Oct. 2, 1945. C. E. LOMAX 2,386,126

TELEPHONE SYSTEM

Filed Jan. 8, 1943 3 Sheets-Sheet 1

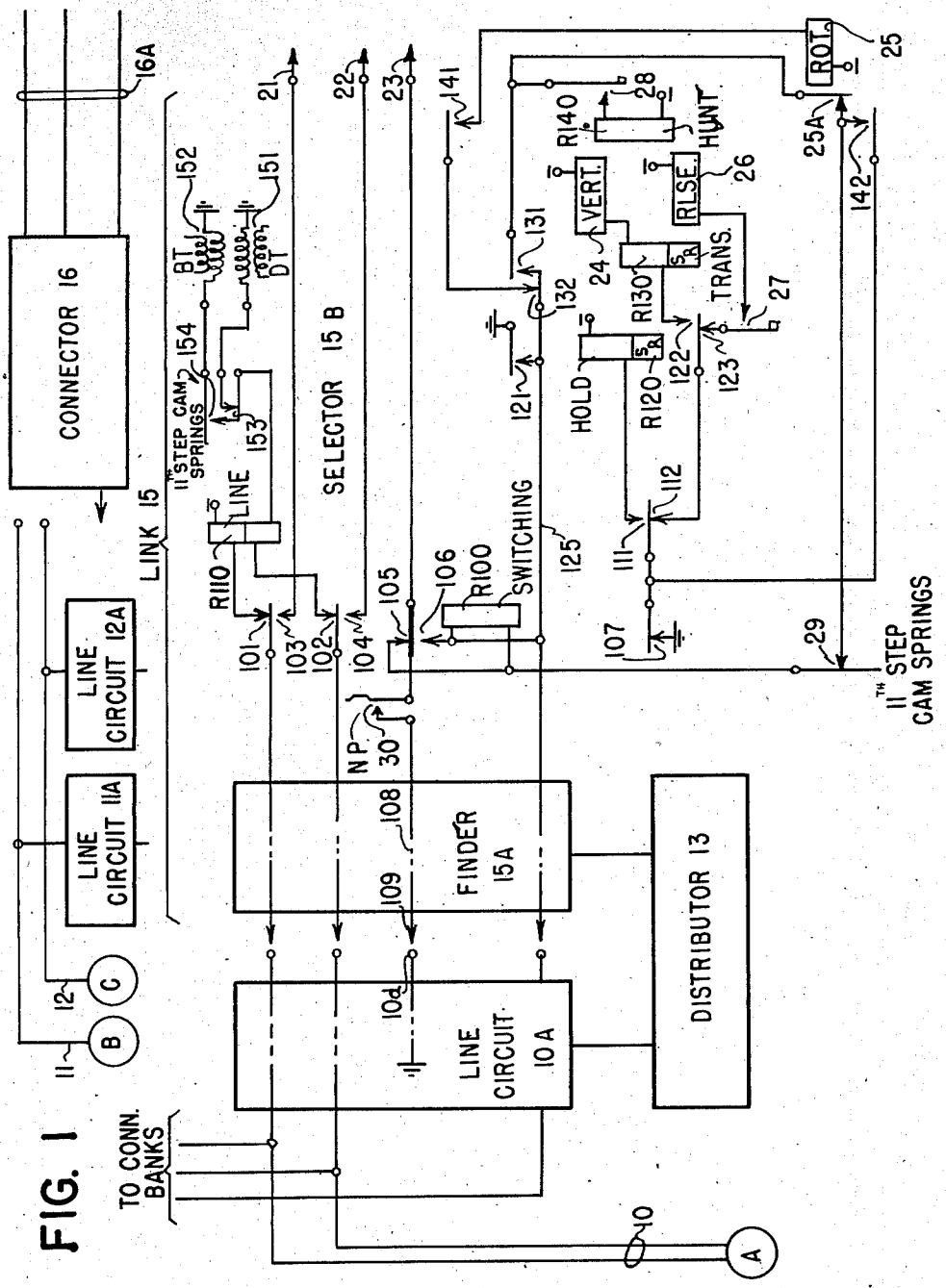


FIG. 1

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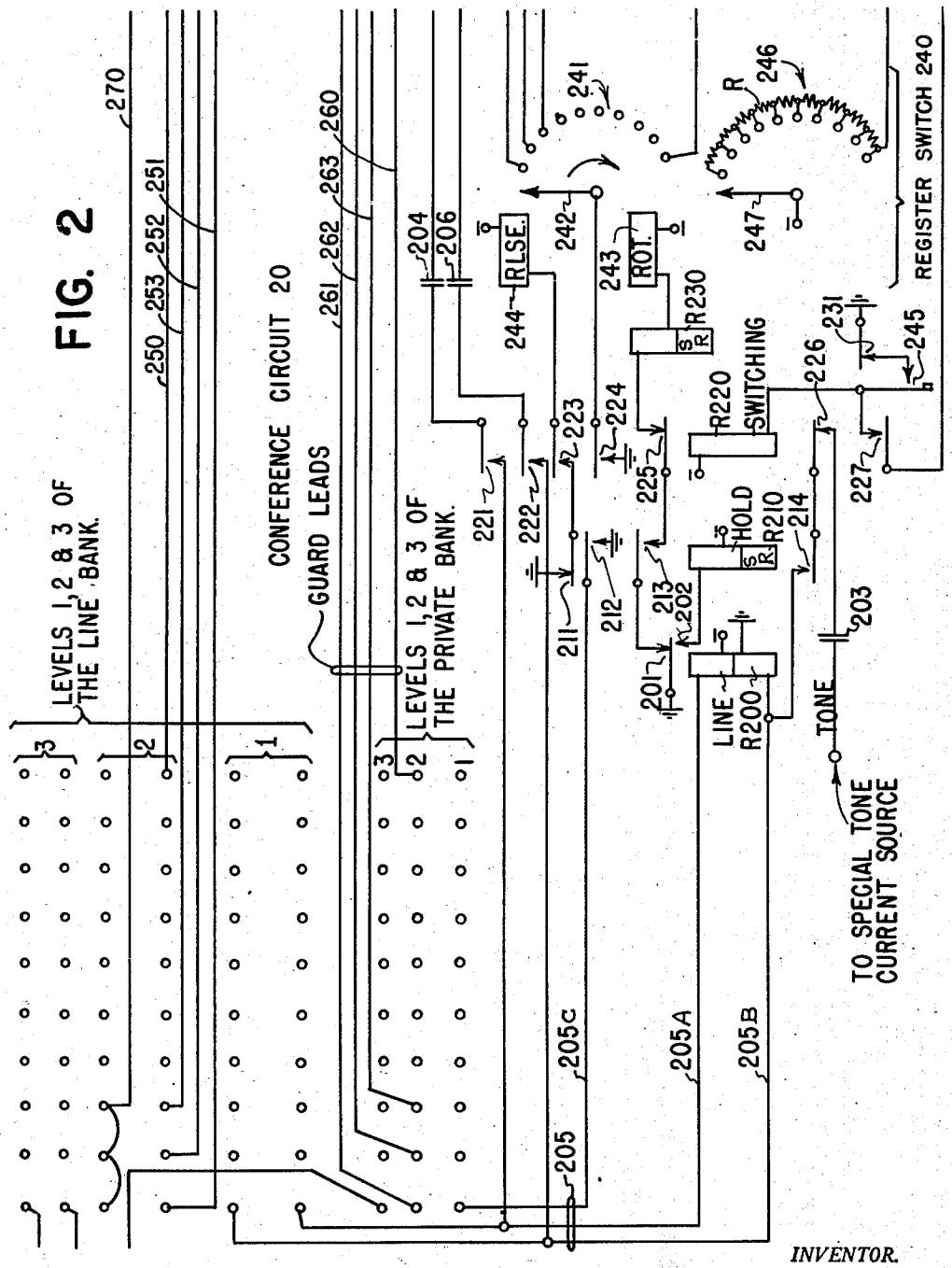
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Oct. 2, 1945. C. E. LOMAX 2,386,126

