

April 22, 1947.

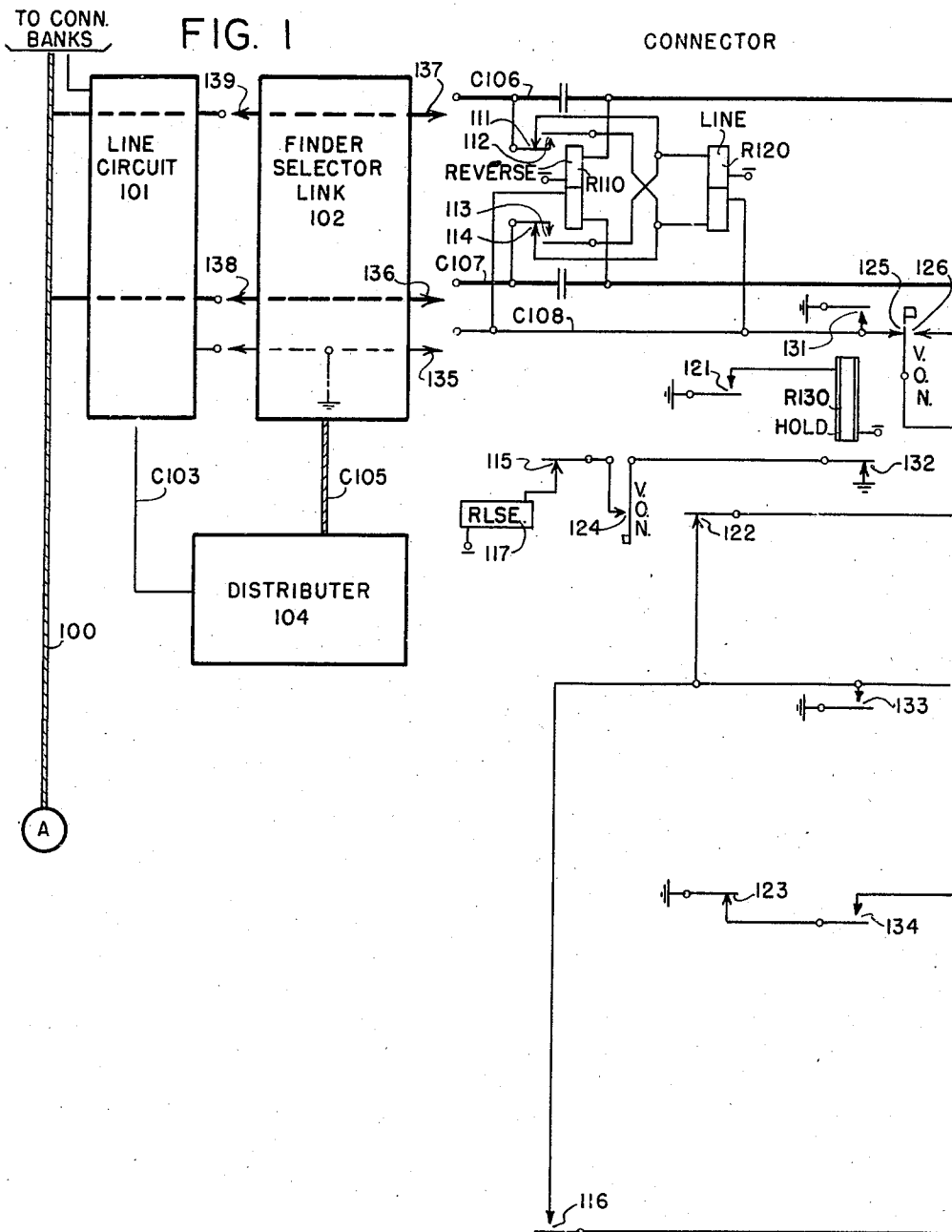
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2,419,282

