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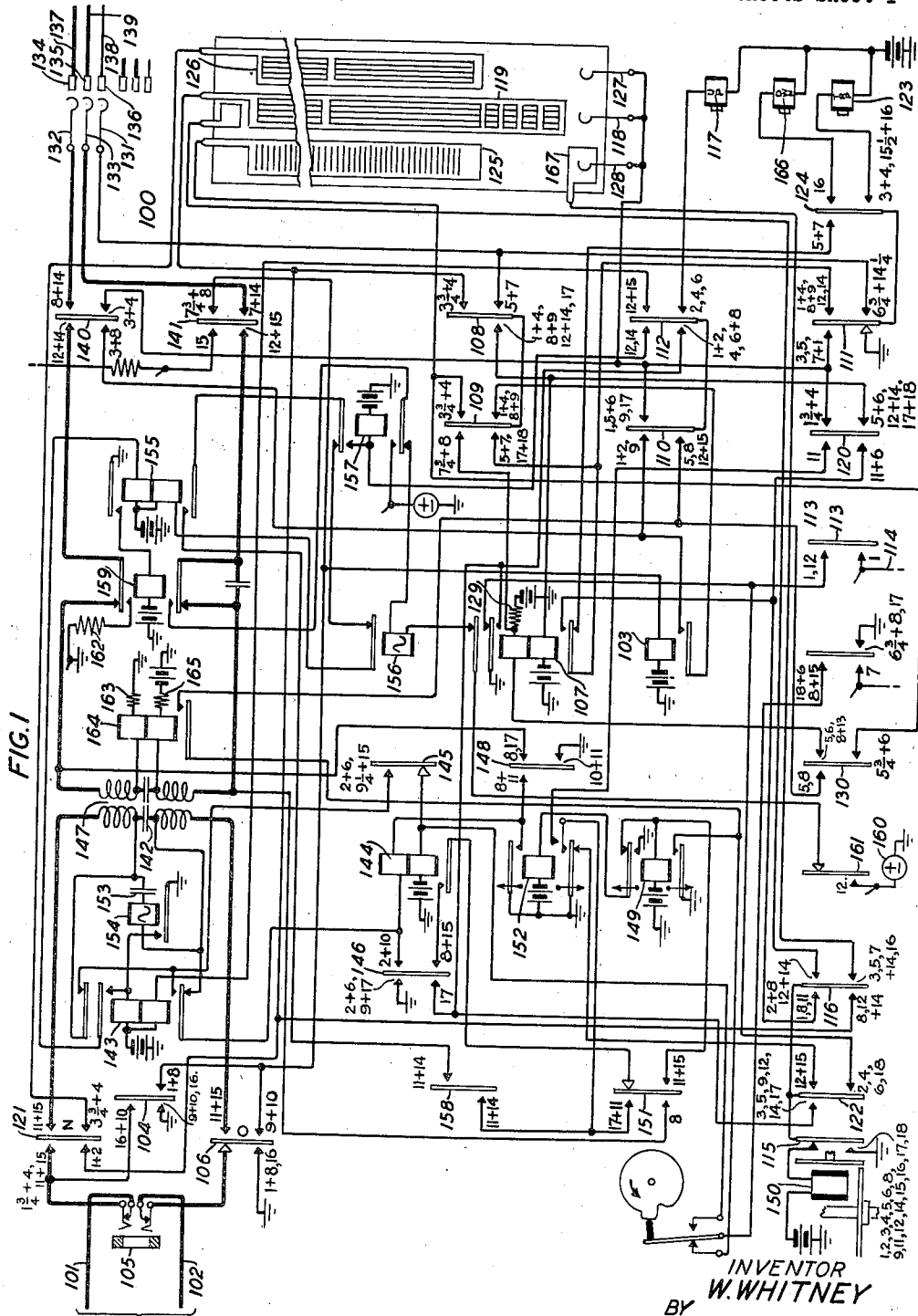
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2,105,898