TELEPHONE SYSTEM

Filed Jan. 8, 1943 3 Sheets-Sheet 2

FIG. 2



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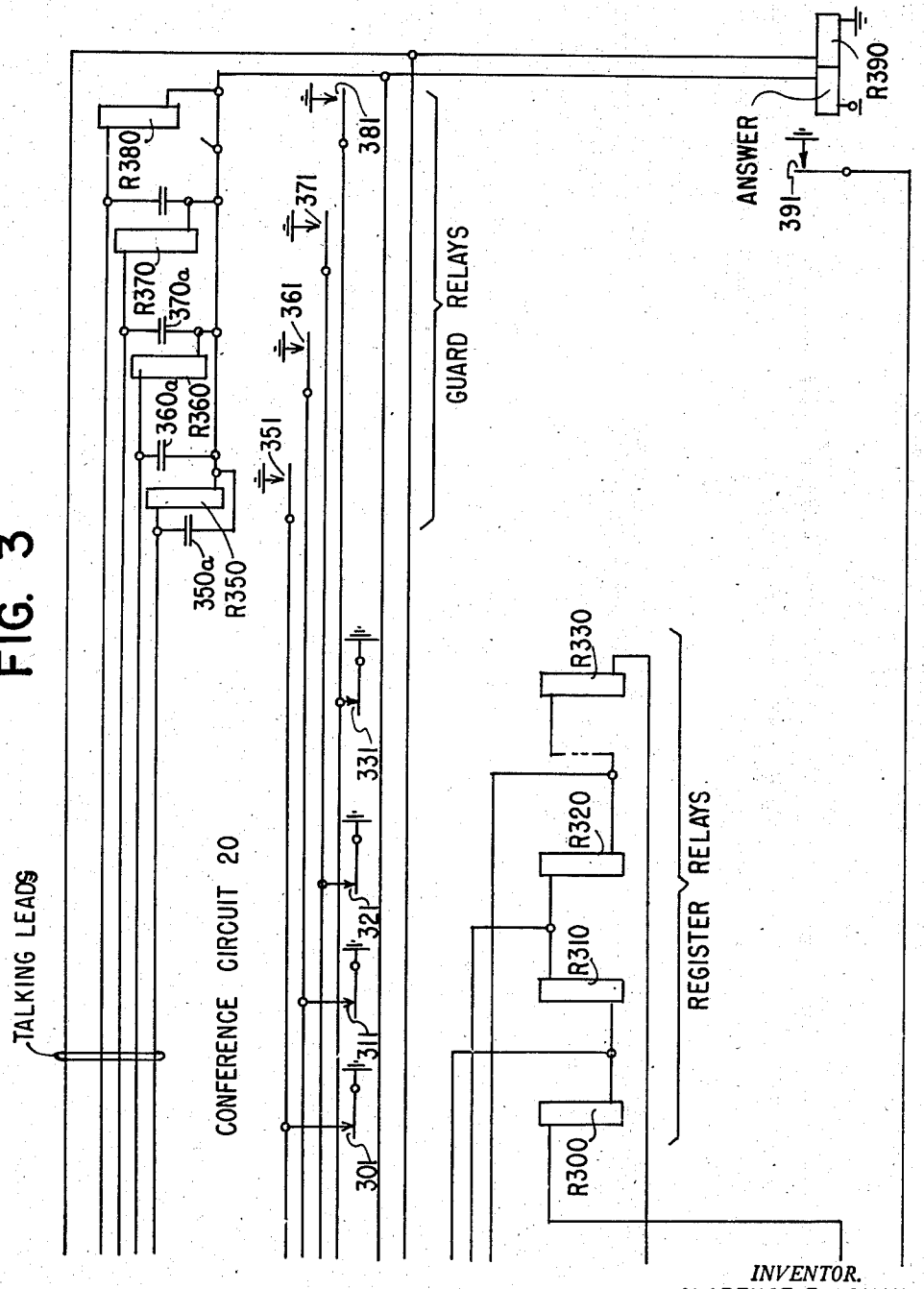
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TELEPHONE SYSTEM

Filed Jan. 8, 1943 3 Sheets-Sheet 3

FIG. 3



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Patented Oct. 2, 1945

2,386,126

UNITED STATES PATENT OFFICE

2,386,126

TELEPHONE SYSTEM

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Application January 8, 1943, Serial No. 471,684

19 Claims. (Cl. 179—18)

The present invention relates to telephone systems and more particularly to improvements in facilities for providing conference service in telephone systems of the automatic type.

Conference service facilities are usually provided in automatic branch exchanges to enable three or more parties to be telephonically interconnected at the same time. The usual arrangement for this purpose is that in which each party desired in a conference connection is notified, either by code, calling or separate communications, to call a predetermined conference number at a designated time. If code calling is used to signal the parties desired in a conference, all parties entitled to conference service will join the conference connection by dialing an assigned conference number. On the other hand, if the party calling the conference desires to include therein only certain of the parties having conference service, only those parties will be notified on an individual basis.

It is an object of the present invention to provide an arrangement of the character described, wherein improved and exceedingly simple provisions are made for permitting only those parties desired in a given conference connection to gain access to the conference facilities.

It is another object of the invention to provide an improved arrangement of the character described, wherein only certain lines of the system are ever permitted to gain access to the facilities for rendering conference service.

It is a further object of the invention to provide an improved arrangement for rendering conference service wherein provisions are made for positively preventing more than a predetermined number of parties from gaining access to a given conference connection.

According to still another object of the invention, the facilities for limiting the number of parties to a given conference connection may be preset in advance of the parties entering the conference connection so that, after all authorized parties have joined the connection, further access to the connection is blocked.

According to a still further object of the invention the facilities for limiting the number of parties to a given conference connection may be automatically preset over any line of the system which is arranged for conference service.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which Figures 1, 2 and 3, when laid side by side in the order named, illustrate an automatic telepehone system provided with facilities for rendering conference service characterized by the features of the present invention.

