Feb. 14, 1933. W. B. STRICKLER 1,897,083

TELEPHONE EXCHANGE SYSTEM

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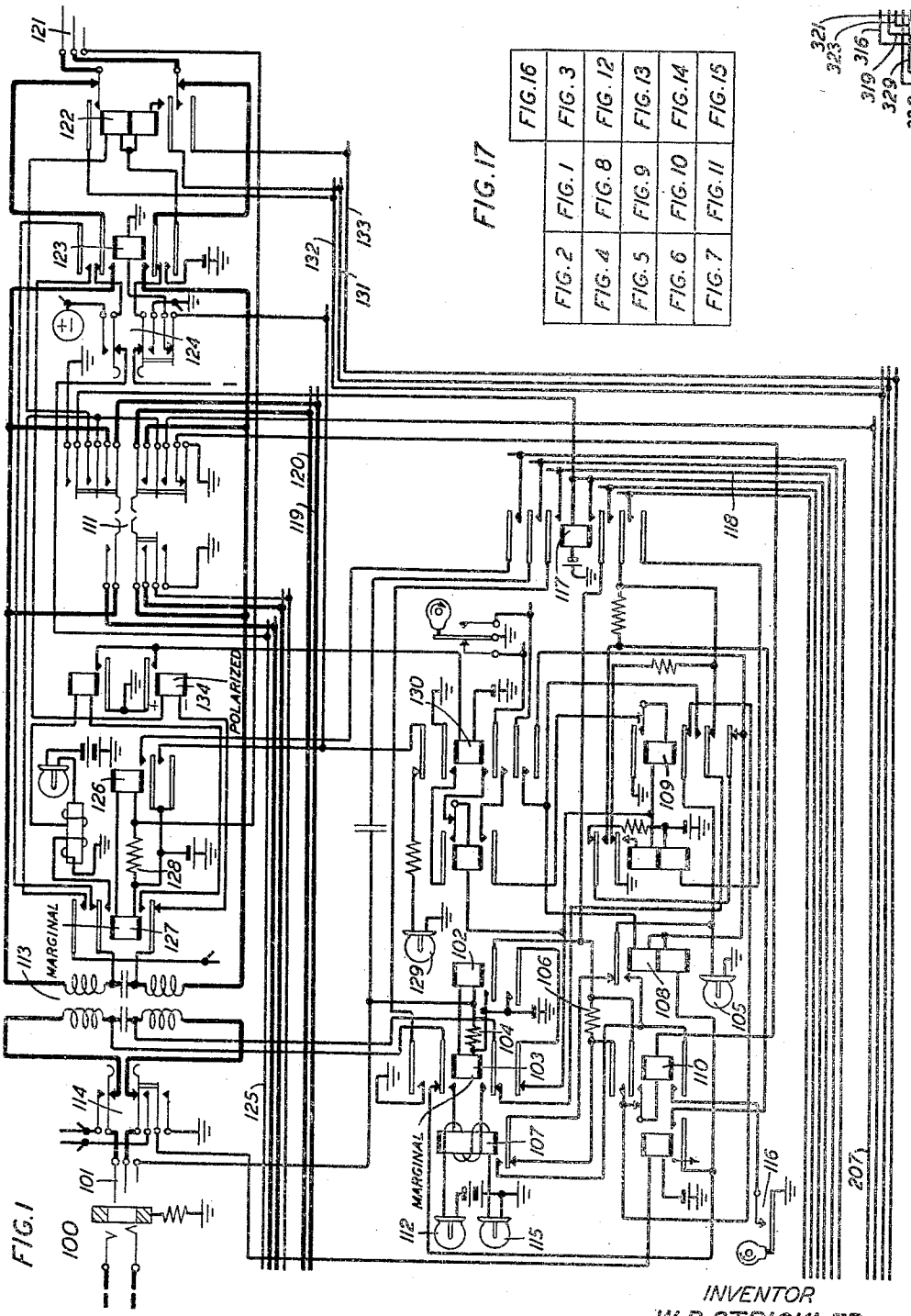