TELEPHONE EXCHANGE SYSTEM

Filed Feb. 21, 1936

4 Sheets-Sheet 1



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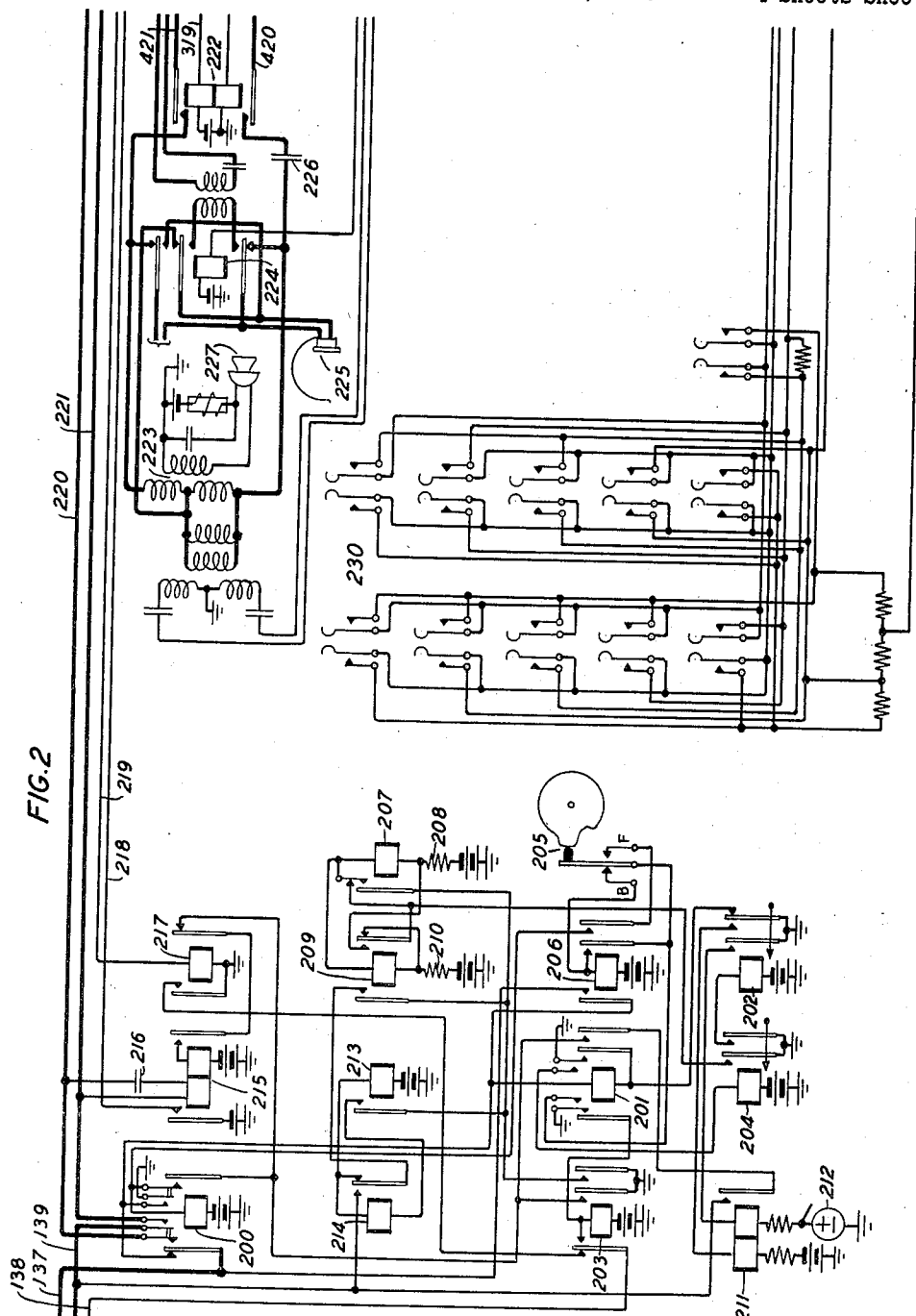
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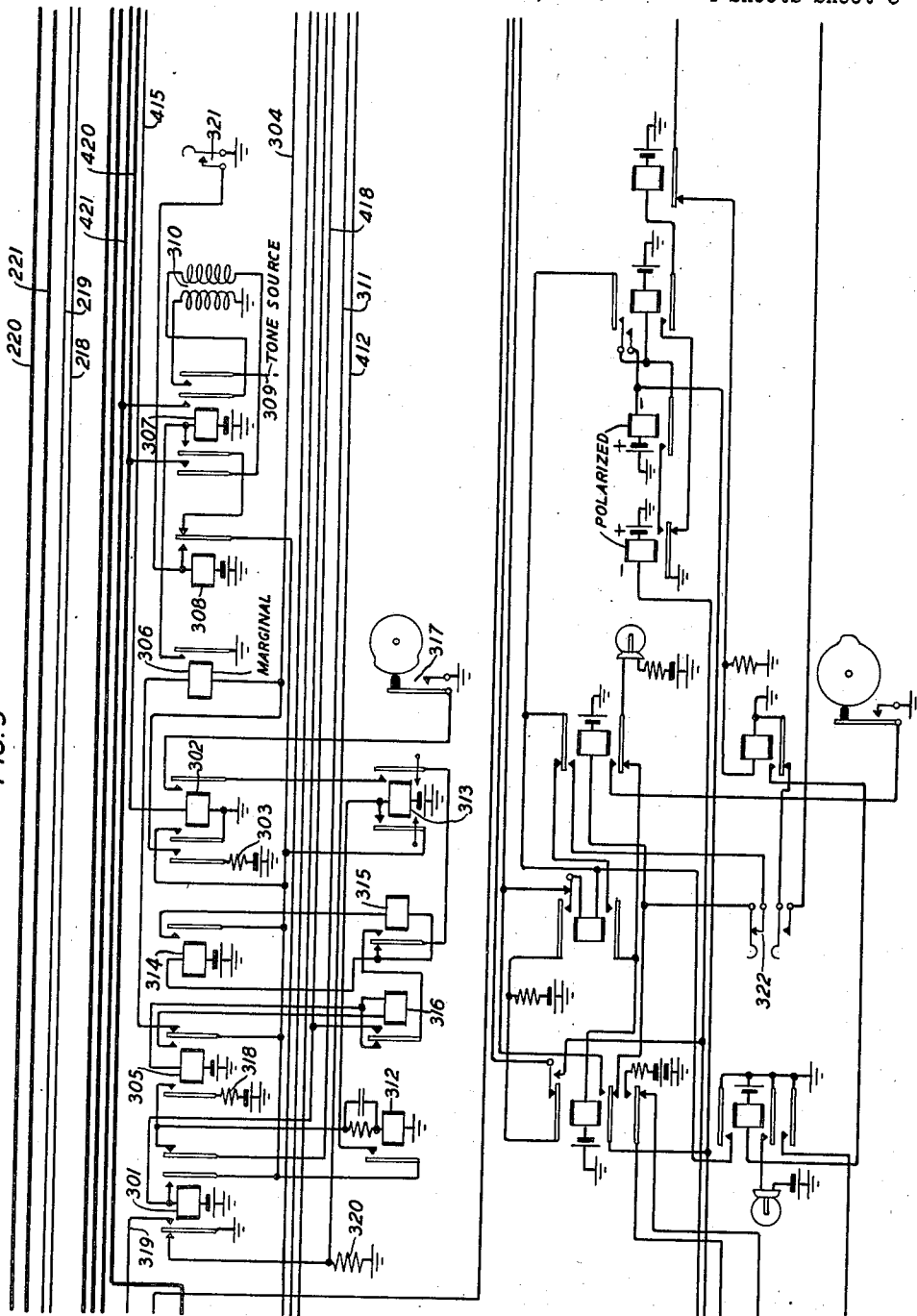
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TELEPHONE EXCHANGE SYSTEM

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FIG. 3



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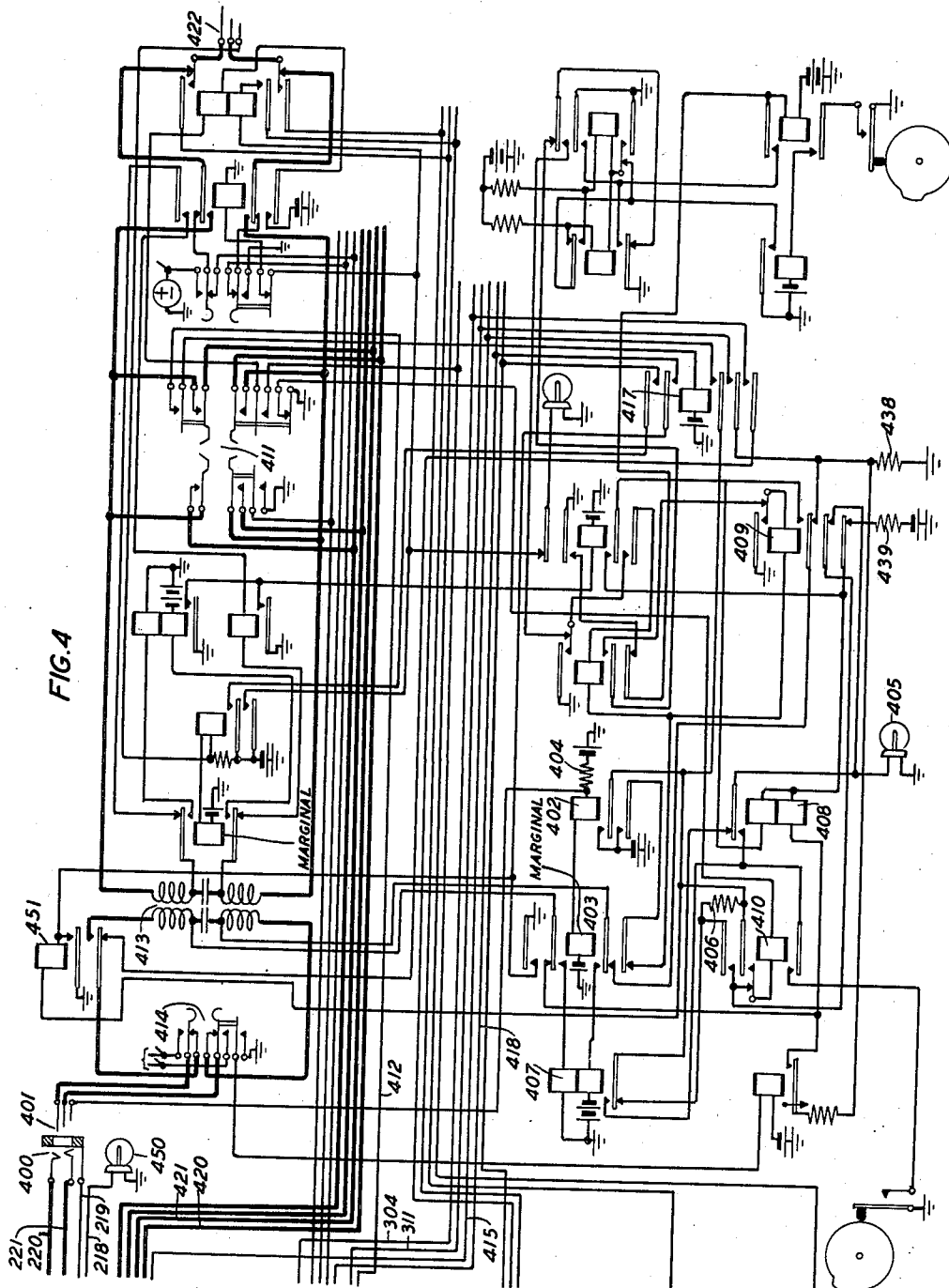
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TELEPHONE EXCHANGE SYSTEM