TELEPHONE SYSTEM

Filed June 28, 1944

3 Sheets-Sheet 1



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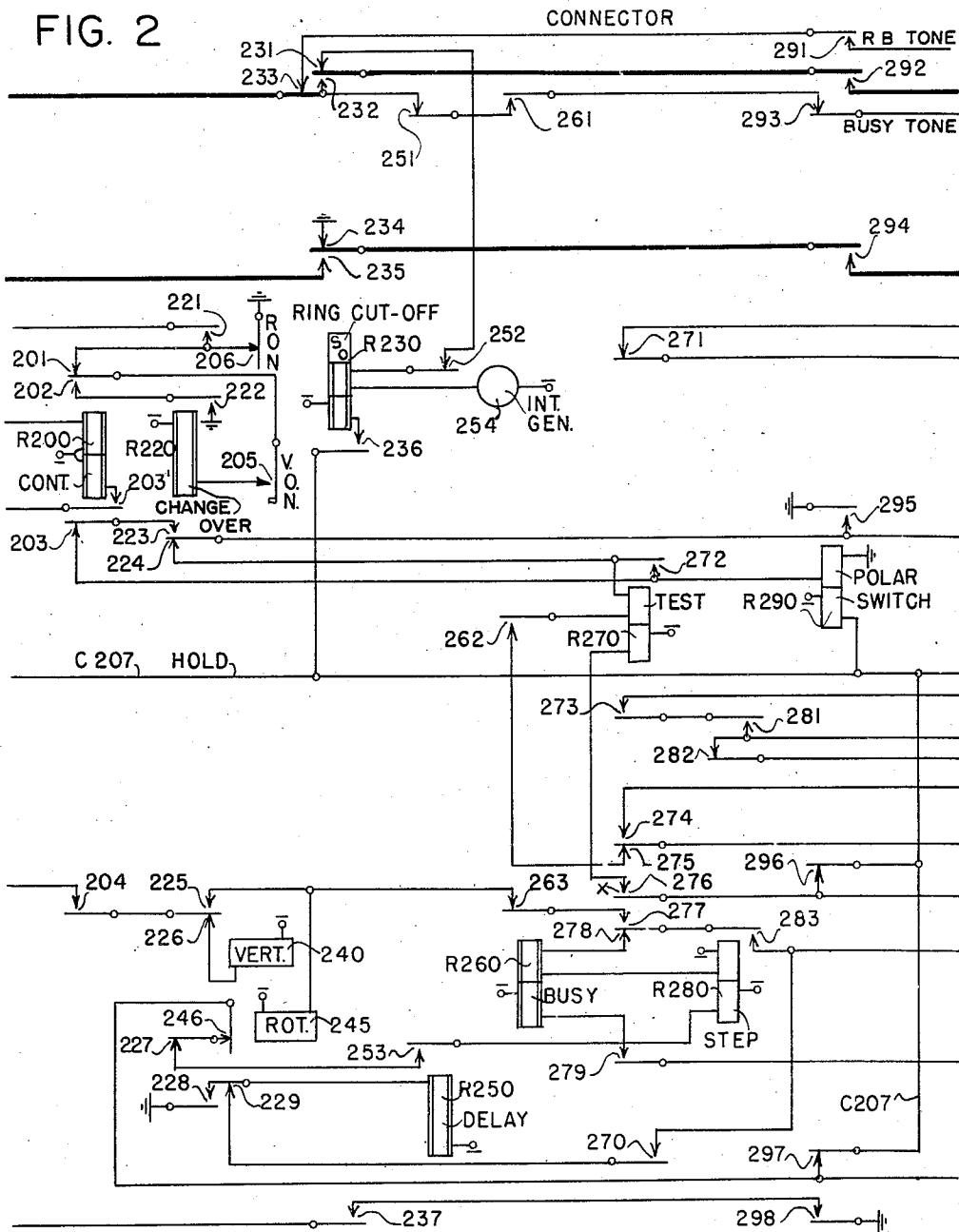
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FIG. 2



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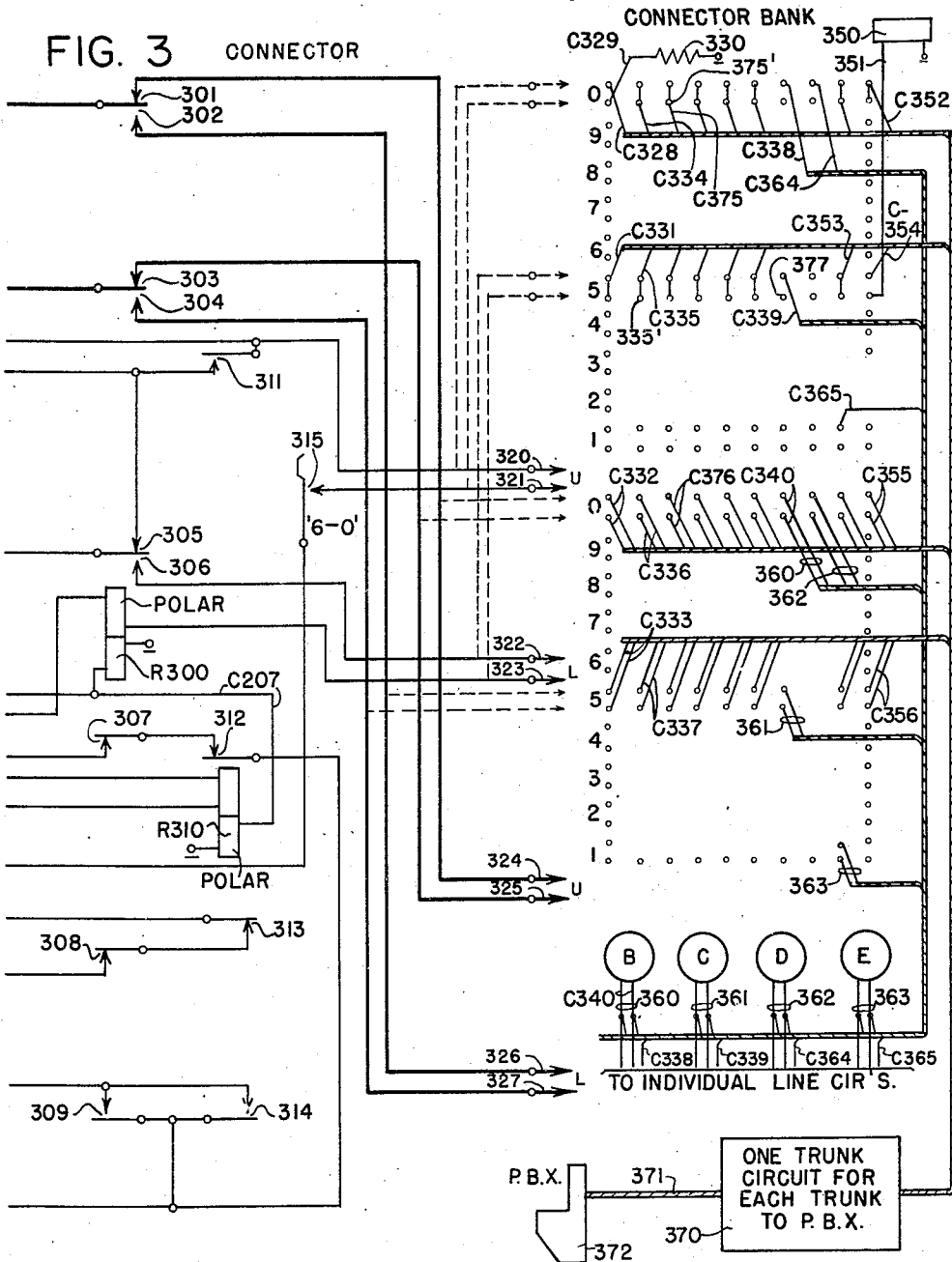
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3 Sheets-Sheet 3



