

Aug. 8, 1944.

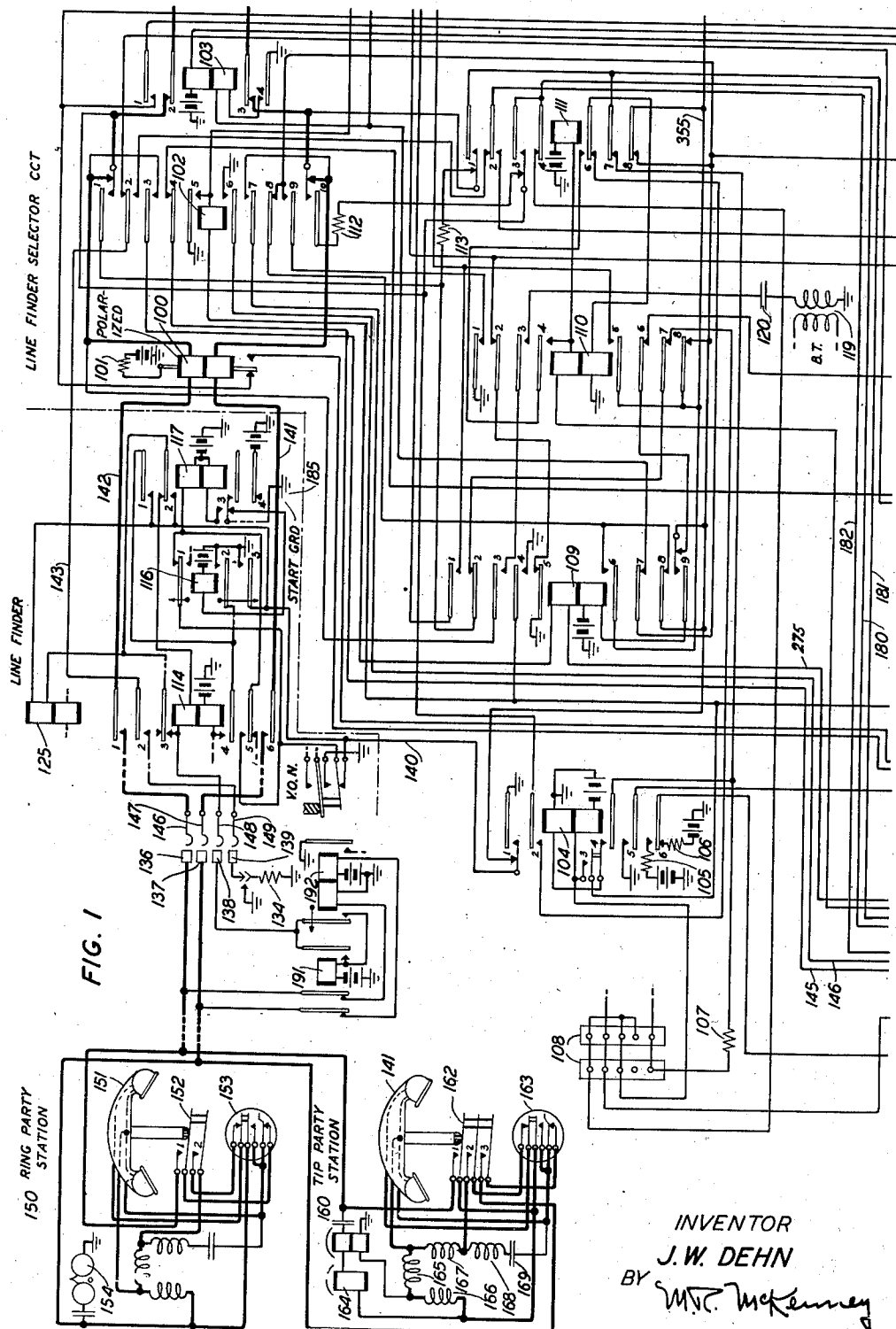
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2,355,207

TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 1



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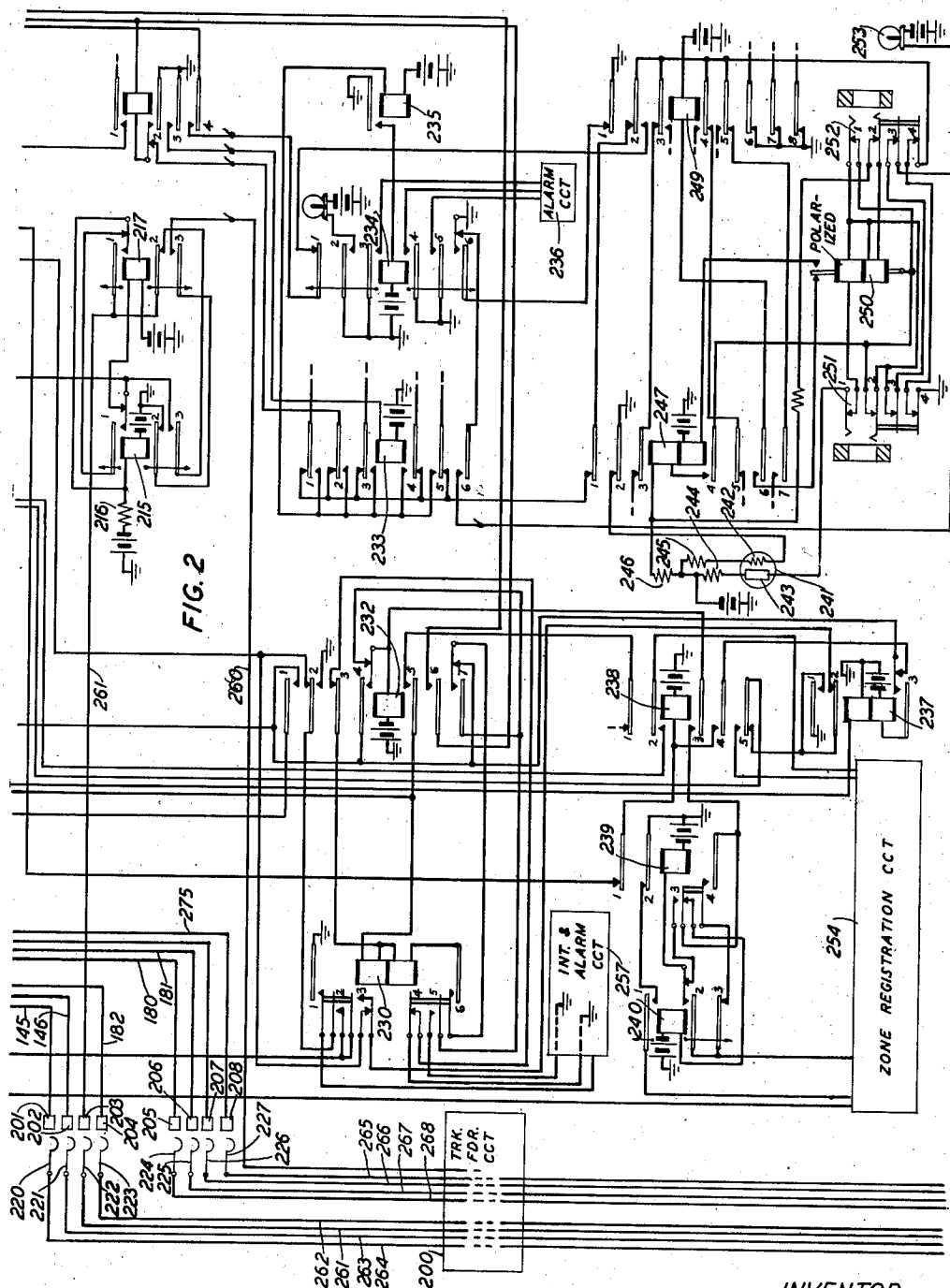
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TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 2



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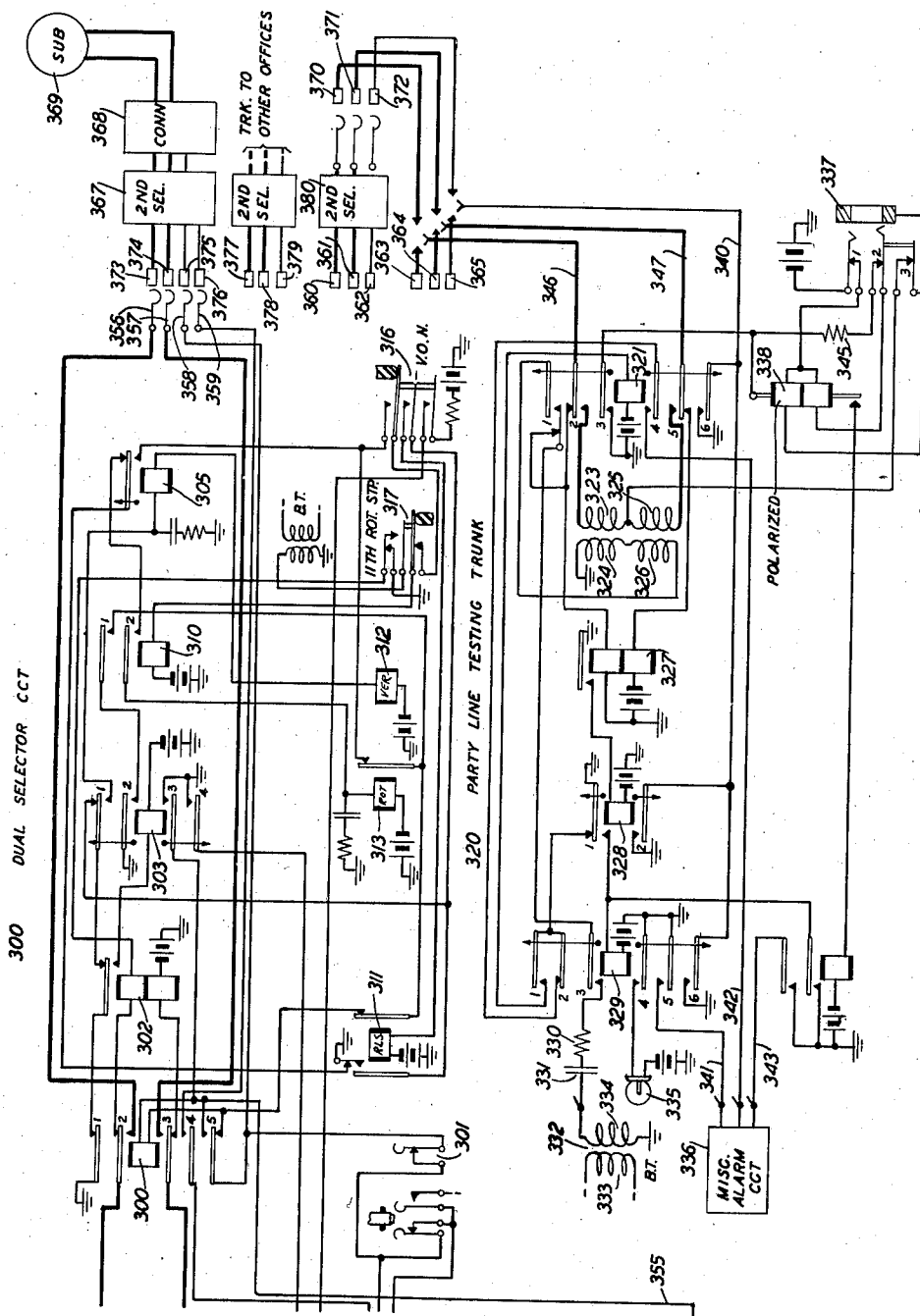
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TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 3

FIG. 3



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TELEPHONE SYSTEM

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12 Sheets-Sheet 4

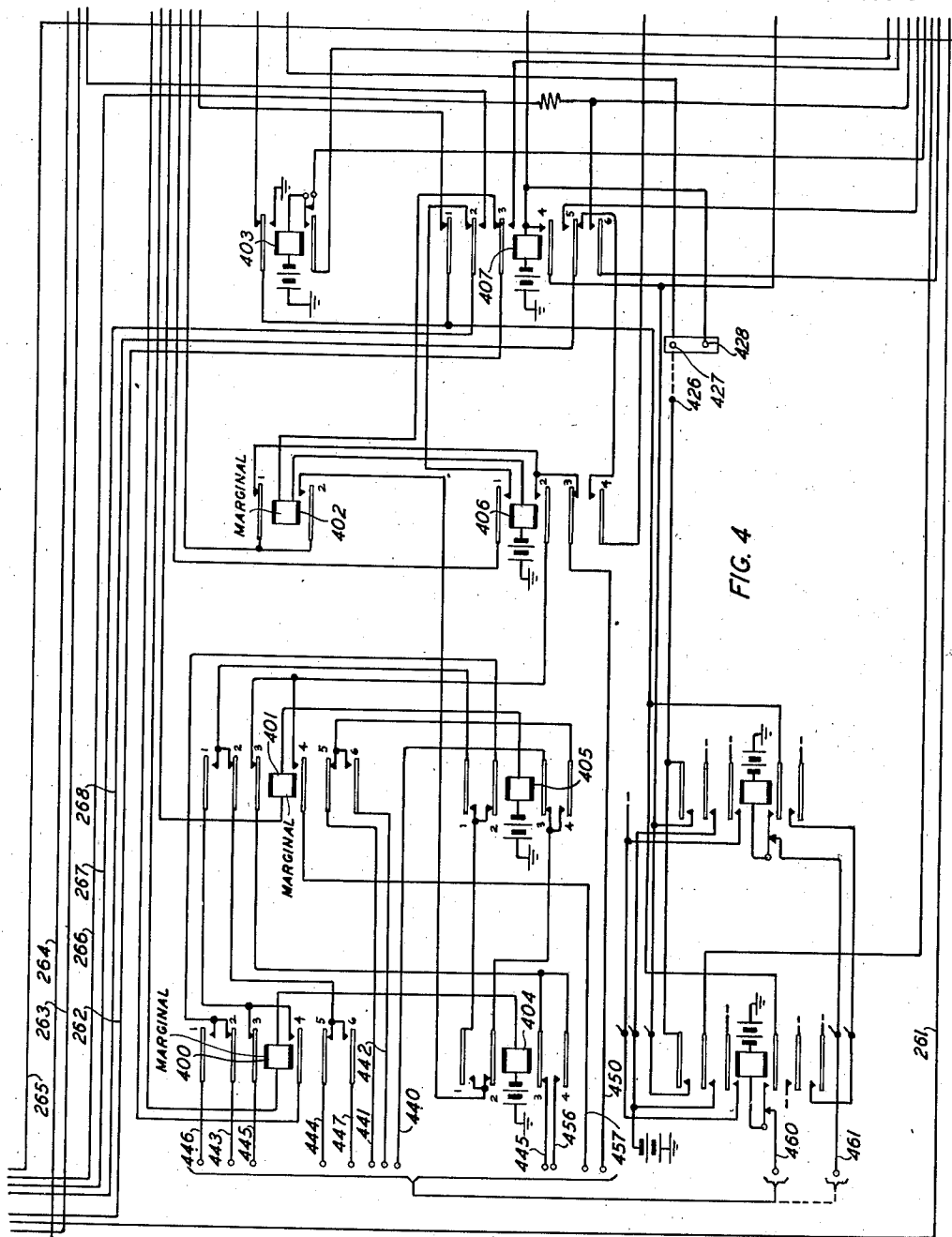


FIG. 4

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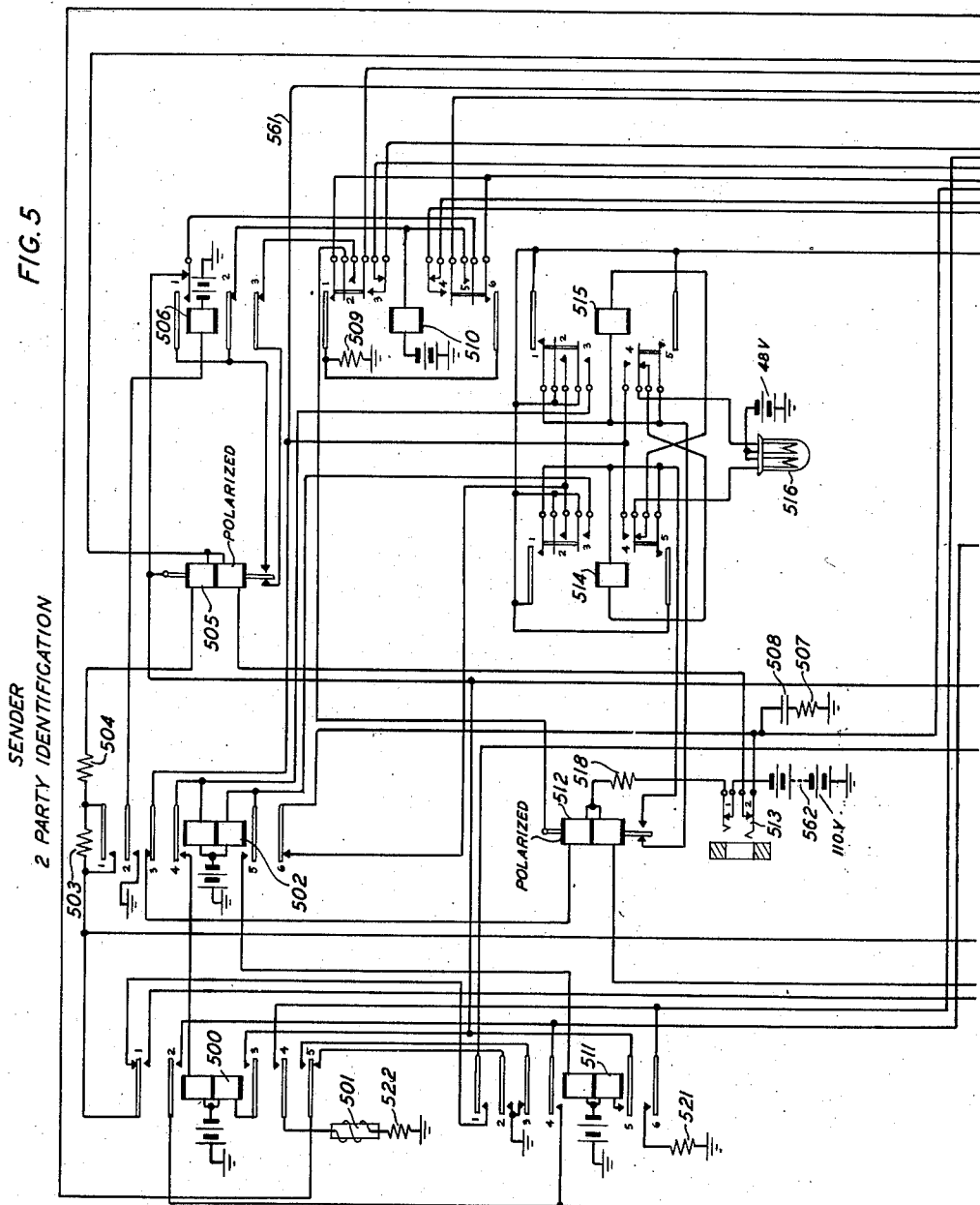
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TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 5