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UNITED STATES PATENT OFFICE

2,105,898

TELEPHONE EXCHANGE SYSTEM

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Application February 21, 1936, Serial No. 65,032

6 Claims. (Cl. 179—27)

This invention relates to automatic telephone exchange systems and more particularly to circuits for enabling an operator to intercept calls which have been extended to blank terminals of selector switches in the establishment of either local or toll connections.

The object of the invention is to simplify and improve the apparatus of an operator's position in a system of this type whereby an operator may answer all types of intercepting calls with the same cord circuit equipment and receive a discriminating signal when she answers an intercepted call incoming over toll selectors.

In the installation of telephone exchanges in which mechanical switching mechanism is employed for extending connections between subscribers' lines, it is the usual practice to divide the exchange area into a plurality of offices and to make provision in each office for ultimately giving service to ten thousand subscribers' lines. The number of offices in the exchange area is so selected that at the outset no office is required to function to ultimate capacity, and therefore there must always be switching units which are not employed to their fullest extent. This is especially true of incoming selector switches which have access to small groups or divisions of trunk lines and to final selector switches which have access to the individual subscriber's lines. Thus there will be a number of terminal sets in the banks of incoming selectors which are blank or not connected to working trunk lines extending to final selector switches and terminal sets in the banks of final selector switches which are blank or not connected to subscribers' lines.

If an incoming selector switch in response to dialing is positioned to extend a connection into a division of an office which has not been fully installed or a final selector is positioned upon a blank terminal to which no subscriber's line has been connected, the attempted connection is routed to a trunk terminating at an operator's position on a so-called "A" switchboard. This operator may also receive calls from subscribers who desire assistance and dial zero and may also receive calls from subscribers who desire to obtain toll connections.

It may occur that in an attempt to terminate a toll connection over a toll incoming selector and final selector, such selectors may inadvertently be set upon a blank terminal. In this case also the attempted connection will be routed to a trunk terminating at the operator's position. Thus both local and toll calls intended for a particular subscriber's line may be routed over a

common group of trunks to an operator's position if either an incoming or final selector switch used in the establishment of such a connection is erroneously set upon a blank terminal.

In accordance with the present invention the operator's position is equipped with cord circuits with which she may answer such intercepted calls and with which she may complete the calls which the subscribers failed to complete. When a call becomes routed to an intercepted trunk, the operator answers and ascertains from the calling subscriber the number of the desired subscriber. She then proceeds to complete the connection if possible. If, however, a connection with a subscriber's line terminating in the office has been attempted from a distant toll point and has become routed to an intercepting trunk terminating at the operator's position, it becomes desirable to inform the operator of the character of the call when she answers it for the reason that it would not be advisable for the operator to attempt to complete such a toll connection.

In order that the operator may receive this special information when she answers an intercepted call from a toll point, the toll incoming selector used in establishing the connection is provided with a resistance in the ringing generator ground lead. Thus the tip talking conductor at the toll incoming selector always provides a resistance to ground when being answered by an intercepting operator either through the generator lead resistance on immediate ringing calls or through the tip winding of the repeating coil of the incoming trunk on delayed ringing calls. Since the tip will always be connected direct to generator ground on calls over other types of incoming selectors when being answered by the intercepting operator, a means of discrimination is thus provided.

At the operator's position circuit a low resistance marginal relay is provided which becomes connected from ground, in parallel with a connection through a resistance to grounded battery, to the tip conductor of the answering end of the cord circuit as soon as the operator answers the call by plugging up in the intercepting trunk jack and by operating the talking key of the cord circuit. If direct ringing generator ground is present on the tip conductor, the marginal relay does not operate and the position circuit proceeds in the regular manner to trip the ringing and to cut the operator's headset through to the calling subscriber's line. If, however, generator ground through a resistance is present on the tip conductor, as on a call from a toll incoming selector, the

marginal relay operates and causes the operation of another relay which prepares a circuit for connecting a source of tone current to the operator's headset. The position circuit then proceeds to trip ringing in the usual manner. When tripping is completed tone current is applied to the operator's headset until the operator depresses a tone removal key, whereupon the tone source is disconnected and the operator's headset is connected for talking. Other means for giving the operator a special signal might be provided such as a lamp or an alarm device.

For a clearer understanding of the invention reference may be had to the following detailed description thereof and the mode of its operation taken in connection with the accompanying drawings of which:

Fig. 1 shows a trunk incoming from a toll point and terminating in an incoming selector switch having access to final selector trunks and to intercepting trunks, the outgoing end of one such intercepting trunk being illustrated;

Fig. 2 shows in the left portion thereof the relay equipment at the incoming end of the intercepting trunk and in the right portion thereof the headset circuit and key-set of an intercepting operator's position;

Fig. 3 shows the position equipment of the intercepting operator's position; and

Fig. 4 shows one cord circuit of the intercepting operator's position.

For a complete disclosure of the invention the several figures of the drawings should be placed end to end with Fig. 1 at the extreme left and Fig. 4 at the extreme right.

The incoming selector switch 100 of Fig. 1 is of the well-known power-driven panel type designed for extending connections from toll operators' positions equipped with key pulsing equipment of the type disclosed, for example in Patent 1,780,906, granted November 11, 1930 to W. W. Carpenter et al.

For the purpose of this discussion it will be assumed that the toll operator has plugged into a trunk jack at her position (not shown), has keyed a subscriber's line number and that a key pulsing sender at the toll office has become connected over trunk conductors 101 and 102 with the incoming selector 100 and proceeds to set the selector to establish a connection toward the terminals of the called line, the designation of which the toll operator has set up on her position key-set. It will further be assumed that the number keyed is 2467.

Upon the association of the sender with the incoming selector a fundamental circuit is established from battery, winding of control relay 103, lower right and upper contacts of sequence switch cam 104, upper normal contacts of test jack 105, conductor 101, through the winding of the stepping relay of the sender (not shown), returning over conductor 102, lower normal contacts of jack 105, left contacts of cam 106 to ground. Relay 103 operates and closes a circuit from battery through the lower winding of relay 107, left contact of cam 108, lower right contact of cam 109, contacts of relay 103, upper contacts of cam 110 to ground over the left contacts of cam 111. Relay 107 operates and locks in a circuit from battery through its lower winding, left contact of cam 108, lower right contact of cam 109, contacts of relay 103, upper left contact of cam 110, lower left contact of cam 112, to ground at the upper front contact of relay 107 whereby it is maintained operated under the control of relay 103

after the sequence switch leaves position 1. At its upper back contact relay 107 removes ground from the circuit extending over the contacts of cam 113 to conductor 114 to provide for the operation of the all-trunks-busy register if all trunks in the group to be selected are busy and at its lower front contact establishes a circuit for advancing the sequence switch of the selector out of position 1 into position 2. This circuit may be traced from battery, winding of sequence switch magnet 150, contacts of cam 115, upper left contact of cam 116, lower front contact of relay 107 to ground over the upper right and lower left contacts of cam 111. Following the advance of the sequence switch to position 2, relay 107 is maintained operated over its locking circuit under the control of relay 103.

