her position into the jack 403 of the trunk to which the lamp 402 is individual, closing a circuit extending from battery, winding of sleeve relay 501, sleeves of plug 500 and jack 403 to ground through the winding of relay 401. Relay 401 energizes, disconnecting the winding of relay 400 from the conductors 310 and 311 of the trunk circuit and through its upper and lower front contacts, respectively, connects ground to conductor 310 and battery to conductor 311, through the back contacts of relay 405 and the windings of relay 404. It is to be noted that battery is now connected to the ring conductor 311 of the trunk, through the lower winding of relay 404 and ground is connected to this trunk conductor through the lower winding of relay 309, and that ground is connected through the upper winding of relay 404 to the tip conductor 310 and battery to the same conductor through the upper winding of relay 309. Relays 309 and 404 both operate in this circuit.

Relay 309, upon operating, locks through its upper alternate contact to ground at the contacts of relay 306 and opens the circuit of relay 307 which now releases, disconnecting the ringing tone as a signal that the operator has answered the call, and bridging the lower windings of relays 312, 313 and 314 in series across the trunk conductors 310 and 311. This bridge extends from conductor 310, through the upper right winding of coil 301, the upper back contact of relay 307, the lower front contact of relay 300, the right back contact of relay 316, the right back contact of relay 317, conductor 315, the lower windings of relays 314, 313 and 312, the lower back contact of relay 307, the lower right winding of coil 301 to conductor 311. The upper windings of relays 312, 313 and 314 are not effective at this time being shunted by the lower front contact of relay 300. Relay 404 is held energized over this bridge.

It is to be noted at this point that prior to the response of the operator there was a wet bridge of the trunk conductors 310 and 311, through the windings of relay 309 at the outgoing end of the trunk and a dry bridge through the winding of relay 400 at the incoming end thereof and that upon the response of the operator, the wet bridge through the windings of relay 404 became substituted for the dry bridge at the incoming end of the trunk and a dry bridge through the windings of relays 312, 313 and 314 was substituted for the wet bridge through the windings of relay 309 at the outgoing end of the trunk.

Relays 313 and 314 do not operate on current of signalling strength over the bridge circuit previously traced, but relay 312 operates closing a holding circuit for relay 306 to replace the operating circuit through the back contact of relay 309 which was opened

upon the energization of relay 309, and establishing a new holding circuit for sleeve relay 304. Relay 306 being slow to release does not have time to completely deenergize following the opening of its circuit by relay 309 before relay 312 closes the new holding circuit through its winding.

At the incoming end of the trunk circuit when the operator inserted the plug 500 into the jack 403, a circuit was established extending from battery, through the winding of answering supervisory relay 503, the lower back contact of relay 504, the lower left winding of repeating coil 505, the lower back contact of relay 506, the lower normal contact of key 507, rings of plug 500 and jack 403, the lower winding of retard coil 408 and the lower winding of relay 409 to ground. Relay 503 does not operate in this circuit due to the high resistance of relay 409, but upon the operation of relay 404 a shunt upon both windings of relay 409 is closed, thereby permitting relay 503 to operate. Relay 503, upon operating, shunts the supervisory lamp 502 which became lighted upon the operation of the sleeve relay 501 and this lamp is thereupon extinguished.

Relay 309 at its lower front contact closes a circuit for the reversing relay 303 extending from battery through the winding of relay 303, lower front contact of relay 309, to ground at the front contact of relay 304. Relay 303 upon operating reverses the connection of ground and battery through resistance 320 and relay 300 to the trunk conductors 219 and 220 whereby the current flowing through the winding of polarized relay 117 is now in the proper direction to operate relay 117. Relay 117 upon operating closes a circuit for relay 126 extending from battery through the winding of relay 126, right normal contacts of relay 126, contact of relay 117, to ground at the outer left front contact of relay 107. Relay 126 upon operating opens its own operating circuit and locks directly to ground at the outer left contact of relay 107. A circuit in parallel with the energizing circuit of relay 126 is also closed through the back contact of relay 127 and the winding of relay 113 to battery. Relay 113 upon operating reverses the connection of the trunk conductors 202 and 203 to the conductors 114 and 116 thereby causing relay 117 to deenergize, and at its lowermost front contact closes a circuit for relay 127 extending from battery, winding of relay 127, lower front contact of relay 113, to ground at the outer left front contact of relay 107. Relay 113 also closes a locking circuit for itself over its lower front contact. Relay 126 upon operating causes the operation of relay 106 in a circuit extending from battery, through the winding of relay 106, inner left front contact of relay 126, to ground on the sleeve conductor 207. With relay 106 operated the conduc-

tors 114 and 116 become connected directly over the brushes of the line switch 101 to the calling line conductors.

