

March 27, 1934.

W. C. JORDAN

1,952,870

TELEPHONE SYSTEM

Filed June 6, 1933

5 Sheets-Sheet 1

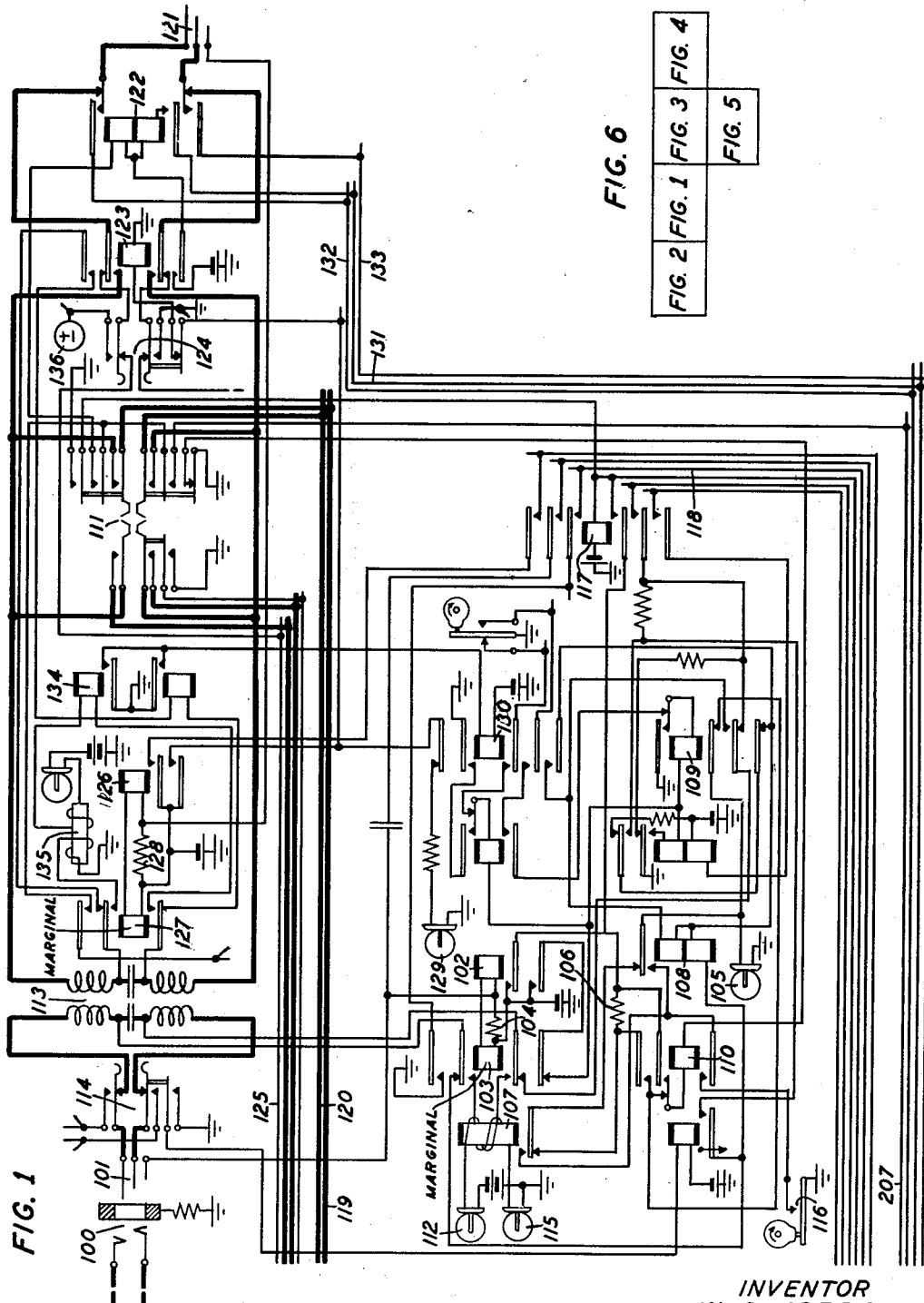


FIG. 1

FIG. 6

FIG. 2	FIG. 1	FIG. 3	FIG. 4
		FIG. 5	

INVENTOR
W. C. JORDON
BY
P. C. Smith
ATTORNEY

March 27, 1934.

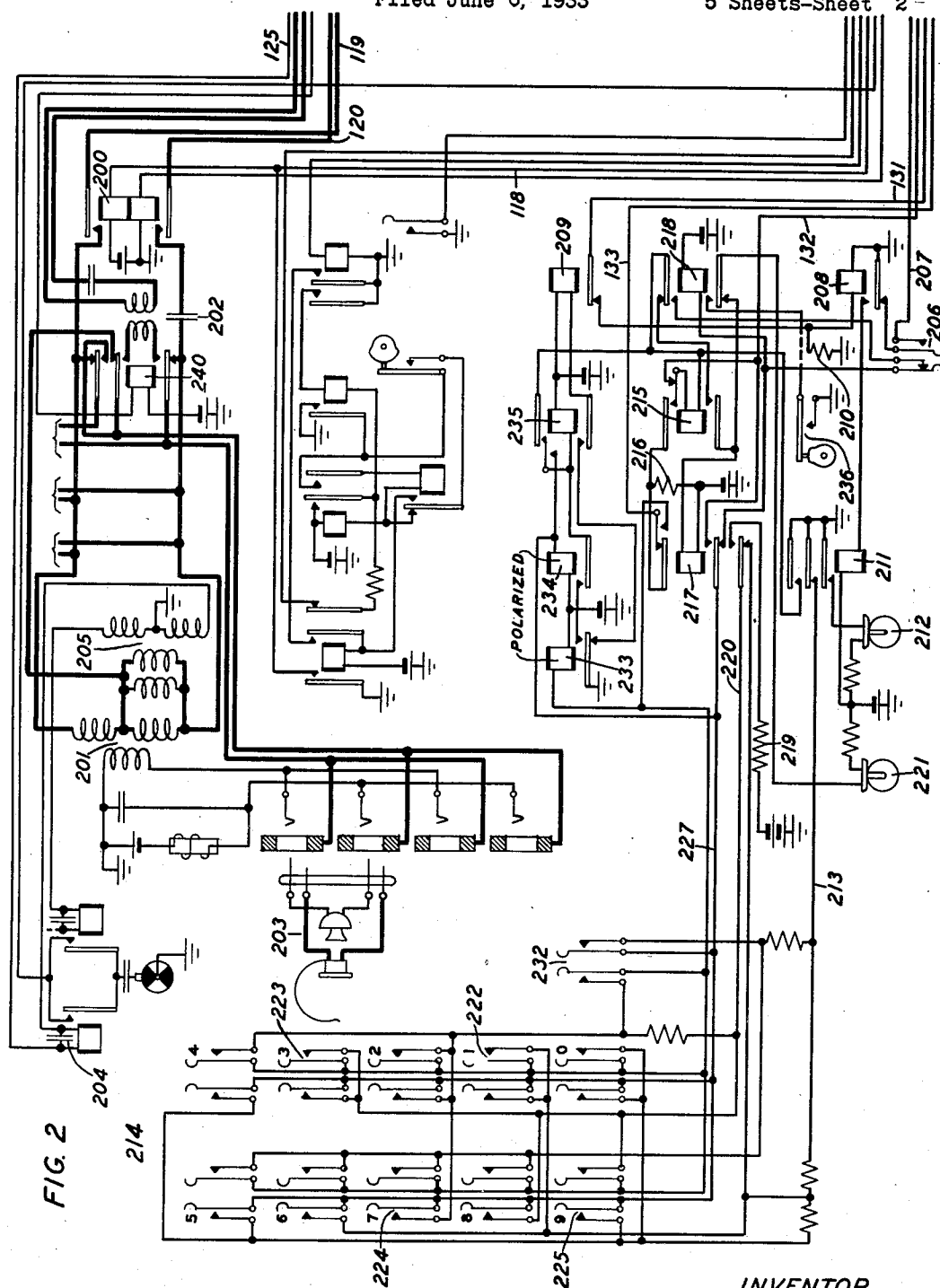
W. C. JORDAN

1,952,870

TELEPHONE SYSTEM

Filed June 6, 1933

5 Sheets-Sheet 2 -



INVENTOR
W. C. JORDAN

BY

P. C. Smith

ATTORNEY

March 27, 1934.

W. C. JORDAN

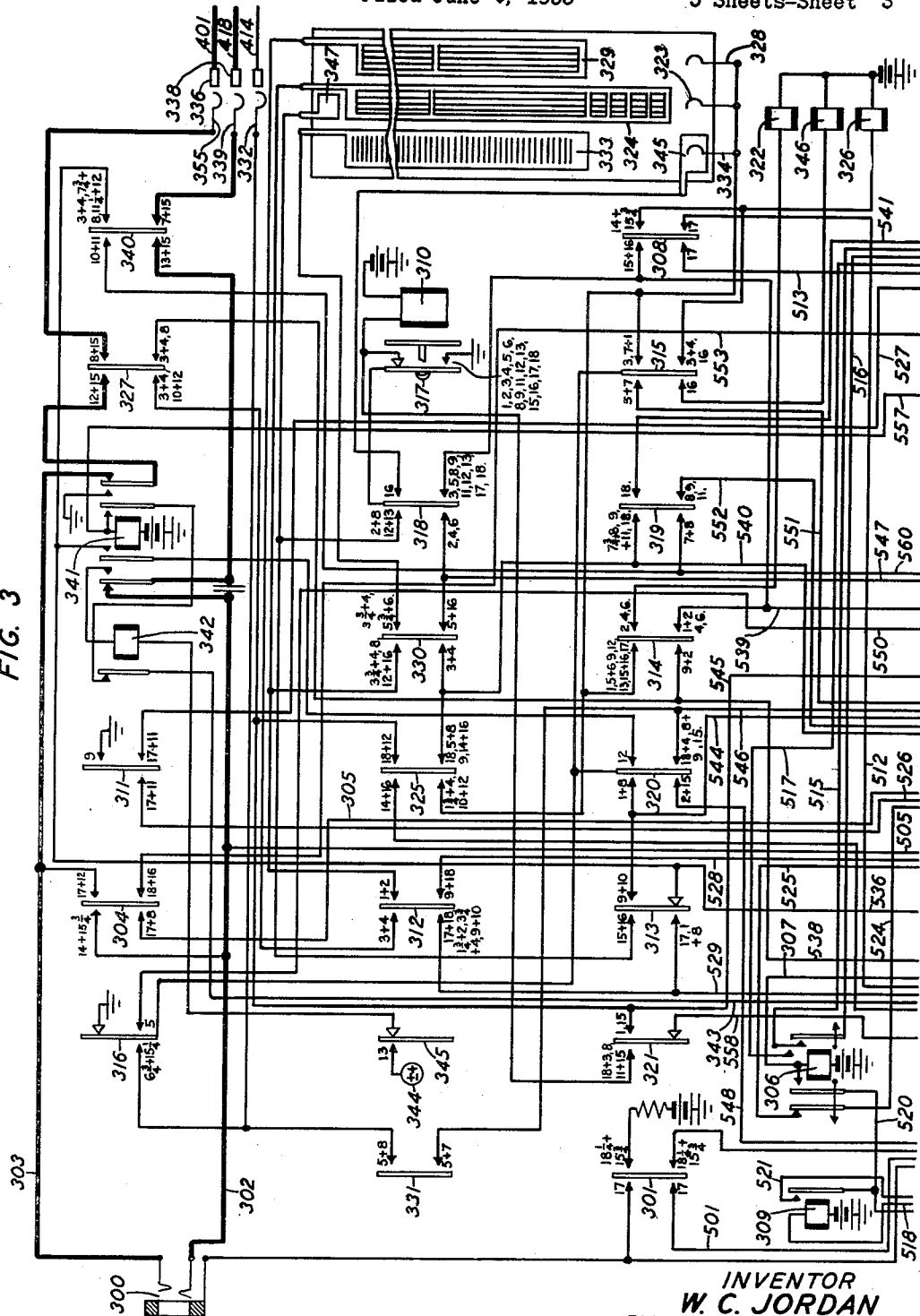
1,952,870

TELEPHONE SYSTEM

Filed June 6, 1933

5 Sheets-Sheet 3

FIG. 3



INVENTOR
W. C. JORDAN
BY
P. C. Smith
ATTORNEY

March 27, 1934.