With the sequence switch in position 2 and relays 103 and 107 operated a circuit is established for the up-drive magnet 117 which may be traced from battery through the winding of this magnet, the lower contacts of cam 112 to ground at the upper front contact of relay 107 and the brush rod of the selector switch 100 is thereby driven upwardly in a brush selection movement. During the upward travel of the brush rod the commutator brush 118 engages the segments of the lower portion of commutator strip 119 thereby intermittently establishing a circuit from ground over the lower left and upper right contacts of cam 111, lower front contact of relay 107, lower left and upper right contacts of cam 120, brush 118, conducting segments of strip 119, left contacts of cam 121 to the tip trunk conductor 101 and also as traced through the winding of relay 103. Relay 103 is held operated but each application of ground to trunk conductor 101 shunts down the stepping relay of the sender in the well-known manner.

When the sender has been satisfied with respect to its incoming brush registration or as assumed after two shunting impulses have been transmitted, the sender opens the fundamental circuit thereby releasing relay 103 which, in turn, releases relay 107. Relay 107 upon releasing opens the circuit of up-drive magnet 117 to arrest the further upward movement of the brush rod and closes a circuit for advancing the sequence switch into position 3. This circuit may be traced from battery, winding of sequence switch 150, contacts of cam 115, lower contact of cam 122, inner upper back contact of relay 107 to ground. The brush rod has now positioned the brush sets carried thereby in such a position that the second brush set will be tripped during the initial portion of the subsequent upward movement of the brush rod.

With the sequence switch in position 3 a circuit is established from battery through the winding of trip magnet 123, lower contact of cam 124 to ground at the lower left contact of cam 111. The fundamental circuit is again closed and relay 103 reoperates thereover closing an operating circuit for relay 107 which now extends from battery, lower winding of relay 107, left contact of cam 108, lower right contact of cam 109, contacts of relay 103, lower contacts of cam 140, left contacts of cam 111 to ground. Relay 107 operates and locks in a circuit from battery through its lower winding, left contact of cam 108, lower right contact of cam 109, contacts of relay 103, lower contacts of cam 140, upper right and lower left contacts of cam 120, lower front contact of relay 107 to ground over the upper right and lower left contacts of cam 111 whereby it is maintained operated under the control of relay 103.

after the sequence switch leaves position 3, and establishes a circuit for advancing the sequence switch out of position 3 into position 4. This circuit may be traced from battery through the winding of sequence switch magnet 150, contacts of cam 115, left contact of cam 122 to ground at the inner upper front contact of relay 107

When the sequence switch enters position 3-3/4 the lower winding of relay 107 is connected over the left and upper right contacts of cam 108 to the commutator strip 119 and over the left contact of cam 108 and the upper right contact of cam 109 to commutator strip 125 and commutator strip 126 is connected over the lower right and upper left contacts of cam 121 to the tip fundamental conductor 101. When the sequence switch reaches position 4 the previously traced circuit for the up-drive magnet 117 is established and the brush rod is again driven upwardly in a group selection movement. Since the trip magnet 123 is operated at this time the second set of brushes becomes tripped during the initial portion of the movement.

As the brush rod continues its travel the brushes 118, 127 and 128 engage with the segments of commutator strips 119, 126 and 125, respectively, and since these brushes are connected to ground over the upper right and lower left contacts of cam 120, the lower front contact of relay 107 and the upper right and lower left contacts of cam 111, intermittent shunting impulses are applied over the circuit traced from commutator strip 126 to the tip fundamental conductor 101 and relay 107 is held operated both under control of the sender through the operation of relay 103 and over the circuits previously traced to the commutator strips 125 and 126. The conducting segments of commutator strip 126 are sufficiently low to send shunting impulses to the sender early enough to satisfy it before it becomes necessary to release the up-drive magnet 117.

As soon as the sender is satisfied with respect to its incoming group selection, or as assumed after one shunting impulse has been transmitted, the fundamental circuit is opened and relay 103 releases and removes its control of relay 107. The segments of commutator strip 119 overlap the segments of strip 125 and thereby prevent the release of relay 107 until the brush rod has traveled high enough for the locking pawl to engage the rack on the lower end of the brush rod when the up-drive magnet 117 is released by the release of relay 107. When the brush 128 engages the next insulating segment of strip 125 at which time the brush 118 will have already engaged an insulating segment of strip 119 and the fundamental circuit will have been opened at the sender, relay 107 releases in turn releasing up-drive magnet 117 and arresting the second tripped brush set upon the lowermost terminal set of the second group of terminals in the terminal bank to which it has access. Relay 107 upon releasing also establishes a circuit for advancing the sequence switch from position 4 into position 5 which may be traced from battery through the winding of magnet 150, contacts of cam 115, lower contact of cam 122, inner upper back contact of relay 107 to ground.

With the sequence switch in position 5 a circuit is established from battery through the non-inductive winding 129 and upper winding of relay 107, upper contacts of cam 130, lower left and upper right contacts of cam 110 to ground over the left contacts of cam 111. Relay 107 oper-

ates and establishes a test circuit from battery through its lower winding, lower contacts of cam 120, lower front contact of relay 107, lower left contact of cam 109, lower right contact of cam 108 to test brush 131, this circuit being maintained in positions 5 and 6 of the sequence switch. Relay 107 also advances the sequence switch into position 6 over a circuit extending from battery through the winding of magnet 150, contacts of cam 115, the left contact of cam 122 to ground at the upper front contact of relay 107. If the first trunk of the group is idle no ground is encountered by test brush 131 on the test terminal thereof and relay 107 releases as soon as the sequence switch leaves position 5 and immediately connects ground over the lower left contact of cam 111, left contact of cam 124, lower back contact of relay 107, thence as traced over test brush 131 to the test terminal of the trunk and advances the sequence switch from position 6 into position 8 over a circuit extending from battery, winding of magnet 150, contacts of cam 115, lower contact of cam 122, inner upper back contact of relay 107 to ground. Busy ground is now connected to test brush 131 over the lower contacts of cam 111 to hold the selected trunk busy as long as the incoming selector is connected thereto.

It will be assumed that the first trunk is busy and that relay 107 is therefore held operated over the test brush 131 when the sequence switch reaches position 6. At this time a circuit is closed from battery through the non-inductive winding 129 and upper winding of relay 107, right contacts of cam 130 to commutator strip 125 and with relay 107 operated the previously traced circuit is established for the up-drive magnet 117 which drives the brush rod upwardly in a trunk hunting movement. When the test brush 131 engages the test terminal of an idle trunk, for example, the terminal of the trunk disclosed, the circuit through the lower winding of relay 107 is opened but the circuit through the upper winding will extend to commutator strip 125 thence over brush 128, the right contact of cam 110, the lower left contact of cam 112, to ground at the upper front contact of relay 107 until the brushes of the switch become centered on the terminals of the idle trunk at which time the commutator brush 128 will engage an insulating segment of strip 125 and the circuit through the upper winding of relay 107 will also be opened. Relay 107 will thereupon release opening the circuit of the up-drive magnet 117 and advancing the sequence switch into position 8 as previously described.