Referring now more particularly to the drawings, the telephone system there illustrated comprises an automatic branch exchange at which are terminated a plurality of substation lines including the lines 10, 11 and 12 serving the substations A, B and C, respectively. Automatic switching apparatus is provided in the exchange for setting up connections between the various substation lines. This apparatus comprises a plurality of finder-selector links, including the link 15, and a plurality of groups of connectors, one of which includes the illustrated connector 16. More specifically, the finder-selector links are arranged in groups, each group being adapted to serve a particular group of lines terminating in the exchange. Each group of links has associated therewith a distributor having the function of assigning idle ones of the links to the use of calling lines in the associated group in a predetermined order. Thus a distributor 13 is provided for allotting the link 15 and the other links of the same group to the use of calling lines in the associated line group. This distributor is arranged to be controlled over a start circuit commonly extending to the various line circuits at which the substation lines are individually terminated, the three illustrated lines 10, 11 and 12 being shown as extending to the line circuits 10A, 11A and 12A, respectively. For the purpose of enabling conference connections to be set up between certain of the lines served by the exchange switching equipment, a conference circuit indicated generally at 20 is provided. This circuit may be seized over the first and second contact levels of the exchange selectors in the manner described below.

The finder, selector and connector switches of the exchange, as well as the line circuits and distributors, may be of any desired commercial construction, although, preferably, the enumerated line selecting switches are of the well-known Strowger type and the distributors are of the well-known rotary type. Each finder is provided with a fourth or special service control path therethrough which is utilized to prevent those lines of the system which are not arranged for conference service from gaining access to the illustrated conference circuit 20. Thus the finder 15A

is shown as including a fourth wire path 108 which extends to the wiper 109 and is utilized to indicate to the selector 15B those lines which are not permitted to obtain access to the conference circuit 20.

More specifically considered, all selectors of the system are of the open circuit searching type and are of the identical arrangement. The illustrated selector 15B is shown as comprising a two-motion switching mechanism of the Strowger type which includes line and private contact banks arranged in ten levels of ten contact sets each. In order to facilitate the following explanation pertaining to the operation of the system, the first three levels of contacts in each of the line and private banks of the selector 15B have been shown in Fig. 2 of the drawings. It is pointed out in this regard that direct multiples are used to connect corresponding contacts of the selector banks of all selectors in the exchange. The Strowger switching mechanism of this selector further comprises line wipers 21 and 22 associated with the contacts forming the line bank of the mechanism; a private or test wiper 23 associated with the contacts forming the private bank of the mechanism; a vertical magnet 24 operative to move the enumerated wipers vertically to a position opposite a desired level of bank contacts; a rotary magnet 25 operative to rotate the enumerated wipers into engagement with the contacts of a desired contact set in a selected level; a release magnet 26 which, when energized, permits the enumerated wipers to be returned to normal; vertical off-normal springs 27 and 28 which are operated when the enumerated wipers are moved off normal; eleventh step cam springs 29, 153 and 154 which are operated when the enumerated wipers are rotated to any eleventh rotary off-normal position thereof; and normal post springs 30 which are only operated into engagement when the enumerated wipers are moved to the first or second vertical off-normal positions thereof. The relay equipment of this selector comprises a switching relay R100, a line or pulsing relay R110, a slow-to-release hold relay R120, a slow-to-release transfer relay R130 and a hunting relay R140. Busy and dial tone signal currents may be delivered to connections routed to the selector, through the busy and dial tone transformers 152 and 151, respectively.

Briefly considered, the conference circuit 20, as illustrated in Figs. 2 and 3 of the drawings, comprises a control channel 205 which is accessible to each selector of the exchange through the first set of outlet contacts in the first contact level thereof. In addition, the conference circuit comprises a talking channel which includes the talking leads 205A and 205B of the control channel 205 and is provided with a number of branches, which respectively include the conductors 251, 252, 253 and 250 and commonly include the conductor 270, and respectively terminate at the ten sets of line contacts in the second contact level of each of the exchange selectors. These ten branches of the talking channel are normally marked as busy to the selectors over the ten guard leads 261, 262, 263, etc., 260. For the purpose of selectively removing the busy markings from any desired number of the enumerated guard leads, ten register relays, including the four illustrated relays R300, R310, R320 and R330, are provided. These relays are arranged to be selectively energized under the control of a register switch 240 of the well-known minor type. Briefly, this switch comprises two sets of contacts 241 and 246 of ten points each, wipers 242 and 247, an operating magnet 243 for driving the wipers 242 and 247 over the contacts of their associated contact sets, a release magnet 244 and a set of off-normal springs 245. In order to impart a predetermined setting to the register switch 240, under the control of impulses received over the talking leads of the control channel 205, a relay network is provided which comprises the usual line or pulsing relay R200, a slow-to-release hold relay R210, a switching relay R220 and a slow-to-release control relay R230. For the purpose of restoring the busy markings to the guard leads 261, 262, etc., as the various branches of the talking channel are seized in setting up a conference connection, a group of ten guard relays, including the four illustrated relays R350, R360, R370 and R380, are provided which individually correspond to the different branches of the talking channel. These relays are arranged to be energized in series with the windings of a common answer relay R390 which functions both as a battery feed relay and as a device for holding the switching relay R220 operated.

Briefly to consider the operation of the system, it may be assumed that a call intended for the substation B, for example, is initiated at the substation A. To initiate the call, the calling party at the substation A removes the receiver provided at this substation from its supporting hook or cradle, whereupon the usual calling loop circuit including the conductors of the line 10 is established between the substation and the line circuit 10A. When this circuit is completed, the line circuit 10A operates in the usual manner to mark the calling line in the banks of the finders having access thereto and to impress starting ground potential upon the start lead extending to the link distributor 13. When this lead is grounded, the finder of the previously assigned link operates in a well-known manner to seize the calling line. Assuming that the illustrated link 15 is utilized in setting up the connection, the wipers of the finder 15A are first elevated to a marked position opposite the level of bank contacts terminating the group of ten lines which includes the calling line 10, following which they are automatically rotated to a position wherein they engage the contacts terminating the conductors of this line. When the calling line 10 is thus seized the calling loop circuit is extended through the finder 15A to the selector portion 15B of the link, ground potential is impressed upon the private conductor of the calling line for the purpose of guarding this line against seizure, and the cutoff relay conventionally embodied in the line circuit 10A is operated to disconnect the distributor start lead from ground. In response to this operation, the distributor 13 functions to preselect another idle one of its associated links for use in handling the next initiated call.

When the calling loop circuit is extended through the contacts 101 and 102 and the cam springs 153 to include the windings of the line relay R110 and the secondary winding of the dial tone transformer 151, the line relay closes its contacts 111 to complete an obvious circuit for energizing the hold relay R120, and the usual dial tone signal is transmitted to the calling substation. At its contacts 112, the relay R110 opens a point in the circuits for transmitting switch directing impulses to the vertical magnet 24. The hold relay R120 now operates and closes its contacts 121 to connect the release conductor 125 to ground and

thus provide locking circuits for the operated relays of the finder 15A and the line circuit 10A. At its contacts 122, the relay R120 prepares the operating circuit for the series transfer relay R130. At its contacts 123, the relay R120 opens a point in the operating circuit for the release magnet 26. Following the operation of the hold relay R120 to perform the functions just described, the selector 15B is conditioned to respond to received impulses.