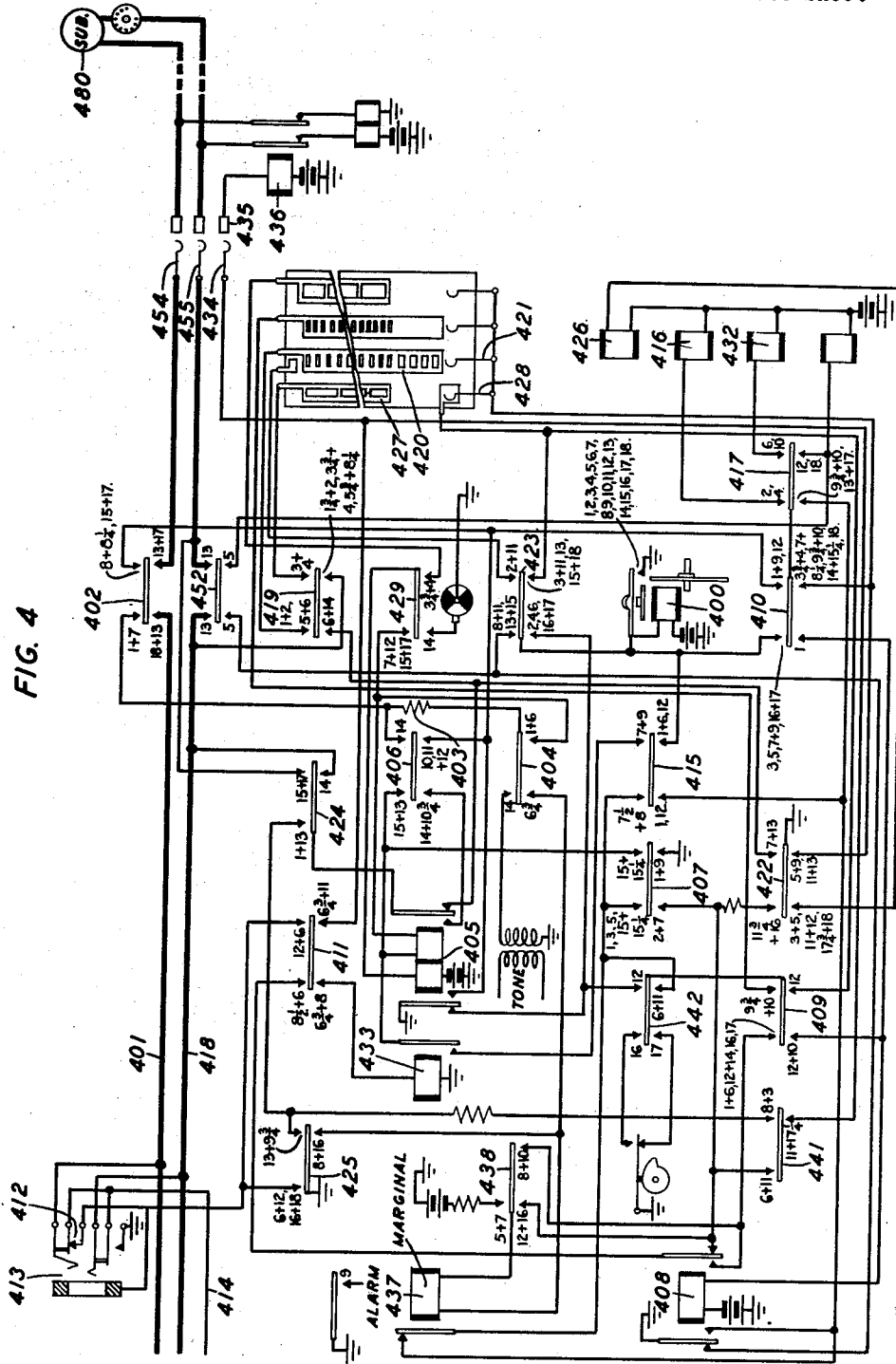
W. C. JORDAN

1,952,870

TELEPHONE SYSTEM

Filed June 6, 1933

5 Sheets-Sheet 4



INVENTOR
W. C. JORDAN
BY
P. C. Smith
ATTORNEY

March 27, 1934.

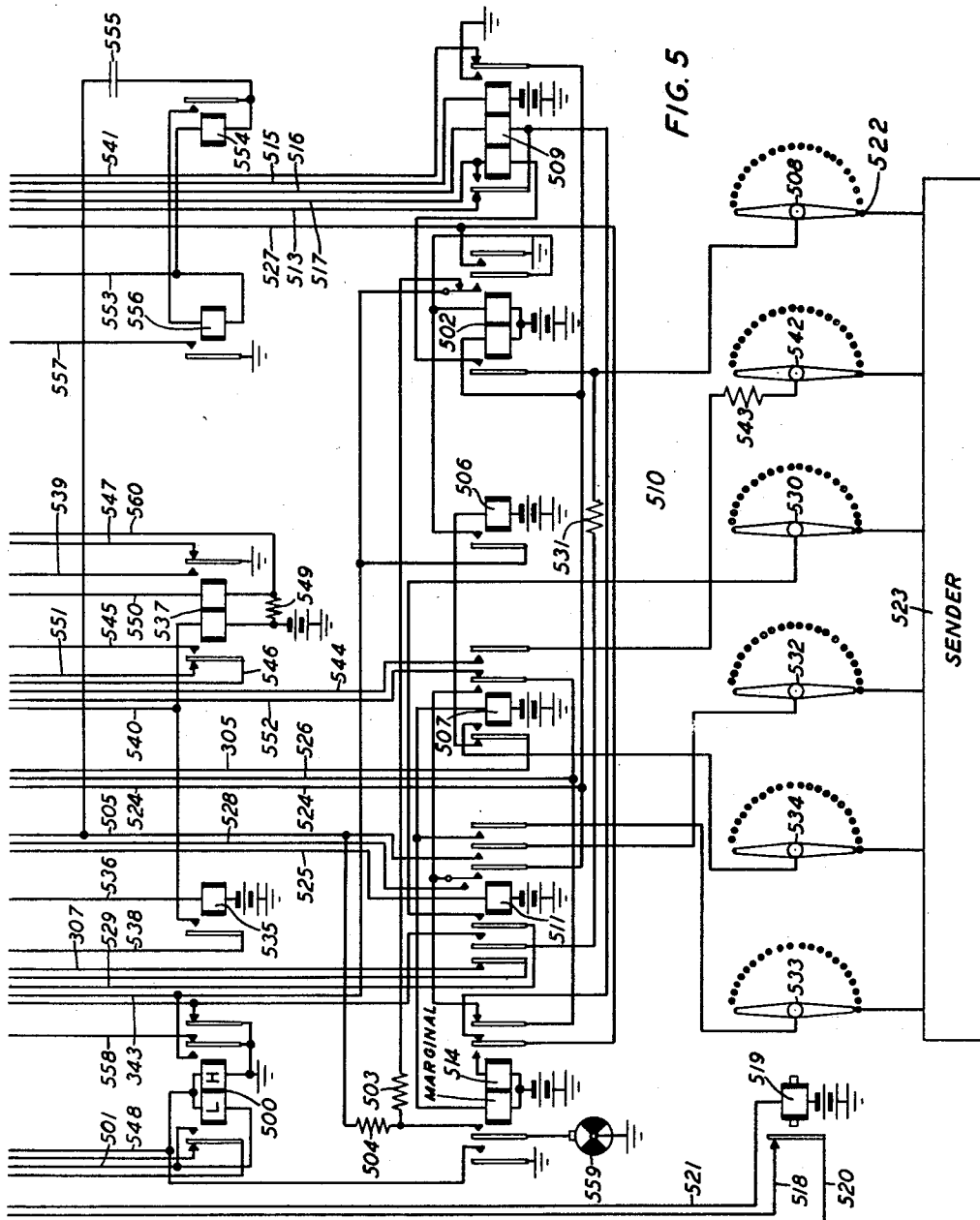
W. C. JORDAN

1,952,870

TELEPHONE SYSTEM

Filed June 6, 1933

5 Sheets-Sheet 5



INVENTOR
W. C. JORDAN
BY
P. C. Smith
ATTORNEY

UNITED STATES PATENT OFFICE

1,952,870

TELEPHONE SYSTEM

William C. Jordan, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 6, 1933, Serial No. 674,508

7 Claims. (Cl. 179—27)

This invention relates to telephone exchange systems and more particularly to systems in which connections may be completed from an operator's position over automatic selector switches. For example, a calling subscriber may require the assistance of an operator for completing a connection to a subscriber's line which terminates in the local area in which the operator's position is located and for that purpose obtains a connection to the operator's position. The operator then ascertains the number of the desired line and proceeds to complete the connection by connecting her cord circuit to an incoming selector trunk which has access to a final selector in which the desired line terminates. The incoming selector also has access over a sender selector associated therewith to a register sender which may be controlled from a sending device associated with the cord circuit of the operator's position to register the numerical designation of the desired subscriber's line and to thereafter control the setting of the incoming selector and a final selector to select the desired subscriber's line.

It is an object of the present invention to render more efficient the circuits of the incoming selector by providing that should the incoming selector advance to an overflow position while trunk hunting or overrun to a tell-tale position in any of its selective movements, the operator will be given a reorder signal and the incoming selector will be restored to normal without waiting for the operator to disconnect her cord circuit in response to the reorder signal. A further object of the invention is to render the incoming selector more accurate in recording the supervisory condition upon the response of the called subscriber.