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TELEPHONE SYSTEM

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Application June 28, 1944, Serial No. 542,505

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This invention relates in general to telephone systems and, more particularly, to automatic switches used in setting up connections to various individual telephones in the system and also for setting up connections by way of an idle trunk of a group of trunk lines terminating in private branch exchanges.

In telephone systems wherein private branch exchanges are served by a number of lines extending to each branch exchange, it is the usual practice so to design the final connecting switch of the system that this switch has facilities for making connections to both individual telephone lines and to an idle trunk line of a group of trunk lines terminating at a branch exchange.

Various types of final connectors equipped for giving the above services are in common usage and have proved quite satisfactory; however, it has been found that when the number of trunk lines extending to a private branch exchange, referred to hereinafter as a P. B. X, exceeds the capacity of a single level of the switch, or when it becomes necessary to increase the number of trunk lines terminating in a P. B. X to a number greater than the number of contacts in a single level of the switch, or if in increasing the number of trunk lines to a P. B. X there are no vacant contacts immediately following the existing group of contacts, problems are presented which may be overcome only with difficulty and expense in order to give the required service.

The present invention provides a simple, economical and efficient means for providing for a group of trunk lines extending to a P. B. X, which group of trunk lines may be greater in number than the number of contacts in a given level; it also provides means for adding trunk lines to a group of lines already extending to a P. B. X, which additional lines may be greater in number than the capacity of the level in which the existing group is located; it permits the additional lines to be located adjoining the existing group, allows for a number of individual lines to be placed between the existing group and the added lines, and permits the additional lines to be located on contacts of another level. These results are accomplished with a minimum of operations of the switch and in such a manner that the wiper sets are moved but once across the bank contacts of a group whereby tests are made on contacts of two levels; that is, as the two respective sets of wipers engage the two respective contact sets in the two levels, a test is first made by the first set of wipers and if that contact is found busy or vacant the second set makes

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a test upon the corresponding contact engaged by the second set of wipers before the switch moves the wipers to the next successive contact.

It is an object of the invention to provide, in a telephone system of the type referred to above, an automatic switch which is adapted to search for an idle line over contacts in a plurality of levels simultaneously. Another object is to provide an automatic switch which is adapted to terminate a group of trunk lines connected to a P. B. X or the like, in which the different lines of the group terminating in the switch bank contacts may be located on a plurality of levels. A further object is to provide an automatic switch adapted to terminate individual subscriber lines and a plurality of groups of trunk lines, said groups of trunk lines extending to one or more P. B. X's or to other exchanges; wherein said groups may be located upon successive contacts of a plurality of levels or may have individual subscriber lines connected to contacts interspersed with the contacts of the group. It is a still further object of the invention to provide an automatic switch having a plurality of sets of wipers arranged to make contact with bank contacts of a plurality of levels of contacts simultaneously, said switch being adapted first to test the busy condition of a contact in one level and then to test the busy condition of the corresponding contact in another level before the sets of wipers are moved to the next adjoining sets of contacts. It is a further object of the invention to provide, in an automatic switch, testing means for ascertaining the idle, busy, or vacant condition of the bank contacts engaged by the wiper sets.

Another object of the invention lies in the arrangement of an automatic switch wherein a group of trunk lines terminate on two levels of a switch, and are arranged so that the trunk lines of said group may or may not be connected to successive contacts in the two levels, whereby the switch is arranged to test the contacts in the two levels alternately and to test the contacts in each level successively to determine the idle or busy condition of the associated trunk line, and in the event contacts of individual subscriber lines are encountered in the course of the test, the latter contacts will be passed over regardless of the idle or busy condition thereof. It is a further object to provide, in an automatic switch as described above, means for giving a busy signal to a calling party in the event all the trunk lines in a group are tested and found busy. A further feature of the invention resides in the arrangement of the rotary connector switch, as

described above, for selecting any particular trunk line in a group of trunks connected to a P. B. X and, if found by test to be busy, a busy tone is caused to be returned to the calling subscriber, and for preventing, on such connectors, automatic rotation of the wipers to search for idle trunk lines in the group. Further objects of the invention relate to the particular arrangement of the circuit elements of the system, whereby the above and other operating advantages of the invention are obtained.

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 specification taken in connection with the accompanying drawings in which Figures 1, 2 and 3 illustrate the arrangement of a telephone system incorporating a rotary connector embodying the present invention.