The first digit dialed at the calling substation is utilized for the purpose of directing the selector 15B in its operation to select an idle connector having access to the desired line 11. More specifically, the line relay R110 functions to repeat the impulses of the first digit to the series connected transfer relay R130 and vertical magnet 24 over a circuit which includes the contacts 107, 112 and 122. Upon operating in response to the release of the line relay R110 at the beginning of the open circuit period of the first impulse, the transfer relay R130 closes its contacts 131 to prepare the operating circuit for the hunting relay R140, and, at its contacts 132, opens a point in the operating circuit for the rotary magnet 25. Due to the slow-to-release characteristics thereof, the hold relay R120 and the transfer relay R130 remain operated throughout the series of impulses transmitted to the selector 15B. Each time a current pulse is delivered to the vertical magnet 24 through the break contacts 112 of the line relay R110, this magnet functions to elevate the wipers 21, 22 and 23 one step. It will be understood, therefore, that at the end of the digit these wipers are left standing opposite the level of bank contacts in which are terminated the trunks extending to connectors having access to the desired line 11. Incident to the vertical off-normal movement of the enumerated wipers, the off-normal springs 27 are closed to prepare the operating circuit for the release magnet 26, and the off-normal springs 28 are closed to complete a circuit through the contacts 131 and 121 for energizing the hunting relay R140. This relay, in operating, closes its contacts 141 to prepare the operating circuit for the rotary magnet 25. At its contacts 142, the relay R140 completes a path for short-circuiting the winding of the switching relay R100, this path extending from ground by way of the contacts 107 and 142, the cam springs 29, the winding of R100 and the contacts 121 back to ground. At its contacts 142, the relay R140 also completes a locking circuit for itself, this circuit extending from ground by way of the contacts 107, 142 and 25A, the off-normal springs 28 and the winding of R140 to battery.

Shortly after the first digit is ended and during the interdigit pause separating the dialing of this digit and the dialing of the second digit, the transfer relay R130 releases. At its contacts 131, the relay R130 opens the operating circuit for the hunting relay R140. At its contacts 132, the relay R130 completes a circuit through the contacts 121 and 141 for energizing the rotary magnet 25. When thus energized, the magnet 25 operates to rotate the wipers 21, 22 and 23 into engagement with the contacts forming the first contact set of the selected level, whereby the trunk extending to the first connector of the desired group is selected. If this connector, i. e. the connector 16, is busy, the test conductor of the associated incoming trunk 16A is marked with ground potential. On the other hand, if this connector is idle, the test conductor of the trunk 16A is marked by an absence of any potential thereon. In operating, the magnet 25 also opens its contacts 25A to deenergize the hunting relay R140. This relay now restores and opens its contacts 141 to deenergize the rotary magnet 25. At its contacts 142, the relay R140 opens another point in its own locking circuit. Assuming first that the test conductor of the trunk 16A is marked with ground potential, the rotary magnet 25, upon closing its contacts 25A reenergizes the hunting relay R140 in a circuit which includes the grounded test conductor of the trunk 16A, the test wiper 23, the contacts 105, the cam springs 29, the contacts 25A, and the off-normal springs 28. In this regard it will be noted that, if the selected first connector of the group is busy, the winding of the switching relay R100 is short-circuited over the trunk test circuit. In reoperating, the hunting relay R140 again locks to ground through its contacts 142 and recloses the operating circuit for the rotary magnet 25. This magnet, in operating the second time, opens its contacts 25A to again deenergize the hunting relay R140, and advances the wipers 21, 22 and 23 a second step in the rotary direction, whereby the trunk extending to the second connector of the group is selected for test. If the second connector of the group is also busy, the hunting relay R140 and the rotary magnet 25 cooperate in the manner just explained to advance the enumerated wipers a third step, whereby the third connector of the group is selected for test. More generally considered, these two circuit elements continue to interact for the purpose of driving the wipers 21, 22 and 23 across the contacts of the selected level until an idle connector of the selected group is found or until these wipers are operated to the eleventh rotary off-normal positions thereof.

If the enumerated wipers are rotated off the bank, i. e. to the eleventh rotary off-normal positions thereof, the eleventh step cam springs 29 opened to interrupt the test circuit through the windings of the hunting relay R140 and thus prevent this relay from reoperating when the rotary magnet 25 releases following the eleventh rotary step of the enumerated wipers. Thus, movement of these wipers in the rotary direction is arrested. Also incident to the eleventh rotary step of the enumerated wipers, the eleventh step cam springs 153 are opened to exclude the secondary winding of the dial tone transformer 151 from the calling loop circuit and the cam springs 154 are closed to include the secondary winding of the busy tone transformer 152 in this loop circuit. Thus, the transmission of the dial tone signal to the calling substation A is terminated, and a busy signal is transmitted to this substation to inform the calling party that the desired connection cannot be obtained. The manner in which the link 15 and the line circuit 10A are released when the calling party disconnects, will be clearly apparent from the following explanation.

As indicated above, if the first connector 16 of the desired group is idle at the time it is selected, the test conductor of the trunk 16A is disconnected from all sources of potential, whereby the circuit through the test wiper 23 for energizing the hunting relay R140 and for short-circuiting the switching relay R100 is not prepared incident to the selection of the trunk 16A. Accordingly, when the rotary magnet 25 releases at the end of the first rotary step of the wipers 21, 22 and 23, the switching relay R100 is energized in series with the hunting relay R140 over

a circuit which extends from ground by way of the contacts 121, the winding of R100, the cam springs 29, the contacts 25A, the off-normal springs 28, and the winding of R140 to battery. Since the winding of the switching relay R100 is of relatively high resistance, the hunting relay R140 does not operate when energized in this circuit. The relay R100, however, operates and opens its contacts 105 to interrupt the previously traced test circuit and the path over which its own winding is short-circuited during a trunk hunting operation. At its contacts 107, the relay R100 opens a point in the previously described circuits for energizing the relays R120, R130 and R140 and the magnets 24, 25 and 26. At its contacts 101 and 102, the relay R100 deenergizes the line relay R110 and opens the dial tone signaling circuit. At its contacts 103 and 104, the relay R100 extends the calling loop circuit by way of the wipers 21 and 22 and the talking leads of the trunk 16A to the windings of the line relay conventionally embodied in the connector 16. This line relay, in operating, energizes an associated hold relay having the function, among others, of connecting the test lead of the trunk 16A to ground. When this lead is connected to ground, the connector 16 is marked as busy in the banks of all selectors in the exchange, and locking circuits, including the test wiper 23 and the contacts 106, are completed for maintaining energized the switching relay R100 and the operated relays of the finder 15A and the line circuit 10A.

As indicated above, the line relay R110 is deenergized and releases in response to the operation of the switching relay R100. In releasing, this line relay opens its contacts 111 further to interrupt the operating circuit for the hold relay R120 and closes its contacts 112 to prepare the operating circuit for the release magnet 26. The hold relay R120, upon restoring, opens its contacts 122 further to interrupt the circuit for transmitting current pulses to the transfer relay R130 and the vertical magnet 24 in series; and closes its contacts 123 further to prepare the operating circuit for the release magnet 26. At its contacts 121, the relay R120 disconnects the release conductor 125 from ground in the selector 15B, whereby the release of the operated switch train is transferred from the selector 15B to the connector 16.