In accordance with the present invention the incoming selector trunk when seized by the connection of an operator's cord circuit therewith becomes associated over a sender selector with an idle sender which has registers which may be set from a key-set associated with the operator's position. The operator's position equipment including the key-set and the sender may be of the type disclosed in Patent No. 1,897,083, granted February 14, 1933 to W. B. Strickler. As soon as the sender has become associated with the operator's key-set over the connected cord circuit, trunk and sender selector and the sender is ready to make registrations, the operator is signaled and she may then depress the proper keys of her key-set to set up in the sender a registration of the numerical designation of the

wanted line. When the registration has been completed, the operator is given a signal to that effect and her key-set is disassociated from the cord circuit. The sender also proceeds to control the setting of the incoming selector and a final selector to complete the connection to the line whose designation has been registered.

At any time after the operator has received the signal that registrations have been completed, she may prepare to ring the called line by depressing the ringing key of her connected cord circuit. The application of ringing current from the cord circuit to the incoming selector trunk operates a ringing current responsive relay in the trunk which in turn operates and locks a ringing relay preparatory to applying ringing current to the called line. As soon as the final selector has been set upon the terminals of the called line, the incoming selector sequence switch is advanced to position 9 dismissing the sender and further advances to position 12 awaiting the initiation of ringing by the operator. When the operator initiates ringing or if she has already done so and the ringing relay has been operated, the sequence switch is then advanced into the ringing position 13 and ringing current is then applied by the ringing relay to the called line and is automatically discontinued when the called subscriber responds. This arrangement of the ringing circuit has the advantage that the operator is not required to wait until the incoming trunk is ready to apply ringing current to the called line, but may prepare the initiation of ringing as soon as she has been apprised that registrations are completed and that therefore her cord circuit is in a condition to transmit ringing current to the incoming trunk.

In the event that the incoming selector sequence switch has advanced to position 12 in readiness to apply ringing current to the called line and the operator delays the initiation of ringing and during such delay the called subscriber to whose line a connection has been established not having been rung up, removes his receiver to initiate a call, provision is made for advancing the incoming selector sequence switch into the talking position 13 so that the operator is given a signal that the called subscriber has answered. She may then inform him that a call is incoming to his line. This is accomplished by a relay in the incoming trunk which becomes energized in position 12 of the sequence switch over the called subscriber's line when he answers. To guard against a false operation of this relay which might occur by the charging of

the final selector trunk through the winding of the relay at the time it is connected, a cable charging circuit is established as the incoming selector sequence switch passes through positions 10 and 11 so that when the sequence switch reaches position 12 for associating the relay with the final selector, the final selector trunk will be already charged and there will be no tendency for the relay to operate until the called subscriber's loop is closed.

Should the incoming selector during trunk hunting find no idle trunk in the selected group or overrun to a tell-tale position in any of its up-drive movements, the incoming selector causes the sender to be dismissed, causes the calling supervisory signal of the cord circuit to be flashed as a reorder signal, and is itself restored to normal. The restoration of the operated incoming selector switch does not wait upon the removal of the operator's cord plug from the incoming trunk jack as heretofore and therefore the time during which the selector switch is held in service upon the encountering of an overflow or tell-tale condition is reduced to a minimum, thus saving in current drain and rendering the selector switch more quickly available for use on other calls.

For a clearer understanding of the invention reference may be had to the accompanying drawings taken in connection with the following detailed description. Referring to the drawings:

Fig. 1 shows an operator's cord circuit for answering special service and intercepting calls;

Fig. 2 shows the operator's telephone and key-set circuits;

Fig. 3 shows a trunk circuit outgoing from the operator's position and terminating in an incoming selector switch;

Fig. 4 shows a final selector switch and the schematic representation of one subscriber's line to which the final selector switch has access;

Fig. 5 shows a sender selector and control relays individual to the incoming selector switch of Fig. 3 and in the lower portion thereof a box indicative of one of the register senders to which the sender selector has access; and

Fig. 6 is a diagram showing how the several figures of the drawings should be arranged to disclose the circuits pertinent to the invention.

The cord circuit of Fig. 1 located at the "A" operator's switchboard position has access over the answering plug shown at the left of the figure to jacks of incoming trunks which trunks may, for example, be intercepting trunks from final selector or incoming selector multiples or special service trunks over which calling subscribers may obtain connection with the "A" operator's position for the purpose of obtaining the assistance of the operator in completing toll or other calls. The operator's telephone and key-set circuits of Fig. 2 are common to all cord circuits such as that shown in Fig. 1 of the operator's position. Through the cord circuit of Fig. 1 the operator has access to a group of trunks one of which is shown in Fig. 3 terminating in an incoming selector switch which in turn has access to final selector switches, one of which is shown in Fig. 4, for completing connections to desired subscribers' lines.

The incoming selector and final selector switches are in general of the well known panel power driven type, the incoming selector being modified to embrace the features of the present invention. The final selector of Fig. 4 is identical with the final selector disclosed in Patent No.

1,658,829, granted February 14, 1928 to C. H. Berry. The sender indicated by the box in the lower portion of Fig. 5 may be of the type fully disclosed in Patent No. 1,897,083 granted February 14, 1933 to W. B. Strickler hereinbefore referred to. This sender is arranged to operate in conjunction with the decoder and decoder connector disclosed in detail in Patent No. 1,862,549 granted June 14, 1932 to R. Raymond and W. J. Scully.

Establishment of connection

It will be assumed that an incoming connection is extended in any well known manner to the trunk jack 100 of Fig. 1 and that the desired connection may be completed over incoming and final selector switches to a desired subscriber's line. The operator noting the illumination of the lamp (not shown) associated with jack 100 inserts the plug 101 of the cord circuit shown in Fig. 1 into jack 100. A circuit is established from ground over the sleeve of jack 100 and plug 101 to battery through the winding of relay 102 and the winding of marginal relay 103 in series and to battery in parallel therewith through the non-inductive winding 104 of relay 103. At the same time the trunk lamp is extinguished. Relays 102 and 103 both operate over a low resistance ground connected to the sleeves of trunks employed for special service and establish a circuit for supervisory lamp 105 which may be traced from battery over the inner contact of relay 102, resistance 106, back contact of relay 107, back contact of relay 108 to ground through lamp 105 and in parallel therewith from battery over the inner contact of relay 102, resistance 106, back contact of relay 107, back contact of relay 108, inner lower back contact of relay 109, inner normal contacts and winding of relay 110 to ground at the lower right normal contacts of key 111. Relay 110 locks in a circuit from battery at the inner contact of relay 102, inner upper alternate contacts and winding of relay 110 to ground at key 111.

As soon as the plug 101 is fully inserted, relay 107 operates in a circuit from battery, ballast lamp 112, upper winding of relay 107, lower front contact of relay 103, lower left winding of repeating coil 113, lower normal contacts of key 114, rings of plug 101 and jack 100, returning over the tips of jack 100 and plug 101, upper normal contacts of key 114, upper left winding of repeating coil 113, inner upper front contact of relay 103, lower winding of relay 107 to ground through ballast lamp 115. Relay 107 operates and a flashing shunt is thereupon established for lamp 105 until the operator throws key 111 to the right or talking position to unlock relay 110, which circuit may be traced from ground, lamp 105, back contact of relay 108, front contact of relay 107, lower front contact of relay 110 to ground at the contacts of interrupter 116. In case, however, relay 107 operates before relay 110 can operate, lamp 105 does not light. The possible flashing of lamp 105 as above described is incidental and has no significance at this time.

When the operator throws key 111 to the right a circuit is established from ground over the upper right contact of key 111 for relay 117 which establishes a circuit from ground at the upper front contact of relay 103, inner upper front contact of relay 117, conductor 118 to battery through the upper winding of relay 200. Relay 200 operates and a talking path is thereupon established from the upper right winding of repeating coil

113, inner upper right contacts of key 111, conductor 119, upper contact of relay 200, right winding of repeating coil 201, condenser 202, lower contact of relay 200, conductor 120, inner lower right contacts of key 111 to the lower right winding of repeating coil 113. Assuming that the operator's headset 203 is plugged up, the transmitter thereof is connected into an obvious circuit through the left winding of repeating coil 201, and thus inductively to the talking path just traced through the right windings of repeating coil 113 and the receiver thereof is connected over the lower back contact of relay 240, lower right winding of repeating coil 201 and the left windings of repeating coil 205 in parallel and the inner upper back contact of relay 240. The operator is thereupon enabled to converse with the calling subscriber to ascertain information concerning the desired connection.

It has been assumed that the desired connection is of a character which can be completed over incoming and final selector switches and therefore the operator first tests for an idle trunk of a group terminating in an incoming selector switch by touching the tip of calling plug 121 to the sleeve of the jack of a trunk of that group. If the trunk is busy there will be battery potential on the sleeve and this potential will be transmitted over the tip of plug 121, the upper normal contacts of relay 122, the upper back contact of relay 123, the upper normal contacts of ringing key 124, conductor 125, condenser 204, to ground through the lower right winding of repeating coil 205 which induces the busy potential through the left winding of repeating coil 205 into the operator's headset receiver thus producing a click. Assuming that she tests the trunk of Fig. 3 and receives no click indicating that it is idle, she inserts the plug 121 into jack 300 thereby establishing a circuit extending from ground, both windings of sleeve relay 500 in series, conductor 501, left contacts of cam 301, the sequence switch of the incoming selector being in position 17 when the selector trunk is idle, sleeves of jack 300 and plug 121, windings of relay 126 and marginal relay 127 in series to battery and in parallel therewith through the non-inductive winding 128 of relay 127 to battery. Due to the resistance of sleeve relay 500, insufficient current flows through the winding of marginal relay 127 to cause its operation, but relay 126 operates. Relay 500 also operates and locks over its left front contact, directly to the circuit just traced over the sleeve of jack 300, connects ground from its right front contact over the right normal contacts of relay 502, resistances 503 and 504 in series, conductor 505 to the ring conductor 302 of the trunk and connects ground to one contact of start relay 506.

Relay 126 upon operating closes a circuit extending from battery over its lower contact, the normal contact of key 124 to ground through the winding of relay 123 which operates opening the busy test circuit at its upper back contact and at its inner upper and inner lower front contacts connects the tip and ring contacts of plug 121 to the right windings of repeating coil 113. Relay 126 at its lower front contact also establishes a circuit for lamp 129 extending over the upper back contact of relay 130. Preparatory to keying the digits necessary to establish the desired connection, the operator now depresses key 206 and with the key 111 operated to the right or talking position a circuit is established from ground at the lower back contact of relay 208, the right contacts of key 206, conductor 207, the lower right

and upper intermediate alternate contacts of key 111, the upper winding of relay 122 to battery at the lower contact of relay 123. Relay 122 thereupon operates and locks in a circuit from battery over the lower contacts of relay 123, lower winding and inner lower contact of relay 122, conductor 131, back contact of relay 209 and in parallel to ground through resistance 210 and the winding of relay 208. Relay 208 operates in this circuit opening the initial operating circuit of relay 122 and closing an obvious circuit for relay 211 which operates. Relay 122 at its upper and lower alternate contacts disconnects the tip and ring contacts of plug 121 from the right windings of repeating coil 113 and connects these contacts over conductors 132 and 133 with the operator's key-set circuit.