It will now be assumed that the bank terminals 136, 134 and 135 upon which the brushes 131, 132 and 133 have been positioned are unequipped, that is, not connected with any final selector trunk and have for that reason been connected to an intercepting trunk disclosed in the left portion of Fig. 2, terminating in a jack at an intercepting position on an "A" switchboard. With the sequence switch in position 8 and the sender ready to control the final brush selection, relay 103 again operates and establishes a circuit from battery through the lower winding of relay 107, left contact of cam 108, lower right contact of cam 109, contacts of relay 103 to the lower left contact of cam 140 and in parallel therewith from battery through the non-inductive winding 129 of relay 107, upper left and lower right contacts of cam 109, contacts of relay 103 to the lower left contact of cam 140 thence over the upper right contact of cam 140, tip brush 132 and terminal

134, conductor 137, left back contact of relay 200, winding of relay 201 to ground at the back contact of relay 202. Relay 201 operates in this circuit but relay 107 does not operate and the sequence switch of the incoming selector therefore remains in position 8.

Relay 201 upon operating closes an obvious circuit for relay 203 which locks over its left front contact to ground over sleeve conductor 138 and test terminal 136, establishes an obvious operating circuit for slow-to-operate relay 204, connects ground to the swinging contact of interrupter 205 and supplies operating ground for itself over its middle right front contact to replace ground supplied from the back contact of relay 202. Relay 204 upon operating closes an obvious circuit for slow-to-operate relay 202 and a circuit for relay 207 extending from battery through resistance 208, winding and normal contacts of relay 207, inner front contact of relay 204 to ground. A branch of this circuit also extends over the normal contacts of relay 207, winding of relay 209, resistance 210 to battery, but the winding of relay 209 being shunted over its own back contact, relay 209 does not operate at this time. Relay 207, however, operates and closes a locking circuit for itself extending over its alternate contacts to ground at the outer right front contact of relay 203. Relay 202 upon operating establishes a circuit from ground through the left winding of relay 211 to battery and a circuit from ground through the right winding of relay 211 and the source of ringing current 212. Relay 211 now operates and releases in response to the ringing cycle.

With relay 201 operated each operation of relay 211 closes a circuit from ground at the inner right contact of relay 203, outer right contact of relay 201, contacts of relay 211, ring conductor 139, terminal 135, brush 133, right contacts of cam 141, lower right and upper contacts of cam 104 to the tip fundamental conductor 101. These ground impulses shunt down the sender stepping relay and hold relay 103 operated. When the sender is satisfied with respect to its final brush registration or as assumed after five shunting impulses have been transmitted, it opens the fundamental circuit releasing relay 103 which in turn opens the previously traced circuit of relay 201 which releases and in turn releases relays 204 and 202 and opens the path over which ground impulses were transmitted by the operation of relay 211. Relay 204 upon releasing opens the short circuit from the winding of relay 209 and relay 209 now operates in a circuit from battery through resistance 210, winding of relay 209, alternate contacts of relay 207 to ground at the outer right contact of relay 203. Relay 209 upon operating closes an operating circuit for relay 213 extending from battery through the winding of relay 213, back contact of relay 214, left contact of relay 209 to ground at the outer right contact of relay 203. Relay 213 upon operating locks in a circuit from battery through its winding, the winding of relay 214, front contact of relay 213 to ground at the outer left contact of relay 203 but the winding of relay 214 being shunted over its own back contact so long as relay 209 remains operated does not operate at this time. The operation of relay 209 has thus registered the completion of the final brush selection. The release of relay 202 opens the operating circuits of relay 211 and at its back contact prepares the initial operating circuit of relay 201.

When the fundamental circuit is again closed at the sender relay 103 operates followed by the reoperation of relays 201, 204 and 202. Relay 204 upon operating establishes a circuit from ground over its inner front contact, right front contact of relay 209 to a point between the winding of relay 207 and resistance 208 thereby shunting the winding of relay 207 which now releases. With relay 207 released relay 209 is now held operated over a circuit extending from battery through resistance 210, winding of relay 209, normal contacts of relay 207 to ground at the inner contact of relay 204. Relay 202 upon operating reestablishes the operating circuits through the windings of relay 211 and this relay again intermittently connects ground over the circuit previously traced to the tip conductor 101 of the fundamental circuit for intermittently shunting down the sender stepping relay.

When the sender is satisfied with respect to its final brush or tens registration or as assumed after seven shunting impulses have been transmitted it opens the fundamental circuit releasing relay 103 and relays 201, 204 and 202 in turn. The release of relay 201 opens the path over which ground impulses were transmitted to the sender. The release of relay 202 opens the circuits through the windings of relay 211 and the release of relay 204 opens the locking circuit of relay 209 which now releases and removes the shunt from the winding of relay 214. Relay 214 operates in the locking circuit of relay 213 thereby registering the completion of final tens selection.

As soon as the fundamental circuit is again closed at the sender relay 103 reoperates followed by the reoperation of relays 201, 204 and 202. Relay 211 again intermittently operates to transmit impulses to the sender. As soon as relay 204 operates relay 207 is again operated in a circuit from battery through resistance 208, winding and normal contacts of relay 207 to ground at the inner contacts of relay 204 and locks over its alternate contacts to ground at the outer right contact of relay 203. As soon as the sender is satisfied with respect to its final units registration or as assumed after eight shunting impulses have been transmitted it opens the fundamental circuit releasing relay 103 and relays 201, 204 and 202 in turn. The release of relay 201 opens the path over which ground impulses were transmitted to the sender. The release of relay 202 opens the circuits through the windings of relay 211 and the release of relay 204 opens the shunt around the winding of relay 209 and relay 209 now operates in a circuit from battery through resistance 210, winding of relay 209, alternate contacts of relay 207, to ground at the outer right contact of relay 203. The reoperation of relay 209 registers the completion of final units selection.

With relays 209 and 214 both operated a circuit is now established from ground at the outer right contact of relay 203, left contact of relay 209, front contact of relay 214, conductor 139, terminal 135, brush 133, right contacts of cam 141, winding of relay 103 to battery operating relay 103 which in turn causes the reoperation of relay 201. When the swing contact of interrupter 205 next engages its left contact relay 206 is operated in a circuit from ground over the left front contacts of relay 201, left contacts of interrupter 205, winding of relay 206 to battery and locks over its inner right contact to ground at the left contacts of relay 201. When there-

after the interrupter 205 closes its right contact a circuit is established from ground thereover, outer right contact of relay 206, winding of relay 200 to battery. Relay 200 upon operating locks over its outer right front contact to ground at the inner right contact of relay 203 and connects shunting ground over its inner right contact to the winding of relay 201 thereby causing its release. The release of relay 201 opens the locking circuit of relay 206 but with relay 200 operated relay 206 remains operated over a circuit from ground at the inner right contact of relay 203, outer right contact of relay 200, outer right contact of relay 206, right contact of interrupter 205, inner right front contact and winding of relay 205 to battery until the interrupter opens its right contact when relay 206 will release.

During the time that relays 200 and 206 are both operated a circuit is established from ground at the inner right contact of relay 200, left front contact of relay 206, tip conductor 137, terminal 134, brush 132, upper right and lower left contacts of cam 140, and thence as traced through the non-inductive winding 129 to battery and the lower winding of relay 107 to battery. Relay 107 now operates and locks in a circuit from battery through its non-inductive winding 129 and upper winding, upper contacts of cam 130, lower contact of cam 110, lower left contact of cam 112 to ground at the upper front contact of relay 107 and closes a circuit for advancing the sequence switch into position 9. This circuit may be traced from battery, winding of sequence switch magnet 150, contacts of cam 115, upper left contact of cam 116, lower front contact of relay 107, upper right and lower left contacts of cam 111 to ground. When the sequence switch advances out of position 9 relays 103 and 107 release.