The second digit of the directory number designating the desired substation B and transmitted through operation of the calling device provided at the substation A, is utilized in the connector 16 to select the group of ten lines in which the called line 11 is included. The third digit of the directory number dialed into this connector from the calling substation is utilized to rotate the wipers of this connector into engagement with the contacts terminating the conductors of the line 11. Immediately after the third and final digit of the directory number has been dialed into the connector 16, the control equipment of this connector functions to test the line 11 for the purpose of determining the idle or busy condition thereof. If the line tests busy, the usual busy tone signal is transmitted to the calling substation A to inform the calling subscriber that the desired connection cannot be obtained. In this case, no further operation of the switching apparatus occurs until the call is abandoned at the calling substation. If the call is abandoned, either before completion or after a busy line is selected, the connector 16, the link 15 and the line circuit 10A are released in substantially the manner explained below. If the called line tests idle, the control equipment embodied in the connector 16 is operated to its ringing setting, wherein ground potential is applied to the private conductor of the line 11 to mark this line as busy; the cutoff relay of the line circuit 11A is operated to disconnect the windings of its associated line relay from the conductors of the line 11; and interrupted ringing current is transmitted over the conductors of the line 11 to energize the ringer provided at the called substation A. The ringing equipment of the connector 16 also functions during the ringing operation to transmit ringing current over the calling end of the connection for the purpose of informing the calling subscriber that the called substation is being rung. The desired talking circuit between the two substations A and B is completed when the call is answered at the latter substation. More particularly, when the receiver provided at the called substation is removed from its supporting hook or cradle, an answering loop circuit is completed by way of the line 11 over which the ring cutoff relay conventionally embodied in the connector 16 is energized. This relay, in operating, opens the ringing current circuits and completes a talking circuit which extends through the link 15 and the connector 16 and connects the calling line 10 with the called line 11.

Preferably, the arrangement of the control apparatus embodied in the connector 13 is such that the release of the connection is entirely under the control of the calling subscriber. As thus arranged, when the calling party replaces the receiver provided at the calling substation A upon its supporting hook or cradle to interrupt the loop circuit extending to the connector 16, the control equipment and the switching mechanism of this connector are restored to normal in a manner well understood in the art. Incident to the release of the control relays embodied in this connector and, more specifically, when the hold relay thereof restores, the test conductor of the trunk 16A is disconnected from ground to deenergize the switching relay R100 and the operated relays of the finder 15A and the line circuit 10A. When the operated switch-through relay of the finder 15A releases, the Strowger switching mechanism of this finder is restored to normal in the usual manner. Incident to the release of the switching relay R100, the contacts 107 are closed to complete the prepared operating circuit through the contacts 112 and 123 and the off-normal springs 27 for energizing the release magnet 26. This magnet, in operating, attracts its associated holding pawl, permitting the wipers 21, 22 and 23 to be returned to rotary and vertical normal in the usual manner. Incident to the normalizing of these wipers, the off-normal springs 28 are opened further to interrupt the operating circuit for the hunting relay R140 and the off-normal springs 27 are opened to deenergize the release magnet 26. Following the release of this magnet, the selector 15B is fully restored to normal. In the event an all-trunks-busy condition is encountered in the selector 15B and the call is abandoned at the calling substation A, the line relay R110 and the hold relay R120 are sequentially released in the order named incident to the interruption of the calling loop circuit. In this case, the release conductor 125 is disconnected from ground to effect the release of the finder 15A and the line circuit 10A when the hold relay R120 opens its contacts 121. In releasing, this relay also closes

its contacts 123 to energize the release magnet 26, whereby the wipers 21, 22 and 23 are restored to normal. Incident to the normalizing of these wipers the off-normal springs 27 and 28 are opened; the cam springs 29 and 153 are closed; and the cam springs 154 are opened. At the off-normal springs 27, the release magnet 26 is de-energized in an obvious manner.

In considering the facilities provided for rendering conference service, it is pointed out above that only certain of the substations served by the exchange are permitted to gain access to the conference circuit 20. In the usual branch exchange system, this type of service is limited to the executives and department heads of the organization served by the exchange. For the purpose of preventing those substations of the system not entitled to conference service from gaining access to the conference circuit 20, special wiring of the line circuits respectively associated therewith is used. In order to explain how this is accomplished, the type of special wiring utilized is shown in conjunction with the line circuit 10A terminating the line 10 for illustrative purposes only. It will be noted that in this line circuit the special service contact 10d of the contact set at which the conductors of the line 10 are terminated is connected directly to ground, so that when the wipers of the finder 15A, for example, are positioned to engage the contacts of this contact set, the special service path 108 through this finder is terminated at ground. In this regard it will be recalled from the preceding explanation that each time the wipers 21, 22 and 23 of the selector 15B are elevated to a position opposite the first or second contact levels thereof the normal post springs 30 are moved into engagement. It is also noted that these normal post springs are reopened if the enumerated wipers are positioned opposite any contact level above the second contact level of the associated bank. With the normal post springs 30 engaged, a circuit including these springs, the special service path 108, the wiper 109 and the special service contact 10d, is provided for holding the switching relay R100 short-circuited and for continuing the energization of the hunting relay R140, independently of the potentials applied to the test wiper 23 during rotary movement of the wipers 21, 22 and 23. Accordingly, these wipers will, under the circumstances described, be rotated to the eleventh off-normal positions thereof, regardless of the idle or busy condition of the control channel 205 or the various branches of the talking channel embodied in the conference circuit 20. When these wipers are moved to the eleventh rotary off-normal positions thereof, the cam springs 29 are opened to arrest the rotary stepping movement; the cam springs 153 are disengaged to terminate the dial tone signal; and the cam springs 154 are moved into engagement to transmit a busy signal to the substation attempting to obtain access to the conference circuit 20. This signal serves to inform the calling party that the desired connection cannot be obtained. After receiving this signal, the calling party may release the link in the manner explained above.

In the line circuits which terminate the lines extending to substations that are to have conference service, the connections between the special service contacts of the finder banks and ground are omitted. Accordingly, when such a substation attempts to seize the conference circuit 20 through one of the links, such, for example, as the link 15, closure of the special service path at the normal post springs 30 is not effective to prevent the selector of the link from seizing either the control channel 205 or the various branches of the talking channel embodied in the conference circuit 20. Thus it will be apparent that, depending upon the wiring of the line circuits individual to the various substations of the system, any desired ones of these substations may be prevented from obtaining conference service without in any way impairing the ability of the other substations to utilize the conference facilities.

In considering the manner in which conference connections utilizing the conference circuit 20 may be set up, it may be assumed that the party for whose use the substation A is provided is entitled to conference service and desires to hold a conference with three other persons, two of whom are served by the substations B and C, respectively. In order to inform the desired persons that a conference is to be held at a specified time, the party at the substation A may utilize the automatic switching equipment of the exchange to call the three desired persons for the purpose of informing them of the time set for the conference. The manner in which the various connections are set up for this purpose is exactly the same as explained above with reference to the routing of a call from the substation A to the substation B.