Relay 211 upon operating closes an obvious circuit to light lamp 212, connects ground to conductor 213 for supplying operating ground to the keys of the key-set 214 and establishes a circuit from ground at its upper contact through the winding and upper normal contacts of relay 215, conductor 132, upper alternate contacts of relay 122, tips of plug 121 and jack 300, trunk conductor 303, upper right and lower left contacts of cam 304, conductor 305, left back contact of relay 507 to battery through the winding of start relay 506. Relay 506 operates in this circuit, but relay 215 being marginal does not receive sufficient current to operate at this time due to the high resistance of relay 506. Relay 506 upon operating closes a circuit from ground at the right front contact of relay 500, front contact of relay 506 to battery through the right winding of relay 502. Relay 502 operates and locks over its right winding and inner right alternate contacts to ground at the right front contact of relay 500, removes ground through resistances 503 and 504 from trunk conductor 302, connects the test wiper 508 of sender selector 510 over its left contact to the left winding of test relay 509 and establishes a circuit extending from battery, winding of relay 306, conductor 307, left back contact of relay 511, conductor 512, lower contacts of cam 308, conductor 513, left back contact of relay 509, inner right back contact of relay 514 to ground at the outer right front contact of relay 502.

Relay 306 operates and establishes a circuit extending from battery, right winding of test relay 509, conductor 515, outer right front contact of relay 306, conductor 516, middle winding of relay 509, inner right back contact of relay 514 to ground at the outer right contact of relay 502, thereby preparing test relay 509 for operation and completes the circuit for test brush 508 over the left contact of relay 502, left winding of relay 509, conductor 517, right contacts of relay 306, conductor 516, middle winding of relay 509, inner right back contact of relay 514 to ground at the outer right contact of relay 502.

It will first be assumed that the sender upon the terminals of which the wipers of the sender selector 510 are at the time standing is busy and that no operating circuit is therefore established over wiper 508 and thence as traced through the left winding of relay 509. A circuit is therefore closed for operating stepping relay 309 extending from battery, winding of relay 309, conductor 518, back contact of stepping magnet 519, conductor 520, left front contact of relay 306 and thence to ground over the operating circuit of relay 306 as previously traced. Relay 309 operates connecting the winding of stepping magnet 519 over conductor 521, the front contact of relay 309 to

the operating circuit of relay 306. Thereupon magnet 519 energizes in turn opening the circuit of relay 309 which releases opening the circuit of magnet 519. Magnet 519 in turn releases
 5 thereby advancing the wipers of switch 510 one step. In this manner through the alternate operation and release of relay 309 and magnet 519 the wipers of switch 510 are advanced step by step until test wiper 508 reaches the test terminal
 10 of an idle sender, for example the terminal 522 of sender 523 which is connected to battery, when the previously traced circuit through the left and middle windings of relay 509 will be completed. All windings of test relay 509 now being energized, relay 509 operates and at its left back contact opens the circuit of relay 306 which releases
 15 and opens the circuit of stepping relay 309 to arrest further movement of switch 510. Relay 509 now locks from battery on the terminal 522, wiper 508, left contact of relay 502, left winding and left front contact of relay 509, inner right back contact of relay 514 to ground at the outer right front contact of relay 502, the increased potential on the sender test terminal engaged by
 20 wiper 508 marking the sender as busy to other sender selectors.

With relay 509 operated and relay 306 released a circuit is established from ground at the right front contacts of relay 509, over conductor 524,
 30 left back contact of relay 306, conductor 525 to battery through the winding of relay 511. Relay 511 upon operating locks over conductor 525, left back contact of relay 306, conductor 524, next to inner right front contact of relay 511, outer
 35 right back contact of relay 514, conductor 526, lower contacts of cam 311, conductor 527 to ground at the outer right front contact of relay 502, extends ground from its inner right front contact over conductor 528, lower contacts of
 40 cam 312, conductor 529, inner left contact of relay 511, wiper 530 thence to the sender to register therein an indication that a trunk terminating in an incoming selector switch has been connected thereto, establishes a holding circuit
 45 for relay 502 extending from battery, left winding of relay 502, inner right front contact of relay 511, thence as traced to ground at the outer right front contact of relay 502, connects test wiper 508 through resistance 531, the outer left
 50 front contact of relay 511 to the right back contact of relay 500 for use on an abandoned call condition, connects the ring conductor 302 of the trunk over conductor 505 and the middle right front contact of relay 511, wiper 532 to the sender
 55 and establishes a circuit from ground through a relay of the sender over wiper 533, outer right front contact of relay 511 to battery in parallel through the winding of relay 507 and the left winding of marginal relay 514.

The sender relay operates to move the sender circuit off normal thereby changing the potential on terminal 522, to release test relay 509 and to mark the sender busy. Relay 507 also operates, but relay 514 being marginal does not operate
 65 at this time. With relay 507 operated the previously traced circuit through the winding of start relay 506 is opened at the left back contact of relay 507 and the tip trunk conductor 303 is extended over the upper right and lower left
 70 contacts of cam 304, conductor 305, left front contact of relay 507, wiper 534 to the sender. When relay 511 operated it also established a circuit extending from battery, winding of relay 535, conductor 536, lower contacts of cam 313,
 75 lower contacts of cam 312, conductor 528, inner

right front contact of relay 511 thence to ground as traced at the outer right front contact of relay 502. Relay 535 operates and closes a circuit for operating relay 537 extending from battery, left winding of relay 537, contact of relay 535, conductor 538, left contacts of cam 314, upper right
 80 contact of cam 315, upper contact of cam 316 to ground. Relay 537 upon operating establishes a circuit extending from battery, winding of sequence switch magnet 310, upper contact of cam 317, lower right contact of cam 318, conductor 539 to ground at the right front contact of relay 537 for advancing the sequence switch out of position 17 into position 18. As the sequence switch advances out of position 17 the initial operating circuit of sleeve relay 500 and the operating circuit of relay 535 are opened and relay 535 releases, relay 500 remaining operated over its locking circuit. Relay 535 upon releasing also releases relay 537.

With relay 509 released when the sequence switch reaches position 18 a circuit is established from battery, left winding of relay 537, conductor 540, upper contacts of cam 319, conductor 541, right back contact of relay 509, inner right
 100 front contacts of relay 511 thence to ground as traced at the outer right front contact of relay 502. Relay 537 operates closing the previously traced circuit through the winding of sequence switch magnet 310 for advancing the sequence switch into position 1. As the sequence switch advances out of position 18, relay 537 again releases. Ground previously connected to the sender over wiper 530 is now removed since by this time the sender has made a registration of the fact that the call incoming thereto is from a trunk terminating in an incoming selector.

A circuit is now established from ground through the winding of a relay (not shown) in the sender, over wiper 532, middle right front
 115 contact of relay 507, conductor 505, trunk conductor 302, rings of jack 300 and plug 121, the lower alternate contacts of relay 122, conductor 133, the upper normal contacts of relay 217 to battery through resistance 216. The sender relay operates and extends an impulse receiving circuit from 24-volt battery through the windings of the tip impulse responsive relays of the sender, wiper 534, left front contact of relay 507, conductor 305, lower left and upper right contacts of
 125 cam 304, trunk conductor 303, tips of jack 300 and plug 121, the upper alternate contacts of relay 122, conductor 132, upper normal contacts and winding of relay 215 to ground at the upper contacts of relay 211 and an impulse receiving circuit from 24-volt battery through the windings of the ring impulse responsive relays of the sender, wiper 532, thence as traced to conductor 133 at the key-set circuit. Relay 215 operates in the circuit just traced through its winding, locks
 135 from ground through its winding and upper alternate contacts to battery through resistance 216 and closes a circuit from ground at the upper contact of relay 211, upper back contact of relay 218, lower contact of relay 215 to battery through the winding of relay 217. Relay 217 upon operating connects 48-volt battery through resistance 219 and the lower front contact of relay 217 to conductor 220 for supplying battery to key contacts of key-set 214 and connects the key-set over its inner lower front and upper alternate contacts and conductors 132 and 133, thence as traced over wipers 534 and 532 to the impulse responsive relays of the sender. Relay 215 also closes a circuit extending from ground at the
 150

upper contact of relay 211, upper back contact of relay 218, lower front contact of relay 215, lower back contact of relay 218 to battery through lamp 221. Lamp 221 lights as an indication to the operator that the sender is in a condition to register digits of a line designation.

Keying the called line designation

It will be assumed that the operator in order to establish a connection to subscriber's line 480, the numerical designation of which is 1379, depresses the keys 222, 223, 224 and 225 in succession in the order named. In the manner fully described in Patent No. 1,897,083 above referred to, the impulse responsive relays of sender 523 are selectively controlled to cause the registration in the sender of the digits of the desired line designation. Following the keying of the numerical designation the operator depresses the start key 232 to operate the start relay of the sender to register the fact that keying is completed and that the sender may then proceed to control the establishment of the connection in accordance with the setting of its registers. Inasmuch as these functions are not directly concerned with the present invention and are fully described in the aforementioned patent, it is considered unnecessary to a full understanding of the present invention to describe them in detail herein. Upon the operation of the sender start relay 48-volt battery is connected at the sender to the terminals with which wipers 532 and 534 are engaged thus causing the operation of both polarized relays 233 and 234 in the operator's key-set circuit which upon operating close an obvious circuit for relay 235. Relay 235 upon operating locks to ground at the upper contact of relay 211 and connects ground over its upper contacts, conductor 132 and thence as traced over wiper 534 to the sender. In response to the closure of direct ground to this circuit the sender functions to open the operating circuits of relays 233 and 234, relay 233 thereupon releasing, but relay 234 being held operated by relay 235. Relay 233 upon releasing closes a circuit from ground at its back contact, lower front contact of relay 235, winding of relay 209 to battery. Relay 209 operates and opens the circuit of relay 208 which upon releasing in turn releases relays 235, 234, 209, 215, 217 and extinguishes lamps 212 and 221. The extinguishment of lamps 212 and 221 serves as a signal to the operator that registration in the sender is completed. Relay 211 upon releasing also releases relay 122 in the cord circuit. The operator's key-set is now in normal condition.

If the operator disregards the pilot signal 221 and starts keying a designation before the sender is attached and relay 217 has been operated from the sender, a circuit will be closed for relay 218 from battery through its winding, inner lower back contact of relay 217, conductor 227 to ground on conductor 213 through contacts of any operated keys of the key-set 214. Relay 218 upon operating locks over the left contact of key 206, upper front contact of relay 218 to ground at the upper contact of relay 211 and at its lower front contact connects lamp 221 in a flashing circuit through interrupter 236. To prepare the key-set for subsequent use the operator must depress key 206 to release relay 218.