FIG. 1

FIG. 17

		FIG. 16	FIG. 3	FIG. 12	
	FIG. 1	FIG. 8	FIG. 9	FIG. 13	FIG. 14	FIG. 15
FIG. 2	FIG. 4	FIG. 5	FIG. 6	FIG. 7	

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 2

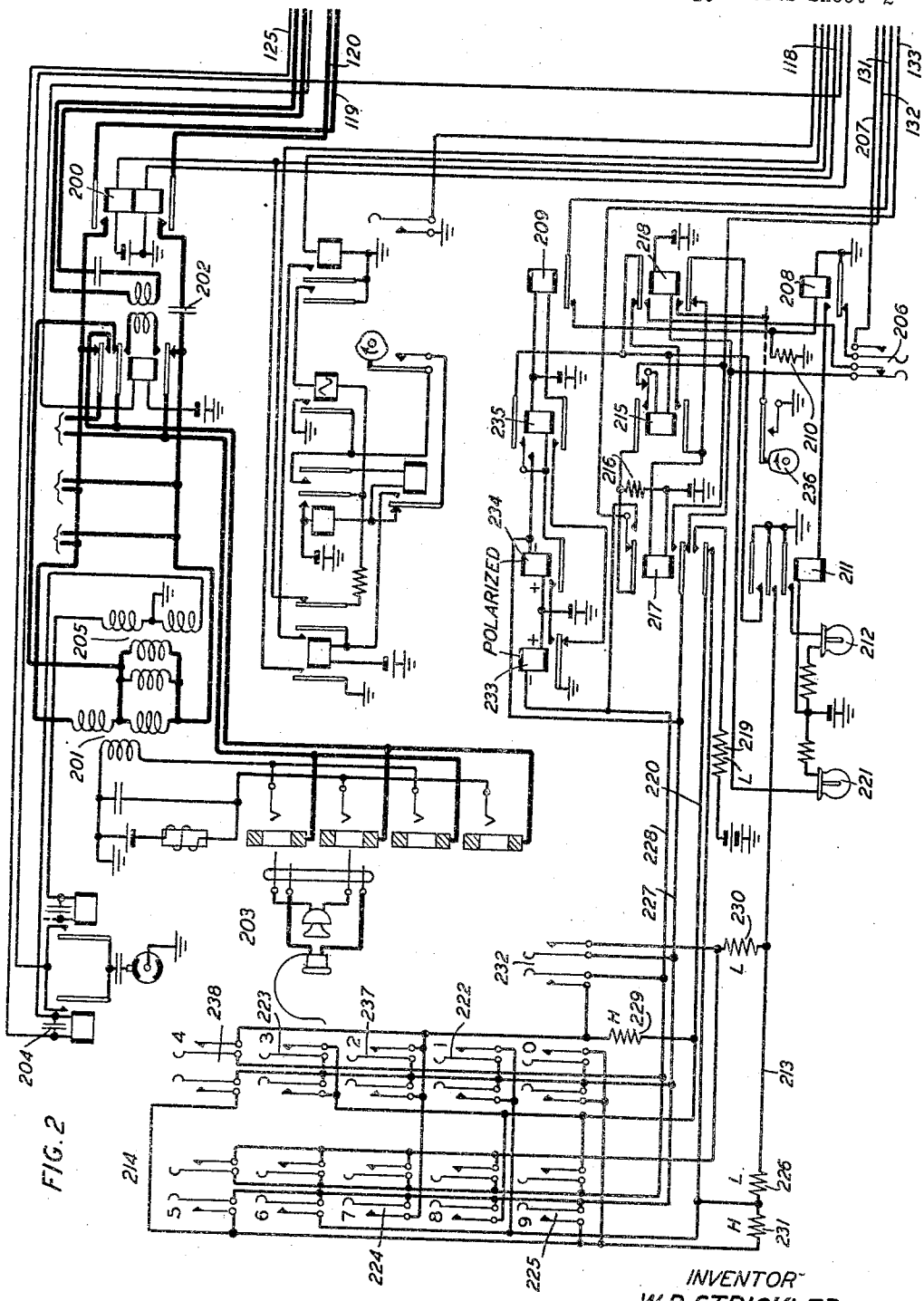

FIG. 2

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 3

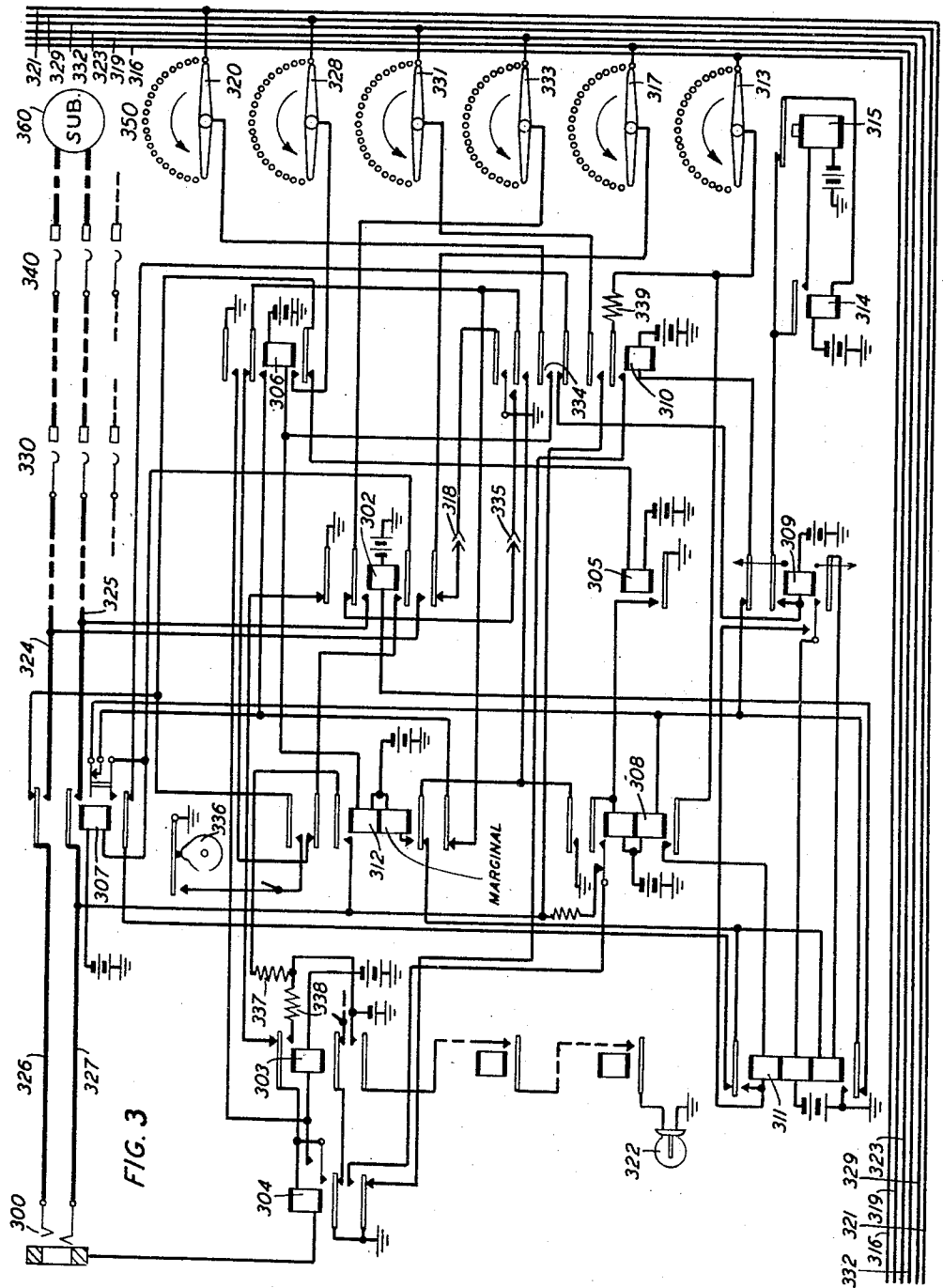

FIG. 3

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 4

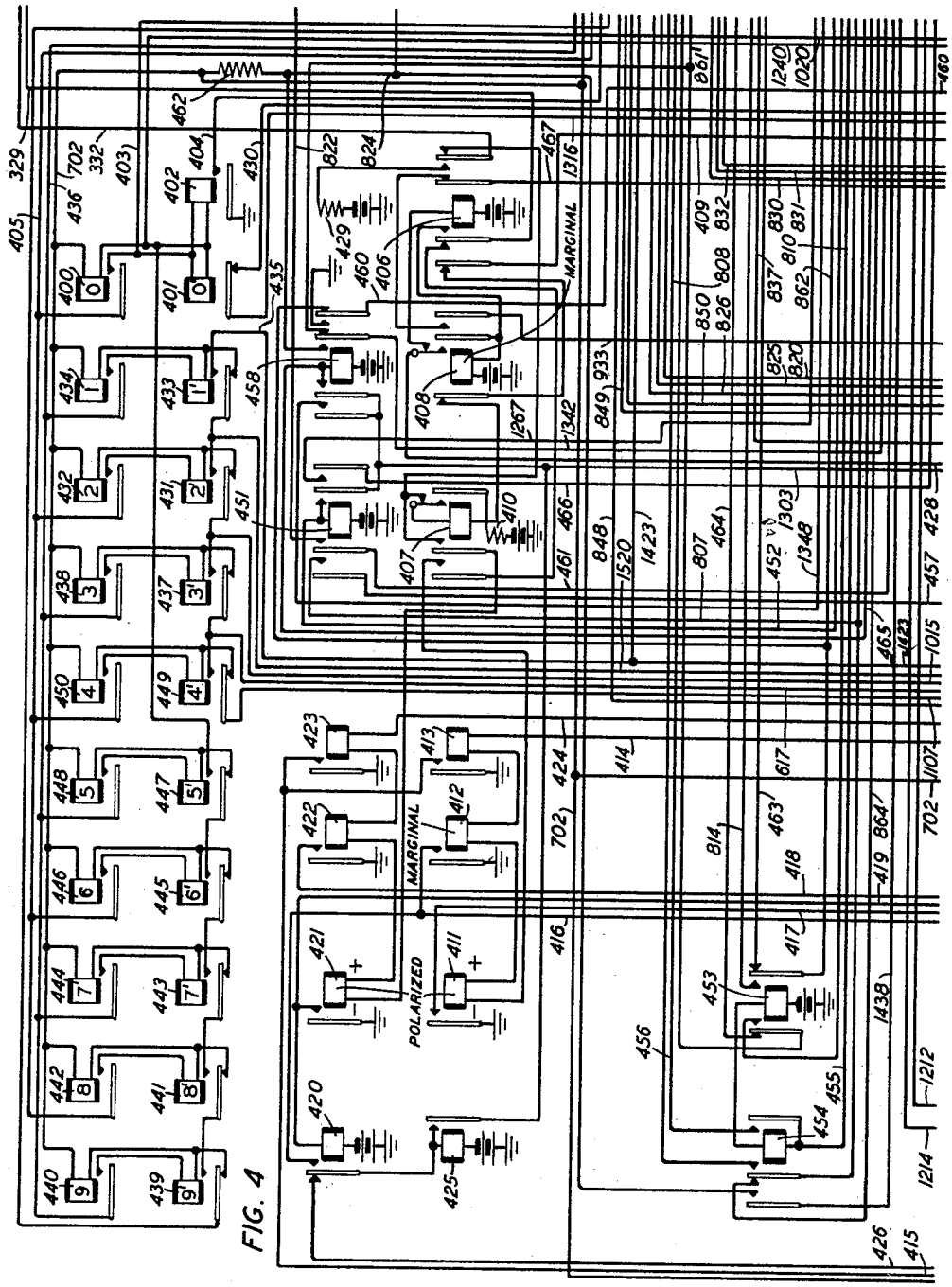

FIG. 4

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 5

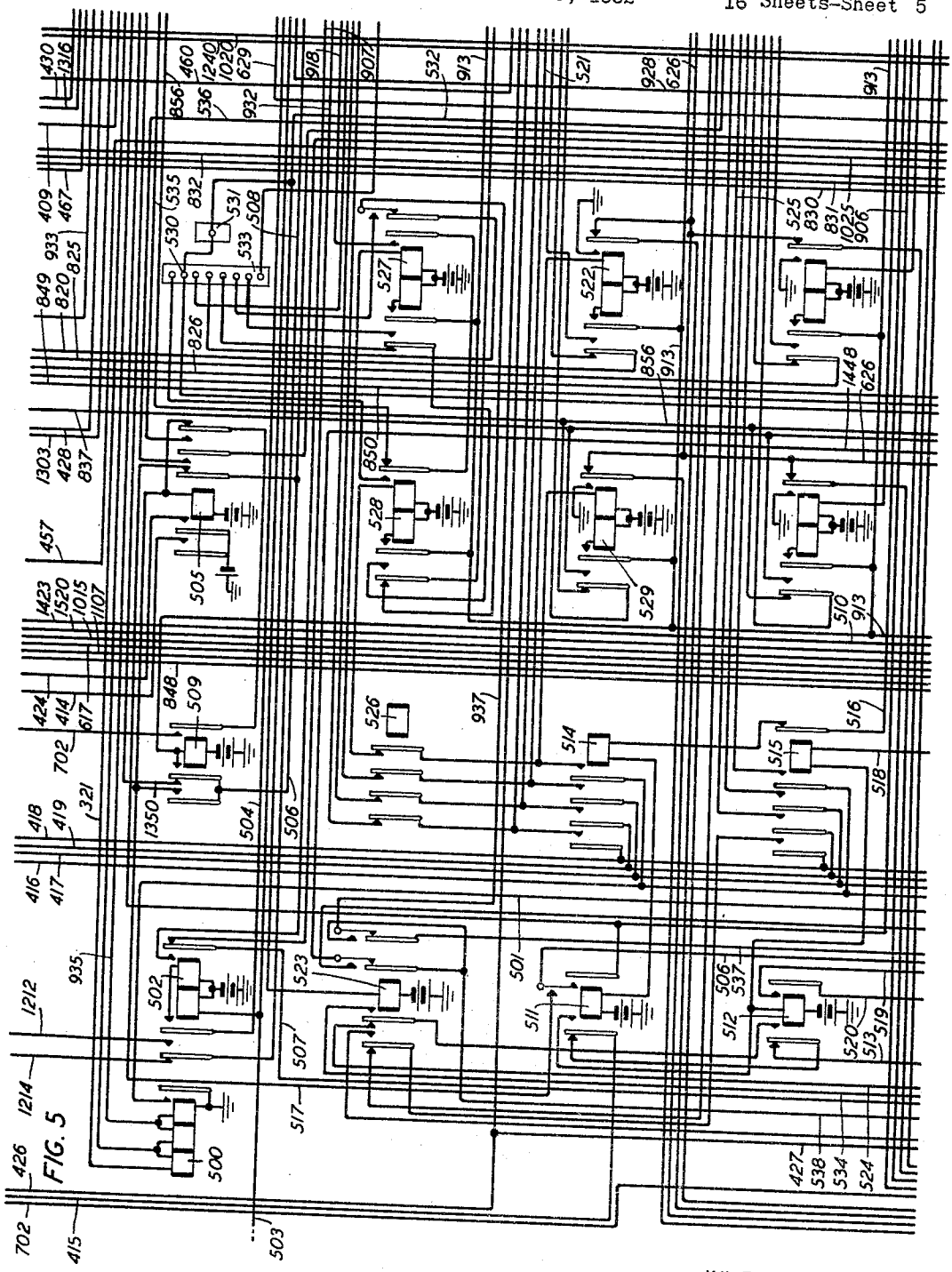

FIG. 5

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 6

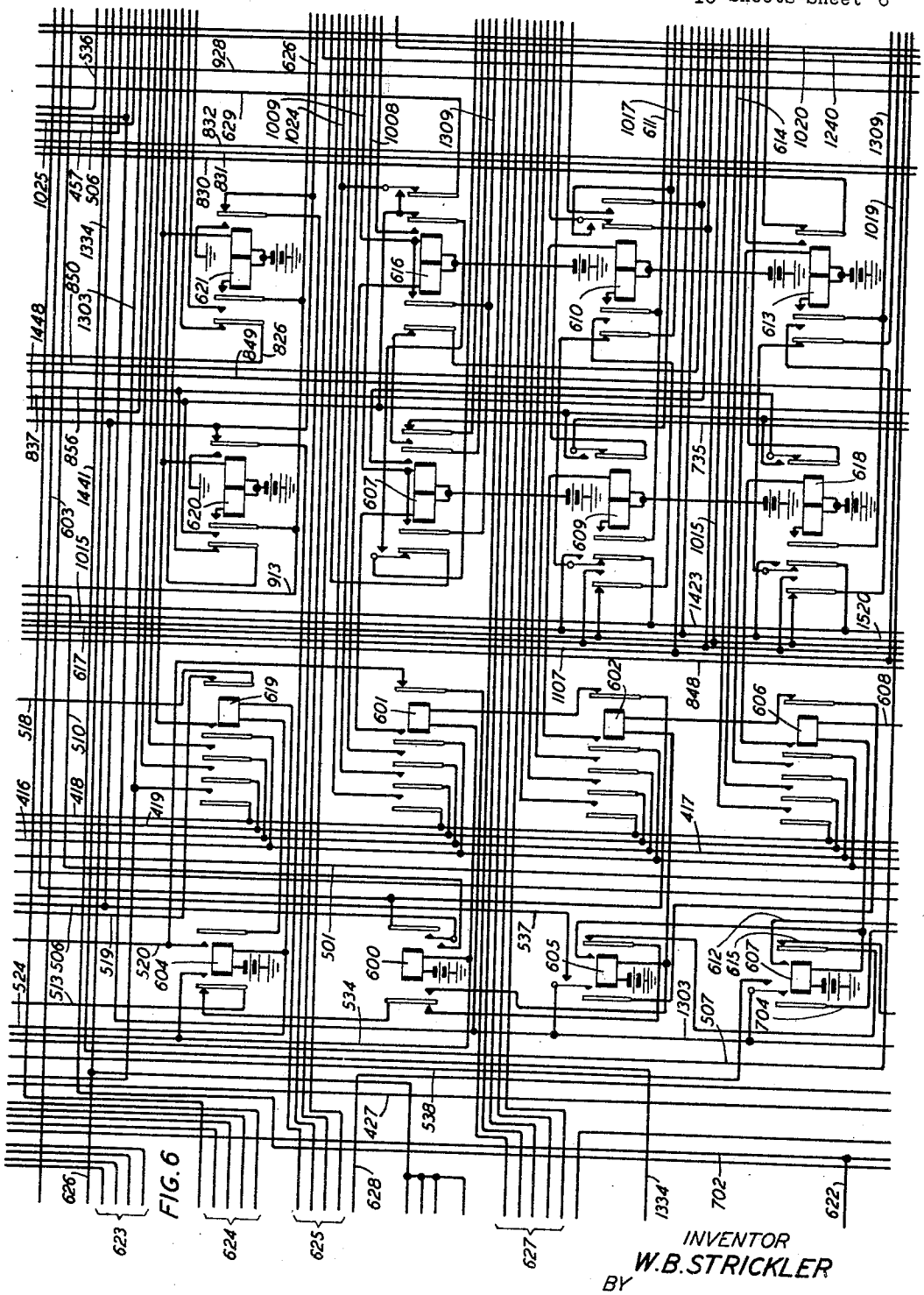

FIG. 6

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 7

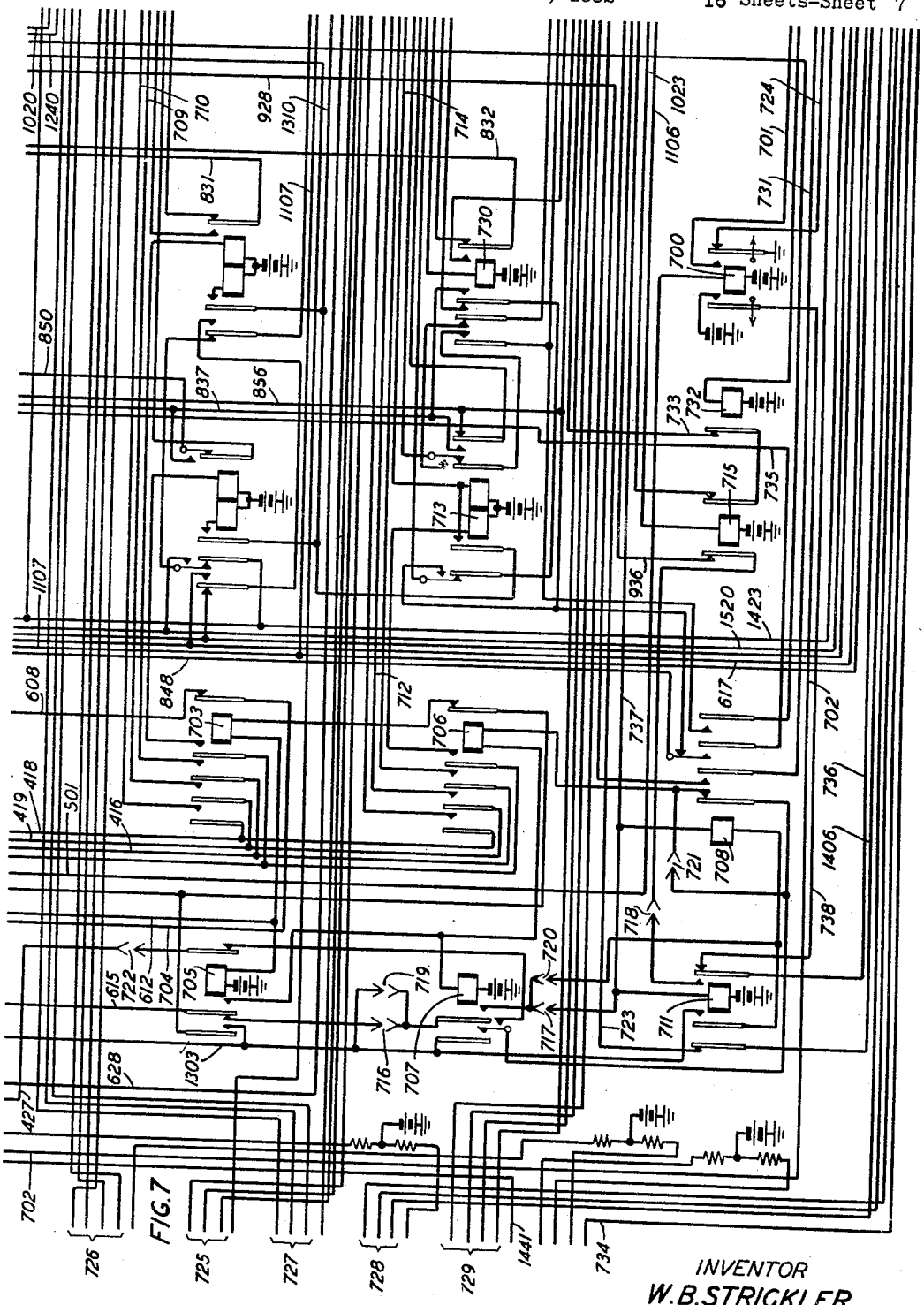

FIG. 7

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 8

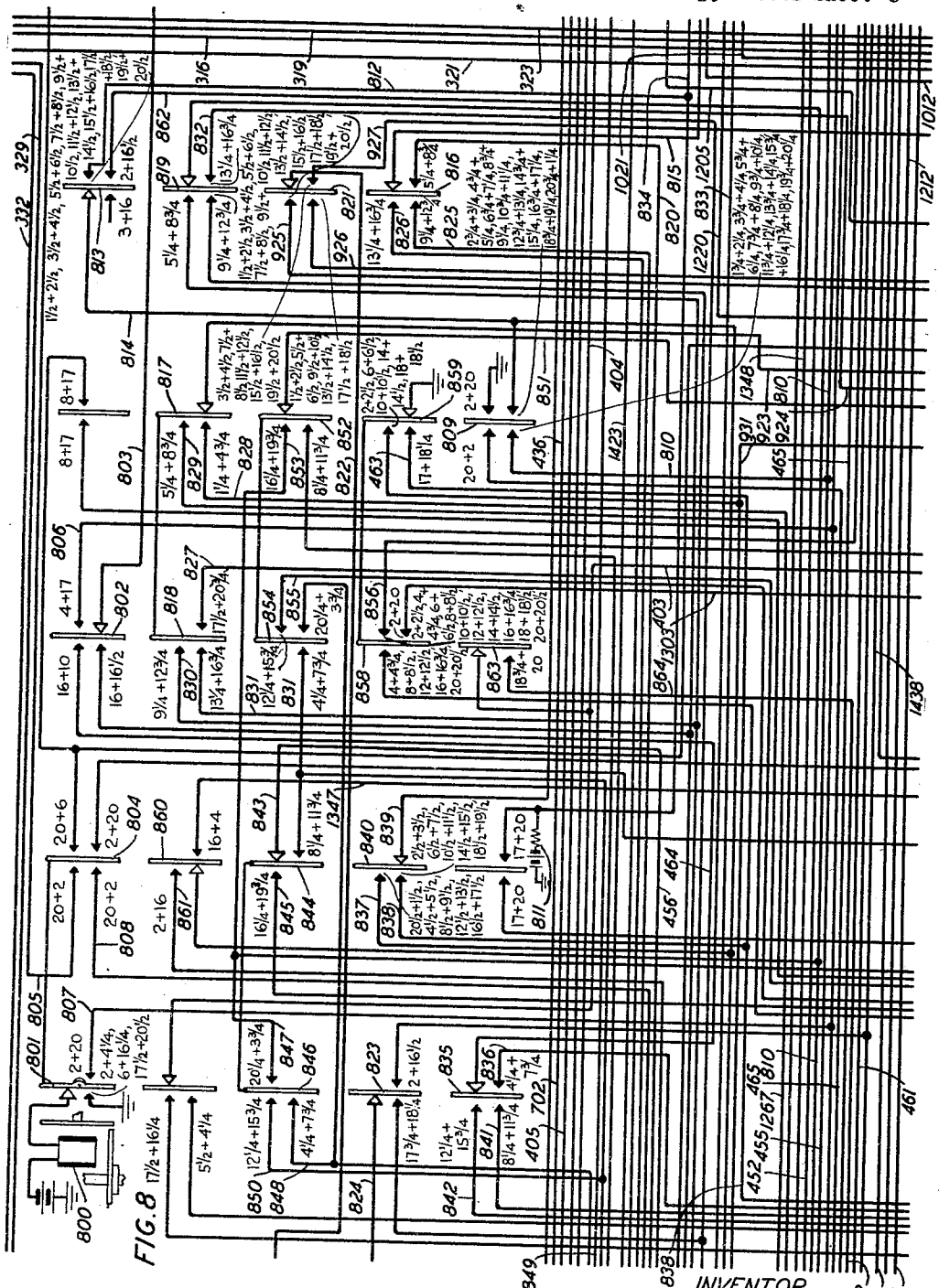

FIG. 8

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 9

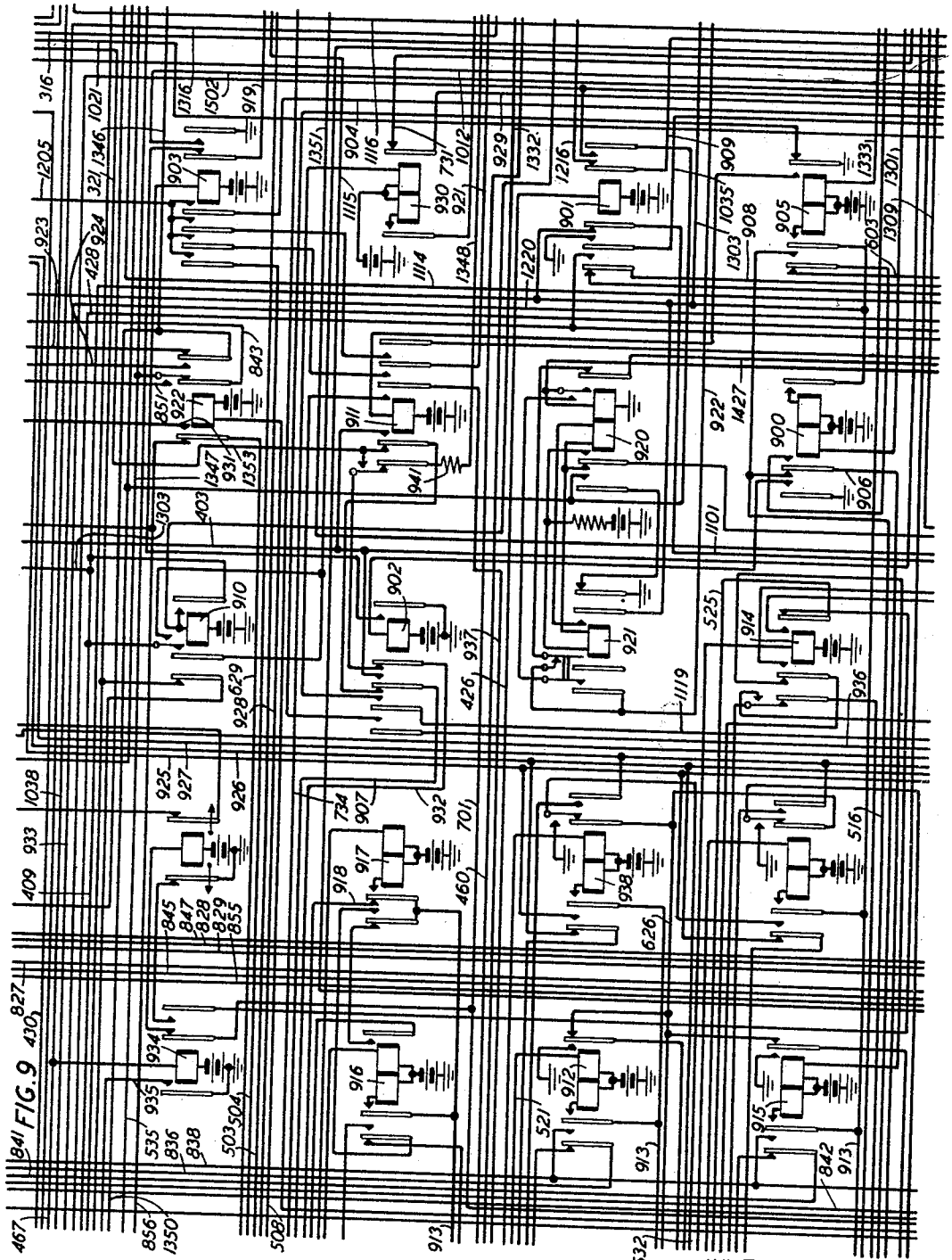

FIG. 9

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 10

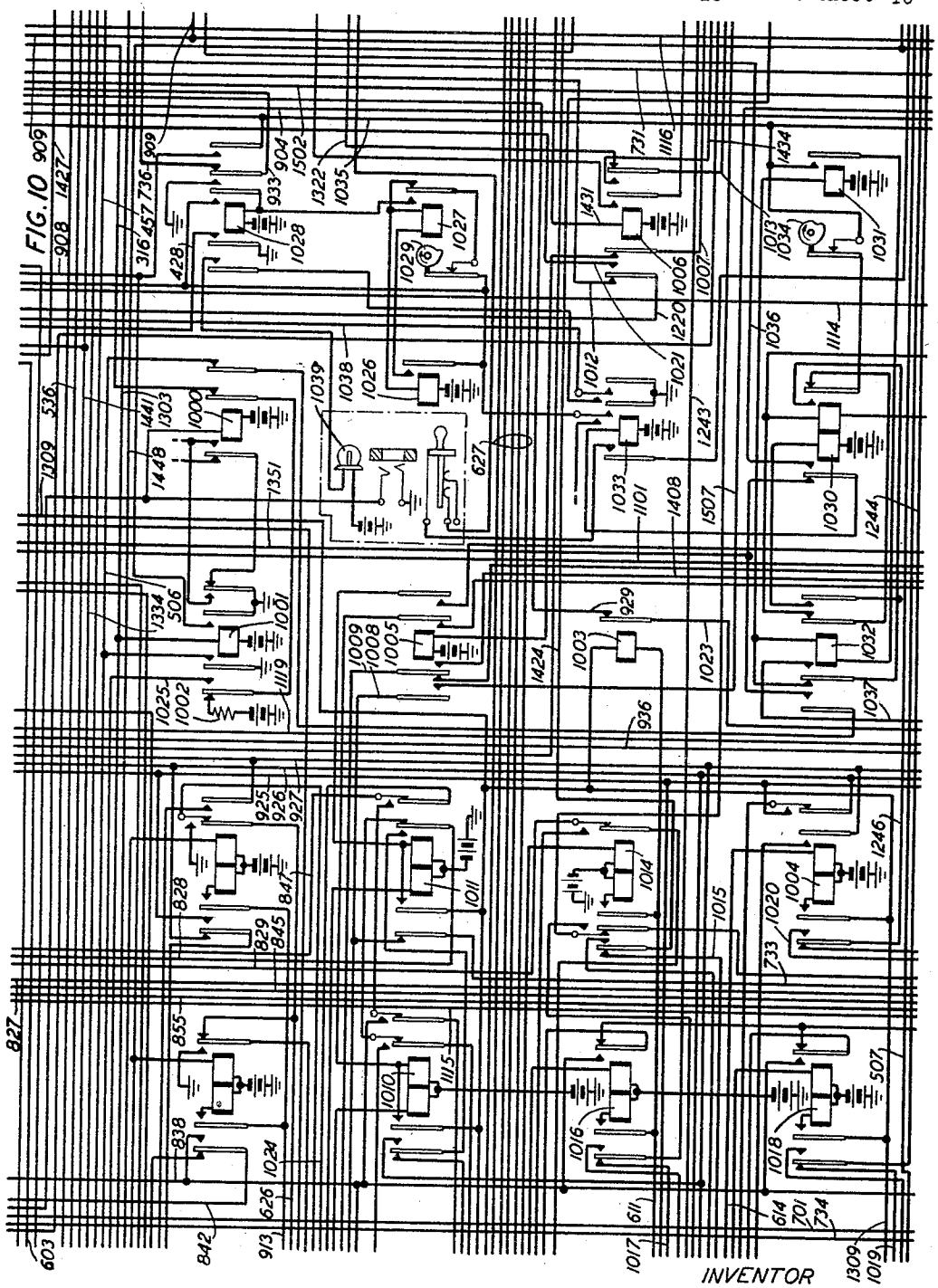

FIG. 10

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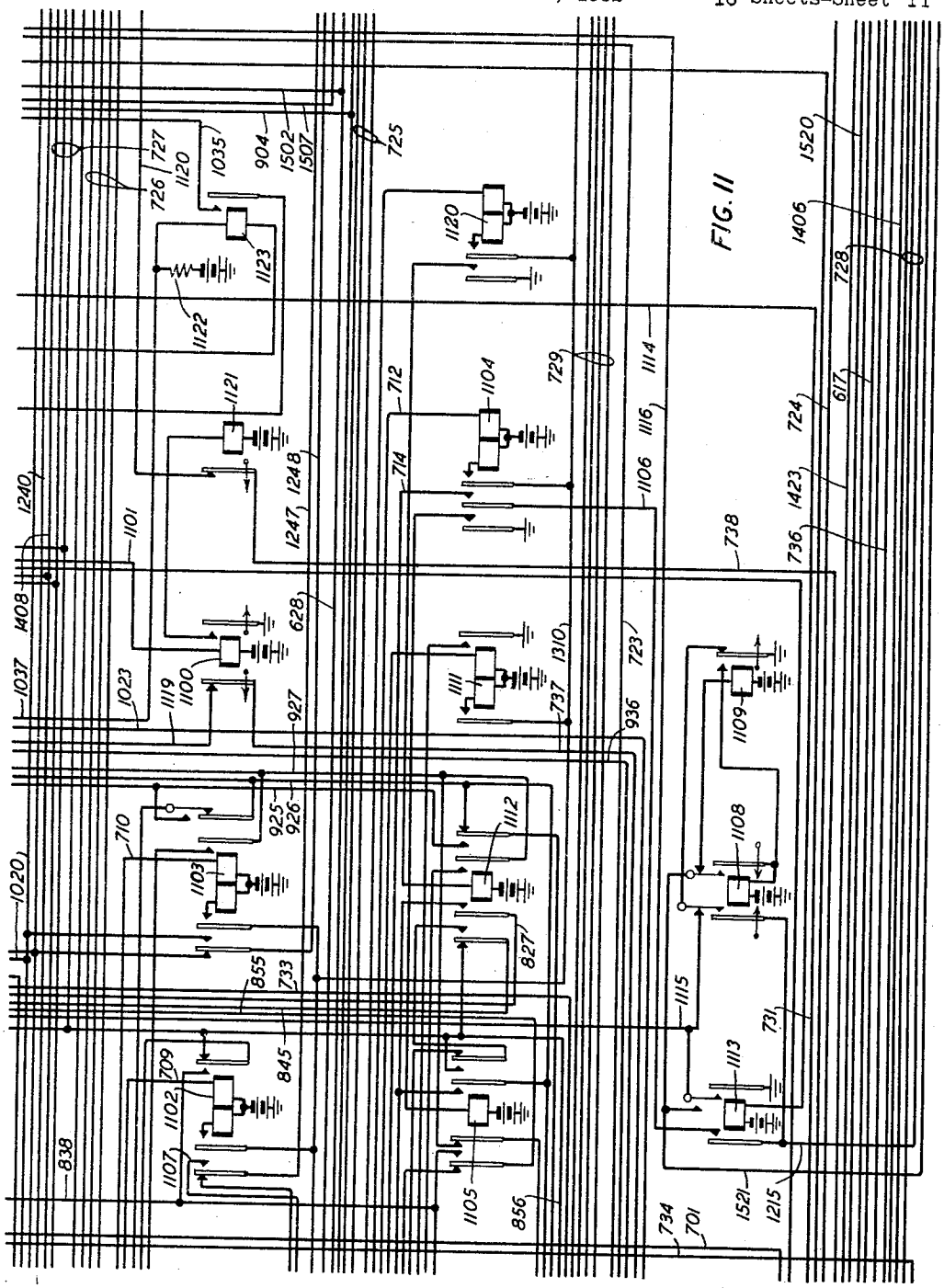
TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 11



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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 12

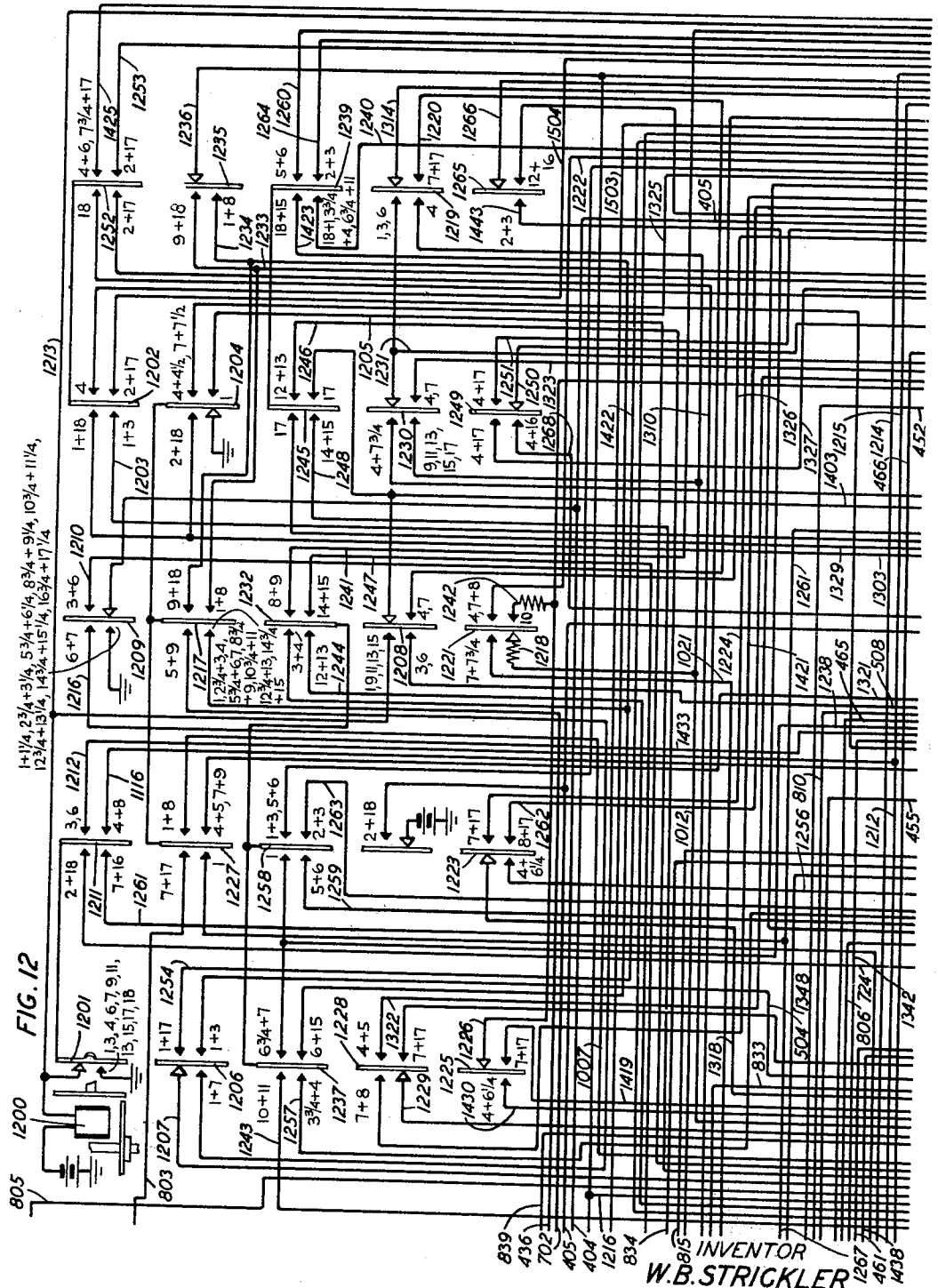

FIG. 12

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 13

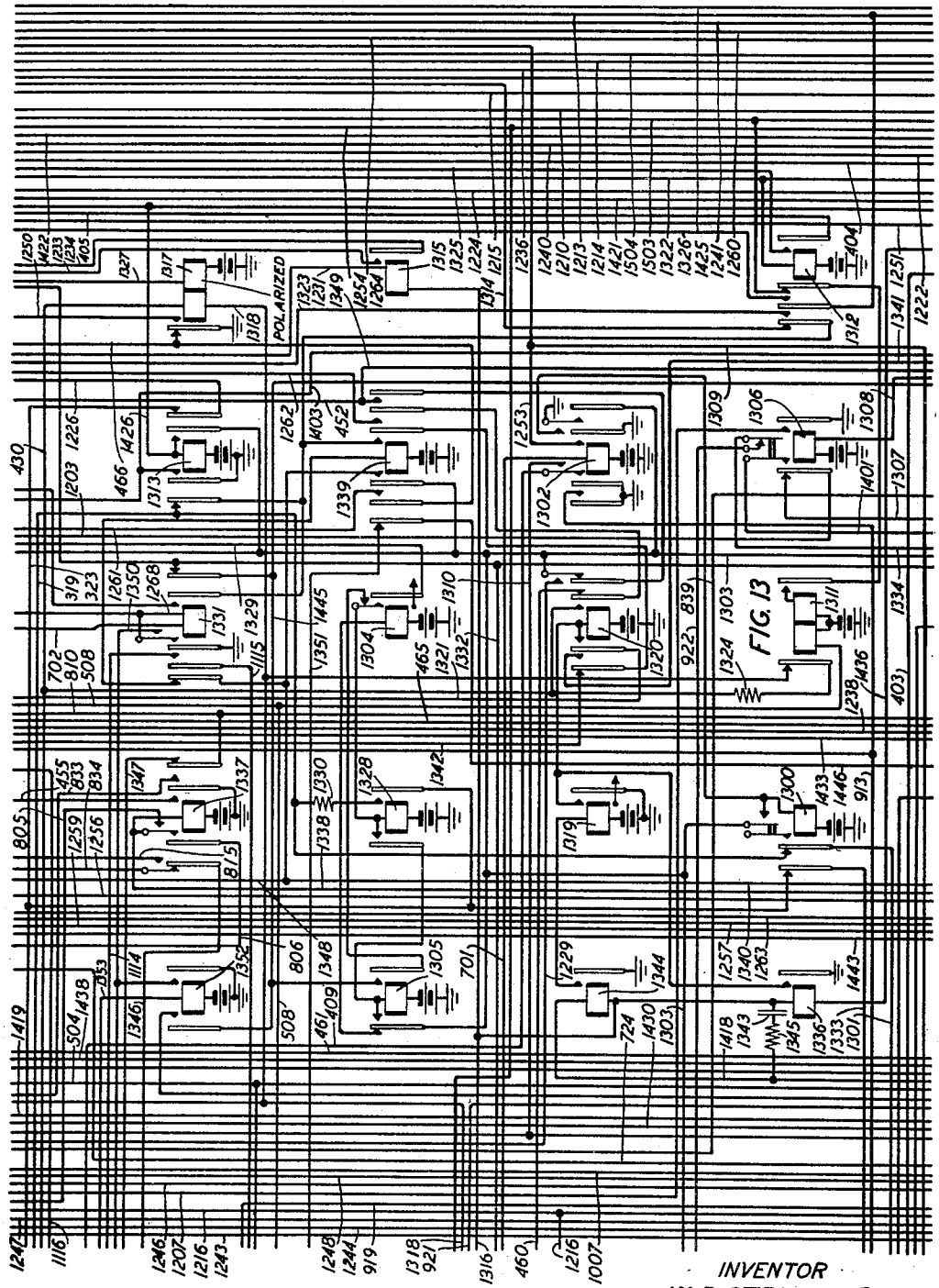

FIG. 13

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 14

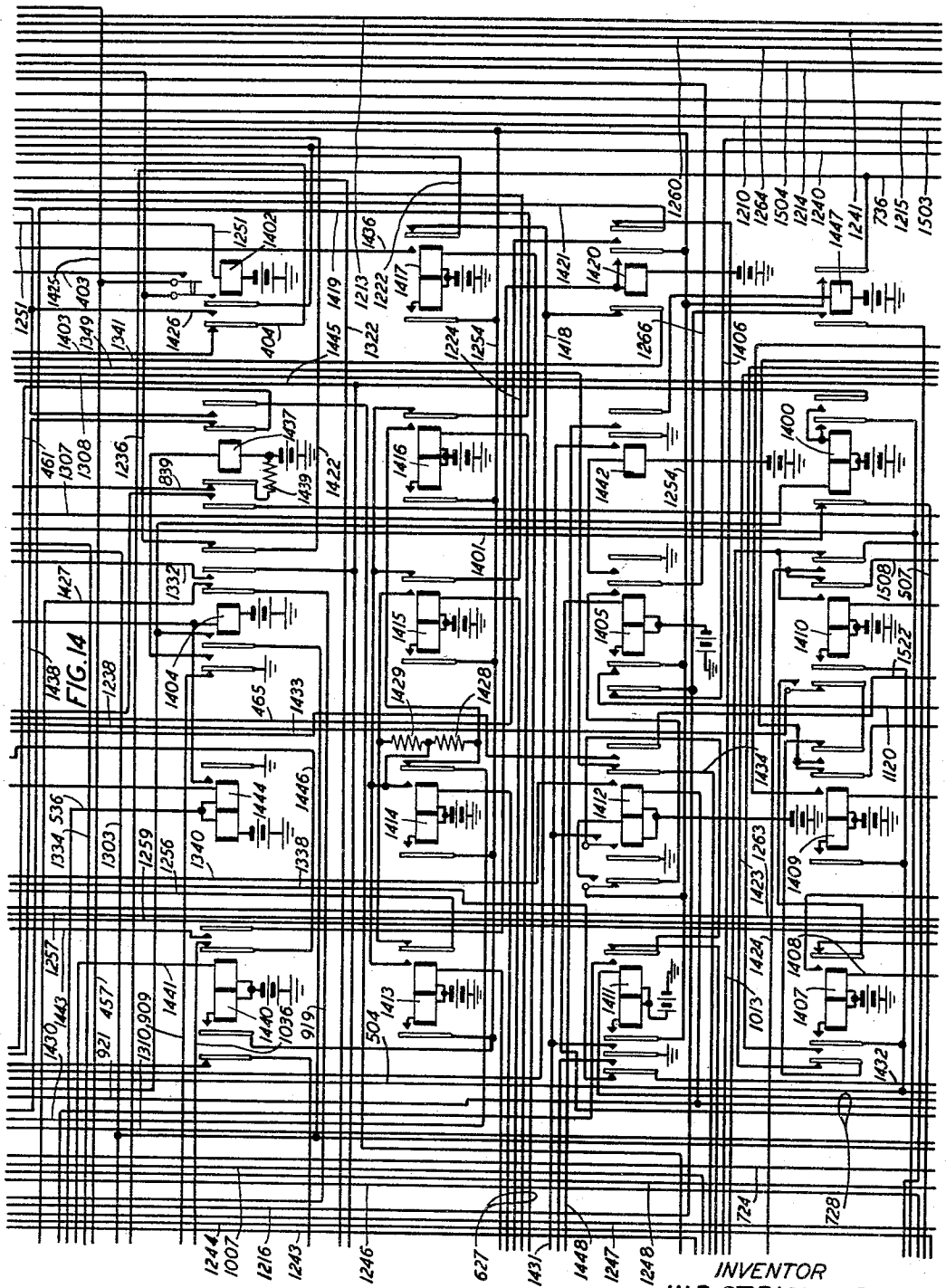

FIG. 14

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TELEPHONE EXCHANGE SYSTEM

Filed March 18, 1932 16 Sheets-Sheet 15

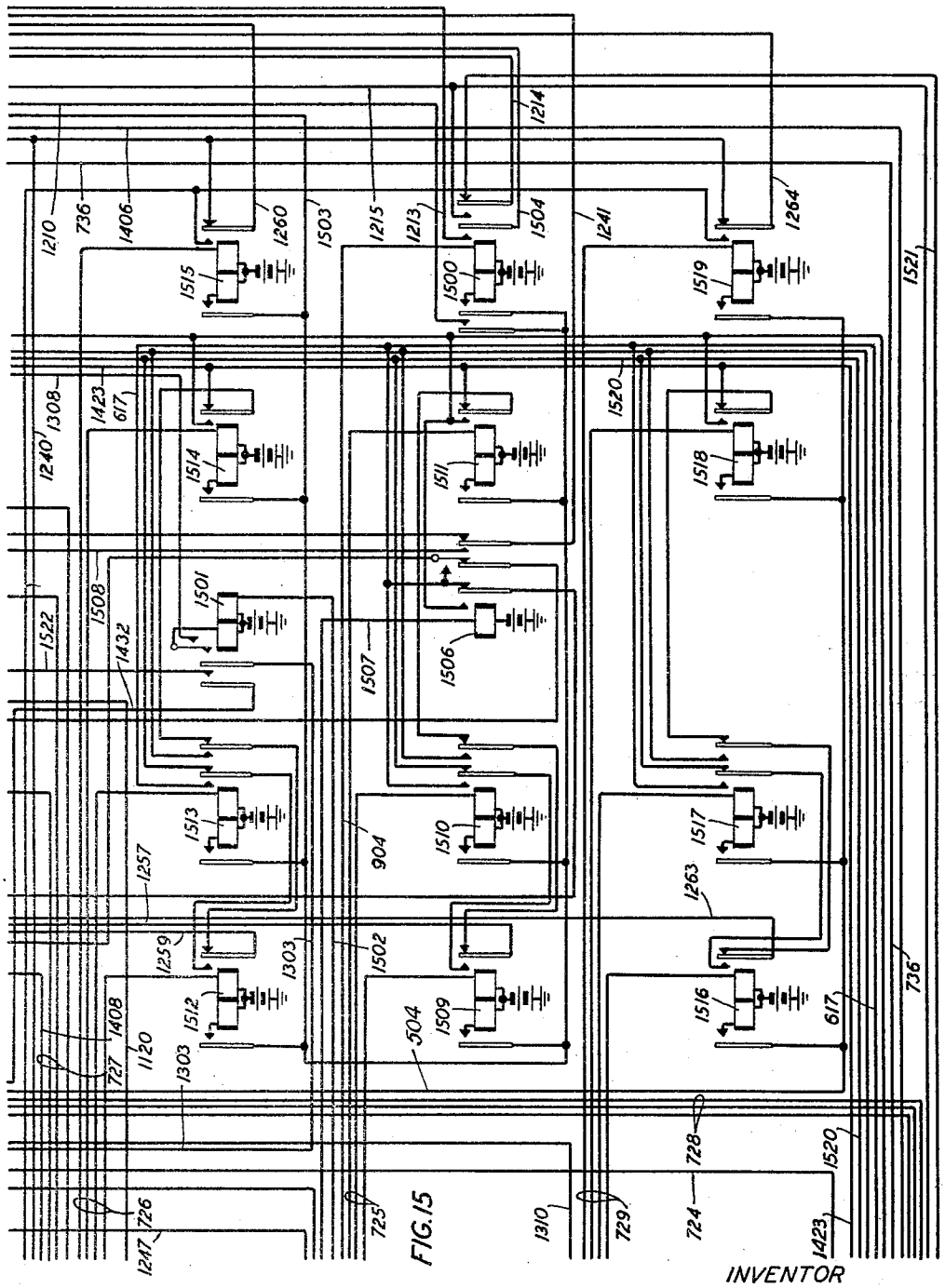

FIG. 15

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TELEPHONE EXCHANGE SYSTEM

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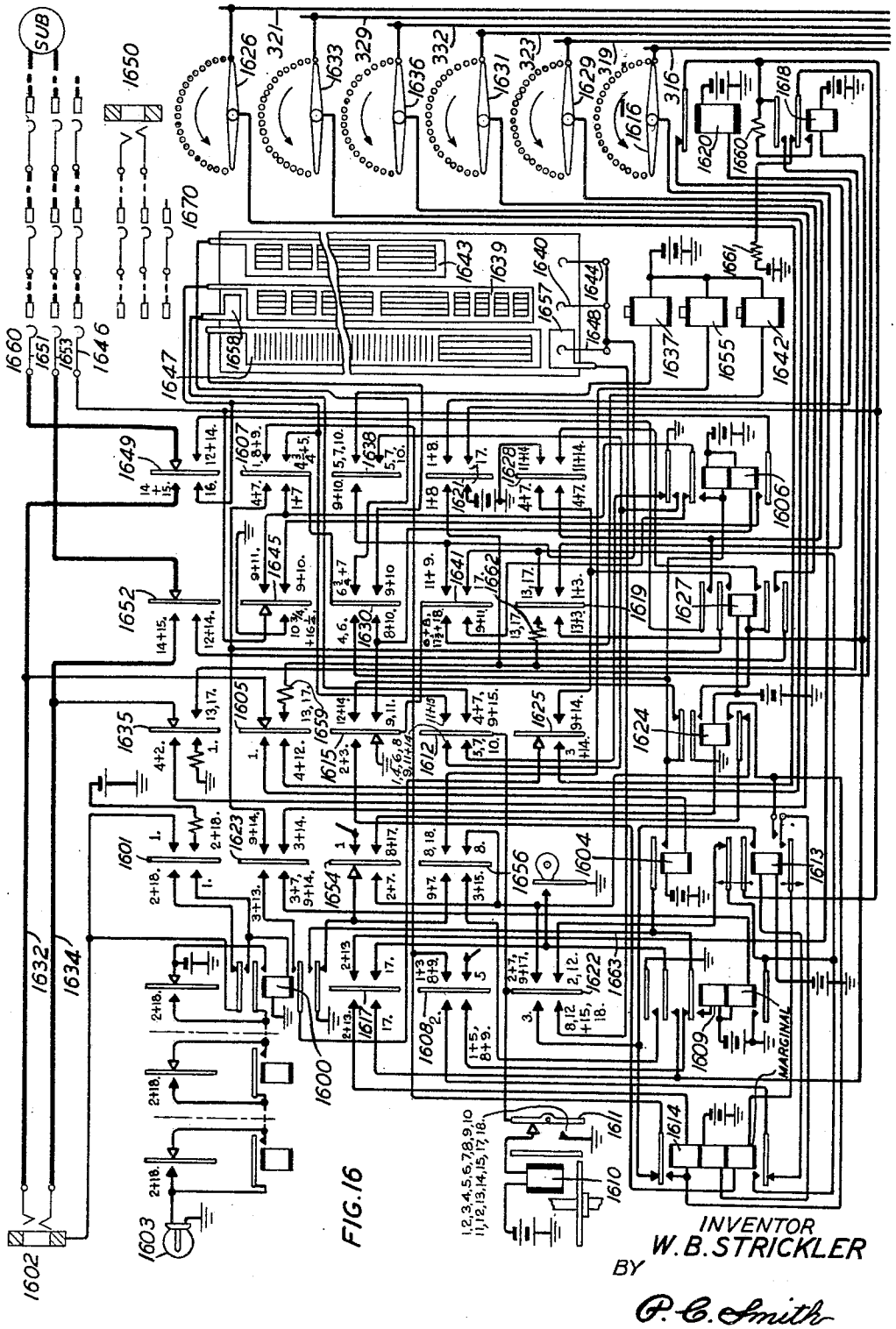

FIG. 16

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Patented Feb. 14, 1933 1,897,083

UNITED STATES PATENT OFFICE

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TELEPHONE EXCHANGE SYSTEM

Application filed March 18, 1932. Serial No. 599,684.