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TELEPHONE SYSTEM

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12 Sheets-Sheet 6

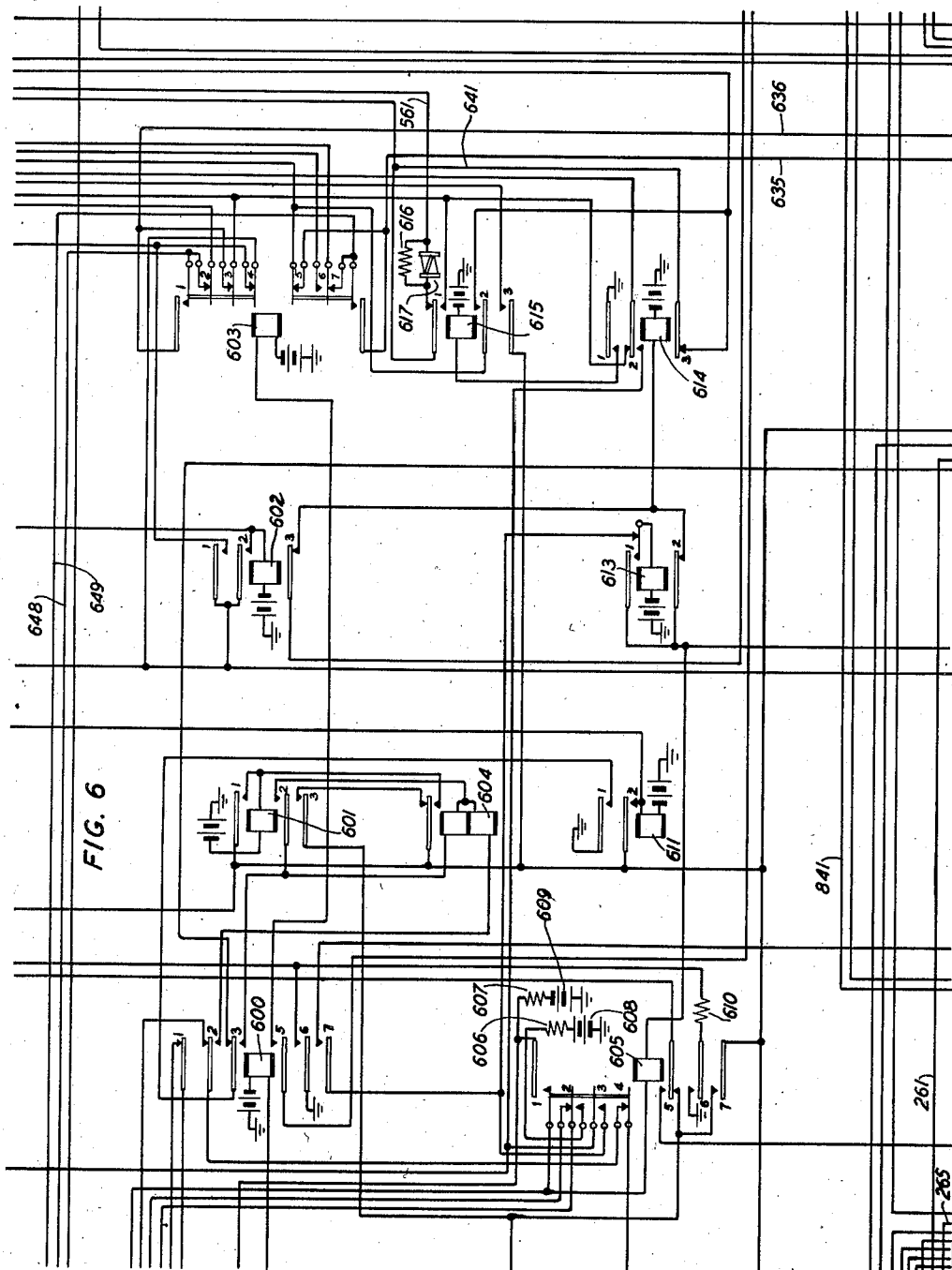


FIG. 6

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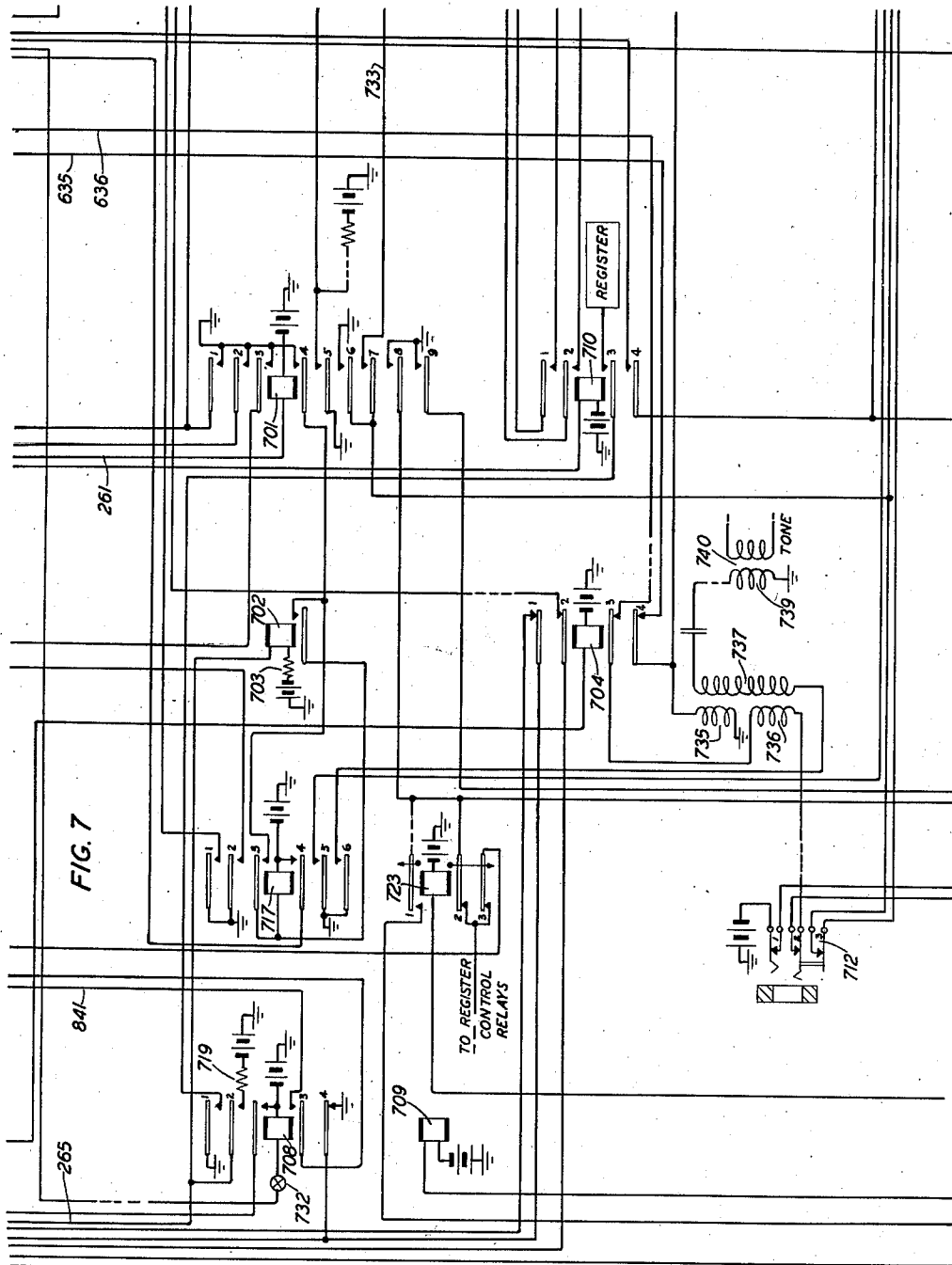
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TELEPHONE SYSTEM

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12 Sheets-Sheet 7



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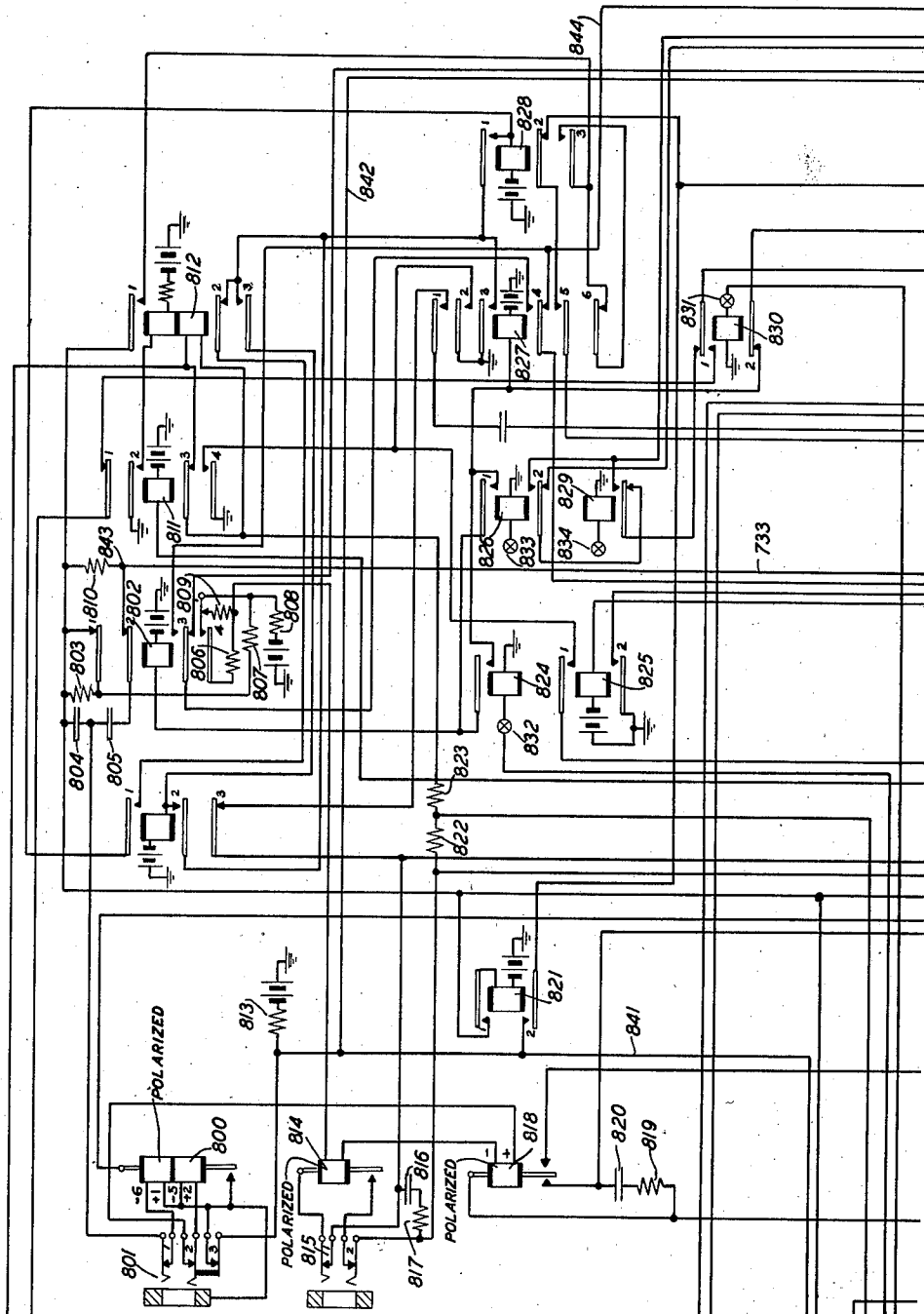
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12 Sheets-Sheet 8

FIG. 8



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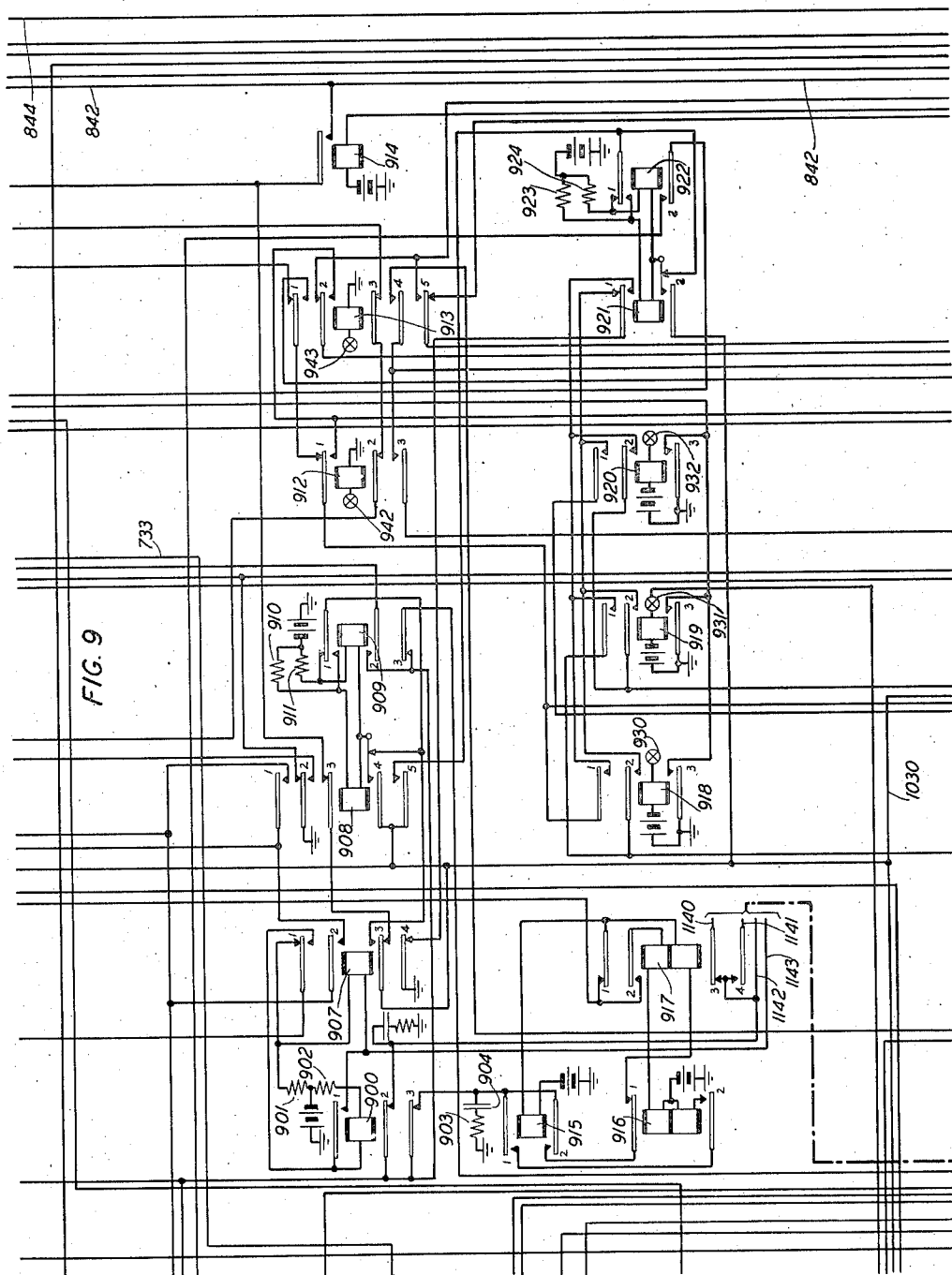
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TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 9