The operator then proceeds in the usual manner to obtain the necessary information from the calling subscriber for the further extension of the connection and then proceeds to complete the connection.

Refunding the deposited coin.

It will first be assumed that the operator does not desire to charge the calling subscriber for the desired connection and wishes to refund the coin which has been deposited in the coin box. The operator then proceeds to refund the coin by depressing the refund key 508. When this key is operated a circuit for the relay 506 is established extending from battery through the winding of this relay to ground at the left contact of key 508. Relay 506 upon energizing disconnects signaling battery from the tip and ring contacts of plug 500 and connects the tip and ring of the plug through the front contacts of relay 506 in parallel to conductor 509, thence through the right alternate contact of key 508 to the 110 volt source of negative refunding potential 511 through the winding of relay 510. Current from the source 511 flows over the tip and ring contacts of jack 403 in parallel through the windings of relay 409 to ground regardless of whether the calling subscriber's receiver is off the hook and relay 404 is still energized, or whether the receiver is on the hook and relay 404 is deenergized.

Due to the high resistance of relay 409 the relay 510 does not operate at this time to close the circuit of the coin pilot lamp 512. Relay 409 operates, however, closing an obvious circuit for relay 405 which disconnects the windings of relay 404 from trunk conductors 310 and 311, connects direct ground to the trunk conductor 310, and connects the trunk conductor 311 through the lower front contacts of relays 401 and 405, through resistance 410, to conductor 407, thence to the 110 volt source of negative potential 511.

Current from the source 511 now flows over the ring conductor 311 of the trunk to ground as traced through the lower windings of relays 312, 313 and 314 causing the operation of relay 312 and of the polarized relay 313 which is poled to respond to 110 volt negative current. Polarized relay 314 being poled oppositely does not respond. Relay 313 upon energizing operates relay 316 in an obvious circuit which latter relay upon energizing removes, at its right contact, the shunt from the upper windings of relays 312, 313 and 314, closes an obvious circuit for relay 302 at its inner left contact, and at its outer left contact connects the 110 volt source 321 of coin refunding current through the winding of relay 322, the front contacts of relay 302 in parallel, thence to the trunk conductors 219 and 220.

Upon the energization of relay 302 the line relay 300 is removed from connection with the incoming trunk conductors 219 and 220. With the shunt removed from the upper windings of relays 312, 313 and 314 the upper and lower windings of these relays are connected in series across the trunk conductors 310 and 311, their resistance being so high that the coin pilot lamp relay 510 at the cord circuit cannot operate. Relay 312 being operated maintains relays 304 and 306 energized.

When the relay 302 operated to connect the refunding current source 321 to the trunk conductors 219 and 220 since these conductors are now both connected directly through to the conductors of the subscriber's line, current from source 321 flows through the coin box magnet 128 in such a direction as to cause the deposited coin to be dropped into the refund chute. Since it has been assumed that a coin has been deposited, the current flowing from source 321 operates relay 322 which replaces the shunt around the upper windings of relays 312, 313 and 314 which was previously removed when relay 316 operated. The shunting of these relay windings now permits sufficient current to flow through the winding of relay 510 to operate the latter relay to light the coin pilot lamp 512 as a signal that the coin has been refunded.

The operator thereupon releases the refund key 508, releasing relays 506, 409 and 405. Signaling battery and ground are now reconnected to the trunk conductors 406 and 407 and the 110 volt source 511 is disconnected. Since relay 313 will not respond to current of signaling strength through the windings of relay 404, it releases in turn releasing relays 316, 302 and 322. With relay 302 released relay 300 again energizes restoring the shunt around the windings of relays 312, 313 and 314. The talking path from the calling line to the operator's cord circuit is now completed.

Collecting the deposited coin.