This invention relates to dial switching telephone systems and more particularly to a central office sender of the so called decoder type for enabling operators at dial switching "A" switchboards to control the establishment of connections to any subscriber's line or to an operator's position in the exchange area.

The decoder type sender such as is disclosed for example in the Patent to Raymond and Scully, No. 1,862,549, granted June 14, 1932, comprises a sender having office code registers for recording the office code and numerical registers for registering the numerical digits of desired connections, apparatus for controlling the setting of panel type selector switches and apparatus for transmitting series of code impulses for recording desired line numbers either in recording apparatus at a terminating manual operator's position or in a sender at a tandem dial switching office. For translating the office code digits registered in a sender of this type into the proper combination of registrations for controlling the setting of selector switches for routing a call to the proper office, a plurality of decoders is provided common to a plurality of senders. An idle one of these decoders is seized following the seizure of a sender and the office code registered in the sender is then transferred to the associated decoder where the necessary translation is made and a routing relay is operated which determines the routing of the desired connection. In accordance with the particular routing relay operated control registers in the sender are selectively operated and the decoder is then dismissed. The operated control registers in conjunction with the numerical registers of the sender then determine the setting of selector switches or the transmission of code impulses for controlling the completion of the desired connection.

In accordance with the present invention the "A" operator has access to trunks of different character over which she may control the termination of desired connections. Certain of these trunks terminate in district selectors, others in incoming selectors, still others in office selectors of distant offices and still others in the district selectors of full mechanical tandem offices. Any one of these trunk circuits when taken for use becomes automatically associated with a sender which is then capable of recording the designation of a desired connection under the control of a keyset at the operator's position.

If, for example, the operator should desire to terminate a toll connection in which case it would not be necessary to operate a district selector or an office selector, she would plug into a trunk circuit of the type terminating in an incoming selector and would record in the sender only the numerical designation of the wanted line. Since in this case no office code digits are recorded in the sender no translation is required and therefore it does not become necessary to associate a decoder with the sender. It is therefore an object of the invention to economize in the use of a decoder by eliminating it from all calls where its services are not required. This object is realized in the present invention by the transmission of a discriminating signal to the sender when the sender is seized from a trunk circuit which terminates in an incoming selector, which signal prevents the attachment of a decoder and so modifies the sender circuit that the numerical digits keyed by the operator will be recorded directly on the numerical registers of the sender and the usual district and office selector controls exercised by the sender will be omitted.

If the operator should desire to terminate a connection over a route through a full mechanical tandem office she plugs into a trunk circuit of the type terminating in a district selector at the tandem office in which case a different discriminating signal is transmitted to the sender. Since in this case the selectors in the tandem office are to be set from the tandem sender it is not necessary to make a translation at the operator's sender and therefore the discriminating signal prevents the attachment of a decoder and modifies the circuits of the sender so that no district and office selection controls are exercised by the sender and code impulses are transmitted to the tandem office in accordance with

the office code and numerical registrations which the operator has caused to be set up in the sender through the operation of her keyset.

Should the operator have plugged into a trunk terminating in a distant office selector for calls to toll operators' positions a still different discriminating signal is transmitted to the sender to indicate to the sender that an office code will be registered therein requiring translations. In this case a decoder becomes associated with the sender and since no district selections are necessary the circuits of the sender are modified to pass over the district selections.

Should the operator have plugged into a trunk terminating in a local district selector for making calls to other nearby offices of the exchange area, no discriminating signals are sent to the sender and consequently the sender functions in the usual manner to associate a decoder and to thereafter function to control the setting of the district selector and office selector, if required, and incoming and final selectors of if the call is to terminate in a manual office, to cause the setting of district and office selectors to extend the connection to the desired office and to then transmit codes of impulses under the control of the numerical registers of the sender to record at the distant manual operator's position the number of the desired line.

The setting of the registers of the sender is accomplished in substantially the same manner as disclosed in Patent No. 1,780,906 granted November 11, 1930 to W. W. Carpenter and R. E. Hersey. That is, impulses of light or heavy negative or positive current are transmitted over the tip or ring or over both tip and ring conductors of the operator's cord circuit and the trunk to which she makes connection to a group of recording relays in the sender. Should the operator plug into a trunk terminating in an incoming selector, she should key but four digits on her keyset as in this case only incoming and final selectors must be set to terminate the desired connection. However, should she through error key more than the required four digits, provision is made for advancing the trunk circuit to a reorder position whereupon the operator is signaled that she has made an error and her keyset is disconnected. She may then take down the connection, plug into another trunk and repeat the call correctly. Provision is also made for giving the operator a reorder signal and for disconnecting her keyset if she has plugged into a trunk to a tandem office, if she has plugged into a trunk to a distant office selector, or into a trunk terminating in a local district selector and keys incorrectly.

Other features of the invention will be apparent from the following detailed description taken in connection with the attached drawings in which:

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

Fig. 2 shows the operator's telephone and keyset circuits;

Fig. 3 shows an outgoing trunk circuit which may terminate in a local incoming selector, in the district selector of a distant tandem office, or in a distant office selector and the schematic representation of an incoming and a final selector and called subscriber's line and a sender selector for connecting the trunk circuit with an idle sender;

Figs. 4 to 15 inclusive, show the circuits of a sender, Fig. 4 showing the counting relays for controlling the setting of selector switches in accordance with digits registered in the sender and other control relays;

Figs. 5, 6, 7, 9, 10 and 11 show registers for registering digits keyed by the operator and additional control relays;

Fig. 8 shows an impulsing switch for transmitting code impulses in accordance with registered digits for setting call indicator apparatus of manual offices, or registering apparatus of tandem senders in tandem offices to which a connection may be established;

Fig. 12 shows a steering or sender control sequence switch;

Fig. 13 shows control relays;

Figs. 14 and 15 show the selection controlling registers and additional control relays;

Fig. 16 shows an outgoing trunk circuit which terminates in a district selector and a sender finder for connecting the trunk circuit with an idle sender; and

Fig. 17 is a diagram showing the manner in which the remaining figures should be arranged to show the complete circuit.

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" switchboard operator's position for the purpose of obtaining the assistance of the operator in completing toll or other calls. The operator's telephone set and keyset 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 plurality of groups of outgoing trunks, for example, the trunks of one group, of which the trunk circuit of Fig. 3 may be one, terminating in incoming selector switches for terminating toll calls; the trunks of a second group terminating in the office selectors of a distant office; the trunks of a third group terminating in the district selectors of a dis-

tant tandem office and the trunks of a fourth group terminating in local district selectors as disclosed in Fig. 16 and more particularly in the application of J. B. Newsom, Serial No. 599,611, filed March 18. 1932. The trunk circuits of the first three groups are all similar except for a slight difference in wiring for indicating the group in which the trunk seized by the operator is located for the purpose of guiding the sender in its functions as will be hereinafter explained.

The sender disclosed in Figs. 4 to 15 inclusive, is similar in general to the sender disclosed in the patent of Raymond and Scully hereinbefore referred to, but differs therefrom by the introduction of the novel features of this invention. This sender is arranged to operate in conjunction with the decoder and decoder connector disclosed in detail in the patent of Raymond and Scully, such decoder and decoder connector having been omitted from the present application for the purpose of simplifying the disclosure. The conductors extending to the left margins of Figs. 6 and 7 correspond with similar conductors shown in the Raymond and Scully patent for connection to the decoder connector.

Connection to trunk terminating in an incoming selector

It will first 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 an incoming and final selector switch. The operator upon 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 sleeves 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 the supervisory lamp 105 extending 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 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 and returning over the tips of jack 100 and plug 101, upper 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 circuit is thereupon established for lamp 105 until the operator throws key 111 to the right to unlock relay 110, which circuit may be traced from ground through 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 her key 111 to the right or talking position, an obvious circuit is established from ground over the upper right contacts 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 coil 113. Assuming that the operator's telephone set 203 is plugged up, the talking path just traced is inductively associated therewith through the left winding of repeating coil 201 and the operator is thereupon enabled to converse with the calling subscriber to ascertain information concerning the desired connection.

It will be assumed that the desired connection is of a character which can be completed over incoming and final selector switches and that 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 inner upper back contact of relay 123, the upper normal contact of 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 coil 205 into the operator's telephone set thus producing a click in her receiver. Assuming that she tests the trunk circuit of Fig. 3 and finds it idle and receives no click, she inserts the plug 121 into jack 300 thereby establishing a circuit extending from ground at the upper back contact of relay 302, the upper back contact of relay 303, winding of relay 304, sleeves of jack 300 and plug 121, windings of relay 126 and marginal relay 127 in series to battery and in parallel through resistance 128 to battery. Due to the resistance of sleeve relay 304 of the trunk circuit sufficient current flows through the winding of relay 126 to cause its operation, but marginal relay 127 does not operate. Relay 304 closes an obvious circuit for relay 303 which at its upper front contact connects battery through resistance 338 to the sleeve of jack 300 for maintaining a busy condition on the sleeve in case of a premature disconnect and closes at its lower front contact a part of the circuit for the all-trunks busy lamp 322.

Relay 126 upon operating closes a circuit extending from battery over its lower contact, the lower normal contacts 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 complete the connection, the operator now depresses the key 206 and, with the talking key 111 operated to the right, a circuit is established from ground at the lower back contact of relay 208, the right contacts of key 206, conductor 207, the lower 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 contact of relay 123, lower winding and inner front 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 keyset circuit.

Relay 211 upon operating closes an obvious circuit to light lamp 212, connects ground over conductor 213 for supplying operating ground to the keys of the keyset 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, upper back contact of relay 307, lower back contact of relay 306 to battery through the winding of relay 305. Relay 305 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 305. Relay 305 upon operating closes an obvious circuit for relay 308 which in turn operates and locks over its upper winding and inner upper front contact to ground at the outer lower front contact of relay 304 and closes a circuit for relay 309 extending from battery, winding of relay 309, back contact of relay 310, lower back contact of relay 307, upper back contact of test relay 311, inner lower back contact of relay 312 to ground at the upper contact of relay 308. At its lowermost contacts relay 309 connects the two lower windings of test relay 311 in a series circuit extending from battery, through the middle winding of relay 311, the lower contacts of relay 309, the lower winding of relay 311, inner lower back contact of relay 312 to ground at the upper contact of relay 308 thereby preparing marginal relay 311 for operation and connects the test brush 313 of sender selector 350 over the lower contact of relay 308, the upper winding of test relay 311, the lower contacts of relay 309, lower winding of relay 311 thence to ground at the upper contact of relay 308.

Seizure of idle sender

It will first be assumed that the sender upon the terminals of which the brushes of selector 350 are at the time standing is busy and that no operating circuit is therefore closed for relay 311. A circuit is therefore closed for operating the stepping relay 314 extending from battery, winding of relay 314, back contact of magnet 315, upper front contact of relay 309 and thence to ground over the operating circuit of relay 309. Relay 314 operates connecting the winding of magnet 315 to the operating circuit of relay 314 whereupon magnet 315 energizes in turn opening the circuit of relay 314 which releases opening of circuit of magnet 315 which in turn releases and thereby advances the brushes of switch 350 one step. In this manner through the alternate operation and release of relay 314 and magnet 315 the brushes of switch 350 are advanced step by step until test brush 313 engages the terminal of an idle sender when the previously traced circuit through the upper and lower windings of test relay 311 to the test brush 313 will be completed, for example, over conductor 316, inner right back contact of relay 1000,

left back contact of relay 1001 to battery through resistance 1002. Relay 311 now receives sufficient current to operate and at its upper back contact opens the circuit of relay 309 which releases and opens the circuit of stepping relay 314 to arrest further movement of switch 350. Relay 311 also locks from battery on conductor 316 over brush 313, the lower contact of relay 308, upper winding and upper front contact of relay 311, inner lower back contact of relay 312 to ground at the upper contact of relay 308, the increased potential on the sender test terminal engaged by brush 313 marking the sender as busy to other hunting sender selectors.

With relay 311 operated and relay 309 released a circuit is established from ground at the lower front contact of relay 311, upper back contact of relay 309, through the winding of relay 310 to battery thus operating relay 310. Relay 310 then locks from battery through its winding, back contact of relay 309, inner lower normal contacts of relay 307, lower back contact of relay 312, next to upper front contact of relay 310 to ground at the upper contact of relay 308. Relay 310 at its next to upper front contact establishes a new holding circuit for relay 308 extending from battery, lower winding of relay 308, inner lower normal contacts of relay 307, lower back contact of relay 312, contacts of relay 310 to ground at the upper contact of relay 308 and establishes a circuit from battery through the winding of relay 306 and in parallel therewith from battery through the upper winding of relay 312 over contact 334 of relay 310, brush 320, conductor 321 and the windings of relay 500 in series to ground. Relay 306 and relay 500 operate, but relay 312 being marginal does not because of the high resistance of the windings of relay 500. Relay 306 upon operating closes over its upper front contact a holding circuit for relay 303 for maintaining the trunk busy should the operator disconnect before the sender is disconnected, and over its inner upper front contact establishes another holding circuit for relay 308 independent of the contacts of relay 312.

Relay 500 upon operating closes an obvious circuit over conductor 501 for relay 700 which in turn causes the operation of relay 1302 over conductor 701 and connects battery to the off-normal battery conductor 702. Relay 1302 upon operating connects ground at its outer right front contact to the off-normal ground conductor 1303 thereby causing the operation of relay 1001 which in turn removes battery through resistance 1002 from conductor 316 to mark the sender as busy. At its next to outer right front contact relay 1302 closes an obvious circuit for relay 1300 which locks to ground on conductor 1303. With ground on conductor 1303 the operating circuit of relay 1100 extends over conductor 1101, the inner left back contact of relay 901 to conductor 1303 and the operating circuit of relay 1304 extends over the back contact of relay 1305 to conductor 1303, relays 1100 and 1304 both operating. A circuit is also closed from ground on conductor 1303, left contacts of cam 1202, conductor 1203, left back contact of relay 1306, conductor 1307 to battery through the left winding of relay 1400. The operation of relay 1400 at this time prevents the sender control switch 1200 from moving off normal if the call is abandoned before selections are started.

Trunk class registration

In the meantime it having been assumed that the trunk circuit of Fig. 3 is one of a group terminating in an incoming selector and that therefore the strap connection 318 shown on the lower back contact of relay 302 is closed and the strap connection 335 is open, then with relay 310 operated, as previously described, a circuit is closed from ground at the upper front contact of relay 310, strap 318, lower back contact of relay 302, brush 317, conductor 319, inner back contact of relay 1300, conductor 1301 to battery through the left winding of trunk class registering relay 900. Relay 900 operates and locks over its right winding and right front contact to ground on conductor 1303 before relay 1300 operates as previously described to open its initial operating circuit. Relay 900 upon operating closes an obvious circuit over its outer left front contact for relay 902 which in turn operates and closes the circuit of relay 903 over its right contact. Relay 903 establishes a circuit for relay 1501 extending from battery through the right winding of relay 1501, conductor 1502 to ground at the outer right front contact of relay 903, relay 1501 locking over its left winding and inner left front contacts to ground on conductor 1303 and closing an obvious circuit for relay 1306 extending over conductor 1308 and the inner left front contacts of relay 1501 to ground on conductor 1303. Relay 1306 upon operating releases relay 1400. Relay 903 also closes a circuit extending from ground over the lower contacts of cam 1204, conductor 1205, inner left contact of relay 903, conductor 904, right winding of relay 1500 to battery, relay 1500 upon operating locking over its left winding and inner left front contact, conductor 1503, left contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306. A circuit is also established from battery through the left winding of relay 502, conductor 503, outer left front contact of relay 903 to ground on conductor 1205, relay 502 locking over its right winding and inner left front contact, conductor 504, lower right and upper left contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306. The operation

of relays 502, 1306 and 1500 at this time indicates that district and office selections are to be skipped and that the association of a decoder will not be required.

With relays 900 and 1001 operated a circuit is established from battery, windings of transfer relays 600 and 601 in series, back contact of transfer relay 602, conductor 603, left back contact of relay 905, inner left front contact of relay 900, conductor 906, inner right back contact of relay 505, conductor 506, inner left contact of relay 1001 to ground. Relays 600 and 601 lock in series over the back contact of relay 602, right front contacts of relay 600, conductor 506 to ground at the inner left front contact of relay 1001. The operation of relays 600 and 601 at this time indicate that the first digit keyed by the operator will be registered on the relays of the thousands register since only four digits will be keyed. With relay 600 operated a circuit is established for relay 509 extending from battery through the winding of relay 509, conductor 510, right front contacts of relay 600, conductor 506 to ground at the inner left front contact of relay 1001, relay 509 locking directly to ground on conductor 506 over its inner left front contact, and closing over its outer left front contact an obvious circuit for relay 505. At its right front contact relay 505 opens the initial operating circuits of relays 600 and 601. When relay 1300 operated, as previously described, the fundamental tip conductor 319 and the fundamental ring conductor 323 are disconnected from the windings of trunk class registering relays 900 and 905 and these conductors are thereby made free for controlling fundamental selections.

Advance of control switch for skipping district and office selections

When relay 1306 operated as previously described, it opened the circuit of relay 1400 which released and with relays 902 and 502 operated, a circuit is closed from battery on conductor 702, winding of counting relay 400, windings of counting relays 401 and 402 in parallel, conductor 403, inner left front contact of relay 902, conductor 907, right front contact of relay 502, conductor 507, left back contact of relay 1400, conductor 1401, left front contact of relay 1306, conductor 1203, left contacts of cam 1202 to ground on conductor 1303. Relays 400, 401 and 402 operate, relay 402 closing a circuit from ground over its contact, conductor 404, outer left back contact of relay 1402, conductor 1403, upper contacts of cam 1208, winding of magnet 1200 for advancing control switch 1200 into position 3. Upon reaching position 3 with the skip office relay 1500 operated relays 400, 401 and 402 lock over the front contact of relay 400, conductor 405, right contacts of cam 1209, conductor 1210, the outer left front contact of relay 1500, conductor 1503, the left contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306, relays 400, 401 and 402 remaining operated until switch 1200 leaves position 6. Relay 401 at its contacts holds the fundamental control circuit open. When switch 1200 reaches position 3 with relay 502 operated, a circuit is established from battery, winding of magnet 1200, contacts of cam 1201, upper right contact of cam 1211, conductor 1212, outer left front contact of relay 502, conductor 508, lower left and upper right contacts of cam 1208, conductor 1403, outer left back contact of relay 1402, conductor 404 to ground at the contacts of relay 402. A circuit is also established at this time for relay 1311 from battery, left winding of relay 1311, conductor 508 and thence to ground at the contacts of relay 404 as just traced. Relay 1311 operates and locks over its right winding and right contact, inner left back contact of relay 1312, conductor 1503, left contacts of cam 1206, conductor 1207, to ground at the right contact of relay 1306, relay 1311 remaining operated until control switch 1200 leaves position 7.

Switch 1200 advances into position 4 releasing relay 502 as it leaves position 3 and is advanced from position 4 into position 6 over a circuit extending from battery, winding of magnet 1200, conductor 1213, inner right front contact of relay 1500, conductor 1504, upper contacts of cam 1202 to ground on conductor 1303. Upon reaching position 6 with relay 1500 operated, relay 502 released and relay 404 operated, a circuit is established from ground over the contacts of relay 402, conductor 404, outer left back contact of relay 1402, conductor 1403, upper right and lower left contacts of cam 1208, conductor 508, left back contact of relay 502, conductor 1214, outer right front contact of relay 1500, conductors 1215 and 1212, upper right contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 advancing switch 1200 into position 7. Until the digits keyed by the operator are all registered, relays 400, 401 and 402 remain locked in a circuit extending through the windings of these relays, the contacts of relay 400, conductor 405, the lower right and upper left contacts of cam 1210, conductor 1216, right back contact of relay 901, conductor 909 to ground at the left back contact of relay 1404, or over conductor 1216, left back contact of register 1405, conductor 1406, left back contact of relay 711, conductor 723, conductor 909 to ground at the left back contact of relay 1404.

When relay 1001 operated to remove battery through resistance 1002 from conductor 316, relay 311 in the trunk circuit released, closing a circuit for relay 302 extending from battery, winding of relay 302, lower back con-

tact of relay 311, inner lower normal contacts of relay 307, inner upper front contact of relay 306, next to upper front contact of relay 310 to ground at the upper contact of relay 308. Relay 302 upon operating transfers the tip and ring fundamental conductors 319 and 323 from connection to ground at the upper contacts of relay 310 to the tip and ring outgoing conductors 324 and 325 of the trunk circuit thereby extending the fundamental circuit from the sender to the control relay of the incoming selector in which the trunk circuit terminates, and at its upper contact opens the initial operating circuit of sleeve relay 304. With relay 306 operated, the incoming tip conductor 326 of the trunk circuit is extended over the upper back contact of relay 307, lower front contact of relay 306, brush 328 to conductor 329 and the ring conductor 327 is extended over the next to inner front contact of relay 310, brush 331, conductor 332, outer right back contact of relay 406, inner right normal contacts and winding of relay 407, left back contact of relay 408, outer left back contact of relay 406, conductor 409 to ground at the inner left front contact of relay 1302. The ring conductor 327 is now extended over the 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. Relay 407 in the sender operates, locking to battery through resistance 410 independently of battery supplied through resistance 216 at the keyset, and extending the tip conductor 329 over the inner left back contact of relay 406, the outer left front contact of relay 407, in series through the windings of relays 411, 412 and 413, over conductor 414 and the outer left front contact of relay 505 to 24-volt battery, and extending the ring conductor 332 over the right back contact of relay 406, the inner left front contact of relay 407, through the windings of relays 421, 422 and 423 over conductor 424 and the inner left front contact of relay 505 to 24-volt battery.

The connection of battery through the windings of relays 411, 412 and 413 to the tip conductor 329 and thence as traced over conductor 326, tips of jack 300 and plug 121, upper alternate contacts of relay 122, conductor 132, upper normal contacts and winding of relay 215 of the keyset circuit to ground at the upper contact of relay 211, operates relay 215 as an indication that the sender is ready to receive impulses from the keyset. Relay 215 operates, locking over its upper alternate contacts to battery through resistance 216 under the control of relay 211 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 keyset 214 and connects the keyset over its inner lower front and upper alternate contacts and conductors 132 and 133 to the tip and ring conductors 329 and 332 as previously described. Relay 215 also closes a circuit extending from ground at the 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 that the sender is in condition to receive the digits of a line designation.

Keying the called designation

It will be assumed that the operator in order to establish a connection to the line 360, the designation of which is 1379, depresses the keys 222, 223, 224 and 225 in succession. Upon the depression of key 222 to register the thousands digit 1, ground on conductor 213 is connected through low resistance 226, the contacts of key 222, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412, and 413. Due to the inclusion of the low resistance 226, sufficient current flows to operate both the sensitive relay 413 and the marginal relay 412, but polarized relay 411 does not receive current in the proper direction through its winding to cause its operation.

Relay 413 upon operating with transfer relay 600 operated, establishes a circuit from ground at its contact over conductor 415, left back contacts of transfer relays 511 and 512, conductor 513, left back contact of transfer relay 604, left front contact of transfer relay 600 to battery through the winding of transfer relay 605. Relay 605 operates and locks in series with the winding of relay 602, back contact of relay 606, left front contacts of relay 605 to ground on conductor 1303, but relay 602 being shunted as long as relay 413 remains operated, does not operate at this time. Relay 412 upon operating closes a circuit extending from ground at its contact over conductor 416, inner left contact of relay 601, which it will be recalled was operated in series with relay 600 to indicate that the first digit is to be recorded on the relays of the thousands register, to battery through the left winding of the thousands register relay 607. Relay 607 upon operating locks over its right winding and inner left front contact, conductor 1309 to ground at the inner right front contact of relay 1302.

When the operator releases the depressed key 222, relays 412 and 413 release, relay 413 opening the shunt around the winding of relay 602 whereupon relay 602 operates in the locking circuit of relay 605, opening at its

right contact the locking circuit of relays 600 and 601 whereupon these relays release, relay 601 disconnecting the operating circuits of the relays of the thousands register from the contacts of impulse relays 411, 412, 421 and 422, and relay 602 upon operating connecting the contacts of these impulse relays to the windings of the hundreds register relays.

When the operator depresses key 223 to register the hundreds digit 3, 48-volt battery through low resistance 219 and conductor 220, is connected over the contacts of key 223, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing through the windings of these relays is such as to operate the polarized relay 411 and since a low resistance has been included in the impulsing path, relays 412 and 413 also operate. Relay 413 upon operating with transfer relay 600 released and transfer relay 605 operated, closes a circuit from ground as traced to conductor 513, thence over the left back contacts of relay 604 and 600, the right front contact of relay 605 to battery through the winding of transfer relay 607. Relay 607 operates and locks in series with the winding of relay 606 over conductor 608, right contact of relay 703, conductor 704, left front contact of relay 607 to ground on conductor 1303, but relay 606 being shunted as long as relay 413 remains operated, does not operate at this time. Relay 412 upon operating closes a circuit extending from ground at its contact, over conductor 416, inner left contact of relay 602 to battery through the right winding of hundreds register relay 609. Relay 609 upon operating locks over its left winding and inner left front contact, conductor 611, winding of relay 1003 to ground on conductor 1309. Relay 411 upon operating closes a circuit extending from ground at its contact, over conductor 417, next to inner left contact of relay 602, right winding of register relay 610 to battery. Relay 610 upon operating locks over its left winding and inner left front contact, conductor 611, winding of relay 1003 to ground on conductor 1309.

When the operator releases depressed key 223, relays 411, 412 and 413 release, relay 413 opening the shunt around the winding of relay 606 whereupon relay 606 operates in the locking circuit of relay 607, opening at its back contact the locking circuit of relays 605 and 602 whereupon these relays release, relay 602 disconnecting the operating circuits of the relays of the hundreds register from the contacts of impulse relays 411, 412, 421 and 422 and relay 606 upon operating connecting the contacts of these impulse relays to the windings of the tens register relays.

When the operator depresses key 224 to register the tens digit 7 of the wanted line number, 48-volt battery on conductor 220 is connected through high resistance 229, left contacts of key 224, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing through the windings of these relays is such as to operate the polarized relay 411 and, since high resistance 229 has been included in the impulsing path, marginal relay 412 does not operate, but relay 413 operates. Relay 413 upon operating with transfer relay 605 now released and transfer relay 607 operated, closes a circuit from ground as traced to conductor 513, left back contacts of relays 604 and 600, right back contact of relay 605, right front contact of relay 607, conductor 612, to battery through the winding of transfer relay 705. Relay 705 operates and locks in series with the winding of relay 703, right contact of relay 706, outer left front contact of relay 705 to ground on conductor 1303, but relay 703 being shunted as long as relay 413 remains operated, does not operate at this time. Relay 411 upon operating closes a circuit extending from ground at its contact, over conductor 417, next to inner left contact of relay 606 to battery through the right winding of relay 613 of the tens register. Relay 613 upon operating locks over its left winding and inner left front contact to ground on conductor 1309.