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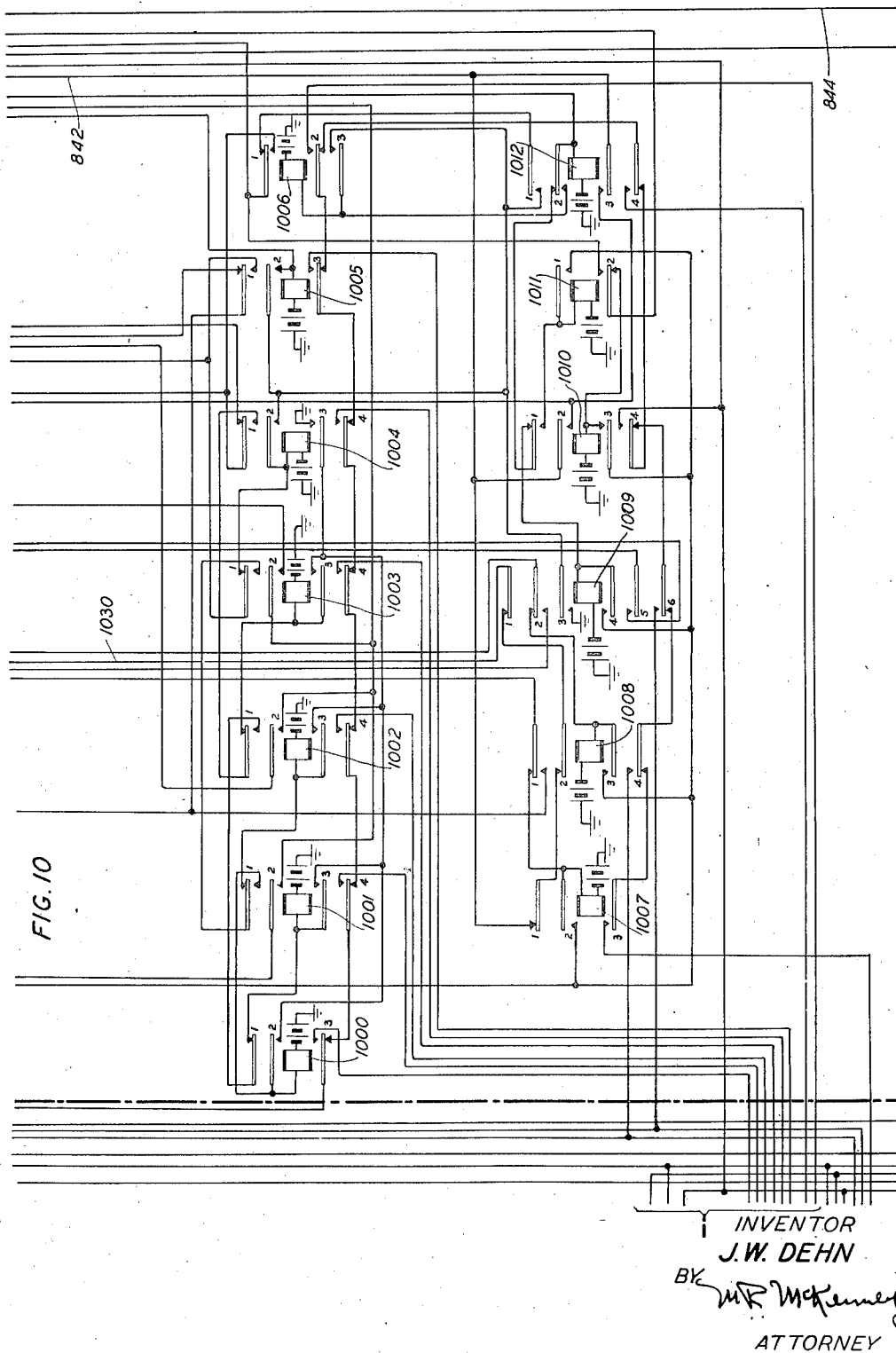
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TELEPHONE SYSTEM

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Aug. 8, 1944.

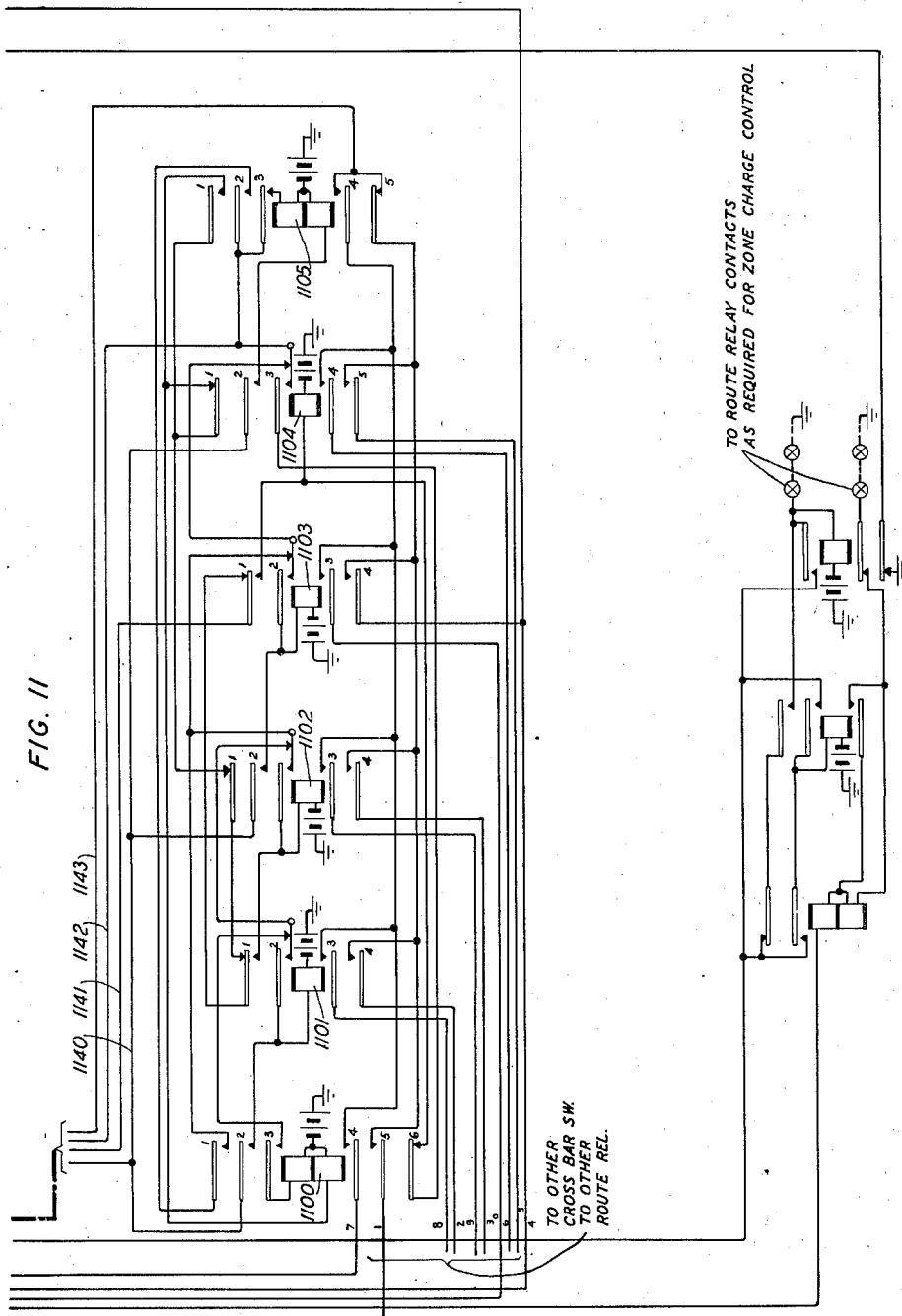
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TELEPHONE SYSTEM

Filed July 20, 1943

12 Sheets-Sheet 11



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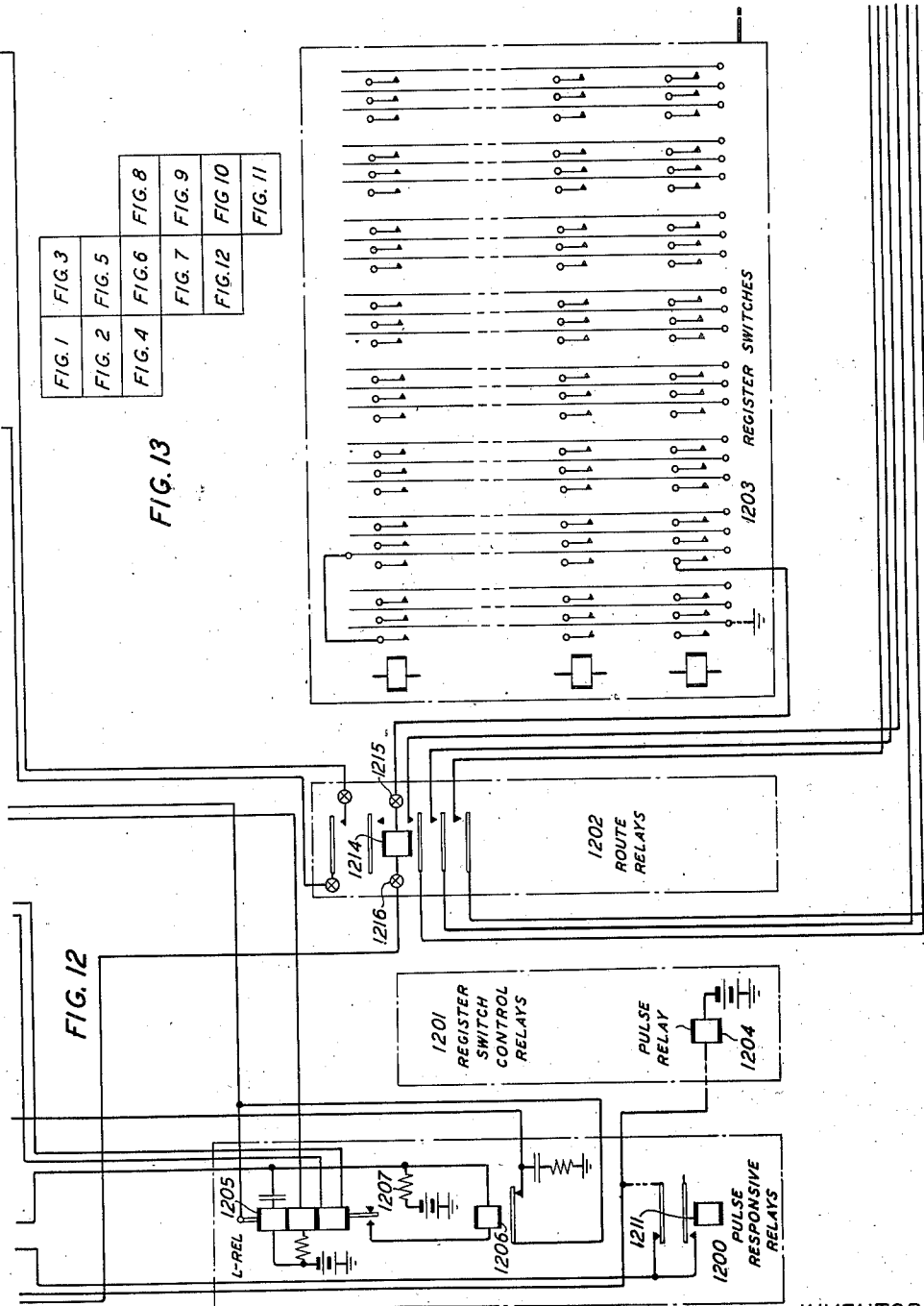
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2,355,207

Filed July 20, 1943

12 Sheets-Sheet 12



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UNITED STATES PATENT OFFICE

2,355,207

TELEPHONE SYSTEM

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Application July 20, 1943, Serial No. 495,488

6 Claims. (Cl. 179—17)

This invention relates to telephone systems and particularly to those in which connections are established by automatic switches.

The object of the present invention is to enlarge the scope and improve the operation of small dial responsive telephone offices.

A feature of this invention consists in a full automatic switching office for small dial areas in a telephone exchange system in which all telephone connections are under the control of a sender which is automatically connected to calling subscribers' lines responsive to the removal of the receiver in a calling subscriber's station, the sender being connected to the line by the operation of a line finder having a line-finder trunk permanently connected thereto and a trunk finder having a sender permanently connected thereto, said sender having means to determine whether the calling line is a single party line or a two-party line and means responsive to its connection to a two-party line to determine which of the two parties is calling, said sender also having means operable in response to its connection to one party, such as the party connected to the tip line conductor, for locking the line finder to the party line, thus providing means to reconnect a sender with said line, after conversation has ceased, to facilitate the test of said line conductors for a false ground, and means automatically operable under the control of said false ground testing means for causing said sender to transmit pulses to operate a first selector for connecting a party line testing trunk with said calling line, said party line testing trunk taking over the control of said line and releasing said sender.

Another and related feature consists in means in said testing trunk for determining whether a false ground is connected to either conductor of said line as a check of the line condition in order that the party calling be charged for the call and operate a signal when the line is not in proper condition for telephone service.

Another and related feature consists in means in said testing trunk for holding said line for inspection when a false ground is connected to said line and for connecting a characteristic tone with said line.

The foregoing and other features of the invention will be described more fully in the following specification which should be taken in connection with the accompanying drawings and appended claims.

Referring to the drawings:

Fig. 1 illustrates two message rate subscribers' stations connected to a party line with the line

terminating in terminals of line-finder switches, the line finder being diagrammatically shown. Figs. 1 and 2 illustrate a line-finder selector trunk circuit permanently associated with the line finder;

Fig. 2 diagrammatically illustrates one of a group of trunk finders, the trunk finder shown being permanently connected to a sender;

Fig. 3 illustrates a first or dual selector permanently connected with the line-finder selector trunk circuit and line finder. Also shown in Fig. 3 is a party line testing trunk circuit selected by the dual selector under control of the sender;

Figs. 4 to 12, inclusive, illustrate the portions of a sender for describing the invention; and

Fig. 13 illustrates the manner of assembling the drawings to illustrate the invention.

The line finder and the trunk selector which are diagrammatically shown herein and the sender which is partly disclosed herein are completely disclosed in detail in my copending application, Serial No. 495,487, filed July 20, 1943. It is believed that the invention may be adequately disclosed and described without the incumbrance of the larger disclosure and description.

GENERAL DESCRIPTION

The telephone office illustrated herein uses step-by-step switches of a type in general use for finder equipment selectors and connectors. An exception to this resides in the cross bar switches for the sender register which may be of the type disclosed in Patent 2,021,329 of November 19, 1935, to Reynolds. The telephone office operates as an automatically operable switching system which may be used as an attended or unattended office in small dial areas adjacent to larger dial office areas. This office will, therefore, be known herein as a fringe office in order to distinguish it from step-by-step offices to which connections are made over outgoing trunks. Trunk connections are also made from this fringe office to panel and cross bar offices.

The office mechanism is organized for rapid operation with the mechanism in groups which normally serve particular lines. The line finder, line-finder selector trunk circuit and the dual selector circuit are permanently connected together. A trunk-finder circuit is permanently connected to the sender and other trunk finders are permanently connected to other senders. The removal of the receiver in a calling station actuates a line finder which immediately establishes

a circuit for actuating the trunk-finder circuit attached to a sender so that the line finder is hunting for the calling line at the same time that the trunk-finder circuit is hunting for the line-finder selector trunk circuit which is permanently connected to the hunting line finder. When both the line finder has found the calling line and the trunk finder has found the line-finder trunk circuit connected with this line finder, the sender which is permanently connected to the trunk finder is energized and immediately associated with the calling subscriber's line by the energization of the equipment in the line-finder selector trunk circuit. Dial tone is transmitted to the calling subscriber's station by the sender and in response the subscriber dials the code of the office in which the called line is located. The office mechanism may therefore be described as divided into units, each unit having a group of line finders and associated equipment for a group of lines which they serve. This group of equipment has a trunk finder circuit and a sender normally associated therewith energized in response to all calls from this group of lines at all times unless the sender is busy when the call is initiated. If the sender is busy a different trunk finder associated with a different sender is used for association with the calling line and the unit of equipment associated therewith. This is also true of the line-finder equipment in order that the mechanism of the office may be operated in a flexible manner.

In response to the removal of a receiver in a subscriber's station a line relay is energized which actuates a line-finder group relay. This energizes a relay in an associated line finder to establish a start circuit for this line finder and a start circuit for the trunk-finder circuit shown diagrammatically in Fig. 2. The line finder, Fig. 1, hunts for the calling line and at the same time the trunk finder hunts for the line-finder selector trunk circuit shown in Figs. 1 and 2 which is connected to the line finder hunting for the line. Thus, a connection between the calling subscriber's line and the sender is established in a very short interval of time. One of the relays in the line finder and relay 102 of the line-finder selector trunk and a relay of the trunk-finder circuit are operated, thus connecting the calling subscriber's line with a sender relay which follows the dial pulses transmitted by the calling subscriber. Circuits are immediately established by the sender for recording the class of service to which the calling subscriber is entitled. For this purpose the mechanism shown in Fig. 4 is connected to class designating mechanism of the line and if a calling subscriber is not entitled to service according to the code dialed, the calling line is automatically routed to an operator who assists the subscriber in completing the switching connection desired.