Incoming brush selection

It will be recalled that the sequence switch of the incoming selector has been advanced into position 1 and that relays 511 and 507 are oper-

A fundamental control circuit is now established from battery, winding of relay 535, conductor 536, lower contacts of cam 313, conductor 529, inner left front contact of relay 511, wiper 530, thence through the winding of the stepping relay of the sender, returning over wiper 542, compensating resistance 543, outer right front contact of relay 507, conductor 544, upper left contact of cam 320 to ground at the upper contact of cam 316. Relay 535 and the stepping relay of the sender operate in this circuit, the stepping relay of the sender preparing the sender for controlling the brush selection movement of the incoming selector and relay 535 closing a circuit extending from battery, left winding of relay 537, contacts of relay 535, conductor 538, left contacts of cam 314, upper right contact of cam 315 to ground at cam 316 over which relay 537 operates. Relay 537 upon operating locks over its left winding, the contacts of relay 535, conductor 538, the lower contacts of cam 314, conductor 539 to ground at its own right front contact and establishes a circuit for advancing the sequence switch into position 2 which may be traced from battery, winding of sequence switch magnet 310, upper contacts of cam 321, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316. After the sequence switch leaves position 1, relay 537 remains operated over its locking circuit.

With the sequence switch in position 2 circuit is established from battery, winding of up-drive magnet 322, right contacts of cam 314, conductor 539 to ground at the right front contact of relay 537 for operating magnet 322 to cause the brush shaft of the incoming selector switch to be driven upward in a brush selection movement. During this movement an intermittent shunt is established around the winding of the sender stepping relay as the commutator brush 323 successively engages conducting segments of commutator strip 324. This circuit may be traced from battery, winding of relay 535, conductor 536, lower contacts of cam 313, lower left and upper right contacts of cam 312, conducting segments of commutator strip 324, brush 323, lower left and upper right contacts of cam 325, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316. Relay 535 is held operated over this circuit and the stepping relay of the sender in the well known manner causes the number of counting relays predetermined by the setting of its thousands digit register to become operated. When the sender has been satisfied the fundamental circuit previously traced through the winding of relay 535 is opened at the sender and as soon thereafter as brush 323 engages the next insulating segment of commutator strip 324 relay 535 releases in turn releasing relay 537 to open the circuit of up-drive magnet 322. The movement of the selector brush shaft is now arrested in a position in which its first brush set will be tripped as later described. Relay 537 upon releasing also closes a circuit from ground over its right back contact, conductor 547, the lower left contact of cam 318, the upper contact of cam 317 to battery through the winding of sequence switch magnet 310 for advancing the sequence switch into position 3.

The sequence switch upon reaching position 2 and until it leaves position 15 places the right high resistance winding of sleeve relay 500 in a short circuit extending from ground through the

right winding of relay 500, conductor 548, lower left contact of cam 320 to ground at cam 316 thus increasing the current flowing in the circuit previously traced through the windings of cord circuit relays 126 and 127 to such an extent that marginal relay 127 now operates to connect the talking battery through the right winding of retard coil 135, the winding of supervisory relay 134, the lower front contact of relay 127, the lower right winding of repeating coil 113, inner lower front contact of relay 123, the lower normal contacts of relay 122, rings of plug 121 and jack 300 to the ring conductor 302 of the incoming selector trunk circuit and to connect ground through the left winding of retard coil 135, the inner upper front contact of relay 127, the upper right winding of repeating coil 113, the inner upper front contact of relay 123, the upper normal contacts of relay 122, tips of plug 121 and jack 300 to the tip conductor 303 of the trunk circuit.

Incoming group selection

As soon as the sequence switch reaches position 3 a circuit is established for operating the trip magnet 326 which extends from battery through the winding of magnet 326, the lower right contact of cam 315 to ground at cam 316. Magnet 326 operates preparatory to tripping the first brush set on the next upward movement of the brush shaft. The previously traced fundamental circuit through the winding of relay 535 and the winding of the sender stepping relay is also established whereupon the sender stepping relay operates to prepare the sender for controlling the group selection movement of the incoming selector and relay 535 operates closing an operating circuit for relay 537 extending from battery, left winding of relay 537, contacts of relay 535, conductor 538, lower contacts of cam 327, upper right and lower left contacts of cam 325, upper right contact of cam 315 to ground at cam 316. Relay 537 operates closing a locking circuit for itself over its left winding, the contacts of relay 535, conductor 538, lower contacts of cam 327, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316 and closing a circuit from battery, winding of sequence switch magnet 310, upper contact of cam 317, lower right contact of cam 318, conductor 539, to ground at the right front contact of relay 537 for advancing the sequence switch into position 4. After leaving position 3 relay 537 is held operated over its locking circuit under the control of relay 535.

With the sequence switch in position 4 the previously traced circuit for up-drive magnet 322 is reestablished and magnet 322 operates to cause the switch shaft to be driven upward in a group selection movement. During the initial portion of this movement with trip magnet 326 operated the selected brush set, in the case assumed the first brush set, is tripped. As the brush shaft continues in its upward movement an intermittent shunt is established around the winding of the sender stepping relay as the commutator brush 328 successively engages conducting segments of commutator strip 329. This circuit may be traced from battery, winding of relay 535, conductor 536, lower contacts of cam 313, left contacts of cam 312, commutator strip 329, brush 328, the lower left and upper right contacts of cam 325, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316. Relay 535 is held operated over this circuit and the stepping relay

of the sender in the well known manner causes the number of counting relays, predetermined by the setting of the thousands and hundreds digit registers of the sender, to become operated. When the sender has been satisfied the fundamental circuit previously traced through the winding of relay 535 is opened at the sender and as soon thereafter as brush 328 engages the next insulating segment of commutator strip 329 relay 535 releases in turn opening the operating circuit of relay 537. Relay 537 will, however, remain operated until commutator brush 323 engages an insulating segment of the upper portion of commutator strip 324 over a holding circuit extending from battery through its left winding, conductor 540, left contacts of cam 330, commutator strip 324, brush 323, lower left and upper right contacts of cam 325, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316. When this locking circuit opens after the brush shaft has traveled far enough for the locking pawl to engage in a notch in the lower portion of the shaft relay 537 releases to open the circuit of up-drive magnet 322. The movement of the selector brush shaft is now arrested with the tripped brush set in position to hunt over the third group of trunks in the bank to which the brush set has access. Relay 537 upon releasing also closes at its right back contact the previously traced circuit for advancing the sequence switch out of position 4 into position 5.

Trunk hunting

In position 5 of the sequence switch a circuit is closed from battery, non-inductive winding 549 and right winding of relay 537 in series, conductor 550, right contact of cam 316 to ground. Relay 537 operates connecting its left winding in a circuit from battery over conductor 540, right contacts of cam 325, conductor 545, left front contact of relay 537, conductor 546, contacts of cam 331, to sleeve brush 332, and closing at its right front contact the previously traced circuit for sequence switch magnet 310 which advances the sequence switch into position 6. If the first trunk of the selected group upon which the tripped brush set is now standing is idle, the test brush 332 will encounter no ground on the test terminal thereof and the locking circuit through the left winding of relay 537 will not be closed and since the initial operating circuit through the right winding of relay 537 is open with the sequence switch advanced out of position 5, relay 537 will release and immediately connect ground to the sleeve terminal of the trunk over brush 332, contacts of cam 331, conductor 546, left back contact of relay 537, conductor 551, upper left contact of cam 315 to ground at cam 316 to mark the selected trunk busy. Relay 537 upon releasing also closes the previously traced circuit through the winding of sequence switch magnet 310 to cause the advance of the sequence switch into position 8. After the sequence switch reaches position $6\frac{3}{4}$ and until it subsequently leaves position $15\frac{1}{4}$ ground is connected directly to the sleeve terminal of the trunk over brush 332 and the left contact of cam 316.

If the first trunk of the group is found busy, however, relay 537 is held locked over its left winding and sleeve brush 332 after the sequence switch reaches position 6 and the previously traced circuit of the up-drive magnet 326 is closed at the right front contact of relay 537 to drive the brush shaft upward in a hunting movement

until the terminal of an idle trunk is reached. When brush 332 engages the test terminal of an idle trunk the holding circuit of relay 537 is opened, but until the brushes become centered on the terminals of the idle trunk, relay 537 is held from releasing by a circuit extending from battery through the non-inductive winding 549 and right winding of relay 537, conductor 550, right contacts of cam 330, commutator strip 333, brush 334, upper left and lower right contacts of cam 314, conductor 539 to ground at the right front contact of relay 537. When the brushes become properly centered, brush 334 engages an insulating segment on commutator strip 333 and relay 537 releases opening the circuit of up-drive magnet 326 and closing the previously traced circuit for advancing the sequence switch into position 8.

Final brush selection

With the sequence switch in position 8 and the sender ready to control final brush selection, relay 535 operates in series with the stepping relay of the sender and closes a circuit which may be traced from battery, left winding of relay 537 and in parallel therewith over the non-inductive winding 549 of relay 537, conductor 560 and left contacts of cam 319 to conductor 540, thence over the contacts of relay 535, conductor 538, right contacts of cam 327, brush 335, terminal 336, tip conductor 401 of the final selector trunk, left contact of cam 402, resistance 403, right contact of cam 404, right winding of relay 405 to ground over the right contacts of cam 407. Relay 405 operates in this circuit, but relay 537 does not and therefore the sequence switch of the incoming selector remains in position 8 until after all final selections are completed.

Relay 405 upon operating locks in a circuit which extends as traced from battery at the incoming selector over the right winding of relay 405, left contacts of cam 406, right front contact of relay 405, left contact of cam 424, upper right contact of cam 425 to ground and closes a circuit from battery through the winding of relay 408, lower left and upper right contacts of cam 410 to ground at the left front contact of relay 405. Relay 408 locks in a circuit through its winding, left contacts of cam 409, right front contact of relay 408, upper contacts of cam 411, contact 412 of jack 413, sleeve conductor 414, sleeve terminal 337, brush 332 to ground at the left contact of cam 316. This locking circuit remains closed until the final selector sequence switch leaves position 6. The operation of relay 408 at this time closes a circuit from battery through the winding of sequence switch magnet 400, lower contacts of cam 415 to ground at the left front contact of relay 408 for advancing the sequence switch into position 2.

With the sequence switch in position 2 a circuit is closed for high speed up-drive magnet 416 extending from battery through the winding of magnet 416, upper left contact of cam 417, upper right contact of cam 410, left front contact of relay 405 to ground. Under the control of magnet 416 the final selector brush shaft is driven upward in a brush selection movement. As brush 421 passes over commutator strip 420 a circuit is intermittently closed from ground over the lower right contact of cam 422, brush 421, commutator strip 420, upper right and lower left contacts of cam 419, ring conductor 418 of the final selector trunk, terminal 338, brush 339, right contacts of cam 340, conductor 536 to battery through the winding of relay 535. This circuit serves to hold

relay 535 operated and to shunt the sender stepping relay in the usual manner. When the sender is satisfied with respect to the setting of its hundreds register it opens the circuit of relay 535 and as soon thereafter as commutator brush 421 engages the next insulating segment of commutator strip 420 relay 535 releases in turn releasing relay 405. Relay 405 opens the circuit of up-drive magnet 416 and brings the final selector brush shaft to rest in position to trip the selected set of brushes, in the case assumed, the fourth set of brushes. With relay 405 released a circuit is closed from battery through the winding of sequence switch magnet 400, lower left contact of cam 423 to ground at the left back contact of relay 405 for advancing the sequence switch to position 3 in which position trip magnet 426 is operated in a circuit extending from ground at the lower left contact of cam 422.