At its right contacts key 224 closes a circuit from ground on conductor 213 through low resistance 230, right contacts of key 224, conductor 228 and thence as traced over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. The current now flowing is not in the proper direction to operate polarized relay 421, but since only low resistance 230 has been included in the impulsing path, both the sensitive relay 423 and marginal relay 422 operate. Relay 423 upon operating merely duplicates the function of relay 413 already described, and relay 422 connects ground at its contact over conductor 418, outer left contact of relay 606, conductor 614 to battery through the right winding of relay 1004 of the tens register. Relay 1004 upon operating locks over its left winding and inner left front contact to ground on conductor 1309.

When the operator releases depressed key 224, impulse relays 411, 413, 422 and 423 release, relays 413 and 423 opening the shunt around the winding of relay 703 whereupon relay 703 operates in the locking circuit of relay 705, opening at its right contact the locking circuit of relays 606 and 607 whereupon these latter relays release, relay 606 disconnecting the operating circuits of the relays of the tens register from the contacts of the impulse relays, and relay 703 upon

operating connecting the contacts of the impulse relays to the windings of the units register relays.

In response to the depression of key 225 for the units digit 9, 48-volt battery through low resistance 219 over conductor 220, the right contacts of key 225 and conductor 228, is applied over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. Due to the connection of 48-volt battery through a low resistance all three impulse relays respond. Relay 423 upon operating connects ground at its contact as previously traced, to conductor 513, left back contacts of transfer relays 604 and 600, right back contacts of transfer relays 605 and 607, conductor 615, inner left front contact of transfer relay 705 to battery through the winding of transfer relay 707. Relay 707 operates and locks through the winding of relay 706, inner back contact of relay 708, outer front contact of relay 707 to ground on conductor 1303, but relay 706 being shunted as long as relay 423 remains operated, does not operate at this time. Relay 421 upon operating closes a circuit extending from ground at its contact over conductor 419, next to outer left contact of relay 703, conductor 709, right winding of units register relay 1102 to battery. Relay 1102 upon operating locks over its left winding, inner left front contact, conductor 1310 to ground at the inner left front contact of relay 1302. Relay 422 upon operating closes a circuit extending from ground at its contact over conductor 418, outer left contact of relay 703, conductor 710 to battery through the right winding of units register relay 1103. Relay 1103 operates and locks over its left winding and inner left front contact to ground on conductor 1310.

At its left contacts key 225 closes a circuit from ground through low resistance 226, high resistance 231, left contacts of key 225, conductor 228, thence over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413, but due to the direction and strength of the current flowing, only relay 413 operates duplicating the function of impulse relay 423 already described.

When the operator releases the depressed key 225, impulse relays 413, 421, 422 and 423 release, relays 413 and 423 opening the shunt around the winding of relay 706 whereupon relay 706 operates in the locking circuit of relay 707, opening at its back contact the locking circuit of relays 703 and 705 whereupon these latter relays release, relay 703 disconnecting the operating circuits of the relays of the units register from the contacts of the impulse relays, and relay 706 upon operating connecting the contacts of the impulse relays to the windings of the stations register relays.

Following the keying of the numerical designation the operator depresses the start key 232 which at its left contacts connects 48-volt battery through low resistance 219 and high resistance 229 and conductor 228 over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. The direction of current flowing is such as to operate polarized relay 421 and is of sufficient strength to operate sensitive relay 423, marginal relay 422 not operating. Relay 423 at its contact connects ground to conductor 615, as previously traced, thence over the inner left back contact of transfer relay 705, strap 716, inner front contact of relay 707, strap 717 to battery through the winding of transfer relay 711 which operates and locks through the winding of relay 708, the left front contact of relay 711 to ground on conductor 1303, but relay 708 being shunted as long as relay 423 remains operated does not operate. Relay 421 closes an obvious circuit for relay 420 and closes a circuit from ground over conductor 419, the next to outer left contact of relay 706, conductor 712 to battery through the right winding of stations register relay 1104. Relay 1104 upon operating locks over its left winding and inner left front contact to ground on conductor 1310 and, at its outer contact closes an obvious circuit for register relay 1105. At its right contacts start key 232 closes a circuit from ground on conductor 213 over low resistance 230, conductor 227, thence over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current flowing is not such as to permit polarized relay 411 to operate, but due to the current strength both sensitive relay 413 and marginal relay 412 operate. Relay 413 upon operating duplicates the function of relay 423. Relay 412 upon operating closes an obvious circuit for relay 425 over the front contact of relay 420, relay 425 locking to ground on conductor 1303. Relay 412 also closes a circuit from ground over conductor 416, inner left contact of relay 706 to battery through the left winding of relay 713. Relay 713 operates and locks over its right winding and inner left front contact to ground on conductor 1310 and extends its holding ground over conductor 714, middle front contact of register relay 1104, conductor 1106 to battery through the winding of relay 715, thereby operating relay 715.

Following the release of the start key 232 impulse relays 421, 423, 412 and 413 release, relay 421 in turn releasing relay 420 which at its back contact connects ground from conductor 1303 over the front contact of relay 425, back contact of relay 420, conductor 426 to battery through the winding of start relay 901. Relays 413 and 423 upon releasing, remove the shunt from the wind-

ing of relay 708 which now operates in the holding circuit of relay 711 opening at its inner right back contact the holding circuit of relays 706 and 707 which now release. Had the operator keyed a numerical designation having a value over 9999, or a numerical designation followed by a station letter, then the fifth digit would have been keyed on the keyset 214 and the start key would then have been operated. In that case relays of the stations register would have been operated in accordance with the fifth digit keyed and then the operation of the start key 232 would operate start relay 901 in the manner described.

In an exchange area where there are only four and seven digit numbers, that is, numbers either involving four digit numerical digits, or involving three-code digits and four numerical digits, the start key 232 may be omitted from the operator's position circuit and in Fig. 7 of the sender the strapping indicated at 716, 717 and 718 may be opened and the strapping indicated at 719, 720, 721 and 722 closed. Under this condition when transfer relay 707 operates in response to the keying of the units digit, it locks through the winding of relay 706 over strap 721 and the outer left contacts of relay 707 and closes a circuit from ground on conductor 1303, strap 719, inner contact of relay 707, strap 720, windings of relays 708 and 711 to battery thereby causing the operation of relays 708 and 711. At the end of keying of the units digit relay 706 operates in the manner previously described. The operation of relay 708 because of the presence of strap 721 around its inner contact does not release relays 706 and 707. Relays 703 and 705, however, release upon the operation of relay 706 as previously described. With relay 707 operated and relay 705 released, the circuit of start relay 901 is closed over conductors 426 and 427, strap 722, right back contact of relay 705, left front contact of relay 707 to ground on conductor 1303.

When the start relay 901 operates under either of the conditions above outlined with relay 1001 operated, a circuit is established from battery, winding of relay 406, inner right normal contacts of relay 408, conductor 428, outer left front contact of relay 901, conductor 908 to ground at the inner right front contact of relay 1001. Relay 406 operates, releasing relay 407, connects 48-volt battery through resistance 429 over its outer right front contact to the ring impulsing path and 48-volt battery through the winding of marginal relay 408 over its inner left front contact to the tip impulsing path, these pulsing paths being connected respectively at the keyset circuit through the windings of polarized relays 233 and 234 to 24-volt battery. Relay 408 being marginal does not operate, but polarized relays 233 and 234 both operate and close an obvious circuit for relay 235 which locks to ground at the upper contact of relay 211 and connects ground over its upper contact to the tip impulsing path whereby marginal relay 408 in the sender operates and locks over its inner right front contact to ground on conductor 428 and opens the circuit of relay 406 which releases. Relay 406 upon releasing opens the operating circuits of relays 233 and 234, relay 233 now 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 relay 211. Relay 211 upon releasing in turn releases relays 235, 234, 209, 215 and 217 and extinguishes lamps 212 and 221. Relay 211 upon releasing also releases relay 122 in the cord circuit. The operator's keyset circuit is now in normal condition.

If the operator disregards the pilot lamp 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 keyset 214. Relay 218 upon operating locks over the left contacts 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 with interrupter 236. To prepare the keyset for use, the operator must depress key 206 to release relay 218.

Returning to the operation of the sender it will be recalled that in response to the keying of the designation 1379 and the start combination, relay 607 of the thousands register, relays 609 and 610 of the hundreds register, relays 613 and 1004 of the tens register, relays 1102 and 1103 of the units register and start relay 901 were operated. With selection control switch 1200 in position 7, a circuit is closed for operating relay 1005 extending from battery, winding of relay 1005, inner left back contact of class relay 1006, conductor 1007, upper left contact of cam 1217 to ground at cam 1204. With relay 1005 operated, as soon as the thousands register relay 607 operates a circuit is closed for transferring the thousands digit registration to relay 1506. This circuit extends from battery through winding of relay 1506, conductor 1507, outer left front contact of relay 1005, conductor 1008, inner left front contact of thousands register relay 607 to ground on conductor 1309. If the thousands digit were 2 with register relay 616 operated, relay 1407 of the district brush register which also serves as an incoming brush register would be op-

erated over a circuit through its right winding, conductor 1408, inner left front contact of relay 1005, conductor 1009, inner left front contact of register relay 616 to ground on conductor 1309. If the thousands digit were 3 with register relays 607 and 616 operated, relays 1506 and 1407 would both be operated over the circuit traced. In a similar manner relays of the district brush register and relay 1506 would be operated as follows to register the thousands digits 4 to 9 inclusive: Thousands register relay 1010 being operated for digit 4 would operate relay 1409; thousands register relay 1011 being operated for digit 5 would operate relay 1410; thousands register relays 607 and 1011 being operated for digit 6 would operate relays 1506 and 1410; thousands register relays 616 and 1011 being operated for digit 7 would operate relays 1407 and 1410; thousands register relays 607, 616 and 1011 being operated for digit 8 would operate relays 1506, 1407 and 1410 and thousands register relays 1010 and 1011 being operated for digit 9 would operate relays 1409 and 1410. If the thousands digit were zero none of the relays 1506, 1407, 1409 and 1410 would be operated. The remaining registrations on the hundreds, tens and units register relays are not transferred.

Incoming trunk test

With start relay 901 operated, or relay 711 operated, the locking circuit of relays 400, 401 and 402 is opened and these relays release, relay 401 closing the fundamental circuit extending to the incoming selector 330 for testing the incoming trunk. Since for a call of the class assumed, relays 1405, 1411, 1412 and 1420 of the class register and class relay 1006 are not operated and relays 1413 to 1417 of the compensating resistance register have not been set, the fundamental circuit may be traced from battery, through the control relay (not shown) of the incoming selector, over the tip trunk conductor 324, lower front contact of relay 302, brush 317, conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, resistance 1218, lower left and upper right contacts of cam 1221, conductor 1222, back contact of compensating resistance relay 1417, conductor 1418, winding of trunk test relay 1344, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, back contacts of compensating resistance relays 1415 and 1416, conductor 1419, right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, brush 333, upper front contact of relay 302, ring trunk conductor 325 to ground at the incoming selector 330.

Relay 1344 operates in this circuit if the trunk is in operative condition, but relay 1317 does not operate. Relay 1344 causes the operation of relays 1319 and 1320, relay 1320 locking over conductor 1321 to ground over the lower right contact of cam 1227 and the lower left contact of cam 1204 until control switch 1200 leaves position 9, and closing a circuit for relay 1312 extending from battery, winding of relay 1312, conductor 1322, right back contact of relay 1006, conductor 1013, right back contact of relay 1420, conductor 1421, left contacts of cam 1228, conductor 1229, outer right front contact of relay 1320, to ground on conductor 1303. Relay 1312 upon operating establishes a new fundamental circuit traceable as previously described from the tip trunk conductor 324, to the outer left front contact of relay 1312 thence over conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, thence as traced to the ring trunk conductor 325. It will thus be noted that the operation of relay 1312 is effective at this time to remove the trunk test relay 1344 and resistance 1218 from the fundamental circuit thereby reducing the resistance of the circuit to such a degree as to cause the operation of the control relay of incoming selector 330 and the operation of stepping relay 1315 of the sender. Polarized overflow relay 1317 does not receive current in the proper direction to operate at this time. Relay 1344 now releases followed by the release of relay 1319. Relay 1312 upon operating also releases relay 1311 which at its left back contact shunts the left winding of overflow relay 1317 by the resistance 1324. The sender is now in condition for controlling the incoming selector in its brush selection movement.

Incoming brush selection

In response to the operation of the control relay of the incoming selector, the brush shaft of the incoming selector is driven upwardly in a brush selection movement causing the intermittent application of a shunting ground to the tip conductor of the fundamental circuit in the well known manner for intermittently shunting down the stepping relay 1315 of the sender. At the sender upon the initial operation of relay 1315 with none of the district brush register relays 1407, 1409 and 1410 operated, but with relay 1506 operated to register the fact that an incoming selector brush set should be selected in accordance with the registered thousands digit 1, a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of pulsing relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay

1404, conductor 1422, right contacts of cam 1237, conductor 1238, left back contact of register relay 1410, outer right back contact of relay 1409, left back contact of relay 1407, conductor 1423, left contacts of cam 1239, conductor 1240, winding of the No. 0 counting relay 400 to battery. Relay 400 operates and locks through the windings of counting relays 401 and 402 in parallel, conductor 405, outer right front contact of relay 1312, conductor 1325, upper right and lower left contacts of cam 1204 to ground, but relays 401 and 402 do not operate in this locking circuit being shunted by ground over the circuit previously traced through the contacts of pulsing relay 1315. When relay 1315 releases due to the connection of ground to the tip fundamental conductor as the incoming brush shaft reaches a position to select the first brush set thereof, relays 401 and 402 operate, relay 401 opening the fundamental circuit to release the incoming selector control relay to arrest further brush selection movement and relay 402 advancing the selection control switch 1200 out of position 7 into position 9. This circuit may be traced from battery, winding of magnet 1200, conductor 1213, inner left front contact of relay 1312, conductor 1326, right contacts of cam 1208, conductor 1403, left back contact of relay 1402, conductor 404 to ground at the contact of relay 402. When sequence switch 1200 leaves position 7½, the locking circuit of counting relays 400, 401 and 402 is opened at the upper right contact of cam 1204 and the counting relays release. As sequence switch 1200 leaves position 8, the circuit of relay 1312 is opened at the upper left contact of cam 1228 and relay 1312 releases.

Incoming group selection

With counting relay 401 and relay 1312 released the fundamental circuit extends from the trunk conductor 324, as previously traced, to the outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, lower left and upper right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, thence as traced through the left winding of overflow relay 1317 to the ring trunk conductor 325. The control relay of the incoming selector and stepping relay 1315 of the sender operate, but overflow relay 1317 does not receive current in the proper direction to operate at this time. The control relay of the incoming selector is now instrumental in driving the selector brush shaft upwardly in a group selection movement, the first set of brushes being tripped in the well known manner during the initial portion of this movement and shunting ground being connected to the fundamental tip conductor from the group commutator segments to intermittently release the sender stepping relay 1315.

Stepping relay 1315 upon operating with relay 1506 and hundreds register relays 609 and 610 operated in accordance with the thousands digit 1 and hundreds digit 3, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of stepping relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, upper right contact of cam 1232, conductor 1241, outer right front contact of relay 1506, conductor 1508, inner right back contact of relay 1410, conductor 1424, outer left back contact of hundreds register relay 1014, conductor 1015, lower back contact of the No. 2′ counting relay 431, winding of the No. 2 counting relay 432 to battery on conductor 702. Counting relay 432 operates closing a locking circuit for itself through its winding, the winding of the No. 2′ counting relay 431, front contact of relay 432, conductor 405 to ground over the lower contacts of cam 1209, but relay 431 being shunted does not operate until stepping relay 1315 deenergizes as the incoming selector brush shaft approaches the first group selection position. When relay 431 operates it extends conductor 1015 over its front contact, the back contact of the No. 1′ counting relay 433 to battery through the winding of the No. 1 counting relay 434, relay 434 operating upon the next energization, of stepping relay 1315 and locking through the winding of counting relay 433, the front contact of relay 434, conductor 436, lower left contact of cam 1217 to ground at cam 1204. On the next deenergization of stepping relay 1315, counting relay 433 operates extending conductor 1015 over the front contacts of relays 431 and 433, conductors 435 and 1423, left contacts of cam 1239, conductor 1240 to battery through the winding of the No. 0 counting relay 400. On the next energization of relay 1315, relay 400 operates locking through the windings of relays 401 and 402 which latter relays operate upon the next deenergization of relay 1315, relay 401 opening the fundamental control circuit to arrest the incoming selector in position for hunting in the third group accessible to the selected first set of brushes and relay 402 closing a circuit to advance sequence switch 1200 out of position 9 into position 11.

The circuit for advancing sequence switch 1200 may be traced from ground at the contact of relay 402, over conductor 404, left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves positions 9 and 9¼, the locking circuits of the operated

counting relays are opened at the lower left contacts of cams 1217 and 1209, relay 401 upon releasing again closing the fundamental circuit. As sequence switch 1200 passes through position 10, the fundamental loop in the sender is closed as previously traced from conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, resistance 1218, lower contacts of cam 1221, resistance of 1242, conductor 1226, right back contact of relay 1313 to conductor 323 thereby establishing a high resistance discharge path for the cable extending to the incoming selector. When sequence switch 1200 reaches position 11, the high resistance discharge path is opened at the sender and the same fundamental loop as employed for incoming group selection is established at the sender through the windings of the sender stepping relay 1315 and overflow relay 1317. Following the completion of group selection the incoming selector hunts for and connects with an idle final selector in the well known manner.

Final brush selection

The sender stepping relay 1315 now operates preparatory to controlling final selector brush selection. In the well known manner, the brush shaft of the final selector is now advanced in a brush selection movement transmitting impulses for intermittently shunting the sender stepping relay 1315. Upon the first energization of relay 1315 over the fundamental circuit with hundreds register relays 609 and 610 operated as described to register the hundreds digit 3, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right and upper left contacts of cam 1237, conductor 1243, left back contact of hundreds register relay 1016, conductor 1017, outer left front contact of register relay 610, outer left front contact of register relay 609, conductor 617, back contact of the No. 3′ counting relay 437, winding of the No. 3 counting relay 438 to battery on conductor 702. Relay 438 operates and locks in series with relay 437 over the front contact of relay 438, conductor 436, lower left contact of cam 1217 to ground at cam 1204, but relay 437 being shunted does not operate. Upon the first deenergization of stepping relay 1315 in response to the first shunting impulse applied from the final selector, relay 437 energizes and transfers conductor 617 over the front contact of relay 437, back contact of the No. 2′ counting relay 431 to battery through the winding of the No. 2 counting relay 432. Upon the next energization of relay 1315, relay 432 operates and locks in series with relay 431. Upon the next deenergization of relay 1315 relay 431 operates. In a similar manner the counting relays 433 and 434 operate in response to the next energization and release of stepping relay 1315. When relay 433 operates, it extends control conductor 617 over its front contact, conductors 435 and 1423, left contacts of cam 1239, conductor 1240, winding of the No. 0 counting relay 400 to battery. Relays 400, 401 and 402 now operate in the manner previously described. When relay 401 operates, the fundamental circuit is opened to arrest the further brush selection movement of the final selector and when relay 402 operates, a circuit is established for advancing sequence switch 1200 out of position 11 into position 13. The final selector has now been positioned preparatory to tripping the fourth set of its brushes.

Final tens selection

The circuit for advancing sequence switch 1200 into position 13 may be traced from ground at the contact of relay 402, over conductor 404, left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves positions 11 and 11¼, the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209. When sequence switch 1200 reaches position 13 the fundamental circuit employed for final brush selection is again established, relay 1315 again operates and the final selector is, in the well known manner, advanced in a group or tens selection movement, the selected fourth set of brushes being tripped during the initial portion of this movement. As the final selector brush shaft advances from group to group, shunting impulses are transmitted for intermittently operating the sender stepping relay 1315.

Upon the first energization of relay 1315 with tens register relays 613 and 1004 operated, as described, to register the tens digit 7, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of stepping relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower left contact of cam 1232, conductor 1244, left back contact of tens register relay 1018, conductor 1019, left front contact of register relay 613, outer left back contact of register relay 618, conductor 1015, back contact of the No. 2′ counting relay 431, winding of the No. 2 counting relay 432 to battery on conductor 702. In response to the intermittent operation of relay 1315, counting relays 432, 431, 434 and 433 operate successively, relay 433 upon operat-

ing extending the counting relay control conductor 1015 over the front contacts of relays 431 and 433, conductors 435 and 1423, upper left contact of cam 1239, upper right contact of cam 1245, conductor 1246, outer left front contact of tens register relay 1004, conductor 1020, back contact of the No. 9′ counting relay 439 to battery through the winding of the No. 9 counting relay 440. In response to the further intermittent operation of stepping relay 1315, counting relays 440, 439, 442, 441, 444, 443, 446, 445, 448, 447, 400, 401 and 402 operate in succession. When relay 401 operates the fundamental circuit is opened to arrest the final selector brush shaft with its fourth set of brushes in position to advance over the terminals of the eighth group of the brush bank in which subscriber's line 360 terminates and relay 402 closes a circuit for advancing sequence switch 1200 out of position 13 into position 15.

Final units selection

The circuit for advancing sequence switch 1200 into position 15 may be traced from ground at the contact of relay 402, conductor 404, left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves position 13 and 13¼ the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209. When sequence switch 1200 reaches position 15 the fundamental circuit is again established, relay 1315 again operates and the final selector is, in the well known manner, advanced in a terminal or units selection movement. As the brush shaft advances from terminal position to terminal position shunting impulses are transmitted for intermittently operating the sender stepping relay 1315.

Upon the first energization of relay 1315 with the units register relays 1102 and 1103 operated, as described, to register the units digit 9, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower right contact of cam 1232, conductor 1247, outer left front contact of units register relay 1102, conductor 1107, back contact of the No. 4′ counting relay 449, winding of the No. 4 counting relay 450 to battery on conductor 702. In response to the intermittent operation of stepping relay 1315, counting relays 450, 449, 438, 437, 432, 431, 434 and 433 operate in succession, relay 433 upon operating extending the counting relay control conductor 1107 over the front contacts of relays 449, 437, 431 and 433, conductors 435 and 1423, upper left contact of cam 1239, lower left contact of cam 1245, conductor 1248, outer left front contact of units register relay 1103, conductor 1020, back contact of the No. 9′ counting relay 439 to battery through the winding of the No. 9 counting relay 440. In response to the further intermittent operation of stepping relay 1315, counting relays 440, 439, 442, 441, 444, 443, 446, 445, 448, 447, 400, 401 and 402 operate in succession. When relay 401 operates the fundamental circuit is opened to arrest the final selector brush shaft with the brushes of the fourth brush set in engagement with terminal 1379 of the desired line 360 and relay 402 closes the previously traced circuit for advancing sequence switch 1200 out of position 15 into position 17. As sequence switch 1200 leaves positions 15 and 15¼, the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209. In position 17 the fundamental circuit is again closed through the winding of the sender stepping relay 1315 and the left winding of overflow relay 1317.

Following the completion of final units selection the sequence switch of the incoming selector advances in the well known manner reversing the connection of battery and ground to the conductors 319 and 323 of the fundamental circuit and, upon finding the fundamental circuit closed at the sender through the back contact of counting relay 401, further advances cutting off the reversed battery. At the sender the momentary reversal of battery causes the operation of stepping relay 1315 and the operation of polarized overflow relay 1317 which locks from battery through its right winding, conductor 1327, upper left and lower right contacts of cam 1249, conductor 1250 to ground at the front contact of relay 1317. At its front contact relay 1317 also establishes a circuit extending over conductor 1250, right contacts of cam 1249, conductor 1251 to battery through the winding of relay 1402. Relay 1402 at its back contact opens the circuit over which operating ground was supplied to contacts of the register relays for operating the counting relays and with stepping relay 1315 operated, closes a circuit for operating the No. 0 counting relay 400. The circuit of relay 400 may be traced from battery, winding of relay 400, conductor 1240, middle front contact of relay 1402, conductor 1236, upper contacts of cam 1235, conductor 1233, contact of stepping relay 1315, conductor 1234, upper right contact of cam 1217 to ground at cam 1204. As soon as the reversed battery is disconnected at the incoming selector relay 1315 releases and counting relays 401 and 402 lock in series with the winding of relay 400 over the front contact of relay 400, conductor 405, to ground over the lower contacts of cam 1209. In the event that relay 1315 does not remain operated long enough to permit counting relay 400 to oper-

ate alternative operating circuit for relays 400, 401 and 402 in series is established over conductor 403, inner front contact of relay 1402, conductor 1425, right contacts of cam 1252, conductor 1253 to ground at the inner right front contact of relay 1302. Relay 401 upon operating opens the fundamental circuit and relay 402 upon operating closes a circuit for operating relay 1313.

The circuit of relay 1313 may be traced from ground at the front contact of relay 402, conductor 404, outer left front contact of relay 1402, conductor 1426 to battery through the winding of relay 1313. Relay 1313 upon operating closes a circuit for relay 1328 over the front contact of relay 1304, conductor 1329, upper left and lower right contacts of cam 1245, conductor 1403 to ground at the inner left front contact of relay 1313. With relay 1328 operated, the fundamental tip conductor 319 is connected through 500 ohm resistance 1330, the front contact of relay 1328 to the ring conductor 323 of the fundamental circuit thus simulating the trunk closure which is usually made when a district selector is employed in an established connection. This circuit is maintained until the fundamental circuit is opened at the trunk circuit of Fig. 3. Relay 1328 upon operating also extends its operating ground to battery through the winding of relay 1305 which locks over its left front contact to ground on conductor 1303, locking relay 1328 operated, and opening the circuit of relay 1304 which releases. With relay 1305 operated and relay 1304 released, ground on conductor 1303 is extended over the left front contacts of relays 1305 and 1328, normal contacts of relay 1304, right front contact of relay 1305, right back contact of relay 1331, conductor 1332, to battery through the winding of relay 910. Relay 910 upon operating locks over its right contact to ground on conductor 1303 and at its left back contact opens the shunt around the high resistance left winding of relay 500. The current now flowing from ground through the windings of relay 500, conductor 321, brush 320, contact 334 of relay 310 to battery in parallel through the windings of sensitive relay 306 and marginal relay 312 is not of sufficient strength to maintain relay 306 operated and it releases.

Relay 306 upon releasing closes a circuit extending from battery, winding of cut-through relay 307, inner lower front contact of relay 302, upper back contact of relay 312, upper back contact of relay 306, next to upper front contact of relay 310 to ground at the upper contact of relay 308. Relay 307 upon operating locks over its lower front contact, upper back contact of relay 311, inner lower back contact of relay 312 to ground at the upper contact of relay 308, closes the tip and ring trunk conductors 326 and 327 through to the trunk conductors 324 and 325 extending to the incoming selector 330 for establishing a talking path from the cord circuit of Fig. 1 to the called line 360 and opens the circuits of relays 302 and 310. Relays 302 and 310 upon releasing open the connections over brushes of switch 350 to the sender for starting the release of the sender.

When the circuit previously traced over brush 320 and conductor 321 through the windings of relay 500 is opened, relay 500 releases in turn releasing relays 700 and 1302. Relay 1302 upon releasing disconnects off-normal ground from conductor 1303 and relay 700 disconnects off-normal battery from conductor 702 whereupon all operated relays of the sender release. At its back contact relay 700 closes a circuit from ground over conductor 724, upper left contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 thus advancing sequence switch 1200 into normal position. All operated apparatus of the sender is now in normal condition.

The talking circuit from the incoming selector 330 may be traced over conductor 324, upper front contact of relay 307, conductor 326, tips of jack 300 and plug 121, upper normal contacts of relay 122 which released when the operator's keyset was released following completion of keying, inner upper front contact of relay 123, upper right winding of repeating coil 113, upper back contact of relay 127, upper front contact of relay 123, winding of polarized supervisory relay 134, lower back contact of relay 127, lower right winding of repeating coil 113, inner lower front contact of relay 123, lower normal contacts of relay 122, rings of plug 121 and jack 300, conductor 327, inner upper front contact of relay 307, conductor 325 to the incoming selector. When the called subscriber answers current flowing over this talking path from the incoming selector is reversed in the well known manner thereby causing the operation of polarized relay 134. Relay 134 causes the operation of relay 130 over an obvious circuit which in turn at its upper back contact opens the circuit of calling supervisory lamp 129.

Upon the termination of the conversation, the calling and called subscribers restore their receivers to the switchhooks thereby releasing the answering supervisory relay 107 and the calling supervisory relay 134 whereupon the lamps 105 and 129 light as disconnect signals. The operator upon noting the lighted lamps withdraws the plugs 101 and 121, releasing the operated relays of the cord circuit, extinguishing lamps 105 and 129 and opening the talking circuit to the incoming selector 330. The incoming and final selectors now restore. The withdrawal of plug 121 also opens the circuit of sleeve relay 304 of the trunk circuit which releases in turn releasing relays 303 and 308. Relay 308 in turn releases relay

307. All apparatus of the trunk circuit is now in normal condition, the switch 350 remaining in the position to which it was set in establishing the connection to the sender.