It will now be assumed that the operator depressed the collect key 513 rather than the refund key 508. The depression of key 513 operates relay 506 as before and connects the source 514 of positive 110 volt coin collecting current through the winding of relay 515 over the outer right contact of key 513, the right normal contact of key 508, thence through the front contacts of relay 506, and as traced through the windings of relay 409, to ground. Relay 409 functions as previously described to operate relay 405 which in turn establishes connections whereby current flows from the source 514, through the lower windings of relays 312, 313 and 314, to ground at the upper front contact of relay 405. Relay 312 and polarized relay 314 now energize. Relay 313 being poled in the opposite direction does not operate. Relay 312 holds relays 304 and 306

operated and relay 314 closes an obvious circuit for relay 317 which in turn closes an obvious circuit for relay 302 and connects the source 323 of 110 volt positive coin collecting current to the tip and ring conductors of the calling line thereby causing the coin box magnet 128 to collect the deposited coin.

At the cord circuit when the key 513 was depressed an obvious circuit was also closed for relay 504 which at its innermost lower front contact prepared a circuit for the lamp 512. If a coin was deposited in the coin box the relay 322 operated upon the application of collecting source 323 to the calling line and in the manner previously described causes the shunting of the upper windings of relays 312, 313 and 314 to permit the coin pilot relay 515 to operate. The circuit of lamp 512 is now completed from battery, through lamp 512, front contact of relay 515, inner right contact of key 513, to ground at the innermost lower front contact of relay 504.

Noting the illumination of the coin pilot lamp 512 the operator restores the collect key 513, releasing relay 506 thereby restoring the connection of the signaling current source to the cord circuit and disconnecting the source of collecting current 514. Relays 409, 405, 312, 314, 317 and 302 thereupon release and the circuits are in condition for talking.

Supervision of connection.

When the calling subscriber restores his receiver to the switch hook, relay 300 releases. With relay 300 released the shunt around the upper windings of relays 312, 313 and 314 is opened thereby including the resistance of all of the windings of these relays in the bridge of trunk conductors 310 and 311. Relay 404 thereupon releases opening the shunt about the windings of relay 409 whereby these windings are effective in the bridge across conductors 406 and 407. Relay 503 at the cord circuit does not now receive sufficient current to maintain itself energized and it releases, opening the shunt about the supervisory lamp 502 to light the lamp as a disconnect signal.

In response to this signal the operator removes the plug 500 from the jack 403. Relay 401 thereupon releases disconnecting the windings of relay 404 from trunk conductors 310 and 311 and connecting the winding of relay 400 in bridge thereof. Relay 312 thereupon releases and since relay 300 is deenergized at this time the holding circuits for relays 304, 306, and 309 are opened and these relays release. Relay 304 upon releasing disconnects ground from conductor 305 releasing relay 201 in the first selector and removing ground from conductor 207.

At the selector a circuit is now closed from ground at the upper back contact of relay 201, over the back contacts of relays 200 and

204, off-normal contacts 221 to battery 65 through the release magnet 222. Magnet 222 operates restoring the selector to normal. When the switch shaft reaches its normal position the contacts 221 open and magnet 222 releases.

When ground was removed from conductor 207, relays 106, 107, 108, 113, 124, 126 and 127 released and since relays 111 and 112 released upon the deenergization of relay 125, all apparatus associated with the trunk circuit of Fig. 1 is released. The release of relays 111 and 107 removes ground through retard coil 129, from sleeve conductor 130, which ground has held the line switch 101 operated, and the line switch releases. All apparatus employed in the establishment of the connection is now restored to normal.

Had the operator disconnected the cord circuit from the trunk jack 403 before the calling subscriber hung up, then relay 300 would still be energized and the withdrawal of plug 500 from jack 403 would deenergize relay 401 thereby disconnecting the windings of relay 404 from the trunk conductors 310 and 311, reconnecting the winding of relay 400 in bridge of the trunk conductors. Relay 312 thereupon releases, releasing relays 303, 306 and 309. Upon the release of relay 309, relay 306 reoperates from ground at the front contact of relay 304, relay 304 being maintained energized by ground at the front contact of relay 300. Relay 307 is now operated and connects the windings of relays 309 to the trunk conductors 310 and 311 thereby operating relay 400 which in turn closes the circuit of the trunk lamp 402. When the calling subscriber hangs up, relay 300 releases in turn releasing relay 304 whereupon the circuits all become restored in the manner previously described.