Final tens selection

When the fundamental circuit from the sender through the winding of relay 535 is again closed by the sender, relay 535 operates again closing the previously traced circuit for relay 405 which operates and locks as before and advances the final selector sequence switch to position 4 in a circuit extending over the upper contacts of cam 410 to ground at the left front contact of relay 405. High speed up-drive magnet 416 is again operated to advance the brush shaft in a group or tens selection movement and an intermittent circuit is completed as previously traced from battery, winding of relay 535 to conductor 418, thence over the right contacts of cam 419, commutator strip 427, brush 428, right contacts of cam 410 to ground at the left front contact of relay 405. Relay 535 is held operated over this circuit and the stepping relay of the sender is intermittently shunted in the usual manner. During the initial portion of the group selection movement with the trip magnet 426 operated the fourth set of brushes is tripped. When the sender is satisfied with respect to the setting of its tens register it opens the circuit of relay 535 and as soon as commutator brush 428 engages the next insulating segment of commutator strip 427, relay 535 releases in turn releasing relay 405. Relay 405 opens the circuit of up-drive magnet 416 and thereby brings the final selector brush shaft to rest with its fourth set of brushes in position to advance over terminals of the eighth group of the brush bank in which subscriber's line 480 terminates. Relay 405 also closes the previously traced circuit for advancing the final selector sequence switch into position 5.

Final units selection

When the fundamental circuit is again established at the sender for controlling the units selection movement of the final selector, relay 535 again operates in turn causing the operation of relay 405 which locks as before described and closes a circuit extending from ground over its left front contact and the upper contacts of cam 410 for sequence switch magnet 400 which advances the sequence switch to position 6. In position 6 the holding circuit of relay 408 is transferred to a circuit through the lower left contact of cam 409, lower right contact of cam 442, back contact of relay 437 to ground at the left front contact of relay 408. With relay 405 operated a circuit is completed from battery through the winding of slow speed up-drive magnet 432, upper right contacts of cams 417 and 410 to ground at

the left front contact of relay 405 for driving the final selector brush shaft upward in a units or terminal selection movement. As the brush shaft advances an intermittent shunt circuit is established from battery through the winding of relay 535 thence as traced to conductor 418, lower right and upper left contacts of cam 419, commutator strip 420, brush 421, lower right contact of cam 422 to ground. Relay 535 is held over this circuit and the stepping relay of the sender is intermittently shunted. When the sender is satisfied with respect to the setting of its units register it opens the circuit of relay 535 which releases as soon as brush 421 engages the next insulating segment of commutator strip 420 at which time the brushes of the final selector will be centered on the terminals of the called line 480. When relay 535 releases, relay 405 also releases stopping the upward movement of the selector brush shaft and closing the previously traced circuit of sequence switch magnet 400 to advance the sequence switch into position 7. The sequence switch is then immediately advanced into position 9 in a circuit extending from battery, winding of magnet 400, upper left and lower right contacts of cam 410 to ground at the lower right contact of cam 422.

When the sequence switch passes through positions $6\frac{3}{4}$ to 8 inclusive, a circuit is closed from ground through the winding of relay 433, lower contacts of cam 411 to the sleeve brush 434. If the called line is in normal condition battery will be connected to the sleeve terminal 435 through the winding of cut-off relay 436, or if the line is busy this relay will be shunted by ground through a resistance. Relay 433 will operate unless the sleeve conductor is open or is grounded through a low resistance such as would occur if the sleeve were accidentally grounded. When relay 433 operates and when the sequence switch reaches position $7\frac{1}{2}$ a circuit is closed from battery through the left winding of relay 405, upper contact of cam 429, right winding of relay 405, contact of relay 433, upper contacts of cam 415, back contact of relay 437, left front contact of relay 408 to ground. Relay 405 operates in this circuit and locks in a circuit through its two windings, left contacts of cam 406, right front contact of relay 405, left contact of cam 424, upper right contact of cam 425 to ground until the sequence switch leaves position $9\frac{1}{4}$.

From the time that relay 405 releases with the sequence switch in position 6 following units selection until the sequence switch leaves position $8\frac{1}{4}$ ground is connected to conductor 418 over the lower contacts of cam 419, right back contact of relay 405, upper left contact of cam 424 and the upper right contact of cam 425 and as soon as position 7 is reached ground is connected to conductor 418 over the lower contacts of cam 419 from the upper right contact of cam 422. This circuit extends as previously traced to battery through the winding of relay 535 for operating that relay independently of the sender.

When the sequence switch passes through positions 8 to $8\frac{1}{4}$ direct ground is connected to conductor 401 over the lower left and upper right contacts of cam 402, right contacts of cam 410 and the lower right contact of cam 422. It will be remembered that the windings of relay 537 are at this time connected to conductor 401. With direct ground connected to conductor 401 relay 537 now operates and closes the previously traced circuit through the winding of sequence switch magnet 310 for advancing the sequence switch of

the incoming selector into position 9, relays 535 and 537 releasing as the sequence switch leaves position 8. In position 9 a circuit is established from battery, winding of relay 535, conductor 536, right contacts of cam 313, conductor 544, outer right contact of relay 507, resistance 543, brush 542 to the sender returning over wiper 530, the inner left contact of relay 511, conductor 529, lower contacts of cam 312, conductor 528, inner right front contact of relay 511, inner right front contact of relay 507, conductor 526, left and upper right contacts of cam 311 to ground thus giving a reverse battery signal to the sender and operating relay 535. With relay 535 operated in position 9 relay 537 operates over a circuit extending from battery through its left winding, contacts of relay 535, conductor 538, left contacts of cam 314, upper right contact of cam 315, to ground at cam 316 and advances the sequence switch of the incoming selector into position 11.

When the sequence switch leaves position 9 relay 537 releases and when it leaves position 10 the fundamental circuit to the sender is opened and relay 535 releases. The sender functions in the well known manner to increase the resistance of the circuit over wiper 533 to such an extent that relay 507 now releases. Relay 507 upon releasing now reoperates relay 537 in a circuit from battery through its left winding, conductor 540, upper left and lower right contacts of cam 319, conductor 552, right back contact of relay 507, conductor 526, lower contacts of cam 311, conductor 527 to ground at the outer right front contact of relay 502. Relay 537 upon operating closes the previously traced circuit through the winding of sequence switch magnet 310 for advancing the sequence switch into position 12. As the sequence switch leaves position 11, relay 537 releases and the holding circuit of relay 511 is opened at the lower contacts of cam 311 and relay 511 also releases opening the circuit over wiper 533 to release the sender.

It will be recalled that relay 405 of the final selector operated as the sequence switch thereof moved into position $7\frac{1}{2}$ and therefore as soon as the sequence switch thereof reaches position 9 a circuit is established from battery, winding of magnet 400, upper contacts of cam 410, left front contact of relay 405 to ground for advancing the sequence switch into position 10. In passing through positions $8\frac{1}{2}$ to 10 a circuit is closed from battery, winding of cut-off relay 436, terminal 435, brush 434, lower right and upper left contacts of cam 411, right front contact of relay 408, right contact of cam 438, winding of relay 437, lower contact of cam 425 to ground. If the called line is an individual line as assumed and is idle, marginal relay 437 will operate and open the holding circuit of relay 408 which in turn opens a circuit for slow speed up-drive magnet 432 extending over the upper right and lower left contacts of cam 417, effective for advancing the selector switch shaft in a private branch exchange terminal hunting movement and closes a circuit extending from its left back contact over the upper left contact of cam 423 to battery through the winding of sequence switch magnet 400 for advancing the sequence switch into position 12. As soon as relay 408 releases ground is connected to sleeve brush 434 from ground at the left front contact of relay 405, lower contacts of cam 406, right front contact of relay 405, left contact of cam 424, through resistance 446, upper contacts of cam 441, right back contact of relay 408, upper left and lower right contacts of cam 180

411 to sleeve brush 434 as a temporary busy condition.

While the sequence switch is passing from position 10 into position 10 $\frac{3}{4}$ the holding circuit of relay 405 is extended from the upper left contact of cam 406 over the lower left contact of cam 406, right front contact of relay 405, left contact of cam 424, through resistance 446 and then to sleeve brush 434 as above traced. If the line on which the brush 434 is positioned is busy, ground will be connected to the sleeve terminal with which it is engaged and relay 405 will be held operated until the sequence switch leaves position 10 $\frac{3}{4}$. A locking circuit for relay 405 would then be closed over the upper left and lower right contacts of cam 406 to ground at the left front contact of relay 405 in position 11 and the two circuits overlap sufficiently to prevent the release of relay 405. It will be assumed, however, that the called line is idle and that relay 405 releases as soon as the sequence switch leaves position 10 and therefore connects ground from the upper right contact of cam 422 over its right back contact, left contact of cam 424, resistance 446, right contacts of cam 441 to sleeve brush 434 to make the called line busy.

When the sequence switch reaches position 12 with relay 405 released, relay 408 is reoperated in a circuit through its winding, lower left contact of cam 409, upper right contact of cam 442, to ground at the left back contact of relay 405. Relay 408 upon operating closes a circuit from battery through the winding of sequence switch magnet 400, lower contacts of cam 415, left front contact of relay 408, to ground, advancing the sequence switch to the talking position 13. As soon as the sequence switch reaches position 13, ground is connected over the upper right contact of cam 425, through resistance 446, the right contacts of cam 441, to the sleeve brush 434 to hold the called line busy throughout the conversation. Relay 408 when operated in position 12 locks over the left contacts of cam 409, right front contact of relay 408, upper contacts of cam 411, contact 412 of jack 413, sleeve conductor 414, brush 332 to ground at cam 316. In the talking position, the tip conductor 401 is extended over the lower contacts of cam 402 to tip brush 454 and the tip of the called line and the ring conductor 418 is extended over the upper contacts of cam 452 to ring brush 455 and the ring of the called line. Testing operations are completed quickly at the final selector and the sequence switch thereof advances to the talking position 13 before the incoming selector sequence switch has advanced to position 12 as previously described preparatory to ringing.

When, therefore, the sequence switch of the incoming selector passes through positions 10 and 11, with the sequence switch of the final selector in position 13, a charge path for charging the subset capacity of the called line 480 before the winding of relay 535 is connected to the called line, is closed which may be traced from ground at cam 316, upper right contact of cam 315, lower left and upper right contacts of cam 325, lower left and upper right contacts of cam 327, brush 335, terminal 338, conductor 401, thence as traced over the called line, returning over conductor 418, terminal 338, brush 339, lower right and upper left contacts of cam 340, conductor 560, non-inductive winding 549 of relay 537 to battery. This is for the purpose of preventing a false operation of relay 535 when it is later connected. When the sequence switch reaches position 12,

relay 535 is connected in a circuit from battery through its winding, conductor 536, right contacts of cam 340, thence as traced to the called line, returning over the upper right and lower left contacts of cam 327 to ground at cam 316 as traced.