Connection to trunk terminating in a distant office selector

It will now be assumed that the operator connects with a trunk of a group terminating in a distant office selector. This trunk will be identical with the trunk of Fig. 3 except that the strapping 335 to the inner upper back contact of relay 302 will be connected and the strapping 318 to the lower back contact of relay 302 will be omitted. Upon the seizure of the trunk, it will proceed in the manner previously described to hunt for and connect with an idle sender. In the sender upon its association with the trunk, relays 500, 700, 1302, 1001, 1300, 1100, 1304 and 1400 operate as previously described. With relay 310 in the trunk operated, a circuit is closed from ground at the upper front contact of relay 310, strap 335, inner upper back contact of relay 302, brush 333, conductor 323, outer left back contact of relay 1300, conductor 1333, right winding of trunk class register relay 905 to battery. Relay 905 operates and locks over its left winding and inner left front contact to ground on conductor 1303 before relay 1300 operates as previously described to open its initial operating circuit. At its right front contact relay 905 establishes an obvious circuit for relay 911. In this case the previously traced circuits for operating relays 903, 1306, 1500, 1501 and 502 are not established.

With relay 1001 operated and relay 900 not operated, a circuit is established from battery, windings of transfer relays 511 and 514 in series, back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, inner left back contact of relay 505, conductor 506, inner right front contact of relay 1001 to ground. Relays 511 and 514 lock in series over the back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, outer right front contact of relay 511, conductor 506 to ground at the front contact of relay 1001. The operation of relays 511 and 514 at this time indicates that the first digit keyed by the operator will be registered on the relays of the first or A code register. With relay 511 operated a circuit is established for relay 505 extending from battery, winding of relay 505, conductor 517, right front contact of relay 511, conductor 506, to ground at the front contact of relay 1001. At its right back contact relay 505 opens the initial operating circuit of relays 511 and 514. When relay 1300 operates as previously described, the fundamental tip conductor 319 and the fundamental ring conductor 323 are disconnected from the windings of the trunk class registering relays 900 and 905 and these conductors are thereby made free for fundamental selections.

When relay 1001 operated to remove battery through resistance 1002 from conductor 316, the trunk circuit functioned as previously described to cut the fundamental circuit through from conductors 319 and 323 to the outgoing trunk conductors 324 and 325 and thence to the control relay of the distant office selector in which the trunk has been assumed to terminate, and connects the operator's keyset over incoming trunk conductors 326 and 327 to conductors 329 and 332 in the sender. Relay 407 in the sender now operates over conductors 327 and 332 and causes the impulse relays 411, 412 and 413 to be connected from 24-volt battery over conductors 329 and 326 and impulse relays 421, 422 and 423 to be connected from 24-volt battery over conductors 332 and 327 to the keyset in the manner previously described. The connection established from battery through the windings of relays 411, 412 and 413 now causes the operation of relays 215 and 217 and the lighting of lamp 221 at the keyset as an indication that the sender is ready to receive impulses from the keyset.

Keying the office code

It will be assumed that to complete the desired connection having the designation CH 3–1379, the operator first depresses the No. 2 key 237 for registering the code letter C on the relays of the A code register. 48-volt battery is now connected through resistance 219, conductor 220, high resistance 229, the contacts of key 237, conductor 227, over the tip impulsing path previously traced, to 24-volt battery through the windings of impulse relays 411, 412 and 413. The current now flowing is of the proper strength and polarity to operate polarized relay 411 and sensitive relay 413, but due to the inclusion of the high resistance 229, marginal relay 412 does not operate. With relay 413 operated a circuit is closed over the contact of relay 413, conductor 415, left front contact of transfer relay 511 to battery through the winding of transfer relay 512. Relay 512 operates and locks in series with the winding of relay 515, conductor 518, back contact of relay 619, conductor 519, right front contact of relay 512, conductor 520, back contact of relay 601 to ground on conductor 1303, but relay 515 being shunted as long as relay 413 remains operated does not operate at this time. Relay 411 upon operating closes a circuit from ground at its contact over conductor 417, next to inner contact of relay 514, to battery through the right winding of the A code register relay 522 and in parallel over the next to the inner back contact of relay 526 to battery through the right winding of relay 527. Relays 522 and 527 operate and lock over their left windings and inner left front

contacts, conductor 913 to ground at the outer left front contact of relay 1302.

When the operator releases the depressed key 237, relays 411 and 413 release, relay 413 opening the shunt around the winding of relay 515 whereupon relay 515 operates, opening at its right back contact the locking circuit of relays 511 and 514 whereupon these relays release. Relay 514 upon releasing disconnects the operating circuits of the relays of the A code register and of relays 527, 528, 916 and 917 from the contacts of impulse relays 411, 412, 421 and 422 and relay 515 upon operating connects these contacts to the windings of the B code register relays.

When the operator depresses the No. 4 key 238 to register the code letter H, 48-volt battery is connected through resistance 219 over conductor 220, high resistance 229, right contacts of key 238, conductor 228, over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. The current now flowing is of such polarity and strength that polarized relay 421 and sensitive relay 423 operate, but marginal relay 422 does not. With relay 423 operated a circuit is closed from ground at its contacts, over conductor 415, left back contact of transfer relay 511, left front contact of transfer relay 512, inner left back contact of relay 523, conductor 524 to battery through the winding of transfer relay 604. Relay 604 operates and locks through its winding and the winding of relay 619, right front contact of relay 604, back contact of relay 601 to ground on conductor 1303, but relay 619 being shunted as long as relay 423 remains operated does not operate at this time. Relay 421 upon operating closes a circuit from ground over conductor 419, the next to outer front contact of relay 515, conductor 525, right back contact of relay 914 to battery through the right winding of relay 915 of the B code register. Relay 915 locks over its left winding and inner left front contact to ground on conductor 913.

At its left contacts key 238 connects ground from conductor 213 through low resistance 226, high resistance 231, conductor 227, thence over the tip impulsing path to 24-volt battery through the impulse relays 411, 412 and 413. The current flowing is not in the proper direction or of sufficient strength to operate polarized relay 411 or marginal relay 412, but sensitive relay 413 operates and performs the same function as just described in connection with the operation of relay 423. As soon as the operator releases key 238, impulse relays 421, 423 and 413 release, relays 413 and 423 removing the shunt from the winding of relay 619 which now operates in the locking circuit of relay 604, opening at its back contact the locking circuit of relays 512 and 515 which now release. Relay 515 upon releasing disconnects the operating circuits of the relays of the B code register from the contacts of impulse relays 411, 412, 421 and 422 and relay 619 upon operating connects the contacts of the impulse relays to the windings of the C code register relays.

When the operator depresses the key 223 to register the code digit 3 upon the relays of the C code register, 48-volt battery through low resistance 219 is connected over the contacts of key 223, conductor 227, thence over the tip impulsing path to 24-bolt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing is such as to operate polarized relay 411 and since a low resistance has been included in the operating circuit both relays 412 and 413 also operate. Relay 413 upon operating with transfer relays 511 and 512 released and transfer relay 604 operated closes a circuit from ground over conductor 513, the left front contact of relay 604 to battery through the winding of relay 600. Relay 600 operates and locks in series with the winding of relay 601, back contact of relay 602, right front contact of relay 600, conductor 506 to ground, but relay 601 being shunted as long as relay 413 remains operated, does not operate at this time. Relay 412 upon operating closes a circuit extending from ground at its contact, over conductor 416, inner front contact of relay 619 to battery through the right winding of register relay 620. Relay 620 upon operating locks over its left winding and inner left front contact to ground on conductor 913. Relay 411 upon operating closes a circuit extending from ground over conductor 417, next to inner front contact of relay 619, right winding of register relay 621 to battery. Relay 621 locks over its left winding and inner left front contact to ground on conductor 913.

When the operator releases the depressed key 223, relays 411, 412 and 413 release, relay 413 opening the shunt around the winding of relay 601 whereupon relay 601 operates in the locking circuit of relay 600, opening at its right back contact the locking circuit of relays 604 and 619 whereupon relays 604 and 619 release, relay 619 disconnecting the operating circuits of the relays of the C code register from the contacts of the impulse relays and relay 601 upon operating connecting the contacts of the impulse relays to the windings of the thousands register relays. From this point the thousands, hundreds, tens and units register relays are set in response to the keying of the numerical designation 1379, relay 901 operates in response to the keying of the start combination and the keyset is released in the manner previously described.

Provision for two or three digit office codes

Returning at this point to the operation of the code register relays, it will be recalled that relay 527 operated in parallel with the A code register relay 522. The group of relays 527, 528, 523, 526, 914, 916 and 917 is provided for enabling the sender to record either two or three digit office codes and to make the necessary changes in the sender circuits in either case. Had the first office code letter dialed had a numerical equivalent of 3, then relays 522 and 529 of the A code registers would have been operated in parallel with relays 527 and 528. Had the code letter had a numerical equivalent of 4, then relays 912 and 916 would have been operated in parallel. Similarly, for other code letters equivalent to digits 5 to 9, inclusive, A code register relays 522, 529, 912 and 938 would have been selectively operated and relays 527, 528, 916 and 917 would have operated similarly. In the case assumed the first code letter keyed was equivalent to 2 signifying that the office code comprised three digits and therefore the operation of relay 527 was without effect. The value of the first code digit determines whether one or two more code digits will be received.

If it be assumed that the first code letter having the numerical value 3 indicates a two-code digit, then the terminal 530 on the cross-connecting rack 538 is strapped to terminal 531, then with relays 527 and 528 operated in response to keying such a code letter, a circuit is established from ground on conductor 913, inner left back contact of relay 917, conductor 918, inner right front contact of relay 527, right front contact of relay 528, terminals 530 and 531 to battery through the winding of relay 523 and in parallel over conductor 532 to battery through the winding of relay 914. Similarly, if any other first code letter is allocated for two-digit codes, other terminals of the distributing rack 533 would be cross-connected to terminal 531 and when the relays of the group 527, 528, 916 and 917 corresponding to such code letters operate, relays 523 and 914 would be operated. With relays 523 and 914 operated, transfer relay 512 operated and transfer relay 511 released in response to keying the first code letter, then when the operator keys the second code letter thereby operating either one of impulse relays 413 or 423 and ground is connected to conductor 415, a circuit is established from conductor 415, left back contact of relay 511, right front contact of relay 512, inner left front contact of relay 523, conductor 534, winding of transfer relay 600 to battery instead of as previously traced through the winding of relay 604 to battery. Relay 600 locks in series with relay 601 over the back contact of relay 602, right front contact of relay 600 to ground on conductor 506, but as long as the operator holds the key depressed relay 601 does not operate. With relays 523 and 914 operated, the conductors 416, 417, 418 and 419 extending from the contacts of the impulse relays now extend over front contacts of relay 515, front contacts of either relay 914 or relay 523, to the windings of relays of the C code register rather than as heretofore traced to windings of the B code register. Thus, for two-digit codes the second code digit is registered on the C code register.

As soon as the depressed key is released, relay 601 operates in the locking circuit of relay 600 and opens the locking circuit of relays 512 and 515 which release, relay 515 opening the circuits extending from the contacts of the impulse relays to the C code register relays and relay 601 upon operating connecting the impulse relay contacts to the windings of the thousands register relays.

Connection of sender to decoder

Regardless of whether a two or three-digit office code has been registered, as soon as the code digits have all been registered and relay 600 operates the previously traced circuit for relay 509 is closed and relay 509 operates locking to conductor 506 and closing a holding circuit for relay 505 which has been previously operated. Relay 509 also connects battery from conductor 702, right contact of relay 509, outer right front contact of relay 505, conductor 535, right back contact of relay 903, conductor 919, inner right back contact of relay 1404, conductor 1427, right back contact of relay 920, left normal contacts of relay 921, conductor 922, inner left normal contacts of relay 1306, conductor 1334, to the decoder connector for causing the connection of a decoder with the sender. As described in the patent of Raymond and Scully hereinbefore referred to, as soon as an idle decoder connector and decoder become free to serve the sender, the sender is connected to the decoder by all of the conductors extending to the left margins of Figs. 6 and 7 with the exception of conductor 1334 and conductor 622 which is branched from off-normal battery conductor 702, and the code digit registrations are now transferred to the decoder, the A code digit being transferred over conductors of group 623 by ground placed thereon at contacts of the operated A code register relays, the B code digit being transferred over the conductors of group 624 by ground placed thereon at contacts of the operated B code register relays, and the C code digit being transferred over the conductors of group 625 by ground placed thereon at contacts of the operated C code register relays. Ground is also applied at the decoder over conductor 626 and thence over the back contacts of all code register relays of the sender which have not been oper-

ated to conductors of the groups 623, 624 and 625 which were not grounded through operation of code register relays so that all of the conductors of the three groups are grounded. When all register relays of the decoder have operated, ground is removed at the decoder from conductor 626 and all decoder register relays release except those corresponding to operated register relays of the sender.

The decoder now translates the office code and determines therefrom the class of the desired call and in the manner fully described in the aforementioned patent of Raymond and Scully, causes the setting of certain of the compensating resistance register relays 1413 to 1417 inclusive, over the group of conductors 627, the setting of certain of the class register relays 1405, 1411 and 1412 over the group of conductors 728, the setting of certain of the office brush register relays 1509 to 1511, over the group of conductors 725 and the setting of certain of the office group register relays 1512 to 1515 over the group of conductors 726. In the case assumed relay 502 is also operated from the decoder over conductor 503 as the call registered does not require the setting of the district brush or district group register relays of the sender since district selections are to be skipped. Relay 502 upon operating locks over its right winding and inner left front contact, conductor 504, lower right and upper left contacts of cam 1206, conductor 1207, to ground at the right front contact of relay 1306 as soon as relay 1306 operates as later described. Had an office code been registered requiring the use of a district selector in which case the operator would have taken into use a trunk of another group, then the relays 1407, 1409 and 1410 of the district brush register would be set selectively over the group of conductors 727 and the relays 1516 to 1519 of the district group register would be set selectively over the conductors of the group 729.

After an interval to allow the register relays of the sender to be operated from the decoder, the decoder connects ground over conductors 628 and 1502 to battery through the winding of relay 1501 which operates and locks over its inner left front contacts to ground on conductor 1303 and extends its locking ground over conductor 1308 to battery through the winding of relay 1306 thereby causing the operation of relay 1306. Relay 1306 upon operating removes battery over its inner left normal contacts from the start conductor 1334 extending to the decoder connector whereupon the decoder connector releases and breaks the connection between the decoder and sender. Relay 1306 at its right front contact connects locking ground over conductor 1207 and the left contacts of cam 1206 to conductor 1503 for locking the operated office brush and office group register relays and over the upper contacts of cam 1206 and conductor 1254 serves to lock the operated relays of the compensating resistance and class registers. The same ground connected over conductor 1207 and the upper left and lower right contacts of cam 1206, and conductor 504 serves to lock relay 502 and the district brush and group register relays which for the call under consideration are not operated.

At its outer left back contact relay 1306 also opens the circuit of relay 1400 which releases and with relay 502 operated from the decoder to indicate that district selections are to be skipped, a circuit is established from battery on conductor 702, winding of counting relay 400, windings of counting relays 401 and 402 in parallel, conductor 403, inner left front contact of relay 911, next to inner left back contact of relay 902, conductor 907, right front contact of relay 502, conductor 507, left back contact of relay 1400, conductor 1401, left front contact of relay 1306, conductor 1203, left contacts of cam 1202 to ground on conductor 1303. Relays 400, 401 and 402 operate, relay 402 closing a circuit from ground over its contact, conductor 404, outer left back contact of relay 1402, conductor 1403, upper contacts of cam 1208, winding of magnet 1200 for advancing switch 1200 into position 3. Relay 401 at its contact holds the fundamental circuit open until after sequence switch 1200 leaves position 3. In position 3 with relay 502 operated, a circuit is established from battery, winding of magnet 1200, contact of cam 1201, upper right contact of cam 1211, conductor 1212, outer left front contact of relay 502, conductor 508, lower left and upper right contacts of cam 1208, conductor 1403, outer left back contact of relay 1402, conductor 404 to ground at the contact of relay 402. A circuit is also established at this time for relay 1311 from battery, left winding of relay 1311, conductor 508 and thence to ground at the contact of relay 402 as just traced, relay 1311 locking over its right winding and right contact, inner left back contact of relay 1312, conductor 1503, left contacts of cam 1206, conductor 1207 to ground at the right contact of relay 1306 and remaining operated until switch 1200 leaves position 7. Switch 1200 advances into position 4 releasing counting relays 400, 401 and 402, relay 401 upon releasing closing the fundamental circuit extending from the office selector in which the trunk seized by the operator terminates, to the sender for trunk testing purposes, and opening and locking circuit of relay 502 which now releases.

For a full mechanical call of the character under consideration, none of the class relays 1411, 1412 and 1405 will have been operated from the decoder. It will also be assumed that for office test and selections, it is necessary to insert 600 ohms resistance into the

fundamental circuit and for selections beyond the office selector it is necessary to insert 300 ohms resistance and that therefore compensating resistance register relays 1413, 1415 and 1417 have been operated from the decoder, relay 1417 always being operated on this class of call if the trunk loop has 1300 ohms resistance or less. The fundamental circuit may now be traced from battery through the control relay (not shown) of the office selector over the tip trunk conductor 324, lower front contact of relay 302, brush 317, conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper right and lower left contacts of cam 1219, resistance 1218, lower left and upper right contacts of cam 1221, conductor 1222, right front contact of compensating resistance relay 1417, conductor 1436, winding of trunk test relay 1336, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of compensating resistance relay 1413, 600-ohm resistance 1428, right back contact of compensating resistance relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, brush 333, upper front contact of relay 302, ring trunk conductor 325 to ground at the office selector.

Office trunk test

Relay 1336 operates if the trunk is in operative condition, but relay 1317 does not. Relay 1336 causes the operation of relay 1320, relay 1320 locking over conductor 1321 to ground over the lower right contact of cam 1227 and the lower left contact of cam 1204 until control switch 1200 leaves position 5 and closing a circuit for relay 1312 extending from battery, winding of relay 1312, conductor 1322, upper right and lower left contacts of cam 1228, conductor 1229, outer right front contacts of relay 1320 to ground on conductor 1303. Relay 1312 upon operating establishes a new fundamental circuit traceable as previously described from the tip trunk conductor 324 to the outer left front contact of relay 1312, thence over conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of relay 1413, resistance 1428, back contact of relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, thence to ground at the office selector. It will be noted that the operation of relay 1312 is effective at this time to remove the trunk test relay 1336 and resistance 1218 from the fundamental circuit thereby reducing the resistance of the circuit to such a degree as to cause the operation of the control relay of the office selector and the stepping relay 1315 of the sender. Polarized relay 1317 does not receive current in the proper direction to operate at this time. Relay 1336 now releases. Relay 1312 upon operating also releases relay 1311 which at its left back contact shunts the left winding of overflow relay 1317 by resistance 1324. The sender is now in condition for controlling the office selector in its brush selection movement.

Office brush selection

It will be assumed that the decoder has caused the operation of office brush register relay 1509. In response to the operation of the control relay of the office selector, the brush shaft thereof is driven upwardly in a brush selection movement causing the intermittent application of a shunting ground to the tip conductor of the fundamental circuit in the well known manner for shunting the stepping relay 1315 of the sender. At the sender upon the operation of relay 1315 with register relay 1509 operated and control switch 1200 in position 4 a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contacts of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, upper left contact of cam 1232, lower left contact of cam 1237, conductor 1257, right front contact of office brush register relay 1509, inner right back contact of register relay 1510, conductor 1520, back contact of the No. 1′ counting relay 433, winding of the No. 1 counting relay 434, to battery on conductor 702. Relay 434 operates and locks through the winding of relay 433, front contact of relay 434, conductor 436, lower left contact of cam 1217 to ground at cam 1204, but relay 433 being shunted does not operate until stepping relay 1315 deenergizes in response to the first shunting impulse from the office selector.

When relay 433 operates it extends the previously traced circuit over conductor 1520 and its front contact, conductors 435 and 1423, left contacts of cam 1239, conductor 1240 to battery through the winding of counting relay 400. Relay 400 operates upon the next operation of stepping relay 1315 and locks through the windings of counting relays 401 and 402, front contacts of relay 400, conductor 405, right front contact of relay 1312, conductor 1325 to ground over the upper right and lower left contacts of cam 1204. Relays 401 and 402 do not operate in this circuit until stepping relay 1315 again releases in response to the next shunting impulse. When relay 401 does operate, it opens the fundamental circuit thereby releasing the control relay of the office selector to arrest

further movement of its brush shaft. Relay 402 upon operating closes a circuit from ground at its contact, over conductor 404, outer left back contact of relay 1402, conductor 1403, right contacts of cam 1208, conductor 1326, inner left front contact of relay 1312, conductor 1213 to battery through the winding of magnet 1200, thereby advancing switch 1200 out of position 4 into position 6. As switch 1200 leaves positions 4 and 4½ the locking circuits of the operated counting relays are opened at the lower left contact of cam 1217 and the upper right contact of cam 1204 and the counting relays release. The office selector brush shaft has now been positioned preparatory to the tripping of the second set of brushes thereof. As sequence switch 1200 leaves position 5 the locking circuit of relay 1320 and the operating circuit of relay 1312 are opened at the lower right contact of cam 1227 and the upper right contact of cam 1228 respectively, and these relays release. With relay 401 released, the fundamental circuit through the control relay of the office selector and stepping relay 1315 of the sender may be traced from battery through the office selector control relay, thence to conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper contacts of cam 1219, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, thence as previously traced to ground at the office selector.

Office group selection

With switch 1200 in position 6 and if it be assumed that office group register relays 1512 and 1513 have been operated from the decoder, a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contacts of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower left contact of cam 1258, conductor 1259, right front contact of office group register relay 1512, inner right front contact of office group register relay 1513, conductor 617, back contact of the No. 3′ counting relay 437, winding of the No. 3 counting relay 438 to battery. Relay 438 operates and locks in series with relay 437, front contact of relay 438, conductor 436, lower left contact of cam 1217 to ground at cam 1204. At the office selector the control relay operating over the fundamental circuit causes the advance of the brush shaft in a group selection movement and the tripping of the selected second set of brushes. During the group selection movement shunting impulses are transmitted over the tip fundamental conductor for intermittently shunting down stepping relay 1315 of the sender. Upon the first shunting down of relay 1315, counting relay 437 operates in the locking circuit of relay 438 and extends the counting relay control circuit over the front contact of relay 437, the back contact of relay 431 to battery through the winding of relay 432. On the next deenergization of relay 1315, relay 432 operates and locks in series with relay 431, front contact of relay 432, conductor 405 to ground over the lower contacts of cam 1209. Upon the next deenergization of stepping relay 1315, relay 431 operates and extends the control circuit over its front contact and the back contact of relay 433 to battery through the winding of relay 434.

On the next energization of stepping relay 1315, relay 434 operates and locks through the winding of relay 433, its own front contact to ground as previously traced on conductor 436. When relay 1315 again deenergizes, relay 433 operates and extends the operating circuit over its front contact, conductors 435 and 1423, upper contacts of cam 1239, conductor 1260, back contact of office group register relay 1515, conductor 1240 to battery through the winding of counting relay 400. Upon the next energization of stepping relay 1315 relay 400 operates and locks in series with relays 401 and 402 over its own front contact and to ground on conductor 405. When stepping relay 1315 again deenergizes, relays 401 and 402 operate, relay 401 opening the fundamental circuit to arrest further group selection movement of the office selector and relay 402 closing a circuit from ground over its contact, conductor 404, outer left back contact of relay 1402, conductor 1403, upper right and lower left contacts of cam 1208, conductor 508, back contact of relay 502 which released when switch 1200 left position 3, conductor 1214, outer right back contact of skip office relay 1500, conductor 1521, right normal contacts of relay 1108 to battery through the winding of slow-to-release relay 1109. Relay 1109 operates and closes an obvious circuit for slow-to-operate relay 1108 which after an interval operates and locks over its right alternate contacts to ground on conductor 1521 opening at its right normal contacts the operating circuit of relay 1109. After an interval relay 1109 releases closing a circuit from ground at its back contact, left alternate contacts of relay 1108, conductor 1215, conductor 1212, upper right contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 for advancing switch 1200 into position 7. The delay introduced through the operation of relays 1108 and 1109 allows sufficient time to permit the office selector to hunt for an idle trunk in the selected group before switch 1200 is advanced

into position 7 for making a test of the selected trunk.

Incoming trunk test

Upon the advance of sequence switch 1200 out of positions 6 and 6¼, the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209, relay 402 upon releasing in turn releasing relays 1108 and 1109 and relay 401 upon releasing again closing the fundamental circuit for testing the selected trunk outgoing from the office selector to an incoming selector. With compensating resistance register relays 1413, 1415 and 1417 operated, as previously assumed, the fundamental circuit may now be traced from battery, through the control relay (not shown) of the incoming selector, thence to conductor 319, as previously traced, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, resistance 1218, lower left and upper right contacts of cam 1221, conductor 1222, right front contact of compensating resistance register relay 1417, conductor 1436, winding of trunk test relay 1336, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, right front contact of compensating resistance register relay 1415, 300-ohm resistance 1429, back contact of register relay 1416, conductor 1419, right contacts of cam 1225, conductor 1226, right back contact of relay 1313, thence as traced to ground at the incoming selector. If the incoming selector is in normal condition relay 1336 operates closing an obvious circuit for relay 1320 which now locks over the locking circuit previously described closing the previously traced circuit for relay 1312. Relay 1312 upon operating establishes a new fundamental circuit traceable as previously described to the left back contact of relay 1313, outer left front contact of relay 1312, conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, right front contact of relay 1415, resistance 1429, back contact of relay 1416, conductor 1419, thence as traced to ground at the incoming selector. With relay 1312 operated, trunk test relay 1336 releases. The sender is now in condition for controlling the incoming selector in its brush selection movement. The setting of the incoming selector and final selector, the disconnection and release of the sender and the cutting through of a talking connection from the operator's cord circuit over the trunk circuit, office, incoming and final selectors, to the desired called line whose number was assumed to be CH 3—1379, now proceeds in the manner previously described in connection with the first call discussed.

Connection to trunk terminating in distant district selector at tandem office

It will now be assumed that the operator connects with a trunk of a group terminating in a distant district selector at a tandem office. This trunk will be identical with that of Fig. 3 except that both straps 318 and 335 will be connected and consequently when the sender is seized relays 500, 700, 1302, 1001, 1300, 1100, 1304 and 1400 will be operated as previously described and in addition upon the operation of relay 310 in the trunk circuit following the seizure of the sender, both trunk class register relays 900 and 905 will be operated, relay 900 causing the operation of relays 902, 903, 502, 1306, 1500 and 1501 as described in connection with the first type of call discussed and relay 905 causing the operation of relay 911 as described in connection with the call just discussed. The operation of relays 502, 1306 and 1500 at this time indicates that district and office selections are to be skipped and that the association of a decoder will not be required.

Relay 911 upon operating with relay 903 operated closes a circuit from ground at cam 1204, conductor 1205, next to outer front contact of relay 903, middle right front contact of relay 911, conductor 921, right winding of class register relay 1412 to battery; relay 1412 upon operating locking over its left winding and outer left front contact, conductor 1254, upper contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306 to indicate that the call is to be routed through a tandem office. Relay 1412 at its inner left front contacts closes a circuit from ground over conductor 1431 for operating relay 1006. With relays 1412 and 1501 operated, a circuit is established from battery, winding of relay 1337, conductor 1338, left back contact of class register relay 1411, conductor 1432, outer front contact of relay 1501, conductor 1522, outer right front contact of class register relay 1412, conductor 1433, upper right contact of cam 1227 to ground at cam 1204. Relay 1337 upon operating closes a circuit for operating relays 453 and 454 in series over conductor 455 to ground at the inner right front contact of relay 1337, these relays locking over the right contact of relay 454, conductor 456, the upper left and lower right contacts of cam 802 of impulser switch 800, conductor 803, upper left contact of cam 1227 to ground at cam 1204 after switch 1200 reaches position 7 and until after impulser switch 800 leaves position 10 of its first revolution. Relay 1337 also closes a circuit for advancing the impulser switch 800 out of posi-

tion 1 into position 5 which may be traced from battery, winding of magnet 800, upper contact of cam 801, upper left contact of cam 804, conductor 805, inner left front contacts of relay 1337, thence over the operating circuit of relay 1337 to ground at cam 1204. When impulser switch 800 reaches position 4 and switch 1200 reaches position 7 a locking circuit is closed for relay 1337 extending through its winding over its inner left front contact, conductor 806, right contacts of cam 802, conductor 803, upper left contact of cam 1227 to ground at cam 1204. Relay 1337 remains operated until impulser switch 800 leaves position 17 of its first revolution.

With relays 1001, 900 and 905 operated a circuit is established from battery through the windings of transfer relays 511 and 514 in series, back contact of relay 515, conductor 516, outer left front contact of relay 905, inner left front contact of relay 900, conductor 906, outer right front contact of relay 511, conductor 506 to ground at the inner left front contact of relay 1001. The operation of relays 511 and 514 indicates that the first digit to be keyed by the operator will be registered on the relays of the A code register. Relays 511 and 514 lock over the back contact of relay 515, conductor 516, front contacts of relays 900 and 905, outer right front contact of relay 511, to ground on conductor 506. With relay 511 operated a circuit is established for relay 505 extending from battery, winding of relay 505, conductor 517, right front contacts of relay 511 to ground on conductor 506. At its back contact relay 505 opens the initial operating circuits of relays 511 and 514. When relay 1300 operates the fundamental circuit conductors 319 and 323 are disconnected from the windings of trunk class registering relays 900 and 905 and these conductors are thereby made free for fundamental selections.