With the sequence switch in position 9 ground is connected to the tip fundamental conductor 101 over the left contacts of cam 104 and battery is connected to the ring fundamental conductor 102 over the upper left and lower right contacts of cam 106 through the winding of relay 103 so that when the sender again closes the fundamental circuit relay 103 and sender relays operate and a reverse battery signal is given for controlling the dismissal of the sender. Relay 103 upon operating closes a circuit from battery through the lower winding of relay 107, left contact of cam 103, lower right contact of cam 109, contacts of relay 103, upper contacts of cam 110 to ground over the left contacts of cam 111. Relay 107 operates and establishes a circuit from battery, winding of sequence switch magnet 150, contacts of cam 115, left contact of cam 122, upper front contact of relay 107 to ground whereby the sequence switch advances through position 10 into position 11. When the sequence switch leaves position 10 relay 103 releases and while passing through positions 9-1/4 to 10 a charging circuit is established for condenser 142 extending from battery, lower winding of relay 144, contacts of cam 145, upper back contact of relay 143, through condenser 142, lower back contact of relay 143, upper contacts of cam 146 to ground in preparation for trunk closure.

When the sequence switch reaches position 11 a circuit is established from battery through the lower winding of relay 144, contacts of cam 145, upper back contact of relay 143, upper left winding of repeating coil 147, upper contacts of cam 121, conductor 101 through the winding of a supervisory relay (not shown) at the toll office,

returning over conductor 102, upper contacts of cam 106, lower left winding of coil 147, lower back contact of relay 143, upper winding of relay 144 to ground over the upper left and lower contacts of cam 148. Relay 144 operates closing a circuit for slow-to-release relay 149 and slow-to-release relay 152 extending from battery through the winding of relay 152, back contact of relay 149, and in parallel from battery through the winding of relay 149, right contacts of cam 151, front contact of relay 144 to ground over the lower right and upper left contacts of cam 146. Relays 149 and 152 operate, relay 149 opening the initial operating circuit of relay 152 and closing a new operating circuit therefor over its upper front contact. At its upper front contact relay 152 supplies operating ground for relay 144 to replace operating ground supplied thereto over contacts of cam 148 after the sequence switch leaves position 11 and establishes a circuit for advancing the sequence switch into position 12 which circuit may be traced from battery, winding of sequence switch magnet 150, contacts of cam 115, the upper left contact of cam 116, left contacts of cam 120, lower front contacts of relay 152 to ground. The incoming selector circuit is now in condition for ringing.

When ringing current is applied at the toll office end of the trunk it flows over conductor 101, upper contacts of cam 121, upper left winding of coil 147, through condenser 153 and the winding of ringing relay 154, lower left winding of coil 147, upper contacts of cam 106, back over conductor 102 thereby operating relay 154 which in turn causes the operation of relay 143. Relay 143 extends its operating ground over its upper front contact to battery through the upper winding of relay 155 which also operates. Relay 143 also opens the circuit of relay 144 but relay 144 is held operated in a circuit extending from battery through the lower winding thereof, contacts of cam 145, lower front contact of relay 143, upper winding of relay 144 to ground at the upper contact of relay 152. Relay 155 upon operating locks in a circuit extending from battery through its lower winding, upper back contact of relay 156, upper back contact of relay 157, lower front contact of relay 155, contacts of cam 158 to ground at the lower contacts of relay 152 and at its upper front contact establishes an obvious circuit for relay 159. A ringing circuit is now established from the source 160 of ringing current, contacts of cam 161, upper back contact of relay 107, winding of ringing trip relay 156, lower back contact of relay 157, lower front contact of relay 159, lower contacts of cam 141, brush 133, terminal 135, conductor 139, inner left front contact of relay 200, left winding of relay 215, condenser 216, outer left front contact of relay 200, conductor 137, terminal 134, brush 132, upper contacts of cam 140, upper front contact of relay 169, through resistance 162 to ground. Relay 156 does not operate in response to this ringing current but relay 215 operates, locks in a circuit from battery through its right winding and right front contact, back contact of relay 217, to ground at the inner right contact of relay 203 and establishes a circuit from battery over its left contact and conductor 218 to ground through the calling lamp 450.

The operator at the "A" switchboard upon seeing the lighted lamp knows that an intercepted call is awaiting her attention and inserts the plug 401 of an idle cord circuit into the trunk jack 400 whereupon a circuit is established from

battery through the windings of marginal relay 403 and relay 402 in series and from battery through the non-inductive winding 404 of relay 403 in parallel thence over the sleeves of plug 401 and jack 400, conductor 219, winding of trunk sleeve relay 217 to ground. Relays 217 and 402 both operate but relay 403 being marginal does not receive sufficient current because of the high resistance of sleeve relay 217. Relay 217 upon operating opens the locking circuit of relay 215 and prepares a disconnect signaling circuit.

Relay 402 upon operating establishes a circuit for supervisory lamp 405 extending from battery over the inner contacts of relay 402, resistance 406, back contact of relay 407, back contact of relay 408 to ground through lamp 405 and in parallel therewith from battery over the inner contacts of relay 402, resistance 406, back contact of relay 407, back contact of relay 408, middle lower back contact of relay 409, inner normal contacts and winding of relay 410 to ground at the lower right normal contacts of key 411. Relay 410 locks in a circuit from battery at the inner contact of relay 402, inner upper alternate contacts and winding of relay 410 to ground at key 411.

When the operator throws her listening key 411 to the right or talking position, relay 410 releases and a circuit is established from ground at the left back contact of relay 301, conductor 412, upper right contacts of key 411 to battery through the winding of relay 417 which operates and establishes a circuit from battery at the inner contact of relay 402, inner lower contact of relay 417, conductor 415, winding of relay 302 to ground. Relay 302 operates and connects battery through resistance 303 over its outer left contact to conductor 304 and ground over its inner left contact and the back contact of relay 305 through the winding of test relay 306 to conductor 304, thence over the lower contact of relay 417, back contact of relay 451, upper normal contacts of key 414, tips of plug 401 and jack 400, conductor 220, outer left front contact of relay 200, conductor 137, terminal 134, brush 132, upper contacts of cam 140, upper front contact of relay 159 to generator ground through resistance 162. Test relay 306 now tests to determine if the connection has been extended to the operator's position from a toll incoming selector such as the selector 100 or from a regular incoming selector. In all regular incoming selectors no resistance, such as 162 is supplied in the ringing generator ground lead and when the previously traced test circuit is established the test relay 306 is shunted by the direct ground at the incoming selector and does not operate. All toll incoming selectors, however, are equipped with a resistance in the ringing generator ground lead, as disclosed at 162 in selector 100, and when the test circuit is established the test relay 306 operates in a circuit from battery through resistance 303, outer left contact of relay 302, winding of test relay 306, back contact of relay 305, to ground at the inner left contact of relay 302. Thus test relay 306 operates to give the operator a special signal only when an intercepted call is incoming to that position from a toll point.