Referring to Figs. 1, 2 and 3 of the drawings, there is illustrated therein a telephone system including an exchange serving a plurality of subscriber substations A to E, inclusive, and a P. B. X switchboard 372. More particularly, a plurality of subscriber lines 100, 200, 301, 302 and 303, respectively, extend to the subscriber substations A, B, C, D and E and terminate in the switching apparatus in the exchange. More specifically, each subscriber line terminates in a line circuit individual thereto included in the switching apparatus, the subscriber line 100 terminating in the line circuit 101 and the subscriber lines 301, 302 and 303 terminating in similar individual line circuits (not shown). The P. B. X switchboard 372 is accessible to the connector over a group of trunk lines comprising as many as twenty trunks. Also each trunk in the group terminates in the connector bank and includes, in tandem therewith, an individual trunk line circuit illustrated at 370.

Further, the system comprises a finder-selector link 102 which may be of any known type but which is preferably of a type including Strowger type switches, according to which the finder comprises a wiper mechanism operable in vertical and rotary directions to find and make contact with a calling line. The selector end of the link comprises a Strowger switch having a wiper mechanism operable in vertical and rotary directions to select and make connection with the conductors of an idle connector switch. A line circuit is provided for each line, such as the line circuit 101 which is used in telephone systems, and which functions to condition a distributor 104 to select an idle finder-selector link for use of a calling line. The line circuit 101, the finder-selector link 102, the distributor 104 and the trunk circuits 370, terminating at the P. B. X switchboard 372, have not been shown in detail as they are well known to those skilled in the art.

The connector circuit illustrated in detail in Figs. 1, 2 and 3 comprises two sets of wipers mounted upon a wiper shaft (not shown), the lower set of wipers being mounted the distance of five steps or levels below the upper set. With this arrangement, the wipers of the two sets are adapted to engage the contact sets in two levels five steps apart, i. e., for example, when the upper set of wipers is positioned opposite the tenth level, the lower set of wipers is positioned opposite the fifth level of contacts. The connector includes a vertical magnet 240, which steps the wipers in a vertical direction, and a rotary magnet 245 which steps the wipers in a rotary direc-

tion. A release magnet 117 operates to release the wiper shaft and allows the sets of wipers to be restored to their normal position. There are a number of relays in the connector, as follows: a reverse relay R110, a line relay R120, a hold relay R130, a control relay R200, a change relay R220, a ring cutoff relay R230, a delay relay R250, a busy relay R260, a test relay R270, a step relay R280, a polarized switch relay R290, and two additional polar relays R300 and R310. The polar relays are designed not to operate when only their lower windings are energized and to remain operated under control of the lower windings after they have been operated over a circuit including their upper windings. There are a number of vertical off-normal springs which operate upon the first vertical step of the switch, including the springs 124, 125, 126 and 205, and there are also a pair of rotary off-normal springs 200 which are operated upon the first rotary step of the switch. The normal post springs 315 are operated upon certain specific levels, which levels terminate groups of trunk lines extending to the P. B. X.

A better understanding of the operation of the system illustrated may be had by describing the progress of a call originating at the substation A and routed through the exchange apparatus to a line terminating at the substation B. The subscriber at substation A by removing the handset of the telephone instrument thereat from its associated switchhook causes a circuit to be completed, whereby the line circuit 101 is operated. The operation of the line circuit 101 places starting ground upon the conductor C103 whereupon the distributor 104, in a well known manner, selects an idle finder-selector link, such as the link 102, for use. When the finder-selector link 102 has been selected, the finder switch thereof operates in a well known manner to automatically search for and connect with the contacts terminating the line circuit 101 of the calling line. At this time the connection has been extended from the substation A by way of the line 100, the line circuit 101, and the finder switch portion of the finder-selector link 102 to the selector portion of the link. The selector is now conditioned to receive and respond to the first digit to be dialed by the subscriber and accordingly transmits dial tone to indicate to the calling subscriber that the digits of the called subscriber number may be dialed. The selector switch of the link 102 operates in response to the dialing of the first digit to elevate its wipers 135 to 137, inclusive, to a position opposite the desired level and then automatically rotates the wipers to select a set of bank contacts terminating an idle connector, such as the connector illustrated.

Upon seizure of the connector, the control relay R200 is operated over a circuit extending from ground in the finder-selector link 102 by way of the control wiper 135 engaging the bank contact terminating the control conductor C108, the vertical off-normal contacts 125, and the upper winding of relay R200 to battery. The relay R200 is operated over this circuit and opens the contacts 203 in the circuit of the switch relay R290. Also, at this time, the line relay R120 is operated over the loop circuit extending to the subscriber substation A. This circuit may be traced as extending from ground in the finder-selector link 102 by way of the control wiper 135, the engaged contact terminating the control conductor C108, the lower winding of relay R120,