In the manner previously described, when relay 1001 operates, the trunk circuit functions to cut the fundamental circuit through from conductors 319 and 323 to the distant district selector in which the trunk circuit has been assumed to terminate, and connects the operator's keyset to impulsing conductors 329 and 332 in the sender. The sender then signals over these conductors to the operator's keyset circuit that it is in condition to register the designation of the desired connection. The operator then proceeds to key the office code and numerical digits of the desired connection which, in the manner previously described, are now registered on the relay registers of Figs. 5, 9, 6, 10, 7 and 11. If a stations letter is keyed it is registered on relays 713, 730 and 1112, or if a numerical designation over 9999 is keyed, the units digit is registered on relays 713, 730, 1105 and 1112 through the operation of relays 1104, 1120 and 1111. Following the completion of keying the start relay 901 is operated, as previously described, and the operator's keyset circuit is restored.

When relay 1306 operated following the operation of relay 900, the sender control switch 1200 is advanced into position 7 in the manner previously described in connection with the first type of call discussed, thus passing by the positions in which district and office selections are usually made. With switch 1200 in position 7 the fundamental circuit is now closed for trunk testing and may be traced from battery at the tandem district selector (not shown), trunk conductor 324, thence as traced to conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left front contact of relay 1006, conductor 1021, upper contacts of cam 1221, conductor 1222, back contact of relay 1417, conductor 1418, winding of trunk test relay 1344, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, back contact of relay 1415, back contact of relay 1416, conductor 1419, right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, thence as traced over trunk conductor 325 to ground at the distant district selector. Relay 1344 operates if the trunk is in operable condition and in turn causes the operation of relays 1319 and 1320 as previously described. Relay 1320 upon operating does not in this case cause the operation of relay 1312 since the circuit previously traced for relay 1312 is open at the right back contact of class relay 1006.

With the class relay 1412 operated, when relay 1320 operates, a circuit is closed for the call indicator relay 1339 extending from battery through the winding of relay 1339, left back contact of relay 1331, conductor 1340, inner right front contact of class register relay 1412, conductor 1434, outer right front contact of class register relay 1006, conductor 1013, right back contact of class register relay 1420, conductor 1421, left contacts of cam 1228, conductor 1229, outer right front contact of relay 1320 to ground on conductor 1303. Relay 1339 operates and locks over the outer left back contact of relay 1331, inner left front contact of relay 1339 to ground on conductor 1303 and closes a circuit from battery through the winding of magnet 1200, contacts of cam 1201, lower left contact of cam 1211, conductor 1261, middle left contact of relay 1339 to ground at the left back contact of relay 1317 thus advancing switch 1200 into position 17. As soon as relay 1339 operates, the fundamental circuit is extended from conductor 319, left back contact of relay 1313, inner right front contact of relay 1339, outer left front contact of relay 1320,

conductor 1341, left back contact of relay 1420, conductor 1418, winding of relay 1344, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, right back contacts of relays 1415 and 1416, conductor 1419, right contacts of cam 1225, conductor 1226, right back contact of relay 1313 to conductor 323. Until a sender has been seized at the tandem office relay 1344 remains operated and the left winding of overflow relay 1317 is shunted over the inner right front contact of relay 1320, middle right contact of relay 1339, conductor 1262, the lower right and upper left contacts of cam 1223 to prevent a false overflow condition. Condenser 1343 and resistance 1345 are connected in shunt of the winding of relay 1344 to prevent the discharge from relay 1344 from causing a false call indicator impulse from being transmitted.

When the sender is advanced at the tandem office battery and ground is replaced at the tandem office by a metallic loop and relay 1344 thereupon releases followed by the release of relay 1319 and the release of relay 1320 if switch 1200 has passed beyond position 9. Relay 1320 upon releasing with relay 1339 operated, now closes a circuit for operating relay 451 over conductor 452, outer right front contact of relay 1339, outer right back contact of relay 1320 to ground on conductor 1303, relay 451 locking directly to ground on conductor 1303. Relay 451 closes a circuit from battery, winding of magnet 800 of the impulse switch, contacts of cam 801, conductor 807, outer left front contact of relay 451, conductor 457, conductor 1425, upper right contact of cam 1252, upper left contact of cam 1202 to ground at the left contacts of cam 1204, switch 800 advancing from position 5 into normal position 1. When switch 800 passes beyond position 17 the locking circuit of relay 1337 is opened at the upper right contact of cam 802 and relay 1337 releases. From position 1 switch 800 is advanced to position 2 of a second revolution by a circuit from battery, winding of magnet 800, upper contact of cam 801, lower left contact of cam 802, conductor 808, inner left front contact of relay 454, conductor 807, outer left front contact of relay 451, conductor 457 to ground as traced. From position 2, switch 800 is advanced into normal position over a circuit from battery, winding of magnet 800, right contact of cam 801, conductor 807, outer left front contact of relay 451, conductor 457, to ground as traced. Upon leaving position 10 of its second revolution the locking circuit of relays 453 and 454 is opened at the upper left contact of cam 802 and these relays release. Therefore, when switch 800 reaches normal at the end of its second revolution it cannot advance further. During its advance from position 5 of its first revolution to the end of its second revolution, switch 800 is instrumental in transmitting code impulses for setting the registers of the tandem sender in correspondence to the setting of the registers of the sender disclosed.

Transmission of code impulses

Impulses are sent out from the impulser switch 800 in three different codes. One code for stations, another for thousands and a third for office code digits and the hundreds, tens and units numerical digits. These three codes are as follows: "N" meaning a heavy negative impulse; "*n*" a light negative impulse; "*p*" a light positive impulse and "—" no impulse:

Thousands	Stations	Office code and other numerical digits
0—*n*—*n* 1—*n*—N 2*pn*—*n* 3*pn*—N 4—N—*n* 5—N—N 6*p*N—*n* 7*p*N—N 8—*npn* 9—*np*N	0—*n*—*n* 1*pn*—*n* 5 (J)—*npn* 6 (M)—*n*—N 7 (R) *p*N—*n* 9 (W)—N—*n*	0—*n*—*n* 1—*pn*—*n* 2—N—*n* 3*p*N—*n* 4—*npn* 5—*n*—N 6*pn*—N 7—N—N 8*p*N—N 9—*np*N

When a numerical designation keyed has but four digits in which case relay 922 is not operated, code impulses are sent out from the registers in accordance with the foregoing codes, the stations code being sent first following the codes for the office digits followed by the thousands and the other numerical codes in order. If a stations letter was not keyed or if any digit was keyed for setting the stations letter except 5, 6, 7 and 9 corresponding to stations letters J, M, R and W a code for zero is transmitted.

If a five numerical digit designation is keyed the first digit of which is 1 and the second digit of which is 0 indicating a designation of a line 10,000 to 10,999, then the first digit 1 would be registered by the operation of thousands register relay 618, no register relays of the hundreds register would be operated, and consequently relay 1003 not being operated, and the stations register relays would be operated to register the units digit in which case the start combination is not registered on the stations register and relay 715 is not operated. The circuit of relay 922 is therefore established from battery, winding of relay 922, conductor 928, inner right front contact of relay 708 which operates following the keying of the units digit, conductor 731, back contact of relay 930, conductor 929, back contact of relay 1003, conductor 1023, right back contact of relay 715, back contact of relay 732, conductor 733, left back contact of thousands register relay 1011, conductor 1008, left front contact of thousands reg-

ister relay 607 to ground on conductor 1309. The operation of relay 922 indicates that the first set of code impulses for the ten-thousands digit 1 of the numerical designation to be sent is to be received on the stations register of the tandem sender and must be sent in the stations code which is "*pn—n*" rather than the thousands code which is "—*n*—N". The units digit which is registered on the stations register and may have any value from 0 to 9 and is to be received on the units register of the tandem sender must be sent in the regular units code instead of the stations code. This translation is brought about by providing extra stations register relays.

Referring to the codes above tabulated, it will be noted that the odd impulses of each code are either blank or light positive and that the even impulses are either light or heavy negative. Consideration will now be given to the manner in which these impulses are generated. As switch 800 passes each even numbered position, ground is connected over the upper right and lower left contacts of cam 809, conductor 810, left front contact of relay 453 which is operated until switch 800 passes beyond position 10 of its second revolution, inner right back contact of relay 458, conductor 1342, outer left back contact of relay 1320, inner right front contact of relay 1339, left back contact of relay 1313 to the tip fundamental conductor, or after switch 800 leaves position 10 of its second revolution with relay 453 deenergized from conductor 810, left contacts of cam 860, conductor 861, inner right back contact of relay 458, thence as traced to the fundamental tip conductor. Battery is connected through the high resistance 811, conductor 812, upper contacts of cam 813, conductor 814, right front contact of relay 453, outer right back contact of relay 458, conductor 460, inner right back contact of relay 1320, middle right front contact of relay 1339, conductor 1262, lower right and upper left contacts of cam 1223, conductor 1318, thence as previously traced to the ring fundamental conductor, or after switch 800 leaves position 10 of its second revolution and relay 453 releases, over the right contacts of cam 813, conductor 862, outer right back contact of relay 458, thence as traced to the ring fundamental conductor. Unless this condition is modified by shunts around resistance 811 by connections controlled by the sender register light negative impulses are generated.

As switch 800 advances from position 5 into position 17 of its first revolution for transmitting impulses corresponding to the office code at which time tandem relay 1337 is operated, the shunt around resistance 811 for modifying the light negative impulses into heavy negative impulses as determined by the setting of relays of the A, B and C code register relays may be trace over conductors 812 and 834, outer left front contact of relay 1337, conductor 815 to the upper right contact of cam 816 and thence in positions 5¼ to 8¾ of switch 800, over the lower right contact of cam 816, conductor 820, contacts of the A code register relays, one of conductors 925, 926 or 927, contacts of cam 821, conductor 822, inner left front contact of relay 451, conductor 461, right back contact of relay 1437, conductor 1438, lower right and upper left contacts of cam 823, conductor 824, resistance 462 to battery on conductor 702; or in positions 9¼ to 12¾ over the lower left contact of cam 816, conductor 825, contacts of the B code register relays, one of conductors 925, 926 or 927 and thence as traced to battery through resistance 462; or in positions 13¼ to 16¾ over the upper left contact of cam 816, conductor 826, contacts of the C code register relays, one of the conductors 925, 926 or 927 to battery through resistance 462.

Assuming first that the designation keyed comprised a four-digit numerical designation followed by a stations letter in which case relay 1003 would be operated and therefore relay 922 would not be operated, then as switch 800 rotates from position 17 of its first revolution through position 16 of its second revolution, with tandem relay 1337 deenergized after switch 800 leaves position 17 of its first revolution, shunts may or may not be placed around resistance 811 to generate heavy negative impulses as determined by the setting of the stations, thousands, hundreds, tens and units register relays in the order named. These shunts are closed over conductors 812 and 834, outer left back contact of relay 1337, conductor 1346, outer right back contact of relay 922, conductor 923, right contact of cam 817 and thence in positions 17½ to 20¾ of the first revolution of switch 800, over the right contact of cam 818, conductor 827, contacts of the stations register relays, one of conductors 925, 926 or 927 through resistance 462 to battery; or in positions 1¼ to 4¾ of the second revolution of switch 800, over the lower left contact of cam 817, conductor 828, contacts of the thousands register relays, one of conductors 925, 926 or 927, through resistance 462 to battery; or in positions 5¼ to 8¾ over the upper left contact of cam 817, conductor 829, contacts of the hundreds register relays, one of the conductors 925, 926 or 927, through resistance 462 to battery; or in positions 9¼ to 12¾ over the upper left contact of cam 818, conductor 830, contacts of the tens register relays, one of conductors 925, 926 or 927, through resistance 462 to battery; or in positions 13¼ to 16¾ over the lower left contact of cam 818, conductor 831, contacts of the units register relays to battery through resistance 462.

If it be assumed that the number keyed comprised a five-digit numerical designation

for a line 10,000 to 10,999 in which case relay 922 operated as previously described, then when switch 800 rotates from position 17 of its first revolution through position 16 of its second revolution with tandem relay 1337 deenergized, shunts may or may not be placed around resistance 811 to generate heavy negative impulses as determined by the setting of the thousands, hundreds, tens, units and stations relays in the order named. As switch 800 rotates through positions 17½ to 20¾ of its first revolution since the thousands digit registered on the thousands register is 1 and is to be sent in the stations code for digit 1 which is "*pn*—*n*" instead of the thousands code which is "*n*—N" no shunt is cut through from the impulser switch to the contacts of the thousands register relays and consequently both of the negative impulses are transmitted as light negative. As switch 800 rotates through positions 1¼ to 4¾ of its second revolution since the thousands digit registered on the hundreds register is zero, the code of which is "—*n*—*n*", no translation is made and two light negative impulses are transmitted. As switch 800 rotates through positions 5¼ to 16¾ in which positions shunts may or may not be established to generate heavy negative impulses, shunts are closed around resistance 811 over conductors 812 and 834, outer left back contact of relay 1337, conductor 1346, outer right front contact of relay 922, conductor 924, upper right contact of cam 819 and thence in positions 5¼ to 8¾ over the upper left contact of cam 819, conductor 830, contacts of the tens register relays on which the hundreds digit is registered, one of conductors 925, 926 or 927, through resistance 462 to battery; or in positions 9¼ to 12¾ over the lower left contact of cam 819, conductor 831, contacts of the units register relays on which the tens digit is registered, one of conductors 925, 926 or 927 through resistance 462 to battery; or in positions 13¼ to 16¾ over the lower right contact of cam 819, conductor 832, contacts of stations register relays upon which the units digit is registered, one of conductors 925, 926 or 927 through resistance 462 to battery.

It is to be noted in this connection that if a four-digit numerical designation of a line 1000 to 1099 has been keyed with the thousands digit 1 registered by the operation of thousands register relay 618, no hundreds register relays operated to register the hundreds digit 0 and relay 1003 consequently not operated, and the start combination registered on relays of the stations register and relay 715 thus operated, relay 922 is not operated and impulsing consequently takes place as previously described in connection with a numerical designation including a stations letter except that the code for zero is transmitted for setting the stations register of the tandem sender, no stations letters being assigned to the numbers 1000 to 1099 in offices with both five-digit numbers and stations letters. On calls to offices in which there are no five-digit numbers, station letters may be assigned to numbers 1000 to 1099 and since in this case a stations letter would be registered on the stations register relays the start combination is not registered therein and relay 715 is not operated. Since it is necessary to permit the operation of relay 922 in this case, relay 930 is operated over conductor 734 from the decoder opening the operating circuit previously traced for relay 922. On calls of the type for which the decoder is not employed, relay 930 cannot operate and therefore it is necessary to restrict the numbers 1000 to 1099 for direct calls with stations letters.

The manner in which light or heavy negative impulses are transmitted in each position of switch 800 having been described, attention will now be directed to the manner in which positive impulses are generated as switch 800 advances through odd numbered positions. As switch 800 passes each odd numbered position, the fundamental ring conductor 323 is connected over the right back contact of relay 1313, conductor 1226, right contacts of cam 1225, conductor 1419, back contacts of relays 1416 and 1415, conductor 1224, right contacts of cam 1223, conductor 1262, middle right contact of relay 1339, inner right back contact of relay 1320, conductor 460, outer right back contact of relay 458, right front contact of relay 453, conductor 814, right contacts of cam 809 to ground until relay 453 releases and switch 800 leaves position 10 of its second revolution and then as traced over the outer right back contact of relay 458, conductor 862, lower right and left contacts of cam 813 to ground at the right contacts of cam 809. As switch 800 passes through the odd positions 5 to 17 of its first revolution, the tip fundamental conductor 319 may or may not be connected over the left back contact of relay 1313, inner right contact of relay 1339, outer left back contact of relay 1320, conductor 1342, inner right back contact of relay 458, left front contact of relay 453, conductor 810, outer right front contact of tandem relay 1337, conductor 833, to the upper right contact of cam 835 and thence in positions 4¼ to 7¾ over the lower right contact of cam 835, conductor 836, contacts of the A code register relay, conductor 837 or conductor 838, contacts of cam 840, conductor 839, left back contact of relay 1437, resistance 1439 to battery; or in positions 8¼ to 11¾ over the lower left contact of cam 835, conductor 841, contacts of the B code register relays, conductor 837 or conductor 838, contacts of cam 840, thence to battery as traced through resistance 1439; or in positions 12¼ to 15¾

over conductor 842, contacts of the B code register relays, conductor 837 or conductor 838, contacts of cam 840, thence to battery through resistance 1439.

Assuming first that the designation keyed comprised a four-digit numerical designation followed by a stations letter in which case relay 922 would not be operated, then as switch 800 rotates from position 17 of its first revolution through position 16 of its second revolution with tandem relay 1337 deenergized after switch 800 leaves position 17 of its first revolution, battery may or may not be connected to the tip fundamental conductor to generate light positive impulses dependent upon the setting of the stations, thousands, hundreds, tens and units register relays in the order named. As switch 800 passes through odd positions the fundamental tip conductor is extended as traced to conductor 810, outer right back contact of tandem relay 1337, conductor 1347, inner right back contact of relay 922, conductor 843, upper right contact of cam 844, thence in positions 16¼ to 19¾ over conductor 845, contacts of stations register relays, conductor 837 or conductor 838, thence to battery through resistance 1439; or in positions 20¼ to 3¾ over the right contact of cam 846, conductor 847, contacts of the thousands register relays, conductor 837 or conductor 838, thence to battery through resistance 1439; or in positions 4¼ to 7¾, over the lower left contact of cam 846, conductor 848, next to outer front contact of relay 708 which is operated when a stations letter has been registered, conductor 735, contacts of hundreds register relays, conductor 837 or conductor 838 to battery through resistance 1439; or in positions 8¼ to 11¾ over the lower right contact of cam 844, conductor 849, contacts of tens register relays, conductor 837 or conductor 838 to battery through resistance 1439; or in positions 12¼ to 15¾ over the upper left contact of cam 846, conductor 850, contacts of units register relays, conductor 837 or conductor 838 to battery through resistance 1439.

If it be assumed that the number keyed comprised a five-digit numerical designation for a line 10,000 to 10,999 in which case relay 922 is operated, as previously described, then as switch 800 rotates from position 17 of its first revolution through position 16 of its second revolution with relay 1337 deenergized, battery may or may not be connected to the tip fundamental conductor to generate light positive impulses dependent on the setting of the thousands, hundreds, tens, units, and stations registers in the order named. As switch 800 passes through odd positions, the fundamental tip conductor is extended as traced to conductor 810 over the right back contact of relay 1337, conductor 1347, inner right front contact of relay 922, conductor 851, right contact of cam 852, thence in position 17 over the upper left contact of cam 852, conductors 853 and 847, the outer right back contact of thousands register relay 1011, conductor 1024, outer right back contact of thousands register relay 616, conductor 629, left front contact of relay 922, conductor 931, conductor 837, thence to battery through resistance 1439. In passing through positions 20¼ to 3¾ no connections are established through the contacts of the hundreds register relays for generating a positive impulse since the thousands digit registered on the hundreds register relay is zero, requiring no positive impulses. In passing through positions 4¼ to 7¾, the fundamental tip is extended as traced to the right contact of cam 852, thence over the left contact of cam 854, conductor 849, contacts of the tens register relays, conductor 837 or conductor 838 to battery through resistance 1439; or in positions 8¼ to 11¾ over the lower left contact of cam 852, conductor 850, contacts of the units register relays, conductor 837 or conductor 838 to battery through resistance 1439; or in positions 12¼ to 15¾ over the upper right contact of cam 854, conductor 855, contacts of the stations register relays, conductor 837 or conductor 838 to battery through resistance 1439.

Blank impulses are generated in odd positions of switch 800 by connecting the fundamental tip conductor to ground through contacts of the register relays in accordance with the setting of the registers to discharge the fundamental loop, then opening the tip fundamental conductor. As switch 800 passes through the odd positions 5 to 17 of its first revolution with tandem relay 1337 operated, the fundamental tip may or may not be connected as traced to the right front contact of relay 1337, conductor 833, to the upper right contact of cam 835, thence in positions 4¼ to 7¾ over the lower right contact of cam 835, conductor 836, contacts of the A code register relays, conductor 856, upper right contact of cam 858 to ground at cam 859, or over conductor 837, upper left contact of cam 859 to ground. Thus, dependent on the operated condition of the A code register relays, both the tip and ring fundamental conductors may be grounded as switch 800 rotates through position 4¾ to discharge the fundamental loop and the tip then opened from position 4¾ to 5¼, or both grounded as switch 800 rotates from positions 6½ to 6¾ and the tip then opened from position 6¾ to 7¼. As switch 800 rotates through positions 8¼ to 11¾ the tip fundamental conductor is extended over the lower left contact of cam 835, conductor 841, contacts of the B code register relays, conductor 838, left contact of cam 858 to ground at cam 859, or over conductor 837, upper left contact of cam 859 to ground dependent on the operated condition of the B

code register relays, grounding both fundamental conductors as it rotates from positions 8½ to 8¾ or 10½ into 10¾ to discharge the fundamental loop and opening the fundamental tip from positions 8¾ to 9¼ or from positions 10¾ to 11¼. As switch 800 rotates through positions 12¼ to 15¾, the tip fundamental is extended over the upper left contact of cam 835, conductor 842, contacts of the C code register relays, conductor 838, left contact of cam 858 to ground at cam 859, or over conductor 837, upper left contact of cam 859 to ground dependent on the operated condition of the C code register relays, grounding both fundamental conductors as it rotates from positions 12½ to 12¾ or 14½ to 14¾ to discharge the fundamental loop and opening the fundamental tip from positions 12¾ to 13¼ or from positions 14¾ to 15¼.

As switch 800 rotates through odd positions, from position 17 of its first revolution through position 16 of its second revolution, relay 1337 being now deenergized and it being assumed that a four-digit numerical designation with a stations letter has been keyed and relay 922 not therefore operated, the fundamental tip conductor may or may not be connected to ground for generating blank impulses dependent on the setting of the relays of the stations, thousands, hundreds, tens and units register relays in the order named. The fundamental tip conductor extends as traced to conductor 810, outer right back contact of relay 1337, conductor 1347, inner right back contact of relay 922, conductor 843, upper right contact of cam 844, in positions 16¾ to 19¼ over the left contact of cam 844, conductor 845, contacts of the stations register relays, conductor 856, upper right contact of cam 858 to ground at cam 859, or over conductor 837, upper left contact of cam 859 to ground, or over conductor 838, upper left contact of cam 858 to ground at cam 859, dependent on the setting of the stations relays, grounding both fundamental conductors as switch 800 rotates from positions 16½ to 16¾ or 18½ to 18¾ to discharge the fundamental loop and opening the tip fundamental from positions 16¾ to 17¼ or from positions 18¾ to 19¼. As switch 800 rotates through positions 20½ to 3¾ the tip fundamental conductor is extended over the right contact of cam 846, conductor 847, contacts of the thousands register relays, conductor 838, left contact of cam 858, or over conductor 837, upper left contact of cam 859, to ground dependent on the operated condition of the thousands register relays, grounding both fundamental conductors as it rotates from positions 20½ to 20¾ or 2½ to 2¾ to discharge the fundamental loop, and opening the tip conductor from positions 20¾ to 1¼ or from positions 2¾ to 3¼. As switch 800 rotates through positions 4¼ to 7¾ the tip fundamental conductor is extended over the lower left contact of cam 846, conductor 848, next to outer front contact of relay 708 which is operated when a stations letter has been registered, conductor 735, contacts of the hundreds register relays, conductor 838, left contact of cam 858, or over conductor 837, upper left contact of cam 859 to ground dependent on the operated condition of the hundreds register relays, grounding both fundamental conductors as it rotates through position 4¾ or from positions 6¼ to 6¾ to discharge the fundamental loop, and opening the tip conductor from positions 4¾ to 5¼ or 6¾ to 7¼. As switch 800 rotates through positions 8¼ to 11¾ the tip fundamental conductor is extended over the lower right contact of cam 844, conductor 849, contacts of the tens register relays, conductor 838, left contact of cam 858, or over conductor 837, upper left contact of cam 859 to ground dependent on the operated condition of the tens register relays, grounding both fundamental conductors as it rotates from positions 8½ to 8¾ or positions 10½ to 10¾ to discharge the fundamental loop, opening the tip conductor from positions 8¾ to 9¼ or 10¾ to 11¼. As switch 800 rotates through positions 12¼ to 15¾, the tip fundamental conductor is extended over the upper left contact of cam 846, conductor 850, contacts of the units register relays, conductor 838, left contact of cam 858, or over conductor 837, upper left contact of cam 859 to ground dependent on the operated condition of the units register relays, grounding both fundamental conductors as it rotates from positions 12½ to 12¾ or 14½ to 14¾ to discharge the fundamental loop, and opening the tip conductor from positions 12¾ to 13¼ or 14¾ to 15¼.

Blank impulses are generated in the manner described in case a five-digit numerical designation should be keyed, except that they are transmitted over the fundamental circuit in the same order as positive impulses in odd positions of switch 800, that is, in accordance with the setting of the thousands, hundreds, tens, units and stations register relays in the order named. The manner in which light and heavy negative, light positive and blank impulses are produced having been explained, it is not considered to be necessary to explain how code impulses for any definite office and numerical designation are transmitted.

As switch 800 passes out of position 16 of its second revolution, the fundamental ring conductor 323 is connected over the right back contact of relay 1313, conductor 1226, right contacts of cam 1225, conductor 1419, back contacts of relays 1415 and 1416, conductor 1224, right contacts of cam 1223, conductor 1262, middle right contact of relay 1339, inner right back contact of relay 1320, con-

ductor 460, outer right back contact of relay 458, conductor 862, lower right and left contacts of cam 813, right contacts of cam 809 to ground. The fundamental tip conductor is connected over the left back contact of relay 1313, inner right front contact of relay 1339, outer left back contact of relay 1320, conductor 1342, inner right back contact of relay 458, left back contact of relay 453, conductor 464, lower contacts of cam 802, conductor 803, upper left contact of cam 1227 to ground at cam 1204. Both fundamental conductors are thus grounded while switch 800 is passing from position 16½ to position 16¾ and the tip fundamental conductor is then opened as switch 800 passes from position 16¾ to position 17¼. From position 17 to position 18¼ the ring fundamental extends as traced over the outer right back contact of relay 458, right back contact of relay 453, conductor 463 to ground over the lower contacts of cam 859 and the tip fundamental extends as traced over the inner right back contact of relay 458, left back contact of relay 453, conductor 464, left contacts of cam 823, conductor 824, resistance 462 to battery thus generating a heavy positive impulse. In passing through positions 19 and 20 the fundamental circuit is opened. As switch 800 reaches position 18¾ with relay 454 released, a circuit is established from battery through the windings of counting relays 400, 401 and 402, conductor 403, left contacts of cam 863, conductor 864, left back contact of relay 454, conductor 807, lower contacts of cam 801 to ground. These relays operate and lock to ground at the lower contact of cam 1209. From this point the sender functions as previously described to operate the cut-through relay 307 of the trunk of Fig. 3 after which the sender is released as previously described.

Assistance calls requiring a local district selector

For this type of call the operator tests and connects with an idle trunk of the type disclosed in Fig. 16 thereby operating relay 1600 over the lower left and upper right contacts of cam 1601 and the sleeves of jack 1602 and plug 121. Relay 1600 locks over its upper front contact directly to the sleeve of jack 1602 and prepares a circuit for lighting the group busy lamp 1603 when all trunks of the group are busy. When the plug 121 is fully inserted into jack 1602, relay 1604 operates in a circuit extending from battery through its winding, the upper contacts of cam 1605, conductor 1632, tips of jack 1602 and plug 121, upper alternate contacts of relay 122, conductor 132, upper normal contacts and winding of relay 215 to ground at the upper contact of relay 211. Relay 1604 operates, but due to the high resistance of its winding relay 215 does not receive sufficient current to operate. Relay 1604 with relay 1600 operated, closes a circuit from battery, upper winding of relay 1606, contact of relay 1604, conductor 1663, to ground at the lower front contact of relay 1600, relay 1606 upon operating locking over its upper winding and inner upper front contact, lower left and upper right contacts of cam 1607, upper right and lower left contacts of cam 1608, inner upper back contact of relay 1609 to ground on conductor 1663 and closing a circuit extending from battery, winding of magnet 1610, contact of cam 1611, upper left contact of cam 1612 to ground at the upper front contact of relay 1606 thus advancing sequence switch 1610 into position 2. Upon leaving position 1, the circuit of relay 1604 and the locking circuit of relay 1606 are opened and these relays release.

With sequence switch 1610 in position 2, relay 1613 operates in a circuit extending from battery through its winding, lower back contact of test relay 1614, left contacts of cam 1608, inner upper back contact of relay 1609 to ground on conductor 1663. At its lowermost contacts relay 1613 connects the two lower windings of test relay 1614 in a series circuit extending from battery through the middle winding of relay 1614, lower contacts of relay 1613, lower winding of relay 1614 to ground at the left contacts of cam 1615 thereby preparing the marginal test relay 1614 for operation, and connects the test brush 1616 of sender selector 1650 over the upper contacts of cam 1617, upper winding of relay 1614, lower contacts of relay 1613, lower winding of relay 1614 and thence as traced to ground at cam 1615.