When relay 306 operates, it establishes an obvious circuit for relay 307 which locks over its inner left contact, the back contact of relay 303 to ground at the inner left contact of relay 302. At its outer right contact it establishes a circuit from the tone source lead 309 through the primary winding of tone coil 310 and over its inner

right and outer left contacts connects the secondary winding of tone coil 310 to the talking conductors 420 and 421 extending to the operator's telephone circuit preparatory to applying tone current to the operator's telephone set. At the time the test circuit was established ringing current from the ringing source 160 in the incoming selector was also transmitted over the circuit previously traced to trunk conductor 139 thence over the inner left front contact of relay 200, conductor 221, rings of jack 400 and plug 401, lower normal contacts of key 414, lower left winding of repeating coil 413, inner lower back contact of relay 403, inner lower back contact of relay 409, middle lower front contact of relay 417, conductor 311, right back contact of relay 301 to ground through the winding of ringing trip relay 312. Ringing current or silent interval battery operates relay 312 which establishes a circuit from ground at the inner left contact of relay 302, contacts of relay 312, winding of relay 313 to battery. Relay 313 operates locking directly to ground over the inner left contact of relay 302 and establishes a circuit from battery through the winding of relay 314, back contact of relay 315, right contacts of relays 313 and 302 to ground as soon thereafter as interrupter 317 makes its contacts. Relay 314 upon operating locks in a circuit through its winding, the winding of relay 315, contacts of relay 314 to ground at the inner left contact of relay 302 and as soon as the interrupter 317 opens its contacts relay 315 operates in this locking circuit. Upon the next closure of the interrupter contacts relay 305 operates in a circuit extending from battery through its winding, back contact of relay 316, front contacts of relays 315, 313 and 302 to ground at the interrupter contacts and locks in a circuit through its winding and the winding of relay 316, right contact of relay 305 to ground at the inner left contact of relay 302, but the winding of relay 316 being shunted, relay 316 does not operate in this locking circuit until the interrupter again opens its contacts.

When relay 305 operates battery is connected through resistance 318 over the left contact of relay 305, right back contact of relay 301 to conductor 311 and thence as traced through the winding of the ringing trip relay 156 of the incoming selector to the source of ringing current 160 and relay 156 now operates, releasing relay 155 which in turn releases relay 159 to disconnect the source of ringing current and ground through resistance 162 from the intercepting trunk thereby releasing relay 312 at the position circuit. With relay 159 released the tip and ring talking conductors at the incoming selector are extended from the right windings of repeating coil 147 to brushes 132 and 133.

It will be noted that the sequential operation of counting relays 314, 315 and 305 under the control of interrupter 317 has measured off a time interval following the operation of relay 312 by the ringing current before the ringing is tripped at the incoming selector. When following the operation of relay 316 the interrupter 317 again closes its contacts the circuit from ground at the contacts of the interrupter is extended as traced over the front contacts of relay 315, thence over the front contacts of relay 316 to battery through the winding of relay 301 and in parallel therewith over conductor 418, inner upper front contact of relay 417, winding of relay 451 to battery at the inner front contact of relay 402. Relays 301 and 451 both operate, relay 451 locking to

ground over its inner front contact, at its lower back contact opening the test circuit from the tip of plug 401 to conductor 304 as previously traced and closing a talking circuit from the left 5 windings of the repeating coil 413 of the cord circuit to the right windings of the repeating coil at the incoming selector. This circuit may be traced from ground through resistance 163, upper winding of supervisory relay 164, upper right winding of repeating coil 147, upper back contact of relay 159, upper contacts of cam 140, brush 132, terminal 134, conductor 137, outer left front contact of relay 200, conductor 220, tips of jack 400 and plug 401, upper normal contacts of key 414, lower front contact of relay 451, upper left winding of repeating coil 413, upper back contact of relay 403, lower winding of relay 408, lower back contact of relay 409, resistance 439 to battery and from battery through resistance 165, lower winding of relay 164, lower right winding of coil 147, lower back contact of relay 159, lower contacts of cam 141, brush 133, terminal 135, conductor 139, inner left front contact of relay 200, conductor 221, rings of jack 400 and plug 401, lower normal contacts of key 414, lower left winding of repeating coil 413, inner lower back contact of relay 403, inner lower back contact of relay 409 to ground through resistance 438.

Relay 164 now operates establishing a circuit 30 from battery through the winding of relay 157 to the upper left contact of cam 112 and in parallel therewith from battery through the lower winding of relay 143 to the upper right contact of cam 112, thence over the lower contact of cam 110, 35 contacts of relay 164 to ground at the lower contacts of relay 149. Relay 143 upon operating disconnects battery and ground through the windings of relay 144 from conductors 101 and 102 of the trunk circuit thereby extinguishing the calling supervisory lamp at the toll operator's cord circuit to apprise her that the call has been answered. Relay 143 also establishes the previously traced circuit for holding relay 144 operated.

When relay 301 operated at the time relay 451 45 operated it locked over its inner right contact to ground at the inner left contact of relay 302, opened the ringing trip circuit at its right back contact and closed a circuit from ground over its left front contact and conductor 319 to battery through the upper winding of relay 222 thereby operating relay 222. At its left back contact relay 301 also removes direct ground from conductor 412 by which the initial operating circuit of relay 417 was completed. Relay 417 is now held 50 operated over the previously traced circuit to conductor 412 and then to ground through resistance 320. Relay 417 of another cord circuit of the position will not operate in this circuit through resistance 320 in case a talking key of such cord circuit should at this time be operated to the talking position. This is for the purpose of preventing two cord circuits from being connected to the operator's telephone set circuit at the same time.

With relays 222 and 307 both operated tone current impressed on the secondary winding of tone coil 310 from source 309, flows over conductor 421, upper contact of relay 222, left windings of repeating coil 223, condenser 226, lower contacts of relay 222, back over conductor 421, and tone current thus flows through the operator's headset receiver through the upper left winding of coil 223, inner back contact of relay 224, through the receiver 225 and lower back contact of relay 224. The operator upon hearing the tone then knows 75 that a call from a toll point has been intercepted.

To discontinue this tone she then operates key 321 thus operating relay 308 which locks over its front contact to ground at the inner left contact of relay 302 and at its back contact opens the locking circuit of relay 307 which now releases. 5 Relay 307 upon releasing completely opens the circuits through the windings of tone coil 310.

Since the operator's transmitter 227 is inductively connected to the talking conductors 420 and 421 through the windings of repeating coil 223 and 10 a talking loop between conductors 420 and 421 is completed at the cord circuit from conductor 420, inner lower right alternate contacts of key 411, right windings of repeating coil 413, inner upper right alternate contacts of key 411 to conductor 421, the operator is enabled to converse with the toll operator to give her any necessary information for reaching the subscriber's line to which a connection has been attempted.