Shortly before the time set for the conference, the person at the substation A who has called the conference, may seize the conference circuit 20 through one of the links of the exchange over the control trunk 205 and set the register equipment comprising the switch 240 and the register relays to indicate the number of substations that are to join the conference connection. Any one of the finder-selector links of the exchange may be utilized for the purpose of permitting the person who has called the conference to gain access to the conference circuit 20 over the control trunk 205. Assuming that the illustrated link 15 is utilized for this purpose, a single digit of one impulse is dialed into the selector portion 15B of the link by the calling party. This digit is utilized in the manner explained above to position the wipers 21, 22 and 23 on the contacts terminating the conductors of the control trunk 205. With the conference circuit 20 idle, the test conductor 205C of this trunk is marked by an absence of ground potential, whereby the switching relay R100 is permitted to operate and thus effect the switch-through operation of the selector 15B. Incident to this operation, the calling loop circuit is extended by way of the talking wipers 21 and 22 and the talking conductors 205A and 205B of the trunk 205 to the line terminals of the line relay R200. When the windings of the line relay R200 are thus included in the calling loop circuit, this relay closes its contacts 202 to complete an obvious circuit for energizing the slow-to-release hold relay R210. At its contacts 201, the relay R200 opens a point in the circuit for transmitting impulses through the series connected windings of the control relay R230 and the magnet 243. The hold relay R210, upon operating, closes its contacts 212 to connect the test conductor 205C to ground, whereby the conference circuit is marked as busy in the banks of the exchange selectors, and locking circuits are provided for the operated relays of the selector 15B, the finder 15A and the line circuit 10A. At its contacts 211, the relay R210 opens a point in the operating circuit for the release magnet 244. At

its contacts 213, the relay R210 prepares the circuit for transmitting impulses to the relay R230 and the magnet 243. At its contacts 214, the relay R210 completes a path, including the condenser 203 and the contacts 226, for transmitting a special tone signal current over the calling end of the connection. This current as reproduced by the receiver provided at the calling substations serves to inform the calling party that the desired connection with the conference circuit 20 has been made.

Upon receiving the special tone signal, the calling party at the substation A dials into the conference circuit 20 a digit, the numerical value of which indicates the number of lines that are to join the conference connection. In the present case, wherein it is assumed that three lines other than the line 10 are to be included in the connection, the calling party will dial the digit "3" as the second digit of the conference number. The line relay R200 in releasing during the open-circuit period of each impulse in this digit, functions to transmit three current pulses to the series connected windings of the control relay R230 and the operating magnet 243. Upon operating at the beginning of the open-circuit period of the first impulse in this digit, the relay R230 opens its contacts 231, thereby to prevent the switching relay R220 from being prematurely energized. Due to the slow-to-release characteristics thereof, the relays R210 and R230 remain operated throughout the digit. Each time a current pulse is transmitted to the magnet 243, this magnet operates to advance the wipers 242 and 247 one step. Accordingly, at the end of the digit, the wipers 242 and 247 are left standing in engagement with their associated third contacts. Incident to the off-normal movement of the wipers, the off-normal springs 245 are moved into engagement to prepare the operating circuit for the switching relay R220.

At the end of the digit, the line relay R200 is held energized in the calling loop circuit, thereby to deenergize the control relay R230 and to maintain the hold relay R210 in its operated position. Accordingly, the relay R230 is caused to restore shortly after the digit is ended. In releasing, this relay closes its contacts 231 to complete the prepared circuit through the off-normal springs 245 for energizing the switching relay R220. This switching relay, upon operating, opens its contacts 226 to interrupt the circuit for transmitting the special tone signal current over the connection to the calling substation and thus terminate the signal being transmitted to the calling party. At its contacts 227, the relay R220 prepares a locking circuit for itself. At its contacts 225, the relay R220 opens the circuit for transmitting current pulses to the series connected windings of the relay R230 and the magnet 243, thereby to prevent further operation of the register switch 240 in the event the calling device at the substation A is inadvertently reoperated or the hook or cradle switch is flashed at this substation. At its contacts 221 and 222, the relay R220 connects the common portion of the talking channel provided in the conference circuit 20 to the branches of this channel which respectively extend to the first to tenth talking contacts of the ten contact sets forming the second level in the line bank of the selector 15B. As previously indicated, suitable multiples are provided, whereby the ten branches of the talking channel are also rendered accessible to all of the selectors of the exchange.

At its contacts 224, the relay R220, upon operating, completes a circuit for energizing in series the three register relays corresponding to the first three branches of the talking channel in the order of their termination in the line contact banks of the second levels of the various selectors. More specifically, the relays R300, R310 and R320 are, in the present case, energized in response to the operation of the switching relay R220, the circuit for energizing these relays extending from ground by way of the contacts 224, the wiper 242 and its engaged third contact, the series connected windings of the relays R320, R310 and R300, seven units of the resistor R and the wiper 247 to battery. Each of the three energized register relays, in operating, removes guarding ground potential from its associated guard lead. Thus the relay R300, upon operating, opens its contacts 301 to disconnect the guard lead 261 from ground and thus render the first branch of the talking channel through the conference circuit 20 accessible to the selectors of the exchange. Similarly, the relays R310 and R320, in opening their contacts 311 and 321 to disconnect the two guard leads 262 and 263 from ground, render the second and third branches of the talking channel accessible to the selectors of the exchange. Following the operation of the three enumerated register relays no further operation of the equipment provided in the conference circuit 20 occurs until connections are extended to this circuit from the substations that are to join the conference connection.

In order for the persons who have been notified of the connection to gain access to the conference cricuit, it is necessary for each such person to initiate a call at his substation and dial the digit "2" into the selector of the particular link utilized in handling the call. From a consideration of the selector 15B it will be understood that, if this link is seized from the substation B, for example, and the digit 2 is dialed thereinto, the wipers of the selector will be operated to engage the contacts forming the first contact set of the second level following which the selector will switch through. This is true for the reason that guarding ground potential has been removed from the guard lead 261 at the contacts 301 of the operated register relay R300. Accordingly, if the first answering call is originated at the substation B and routed through one of the links to the first branch of the talking channel provided in the conference circuit 20, the calling loop circuit as set up through the link in use to the conference circuit 20 is extended by way of the conductors 251 and 270 to include in series the two windings of the answer relay R390 and the winding of the guard relay R350. When thus energized the guard relay R350 closes its contacts 351 to connect the guard lead 261 to ground and thus mark the first branch of the talking channel as busy in the banks of the exchange selectors. Also, when this lead is connected to ground, circuits are provided for maintaining energized the operated relays of the link in use and the cut-off relay of the line circuit 11A. The answer relay R390 also operates when energized in the loop circuit connecting the substation B with the conference circuit 20, and closes its contacts 391 to complete the prepared locking circuit for the switching relay R220.

With the first branch of the talking channel through the conference circuit 20 occupied with the answering call as originated at the substa-

tion B, the call next initiated at the second substation to join the conference will be extended to include the second branch of the talking channel, for reasons clearly apparent from the above explanation. More specifically, with the first branch of this channel marked as busy through the contacts 351 of the guard relay R350, the selector of the link occupied with the second call will necessarily operate to select the second branch of the talking channel, since this will be the first idle branch tested during rotary movement of the selector. When this branch is seized, the guard relay R360 is energized in the calling loop circuit in series with the windings of the answer relay R390. In operating, this guard relay closes its contacts 361 to impress guarding ground potential upon the guard lead 262, whereby the second branch of the talking channel is rendered nonaccessible to the exchange selectors and suitable locking circuits are established for maintaining energized the operated relays of the link occupied with the call.