Ringling on the called subscriber's line

Ringling the called subscriber is under the control of the operator, and the operator proceeds to initiate the ringling as soon as she is informed through the extinguishing of lamps 212 and 221 that the sender has completed the registration of the digits keyed. At this time the cord circuit relay 122 is released. The operator thereupon operates the ringling key 124 releasing relay 123. With relays 122 and 123 both normal and key 124 operated a ringling circuit is established from the ringling generator 136, upper alternate contacts of key 124, upper back contacts of relay 123, upper normal contacts of relay 122, tips of plug 121 and jack 300, conductor 302, right contacts of cam 304, conductor 553, winding of alternating current relay 554, condenser 555, conductors 505 and 302, rings of jack 300 and plug 121, lower normal contacts of relay 122, lower back contact of relay 123, intermediate lower alternate contacts of key 124 to ground. Relay 554 operates in turn connecting the winding of alternating current relay 556 to the ringling circuit and relay 556 also operates and closes a circuit from ground at its contacts over conductor 557 to battery through the winding of ringling relay 341. Relay 341 upon operating locks over its inner right front contact, back contact of relay 342, conductor 343, to ground at the inner right front contact of sleeve relay 500.

When the sequence switch of the incoming selector reaches position 12 as previously described, if relay 341 is operated or as soon thereafter as it operates, a circuit is established extending from battery winding of relay 535, conductor 536, inner left front contact of relay 341, upper right contact of cam 320 to ground at cam 316. Relay 535 operates and closes a circuit extending from battery, left winding of relay 537, contacts of relay 535, conductor 538, left contacts of cam 314, upper right contact of cam 315 to ground at cam 316. Relay 537 operates closing the previously traced circuit through the winding of sequence switch magnet 310 for advancing the sequence switch into position 13. Upon leaving position 12 relays 535 and 537 release and the windings of relays 554 and 556 are disconnected from the trunk conductors 302 and 303 and these relays also release. Ringling current is now applied from the source of ringling current 344 over the contacts of cam 345, winding of relay 342, outer left front contact of relay 341, lower contacts of cam 340, thence as traced over the ring brushes of the selector switches and the called line loop returning over the tip brushes of the selector switches, the upper contacts of cam 327, to ground at the right front contact of relay 341.

When the called subscriber answers in response to the ringling of his substation bell, relay 342 operates opening the holding circuit of relay 341 which thereupon releases to disconnect the source of ringling current from the called line. The called subscriber's line is now supplied with talking current from the cord circuit as soon as the ringling key 124 is restored, in a circuit extending as previously traced from battery and ground through the windings of retard coil 135 and winding of supervisory relay 134 to the

trunk conductors 302 and 303, thence through back contacts of relay 341 and as traced to the called line. Relay 134 operates in this circuit in turn operating relay 130 which at its upper back contact opens the circuit of lamp 129. Lamp 129 is thereby extinguished as a signal that the called subscriber has answered.

Should the operator delay ringing and the subscriber 480 remove his receiver to initiate a call after the incoming selector sequence switch has advanced to position 12, then relay 535 will be operated in a circuit through its winding, conductor 536, right contacts of cam 340, thence as traced over the called line loop returning over the upper right and lower left contacts of cam 327, the upper right and lower left contacts of cam 325, the upper right contact of cam 315, to ground at cam 316. Relay 535 upon operating closes the previously traced circuit for relay 537 which operates and advances the sequence switch into position 13. The talking circuit is now established from the cord circuit as traced to the called line and the operator may talk with the called subscriber to inform him that a call is incoming to his line.

Disconnection

Should the operator withdraw plug 121 from jack 300 before the sender 523 is attached to the trunk relay 500 will release in turn releasing relay 502 and the trunk is thereby restored to normal condition.

Should the operator disconnect after the sender has been associated with the trunk, relay 500 will release but relay 502 will not release being held operated under the control of relays 507 and 511 which operated as previously described as soon as the sender was connected to the trunk. With relay 500 released battery is connected over the right contacts of cam 301 and the left back contact of relay 500 to the sleeve of jack 300 to mark the trunk as busy and ground is connected from the outer right back contact of relay 500, outer left front contact of relay 511, resistance 531, wiper 503 to the sender. If the sender control sequence switch has not advanced from normal, the connection of ground through resistance 531 causes the sender to increase the resistance of the circuit over wiper 533, the outer right contact of relay 511 to battery through the winding of relay 507, to such an extent that relay 507 releases.

With relay 500 released, a circuit is established from ground at the inner right back contact of relay 500, conductor 558, lower right and upper left contacts of cam 321, winding of sequence switch magnet 310 to battery for advancing the sequence switch into position 4. Upon reaching position 4, since relay 537 is not operated, a circuit is established from ground at the right back contact of relay 537, conductor 547, lower left contact of cam 318, upper contact of cam 317 to battery through the winding of magnet 310 for advancing the sequence switch into position 5. With the sequence switch in position 5 relay 537 operates in a circuit extending from battery through its non-inductive winding 549 and right winding in series, conductor 550 to ground at the right contacts of cam 316 and at its right front contact closes a circuit from ground over conductor 539, the lower right contact of cam 318, the upper contact of cam 317 to battery through the winding of magnet 310 for advancing the sequence switch into position 6. Upon leaving position 5 the sequence

switch opens the circuit of relay 537 and relay 537 releases closing over its right back contact the previously traced circuit for advancing the sequence switch into position 8. With the sequence switch in position 8 the magnet 310 is again operated over the circuit previously traced to ground at the inner right back contacts of relay 500 and advances the sequence switch into position 9. When the sequence switch reaches position 9 since at this time relay 507 is released a circuit is closed from battery through the left winding of relay 537, conductor 540, upper left and lower right contacts of cam 319, conductor 552, right back contact of relay 507, conductor 526, to ground over the left and upper right contacts of cam 311. Relay 537 operates and closes the previously traced circuit from ground at its right front contact through the winding of sequence switch magnet 310 for advancing the sequence switch into position 11, relay 537 releasing as the sequence switch leaves position 9. Upon reaching position 11 the previously traced circuit from ground at the inner right back contact of relay 500 over the left contact of cam 321 to battery through the winding of magnet 310 is closed and the sequence switch is advanced into position 16. Upon leaving position 11 the sequence switch opens the circuits of relays 511 and 502 and these relays release dismissing the sender. Since the incoming selector brush shaft has not been advanced from normal, when the sequence switch reaches position 16 a circuit is closed from battery, winding of magnet 310, upper contact of cam 317, upper right contact of cam 318, normal commutator segment 345, brush 334, upper right contact of cam 315 to ground at cam 316 and the sequence switch is advanced to its normal position 17. All apparatus of the trunk and sender are now in normal condition.

If, however, the sender control sequence switch has advanced from normal at the time the operator disconnects, the release of relay 500 does not release relays 507 and 511 and the connection of ground through resistance 531 to wiper 503 does not cause the sender to immediately increase the resistance over wiper 533 to release relay 507 but causes the sender to function to maintain a closed fundamental circuit over wipers 530 and 542. As just described, the release of relay 500 causes the sequence switch of the incoming selector to advance to position 9. With the sequence switch in position 9 reverse battery is connected to the sender in the same manner as for the completed call previously described. The sender recognizes the reverse battery condition and increases the resistance in the circuit over wiper 533 through the winding of relay 507 so that relay 507 now releases. In position 9 relay 535 operates over the fundamental circuit closing a circuit for relay 537 extending from battery, left winding of relay 537, contacts of relay 535, conductor 538, left contacts of cam 314, upper right contact of cam 315 to ground at cam 316. Relay 537 operates and advances the sequence switch to position 11 as previously described, relays 535 and 537 releasing. From this point the circuits function as previously described to dismiss the sender and to advance the sequence switch of the incoming selector into position 16. Since the brush shaft of the incoming selector may have been advanced off-normal by the sender, when the sequence switch reaches position 16, a circuit is established from battery, winding of down-drive magnet 346, lower left

contact of cam 315 to ground at cam 316. When the selector brush shaft reaches normal and brush 334 engages normal commutator segment 345, the sequence switch is advanced as previously described into normal position.

If the connection is successfully completed and both subscribers restore their receivers to the switchhook upon the termination of conversation, cord lamps 105 and 129 will become lighted as disconnect signals and in response thereto the operator will remove the cord plugs 101 and 121 from the jacks 100 and 300 thereby restoring the cord circuit to normal condition and releasing sleeve relay 500. Relay 500 upon releasing will as before described connect busy battery potential to the sleeve of jack 300, release relay 502, since the holding circuit of relay 502 was opened after the incoming selector sequence switch left position 11, and close over its inner right back contact and the left contact of cam 321 the previously traced circuit for advancing the sequence switch into position 16. In position 16 the circuit for down-drive magnet 346 is closed and the incoming selector brush shaft is restored to normal. Upon reaching normal the sequence switch is advanced to normal position 17 as previously described. When the sequence switch advances beyond position 15½ busy battery potential is removed at cam 301 from the sleeve of jack 300 to render the trunk again selectable and holding ground is removed at the left contact of cam 316 from sleeve brush 332 to initiate the restoration of the final selector.

Overflow

It will be recalled that trunk hunting by the incoming selector occurred with the sequence switch of the incoming selector in position 6 and relay 537 held operated so long as the test brush 332 encountered test terminals of busy trunks. If the incoming selector finds all trunks of a group busy then the shaft brushes are driven to the top or overflow set of terminals of the group in which position the test brush 332 encounters a test terminal to which neither ground nor battery is connected and relay 537 therefore releases releasing the up-drive magnet 322 and advancing the sequence switch as previously described from position 6 into position 8. Commutator brush 323 will now be in engagement with the upper conducting segment of strip 324 and a circuit will be established from battery, non-inductive winding 549 and right winding of relay 537 in series, conductor 550, lower right and upper left contacts of cam 318, commutator strip 324, brush 323, upper right contact of cam 315 to ground at cam 316. Relay 537 now operates and closes the previously traced circuit from ground at its right front contact through the winding of magnet 310 for advancing the sequence switch into position 9. Relay 537 releases as the sequence switch leaves position 8. In position 9 reverse battery is connected over the fundamental circuit through the winding of relay 535 as previously described in connection with the regular completed connection giving the sender an overflow signal. Relay 535 operates in turn causing the operation of relay 537 which advances the sequence switch into position 11 in the manner previously described. Relay 535 releases after the sequence switch leaves position 10 and relay 537 releases after the sequence switch leaves position 9.

The premature connection of reverse battery to the sender in this case causes the sender to

first reduce the resistance of the circuit previously traced over wiper 533 to battery in parallel through the winding of relay 507 and the left winding of relay 514, relay 514 now operating and locking in a circuit from battery through its right winding and right front contact to ground at the outer right front contact of relay 502, and to later increase the resistance of the circuit through the winding of relay 507 to cause the release of relay 507. Relay 507 upon releasing now causes the release of relay 511 releasing the sender and closing a circuit extending from battery, left winding of relay 537, conductor 540, upper left and lower right contacts of cam 319, conductor 552, right back contact of relay 507, conductor 526, lower contacts of cam 311, conductor 527 to ground at the outer right front contact of relay 502. Relay 537 operates closing the previously traced circuit from ground at its right front contact through the winding of magnet 310 for advancing the sequence switch into position 12, relay 537 releasing as the sequence switch leaves position 11. In position 12 relay 537 reoperates in the circuit previously traced through its right winding over the commutator segment 324 remaining operated until after the sequence switch has passed position 16.