It will first be assumed that the sender upon the terminals of which the brushes of selector 1650 are at the time standing is busy and that no operating circuit is therefore closed for relay 1614. A circuit is therefore closed from battery, winding of stepping relay 1618, lower contacts of cam 1619, back contact of stepping magnet 1620, upper front contact of relay 1613, upper back contact of test relay 1614, upper right and lower left contacts of cam 1608, upper back contact of relay 1609 to ground on conductor 1663. Relay 1618 operates connecting the winding of stepping magnet 1620 in a circuit extending over the upper contacts of cam 1621, upper front contact of relay 1618 to ground over the operating circuit of relay 1618, whereupon magnet 1620 energizes in turn opening the circuit of relay 1618 which releases, opening the circuit of magnet 1620 which in turn releases and advances the brushes of switch 1650 one step. In this manner through the alternate operation and release of relay 1618 and magnet 1620 the brushes of switch 1650 are advanced step by step until test brush 1616 engages the terminal of an idle sender when the previously traced circuit through

the upper and lower windings of test relay 1614 to the test brush 1616 will be completed, for example, over conductor 316, inner right back contact of relay 1000, left back contact of relay 1001 to battery through resistance 1002. Relay 1614 now receives sufficient current to operate and at its lower back contact opens the circuit of relay 1613 which releases and opens the circuit of stepping relay 1618 to arrest further movement of switch 1650. Relay 1614 locks from battery on conductor 316, over brush 1616, upper contacts of cam 1617, upper winding and upper front contact of relay 1614, upper right and lower left contacts of cam 1608, upper back contact of relay 1609 to ground on conductor 1663, the increased potential on the sender test conductor 316 marking the sender as busy to other sender selectors. Relay 1613 upon releasing also closes a circuit extending from battery, winding of magnet 1610, contact of cam 1611, lower right contact of cam 1622, upper back contact of relay 1613, lower front contact of relay 1614, left contacts of cam 1608, upper back contact of relay 1609 to ground on conductor 1663 advancing the sequence switch 1610 into position 3.

With the sequence switch in position 3 a circuit is closed from battery through the lower winding of marginal relay 1609 to the lower left contact of cam 1623, and from battery through the winding of sensitive relay 1624 to the lower right contact of cam 1623 and thence over the upper left contact of cam 1623, inner lower front contact of relay 1600, left contacts of cam 1625, brush 1626, conductor 321 and windings of relay 500 of the sender in series to ground. Relays 1624 and 500 operate, but relay 1609 being marginal does not because of the high resistance of the windings of relay 500. Relay 1624 upon operating closes an obvious circuit for relay 1627 which locks over its inner lower front contact and the right contacts of cam 1628 to ground after sequence switch 1610 reaches position 11 and until it leaves position 14. At the sender upon the operation of relay 500, relays 700, 1302, 1001, 1300, 1100, 1304 and 1400 operate as previously described in connection with the first class of call discussed, relay 1001 upon operating, removing battery from test conductor 316 thus releasing relay 1614. Relay 1614 upon releasing closes a circuit for advancing sequence switch 1610 into position 4 extending from battery, winding of magnet 1610, contact of cam 1611, upper left contact of cam 1622, upper back contact of relay 1614, upper right and lower left contacts of cam 1608, upper back contact of relay 1609 to ground on conductor 1663. Neither of the trunk class register relays 900 or 905 operate for this type of call and consequently relays 902, 903, 911, 1306, 1500 and 1501 do not operate as previously described.

With relay 1001 operated and relay 900 not operated, a circuit is established from battery, windings of transfer relays 511 and 514 in series, back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, inner right back contact of relay 505, conductor 506, inner left front contact of relay 1001 to ground. Relays 511 and 514 lock in series over the back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, outer right front contact of relay 511, conductor 506 to ground, the operation of transfer relays 511 and 514 indicating that the first digit keyed by the operator will be registered on the first or A code register. With relay 511 operated, the previously traced circuit for relay 505 is established, relay 505 opening the initial operating circuit of relays 511 and 514. When relay 1300 operates the fundamental tip conductor 319 and the fundamental tip conductor 323 are disconnected from the windings of relays 900 and 905 and are made free for fundamental selections.

With sequence switch 1610 in position 4 the fundamental tip conductor 319 is extended over brush 1629, left contacts of cam 1628, inner upper contact of relay 1627, upper left contact of cam 1607, upper left contact of cam 1630, upper winding of control relay 1606 to battery and the operator's keyset is connected over tip trunk conductor 1632, upper right and lower left contacts of cam 1605, brush 1633 to conductor 329 in the sender and over ring trunk conductor 1634, upper contacts of cam 1635, brush 1636 to conductor 332. Relay 407 in the sender now operates over conductors 1634 and 332 and causes the impulse relays 411, 412 and 413 to be connected from 24-volt battery over conductors 329 and 1632 and impulse relays 421, 422 and 423 to be connected from 24-volt battery over conductors 332 and 1634 to the keyset in the manner previously described. The connection established from battery through the windings of relays 411, 412 and 413 now causes the operation of relays 215 and 217 and the lighting of lamp 221 at the keyset as an indication that the sender is ready to receive impulses from the keyset.

It will be assumed that the operator keys a three-digit code for establishing a connection with another operator's position which is to be reached over the brushes of the district selector 1660 and the brushes of office selector 1670. The depression of keys of keyset 214 now causes the setting of relays of the A, B, and C code registers in the manner previously described. As soon as the three-code digits have been registered and relay 600 operates, the previously traced circuit for relay 509 is closed and relay 509 operates, locking to conductor 506 and closing a holding circuit for relay 505 which has been previously operated. Relay 509 also connects battery to conductor 1334, as previously described, for causing the connection of a de-

coder with the sender whereupon the office code registered is transfered to the decoder. The decoder now translates the office code and determines therefrom that the desired call is for a connection to an operator's position involving the setting of district selector 1660 and office selector 1670 and causes the setting of certain of the compensating resistance register relays 1413 to 1417 inclusive, over the group of conductors 627, the setting of class register relay 1405 which in turn operates relays 1442 and 1006 and the setting of relays of the district brush and group, and office brush and office group register relays. In this case since district selections are to be made relay 502 is not operated from the decoder and since office selections are also to be made, relay 1440 is operated from the decoder over conductor 1441 and locks over its left winding and left front contact to ground on conductor 1254 as soon as relay 1306 operates and until sequence switch 1200 leaves position 7.

After an interval to allow the register relays of the sender to be operated from the decoder, the decoder connects ground over conductors 628 and 1502 to battery through the winding of relay 1501 which operates and locks over its inner left front contact to ground on conductor 1303 and extends its locking ground over conductor 1308 to battery through the winding of relay 1306 thereby causing the operation of relay 1306. Relay 1306 upon operating causes the release of the decoder, prepares locking ground for operated relays of the district brush and group and office brush and group register relays and opens the circuit of relay 1400 which now releases, all in the manner previously described. With relay 1400 released and relay 502 not operated, no circuit is established for relays 400, 401 and 402 and consequently control switch 1200 remains in position 1 in which the fundamental circuit is established for controlling district brush selection. It will be assumed that for this type of call the class register relays 1405, 1442 and 1006, compensating resistance register relays 1413 and 1415 have been operated and locked and that no district brush, district group, office brush or office group register relays have been operated.

With control switch 1200 in position 1, and sequence switch 1610 in position 4 the fundamental circuit is now completed from the winding of control relay 1606 of the district selector as traced to conductor 319, thence over the left back contact relay 1313, outer left back contact of relay 1312, conductor 1314, upper contacts of cam 1219, conductor 1231, winding of relay 1315, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, conductor 1348, resistance 941, outer left back contact of relay 911, inner left back contact of relay 902, conductor 932, right back contact of relay 502, conductor 507, back contact of relay 1400, conductor 1401, outer left front contact of relay 1306, conductor 1203, left contacts of cam 1202 to ground on conductor 1303. Relays 1315 and 1606 operate over this circuit, relay 1606 locking over its inner upper front contact and the left contacts of cam 1607 to the fundamental tip and closing a circuit for advancing sequence switch 1610 into position 5. This circuit may be traced from battery, winding of magnet 1610, contact of cam 1611, upper left contact of cam 1612 to ground at the upper front contact of relay 1606. As switch 1610 leaves position 4, relay 1606 remains operated over its locking circuit and closes a circuit with switch 1610 in position 5 extending from battery, through the winding of up-drive magnet 1637, right contacts of cam 1638 to ground at the upper front contact of relay 1606 for advancing the district selector brushes in a brush selection movement. As the brushes advance an intermittent shunting ground is connected to the tip fundamental over the lower contacts of cam 1607, commutator segment 1639, brush 1640, upper right contact of cam 1641 to ground at the lower left contact of cam 1615 for holding relay 1606 operated and for intermittently shunting down the sender stepping relay 1315.

In the sender upon the operation of relay 1315 a circuit is established from ground at the lower left contact of cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, upper contacts of cam 1258, conductor 1238, left back contact of district brush register relay 1410, outer right back contact of register relay 1409, outer right back contact of register relay 1407, conductor 1423, left contacts of cam 1239, conductor 1240 to battery through the winding of the No. 0 counting relay 400. Relay 400 operates and locks as previously described through the windings of relay 401 and 402 and when stepping relay 1315 deenergizes in response to the first shunting impulse from the district selector relays 401 and 402 operate in the locking circuit of relay 400, relay 401 opening the fundamental circuit thereby releasing the district selector control relay 1606. Relay 1606 upon releasing opens the circuit of the up-drive magnet 1637 to arrest the brush shaft in position to trip the first set of brushes thereof and closes a circuit for advancing sequence switch 1610 into position 6. This circuit extends from battery, winding of magnet 1610, contact of cam 1611, lower left contact of cam 1612 to ground at the upper back contact of relay 1606. At the sender upon the operation of relay 402 a circuit is established as previously traced for

advancing sequence switch 1200 into position 3.

Since it has been assumed that a distant office selector 1670 is to be employed in the connection and relays 1405 and 1440 have been operated, when switch 1200 reaches position 2 a circuit is closed for relay 1420 extending from battery, winding of relay 1420, right front contact of relay 1440, conductor 1443, left and upper right contacts of cam 1265, conductor 1266, inner right front contact of relay 1405, left back contact of relay 1412, conductor 1254, upper contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306. Relay 1420 locks to ground on conductor 1254.

With sequence switch 1610 in position 6 and sequence switch 1200 in position 3 the fundamental circuit is again established and relays 1606 and 1315 both operate, relay 1606 upon operating locking over the fundamental circuit and closing the previously traced circuit for moving sequence switch 1610 out of position 6 into position 7. In position 7 the circuit of up-drive magnet 1637 is again closed thereby advancing the selector brushes in a group selection movement. Since trip magnet 1642 operated in a circuit extending over the upper left contact of cam 1641 and the lower left contact of cam 1615 as soon as switch 1610 reached position 6, the first set of brushes is tripped during the initial portion of the group selection movement of the brush shaft. As the brush shaft advances the sender stepping relay 1315 is intermittently shunted over a circuit extending from the upper left contact of cam 1607, upper right contact of cam 1630, commutator segment 1643, brush 1644, upper right contact of cam 1641 to ground at cam 1615.

In the sender upon the operation of relay 1315 a circuit is established from ground at the lower left contact of cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, right contacts of cam 1258, conductor 1263, back contacts of district group register relays 1516, 1517 and 1518, conductor 1423, upper left and lower right contacts of cam 1239, conductor 1264, back contact of district group register relay 1519, conductor 1240 to battery through the winding of the No. 0 counting relay 400. Relay 400 operates and locks as previously described through the windings of relays 401 and 402 and, when stepping relay 1315 deenergizes in response to the first shunting impulse from the district selector, relays 401 and 402 operate, relay 401 opening the fundamental circuit thereby releasing the district selector control relay 1606. Relay 1606 upon releasing opens the circuit of the up-drive magnet 1637 to arrest the selected set of brushes in position to hunt over the first group of trunks to which it has access and closes the circuit previously traced for advancing sequence switch 1610 into position 8.

In position 8 relay 1606 operates in a circuit extending from battery through its lower winding, lower left contact of cam 1630, upper right contact of cam 1607, upper right and lower left contacts of cam 1608, upper back contact of relay 1609 to ground on conductor 1663 closing the previously traced circuit for advancing sequence switch 1610 into position 10. After leaving position 9 relay 1606 is held operated over its upper winding and inner upper front contact, upper contacts of cam 1645, brush 1646 to ground on the sleeve terminal of the first trunk of the selected group, if such a trunk is busy. It will be assumed that it is busy and that when sequence switch 1610 reaches position 10, relay 1606 is locked operated thereby closing the previously traced circuit for up-drive magnet 1637. Magnet 1637 now causes the switch shaft to be advanced in a trunk selection movement. As soon as an idle trunk is encountered this locking circuit of relay 1606 is opened and until the selector brushes are centered on the terminals of the idle trunk, relay 1606 is maintained locked over its lower winding, lower contacts of cam 1630, centering commutator segment 1647, brush 1648, left and lower right contacts of cam 1638 to ground at the upper front contact of relay 1606. As soon as the brushes are centered, relay 1606 releases opening the circuit of up-drive magnet 1637 and closing the previously traced circuit for advancing sequence switch 1610 into position 11. In position 11 relay 1606 again operates over its lower winding and lower contacts of cam 1615 and closes the previously traced circuit for advancing sequence switch 1610 out of position 11 into position 12, relay 1606 deenergizing as soon as the switch leaves position 11. With switch 1610 in position 12 the tip fundamental conductor 319 is extended over brush 1629, upper front contact of relay 1627, right contacts of cam 1649, brush 1651 and thence to battery through the control relay of the office selector 1670 and the ring fundamental conductor 323 is extended over brush 1631, lower front contact of relay 1627, lower left and upper right contacts of cam 1652, brush 1653 to ground at the office selector.

At the sender upon the operation of relay 402 at the end of district group selection a circuit is established from its contact, over conductor 404, outer left back contact of relay 1402, conductor 1403, upper right and lower left contacts of cam 1208, conductor 508 to battery through the left winding of relay 1311 and in parallel over the back contact of relay 502, conductor 1214, outer right back contact of relay 1500, conductor 1521, right normal contacts of relay 1108 to battery through the winding of slow-to-release

relay 1109. Relay 1109 operates and closes an obvious circuit for slow-to-release relay 1108 which after an interval operates and locks over its right alternate contacts to ground on conductor 1521 opening at its right normal contacts the operating circuit of relay 1109. After an interval relay 1109 releases, closing a circuit from ground at its back contact, left alternate contacts of relay 1108, conductor 1215, conductor 1212, upper right contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 for advancing switch 1200 into position 4. The delay introduced through the operation of relays 1108 and 1109 allows sufficient time to permit the district selector 1660 to hunt for an idle trunk in the selected group before switch 1200 is advanced into position 4 for making a test of the selected trunk. Upon the advance of switch 1200 out of position 3¼ the locking circuit of the operated counting relays is opened at the lower contacts of cam 1209, relay 402 upon releasing in turn releasing relays 1108 and 1109 and relay 401 upon releasing again closing the fundamental circuit. Relay 1311 also operates and locks over its right winding and contacts, inner left back contact of relay 1312 to ground on conductor 1503, removing the shunt from the left winding of relay 1317.

Office trunk test

The fundamental circuit may now be traced from battery through the control relay of the office selector (not shown) thence as traced to conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper right and lower left contacts of cam 1219, conductor 1012, resistance 1218, lower left and upper right contacts of cam 1221, conductor 1222, back contact of relay 1417, conductor 1418, winding of trunk test relay 1344, conductor 1316, back contact of relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of compensating resistance relay 1413, resistance 1428, back contact of relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, thence as traced to ground at the office selector. Relay 1344 operates if the trunk is in operable condition and in turn causes the operation of relays 1319 and 1320 as previously described. Relay 1320 upon operating closes a circuit for relay 1312 over conductor 1322, upper right and lower left contacts of cam 1228, conductor 1229, outer right front contacts of relay 1320 to ground on conductor 1303. Relay 1312 upon operating releases relay 1311 to again shunt the left winding of relay 1317 and establishes a new fundamental circuit traceable, as previously described, from the tip fundamental conductor 319, left back contact of relay 1313, the outer left front contact of relay 1312, conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of relay 1413, resistance 1428, back contact of relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313 to the ring fundamental conductor 323 to ground at the office selector. The operation of relay 1312 is effective at this time to remove the trunk test relay 1344 and resistance 1218 from the fundamental circuit thereby reducing the resistance of the circuit to such a degree as to cause the operation of the control relay of the office selector and the operation of stepping relay 1315 of the sender. Relay 1344 now releases. The sender is now in condition for controlling the office selector in its brush and group selection movements.

Since the control of the office selector in its brush and group selection movements is made in substantially the same manner as in the second type of call previously discussed, it will not be described in detail except to state that since no office brush register relays or office group register relays have been operated as assumed, the office selector is controlled in positions 4 and 6 of the control switch 1200 to select the first set of brushes and the first brush group accessible thereto. Following the completion of the office group selection control sequence switch 1200 is advanced into position 7 for trunk test under the control of relays 402, 1108 and 1109, as previously described. The fundamental circuit for trunk test is the same as previously traced for office trunk test and if the trunk selected by the office selector is in operable condition, trunk test relay 1344 operates, followed by the operation of relays 1319 and 1320 as previously described. Since, however, relay 1006 has been operated, when relay 1320 operates relay 1312 is not operated but a circuit is established extending from battery, winding of relay 458, conductor 465, outer right front contact of relay 1420, conductor 1421, left contacts of cam 1228, conductor 1229, outer right contacts of relay 1320 to ground on conductor 1303. Relay 458 operates and locks over its inner left front contact to ground on conductor 1303 and closes a circuit extending from battery, winding of relay 1339, left back contact of relay 1331, conductor 1348, outer left contact of relay 458 to ground on conductor 1303. Relay 1339 upon operating closes a circuit from battery through the winding of magnet 1200, contacts of cam 1201, lower left contacts of cam 1211, conductor 1261, outer left front contact

of relay 1339 to ground at the back contact of relay 1317 for advancing switch 1200 out of position 7 into position 17.

As switch 1200 leaves position 9, relay 1320 releases and the fundamental circuit is established from battery on conductor 702, resistance 462, inner right front contact of relay 458, conductor 1342, outer left back contact of relay 1320, inner right front contact of relay 1339, left back contact of relay 1313, fundamental tip conductor 319, thence to the office selector, returning over fundamental ring conductor 323, right back contact of relay 1313, conductor 1226, right contacts of cam 1225, conductor 1419, back contact of relay 1416, resistance 1429, right front contact of relay 1415, conductor 1224, right contacts of cam 1223, conductor 1262, middle right front contact of relay 1339, inner right back contact of relay 1320, conductor 460, outer right front contact of relay 458 to ground for advancing the office selector in the well known manner. Upon reaching position 12 a circuit is established for operating relay 1313 extending from battery, winding of relay 1313, right contacts of cam 1265, conductor 1266, inner right contact of relay 1405, left back contact of relay 1412, conductor 1254, upper contacts of cam 1206, conductor 1207 to ground at the right front contact of relay 1306. Relay 1313 locks to ground on conductor 1303 and opens the fundamental circuit. When switch 1200 reaches position 17, a circuit is closed for relay 1328 over the front contact of relay 1304, conductor 1329, upper left and lower right contacts of cam 1245, conductor 1403 to ground at the left front contact of relay 1313. Relay 1328 upon operating extends its operating ground to battery through the winding of relay 1305 which locks over its left front contact to ground on conductor 1303, locking relay 1328 operated and opening the circuit of relay 1304 which now releases. With relay 1305 operated and relay 1304 released ground on conductor 1303 is extended over the left front contacts of relays 1305 and 1328, normal contacts of relay 1304, right front contact of relay 1305, right back contact of relay 1331, conductor 1332, to battery through the winding of relay 910. Relay 910 upon operating locks over its right contact to ground on conductor 1303 and at its left back contact opens the shunt around the high resistance left winding of relay 500. The current now flowing from ground through the windings of relay 500 over conductor 321, brush 1626 and thence as previously traced to battery in parallel through the windings of relays 1624 and 1609, is not of sufficient strength to maintain relay 1624 operated and it releases.

Relay 1624 upon releasing closes a circuit from battery, upper winding of relay 1606, upper back contact of relay 1624 to ground over the upper right and lower left contacts of cam 1615, relay 1606 upon operating closing a circuit from ground at its upper front contact, upper left contact of cam 1612 to battery through the winding of magnet 1610 for advancing sequence switch 1610 out of position 12 into position 15. As sequence switch 1610 leaves position 14 the conductors extending to the sender are opened and the sender is released in the manner previously described. With sequence switch 1610 in position 15 the talking circuit is extended from the operator's cord circuit over conductor 1632, upper contacts of cam 1649, tip brushes of district selector 1660 and office selector 1670, and over ring conductor 1634, the upper contacts of cam 1652 and ring brushes of district selector 1660 and office selector 1670 to the distant operator's position.

If the call keyed by the operator had not required the use of a distant office selector such as 1670, then relays 1440 and 1420 would not have been operated and skip office relay 1500 would have been operated from the decoder. Consequently, sequence switch 1200 passes from position 3 to position 7 in the manner previously described and in response to the trunk test which is made in position 7, relays 1344, 1319 and 1320 operate, relay 1320 establishing a circuit for relay 451 extending over conductor 452, conductor 1349, right back contact of relay 1412, conductor 1434, outer right front contact of relay 1006, conductor 1013, right back contact of relay 1420, conductor 1421, left contacts of cam 1228, conductor 1229, outer right front contacts of relay 1320 to ground on conductor 1303. Relay 451 operates locking to ground on conductor 1303 and closing a circuit from battery, winding of magnet 1200, lower left contact of cam 1211, conductor 1261, conductor 1267, right front contact of relay 451, conductor 466 to ground at the back contact of relay 1317 for advancing switch 1200 from position 7 into position 17. From this point, the circuit functions in the manner previously described.

Upon the termination of the conversation, the operator withdraws plug 121 from jack 1602 thereby releasing relay 1600 which closes a circuit from ground at its lower back contact, upper left and lower right contacts of cam 1654, lower back contact of relay 1624, upper right contact of cam 1622 to battery through the winding of magnet 1610 for advancing switch 1610 into position 18. As switch 1610 leaves position 16¼, ground is removed from district test brush 1646 at the lower left contact of cam 1645. In position 18, the circuit of down-drive magnet 1655 is established over the upper contacts of cam 1656 to ground at the back contact of relay 1600 and the district selector shaft is driven into normal position where a circuit is established from battery, winding of magnet 1610, lower left contact of cam 1622, normal commutator segment 1657, brush 1648, upper right contact of cam 1641 to ground at cam

1615 for advancing sequence switch 1610 into normal position. The circuits of the district selector are now in normal condition. Other selectors which may have been used in the establishment of the connection are restored to normal in the well known manner.

In the foregoing description it was assumed that the operator keyed a connection to another operator's position involving the employment of district selector 1660 and a distant office selector 1670. It is to be understood that the operator might have keyed a full mechanical number which would require the use of district selector 1660 with or without a local office selector and incoming and final selectors or keyed a call to a manual position equipped with a call indicator.

Overflow and tell-tale conditions—District selector goes to tell-tale

The operation of the sender in successfully completing a connection of each class of call having been described, consideration will now be given to connections which are not completed on account of some irregularity and first, those which fail because a selector shaft runs to an overflow terminal on account of all trunks being busy or to a tell-tale position because some trouble arises in the operation of the apparatus or circuits. These conditions will be considered in the order of their occurrence in the advance of selection control switch 1200.

If the shaft of district selector 1660 goes to tell-tale in making brush or group selections, that is, with sequence switch 1610 in either position 5 or 7, a circuit is established from battery through the winding of magnet 1610, lower right contact of cam 1612, tell-tale commutator segment 1658, brush 1640, upper right contact of cam 1641, to ground at cam 1615 for advancing switch 1610 into position 8. In position 8 a circuit is closed from battery, lower winding of relay 1606, lower left contact of cam 1630, upper right contact of cam 1607, upper right and lower left contacts of cam 1608, back contact of relay 1609 to ground on conductor 1663. Relay 1606 operates and advances sequence switch 1610 to position 9, sequence switch 1610 being then advanced into position 17 over a circuit extending from battery through the winding of magnet 1610, lower right contact of cam 1612, segment 1658, brush 1640, upper right contact of cam 1641, to ground at cam 1615. When sequence switch 1610 leaves position 14, the conductors extending to the sender are opened and the sender restores as previously described.

With sequence switch 1610 in position 17 interrupted ground is applied over the lower contacts of cam 1617 through the winding of stepping relay 1618 to battery, thereby intermittently operating relay 1618. On the first operation of relay 1618, 48-volt battery is connected over the lower contacts of cam 1621, resistance 1660, inner front contact of relay 1618, right contacts of cam 1635, to ring trunk conductor 1634 and over the lower contacts of cam 1621, upper contact of relay 1618, resistance 1659, right contacts of cam 1605 to the tip trunk conductor 1632. If the keyset is still connected with the cord circuit and relay 122 of the cord circuit is still operated, trunk conductors 1632 and 1634 are extended over alternate contacts of relay 122 to 24-volt battery through the windings of polarized relays 234 and 233, respectively. These relays then operate, in turn operating relay 235 which locks to ground at the contacts of relay 211 and locks relay 234. When relay 1618 releases, relay 233 releases and with relay 235 operated the keyset is released and in turn releases relay 122 as previously described. Relay 1618 upon releasing also connects 24-volt battery through resistance 1661, back contact of relay 1618, right contacts of cam 1635 to the ring trunk conductor 1634 and ground from cam 1615 over the lower right contact of cam 1641, upper contacts of cam 1619, resistance 1662, resistance 1659, right contacts of cam 1605 to the tip trunk conductor 1632, the trunk conductors 1632 and 1634 then extending at the cord circuit with relay 122 released through the winding of polarized supervisory relay 134. Relay 134 is thus operated and closes the previously traced circuit for relay 130 which operates in turn opening the circuit of supervisory lamp 129. When relay 1618 again operates, relay 134 releases in turn releasing relay 130 to relight lamp 129. Thus, due to the intermittent operation of relay 1618, the cord supervisory lamp 129 is flashed as a reorder signal that the operator should pull down the connection and try again to establish the connection with another district selector trunk. When the cord circuit plug 121 is removed from jack 1602, relay 1600 releases and the district selector circuit is returned to normal as previously described.

District selector goes to an overflow position

If the district selector shaft goes to an overflow terminal in hunting for an office selector in position 10 of sequence switch 1610, relay 1603 releases since ground is not connected to the overflow sleeve terminal with which brush 1646 engages and sequence switch 1610 is thereby advanced into position 11. From position 11, switch 1610 is now advanced into position 17 over a circuit extending from battery, winding of magnet 1610, upper right contact of cam 1612, segment 1639, brush 1640, upper right contact of cam 1641 to ground at cam 1615. With sequence switch 1610 in position 17, the keyset is dismissed if

it is still connected and the cord supervisory lamp 129 is flashed as a recorder signal through the intermittent operation of relay 1618 as previously described in connection with the establishment of the tell-tale condition. As switch 1610 leaves position 14, the sender is released as previously described.

Office selector goes to tell-tale position

If an office selector has been employed in an established connection having been seized either by the district selector 1600 of Fig. 16 or over the trunk circuit of Fig. 3 and goes to the tell-tale position in making brush selection, with control switch 1200 of the sender in position 4, or in making group selection with switch 1200 in position 6, and is of the type which does not return reversed battery over the fundamental circuit in that condition, the sender times out as hereinafter described, advances the district or trunk circuit to the reorder position and releases. If the office selector is of the type which sends reversed current, stepping relay 1315 and overflow relay 1317 of the sender function in the same manner as will be described in connection with the advance of the office selector to an overflow terminal in hunting for an idle trunk.

Office selector goes to overflow position

If the office selector goes to an overflow terminal while hunting for an idle trunk, it transmits reversed current over the fundamental circuit to the sender and with sender control switch 1200 in position 7 the trunk test relay 1344 operates in turn operating relays 1319, 1320 and 1312 as previously described if the call was of the full mechanical type, relay 1312 removing the high resistance 1218 and the winding of trunk test relay 1344 from the fundamental circuit and connecting the winding of stepping relay 1315 into the fundamental circuit as previously described. The resistance of the fundamental circuit is now reduced to such an extent that stepping relay 1315 and overflow relay 1317 operate on the reversed current. Relay 1317 upon operating locks over its right winding, conductor 1327, upper left and lower right contacts of cam 1249, conductor 1250 to ground at the front contact of relay 1317 and extends its locking ground over the right contacts of cam 1249 and conductor 1251 thereby operating relay 1402 and, over the lower left contact of cam 1249, conductor 1268, winding of relay 1331 to battery on conductor 702. Relay 1331 upon operating locks to ground at its inner left front contact and establishes a circuit from battery, winding of relay 1113, conductor 1114, outer left front contact of relay 1331, conductor 1115, left normal contacts of relay 1108 to ground at the back contact of relay 1109. Relay 1113 operates, connects locking ground to conductor 1115 and establishes a circuit for relay 1109 extending from ground at its right contacts over the right normal contacts of relay 1108. Relay 1109 operates closing an obvious circuit for relay 1108 which, after an interval operates, locking to ground at the front contacts of relay 1113 and opening the circuit of relay 1109 which, after an interval, releases. With relay 1113 operated and relay 1109 released, a circuit is closed from ground at the back contact of relay 1109, left alternate contacts of relay 1108, left contact of relay 1113, conductor 1116, lower right contact of cam 1211, winding of magnet 1200 to battery for advancing the control switch 1200 into position 9.

If the office selector has been used to establish a connection to an operator's position, in response to the keying of an operator's code or in response to the keying of a code indicating a call indicator connection, then when the trunk test relay 1344 operates with control switch 1200 in position 7 and relay 1320 operated, relay 1312 is not operated. In this case, the fundamental circuit does not include resistance 1218 and therefore relay 1317 operates in series with relay 1344 in response to reversed battery over the fundamental circuit and following the operation of relay 1317, relays 1331, 1113, 1109 and 1108 operate to advance control switch 1200 into position 9 as just described. On a call indicator class of call relay 1339 may momentarily operate in the manner hereinbefore described when relay 1320 operates but it releases as soon as relay 1331 operates. On an operator's class of call, relay 1320 will cause the operation of relay 451 but this has no effect at this time.