The first selector, known herein as the dual selector because of its dual functions, is not connected to any type of a pulsing device until after the code digits have been registered in the sender. Relay 102 disconnects the dual selector from the line and sender pulsing mechanism, but as soon as the office code has been recorded by the sender means, is operated under the control of the sender registering equipment for selecting one of two methods or means for operating the dual selector circuit. If the call is for a subscriber in the fringe office, termed herein a local subscriber, the sender causes the release of relay 102 in the line-finder selector trunk circuit as soon as the code digits

have been completely dialed, thus connecting the dual selector pulse responsive mechanism to the calling subscriber's line and dial over the tip and ring conductors. The A relay of the first or dual selector follows the dial pulses of the next digit after the last code digit dialed by the calling subscriber. This connects the brushes of the dual selector with a second selector for extending the call to a local subscriber. As soon as the mechanism is energized in the sender responsive to registration of the local code digits which cause the connection of the calling subscriber directly to the first selector, other mechanism in the sender is energized to cause the immediate release of the sender and the release of the trunk finder diagrammatically shown in Fig. 2. The sender and trunk finder may, therefore, be seized by another calling subscriber for completing another switching connection.

When the office code dialed by a calling subscriber and registered by the sender indicates that the office connection desired is over an outgoing trunk to another office, the sender remains connected to the calling subscriber's line until all of the digits have been dialed. As soon as the office code has been registered, the sender controls the operation of relays in the line-finder selector trunk circuit, Figs. 1 and 2, so that the first or dual selector is connected through the contacts of these relays to the sender pulsing mechanism instead of being connected to the calling subscriber's line as above described. When sufficient digits have been recorded by the sender, pulses are transmitted by the sender pulsing mechanism through the relay contacts of the line-finder selector trunk circuit for positioning the first or dual selector. The first digits transmitted by the sender position the dual selector for the selection of a trunk to the wanted office according to the code registered in the sender by the calling subscriber. Thus, the sender automatically determines what pulsing means should be used for operating the first selector under control of the sender registers responsive to the dialing of the code digits.

If the code dialed by the calling subscriber is that of a distant step-by-step office, the sender transmits a maximum of three digits to cause the dual selector and subsequent selectors to find a trunk to the desired step-by-step office. The thousands, hundreds, tens and units digits dialed by the calling subscriber are registered in the sender and subsequently are transmitted by the sender as four numerical digits as soon as the outgoing trunk has been found. These digits actuate two selectors and a connector at the distant step-by-step office.

If the distant office is a panel or cross bar office, the sender does not immediately transmit the digit pulses as it does to a step-by-step office but waits for a signal from the trunk circuit at the distant office indicating that the trunk has been attached by means of a link to the subscriber's sender in the distant office. This is accomplished by a reversal of current over the trunk from the distant office to the sender equipment in the fringe office. After this signal has been received by the fringe office sender, it transmits digits covering the office code and numerical digits and also station digits if they are required. These are registered by the sender in the distant panel or cross bar office. After the completion of registrations by the sender of a panel or cross bar office, a signal is transmitted to the fringe office sender which causes the disconnection of

the fringe office sender which may now restore to normal. At this time the fringe office sender operates a relay in the line-finder selector trunk circuit causing the connection of the calling subscriber to the mechanism of the distant office which connects the calling subscriber with the called subscriber as registered by the fringe office sender and the distant office sender.

The class of service to which the calling subscriber is entitled is determined by leads connected from the calling line mechanism to marginal and non-marginal relays of Fig. 4. This mechanism also designates to the sender whether the line is a single party line or a two-party message rate line. The lines are variously equipped for indicating the class of service to which they are entitled and whether they are individual or two-party message rate lines. For example, this line mechanism may be a high resistance connected to ground which causes the equipment of Fig. 4 to operate in a manner as to indicate to the sender that a coin line is calling. Other classifications are transmitted to the mechanism of Fig. 4 which are not particularly of interest in the disclosure of this invention but each class of service indication serves to guide the sender in its functions. When the calling subscriber is connected to a two-party line, a two-party identification test is necessary. Other devices are operated to indicate what routes the line is permitted to call and to indicate what charge should be made for the call which is made.

If the call is from a two-party message rate subscriber's line, the sender makes a party line test to identify which party is calling. This test is made at the completion of the first digit and the result of the test is employed by the sender for controlling the energization of mechanism in the line-finder selector trunk circuit and for energizing zone registration circuit equipment. The two-party message rate line as shown in the left portion of Fig. 1 has differently wired subscribers' station sets connected to the conductors of the line, one being termed herein the tip party station and the other the ring party station for identification purposes. During the dialing of the first digit by one of these parties, the sender, upon recognizing that a two-party message rate line is connected thereto, prepares to connect the party line identification mechanism with the line. As soon as the first digit has been dialed, this mechanism is connected to the line so that an identification test can be made between the dialing of the first and second digits to determine which party is calling. The identifying mechanism is then disconnected from the line before the second digit is dialed.

The tip subscriber's station has ground extending through a winding of the ringer to the tip line conductor when the receiver is removed from the switchhook. This provides an identification of this party by the sender mechanism. The absence of ground is used by the sender mechanism to identify the ring party but a false ground connected to the tip or ring conductor would be extended over the line loop to the sender identifying mechanism and might cause the tip party to be charged for a call when the ring party is calling. When the sender receives the indication that the tip party is the one making the telephone call, it causes a circuit to be established for operating relay 104 in the line-finder selector trunk circuit which locks and later functions to hold the line finder connected with the line after the connection between the subscribers is released.

As previously described, the code dialed by the calling subscriber determines whether the first selector will be operated from pulses dialed by the calling subscriber or from pulses dialed by the sender. In one case the telephone switching connection is established between the calling subscriber and a called subscriber in the fringe office and in the second case between the calling subscriber and a subscriber in a distant office, the connection to a subscriber in the distant office being under control of the pulsing mechanism in the fringe office sender. For the latter telephone connection the mechanism of the sender is progressively operated as the digits are dialed for operating the sender register switches, the select magnets and hold magnets of the register switches being progressively operated responsive to each digit dialed. Responsive to the dialing of the code digits for a call to a distant office, a route relay is operated and pulses are transmitted by the sender for controlling the first selector to select an outgoing trunk to the distant office as governed by the route relay operated. This route relay is arranged to control the number of digits dialed for selecting the outgoing trunk and the number of pulses in each digit and also controls the speed of pulsing depending upon the character of office to which the connection is extended.

The release of a telephone connection initiated by the tip party causes the operation of mechanism in the line-finder selector trunk circuit under the control of relay 104 which operates a trunk finder permanently connected with a sender to again connect a sender to the line-finder selector trunk circuit. It will be remembered that relay 104 holds the line finder connected with the calling line. Relay 104 connects signal sources to the sender which automatically arranges the sender for testing the tip and ring conductors of the calling line after the receiver has been replaced on the switchhook. If the sender finds a ground on the line at this time, it is automatically connected to the dual selector by its own devices and the devices of the line-finder selector trunk circuit. This mechanism now automatically operates a special circuit arrangement in the second sender associated with the line connection to cause pulses to be transmitted by the sender pulsing mechanism to control the dual selector. The brushes of the dual selector are thus connected with a party line testing trunk as shown in Fig. 4. The sender is then released and the line-finder selector trunk circuit is responsive for connecting the party line testing trunk with the calling line. The calling line will at this time have the receivers on the switchhooks unless another call has been immediately started. A test of the line is made by the party line testing trunk and if no ground is found connected to the line, the connection is released and the tip party is correctly charged for the call. It is apparent that with both receivers on their respective switchhooks ground would not be connected to either line conductor unless it were a false ground from a source other than through the winding of the ringer in the tip party station. When ground is found connected with the line a busy tone is connected to the line, the line is held by the party line testing trunk for inspection and an alarm is sounded to attract the attention of a maintenance man in the fringe office if it is an attended office or in a supervising office if the fringe office is unattended.

DETAIL DESCRIPTION

Incoming calls

For this description it may be assumed that an incoming call is initiated by one of the two parties 150 or 160 shown in Fig. 1 connected to the line entering the fringe office, either of which energizes the line relay 192 which causes the operation of a line finder associated with the group of lines served by the line-finder group. It was previously indicated in the general description that a line finder, a line-finder selector trunk circuit and a dual selector are permanently connected together as shown in Figs. 1, 2 and 3. Only sufficient mechanism is shown in the line finder and the dual selector for establishing circuits for this invention since the line finder and dual selector are completely shown in my co-pending application Serial No. 495,487, filed July 20, 1943. The sender has a trunk-finder circuit permanently connected thereto as diagrammatically shown in Fig. 2 and Figs. 4 to 11 of the sender. The trunk-finder circuit is shown diagrammatically to save description since this trunk finder is also disclosed in detail in my co-pending application Serial No. 495,487, filed July 20, 1943, and reference may be had to this patent application for a complete description of these finders and the selector. The energization of the line relay 192, when the receiver is removed from the switchhook, energizes a line-finder group control relay for selecting a line finder to serve the calling line. The operation of the line-finder group relay connects a start ground shown as start ground 180 through contacts 3 of relay 117, winding of relay 116 to battery energizing relay 116. Relay 116 establishes circuits in the line finder, one of which actuates the vertical magnet which starts the line finder in search of the calling line. Relay 116 also establishes a start circuit for the trunk finder 200 which is one of a group similar to the group of line finders and includes a similar start relay as will be apparent by reference to my co-pending patent application, Serial No. 495,487, filed July 20, 1943. The start circuit for the trunk finder may be traced from ground on contact 3 of relay 116, thence over the sleeve lead 140, contact 9 of relay 109, contact 6 of relay 110, contact 1 of relay 215, winding of relay 217 to battery. Relay 217 operates to establish a circuit for the start relay in the trunk finder 200. This circuit may be traced from ground through contact 2 of relay 215, contact 3 of relay 217, conductor 260 to the group start relay in the trunk finder 200. Various mechanisms in the trunk finder are thus operated so that the trunk finder 200 starts to hunt for the line-finder-selector trunk circuit, Figs. 1 and 2, connected to the line finder that is hunting for the calling line. The vertical magnet of the line finder steps the brushes in an upward movement and the rotary magnet steps the shaft and brushes until one of the sleeve wipers reaches the terminal which is connected to the calling line and therefore to battery through the winding of the cut-off relay 191 in the line circuit. A circuit for relay 114 is thus established from battery through the winding of the cut-off relay, sleeve brush 143, upper winding of relay 114, contact 2 of relay 117, upper winding of relay 125 to ground on contact 3 of relay 116. Relay 114 is sufficiently operated to close its contact 4, thus establishing a circuit from battery through its lower winding, over dotted lines through contact 1 of the rotary magnet, not shown, contact of relay 125, not shown,

to ground on contact 2 of relay 116. This completely operates relay 114 to close the leads from the line circuit to the line-finder selector trunk circuit and establishes a circuit for operating relay 117. The circuit for relay 117 may be traced from battery through its upper winding, contact 5 of relay 114 to the vertical off-normal ground. The operation of relay 117 connects sleeve lead 140 and ground from contact 3 of relay 116 through its contact 2 to the line circuit and also establishes a locking circuit for relay 114. The circuit for relay 116 is also open but the latter relay is made slow to release in order to hold the ground on the sleeve lead during the time required by the dual selector to connect ground to this sleeve lead. The original locking circuit for relay 114 may be traced from battery through its lower winding and contact 4, contact 1 of relay 117 to ground on contact 3 of relay 116.

The energization of relay 114, as originally stated, connects the line conductors to the tip and ring leads 141 and 142 which extend through polarized relay 100, contacts 1 and 10 of relay 102, contacts 2 and 3 of relay 103 to battery and ground through the windings of the A relay 302 in the dual selector circuit operating the latter relay. The A relay in the dual selector circuit establishes a circuit for the B relay 303 which remains operated over different circuit paths under varying conditions of the switching connection. This control is established by the sender for both local and trunk connections as hereinafter described. The B relay connects ground through its contact 3 to sleeve lead 355 before relay 116 is released. This may be traced over lead 355, contact 8 of relay 111, contact 1 of relay 104 to the sleeve conductor 140. With this ground established and relay 117 operated, the locking circuit for relay 114 remains established and a circuit connection also remains established for continuing the operation of the line cut-off relay. The locking circuit for relay 117 extends to the off-normal ground through contact 5 of relay 114.

Trunk finder

As previously stated, the trunk finder 200 is energized by relay 116 to cause the simultaneous hunting of this trunk finder and the line finder. The vertical and rotary magnets of the trunk finder 200 are energized for connecting the brushes 220 to 227 with terminals 201 to 208. The brushes 220 to 227 are arrested in their rotary motion when battery is found on the sleeve terminal 203 connected to lead 261. A circuit is thus established for cut-off relay 215 from battery through its winding, contact 1 of relay 217, conductor 261, terminal 203, brush 222, through the winding of a cut-in relay in trunk finder 200 to ground on the contact of a trunk-finder relay. Relay 215 is operated and the trunk finder cut-in relay is operated in series with relay 215 which causes the connection leads shown from the line-finder selector trunk circuit to the sender. Relay 215 in operating releases relay 217 and establishes a locking circuit for itself from battery through its winding, continuity contact 1 of relay 217, contact 1 of relay 215, contact 6 of relay 110, contact 9 of relay 109, contact 8 of relay 111 to ground on sleeve conductor 355.

Sender

When the trunk finder is connected with the line-finder selector trunk circuit, the mechanism is operated in both the sender and the line-finder

selector trunk circuit. A circuit is immediately established for relay 102 in the line-finder selector trunk circuit in order to connect the calling subscriber's line with the sender and disconnect the dual selector circuit A relay 302 from any character of pulsing mechanism. The A relay of the dual selector is, however, held operated by a bridge which is established when relay 102 operates as later described and the A relay maintains the B relay of the dual selector circuit operated. At a later time when the code digits have been dialed by the calling subscriber the sender will then determine what pulsing means shall be used for operating the dual selector circuit. The circuit for relay 102 may be traced from ground on contact 4 of the B relay 303 in the dual selector circuit, winding of relay 102, upper winding of relay 109, terminal 208 and brush 227, thence over conductor 265 through the mechanism of the trunk-finder circuit, conductor 742, winding of relay 702, resistance 703 to battery. Relay 102 operates in a circuit traced but because of the high resistance 703 in series with the winding of relay 702, relay 109 does not operate at this time. Relay 702 also operates but the result of the operation of the latter relay will be deferred for the moment. The operation of relay 102 establishes a holding bridge for the A relay 302 in the dual selector circuit. The holding bridge for relay 302 may be traced from battery through its lower winding, contact 3 of relay 103, contact 10 of relay 102, resistance 112, contact 3 of relay 111, contact 2 of relay 103, upper winding of relay 302 to ground. A second bridge in multiple with this bridge may be traced from ground through the upper winding of the A relay, contact 1 of relay 102, resistance 113, contact 3 of relay 103 to battery through the lower winding of the A relay. Relay 102 connects the tip and ring conductors 141 and 142 from the subscriber's line to the sender L relay 1205. These leads may be traced through contacts 3 and 7 of relay 102, terminals 201 and 202, brushes 220 and 221, thence over conductors 263 and 264 through the mechanism of the trunk-finder circuit 200 over conductors 648 and 649 through the party line testing mechanism, Figs. 5 and 6, and the dial tone coil to the L relay 1205 as later traced.

A circuit was traced through the winding of relay 702 for operating relays 102 and 702. The operation of relay 702 establishes locking circuits for relays energized over circuits which may now be described resulting from the connection of the line finder with the calling line and the connection of the trunk finder with the line-finder selector trunk circuit. The off-normal ground relay 701 is operated from battery through its winding, over sleeve conductor 262 to ground established in the trunk finder when the sleeve circuit from the sender is connected to the sleeve circuit of the line-finder selector trunk circuit as described in the aforementioned copending patent application. Relay 701 supplies ground circuits throughout the sender mechanism and provides operating and holding circuits for various relays of the sender. The operation of relays 702 and 701 establishes a circuit for relay 717 from battery through its winding, contact of relay 702 to ground on contact 4 of relay 701. Relay 717, in operating, locks to its operating ground through its contact 3. A circuit is also established for out-dialing pulse relays 814 and 818 at this time which may be traced from battery through resistance 808, contact 4 of relay 802 and resistance 809 which forms a potentiometer,

winding of relay 814, winding of relay 818, contact 2 of jack 801, lower winding of relay 800, contact 3 of jack 801, conductor 842, contact 1 of relay 1007, contact 2 of relay 1008, contact 1 of relay 1009, conductor 1030, to ground on contact 6 of relay 701. It will be noted that ground is also connected to conductor 733 which extends to a point 843 in the potentiometer circuit associated with condensers 804, 805. These condensers are later used for controlling the operation of the pulsing relay 800. Polarized relays 814 to 818 are operated over the circuit traced since the flow of current is in the correct direction for their operation, but relay 800 is not operated since the current flow is in the opposite direction to the polarization of the latter relay. The functions of these relays will be described after digit pulses have been dialed by the calling subscriber, registered by the sender and the sender is ready to use this mechanism for transmitting digit pulses.