In a manner similar to that just described, the third and only remaining idle branch of the talking channel is seized from the third substation to join the conference through the banks of the selector occupied with the call originating at the third answering substation. Incident to the seizure of this branch of the talking channel, the guard relay R370 is energized in series with the windings of the answer relay R390 and closes its contacts 371 to impress guarding ground potential upon the third guard lead 263. With the three relays R350, R360 and R370 operated in the guard relay group and only the three relays R300, R310 and R320 operated in the register relay group, all ten branches of the talking channel through the conference circuit 20 are marked as busy in the banks of the exchange selectors over the guard leads 261, 262, 263, etc., 260. Thus, other parties trying to obtain access to the conference circuit for the purpose of eavesdropping are blocked against seizure of any of the branches of the conference talking channel.

As each substation joins the conference connection in the manner explained above, a talking circuit is completed between this substation and the substation A. Thus the common branch of the talking channel as directly connected to the conductors of the line 10 extending to the substation A, includes the talking conductors 205A and 205B of the control trunk 205, the contacts 221 and 222, and the condensers 204 and 206. Talking battery is supplied to this circuit through the windings of the line relay R200. The first branch of the talking channel, i. e. that connected to the first of the called substations to join the conference connection, includes the common conductor 270, the branch conductor 251 and the by-pass condenser 350a shunting the winding of the guard relay R350. The second branch of the talking channel as extended to the second called substation to join the conference connection includes the common conductor 270, the branch conductor 252 and the by-pass condenser 360a shunting the winding of the guard relay R360. Finally, the third branch of the talking channel as connected through one of the links of the exchange to the third called substation to join the conference connection includes the common conductor 270, the branch conductor 253 and the by-pass condenser 370a shunting the winding of the guard relay R370. Talking battery is supplied to all three of these branches of the talking channel of the conference circuit 20 through the windings of the answer relay R390.

The release of the conference circuit 20 is partially under the control of the calling party at the substation A and partially under the control of the three called parties who joined the conference. Thus it will be noted that as the three connections extending to the three called substations, including the substations B and C, are released, the corresponding guard relays R350, R360 and R370 are deenergized and restore to disconnect their respective associated guard leads 261, 262 and 263 from ground. When the last of these connections is cleared out, the answer relay R390 is also deenergized and releases. This relay, in restoring, opens its contacts 391 to interrupt the holding circuit for the switching relay R220.

When the connection as extended from the calling substation A to the conference circuit 20 over the control trunk 205 is released at this substation, the line relay R200 and the hold relay R210 are sequentially released in an obvious manner. The relay R210, upon restoring, opens its contacts to disconnect the test conductor 205C of the trunk 205 from ground and thus effect the release of the link through which the connection was extended to the control trunk 205 from the calling substation A and the release of the line circuit 10A, all in the exact manner previously explained. At its contacts 211, the relay R210 completes a circuit through the contacts 223 for energizing the release magnet 244. This magnet, upon operating, attracts its associated holding pawl to permit the wipers 242 and 247 to be restored to normal. Incident to the release of this switch, the off-normal springs 245 are opened to interrupt the operating circuit for the switching relay R220.

From the above explanation it will be understood that the switching relay R220 is only deenergized when the connection extending to the calling substation A and the three connections extending to the called substations have all been released to effect the release of both the answer relay R390 and the register switch 240. Upon restoring, the switching relay R220 opens its contacts 223 to deenergize the release magnet 244. At its contacts 224, the relay R220 deenergizes the three series connected register relays R300, R310 and R320. These three relays, upon restoring, close their contacts 301, 311 and 321, respectively, to again impress guarding ground potential upon the three guard leads 261, 262 and 263, respectively. Following the release of these three relays the conference circuit 20 is fully restored to normal.

From the above explanation with reference to the operation of the conference circuit 20 it will be apparent that normally, i. e. when this circuit is not occupied with a conference connection, all ten branches of the talking channel are marked as busy in the banks of the exchange selectors. It will also be apparent that the register switch 240 and the ten register relays R300, R310, etc., constitute register means which may be present over any calling one of the lines entitled to conference service, to indicate the number of lines that are subsequently to gain access to the talking channel of the circuit. The setting of this register apparatus is determined entirely by the numerical value of the digit transmitted to the conference circuit over the control trunk 205. Thus, if a digit 8 is dialed into this circuit from a calling one of the substations, the register switch 240 will be operated to its eighth off-normal position to

effect the energization of eight of the series connected register relays with the result that the first eight branches of the talking channel are unguarded and rendered accessible to the exchange selectors. Similarly, if a digit comprising six impulses is dialed into the conference circuit, the register apparatus functions to unguard the first six branches of the talking channel, leaving the remaining four branches guarded against seizure.

In this connection it is pointed out that the wiper 247 and contact set 246, acting in conjunction with the resistor R, function to insure the same magnitude of current flow through the series connected windings of the register relays, regardless of the number of relays included in the circuit. To this end, each of the nine sections of the resistor R is chosen of a value equal to the winding resistance of each register relay. Accordingly, if only the winding of the first register relay R300 is included in the series energizing circuit, all nine sections of the resistor R are included in the circuit to limit the magnitude of current flow in the circuit. Again, if the switch 249 is operated to include the windings of four register relays in the series energizing circuit, six sections of the resistor R are included in the circuit to establish the same magnitude of current flow in the circuit. By virtue of this arrangement, overheating of the coils of the register relays when only a few or one of these relays is to be energized, is prevented.

It will also be apparent from the preceding explanation that, as each unguarded branch of the talking channel is seized through one of the exchange selectors, its associated guard relay operates to return the busy marking to the associated guard lead. Accordingly, when all of the branches of this channel that have been unguarded through operation of the register apparatus have been seized through the selectors of the exchange, guarding potential is restored to the associated guard leads through operation of the respective associated guard relays.

While one embodiment of the invention has been disclosed, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a plurality of lines a group of which are arranged for conference service, apparatus for providing conference connections between the lines of said group, and presettable means controllable over any line of said group prior to the setting up of a given conference connection for preventing more than a predetermined number of lines of said group from gaining access to said given conference connection.

2. In a telephone system, a plurality of lines a group of which are arranged for conference service, apparatus for providing conference connections between the lines of said group, presettable means controllable over any line of said group prior to the setting up of a given conference connection for preventing more than a predetermined number of the lines of said group from gaining access to said given conference connection, and means whereby all of said lines other than the lines of said group are at all times prevented from gaining access to said circuit.

3. In a telephone system, a plurality of lines a group of which are arranged for conference service, apparatus for providing conference connections between the lines of said group, presettable means controllable over any line of said group prior to the setting up of a conference connection for indicating the number of lines that are to gain access to the connection, and means for preventing more than the indicated number of the lines of said group from gaining access to the connection.

4. In a telephone system, a plurality of lines a group of which are arranged for conference service, apparatus for providing conference connections between the lines of said group, presettable means controllable over any line of said group prior to the setting up of a conference connection for indicating the number of lines that are to gain access to the connection, means for preventing more than the indicated number of the lines of said group from gaining access to the connection, and means whereby all of said lines other than the lines of said group are at all times prevented from gaining access to said circuit.

5. In an automatic telephone system which includes automatic switching apparatus for setting up connections between the lines of the system; a conference circuit including means providing a talking channel which is accessible through said apparatus to the lines joining a conference, and means presettable before each conference connection is established for preventing more than a predetermined but variable number of lines from obtaining access to said talking channel through said apparatus.