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the contacts 114, to the conductor C107; and from battery by way of the upper winding of the line relay R120, the contacts 111, to the conductor C106, the conductors C106 and C107 being connected together over a loop circuit including the wipers 136 and 137 of the selector switch which are connected to the wipers 138 and 139, respectively, of the finder switch of the link 102, the line circuit 101, and the conductors of line 100 extending to the subscriber substation A. Upon operating, the line relay R120 completes, at its contacts 121, an obvious circuit for energizing the hold relay R130. The hold relay R130, upon energizing, applies, by way of its contacts 131, ground potential to the control conductor C108, thereby causing the finder-selector link 102 to be held in its operated position; and it also applies, at its contacts 131, ground potential to the upper winding of the control relay R200. At its contacts 132, the hold relay R130 interrupts a point in the incomplete circuit for energizing the release magnet 117. At its contacts 133, the relay R130 applies ground potential to the hold conductor C207 which completes a circuit for energizing the lower windings of the switch relay R290 and of the polar relays R310 and R360. Since these relays are of the polar type, they will not operate until their upper windings have also been energized. The connector switch is now ready to receive the second digit to be dialed by the calling subscriber. As was assumed previously, the called line 360 extending to the station B terminates in the tenth level of the switch contact bank. The line conductors C340 of this line and the control conductor designated C338, it is noted, are located in the tenth level and upon the seventh contact. It will be necessary then that the second digit to be dialed be "0." The line relay R120 will respond to this digit by restoring and reoperating ten times. When it restores the first time, the circuit for energizing the hold relay R130 is interrupted at the contacts 121. However, the hold relay, being of the slow-to-release type, remains operated during the entire ten impulses produced by the dialing of this digit.

At its contacts 122, the relay R120 completes an intermittent circuit for the control relay R200. This circuit may be traced from ground by way of the contacts 133, the contacts 122 and 203', and the lower winding of R200 to battery. The relay R200 is also of the slow-to-release type and remains operated during the entire period of dialing of the digit. At its contacts 123, the relay R120 completes a circuit for energizing the vertical magnet 240 each time this relay restores. This circuit may be traced from ground by way of the contacts 123, 134, 204 and 226, and the winding of the vertical magnet 240, to battery. The energization of the vertical magnet 240 drives the wiper shaft one step, thereby closing the vertical off-normal springs 124, 126 and 205 and opening the vertical off-normal springs 125. The line relay R120, in responding to the digit "0," completes the above-traced circuit for the vertical magnet 240 ten times, thereby driving the wipers ten steps in the vertical direction, positioning the wipers 320, 321, 324 and 325 opposite the tenth level of the associated bank contacts and positioning the wipers 322, 323, 326 and 327 opposite the fifth level of the associated bank contacts. When the wipers 320, 321, 324 and 325 are raised to the tenth level, the normal post springs 315 are operated into engagement to prepare a test circuit for the test relay R270 and

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the polar relay R310. However, since the connection being described is to be completed to an individual subscriber line, the circuit including the normal-post springs 315 is ineffective. At the termination of the dialing of the second digit, the line relay is held in its operated position to interrupt, at its contacts 122, the energizing circuit for the lower winding of the control relay R200, thereby allowing the relay R200 to restore since the holding circuit for its upper winding is now open at vertical off-normal springs 125. Upon restoring, the relay R200 interrupts a further point in its own holding circuit at the contacts 203' and completes, at its contacts 201, a circuit for energizing the winding of the change-over relay R220. This circuit extends from ground by way of the rotary off-normal springs 206, the contacts 201, the vertical off-normal contacts 205, and the winding of R220 to battery, thereby causing the relay R220 to be operated to complete, at the contacts 221, a circuit for energizing the upper winding of R200. This circuit extends from ground by way of the rotary off-normal springs 206, the contacts 221, the vertical off-normal springs 126, and the upper winding of relay R200 to battery. Upon being energized, the relay R200 opens the initial energizing circuit for the slow-to-release relay R220 at its contacts 201 and it completes, at its contacts 202, a holding circuit for the change-over relay R220, before the latter relay restores, which circuit extends from ground by way of the contacts 222 and 202, the vertical off-normal springs 205 and the winding of R220 to battery. At contacts 226, relay R220 upon energizing opens a point in the previously traced impulsing circuit for the vertical magnet 240 and at its contacts 225 it prepares a point in the impulsing circuit for the rotary magnet 245. At contacts 204, relay R200 upon energizing prepares a further point in the impulsing circuit for the rotary magnet 245. At its contacts 223, the relay R220 also prepares a point in the incomplete circuit for the switch relay R290, and at its contacts 228, relay R220 completes an obvious circuit for energizing the winding of the delay relay R250. The relay R250, in operating, interrupts, at its contacts 252, a circuit for applying interrupted ringing generator to one of the negative wipers 324 or 326.

The connector now is ready to receive the impulses transmitted as a result of the dialing of the third and final digit to set the wipers upon the contacts terminating the called line. The line relay R120 now responds to the third digit, which at this time is the digit "7," by restoring seven times, thereby to complete a circuit for energizing the rotary magnet 245 a corresponding number of times. This circuit may be traced from ground by way of the contacts 123, 134, 204 and 225, and the winding of the rotary magnet 245 to battery. The rotary magnet 245 drives the wipers across the contact bank and thereby moves the wipers into engagement with the seventh set of bank contacts, whereupon the wiper 320 engages the contact terminating the conductor C338 and the wipers 324 and 325 engage the contacts terminating the line conductors C340 of the line 360 extending to the substation B. When the wipers are rotated one step, the rotary off-normal springs 206 were disengaged to interrupt the previously traced circuit for energizing the upper winding of the relay R200, thereby allowing that relay to restore after all of the impulses of the final digit have been sent, this relay being held by a circuit including its lower

winding during the dialing period. At the termination of the dialing of the final digit, the relay R200 restores to interrupt, at the contacts 202, the circuit for energizing the relay R220 but due to its slow-to-release characteristics relay R220 does not immediately restore. Upon restoring, the relay R200 also completes, at the contacts 203, a test circuit for the upper winding of the switch relay R290, this circuit extending by way of the contacts 223, 305 and 271, to the wiper 320 which is now engaging the contact terminating the conductor C338. If the called line is busy, ground potential will be found upon the test conductor C338, thereby short-circuiting the upper winding of the relay R290. However, if the called line is idle battery potential will be found upon the test conductor C338, thereby causing the relay R290 to be energized over a circuit including its upper winding.