Dial pulsing system

As already set forth, relay 102 connects the tip and ring conductors from the subscriber's station through the line finder and line-finder selector trunk circuit, contacts 3 and 7 of relay 102, thence over conductors 145 and 146 to the trunk selector terminals and brushes, through the trunk finder 200 over conductors 263 and 264 to conductors 648 and 649 in the sender. The tip conductor 649 may be traced through contact 6 of relay 603, contact 3 of relay 510, contact 5 of relay 603, thence over conductor 635 through contact 4 of relay 704, winding 735 of transformer 734 to ground. The ring conductor 648 may be traced through contact 2 of relay 603, contact 4 of relay 510, contact 3 of relay 603 over conductor 636, contact 3 of relay 704, winding 736 of transformer 734, contact 2 of jack 712, lowermost winding of L relay 1205, contact 1 of jack 712 to battery. The L relay 1205 is thus held operated over the line loop. The tone coil transformer 734 is energized by the operation of relay 717 as previously described, the circuit extending from ground on contact 1 of relay 717, through winding 737 of transformer 734, winding 739 of tone coil 740 to ground. This actuating circuit extends through contacts of other relays which when operated cuts off the transmission of tone after the first code digit is dialed. The subscriber, upon hearing the tone, begins to dial the office code. As the dial is manipulated by the subscriber, each open period of the dial releases the L relay 1205 and each closed period of the contact of the dial reoperates the L relay 1205. The pulsing system including the pulse responsive relays is diagrammatically shown since it is the same as shown in detail in my copending application, Serial No. 495,487, filed July 20, 1943. This is also true of the register switch control relays 1201, the route relays 1202 and the register switches 1203. Relay 1206 and other relays are responsive to the operation and release of the L relay 1205 for energizing the register switch control relays, one relay being operated responsive to each pulse until the digit has been dialed. The digits are successively registered on the register switches 1203. Relay 709 is shown merely to complete the wiring of the L relay 1205 and is used in connection with calls which are delayed by the calling subscriber. It is a slow release relay and will release only if the subscriber opens the line for a relatively long interval, thus completing

circuits in the sender to indicate to the sender that a call has been abandoned.

Since a complete description of the registration of digits from a calling subscriber is given in the aforementioned patent application, Serial No. 495,487, filed July 20, 1943, it appears unnecessary to encumber this application with a description and disclosure of this mechanism. The register switch controlling relays are operated responsive to each pulse dialed and each digit is registered as fully described in this application.

Class of service signals

Returning to the point when the path between the calling line and the sender is first established, class signals are sent to the sender as the first digit is dialed by the calling subscriber. These signals are sent over leads 180, 181 and 182 and energize the mechanism of Fig. 4 as a matter of information to the sender regarding the character of calls the subscriber is permitted to make without a charge and what calls shall be under the control of a registering device for computing the charge. This mechanism also indicates whether the calling line is a single party line or a two-party message rate line. The first signal received is over lead 182. This lead is extended from line terminal 139 through the line finder and line-finder selector trunk circuit to the sender and the signal sent from the line depends upon the mechanism connected to the terminal and if all of the lines in the group are of the single character. Other signals are transmitted over conductors 180 and 181 from the line-finder selector trunk circuit, otherwise the signals over these leads are governed by normal post springs in the line finder serving this line. The circuit established to brush 149 may be direct ground, ground through a high resistance or ground through a low resistance message register or the lead may be open. In cases where all of the lines of a line-finder level are of the same character, ground through resistance or direct ground or open may be connected through the normal post springs of the line finder and thus establish the character of all of the lines of this particular level, otherwise the indication is individual to each line.

Marginal and non-marginal relays are shown in the class responsive relays of Fig. 4. Relays 402 and 406 are operated by the signal received over lead 182 and relays 400, 401, 404 and 405 are operated by signals received over leads 181 and 182. The circuit for relays 406 and 402 may be traced from battery through the windings of relays 406 and 402, contact 3 of relay 407, thence over conductor 262 through the mechanism of trunk finder 200, brush 223, terminal 204, conductor 182, contact 2 of relay 111, contact 2 of relay 102, conductor 143, contact 2 of relay 114, brush 149 to the mechanism connected to terminal 139 associated with this brush. If brush 149 is associated with an open conductor neither relay 402 nor 406 operates and a circuit is established to class terminal 450. The class indications are first established and are used later by the sender when circuits are established between the sender mechanism and the class mechanism. With neither relay 402 nor 406 energized, battery is connected to terminal 450 from the battery 609 shown in Fig. 6 through resistance 607, contact 1 of relay 403, contact 1 of relay 407, contact 1 of relay 600, contact 1 of relay 402, contact 3 of relay 406 to class terminal 450.

which condition is later altered by the operation of relay 403 to produce the class indication for the sender after certain other mechanisms have operated. When terminal 149 is connected to ground through a high resistance, the marginal relay 402 does not operate but relay 406 operates in this circuit. The operation of relay 406 establishes a circuit to terminals 455, 456 or 457 depending upon the combination of other relays 400, 401, 404 and 405 which are operated over conductors 444 and 445 as will later be described. When brush 149 is connected through a low resistance message register or directly to ground, both relays 406 and 402 are operated. When both relays are operated a circuit is closed to one of the terminals 440 to 448, inclusive, depending upon the combination of other relays 400, 401, 404 and 405 which are operated.

When relay 406 operates it connects the fundamental tip lead 268 to the marginal relay 400 and non-marginal relay 404 as follows: Tracing from the line-finder selector trunk circuit from a resistant or non-resistant condition in the line-finder selector trunk circuit to the sender over fundamental tip lead 180, it is found that this lead extends through contact 5 of relay 407, contact 4 of relay 406, contact 4 of relay 605, contact 2 of relay 600, winding of relay 400, winding of relay 404 to battery. The fundamental ring lead 181 extends from the line-finder selector trunk circuit or normal post spring through contact 2 of relay 407, contact 1 of relay 406, contact 2 of relay 605, winding of relay 401, winding of relay 405 to battery. Each of these leads, the fundamental tip lead 180 and the fundamental ring lead 181, is connected in the line-finder selector trunk circuit either directly to ground or ground to a high resistance or left open. If lead 180 or lead 181 is open, neither the marginal relay nor the non-marginal relay operates. This applies to either the 400, 404 combination or the 401, 405 combination. If either of these leads is connected directly to ground, both relays associated with the lead operate and if either is connected through a high resistance to ground, relay 404 or 405 operates depending upon which lead is associated with the high resistance. The marginal relay, relay 400 or 401, does not operate under this condition. One of terminals 440 to 448, 450 and 455 to 457 are connected to ground as a result of signals over leads 262, 267 and 268 according to the following table:

Leads	262	267	268
Restricted service	450 455	Open H. R. G.	Open. Do.
Coin.	456 457 440 441 442	H. R. G. H. R. G. G. H. R. G. G.	Open. Do. Do. Do. Do.
Message rate or extended scope.	443 444 445 446 447	G. H. R. G. G. Open H. R. G.	H. R. G. H. R. G. H. R. G. G. G.

G=direct ground. H. R. G.=high resistance ground.

Terminals 450, 455 to 457 and 440 to 447 are cross-connected directly to class signal terminals such as 450 and 461 which causes the eventual operation of a class signal relay such as relays 408 and 409. One such class signal relay is operated for each class of service provided in the office when the above relays 402, 406, 400, 401 and 405 have been given an opportunity to oper-

ate and select the path to the proper class signal relay.

Relay 605 is also a class signal relay operable through the contacts of relays 402, 406, 400, 401, 404 and 405 for party lines as will be explained later.

The class signal relays are operated in the above manner when the sender is seized, thus indicating the class of the subscriber calling and whether it is a single party line or a two-party message rate line. The signal covering this class of service may be indicated to the sender shortly thereafter. The time of dialing one pulse is allowed for the operation of the class relays to establish the combination circuit paths through the contacts of relays 400 to 401 and 404 to 406 and when the calling subscriber dials the second pulse, relay 403 is operated in multiple with the relay which responds to this second pulse. Relay 1204 has been indicated to illustrate the circuit for the pulse-2 responsive relay and a circuit is established through contact 1211 which is closed by the pulse responsive relay when the second pulse is dialed by the calling subscriber. The circuit for the pulse-2 relay and relay 403 may, therefore, be traced from battery through their windings, contact 1211, contact 1 of relay 723 to ground on contact 8 of off-normal relay 701. It will be noted from the pulse responsive relay circuits that relay 723 is operated during the pulses of a digit and released between digits. Relay 403, in operating, locks through its continuity contact 2 to ground on contact 2 of relay 701 and associates ground through its contact 1 with the class relays. For example, if neither class selecting relay 402 nor 406 is operated, the ground is extended through contact 1 of relay 403, contact 1 of relay 407, contact 1 of relay 600, contact 1 of relay 402, contact 3 of relay 406 to terminal 450. Thus, where terminal 450 is cross-connected to a class indicating relay such as 408, a circuit is established for operating the latter relay. If relay 402 is operated, this ground extends from contact 1 of relay 403 through contact 1 of relay 407, contact 1 of relay 600, contact 2 of relay 402, contact 2 of relay 404, assuming this relay to be normal, contact 3 of relay 405, assuming this relay to be normal, to terminal 440, thus operating a different class indicating relay. Assuming that relays 402, 401 and 405 are operated, this ground is connected from contact 1 of relay 403 through contact 1 of relay 407, contact 1 of relay 600, contact 2 of relay 402, contact 2 of relay 404, contact 4 of relay 405, contact 6 of relay 401 to terminal 442. The combinations of these relays are such that after the class registration has been made, the ground connected to terminal 1 of relay 403 may be extended to any one of terminals 440 to 447, inclusive, 450 or 455 to 457, inclusive, to operate any of the different class indicating relays connected to these terminals.

Relays, such as 408 and 409, are provided for each class of service given to subscribers of the office and terminals such as 460 or 461 are connected to any of the terminals 440 to 447, 450 or 455 to 456 so that the class indicated by the relays in the upper portion of Fig. 4 will establish a circuit for associating ground from contact 1 of relay 403 to the correct terminal for energizing a class relay which will provide circuits in the sender for certain functions. In some instances, two relays are provided for the given class of service, particularly on coin and non-coin lines where the routing is to the same destination but

over a different trunk connection in order that the coin may be collected where the call originates in a coin collection subscriber's station and not collected where the call originates in a non-coin subscriber's station. In this case, one route relay is connected to the contacts of relay 408 and a second route relay to the contacts of relay 409 and different characters of trunks are selected by the different route relays to the same destination.

For classes other than two-party message rate calls, the terminal 426 is cross-connected to the terminal 428 so that relay 407 is operated as soon as the class relay is operated. Terminal 426 is, however, shown cross-connected to terminal 427 for two-party message rate classes. This causes a two-party identification test to be made as soon as the class relay is operated, and at the conclusion of the two-party identification test, relay 407 is operated as will be described. For this example, it may be assumed that terminal 460 is cross-connected to terminal 441 and that terminal 441 was grounded by the operation of relays 405 and 402. It will be remembered that the operation of relays 402 and 405 connects ground from contact 1 of relay 403 through contact 1 of relay 407, contact 1 of relay 600, contact 2 of relay 402, contact 2 of relay 404, contact 4 of relay 405, contact 5 of relay 401, terminal 441, winding of relay 408 to battery. Relay 408 in operating establishes a locking circuit for itself through this contact 4 to ground on contact 1 of relay 403. A circuit is now established for the two-party line test by the operation of relay 600 which may be traced from battery through its winding, terminal 427, terminal 426, contact 1 of relay 408, to ground on contact 1 of off-normal relay 701.

The party identification test is made as soon as the first digit has been received by the sender and is used by the sender to determine whether the calling subscriber of the two-party message rate line is the tip party or the ring party of the line. This test is made only when the operated class signal relay indicates that the calling line is a two-party message rate line. This was indicated by the operation of relay 408 and the cross-connection of terminal 426 to terminal 427 through the contacts of this relay. This character of class signal relay establishes a circuit as traced for operating relay 600. Relay 600 is operated while the first or A digit is being received which prepares the sender for making a test of the calling line between the dialing of the first and second digits. For the two-party line identification test, as will be shown by the circuits traced, relay 512 is connected to the tip and ring of the calling subscriber's line for a given time interval. If relay 512 is operated at the end of this interval between the first and second digit, it indicates that the calling subscriber is a tip party subscriber since this relay 512 will operate in a circuit to the ground connected to the lower ringer winding in the tip party station of the two-party line shown in Fig. 1. The timing is controlled by condensers and if relay 512 is not operated at the end of an accurate time interval between digits, it indicates that the calling party is a ring party on a two-party message rate line.

Control and time of two-party message rate line test

It will be remembered that relays 701 and 717

were operated when the sender is first seized in order to establish battery and ground supplies to the relays of the sender. This establishes a current flow in the biasing winding of polarized relay 505 and operates relay 614. The circuit for relay 614 may be traced from contact 3 of relay 701, contact 2 of relay 613, winding of relay 614 to battery. The circuit through the biasing winding of relay 505 may be traced from ground on contact 1 of relay 701, through resistances 503 and 504, upper winding of relay 505, contact 3 of relay 717 to battery. Relay 614 in operating establishes a circuit for relay 615 which is obvious and need not be traced. Relay 615 establishes a circuit through the lower winding of relay 505 traced from ground on contact 1 of relay 701, contact 3 of relay 615, contact 2 of jack 513, lower winding of polarized relay 505 to battery on contact 4 of relay 717. Relay 505 operates and in so doing establishes an operating circuit for relay 510 traced from battery through the winding of the latter relay, contact 2 of relay 506, contact 1 of relay 505 to ground on contact 2 of relay 717. Relay 510 in operating locks through its contact 5 to its operating ground as traced. The two-party message rate line test now awaits the completion of the first digit which is indicated by the release of relay 723.

Relay 723 remains operated during the pulse of a digit and restores to normal after the pulses of each digit have been dialed by a calling subscriber. The circuit for relay 723 may be traced from battery through its winding, contact of pulsing relay 1206 to ground on contact 9 of relay 701. Relay 1206, through which the above circuit is traced, follows the operation of the L relay 1205 as the contact of the L relay is connected to the armature during each pulsing period from the calling subscriber's dial. Relay 1206 is therefore released during each open period of the dial and operated during each closed period. Relay 723 is a slow releasing relay and therefore remains operated during the pulsing of the digit but after the pulses of the digit are dialed, the contact of relay 1206 remains open and relay 723 releases. Referring again to the operation of the party line test relays, it will be remembered that relay 600 is operated and relays 614 and 615 are operated. At the end of the first digit dialed by the calling subscriber, the release of relay 723 therefore establishes a circuit for relay 613. The circuit for relay 613 may be traced from battery through its winding and continuity contact, contact 7 of relay 600, contacts 3 and 2 of relay 723 to ground on contact 8 of the off-normal ground relay 701. Relay 613 in operating locks through its continuity contact to ground on contact 3 of relay 701 and causes the release of relay 614 since the operated circuit for the latter relay extends through contact 2 of relay 613. The release of relay 614 releases relay 615 which opens the circuit to the condenser timed relay 505. With relays 614 and 615 released and relay 510 operated a circuit is now established from 110-volt battery 562 to the tip and ring conductors of the subscriber's line connected to the calling subscriber's station mechanism. This circuit may be traced from the 110-volt battery 562 through contact 1 of jack 513, resistance 518, upper winding of relay 512, contact 3 of relay 502, varistor 617 in multiple with resistance 616, contact 1 of relay 615 to a junction point 641 connected with the tip and ring conductors of the subscriber's line. The connection to the tip conductor extends through contact 3 of relay 614,

contact 3 of relay 510, contact 6 of relay 603, tip conductor 649 which extends to the tip conductor of the line connected with subscribers' stations 150 and 160 as previously traced. From the junction point 641 the connections made to the ring conductor of the subscriber's line are through contact 4 of relay 510, contact 2 of relay 603, ring conductor 648 which extends over the ring conductor of the line to the subscribers' stations 150 and 160, as previously traced. The relay 512 is thus held associated with the subscriber's line for a period of time between the first and second digit dialed by the calling subscriber. During the time that relay 512 is presented to the calling subscriber's line the L relay 1305 is held operated in a local circuit under control of relays 614 and 510 so that a false pulse will not be sent to the registering mechanism. This circuit may be traced from battery through the upper contact 1 of jack 712, lowermost winding of the L relay 1205, contact 2 of jack 712, coil 736 of transformer 734, contact 3 of relay 704, contact 3 of relay 603, contact 2 of relay 614, contacts 1 and 6 of relay 510, resistance 509 to ground.

Relay 505 releases in approximately .050 second under the control of condenser 508 and when released connects ground through contact 2 of relay 506 released and contact 2 of relay 510 operated to the armature of relay 512. If the calling subscriber is a tip party of the two-party message rate line, relay 512 will have been operated when associated with the ground extending through the lower winding of ringer 164 at the tip party station 160. With relay 512 operated, ground is connected through the armature and contact of relay 512, winding of relay 514 to battery through resistance lamp 516. If relay 514 is thus operated, it establishes a locking circuit for itself to ground through its contacts 1 and 5, contact 4 of relay 603 to ground on contact 2 of relay 717. Relay 514 establishes a circuit to reoperate relay 505 and operate relay 502. The circuit for relay 502 may be traced from battery through its lower winding, contact 3 of relay 514, contact 4 of relay 603 to ground on contact 2 of relay 717. Relay 514 connects 48-volt battery through lamp 516, contact 4 of relay 514, to the tip lead conductor 561 to replace the 110-volt battery supply which is cut off by the operation of relay 502. It will be remembered that lead 561 extends through varistor 617 and resistance 616, contact 1 of relay 615, contact 3 of relay 614, contact 3 of relay 510, contact 6 of relay 603 to tip conductor 649. Relay 502 extends its operating ground through its contact 5 to operate relay 511. This circuit extends through the upper winding of relay 511 to battery. The operation of relay 502 also shunts resistance 503 which is in series with the biasing winding of relay 505 and opens the operating circuit for relay 505.