Relay 1331 upon operating maintains the fundamental circuit closed over the upper contacts of cam 1230 and its right front contact, while control switch 1200 advances from position 4 to 7¾. After switch 1200 leaves position 7¾, the fundamental circuit is opened releasing stepping relay 1315. The operation of relay 1315 with relay 1402 operated causes the operation of counting relay 400 over a circuit extending from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, contacts of cam 1235, conductor 1236, front contact of relay 1402, conductor 1240 to battery through the winding of relay 400. Relay 400 operates and locks through the windings of relays 401 and 402, relays 401 and 402 operating as soon as relay 1315 releases. Relay 402 upon operating closes a circuit from ground at its contact over conductor 404, outer front contact of relay 1402, conductor 1426 to battery through the winding of relay 1313 which operates, locking to ground on conductor 1303, permanently opening the fundamental circuit and closing

a circuit extending from ground at its left front contact over conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200 for advancing switch 1200 into position 17. With switch 1200 in position 17 and relay 1313 operated, a circuit is closed for relay 1328 over the front contact of relay 1304, conductor 1329, upper left and lower right contacts of cam 1245, conductor 1403, to ground at the inner left front contact of relay 1313. Relay 1328 extends its operating ground to battery through the winding of relay 1305, which locks itself and relay 1328 to ground on conductor 1303 and opens the circuit of relay 1304 which releases.

Relay 1331 also closes a circuit extending from ground at its inner left front contact, conductor 1350, right front contact of relay 901, conductor 933, outer right front contact of relay 408, inner right back contact of relay 406, conductor 467 to battery through the winding of relay 934. Relay 934 operates, closing a shunt from ground at its left contact, conductor 935 to ground through the right winding of relay 500 and, since the high resistance left winding of relay 500 is at the time shunted by the left back contact of relay 910, the resistance of relay 500 is reduced to 5 ohms whereby the current flowing over conductor 321 to battery through the windings of relays 1609 and 1624 is increased to such an extent as to cause the operation of marginal relay 1609 of the district selector. Relay 1609 upon operating locks over its upper winding and upper front contact to ground on conductor 1663 and closes a circuit from ground at its upper front contact, left contacts of cam 1656, upper left and lower right contacts of cam 1654, lower front contact of relay 1624, upper winding of relay 1614, upper contacts of cam 1617, brush 1616, conductor 316, back contact of relay 1000, outer left front contact of relay 1001, conductor 1025, inner right front contact of relay 505, conductor 536, to battery through the left winding of relay 1444. Relay 1444 operates, in turn operating relays 1404 and 1437. Relay 1404 also closes a circuit extending from battery, winding of relay 910, conductor 1332, right front contact of relay 1404, conductor 1445, right front contact of relay 1305, normal contacts of relay 1304, thence to ground on the locking circuit of relay 1305. Relay 910 upon operating locks over its right front contact and at its left back contact opens the shunt around the left high resistance winding of relay 500.

The current now flowing from ground through the windings of relay 500 and winding of relay 1624 is not sufficient to hold relay 1624 operated and it releases. With relay 1609 operated, and relay 1624 released, a circuit is established for advancing sequence switch 1610 into position 17 extending from battery, winding of magnet 1610, upper right contact of cam 1622, lower back contact of relay 1624, lower right and upper left contacts of cam 1654, left contacts of cam 1656 to ground at the upper contact of relay 1609. When relay 1624 releases and switch 1610 passes beyond position 13, the sender is released and when switch 1610 reaches position 17, the cord supervisory lamp 129 is flashed as previously described as a reorder signal. In passing beyond position 16¼, the district selector brushes are disconnected and any switches beyond the district selector are released in the well-known manner. District selector 1660 releases as previously described as soon as the operator removes plug 121 from jack 1602.

If the office selector is one in which the trunk of Fig. 3 terminates directly, then when relay 934 operates as just described to shunt the right winding of relay 500, marginal relay 312 of the trunk circuit operates locking over its lower winding and lower front contact to ground at the upper contact of relay 308, connecting 24-volt battery through resistance 337, inner upper front contact of relay 312 to the ring trunk conductor 327 and connecting interrupted ground through interrupter 336, the upper front contact of relay 312, upper back contact of relay 307 to the tip trunk conductor 326. The connection of battery and interrupted ground to trunk conductors 327 and 326 causes the intermittent operation of the cord supervisory relay 134 and the flashing of lamp 129 as a reorder signal.

The operator upon noting the reorder signal will disconnect her cord circuit from the trunk jack 300 thereby releasing relay 304. Since relays 306 and 312 are now held operated from the sender, relay 308 does not release being held operated over its lower winding, inner lower normal contact of relay 307, inner upper front contact of relay 306, next to upper front contact of relay 310, to ground at the upper contact of relay 308. With relay 304 released and relay 303 held operated by relay 306, battery through resistance 338 is connected over the upper contact of relay 303 and the winding of relay 304 to the sleeve of jack 300 to make the trunk busy, and ground is connected from the lower back contact of relay 304, inner front contact of relay 310, resistance 339, brush 313, conductor 316, back contact of relay 1000, outer left front contact of relay 1001, conductor 1025, inner front contact of relay 505, conductor 536, right winding of relay 1444 to battery. Relay 1444 locks and causes the operation of relay 1404 and 1437. Relay 1404 upon operating closes a circuit extending from battery winding of relay 910, conductor 1332, right front contact of relay 1404, conductor 1445, right front contact of relay 1305, normal contacts of relay 1304, thence to ground on the locking circuit of

relay 1305. Relay 910 upon operating locks over its right front contact and at its left back contact opens the shunt around the left high resistance winding of relay 500.

The current now flowing from ground through the windings of relay 500 and the winding of relay 306 is not sufficient to hold relay 306 operated and it releases, in turn releasing relay 303 and opening the circuit of relays 308, 302 and 310 which release, relay 308 in turn releasing relay 312. The trunk is now restored to normal and upon the release of relays 302 and 310 the sender is dismissed and returns to normal.

Incoming selector goes to tell-tale or overflow

If an incoming selector is employed in the establishment of a connection and goes to the tell-tale position during brush selection with control switch 1200 of the sender in position 7, or during group selection with control switch 1200 in position 9, reversed current is sent over the fundamental circuit operating relays 1315 and 1317, followed by the operation of relays 1402 and 1331 as previously described in connection with office overflow. Relays 1113, 1109 and 1108 also operate but perform no useful function at this time, since, when relays 1315 and 1402 operate, relay 400 operates over a circuit from battery through its winding, conductor 1240, middle front contacts of relay 1402, conductor 1236, right and lower left contacts of cam 1235, conductor 1234, contact of relay 1315, conductor 1233, lower right contact of cam 1217 to ground at cam 1204, locking through the windings of relays 401 and 402. As the incoming selector advances out of the reversed battery position, relay 1315 releases permitting relays 401 and 402 to operate. A circuit is now established from ground at the contact of relay 402 over conductor 404, front contact of relay 1402, conductor 1426 to battery through the winding of relay 1313. Relay 1313 then advances control switch 1200 to position 17 as previously described. From this point the sender functions as previously described to advance the district selector of Fig. 16 to the reorder position for flashing the cord supervisory lamp 129 and for releasing the sender or for advancing the trunk circuit of Fig. 3 if the incoming selector is one which is connected directly to a trunk circuit of the type shown in Fig. 3 to the reorder position for flashing the cord supervisory lamp 129 and for releasing the sender in the manner previously described in connection with the advance of an office selector to overflow.

If the incoming selector goes to overflow during trunk hunting for a final selector with control switch 1200 in position 11, reversed current is transmitted from the incoming selector over the fundamental circuit and the sender functions in the same manner as described in connection with the advance of the incoming to tell-tale and the district selector of Fig. 16 or the trunk circuit of Fig. 3 is advanced to the reorder position dismissing the sender. If the final selector goes to tell-tale in making any selection the incoming selector is advanced in the well-known manner to momentarily send reversed current over the fundamental circuit just as previously described for a successful final units selection and the district selector of Fig. 16 or the trunk circuit of Fig. 3 is then advanced to the reorder position dismissing the sender.

Trouble conditions in the sender

Conditions in the sender will now be discussed which may arise when the sender operations do not progress fast enough to satisfy the sender time measure circuit due to failure of the operator to key at all, failure to complete keying, failure to depress the start key after all digits have been keyed or due to an apparatus or circuit trouble which prevents the sender from completing its work and clearing out after keying has been completed. The sender is provided for this purpose with two sets of timing circuits, one for measuring the allowable interval from the time the sender is seized until all the digits have been registered, and the other for measuring the allowable interval for making selections starting from the time all digits have been keyed. The first timing circuit consists of relays 1026, 1027, 1028 and interrupter 1029 and is started from relay 1001, when the sender is seized. The second timing circuit consists of relays 1123, 1030, 1031, 1032 and 1033 and interrupter 1034 and is started from the start relay 901 or from relay 1027 when operated.

As soon as relay 1001 operates following the seizure of the sender and interrupter 1029 closes its contacts, relay 1026 operates in a circuit extending over the back contact of relay 1027, contacts of interrupter 1029, outer left back contact of start relay 901, conductor 908, to ground at the inner right contact of relay 1001, locking through the winding of relay 1027, front contact of relay 1026 thence to ground at the front contact of relay 1001. Relay 1027 does not operate in this locking circuit until interrupter 1029 opens its contacts. Upon the operation of relay 1027 and the next closure of the interrupter contacts relay 1028 operates in a circuit extending over the front contacts of relay 1027, contacts of interrupter 1029, back contact of relay 901 to ground on conductor 908, locking over its outer right front contact to ground on conductor 908 independent of the interrupter contacts. If all digits have been registered and start relay 901 is operated before the above described operations are completed, relay 1028 does not operate and relays 1026 and 1027 release. If, however, the keying is not completed before relay 1028 operates and locks, relay 1028 closes a circuit

for relay 406, extending over the right normal contacts of relay 408, conductor 428 to ground at the inner left front contact of relay 1028. Relay 406, upon operating releases relay 407 which disconnects the impulse relays 411, 412, 413, 421, 422 and 423 from the tip and ring impulsing conductors 329 and 332 extending to the operator's keyset, connects conductor 329 through the inner left front contact of relay 406 to 48-volt battery through the winding of relay 408 and connects conductor 332 over the right front contact of relay 406 to 48-volt battery through resistance 429. As previously described, both polarized relays 233 and 234 in the keyset now respond to release the keyset, direct ground being connected at the keyset to conductor 329 thereby causing the operation of marginal relay 408. Relay 408 upon operating locks to ground applied to conductor 428 by relay 1028, opens the operating circuit of relay 407 to prevent its reoperation, releases relay 406 and closes a circuit extending from ground at the middle right front contact of relay 1028, conductor 933, outer right front contact of relay 408, inner right back contact of relay 406, conductor 467, winding of relay 934 to battery. Relay 934 upon operating shunts the right winding of relay 500 as previously described, and since the left winding of relay 500 is at this time also shunted at the back contact of relay 910, the resistance of relay 500 is reduced to such an extent that relay 312 of the trunk circuit of Fig. 3 or relay 1609 of the district selector of Fig. 16 operate depending on which trunk circuit has been used by the operator. The operator is thereupon given a reorder signal as previously described and the sender is dismissed.

When the start combination has been keyed and relay 901 is operated indicating that all digits have been keyed, a circuit is established for operating the relays of the second timing circuit. On the first closure of the contacts of interrupter 1034 a circuit is established from battery, resistance 1122, winding of relay 1123, right back contact of relay 1032, right back contact of relay 1030, contacts of interrupter 1034, conductor 1035 to ground at the inner left front contact of relay 901. Relay 1123 locks through the right winding of relay 1030, front contact of relay 1123 to ground on conductor 1035 but relay 1030 does not operate until the interrupter contacts open. On the next closure of the interrupter contacts, ground on conductor 1035 is extended through the interrupter contacts, right front contact of relay 1030, left back contact of relay 1032 to battery through the winding of relay 1031, relay 1031 then operating and locking through the winding of relay 1032, front contact of relay 1031 to ground on conductor 1035. On the next opening of the interrupter contacts relay 1032 operates in this locking circuit. If neither relay 1440 or 1339 is operated at this time indicating that the call does not involve a distant office selector or the transmission of call indicator code impulses, a circuit is now established for relay 1033 which may be traced from battery, winding of relay 1033, left front contact of relay 1030, conductor 1036, right back contact of relay 1440, conductor 1446, outer left back contact of relay 1339, conductor 1351, outer left front contact of relay 1032, outer back contact of relay 1000 to ground at the inner left front contact of relay 1001. If either relay 1440 or relay 1339 is operated, the circuit of relay 1033 is not established directly following the operation of relay 1032 as just described but is delayed until after the contacts of interrupter 1034 close and open again. This is brought about as follows: When the interrupter contacts close following the operation of relay 1032, a circuit is closed from ground on conductor 1035, interrupter contacts, right front contact of relay 1030, right front contact of relay 1032 to battery through the left winding of relay 1030 for holding relay 1030 operated and, over the inner left front contact of relay 1032, conductor 1037 to battery through resistance 1122, thus shunting relay 1123 and the right winding of relay 1030. Relay 1123 then releases. As soon as the interrupter contacts open again, the holding circuit of relay 1030 is opened and relay 1030 releases. A circuit is now closed for relay 1033 over the left back contact of relay 1030, outer left front contact of relay 1032, outer back contact of relay 1000 to ground at the inner left front contact of relay 1001 and relay 1033 operates. Thus, for calls involving a distant office selector or full mechanical tandem equipment a longer time interval is measured before relay 1033 operates.

When relay 1033 operates it closes a circuit for relay 934 extending over conductor 1038 to ground at the outer right front contact of relay 1033, relay 934 in turn shunting the right winding of relay 500 to cause the advance of the district selector trunk of Fig. 16 or the trunk of Fig. 3 to the reorder position and the release of the sender in the manner previously described. At its inner right front contact relay 1033 connects ground to contacts of interrupter 1029 thereby starting the operation of timing relays 1026, 1027 and 1028 which, after a period of thirty to sixty seconds lights the stuck sender lamp 1039 over a circuit extending from battery, lamp 1039, outer left front contact of relay 1028, to ground at the outer right contacts of relay 1033 if the sender does not restore in the meantime.

Operating errors

If the operator plugs into the trunk circuit of Fig. 3 when it is assumed to be terminated

directly in an incoming selector and keys more than the four digits necessary, the start combination is not registered on the stations register relays and consequently relay 715 is not operated. Since, for this type of call, the trunk class register relay 900 is operated and, in turn, has operated relay 902, then when relay 711 operates in response to the keying of the extra digits a circuit is established from ground at the right back contact of relay 905, outer left front contact of relay 902, conductor 936, left back contact of relay 715, right front contact of relay 711, conductor 736, right back contact of relay 1028, conductor 933, outer right front contact of relay 408, right back contact of relay 406, relay 408 having operated and released relay 406 due to the operation of start relay 901, conductor 467 to battery through the winding of relay 934. Relay 934 operates to shunt the right winding of relay 500 thus causing relay 312 of Fig. 3 to flash the cord supervisory lamp 129 as a reorder signal. The sender is then released as previously described.

If the operator plugs into the trunk circuit of Fig. 3 when it is assumed to be terminated directly in a full mechanical tandem district selector and keys only four digits, the first of which designates a three-letter office code and then keys the start combination, relays 606 and 607 operate and lock after the start key is released. When relay 901 operates in response to keying the start combination relay 1100 releases. Relay 1100 is slow to release to prevent a false operation of relays 708 and 711 over a circuit which may be traced from battery through the winding of relay 711, conductor 737, back contact of relay 1100, conductor 1119, middle left front contact of relay 902, inner right front contact of relay 911, relays 902 and 911 being operated on this type of call, conductor 937, outer right back contact of relay 523, conductor 537, left front contacts of relay 605, to ground on conductor 1303. With relay 711 not operated, relay 1306 operated due to the operation of relay 902 and relay 408 operated and relay 406 released due to the operation of start relay 901, a circuit is established from battery, winding of relay 934, conductor 467, inner right back contact of relay 406, outer right front contact of relay 408, conductor 933, right back contact of relay 1028, conductor 736, right back contact of relay 711, conductor 738, back contact of relay 1121, which releases following the release of relay 1100, conductor 1120, inner left back contact of class register relay 1405, conductor 1254, upper contacts of cam 1207, to ground at the outer right front contact of relay 1306. Relay 934 in the manner previously described advances the trunk circuit of Fig. 3 into the reorder position, after which the sender is released as previously described.

If only four digits are keyed, the first of which designates a two-letter office code and then the start combination is keyed, relays 703 and 705 are operated as soon as the start key is released as previously described, and relays 1100 and 1121 release to prevent the false operation of relays 708 and 711, relay 523 being operated at this time, and relay 934 is operated in the manner just described to advance the trunk circuit of Fig. 3 into the reorder position after which the sender is released.

If the operator plugs into a trunk circuit such as Fig. 3, terminating in a distant office selector in which case the trunk class register relay 905 and in turn relay 911 are operated, and then keys a code of a non-existing office, the error will be recognized by the sender due to the non-operated condition of relay 502, which for a legitimate code would have operated. The non-operated condition of relay 502 together with the operated condition of relays 905 and 911, prevents selections from starting and closes the circuit of relay 1352 extending over conductor 1353, outer left alternate contacts of relay 911, inner left back contact of relay 902, conductor 932, right back contact of relay 502, conductor 507, back contact of relay 1400, conductor 1401, left front contact of relay 1306, relay 1400 having released and relay 1306 having operated as soon as the decoder has transferred the translated office code to the sender, thence over conductor 1203, left contacts of cam 1202 to ground on conductor 1303. Relay 1352 upon operating closes a circuit from ground at its right contact over the outer right front contact of start relay 901, conductor 933, outer right front contact of relay 408, inner right back contact of relay 406, conductor 467 to battery through the winding of relay 934. Relay 934 as previously described, shunts the right winding of relay 500 thereby reducing the resistance in the circuit previously traced through the winding of marginal relay 312 of the trunk circuit to advance the trunk to the reorder position in which the cord supervisory relay 129 is flashed as a reorder signal in the manner previously described. The sender is then released.

If the operator, after plugging into a trunk circuit terminating in a distant office selector, keys a code which requires district selections, relay 502 is not operated and relay 1352 operates as just described to cause the trunk circuit to give the operator a reorder signal after which the circuits are released as previously described.

If the operator plugs into a trunk circuit terminating in a district selector, such as the trunk circuit of Fig. 16, and keys a number that requires a trunk terminating directly in an incoming selector, the first three digits of the number corresponding to an operator's

code, class register relays 1405 and 1442 are operated as previously described in connection with the operator type call previously discussed, and a circuit is established for relay 1447 extending over the outer contacts of relay 1442, conductor 1448, inner right back contact of relay 523, conductor 538, left front contacts of transfer relay 607 to ground on conductor 1303. With relay 1447 operated, a circuit is closed for relay 934 extending over conductor 467, inner right back contact of relay 406, outer right front contact of relay 408, which operated releasing relay 406 following the operation of start relay 901, conductor 933, right back contact of relay 1028, conductor 736, right front contact of relay 1447, conductor 1254, upper contacts of cam 1207 to ground at the outer right front contact of relay 1306. Relay 934 in the manner previously described, causes the advance of the district selector circuit of Fig. 16 to the reorder position dismissing the sender.

What is claimed is:

1. In a telephone exchange system a plurality of trunk circuits of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders and means in said sender operable in accordance with the character of the trunk circuit with which it is associated for determining whether said decoder associating means shall or shall not be operated.

2. In a telephone exchange system a plurality of trunk circuits of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, means in said trunk circuits for transmitting to an associated sender discriminating signals in accordance with the character of the particular trunk circuit with which the sender is associated, and means in said sender operable in response to the discriminating signals for determining whether said decoder associating means shall or shall not be operated.

3. In a telephone exchange system, a plurality of trunk circuits of different characters, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, means in said trunk circuits for transmitting to an associated sender discriminating signals in accordance with the character of the particular trunk circuit with which the sender is associated, means in said sender operable in response to the discriminating signals for determining whether said decoder associating means shall or shall not be operated, and means also operable in response to said signals for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuit.

4. In a telephone exchange system a plurality of trunk circuits of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, two impulsing conductors extending from said sender over said sender associating means to the trunk circuit with which said sender is associated, means in said trunk circuits for establishing circuits over either one, both or neither of said impulsing conductors in accordance with the character of the trunk circuit which is associated at the time with a sender, relays in said sender operable over said impulsing conductors, means controlled by said relays for determining whether said decoder associating means shall or shall not be operated and means also controlled by said relays for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuits.

5. In a telephone exchange system, a plurality of trunk circuit of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, a circuit extending from said sender over said sender associating means to be selected trunk circuit over which said connection extending means are controlled, said circuit comprising two conductors, means in said trunk circuits for establishing a discriminating condition on either one, both or neither of said conductors in accordance with the character of the trunk circuit which is associated at the time with a sender,

relays in said sender operable in response to said discriminating condition, means controlled by said relays for determining whether said decoder associating means shall or shall not be operated, and means also controlled by said relays for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuits.

6. In a telephone exchange system, a plurality of trunk circuits of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, a circuit extending from said sender over said sender associating means through the selected trunk circuit over which said connection extending means are controlled, said circuit comprising two conductors, means in said trunk circuits for grounding either one, both or neither of said conductors in accordance with the character of the trunk circuit which is associated at the time with a sender, relays in said sender operable selectively over said conductors, means controlled by said relays for determining whether said decoder associating means shall or shall not be operated, and means also controlled by said relays for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuits.

7. In a telephone exchange system, a plurality of trunk circuits of different character, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, a plurality of decoders common to said senders, means for associating an idle decoder with any one of said senders, conductors extending from said sender over said sender associating means to the selected trunk circuit over which said connection extending means are controlled, means in said trunk circuits for establishing discriminating conditions on said conductors in accordance with the character of the trunk circuit which is associated at the time with a sender, relays in said sender operable in response to said discriminating conditions, means controlled by said relays for determining whether said decoder associating means shall or shall not be operated, means also controlled by said relays for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuits, and means operable following the operation of said relays to dissociate said relays from said conductors and to render said conductors available for controlling said connection extending means.

8. In a telephone exchange system, a plurality of trunk circuits of different character, connection extending means accessible, respectively, from said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, and means in said sender operable in accordance with the character of the trunk circuit with which it is associated for modifying the circuits of said sender in accordance with the character of the connection to be established over said trunk circuit and over the connection extending means accessible therefrom.

9. In a telephone exchange system, a group of trunk circuits terminating directly in incoming selectors, a second group of trunk circuits terminating directly in office selectors, a third group of trunk circuits terminating directly in district selectors, a plurality of senders for controlling in succession, the setting of district, office and incoming selectors in the order named, means operable upon the seizure of any one of said trunk circuits for associating an idle one of said senders therewith, and means in said sender operable in accordance with the grouping of the trunk circuit with which it is associated for determining whether its district selector control functions or both its district selector and office selector control functions shall be omitted.

10. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits accessible to said cord circuit, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in an associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the designation registered in said sender, a time measuring means in said sender, and means controlled by said time measuring means for transmitting a reorder signal to said cord circuit if said sender fails to complete its control over said connection extending means within a predetermined interval.

11. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits accessible to said

cord circuit, connection, extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in an associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the designation registered therein, a time measuring means in said sender, and means controlled by said time measuring means for transmitting a reorder signal to said cord circuit if the registering means of said sender are not completely set from said operator's sending means within a predetermined interval.

12. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits accessible to said cord circuit, connection extending means operative over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in an associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the designation registered in said sender, means in said sender responsive to the failure of said connection extending means to properly respond to control from said sender, and means controlled by said last means for transmitting a reorder signal to said cord circuit.

13. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits accessible to said cord circuit, selector switches operable over said trunk circuits, said switches having selection and trunk hunting movements, a plurality of senders for controlling said selector switches, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in the associated sender the designation of a desired connection, means in said sender for controlling said selector switches in their selective movements in accordance with the designation registered in said sender, means in said sender responsive to an over-running of any of said selector switches during either the selection or trunk hunting movements thereof, and means controlled by said last means for transmitting a reorder signal to said cord circuit.

14. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits of different character accessible to said cord circuit, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in an associated sender the designation of a desired connection and means controlled by said sender for signaling said operator and for disassociating said sending means from said cord circuit if the operator erroneously sets up in said sender the designation of a connection which cannot be established over the particular trunk circuit to which she has connected her cord circuit.

15. In a telephone exchange system, an operator's position having a cord circuit, a keyset associable therewith, a plurality of trunk circuits of different character accessible to said cord circuit, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said keyset for registering in an associated sender the designation of a desired connection, and means controlled by said sender for signaling said operator and for disassociating said keyset from said cord circuit if the operator erroneously keys the designation of a connection which cannot be established over the particular trunk circuit to which she has connected her cord circuit.

16. In a telephone exchange system, an operator's position having a cord circuit, a keyset associable therewith, a plurality of trunk circuits of different character accessible to said cord circuit, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said keyset for registering in an associated sender the designation of a desired connection, means in the connected trunk circuit operable from said sender if the operator erroneously keys the designation of a connection which cannot be established over that particular trunk circuit and means in said cord circuit controlled from said trunk circuit for signaling the operator and for disassociating said keyset from said cord circuit.

17. In a telephone exchange system, an operator's position having a cord circuit, a trunk

circuit accessible to said cord circuit, connection extending means operable over said trunk circuit, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit with said trunk circuit for associating an idle one of said senders therewith, a control circuit extending from said trunk circuit to the associated sender, a marginal and a sensitive relay at said trunk circuit in said control circuit, said sensitive relay operable over said control circuit as soon as said control circuit is established, means in said sender operative upon the completion of the control of said connection extending means thereby for increasing the resistance of said control circuit to release said sensitive relay, means controlled upon the release of said sensitive relay for completing the talking circuit from the connected cord circuit to said connection extending means, means in said sender for decreasing the resistance of said control circuit to thereby operate said marginal relay and means controlled by said marginal relay for transmitting a reorder signal to said cord circuit.

18. In a telephone exchange system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit, connection extending means operable over said trunk circuit, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit with said trunk circuit for associating an idle one of said senders therewith, a control circuit extending from said trunk circuit to the associated sender, a marginal and a sensitive relay at said trunk circuit in said control circuit, said sensitive relay operable over said control circuit as soon as said control circuit is established, means in said sender operative upon the completion of the control of said connection extending means thereby for increasing the resistance of said control circuit to release said sensitive relay, means controlled upon the release of said sensitive relay for completing the talking circuit from the connected cord circuit to said connection extending means, means in said sender for decreasing the resistance of said control circuit to thereby operate said marginal relay, means controlled by said marginal relay for transmitting a reorder signal to said cord circuit, and means also controlled by said marginal relay for releasing said sender.

19. A telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a trunk circuit accessible to said cord circuit, connection extending means operable over said trunk circuit, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit with said trunk circuit for associating an idle one of said senders with said trunk circuit, means controlled by said sending means for registering in the associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the registered designation, a control circuit extending from said trunk circuit to the associated sender, a marginal relay at said trunk circuit in said control circuit, a time measuring means in said sender, means controlled by said time measuring means for decreasing the resistance of said control circuit to operate said relay if said sender fails to complete its control over said connection extending means within a predetermined interval, and means controlled by said relay for transmitting a reorder signal to said cord circuit and for controlling the release of said sender.

20. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a trunk circuit accessible to said cord circuit, connection extending means operable over said trunk circuit, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit with said trunk circuit for associating an idle one of said senders with said trunk circuit, means controlled by said sending means for registering in the associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the designation registered therein, a control circuit extending from said trunk circuit to said sender, a marginal relay at said trunk circuit in said control circuit, a time measuring means in said sender, means controlled by said time measuring means for decreasing the resistance of said control circuit to operate said relay if the registering means of said sender are not completely set from said operator's sending means within a predetermined interval, and means controlled by said relay for transmitting a reorder signal to said cord circuit and for controlling the release of said sender.

21. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a trunk circuit accessible to said cord circuit, connection extending means operable over said trunk circuit, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit with said trunk circuit for associating an idle one of said senders with said trunk circuit, means controlled by said sending means for registering in the associated sender the designation of a desired connection, means in said sender for controlling said connection extending means in accordance with the designation registered therein, a control circuit extending from said

trunk circuit to said sender, a marginal relay at said trunk circuit in said control circuit, means in said sender responsive to the failure of said connection extending means to properly respond to control from said sender to decrease the resistance of said control circuit to operate said relay, and means controlled by said relay for transmitting a reorder signal to said cord circuit and for controlling the release of said sender.

22. In a telephone exchange system, an operator's position having a cord circuit, a sending means associable therewith, a plurality of trunk circuits of different character accessible to said cord circuit, connection extending means operable over said trunk circuits, a plurality of senders for controlling said connection extending means, means operable upon the connection of said cord circuit to any one of said trunk circuits for associating an idle one of said senders therewith, means controlled by said sending means for registering in an associated sender the designation of a desired connection, a control circuit extending from the selected trunk circuit to said sender, a marginal relay at said trunk circuit in said control circuit, means in said sender for decreasing the resistance of said control circuit to operate said relay if the operator erroneously sets up on the registers of said sender the designation of a connection which can not be established over the particular trunk circuit to which she has connected her cord circuit, and means controlled by said relay for transmitting a reorder signal to said cord circuit and for controlling the release of said sender.

In witness whereof, I hereunto subscribe my name this 7th day of March, 1932.

WALTER B. STRICKLER.