It will be assumed at this time that the called line is busy and therefore the upper winding of relay R290 is short-circuited in the manner described above. After a short time, the relay R220 restores to open, at its contacts 228, the circuit for energizing the slow-to-release delay relay R250. Before the relay R250 restores, a circuit for energizing the lower winding of the step relay R280 is completed over a path from the grounded hold conductor C207 by way of contacts 297, 246, 227 and 253 and the lower winding of R280 to battery. The relay R280 thereupon operates and, at its contacts 283, completed a circuit for energizing the upper windings of the relays R280 and R260, causing the relay R260 to operate. This circuit can be traced from the hold conductor C207 through the contacts 296, 313, 308, 283, and 278, and the upper windings of the relays R260 and R280 in series to battery. At contacts 251, the delay relay R250 upon restoring also prepares a circuit for transmitting busy tone to the calling line which circuit may be traced from the busy tone conductor by way of the contacts 292, 261, and 251, the negative conductor C106, the negative wipers of the link 102, over the negative conductor and to the telephone instrument at substation A, in order to indicate to the calling subscriber that called line is busy.

The subscriber at station A is thus notified that the called line is busy and that he should replace the handset of the telephone instrument upon the associated switchhook in order to release the connection thus far set up. This release of the equipment will be hereinafter described.

Assuming, on the other hand, that the called line 360 of the substation B is idle when the wiper 320 engaged the contact terminating conductor C338, the wiper 320 will encounter negative battery potential thereon thereby energizing the switch relay R290 over a circuit extending from ground, through the upper winding of the relay R290, the contacts 203, 223, 305, and 271, and the wiper 320 to negative battery on the conductor C338. The relay R290 then operates immediately, due to the energized condition of its lower winding and prepares, at its contacts 292 and 294, a circuit for transmitting ringing current to the called line 360 to signal the called party. As a further result of the operation of relay R290 ground potential is applied, at its contacts 295, to the bank contact terminating the control conductor C338 thereby to mark the called line busy in the banks of the other connectors having access thereto, and, at its contacts 291, a

path is completed for transmitting ring-back tone to the calling line over a circuit including the contacts 233 and the negative line conductor C106, to indicate to the calling subscriber at substation A that the called line is being signalled.

It will be recalled that the relay R220 remained operated for a short interval of time, after its energizing circuit was opened by the restoration of relay R200, in order to complete the above traced circuit for relay R290. Subsequently relay R220 restores to normal and, at contacts 228, it opens the energizing circuit for delay relay R250. Due to the fact that switch relay R290 has energized and opened its contacts 297 the previously traced circuit for operating the step relay R280 and busy relay R260 cannot be completed at this time. Subsequently the slow-to-release delay relay R250 restores to normal and, at contacts 252, it completes a circuit for transmitting ringing current over the conductors C340 of line 360 to signal the subscriber at substation B.

The path for projecting ringing current to signal the substation B may be traced from the battery connected interrupted generator 254, the upper winding of ring cut-off relay R230, contacts 252, 231, 292 and 301, wiper 224 in engagement with the seventh contact in the tenth level of bank contacts, negative conductor C340 of the line 360, the ringer at substation B, and returning by way of the positive conductor C340 of the line 360, wiper 325, contacts 303, 294 and 324 to ground.

When the called subscriber at substation B responds to the ringing of his bell by removing his handset from the associated telephone instrument, a direct current bridge is closed across the line conductors C340 in the usual manner, whereupon the ring cut-off relay R230 is energized. Upon energizing, relay R230 closes a locking circuit for its lower winding at contacts 236 from the grounded conductor C207 and, at the same time, its contacts 231 and 234 are opened to disconnect ringing current from the line. Also, at the contacts 233, relay R230 interrupts the path for transmitting ring-back tone to the calling station A. The relay R230, upon operating, also closes its contacts 232 and 235 to complete the talking connection between the called substation B and the calling substation A. Transmitter current is now supplied to the called substation through the windings of the reversing relay R110, whereupon relay R110 operates over the called subscriber's loop, and reverses the flow of current to the calling substation A in an obvious manner at its contacts 111 to 114, inclusive.

It is noted that upon a call being made to an individual line, such as the one just described, with the control wipers 320 and 321 resting upon the seventh contacts of the tenth level in the upper set of bank contacts and line wipers 324 and 325 resting upon the corresponding contacts in the lower set of bank contacts, the wiper 321 engages a contact upon which no conductor is terminated and, therefore, no circuit can be completed for operating relays R270 or R310 and that, also, the control wipers 322 and 323 are resting upon the corresponding contacts in the fifth level in the upper bank, but, since the relays R270 and R310 are in their restored positions, no effective circuit is completed by these wipers. Finally, since the line wipers 326 and 327 are resting upon the seventh contacts of the fifth

level in the lower bank, it will be seen that no effective circuit is completed by these wipers, as the contacts 302 and 304 are in disengaged positions.