Relay 505, due to the reduction of resistance in series with its upper or biasing winding, releases in approximately .015 second. During this interval the 48-volt battery connected to the subscriber's line along with the varistor 1217 and resistance 1216 causes the discharge of the line in such a way as to prevent bell tapping at the subscriber's station.

The release of relay 505 and the operation of relay 506 open the locking circuit previously traced for relay 510 which now releases. This removes the holding circuit for the L relay 1205 and reconnects the tip and ring line leads through continuity contacts to the L relay 1205. The

party identification is now complete and the pulse responsive mechanism is ready to receive the pulses of the next digit dialed by the subscriber. The subscriber was not delayed at any time since the identification test operates in a very short interval of time between the first and second digit. The complete party identification test cycle, that is, testing the line and subscriber's station, discharging the line after the test and the function of the test control relays, is such that the open period introduced to the subscriber's line between the dialing of the first and second digit does not exceed .105 second.

If the calling subscriber is not a tip party on the two-party message rate line relay 512 will not be operated when relay 505 releases for the first time. This will result in the operation of relays 515 and 500 instead of relays 514 and 511. Otherwise the operation is the same as for the tip party.

The following relays remain operated at the end of the party identification test if the calling party is a tip party of a two-party message rate line. Relays 514, 511 and 506 remain operated under the control of relay 603 which is normal. Relays 511 and 611 remain operated under the control of relays 717 and 701, respectively. The circuits for the above relays with the exception of relay 611 have previously been traced. Relay 611 is energized from battery through its winding, contact 1 of relay 511, contact 1 of relay 500 to ground on contact 1 of relay 701. Relay 611 in operating locks directly to its operating ground on contact 1 of relay 701.

If the calling party is not a tip party of a two-party message rate line the following relays remain operated. Relay 515, relay 502 and relay 506 under the control of relay 603 and relay 500 under the control of relay 717.

If relay 611 is operated because the tip party is calling, a circuit is closed for operating the tip party relay 104 in the line-finder selector trunk circuit, Fig. 1. A circuit for relay 104 may be traced from ground on contact 1 of relay 611, contact 3 of relay 600 which it will be remembered was operated by the class relay 408, upper and lower windings of relay 604, contact 2 of relay 600, contact 4 of relay 605, contact 4 of relay 406, contact 5 of relay 407, conductor 268 which extends through the trunk-finder circuit 200, brush 224, terminal 205 of the trunk finder 200, thence over lead 180 through contact 4 of relay 111, lower winding of tip party relay 104 to battery. Relay 604 operates in the circuit traced but relay 104 does not operate in this circuit. The operation of relay 604 establishes an operating circuit for relay 601 from battery through its winding, contact of relay 604 to ground on contact 1 of relay 701. The operation of relay 601 short-circuits the high resistance upper winding of relay 604 which holds relay 604 operated and now causes the operation of the tip party relay 104.

The operation of tip party relay 104 connects ground to the fundamental tip lead 180 which may be traced as follows: The operation of relay 104 in closing its contact 3 establishes a locking circuit for itself to ground on contact 6 of relay 102 later replaced by ground on contact 4 of relay 109. This ground also extends through contact 4 of relay 111 to conductor 180 which as previously traced extends to the lower winding of relay 604 and now causes the release of relay 604. The release of relay 604 operates relay 407 which may be traced from battery through the winding of

relay 407, contact 3 of relay 601, contact of relay 604 to ground on contact 1 of relay 701. It will be remembered that relay 601 remains locked through its contact 1 to ground on contact 1 of relay 701. Relay 407 in operating locks through its contact 4 to ground on contact 1 of relay 701. The operation of relay 407 transfers the fundamental tip and fundamental ring leads 268 and 267 to the circuit which transmits pulses over the outgoing leads for selecting an idle trunk to the proper office and for either positioning step-by-step selectors or for operating senders in distant cross bar or panel offices. Relay 407 also makes connection with the zone charge control circuit of the sender and arranges the circuit so that the line-finder selector trunk circuit may connect the fundamental tip and fundamental ring leads under control of the sender to the first or dual selector after the code digits have been completely dialed by the calling subscriber and registered by the sender.

If the ring party is calling and therefore relay 500 is operated instead of relay 511 and relay 611, the operation of relay 407 takes place immediately and relay 104 of the trunk circuit is not operated since a circuit is not established for the latter relay.

Check for ability of line test to function

Relay 512 as set forth in the foregoing should operate over the tip line conductor to ground through the winding in the ringer of the tip line subscriber's station and should not operate under all other line conditions with the exception of a false ground connected to the line. In order to insure against faulty operation of relay 512 and thus insure against false charges to a subscriber for telephone calls which were not made by the subscriber, a check test is made after the sender has started to transmit pulses and before the sender is released. If relay 512 operated on the party identification test, this relay is checked by the sender to meet its non-operating condition thus assuring that it did not operate falsely when associated with current which would be the equivalent of its non-operated circuit. If relay 512 is non-operated on the party identification test, this relay is checked for its ability to meet its operating condition so that if a call were made by the tip party and this relay did not operate, it would be apparent that the ring party of the two-party line should not be charged for the call. This test is accomplished in the following manner:

When relay 512 originally operates on the party identification test and relays 511 and 611 operate and lock as stated in the foregoing description, and in response to the operation of the route relay for routing a call to the proper destination, one of relays 918, 919 or 920 is operated as later described, a circuit is established for operating relay 603. Relays 514, 502 and 506 are released. The circuit for relay 603 may be traced from battery through its winding, contact 5 of relay 600 to ground on contact 3 of any of relays 918, 919 or 920 whichever is first operated. Relay 603 transfers the tip and ring leads 648 and 649 to the L relay 1295 without disturbing the L relay 1295 and prepares for testing relay 512. For this description it may be assumed that route relay 1214 is operated for the telephone connection, that this route relay controls the transmission of a two-digit code by the sender and that consequently relay 919 is operated over the circuit

shown for controlling the number of digits transmitted.

The test of relay 512 occurs after the first digit is transmitted by the sender for selecting an outgoing trunk extending to the wanted party. During the interdigital period after the first digit has been transmitted by the sender, relay 922 is operated through contact 2 of relay 921. The operation of relay 922 operates relay 614 and the latter relay operates relays 615, 613 and 510. The operating circuit for relay 614 may be traced from battery through its winding, contact 3 of relay 602, contact 2 of relay 922 to ground on contact 1 of relay 701. Relay 510 is operated from battery through its winding, contact 2 of relay 506, contact of relay 505 to ground on contact 2 of relay 717. Relay 510 connects ground through resistance 509 over a circuit through contact 1 of relay 510, contact 2 of relay 614, contact 4 of relay 511, winding of relay 602 to battery thus operating relay 602. The latter relay in operating releases relays 614 and 615 since it opens the circuit for relay 614 and the release of relay 614 opens the operating circuit for relay 615. This test cycle is very much the same as previously described for testing the line excepting that instead of having relay 512 connected to the tip and ring conductors of the line, it is connected to resistance 521 through contact 6 of relay 511. This circuit may be traced from battery through the contact of jack 513, resistance 518, upper winding of relay 512, contact 3 of relay 502, thence over conductor 561, varistor 617 in multiple with resistance 616, contact 1 of relay 615, contact 3 of relay 614 which is now released, contact 3 of relay 510, contact 6 of relay 603 to ground through resistance 521. This is a non-operate condition for relay 512 and as a result of the relay in operating, relays 515, 502, 506 and 500 are operated. If relay 512 is operated when associated with the foregoing resistance 521 in its non-operate condition, then relay 500 will not operate and the sender will be prevented from dialing the tens digit.

When relay 512 does not operate on the party identification test, relay 500 is operated as a result of the non-operation of relay 512 and relay 500 locks to ground. As a result of this operation, relay 603 is operated as described in the foregoing. Relays 515, 502 and 506 are released. The party identification relay 512 functions as described in the foregoing party identification test with the exception that with relay 500 operated, the party identification relay 512 is connected to an operating network designated 501 through contact 4 of relay 500. If relay 512 is in correct adjustment, it will operate when associated with this network and relay 511 will be operated. However, if relay 512 fails to operate, relay 511 will not be operated and the sender will be prevented from dialing the tens digit.

Sender pulsing mechanism

Pulses are transmitted by the sender pulsing mechanism shown in Figs. 8, 9, 10 and 11 for selecting an outgoing trunk where the call is for a distant step-by-step panel or cross bar office according to the cross-connections of a route relay, such as route relay 1214 which was energized responsive to the dialing of the code digits by the calling subscriber. The numerical digits and stations digits, if any, are transmitted by this sender pulsing mechanism as recorded on the cross bar switch registers responsive to the numerical digits dialed by the calling subscriber as described

in detail in my copending patent application, Serial No. 495,487, filed July 20, 1943, the pulses to the panel or cross bar office sender being transmitted at a faster rate than the pulses to the switches of a step-by-step office under the control of relays connected to the contacts of the respective route relays governing the telephone connections. The fringe office sender and the trunk finder are automatically disconnected from the line-finder selector trunk circuit as soon as the switching connection is completed. This is accomplished by the operation of relay 708; also as fully described in my above-mentioned copending patent application.

Recall of sender after disconnection of subscribers

The action of the system upon the termination of a telephone connection initiated by the tip party of a two-party message rate line may now be considered. It will be remembered that the sender automatically tested the line and operated relay 104 in the line-finder selector trunk circuit when it was found that the tip party 160 of a two-party message rate line had initiated a call. Returning back to the time when this operation took place by the sender, the operation of relay 104 connects ground through its contact 1 to sleeve lead 140 which holds the line finder connected to the calling line and makes this line and line finder test busy. Sleeve lead 140 extends through contacts 1 and 2 of line-finder relay 117 to lock relay 114. Relay 117 is locked through contact 5 of relay 114 to the vertical off-normal ground. The sleeve ground from contact 1 of relay 104 through contact 2 of relay 117 and contact 3 of relay 114 also extends to the line-finder sleeve terminal 148 which holds cut-off relay 191 operated. Relay 104 in operating disconnects the sleeve lead 140 from the sleeve lead extending to the dual selector when it connects ground to the sleeve 140. Ground is, however, maintained on the sleeve lead 355 from the dual selector B relay 303 until the trunk to a distant step-by-step panel or cross bar office is selected or until a second selector is selected which causes the operation of relay 300. At this time ground is connected from the trunk or second selector through contact 4 of relay 300 to hold ground on the sleeve conductor 355 extending to the line-finder selector trunk circuit, Fig. 1, the trunk finder and the sender.

When the switching connection reached the station of the called subscriber and the called subscriber removed the receiver from the switchhook to answer the call, relay 100 was operated by a reversal of current either from a step-by-step connector or from a trunk relay energized for this purpose. The operation of relay 100 establishes a circuit for relay 230 extending from battery through resistance 101, contact of relay 100, upper winding of relay 230, contact 3 of relay 232, contact 4 of relay 230 to ground through the interrupter and alarm circuit 257. Relay 230 partly operates in this circuit to establish its contacts 1 and 6. This establishes a circuit from battery, through resistance 101 and contact of relay 100, thence through the upper and lower windings of relay 230, contact 6 of relay 230, contact 7 of relay 232 to ground on contact 6 of relay 102. The operation of relay 230 establishes a circuit for relay 232 from battery, through its winding and contact 4, contact 5 of relay 230, to ground in the interrupter circuit 257. Relay 232 in operating establishes a locking circuit for itself from bat-

tery, through its winding, contact 4 and contact 1 to ground on contact 5 of relay 104. This ground on contact 5 of relay 104 now extends through contact 1 of relay 232, contact 3 of relay 104, lower winding of relay 104 to battery for locking this relay so that other relays may be released, without releasing relay 104.

After a sender has set up a switching connection to a distant office it is automatically released by the operation of relay 708 as fully described in my aforementioned patent application. The operation of relay 708 connects battery through low resistance 719 to lead 265 which extends through the trunk finder 200, brush 227, terminal 208, thence over lead 275, through the upper winding of relay 109, winding of relay 102 to ground on contact 5 of relay 102. The lower resistance 719 causes the operation of relay 109. Previously to this time, relay 102 is maintained operated and locked to battery, through the winding of relay 702 and higher resistance 703, which higher resistance prevented the operation of relay 109. Relay 109 in operating establishes a locking circuit for itself from battery through its lower winding and contact 9, contact 8 of relay 110 to ground over the sleeve circuit to the dual selector. Relay 109 disconnects ground from the sleeve lead 261 extending to the sender. It will be remembered that this sleeve ground was traced from the dual selector through contact 8 of relay 110, contact 9 of relay 109, contact 6 of relay 110, contact 3 of relay 215, contact 2 of relay 217, thence over lead 261 through the trunk-finder circuit 200 and through the winding of off-normal relay 701 to battery. The operation of relay 109 thus causes the release of off-normal relays 701 and 717 and the disconnection of the sender and trunk finder from the line-finder selector trunk circuit, Fig. 1, and in so doing releases relay 102 in order to connect the calling party through contacts 1 and 10 directly to the called party in the distant station.

With the above circuit combinations in mind a description may now be given of the disconnection of the called subscriber with the tip party relay 104 energized. Since relay 104 disconnected the line finder sleeve ground from the dual selector this dual selector may release upon the disconnection of the called subscriber. The release of relay 300 in the dual selector removes the locking circuit for relay 109 which causes the release of the latter relay. Since relay 104 retains ground connected to lead 140 extending to the mechanism of the line finder, the line finder is retained in connection with the calling subscriber's line and the cut-off relay of this line remains operated since ground from lead 140 extends through contact 3 of relay 114, winding of the cut-off relay to battery. This also presents a busy condition on the sleeve of the calling line. Relay 232 is operated and therefore relay 104 remains locked through contact 1 of relay 232 to ground on contact 5 of relay 104. A bridge is now placed across the tip and ring conductors of the dual selector to cause the reoperation of the A relay 302. This bridge may be traced from ground, through the upper winding of the A relay 302, contact 2 of relay 103, contact 2 of relay 104, contact 7 of relay 110, contact 2 of relay 109, resistance 113, contact 3 of relay 103, lower winding of the A relay 302 to battery.

Reselection of sender

Relay 302 is therefore again operated and causes the energization of the B relay 303 and the start relay 217. This energizes the trunk-finder

circuit 200 and causes the association of a sender with the line-finder trunk circuit, Fig. 1. The circuit for relay 217 may be traced from battery, through its winding, contact 1 of relay 215, contact 6 of relay 110, contact 9 of relay 109, contact 8 of relay 110, to ground on contact 3 of B relay 303. The operation of relay 217 connects ground from contact 2 of relay 215 through contact 3 of relay 217, thence over lead 260 to the trunk-finder start relay for energizing the trunk-finder circuit 200 which is connected to a sender and causes its brushes 220 to 227, inclusive, to select the trunk finder energizing this start circuit. Upon the connection of the sender to the line finder selector trunk circuit, the off-normal relay 701 is energized over the sleeve lead 261, the same as previously described. Relays 702 and 717 are also energized as previously described. It will be remembered that battery through resistance 703 and the winding of relay 702 is connected to lead 265 through the upper winding of relay 109 and the winding of relay 102 to ground on contact 4 of relay 303 which causes the energization of relays 102 and 702. But, as previously explained, the resistance of relay 702 and resistance 703 is too high to cause the energization of relay 109. The relays of the sender are thus energized and the class relays of Fig. 4 are connected to the line-finder selector trunk circuit, Fig. 1.

Class of service indication

Lead 262 is connected to the lead 182, lead 268 to lead 180 and lead 267 to lead 181. Lead 182 extends through contact 2 of relay 111, contact 2 of relay 102 to low resistance ground connected to the line. Lead 180 extends through contact 4 of relay 111, contact 3 of relay 104, contact 1 of relay 232 to ground on contact 5 of relay 104. Lead 181 extends through contact 7 of relay 111, contact 4 of relay 104, through the low resistance upper winding of relay 104 to ground. Since all of these ground circuits are of low resistance the marginal relays of Fig. 4 and the non-marginal relays are operated. Lead 262 extends through contact 3 of relay 407, winding of relay 402, winding of relay 406 to battery. Both of relays 402 and 406 are operated causing the extension of circuits from leads 267 and 268 through their contacts. Lead 267 extends through contact 2 of relay 407, contact 1 of relay 406, contact 2 of relay 605, winding of relay 401, winding of relay 405 to battery which causes the operation of both the latter relays. Lead 268 extends through contact 5 of relay 407, contact 4 of relay 406, contact 4 of relay 605, contact 2 of relay 600, winding of relay 400, winding of relay 404 to battery causing the operation of both relays 400 and 404.