With relay 537 operated the sequence switch is advanced into position 15 over a circuit extending from ground at the right front contact of relay 537, conductor 539, lower right contact of cam 318, upper contact of cam 317 to battery through the winding of magnet 310. Upon reaching position 15 with relay 514 operated a circuit is closed from ground at the outer left contact of relay 514, conductor 548, lower contact of cam 320, conductor 546, left front contact of relay 537, conductor 545, upper contacts of cam 321 to battery through the winding of magnet 310 for advancing the sequence switch into position 16 where the down-drive magnet 346 will be operated to restore the switch shaft to normal as previously described. Upon reaching normal, the engagement of brush 334 with normal commutator segment 345, will advance the sequence switch to normal position 17. Upon leaving position 16 relay 537 releases. Relay 514 upon operating also connects ground through interrupter 559, through low resistance 504, conductor 505, conductor 302, rings of jack 300 and plug 121, lower normal contacts of relay 122, inner lower front contact of relay 123, lower right winding of repeating coil 113, lower front contact of relay 127, winding of relay 134, right winding of retard coil 135 to battery, thus intermittently operating relay 134 to cause the cord lamp 129 to flash as a reorder signal. Seeing the flashing lamp, the operator removes plug 121 from jack 300 thus releasing relay 500 which, in turn, releases relays 502 and 514. The incoming trunk circuit is now in normal condition for reselection.

Incoming selector goes to tell-tale

If the incoming selector overruns in either its brush selection movement with the sequence switch in position 2 or its group selection movement with the sequence switch in position 4 and advances to the tell-tale position, a circuit is established from battery, winding of sequence switch magnet 310, upper contact of cam 317, upper left contact of cam 318, tell-tale commutator segment 347, brush 323, lower left and upper right contacts of cam 325, conductor 545, left front contact of relay 537, which is operated at

this time, conductor 546, lower right contact of cam 320 to ground at cam 316 and the sequence switch is thereby advanced into position 9. In position 9 a reverse battery condition through the winding of relay 535 is established over the fundamental circuit to the sender causing the sender to function as on the overflow condition to first operate relay 514 which locks and to then release relay 507. Relay 535 functions as previously described to advance the sequence switch to position 11. The release of relay 507 releases relay 511 thus dismissing the sender and advancing the sequence switch to position 12 as previously described. A circuit is now closed from battery, winding of magnet 310, upper contact of cam 317, upper left contact of cam 318, tell-tale segment 347, brush 322, upper right contact of cam 315 to ground at cam 316 for advancing the sequence switch into position 15. With the sequence switch in position 15 a circuit is established from battery, winding of relay 535, conductor 536, lower right and upper left contacts of cam 313, tell-tale segment 347, brush 323, upper right contact of cam 315 to ground at cam 316 and relay 535 operates closing a circuit from battery, right winding of relay 537, contacts of relay 535, conductor 538, left contacts of cam 314, upper right contact of cam 315 to ground at cam 316. Relay 537 upon operating closes a circuit from battery, winding of magnet 310, upper contacts of cam 321, conductor 545, left front contact of relay 537, conductor 546, lower right contact of cam 320 to ground at cam 316 for advancing the sequence switch into position 16. Upon leaving position 15 relay 537 releases but relay 535 remains operated. From this point the circuits function as previously described to cause the restoration of the selector switch shaft, the advance of the sequence switch to normal position 17, and the transmission of a reorder signal to the operator. When the operator disconnects from the trunk jack 300, the incoming selector circuit is restored to normal condition in readiness for reselection.

Final selector goes to tell-tale

If the final selector overruns in its brush selection movement with the sequence switch in position 2 and advances to the tell-tale position, a circuit is established from battery, winding of sequence switch magnet 400, upper right contact of cam 423, tell-tale segment 430, brush 421, to ground at the lower right contact of cam 422 for advancing the final selector sequence switch into position 4. In position 4 a circuit is established from battery, winding of magnet 400, upper right contact of cam 423, segment 430, brush 421, right contacts of cam 410 to ground at the left front contact of relay 405 for advancing the sequence switch into position 5 whereupon the magnet 400 is operated over the circuit just traced to ground at the lower right contact of cam 422 for advancing the sequence switch into position 10. As the sequence switch passes through positions 8 and $8\frac{1}{4}$ direct ground is applied from the lower right contact of cam 422, right contacts of cam 410, upper right and lower left contacts of cam 402 to conductor 401 which causes the sequence switch of the incoming selector to advance to position 9 in the manner previously described for a completed call.

With the incoming sequence switch in position 9 a reverse battery signal is transmitted to the sender and the incoming sequence switch is advanced to position 11. In response to this premature reverse battery signal the sender causes

the operation of relay 514 followed by the release of relay 507. Relay 507 upon releasing dismisses the sender and advances the incoming sequence switch into position 12. Relay 514 upon operating causes the transmission of a reorder signal to the operator's cord circuit. These operations are effected in the manner previously described in connection with the advance of the incoming selector on an overflow condition. In response to the reorder signal the operator then removes plug 121 from jack 500 and the incoming and final selector switches are restored to normal as previously described in connection with their restoration after a completed call.

It will be obvious from the preceding description that if the final selector goes to tell-tale during its tens or units selection movements with the sequence switch in positions 4 and 6, respectively, that the final sequence switch will be advanced through positions 8 and $8\frac{1}{4}$ to position 10 to cause the tell-tale condition to be established at the incoming selector.

Stuck sender

Should the sender fail to complete selections within the required time interval, the sender functions as fully described in the patent to W. B. Strickler, above referred to, to first reduce the resistance of the circuit of marginal relay 514 and relay 507 to cause relay 514 to operate and lock as previously described, and to then increase the resistance to such an extent that relay 507 releases in turn releasing relay 511 and dismissing the sender. Should this occur before the sequence switch of the incoming selector has advanced to position 2, that is before the incoming selector has been advanced in any selection movement, the operation of relay 514 results in the short-circuiting of the right high resistance winding of relay 500 thus causing the operation of marginal relay 127 of the cord circuit for connecting battery through the winding of supervisory relay 134 to the ring conductor of the cord circuit preparatory to receiving a flashing reorder signal. The operation of relay 514 in any stage of progress of the call will connect interrupted ground through interrupter 559 to the ring conductor 302 of the trunk circuit and thence to the ring conductor of the cord circuit for intermittently operating the cord supervisory relay 134 thereby flashing the supervisory lamp 129 as a reorder signal. When the operator disconnects, relay 500 releases in turn releasing relays 502 and 514 and advancing the incoming selector sequence switch to position 16 under the control of relays 500 and 507. The brush shaft of the incoming selector is then restored to normal and the sequence switch is returned to its normal position 17 in the manner previously described.

What is claimed is:

1. In a telephone system an operator's cord circuit, a trunk circuit terminating in a selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, means controlled from said cord circuit for setting said selector switch to select a desired trunk group and an idle trunk circuit in the selected group, and means for automatically returning said selector switch to normal prior to the disconnection of said cord circuit from said selector trunk circuit in the event that said selector switch overruns and goes to a tell-tale position while being set to select a group of outgoing trunk circuits.
2. In a telephone system, an operator's cord

circuit, a trunk circuit terminating in a selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, means controlled from said cord circuit for setting said switch to select a desired trunk group and an idle trunk circuit in the selected group, and means for automatically returning said selector switch to normal prior to the disconnection of said cord circuit from said selector trunk circuit in the event that said selector switch in hunting for an idle trunk finds all trunks of the selected group busy and advances to the group overflow position.

15 3. In a telephone system, an operator's cord circuit, a trunk circuit terminating in a first selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, each of said trunk circuits terminating in a second selector switch, means controlled from said cord circuit for setting said selector switches to extend a connection from said cord circuit, means for automatically returning said first selector switch to normal prior to the disconnection of said cord circuit from said trunk circuit in the event that said first selector switch overruns and goes to a tell-tale position while being set, and means for returning said first and second selector switches to normal after the disconnection of said cord circuit from said trunk circuit in the event that said second selector switch overruns and goes to a tell-tale position while being set.

4. In a telephone system, an operator's cord circuit having a sending device associable therewith and a supervisory lamp, a trunk circuit terminating in a selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, a sender associable with said trunk circuit and controllable from said sending device for controlling the setting of said selector switch to select a desired trunk group and an idle trunk circuit in the selected group, means in said trunk circuit for dismissing said sender and for flashing said supervisory lamp as a reorder signal in the event that said selector switch overruns and goes to a tell-tale position while being set to select a group of outgoing trunk circuits, and means for thereupon returning said selector switch to normal prior to the disconnection of said cord circuit from said selector switch trunk circuit.

5. In a telephone system, an operator's cord circuit having a sending device associable therewith and a supervisory lamp, a trunk circuit terminating in a selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, a sender associable with said trunk circuit and controllable from said sending device for controlling the setting of said selector switch to select a desired trunk group and an idle trunk

circuit in the selected group, means in said trunk circuit for dismissing said sender and for flashing said supervisory lamp as a reorder signal in the event that said selector switch in hunting for an idle trunk circuit finds all trunks of the selected group busy, and means for thereupon returning said selector switch to normal prior to the disconnection of said cord circuit from said selector switch trunk circuit.

6. In a telephone system, an operator's cord circuit having a sending device associable therewith and a supervisory lamp, a trunk circuit terminating in a first selector switch to which said cord circuit has access, a plurality of groups of outgoing trunk circuits to which said selector switch has access, each of said trunk circuits terminating in a second selector switch, a sender associable with said first trunk circuit for controlling the setting of said selector switches, means in said first trunk circuit for dismissing said sender and for flashing said supervisory lamp as a reorder signal in the event that either said first or a second selector switch overruns and goes to a tell-tale position while being set, means for thereafter automatically returning said first selector switch to normal prior to the disconnection of said cord circuit from said first trunk circuit in the event that said first selector overruns and goes to a tell-tale position while being set, and means for returning said first and second selector switches to normal after the disconnection of said cord circuit from said first trunk circuit in the event that said second selector switch overruns and goes to a tell-tale position while being set.

7. In a telephone system, a called subscriber's line, an operator's cord circuit, a trunk circuit terminating in a selector switch to which said cord circuit has access, an outgoing trunk circuit to which said selector switch has access and terminating in a further selector switch, means controlled from said cord circuit for setting said selector switches to extend a connection from said cord circuit to said called line, a source of ringing current associated with said first trunk circuit, a control switch for said first selector switch, means for advancing said control switch to a definite position following the setting of said selector switches, means operative in the advance of said control switch into said definite position for establishing a charging potential on said outgoing trunk circuit, means controllable from said cord circuit at any time prior to the advance of said control switch beyond said definite position, for causing the application of ringing current from said source to said called line, and a relay in said trunk circuit operable after said control switch reaches said definite position over said called line if said called subscriber responds prior to the application of ringing current there-to for advancing said control switch to a talking position.

WILLIAM C. JORDAN.