The control wiper 320 is utilized to test the idle or busy condition of the individual lines terminated in the connector bank and the wipers 321, 322 and 323 are employed in the testing of the trunk lines in the group of lines extending to the P. B. X 370. Thus if a call is made to the line 361 extending to the substation C, the second digit "5" transmitted by the calling subscriber causes the connector to position the wipers 320, 321, 324 and 325 opposite the fifth level of the associated set of bank contacts. The final digit "7" transmitted by the calling subscriber rotates the wipers mentioned into engagement with the seventh set of bank contacts in the fifth level whereupon control wiper 320 engages the contact terminating the control conductor C333 and the line wipers 324 and 325 engage the contacts terminating the line 361. The control wiper 321 is ineffective at this time, as it engages the vacant contact 377, and the wipers 322, 323, 326 and 327 do not engage contacts in any level because they are rotated below the set of bank contacts and, therefore, are ineffective to cause operation of relays R200 and R130.

Testing the busy condition of the called line 361, signalling the called line, and completion of the connection to the called line are accomplished in the same manner as has been described above in connection with extension of a call to substation B.

Release of equipment

The release of the switch train is under the control of the calling party. To terminate the connection and cause the switches to be restored to their normal positions, the calling subscriber replaces the handset upon the telephone instrument whereupon the loop circuit extending to the line relay R120 is opened, causing this relay to restore and, at its contacts 121, to open the circuit to the relay R130. The relay R130 restores after a short interval and thereby interrupts, at its contacts 131, the application of ground potential to the control conductor C108. The removal of ground potential from the conductor C108 causes the link 102 and the line circuit 101 to be restored to their normal positions. The relay R130, in restoring, also opens, at its contacts 133, the circuit for applying ground potential to the hold conductor C207, thereby causing the relays R230 and R290 to restore. The relays R230 and R290, in restoring, open the loop circuit to the called station, thereby allowing the reversing relay R110 to restore. Also, the relay R130, in restoring, completes, at contacts 132, a circuit for energizing the release magnet 117, this circuit extending from ground by way of the contacts 132, vertical off-normal springs 124, contacts 115, and the winding of 117 to battery. The energization of the release magnet 117 causes the wipers to be restored to their normal positions, whereupon the vertical off-normal springs 124, 125, 126 and 205 are restored to the normal position shown in the drawings, the previously traced circuit for energizing the release magnet 117 being interrupted when the vertical off-normal springs 124 are disengaged. At this time the connector switch is completely restored to normal and is available for use in another call.

Call to the P. B. X

Assuming that a call is to be made from the substation A to the P. B. X switchboard 372, and that the link 102 has been operated in the manner previously described to select the connector illustrated, when the connector is selected relays R200, R120 and R130 operate, in the order named, to prepare the connector for further operation. The connector is now ready to receive the impulses of the first digit, which is the second digit dialed at the substation A.

The line relay R120 responds to the impulses of the dialed digit by restoring and operating a corresponding number of times. In this case, ten impulses are transmitted, whereupon the wipers 320, 321, 324 and 325 are raised to a position opposite the tenth level of the associated bank contacts, it being remembered that the wipers 322, 323, 326 and 327 of the lower set are normally five steps below the wipers of the upper set and are, therefore, positioned opposite the fifth level of the associated bank contacts.

A short time after the second digit has been dialed, the control relay R200 restores and completes a circuit, at its contacts 201, for the change-over relay R220. This circuit may be traced from ground by way of the rotary off-normal springs 206, contacts 201, vertical off-normal springs 205, and the winding of relay R220 to battery. The relay R220 is operated over this circuit and completes a circuit for the upper winding of the control relay R200 which circuit extends from ground by way of the rotary off-normal springs 206, contacts 221, vertical off-normal springs 126, and the upper winding of R200 to battery. Upon being energized, the relay R200 opens the initial energizing circuit for the slow-to-release relay R220 at its contacts 201 and it completes, at its contacts 202, a holding circuit for change-over relay R220, before the latter relay restores, extending from ground by way of the contacts 222 and 202, vertical off-normal springs 205, and the winding of relay R220 to battery. At its contacts 226, relay R220, upon energizing, opens a point in the previously traced impulsing circuit for the vertical magnet 240 and, at its contacts 225, it prepares a point in the impulsing circuit for the rotary magnet 245. The operation of the relay R220 also completes, at its contacts 228, an obvious circuit for the delay relay R250 which then operates and, at the contacts 251, opens a point in the incomplete busy tone circuit. The operation of the relay R250 also opens, at the contacts 252, a point in the circuit for applying interrupted ringing generator to the called line. When the wipers 320, 321, 324 and 325 of the upper set reach the tenth level, the normal post springs 315 are operated into engagement to prepare a test circuit for the test relay R270 and the polar relay R310.