With all the class relays operated a circuit is established for class of service relay 605 which may be traced from battery 609, through resistance 607, contact 1 of relay 403, contact 1 of relay 407, contact 1 of relay 600, contact 2 of relay 402, contact 1 of relay 404, contact 1 of relay 405, contact 1 of relay 401, contact 4 of relay 400, winding of relay 605 to ground on contact 3 of relay 701. Relay 605 in operating closes its contact 1 before opening its other contacts and in so doing establishes a locking circuit for itself from ground on contact 3 of relay 701, through its winding and contact 1, resistance 607 to battery 609. The operation of relay 605 presents positive battery 608 through resistance 606 to the winding of relay 104. This may be traced through contact 2 of relay 605, contact 1

of relay 406, contact 2 of relay 407, thence over lead 267 through the trunk finder to lead 181, through contact 7 of relay 111, contact 4 and upper winding of relay 104 to ground which differentially releases relay 104. The release of relay 104 does not disconnect ground from the sleeve lead 140 since ground is now associated with this lead from contact 3 of the B relay 303 and contact 8 of relay 111, maintaining the line finder operated and connected with the calling line. The operation of relay 605 also establishes a circuit for relay 407 from battery, through the winding of the latter relay, contact 7 of relay 605 to ground on contact 1 of relay 701. A circuit is also established to the biasing winding of relay 512 from ground through contact 6 of relay 605, resistance 510, lower winding of relay 512, resistance 518, contact 1 of jack 513 to 100-volt battery 562. This circuit is provided to make relay 512 more sensitive and permits it to operate when connected to a line ground which would cause its operation on a party identification test. The relays of Figs. 5 and 6 now operate as previously described for the party line test. Relays 614, 615, 505 and 510 operate in the manner previously described. The operation of relay 510 supplies ground through resistance 509 for operating relay 613. This circuit may be traced from battery, through the winding of relay 613 and its contact 1, contact 3 of relay 605, contact 2 of relay 614, contact 1 of relay 510, resistance 509 to ground. Relay 613 in operating locks through its continuity contact to ground on contact 3 of relay 701 and releases relay 614. The release of relay 614 releases relay 615. With relays 615 and 614 released and relay 510 operated, a circuit is established from 110-volt battery 562 through the upper winding of relay 512 over lead 561 to junction point 641 and to the tip and ring conductors of the subscriber's line over the circuits from junction point 641 as previously traced.

It was previously stated that relay 505 was energized when relay 701 and relay 717 operated. This circuit extends from ground on contact 1 of relay 701, through resistances 503 and 504, upper winding of relay 505 to battery on contact 4 of relay 717. Condenser 508 is thus charged for timing the release of relay 505. Relay 505 is thus differentially released in approximately .050 second and when released connects ground through contact 3 of relay 506, contact 2 of relay 510 to the armature of relay 512. If a false ground is now connected to the calling line with the receiver on the switchhook, relay 512 will have been operated when it was connected to the tip and ring conductors as previously stated. With relay 512 operated and relay 505 released, ground is connected through the armature and contact of relay 512, winding of relay 514, contact 4 of relay 515, resistance lamp 516 to battery. Relay 514 locks and establishes a circuit for operating relay 502. Relay 502 is operated through its lower winding, contact 3 of relay 514, contact 4 of relay 603, to ground on contact 2 of relay 717. Relay 502 shunts resistance 503 in series with the biasing winding of relay 505. Relay 506 is operated over an obvious circuit and the 110-volt battery supply 562 is opened by contact 3 of relay 602. Relay 505, due to the reduction of resistance in series with its upper or biasing winding, causes a rapid charge of relay 508 which releases this relay in .015 second. During the .015 second, 48-volt battery connected to the subscriber's line in conjunction with the varistor 617 and resistance 616 causes the discharge of the

line in such a way as to prevent bell tapping at the subscriber's station.

Party line testing trunk route relay

The operation of relays 514 and 502 establishes a circuit for relay 511 as a signal to the sender that ground is connected to the line conductor with the receiver on the switchhook. The circuit for relay 511 is traced from battery, through its upper winding, contact 5 of relay 502, contact 3 of relay 514, contact 4 of relay 603 to ground on contact 2 of relay 717. Relay 511 establishes a circuit for relay 611 traced from battery, through its winding, contact 1 of relay 511, contact 1 of relay 500, to ground on contact 1 of relay 701. The operation of relay 611 with relay 600 normal operates route relay 710 which causes the sender to automatically transmit pulses to the dual selector circuit. This route relay is operated from ground on contact 1 of relay 611, contact 3 of relay 600, winding of route relay 710 to battery. It will be remembered that during the original test of the line for determining whether a tip or ring party is calling, relay 600 is operated by the class relays and thus at that time a circuit for this route relay cannot be established. The functions of the route relay will be later described.

If relay 512 did not operate when connected to the tip and ring conductors of the line, as would be the case when no false ground existed on the line with the receivers on the switchhook, it would indicate that the tip party of the line made the original call, that the line is in good condition and that the tip party was properly charged for the call. Therefore, at the time that relay 502 is operated with relay 512 normal, a circuit is established for relay 515 from battery, through lamp 516, winding of relay 515, contact of relay 512 normal, contact 2 of relay 510, contact 3 of relay 506, contact of relay 505 to ground through contact 2 of relay 717. With relay 515 operated a circuit is established for relay 500 from battery through its upper winding, contact 4 of relay 502, contact 3 of relay 515, contact 4 of relay 603 to ground on contact 2 of relay 717. The operation of relay 500 causes the immediate release of the sender by the operation of relay 704. The circuit for relay 704 may be traced from battery through its winding, contact 5 of relay 605, contact 1 of relay 500 to ground on contact 1 of relay 701. It will be remembered that relay 605 was operated by the class relays to make the false ground test. Since the tip and ring conductors from the calling subscriber's station extend through contacts 3 and 4 of relay 704, the line is therefore opened by the operation of relay 704. The fundamental tip lead also extends through contact 2 of relay 704 to the pulsing mechanism of the sender and therefore the fundamental extending to the dual selector is also opened causing the release of the A relay 302 and B relay 303 in the dual selector. The release of relays 302 and 303 removes the sleeve ground from lead 355 and since the sleeve ground from lead 140 was previously disconnected by the release of relay 104, the relays in the trunk-finder circuit 209 are released and ground is removed from sleeve lead 261. This opens the circuits to the sender causing the release of relays 701, 702 and 717. The sender and the trunk finder 200 thus restore to normal. Since the ground is removed from the line finder, the line finder also restores to normal and the line-finder selector trunk circuit restores to normal.

In the event that false ground is found upon the calling subscriber's line thus causing the operation of route relay 710 in the manner previously described, the pulsing mechanism of the sender is automatically energized. For this description it may be assumed a two-digit code is required to connect the dual selector with the party line testing trunk circuit shown in Fig. 3. This trunk circuit determines the nature of the difficulty on the line when the line is held and connected thereto by the sender.

Relays 1007, 1008 and 1009 are used for transmitting three-digit, two-digit and one-digit codes and the relay operated is the starting point of progression through the progress relays shown in Fig. 10. Relay 1007 is operated for a three-digit code; relay 1008 for a two-digit code, and relay 1009 for a one-digit code. The contacts of these relays are taken through the contacts of the route relay to contacts of relays in Fig. 11 to determine the number of pulses for each digit. For example, on a two-digit code the contacts of relay 1008 are connected through a contact of the route relay to a number contact of one of relays 1100 to 1105 in Fig. 11 to determine the number of pulses in the first digit transmitted by the sender. After the first digit is transmitted by the sender, relay 1009 is operated which associates a circuit through its contact and the contact of the route relay to a number contact on one of the relays shown in Fig. 11 to determine the number of pulses the sender shall transmit for the second digit. Relays 918, 919 and 920 are also used for one-, two- and three-digit codes. Relay 918 is connected through a contact of the route relay for transmitting a one-digit code, relay 919 is connected through a contact of the route relay for a two-digit code and relay 920 for a three-digit code. Since it has been assumed that the party line testing trunk of Fig. 3 will be selected by transmitting a two-digit code, the winding of relay 919 is shown connected through contact 4 of the route relay 710 to ground, thus operating relay 919 when the route relay 710 is operated. This establishes a circuit for the two-digit relay 1008 which may be traced from battery, through its winding, contact 2 of relay 1009, contact 2 of relay 919, contact 1 of relay 921, contact 4 of relay 907 to ground. The operation of relay 1008 connects ground from contact 5 of relay 717, contact 3 of relay 909, lower contacts of progress relays 1000 to 1006 inclusive, lower contacts of relays 1012, 1010, 1009, inner contact 4 of relay 1008 which is operated, contact 1 of route relay 710, and contact 3 of relay 1103. Relay 1103 operates when the fourth pulse is transmitted, as will be explained later, indicating that four pulses comprise the first digit transmitted by the sender for elevating the dual selector brushes. Thus when relay 1103 is operated a circuit is established through its contact 3 from the circuit previously traced, contact 5 of relay 1105, thence over lead 1143, winding of relay 907, resistance 901 to battery. This operates relay 907 which terminates the transmission of pulses as will be explained later. To continue the explanation of the operation of relays 1008 and 1009 before proceeding with the transmission of pulses, the circuit for relay 1009 may be described between the transmission of the first pulse and the transmission of the second pulse. Between the first and second pulse, relay 921 is operated. After the first digit, relay 907 is released before the second digit

mechanism is operated and the release of relay 907 establishes a circuit from ground through its contact, inner contact 1 of relay 921 operated, contact 1 of relay 919, contact 1 of relay 1005, contact 2 of relay 913, contact 2 of relay 1012, contact 1 of relay 1010, winding of relay 1009 to battery. Relay 1009 is thus operated for controlling the number of pulses transmitted for the second digit. It will be seen that ground over the path previously traced is connected to the inner contact 6 of relay 1009 operated for the second digit, thence through contact 2 of route relay 710 to contact 4 of relay 1100. Relay 1100 is operated for the first pulse and also for the seventh. Relay 1105 is operated for the sixth pulse and remains operated when the seventh pulse is transmitted. Consequently, relays 1100 and 1105 are held operated when the seventh pulse is transmitted. This connects the lead just traced through contact 4 of relay 1100, contact 4 of relay 1105, over lead 1143, winding of relay 907, resistance 901 to battery which terminates the second digit upon the transmission of the seventh pulse.

Sender pulsing

The pulses transmitted by the sender for operating the dual selector and subsequently connected selectors are generated by relay 800. Ground is connected to terminal 5 of relay 800 when relay 701 originally operated at the time that the sender is seized. Relay 800 is thus held unoperated and the polarized relays 814 and 816 are held operated. The ground on terminal 5 of the lower winding of relay 800 may be traced from ground on contact 6 of relay 701, over lead 1030, through contact 1 of relay 1009, contact 2 of relay 1008, contact 1 of relay 1007, lead 842, contact 3 of jack 801 to terminal 5 of relay 800. This extends through the lower winding of relay 800, winding of polarized relay 818, winding of polarized relay 814, resistances 809 and 808 to battery. As will be seen, the current is in the correct direction to operate relays 814 and 818 but maintains relay 800 unoperated. Ground is also connected to point 843 of the potentiometer from contact 7 of relay 701. The springs 6 and 7 of relay 701 are arranged so that contact 6 makes ahead of contact 7. The ground held on terminal 5 of winding 800 is removed by the operation of relay 1008 when the route relay operates this relay. It will be remembered that this ground extended through contact 2 of relay 1008. The removal of this ground permits the polarized relay 800 to generate pulses under the control of the potentiometer associated with relay 802 including condensers 804 and 805. Under normal conditions pulses are generated at 10 pulses per second but when desired can be arranged to generate pulses at 20 pulses per second for pulsing into a cross bar or panel sender. The operation and release of relay 800 after the ground is removed from its winding of terminal 5 cause the responsive operation and release of relays 814 and 818. Relay 814 interrupts the circuit of the fundamental tip and the fundamental ring leads to cause the operation and release of the dual selector A relay 302. Pulses from the contact of relay 818 are counted by relays 915, 916, 917 and relays 1100 to 1105 inclusive, as previously indicated. Relay 818 in its operated position establishes a circuit for relay 915 from battery, through its winding, contact 1 of relay 917, contact of relay 818 to ground on contact 5 of relay 717. The first release of relay 818 causes relay 917 to

operate and hold relay 915. The next operation of relay 818 operates relay 916, holds relay 917 and releases relay 915. The next release of relay 818 releases relays 916 and 917. This continues for successive pulses to establish circuit for successive progress relays, Fig. 11. Up to the time when pulsing begins the contact of relay 814 has been holding the A relay 302 of the first or dual selector energized at the same time that relay 818 holds relay 915 energized. The circuit for the A relay 302 may be traced over the pulsing circuit from battery, through its lower winding, contact 3 of relay 103, contact 1 of relay 111, thence over lead 181 as previously traced, through the trunk-finder circuit 200 to the ring lead 267 of the sender, contact 2 of relay 407, contact 3 of relay 811, resistances 823 and 822, contact 2 of jack 815, contact of relay 814, returning now over the tip conductor through contact 1 of jack 815, contact 2 of relay 704, contact 5 of relay 407, thence over lead 268 through the trunk-finder circuit 200, lead 180, contact 3 of relay 111, contact 2 of relay 103, upper winding of the A relay 302 to ground.

The pulsing period begins as soon as ground is removed from the winding terminal 5 of relay 800 and relays 814 and 818 are immediately released. This ground is removed from winding terminal 5 of relay 800 by the operation of the route relay and the subsequent operation of one of the pulse control relays 1007, 1008 or 1009. Relay 800 functions under the control of the potentiometer including resistances 804 and 805 and the current for operating relay 900 causes the release of relays 818 and 814, as will be apparent by the markings on windings of these polarized relays. Each release of relay 814 causes the release of the A relay 302 of the dual selector. The first release of relay 818 removes a short-circuit from relay 917 causing it to operate in series with relay 915. A subsequent operation of relay 818 causes the operation of relay 916 and holds relay 917 operated. The next release of relay 818 causes the release of both relays 916 and 917 and the reoperation of relay 818 causes the operation of relay 815. This cycle of operation and release of relays 815, 816 and 817 occurs for each two pulses transmitted over the fundamental tip and fundamental ring conductors to the dual selector A relay 302. The first operation of relay 817 as the first pulse is transmitted causes the operation of pulse counting relay 1100. A circuit for relay 1100 may be traced from battery, through its winding, contact 1 of relay 1104, contact 1 of relay 1102, contact 1 of relay 1101, contact 1 of relay 1103, thence over conductor 1141, contact 4 of relay 917, contact 2 of relay 900 to ground on contact 5 of relay 717. As the second pulse is transmitted relay 917 is released which causes the operation of relay 1101 traced from battery through the winding of relay 1101, contact 2 of relay 1100, thence over lead 1140, contact 3 of relay 917, contact 2 of relay 900 to ground on contact 5 of relay 717. Since, as stated, the first digit comprises four pulses, relay 1103 is energized when the fourth pulse is transmitted, traced from battery, through its winding, contact 2 of relay 1102 which operated for the third pulse, thence over lead 1140, contact 3 of relay 917, contact 2 of relay 900 to ground.

The operation of relay 1103 establishes a circuit for terminating the pulses of the first digit by establishing an operating circuit for relay 907. The circuit for relay 907 may be traced from battery, through resistance 901, winding

of relay 907, lead 1143, contact 5 of relay 1105, contact 3 of relay 1103, contact 1 of the route relay, contact 4 of relay 1008 to ground as previously traced, through the contacts of the progress relays to contact 5 of relay 717. The winding of relay 907 is short-circuited by ground on the contact of relay 818 until the last pulse of the digit ends and relay 818 is operated. The operation of relay 907 removes ground through its contact 4 to the armature 1 of relay 921 for holding the circuit for relay 1009 open during the interdigital period. Relay 907 in operating short-circuits the contacts of relay 814 and operates relay 908. Relay 908 also short-circuits the contacts of relay 814 and operates relay 921. The fundamental pulsing circuit is thus closed during the interdigital period. Relays 800, 814 and 818 continue to pulse but these pulses are not sent out over the fundamental. The next closure of the contacts of relay 818 during the interdigital period operates relay 900, the circuit for relay 900 extending through contact 1 of relay 907, winding of relay 900 and resistance 902 to battery. Relay 900 in operating establishes a holding circuit for relay 907 through its contact 1 and contact 1 of relay 907 to retain relay 907 operated until preparations have been made for the pulses of the subsequent digit. Relay 900 in operating releases relays 915, 916 and 917 and releases any of relays 1100 to 1105 which are operated. When relay 818 again operates as the pulses of this relay continue, relays 907 and 900 releases. The release of relay 907 establishes a circuit for the next in order progress relay which, in this case, is relay 1009 and removes the shunt on relay 909 to cause the operation of relay 909 in series with relay 908. Relay 909 is used during the interdigital period to count the period of time before the pulsing circuit for the next digit is established.

The operation of relay 909 connects ground from contact 5 of relay 717 through its contact 2, contact 4 of relay 827, lead 844, to the No. 4 contact on the No. 4 pulse relay 1103. Four cycles of relay 800 are followed with the contacts of relays 814 and 818. The contact of relay 814 is short-circuited by contact 1 of relay 908. This is part of an interval to permit the selector to recognize the end of a digit, operate its mechanism and find an idle selector or trunk. At the end of the four-cycle period, relay 907 operates as previously described, a circuit for this relay being established through contact 3 of relay 1103 after the fourth operation of the pulsing relays. This short-circuits relay 908 causing relay 908 to release. The release of relay 908 causes the operation of relay 922. Relay 800, 814 and 818 continue to pulse with the contact of relay 814 short-circuited by the contact of relay 907. Upon the next release of relay 818, relay 900 operates. This provides a holding circuit for relay 907 and releases relays 915, 916 and 917, 1100 to 1103 which were operated during the interdigital period. When relay 818 again operates, the circuit for relays 907 and 900 is open causing their release which recloses the locking circuits for relays 915 to 917, 1100 to 1105 so that when they operate they will lock to their locking ground. This also removes the short-circuit on the contact of relay 814 and releases relay 908. The release of relay 909 removes a ground from lead 844 and connects ground to the progress relays.