6. In an automatic telephone system which includes automatic switching apparatus for setting up connections between the lines of the system; a conference circuit including means providing a talking channel which is accessible through said apparatus to the lines joining a conference, register means having a plurality of different settings designating different numbers of lines that may obtain access to said talking channel, means controllable through said apparatus from a calling point for imparting a predetermined setting to said register means, and means controlled in accordance with the setting of said register means for preventing more than the designated number of lines from obtaining access to said talking channel.

7. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, selectors accessible to said lines and provided with outlet contacts arranged in groups, a conference circuit including a talking channel accessible to said lines through the contacts of said selectors which form one of said groups, and presettable means controlled through contacts in another of said groups for preventing more than a predetermined but variable number of lines from obtaining access to said talking channel through the selector outlet contacts of said one group.

8. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, selectors accessible to said lines and provided with outlet contacts arranged in groups, a conference circuit including a talking channel accessible to said lines through the contacts of said selectors which form one of said groups, means normally operative to prevent said lines from obtaining access to said talking channel through the selector outlet contacts of said one group, and presettable means controlled through the contacts in another of said groups for controlling said last-named means to permit a predetermined but variable number of said lines to obtain access to said talk-

ing channel through the selector outlet contacts of said one group.

9. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, a conference circuit including a talking channel provided with a plurality of branches and a control channel, selectors accessible to said lines and provided with outlet contacts which terminate the branches of said talking channel and said control channel, the outlet contacts terminating said control channel being designated by a different directory number than the outlet contacts terminating said branches, means normally marking all of the branches of said talking channel as busy in the outlet contacts of said selectors, and means controllable over said control channel through one of said selectors from a calling point of the system for removing the busy marking from a number of the branches of said talking channel, thereby to permit certain of said lines to gain access to said talking channel through said selectors.

10. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, a conference circuit including a talking channel provided with a plurality of branches and a control channel, selectors accessible to said lines and provided with outlet contacts which terminate the branches of said talking channel and said control channel, the outlet contacts terminating said control channel being designated by a different directory number than the outlet contacts terminating said branches, means normally marking all of the branches of said talking channel as busy in the outlet contacts of said selectors, and presettable means controllable over said control channel through any one of said selectors from a calling point of the system for removing the busy marking from a predetermined but variable number of the branches of said talking channel, thereby to permit said predetermined number of said lines to gain access to said talking channel through said selectors.

11. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, a conference circuit including a talking channel provided with a plurality of branches and a control channel, selectors accessible to said lines and provided with outlet contacts which terminate the branches of said talking channel and said control channel, the outlet contacts terminating said control channel being designated by a different directory number than the outlet contacts terminating said branches, means normally marking all of the branches of said talking channel as busy in the outlet contacts of said selectors, means controllable over said control channel through one of said selectors from a calling point of the system for removing the busy marking from a number of the branches of said talking channel, thereby to permit certain of said lines to gain access to said talking channel through said selectors, and means controlled through said selectors for restoring said busy markings on an individual basis as the branches of said talking channel are seized through said selectors, whereby only said certain lines are permitted to gain access to said talking channel.

12. In a telephone system which includes a plurality of lines and automatic switching apparatus for setting up connections between said lines, a conference circuit including a talking channel provided with a plurality of branches and a control channel, selectors accessible to said lines and provided with outlet contacts which terminate the branches of said talking channel and said control channel, the outlet contacts terminating said control channel being designated by a different directory number than the outlet contacts terminating said branches, means normally marking all of the branches of said talking channel as busy in the outlet contacts of said selectors, presettable means controllable over said control channel through any one of said selectors from a calling point of the system for removing the busy marking from a predetermined but variable number of the branches of said talking channel, thereby to permit said predetermined number of said lines to gain access to said talking channel through said selectors, and means controlled through said selectors for restoring said busy markings on an individual basis as the branches of said talking channel are seized through said selectors, whereby only said predetermined number of lines are permitted to gain access to said talking channel through said selectors.

13. In a conference circuit comprising a talking channel provided with a number of branches over which said channel may be seized through the apparatus of an automatic telephone system from certain of the lines of the system, means normally marking all of the branches of said channel as busy in said apparatus, and means controlled from one of said lines for removing the busy marking from a variable number of the branches of said talking channel, thereby to permit a variable predetermined number of the lines of said system to gain access to said talking channel.

14. In a conference circuit comprising a talking channel provided with a number of branches over which said channel may be seized through the apparatus of an automatic telephone system from certain of the lines of the system, means normally marking all of the branches of said channel as busy in said apparatus, means controlled from one of said lines for removing the busy marking from a variable number of the branches of said talking channel at will, thereby to permit different numbers of the lines of said system to gain access to said talking channel, and means for automatically restoring said busy markings on an individual basis as the branches of said talking channel are seized through said apparatus, whereby only said predetermined number of lines are permitted to gain access to said talking channel through said apparatus.

15. In a conference circuit which comprises a talking channel provided with a number of branches over which said channel may be seized through the switching apparatus of an automatic telephone system from certain of the lines of the system, means normally marking all of the branches of said channel as busy in said apparatus, register means having different settings designating different numbers of said lines that may be connected to said talking channel, means controllable through said apparatus over any one of said lines for imparting a predetermined setting to said register means, and means controlled by said register means when operated to said predetermined setting for removing the busy marking from the number of the branches of said talking channel corresponding to said predetermined setting of said register means, thereby to permit a corresponding number of said lines to gain access to said talking channel.

16. In a conference circuit which comprises a talking channel provided with a number of branches over which said channel may be seized through the switching apparatus of an automatic telephone system from certain of the lines of the system, means normally marking all of the branches of said channel as busy in said apparatus, register means having different settings designating different numbers of said lines that may be connected to said talking channel, means controllable through said apparatus over any one of said lines for imparting a predetermined setting to said register means, means controlled by said register means when operated to said predetermined setting for removing the busy marking from the number of the branches of said talking channel corresponding to said predetermined setting of said register means, thereby to permit a corresponding number of said lines to gain access to said talking channel, and means controlled through said apparatus for automatically restoring said busy markings on an individual basis as the branches of said talking channel are seized through said apparatus, whereby only the number of lines corresponding to the setting of said register means are permitted to gain access to said talking channel.

17. In an automatic telephone system which includes automatic switching apparatus for setting up connections between the lines of the system, a conference circuit accessible to said apparatus, and means responsive to the seizure of said circuit through said apparatus from one of the lines of the system for transmitting a signal over said one line.

18. In an automatic telephone system which includes automatic switching apparatus for setting up connections between the lines of the system, a conference circuit including means providing a talking channel which is accessible through said apparatus to the lines joining a conference, and means responsive to the seizure of said channel through said apparatus for transmitting a signal over said talking channel.

19. In an automatic telephone system which includes automatic switching apparatus for setting up connections between the lines of the system, a conference circuit accessible to said apparatus, means responsive to the seizure of said circuit through said apparatus from one of the lines of the system for transmitting a signal over said one line, and means controllable over said one line before a conference connection is established for preventing more than a predetermined number of the lines from gaining access to said circuit.

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