Only those portions of Fig. 1 and Fig. 5 have been described herein whose functions are necessary to an understanding of the present invention. For a further description of the operation of the circuit of Fig. 1, reference may be had to the patent to Dunham 1,569,623, issued January 12, 1926.

What is claimed is:

1. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, coin box control keys associated with said cord circuit, a bridge across said trunk circuit comprising a plurality of relays, said relays being controlled by said keys, and means under the control of said relays for applying coin box operating current to said calling line.

2. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat,

means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, coin box control keys associated with said cord circuit for applying current of coin box operating voltage to said trunk circuit, a bridge across said trunk circuit comprising polarized relays responsive only to said coin box operating current and a relay responsive to current of signaling strength, means controlled by said latter relay for controlling the release of said line extending means, and means controlled by said polarized relays for applying coin box operating current to said calling line.

3. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk terminating thereat, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, a coin box control key associated with said cord circuit for applying coin box operating current to said trunk circuit, a pilot lamp associated with said key, a high resistance bridge across said trunk circuit comprising a relay, said relay being controlled by said key, means under the control of said relay for applying coin box operating current to said calling line, and means operative upon the application of said current to said line to reduce the resistance of said bridge to operate said pilot lamp.

4. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, a source of coin box operating current, a pilot relay, a coin box control key for connecting said source through said relay to said trunk circuit, a pilot lamp controlled by said relay, a high resistance bridge across said trunk circuit comprising a relay, said relay being controlled by said key, means under the control of said latter relay for applying coin box operating current to said calling line, and means operative upon the application of said current to said line to reduce the resistance of said bridge to operate said pilot relay.

5. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, coin collect and refund keys associated with said cord circuit for applying coin box operating current of opposite polarities to said trunk circuit, a pilot lamp associated with said keys, a high resistance bridge across said circuit comprising two oppositely polarized relays, each of said relays being controlled re-

spectively by one of said keys, means under the control of said relays for applying operating current to said line for collecting or refunding coins deposited in said coin box, and means operative upon the application of said current to said line to reduce the resistance of said bridge to operate the pilot lamp.

6. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat, said trunk circuit being inductively divided into a plurality of sections, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, a coin box control key associated with said cord circuit, a relay bridged across said trunk circuit at its incoming end and responsive to said key, a bridge across said trunk circuit at its outgoing end including a relay, means under the control of said last named relay for applying coin box operating current to said calling line, and means controlled by said first relay to extend a conductive connection from said key over both sections of said trunk circuit whereby said second relay is placed under the control of said key.

7. In a telephone exchange system, a calling line, a coin box thereon, an operator's position, a trunk circuit terminating thereat, means for extending said calling line to said trunk circuit, a cord circuit at said position for connection with said trunk circuit, a supervisory relay in said cord circuit, a coin box control key associated with said cord circuit, a bridge including a relay connected across said trunk circuit for controlling said coin box, said bridged relay being responsive to current of coin box operating voltage applied by said key but unresponsive to current of signaling voltage applied through said supervisory relay from said cord circuit and having such resistance that said supervisory relay does not operate in series therewith, and means responsive to the removal of the subscriber's receiver from the switchhook for reducing the resistance of said bridge whereby said supervisory relay operates.

8. In a telephone exchange system, a calling line, an operator's position, a trunk circuit for extending said line to said position, a trunk lamp, a bridged relay at the incoming end of said trunk circuit for controlling said lamp, means for establishing a battery bridge across said trunk circuit at its outgoing end upon seizure of said trunk circuit by said subscriber's line to operate said relay, a relay in said battery bridge inoperative in circuit with said first relay, means operative upon the connection of said operator's position to the incoming end of said trunk circuit to disconnect said first relay from said trunk circuit and to connect a battery bridge there-

to, whereby said second relay operates, a relay bridge at the outgoing end of said trunk circuit established upon the response of said second relay, and a third relay under the control of said latter bridge for holding said second relay operated, whereby if said trunk is released at said incoming end before the subscriber releases said second relay deenergizes and said first relay reenergizes to re-operate said trunk lamp. 10

In witness whereof, I hereunto subscribe my name this 3rd day of December, A. D. 1927.

FREDERICK R. LAMBERTY.