The interdigital interval may consist of four

pulse cycles plus one pulse cycle for operating relay 900 before the four cycles are counted. The entire interdigital interval therefore may consist of a plurality of pulse cycles. The number of pulses for the interdigital interval is determined by contacts of certain relays depending upon the routing of the call to either a step-by-step, cross bar, or panel office. When relay 907 releases during the interdigital interval the next relay in the chain of out dialing progress relays is operated. Thus at this time relay 1009 is operated as previously explained for transmitting the second digit to a selector. It will be recognized that relay 921 is released for one digit and operated for the next. Each operation or release of relay 921 and the subsequent release of relay 907 will operate the next out dialing progress relay in the order to be operated. Exception is set forth when some of the progress relays are skipped under the control of the route relay operated. This, however, is of no concern in the positioning of selectors for the selection of the party line testing trunk circuit, Fig. 3. A second selector may operate from pulses comprising the second digit in the same manner as described and thus the party line testing trunk is selected under the control of a route relay operated for controlling the pulsing system of the sender. One or two digits may be transmitted by the sender for selecting the party line testing trunk depending upon the location of this trunk.

It has been assumed that a false ground was found by the sender on the line which initiated the call from a two-party message rate line and that this condition was found when the sender was actuated through the agency of relay 104, the latter relay having been operated when the sender found, during the time the original telephone connection was established, that the tip party of a two-party message rate line had initiated the call. The sender after having been actuated a second time and associated with the line found a false ground connected with the line which may have falsely indicated that the tip party had made the original call. In response to finding the false ground on the line the sender automatically caused the selection of a route relay which connected the sender pulsing mechanism with the dual selector and caused pulses to be transmitted for connecting the dual selector with the party line testing trunk circuit, Fig. 3.

As previously outlined, the dual selector A relay 302 responds to the pulses from the sender and the B relay 303 remains operated during the pulsing of the digit. This selector operates in the usual manner for associating its brushes with the terminals of the party line testing trunk 320 or with a second selector which may be used to reach the party line testing trunk. The association of the dual selector with an idle trunk or selector causes the operation of cut-in relay 300. The operation of the selector cut-in relay when the party line testing trunk 320 is selected, dissociates the selector A relay from the sender and connects the trunk relay 327 through the line-finder selector trunk circuit to the sender fundamental circuit which at this time is closed. The operation of relay 327 when connected to the sender causes the operation of relay 328 and the operation of relay 328 causes the operation of relay 329. The circuits for operating these relays are obvious and need not be traced. Relay 328 connects ground to the sleeve lead 340 which

marks the terminal busy and this ground or a selector sleeve ground extends through the winding of relay 300 to maintain relay 300 operated. The operation of relay 329 lights lamp 335 through its contact 4, connects ground to the alarm circuit 339 through its contact 5 and lead 341. Relay 329 also connects ground to the sleeve lead 340 through its contact 6 and also connects busy tone through contact 3, contact 1 of relay 321, winding of relay 327 to ground. The circuit through contact 1 of relay 329 is not established at this time.

The sender is disconnected as soon as the last digit has been dialed for selecting the party line testing trunk circuit 320 which, in this example, is the second digit. The circuit for releasing the sender extends through relays which control the sending of the second digit and assures a time interval after the last digit has been sent out. Relay 811 operates during the sending of digit pulses since it will be noted that ground from contact 2 of relay 908 is connected through the winding of relay 811 to battery. Relay 811 releases when the digit has been completed. Relay 830 is operated through a contact of route relay 710, winding of the two-digit control relay 919 to battery. Relay 1009 is operated to control the number of pulses in the second digit. The circuit for releasing the sender may therefore be traced through the contacts of these control relays from ground on contact 4 of relay 907 which is released after a time period during the interdigital period, contact 1 of relay 921, contact 2 of relay 919, contact 2 of relay 1009, contact 1 of relay 912, contact 1 of relay 913, contact 1 of relay 830, contact 1 of relay 811, winding of sender release relay 708 to battery, operating the sender release relay. The operation of relay 708 removes ground from lead 266 releasing relay 111. Relay 708 also connects battery through low resistance 719 with conductor 265 which extends through the upper winding of relay 109, winding of relay 102 to ground on contact 5 of the latter relay. This operates relay 109 which opens the sleeve ground extending to the sender circuit. This ground extends to the sender circuit from lead 355 through contact 8 of relay 110, contact 9 of relay 109, contact 6 of relay 110, contact 3 of relay 215, contact 2 of relay 217, thence over lead 261 through the winding of the off-normal relay 701 to battery. The operation of relay 109 therefore causes the release of the trunk-finder circuit 200 and the sender by removing the ground and battery circuits from the sender relays. The release of relay 701, it will be noted, releases relay 717. The release of the trunk-finder circuit opens the circuit from the sender through relay 702, resistance 703 to battery and also through resistance 719 to battery, releasing relay 102. Relay 109, however, locks from battery through its lower winding, contact 9, contact 8 of relay 110 to the sleeve ground connected to lead 355. The release of relay 102 connects the subscriber's line to the mechanism of the party line testing trunk 320 in order that a test of the line or false ground can be made.

If a subscriber should remove the receiver either in station 150 or station 160 the busy tone connected to the tip conductor by the operation of relay 329 will be carried directly to the subscriber who will replace the receiver on the switchhook upon finding that the line is busy. If a subscriber does not have the receiver off the switchhook there will be no bridged condition for relay 327 and consequently the latter relay re-

leases which causes the release of relay 328. The release of relay 328 opens the operating circuit for relay 329 but relay 329 is slow in releasing and therefore at this time a circuit is established from ground through contact 1 of relay 328, contact of relay 329, winding of relay 321 to battery operating the latter relay. The tip and ring line conductors now extend through upper winding of relay 338. The tip conductor may be traced from the line thence over lead 346, contact 2 of relay 321, upper winding 323 of repeating coil 322, contact 3 of jack 337, upper winding of relay 338, contact 1 of jack 337 to battery. The ring conductor extends over lead 347, lower winding 325 of repeating coil 322 thence through the upper winding of relay 338 to battery. Thus both the tip and ring conductors are connected through the upper winding of relay 338 to test for the ground on either the tip or ring of the line. At this time a busy tone extends through contact 3 of relay 329, contact 1 of relay 321, lower and upper windings 326 and 324 of repeating coil 322 to ground. This busy tone will be transmitted to a subscriber who might remove the receiver from the switchhook when this test is being made. Relay 321 also connects ground to sleeve conductor 340. The lower winding of relay 338 is the biasing winding of the relay and is energized to make it more sensitive by associating ground from contact 3 of relay 321, resistance 345, contact 2 of jack 337, lower winding of relay 338, contact 1 of jack 337 to battery. This does not operate relay 338 but increases the speed of its operation if a high resistance ground is found on either the tip or ring conductor of the line. A false ground on either line conductor will thus operate relay 338 which connects ground from contact 3 of relay 321, winding of relay 339 to battery operating the latter relay. Relay 339 connects ground through the winding of relay 329 which holds relay 329 and does not permit it to release. Relay 339 also connects ground through its contact 1 to a peg count meter in the miscellaneous alarm circuit to show that the false ground was found by the party line testing trunk circuit and keep track of the number of false grounds which are found by this trunk. The alarm sounded by the connection of ground to lead 341 attracts the attention of the maintenance man who then makes an investigation of the line and may keep the line permanently busy by inserting a test plug in the line jack until this line has been cleared of trouble. As soon as the line is made busy the maintenance man may disassociate the line from the line finder, line-finder selector trunk circuit, dual selector and party line testing trunk which causes the release of relay 338. The release of relay 338 causes the release of relays 339 and 329. The release of relay 329 extinguishes the lamp 335 and removes the alarm indication over lead 341. This also removes ground from lead 340 which releases the dual selector and other circuits connected thereto.

If with both receivers on their respective switchhooks in stations 150 and 160 no ground is found on the line by the party line testing trunk circuit 320, relay 338 does not operate after the release of relay 327 and operation of relay 321. Consequently relay 329 releases after a short interval due to its slow releasing characteristic. The release of relay 329 extinguishes the lamp 335 and removes the ground connected to lead 341 so that the alarm is not sounded. Ground connected to lead 341 does not immediately sound the alarm since an arrangement is

provided so that the alarm will be sounded after this ground is connected thereto a predetermined period of time. The release of relay 329 disassociates tone from the line conductors and releases relay 321. The release of relay 321 removes ground from the sleeve lead 340 and causes the release of the dual selector, the line-finder selector trunk circuit and line finder thus freeing the line so that calls may be made by the subscribers in stations 150 and 160. Relay 321 is slow in releasing to actuate the peg count circuit after relay 329 has released. A circuit for this peg count meter may be traced from ground through contact 1 of relay 328, contact 2 of relay 329, contact 4 of relay 321, thence over lead 342 to a peg count meter in the miscellaneous alarm circuit 326. This meter indicates the number of times that the party line testing trunk circuit was called into service and a false ground was not found on the line.

What is claimed is:

1. In an automatic switching telephone office, lines including party lines having individual subscribers' stations with dials for each party, said lines and said party line stations having individual characteristic indicating means, line finders, register senders, means responsive to the initiation of a call over a line for connecting a line finder and a sender therewith, means operable in said sender for determining the character of a line connected thereto, means in said sender for determining and recording which party station of a party line is calling, means responsive to the connection of a party line with a sender for associating said sender party line station determining means with said line, a line finder locking device associated with the line finder, means in said party line station determining means operable in response to its connection with certain party line stations for operating said line finder locking device, means in said sender for completing a telephone connection corresponding to the digit pulses dialed by the calling subscriber and thereupon automatically disconnecting itself from said connection leaving the line finder locked to the calling line, means responsive to the release of the line by the calling subscriber controlled by said line finder locking device for reconnecting a sender with said line, a party line testing trunk, selectors associated with said line finder, means in said latter sender operated under the control of said line finder locking device for automatically causing the transmission of digit pulses by the sender for operating one or more of said selectors to connect said testing trunk with said line, and means in said testing trunk to determine the condition of said line and from the condition of the line determine whether the first sender correctly recorded the calling party line station.

2. In an automatic switching telephone office, lines including two party lines having individual subscribers' stations for each party, one of said party stations having an identifying signal source, said lines being subject to extraneous signal sources, line finders, register senders, line signal sources for classifying each character of line, means responsive to the initiation of a call on any line for connecting a line finder and a sender therewith, dials in each subscriber's station, electrically operable class of line devices in each sender responsive to a two-party line characterizing signal source for causing the sender connected with said line to determine which party station is being used for the call, a line finder locking device, means in said party station deter-

mining means operably responsive to the station identifying signal source in one station for operating said line finder locking device, means in said sender responsive to the manipulation of the subscriber's station dial for registering digits designating the office code and number of the called party and for responsively transmitting digit pulses for completing the telephone switching connection and thereafter automatically releasing itself from said connection, means in said line finder locking device for holding said line finder connected with said calling line after the connection is released by the calling party replacing the receiver on the switchhook and for reconnecting a sender with said line finder and line, a party line testing trunk, selectors associated with said line finder, means in said sender automatically operable under the control of said line finder locking device for automatically causing said sender to transmit digit pulses for operating one or more selectors to connect said party line testing trunk with said line and for releasing said latter sender, and means in said party line testing trunk to test whether the sender correctly determined which party line station initiated the call.

3. In an automatic switching telephone office, lines including two party lines having individual subscribers' stations for each party, one of said party stations having an identifying signal source, said lines being subject to extraneous signal sources, line finders, register senders, line signal sources for classifying each character of line, means responsive to the initiation of a call on any line for connecting a line finder and a sender therewith, dials in each subscriber's station, electrically operable class of line devices in each sender responsive to a two-party line characterizing signal source for causing the sender connected with said line to determine which party station is being used for the call, a line finder locking device, means in said party station determining means operably responsive to the station identifying signal source in one station for operating said line finder locking device, means in said sender responsive to the manipulation of the subscriber's station dial for registering digits designating the called office and called party and for responsively transmitting digit pulses for completing the telephone switching connection and thereafter automatically releasing itself from said connection, means in said line finder locking device for holding said line finder connected with said line after the connection is released by the calling party replacing the receiver on the switchhook and for reconnecting a sender with said line finder and line, a party line testing trunk, selectors associated with said line finder, means in said sender automatically operable under the control of said line finder locking device for automatically causing said sender to transmit digit pulses for operating one or more selectors to connect said party line testing trunk with said line and for releasing said latter sender, and means in said party line testing trunk to determine whether an extraneous signal source is connected to either conductor of said two-party line with the receivers of said party line stations on their respective switchhooks.

4. In an automatic switching telephone office, lines including two party lines having individual subscribers' stations for each party, one of said party stations having an identifying signal source, said lines being subject to extraneous signal

sources, line finders, register senders, line signal sources for classifying each character of line, means responsive to the initiation of a call on any line for connecting a line finder and a sender therewith, dials in each subscriber's station, electrically operable class of line devices in each sender responsive to a two-party line characterizing signal source for causing the sender connected with said line to determine which party station is being used for the call, a line finder locking device, means in said party station determining means operably responsive to the station identifying signal source in one station for operating said line finder locking device, means in said sender responsive to the manipulation of the subscriber's station dial for registering digits designating the called office and called party and for responsively transmitting digit pulses for completing the telephone switching connection and thereafter automatically releasing itself from said connection, means in said line finder locking device for holding said line finder connected with said line after the connection is released by the calling party replacing the receiver on the switchhook and for reconnecting a sender with said line finder and line, a party line testing trunk, selectors associated with said line finder, means in said sender automatically operable under the control of said line finder locking device for automatically causing said sender to transmit digit pulses for operating one or more selectors to connect said party line testing trunk with said line and for releasing said latter sender, means in said party line testing trunk to determine whether an extraneous signal source is connected to either conductor of said two-party line with the receivers of said party line stations on their respective switchhooks, and means in said testing trunk operably responsive to the connection of an extraneous signal source to either line conductor for holding said line out of service for inspection and for sounding a line inspection alarm.

5. In an automatic switching telephone office, lines including party lines having individual subscribers' stations with dials for each party, said lines and said party line stations having individual characteristic indicating means, line finders, senders having registers operable by subscribers' dial pulses and pulsing mechanism for controlling selections, means responsive to the initiation of a call over a line for connecting a line finder and a sender therewith, means in said sender for completing a telephone connection corresponding to the digit pulses dialed by the calling subscriber, means operable in said sender for determining the character of a line connected thereto, means in said sender operable between two successive digits dialed by the calling subscriber for determining and recording which party station of a two-party line station is calling, means responsive to the connection of a two-party line with a sender for associating said party line station determining means with said line, a line finder locking device associated with a line finder, means in said party line station determining means operable in response to its connection with said party line stations for operating said line finder locking device, means in said sender for automatically disconnecting itself from said line connection after completion leaving the line finder locked to the calling line, means responsive to the release of the line by the calling subscriber controlled by said line finder locking device for reconnecting a sender with said

line, a party line testing trunk, selectors associated with said line finder, means under the control of said line finder locking device for operating said latter sender for testing the condition of said line with the party station receivers on their respective switchhooks, means operated by an unstandard line for associating the sender pulsing mechanism with said selectors, and means independent of the sender registers for controlling the operation of said pulse mechanism to connect said party line testing trunk with said line and cause the disconnection of said latter sender after the last pulse is transmitted for positioning one or more of said selectors, and means in said trunk for holding an unstandard line out of service and for sounding an inspection alarm.

6. In a telephone system, lines including party lines having individual subscriber stations with dials for each party, said lines and said party line stations having individual characteristic indicating means, line finders each having a trunk and a first selector permanently connected therewith, senders each having a trunk selector permanently connected therewith, means responsive to the initiation of a call over one of said lines for starting a line finder to hunt for said line and for starting a trunk finder to hunt for the trunk permanently connected with said hunting line finder, thus connecting a line finder with said line and a sender with said trunk permanently connected with the line finder, means in said trunk operated by said sender connection for connecting the sender with the line, dials in each subscriber station, a register in said sender responsive to the manipulation of a dial in the calling subscriber's station for controlling said sender in the automatic completion of a telephone con-

nection, means in the connected sender responsive to its actuation for associating class identifying means with said calling line classifying signal source for operating a class mechanism as a signal to the sender covering the class of line connected thereto, means responsive to the operation of class mechanism indicating that the sender is connected to a party line for connecting party station identifying means with said line, means responsive to the individual station characteristic signal source of one of said stations but non-responsive to the alternate one of said party stations, means in said sender responsive to said station characteristic signal source for operating the line finder locking device in said trunk arranged to hold the line finder connected with the line after the calling subscriber has released the connection, means responsive to the disconnection of said connected subscribers for recalling a sender under the control of said line finder locking device, means for operating said latter sender under the control of said line finder locking device and independent of said sender registers for determining whether extraneous signal sources are falsely connected to said line, said tests being made with the receivers of said party line stations on their respective switchhooks, a party line testing trunk, pulsing devices in said sender and a route relay automatically operated by said line testing means for causing digit pulses to be transmitted by said sender operating said first selector to connect said testing trunk with said calling line, means responsive to the selection of said testing trunk for releasing said latter sender, and means in said testing trunk for holding said line for repairs and for sounding an alarm.

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