Should the intercepting operator desire to recall the toll operator after the toll operator has disconnected her headset from the toll cord circuit she may do so by depressing key 414. The operation of key 414 opens the circuit of supervisory relay 164 which in turn releases relay 143. 15 Relay 143 upon releasing reconnects battery and ground through the windings of relay 144 to the trunk conductors 101 and 102 and thereby causes the lighting of the calling supervisory lamp at the toll operator's cord circuit. When key 414 is released relays 164 and 143 again operate and the cord circuit lamp is extinguished. Thus by intermittently operating key 414 the toll cord circuit supervisory lamp may be flashed to signal the toll operator. 35

After having given the necessary information the intercepting operator removes plug 401 from jack 400 thereby releasing all operated relays of her cord circuit and position circuit, releasing relay 217 of the intercepting trunk circuit and supervisory relay 164 of the incoming selector. 40 Relay 164 upon releasing in turn releases relay 143 which reconnects relay 144 to conductors 101 and 102 and thereby causes the relighting of the calling supervisory lamp as a disconnect signal. The toll operator noting the signal withdraws her cord circuit plug from the jack of trunk 101, 102 thereby releasing relay 144 which, in turn, releases relays 149 and 152. Relay 152 upon releasing closes a circuit from battery, winding of sequence switch magnet 150, contacts of cam 115, 45 upper right contact of cam 122 to ground at the back contact of relay 152, for advancing the sequence switch out of position 12 into position 16. In position 16 a circuit is established for the down-drive magnet 156, over the upper right contact of cam 124 to ground at the lower left contact of cam 111 for driving the incoming selector brush rod into normal position. To prevent the snagging of the brushes during this downward movement the trip magnet 123 is operated over the lower contact of cam 124 and the lower left contact of cam 111. Upon reaching normal a circuit is established from ground over the left contacts of cam 111, brush 128, normal commutator segment 167, lower right contact of cam 116, contacts of cam 115 to battery through the winding of sequence switch magnet 150 thereby advancing the sequence switch into position 17. 50 In position 17 a circuit is established from battery, winding of sequence switch magnet 150, contacts of cam 115, upper left contact of cam 122 to ground over the left contacts of cam 146 advancing the sequence switch into position 18 in which position the circuit of sequence switch 75

magnet 150 is extended over the lower contact of cam 122 and the inner upper back contact of relay 107 to ground thereby advancing the sequence switch into normal position 1. The incoming selector is now fully restored.

When the sequence switch leaves position 14-1/4 ground is removed from test brush 131 at the lower contacts of cam 111, thus releasing relay 203 of the intercepting trunk circuit. Relay 203 upon releasing releases relays 200, 207, 209, 213 and 214. The intercepting trunk is now in normal condition.

Had the call been incoming to the intercepting position from a regular incoming selector the intercepting operator would not have received the tone signal as previously described but the tripping of ringing and the establishment of the talking circuit between the calling subscriber and the operator would have been accomplished in the same manner. After ascertaining from the subscriber the designation of the line with which he attempted to obtain a connection the operator may then proceed to complete the connection by inserting plug 422 into the jack of an outgoing trunk, operating the dialing key 322 and then keying up the digits of the required line designation on the key-set 230. Since the manner in which the key-set and cord circuit apparatus function in the establishment of the connection does not directly concern the present invention it will not be described herein. Reference to Patent 1,916,760 granted July 4, 1933 to I. H. Henry may be had for a complete description.

In the foregoing discussion it was assumed that in attempting to establish a connection to the subscriber's line whose directory number was 2467, the incoming selector 100 was set upon trunk terminals which were unequipped for a regular service connection and were connected to the intercepting trunk disclosed in Fig. 2. It will now be assumed that the terminals upon which the incoming selector was set are connected to a final selector and that in accordance with the final brush, final tens, and final units registrations set up in the sender at the toll position a final selector is set upon the terminals identified by the keyed designation 2467 but that this set of terminals is unequipped, the called subscriber's line, for example, having been disconnected or given a new directory number. In this case this set of terminals in the final selector would be connected to an intercepting trunk of the type disclosed in Patent 1,930,612 granted October 17, 1933 to E. L. Getz and upon the seizure of this trunk by the final selector a trunk lamp at the "A" switchboard would be lighted to signal an intercepting operator that an intercepted call is awaiting her attention.

The operator would answer the call in the manner previously described resulting in the operation of cord circuit relays 402 and 417 and the operation of relay 302 at the position circuit. With relays 417 and 302 operated the previously traced test circuit from the test relay 306 to the tip of plug 401 would be extended over the tip conductor of the intercepting trunk, tip brush of the final selector, tip brush 132 of incoming selector 100 over the upper contacts of cam 140, upper back contacts of relay 159, this relay being unoperated because of the delayed initiation of ringing, upper right winding of repeating coil 147, upper winding of relay 164, resistance 163 to ground. Test relay 306 operates in this case preparing the tone circuit at the operator's position. As soon as ringing is initiated and relay

159 operates, ringing current is then transmitted from the incoming selector, is tripped at the operator's position circuit and the circuits then function in the manner previously described.

Had the call been extended through a regular service incoming selector and final selector to the intercepting position then upon automatic ringing from the incoming selector direct ringing ground would be connected to the test circuit and relay 306 would not function. Thus test relay 306 determines in the manner previously described whether the intercepted call is incoming from a regular service connection or from a toll connection.

What is claimed is:

1. In a telephone system, an operator's position, trunk lines extending to said position, a plurality of groups of selector switches having access to said trunk lines, a cord circuit at said operator's position for connection with said trunk lines, signaling means at said operator's position and a discriminating relay at said position for controlling said signaling means and operable only when a connection to said operator's position is established over a selector switch of one of said groups.

2. In a telephone system, an operator's position, trunk lines incoming to said position, a plurality of groups of selector switches having access to said trunk lines, a cord circuit at said operator's position for connection with said trunk lines, a source of tone current and a telephone set at said operator's position, and a discriminating relay at said position for controlling the connection of said source of tone current to the telephone set and operable only when a connection to said operator's position is established over a selector switch of one of said groups.

3. In a telephone system, an operator's position, trunk lines incoming to said position, a plurality of groups of selector switches having access to said trunk lines, a cord circuit at said operator's position for connection with said trunk lines, signaling means at said operator's position, a marginal relay at said position operable to control said signalling means and a circuit for said relay established either directly to ground when a connection is completed to said position over a selector switch of one of said groups or to ground through a resistance when a connection is completed to said position over a selector switch of another of said groups, said relay being operable only when a connection is established over a selector switch of the latter group.

4. In a telephone system, an operator's position, trunk lines incoming to said position, a plurality of groups of selector switches having access to said trunk lines, a cord circuit at said operator's position for connection with said trunk lines, a source of tone current and a telephone set at said operator's position, a marginal relay at said position operable to control the connection of said source of tone current to said telephone set and a circuit for said relay established either directly to ground when a connection is completed to said position over a selector switch of one of said groups or to ground through a resistance when a connection is completed to said position over a selector switch of another of said groups, said relay being operable only when a connection is established over a selector switch of the latter group.

5. In a telephone system, an operator's position, trunk lines incoming to said position, a selector switch having access to said trunk lines,

5 a cord circuit at said operator's position for connection with said trunk lines, means in said switch operable following the seizure of a trunk line for applying ground through a resistance and
10 a source of ringing current over the tip and ring conductors respectively of said trunk line to said operator's position, a source of tone current, a telephone set and a relay at said position, said relay operable upon the connection of said resistance ground to prepare a circuit for applying
15 said source of tone current to said telephone set, means at said operator's position for discontinuing the application of ringing current and means for thereafter completing said latter circuit.

6. In a telephone system, an operator's position, trunk lines incoming to said position, a selector switch having access to said trunk lines, a cord circuit at said operator's position for connection with said trunk lines, a relay in said cord

circuit, a source of tone current, a telephone set and a test relay at said position, means in said switch operable following the seizure of a trunk line for establishing a test circuit from ground through a resistance at said switch over the tip conductor of said trunk line to said test relay and a ringing circuit from a source of ringing current at said switch over the ring conductor of said trunk line to said position, said test relay being responsive to the establishment of said test circuit to prepare a circuit for applying said source of tone current to said telephone set, means at said operator's position for discontinuing the application of ringing current and for operating said cord circuit relay to open said test circuit and to complete the talking circuit over said cord circuit, and means for thereafter completing said tone circuit.

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