The connector is now in readiness to receive the final digit to be dialed, which, in this case, will be the digit "1." Upon dialing the digit "1," the line relay R120 is restored once and it is then held energized, thereby to transmit, at its contacts 123, one impulse to the rotary magnet 245. The rotary magnet 245 then operates to drive the wipers 320 to 327, inclusive, one step in the rotary direction into engagement with the respective first sets of contacts in the contact banks. When the wipers are rotated one step, the rotary off-normal springs 206 disengage each other to interrupt the previously traced circuit for energizing the upper winding of the relay R200. The

relay R200 shortly thereafter restores to interrupt, at its contacts 202, the circuit for energizing the relay R220, but due to its slow-to-release characteristics relay R220 does not immediately restore. The restoration of relay R200 also completes, at its contacts 203, a test circuit for the upper winding of the switch relay R290, which circuit extends from ground, the upper winding of relay R290, the contacts 203, 223, 305 and 271, to the wiper 320, which is in engagement with the bank contact terminating conductor C328. The operation of the switch now depends upon the busy or idle condition of the first set of contacts in the banks engaged by the wipers. It will be noted that the first to the sixth, inclusive, and ninth and tenth contacts in the tenth and fifth levels terminate trunk lines extending to the trunk circuits indicated at 370, which connects to the P. B. X switchboard 372 by way of the cable 371.

Assuming that the trunk line, including line conductors C332 and control conductor C328, terminated by the first contact set in the tenth level in the associated contact bank is the first idle trunk in the associated group of trunks, accordingly when the wipers are rotated into engagement therewith, battery potential upon the control conductor C328, marking the trunk idle, is applied to the wiper 320. The application of battery potential to the wiper 320 completes a circuit, including contacts 271, 305, 223 and 203, for energizing the upper winding of the switch relay R290.

When thus energized the switch relay R290 operates to interrupt, at contacts 297, a point in the circuit of step relay R230 thereby to prevent energization of the latter relay when the slow-to-release change-over relay R220 subsequently restores, and to complete, at contacts 295, a circuit, including the contacts 305 and 271, for applying direct ground potential to the wiper 320 in order to busy the trunk in the associated bank contacts of other connectors having access thereto. The slow-to-release change-over relay R220 now restores and, at its contacts 223, opens the initial energizing circuit for the upper winding of switch relay R290. However, the latter relay remains in its energized position under control of the circuit including its lower winding. As a further result of the restoration of relay R220, the circuit for the delay relay R250 is opened at contacts 228, whereupon relay R250 restores and prepares, at contacts 252, the circuit for signaling the operator at the P. B. X switchboard 372.

Also, upon operating, the switch relay R290, at its contacts 291, connects the ring-back tone to the calling line by way of contacts 233 and negative line conductor C106 to indicate to the calling subscriber at substation A that the called trunk line is being signaled, and, at its contacts 292 and 294, relay R290 completes a signaling circuit whereby the interrupted generator 254 and direct ground at contacts 234, respectively, are connected to the trunk line conductors C332 by way of wipers 324 and 325 to signal the operator at the P. B. X switchboard 372. From this point, the operation of the apparatus with respect to ringing, answering, and releasing the connection is similar to that explained above.

It will now be assumed that when the connector was operated in the above-described manner and the wiper 320 engaged the first contact in the tenth level of the associated set of bank contacts, the first trunk line was busy and, therefore, the control conductor C328 was grounded by

a control wiper, such as 320, of another connector. Accordingly, when the wiper 320 of the illustrated connector encounters the bank contact terminating the grounded control conductor C328, the switch relay R 290 will not operate due to the fact that the upper winding thereof is short-circuited. The change-over relay R220 restores after a short interval to prepare, at its contacts 224, a circuit for the test relay R270. Upon restoring, relay R220, at its contacts 228, also opens the energizing circuit for the slow-to-release delay relay R250 and it prepares, at its contacts 229, a circuit for energizing relay R250, the latter circuit being completed responsive to the energization of test relay R270 before the slow-to-release relay R250 restores to normal, as will be subsequently described. Also, upon restoring, the relay R220 completes, at its contacts 227, a circuit for energizing the lower winding of the step relay R280. This circuit may be traced from the grounded hold conductor C207 by way of the contacts 297, 246, 227 and 253, and the lower winding of the relay R280 to battery. The relay R280 then operates to complete a holding circuit for its upper winding in series with the upper winding of the busy relay R260, this circuit extending from the grounded hold conductor C207 by way of the contacts 296, 313, 308, 263 and 278, and the upper windings of the relays R260 and R280 in series to battery. The busy relay R260 is operated over the above-traced circuit and completes, at contacts 262, the test circuit including the upper winding of the test relay R 270. With ground potential applied to the contact terminating the conductor C328, a circuit will be completed for the upper winding of the test relay R270, this circuit extending from the grounded conductor C328 and its associated bank contact, wiper 320, the contacts 271, 305 and 224, the upper winding of R270, the contacts 262 and 275, the normal post springs 315, the wiper 321, the bank contact terminating the conductor C329, and the resistor 330, to negative battery. The relay R270 is operated over this circuit and completes, at the contacts 276, a holding circuit for its lower winding, this circuit including the contacts 296 and the grounded holding conductor C207. At this time, when the wipers 320 and 321 have tested the busy condition of the first trunk line in the tenth level, a circuit is prepared at the contacts 273 of the test relay R270 for testing the first trunk line in the fifth level. Assuming that the contacts terminating the first trunk line in the fifth level are found busy, ground potential will be found on the conductor C331, thereby grounding the wiper 323 to complete a short circuit for the upper winding of the polar relay R300, this circuit including the contacts 273, 281, 307, 312 and 297 and the grounded hold conductor C207. Also, upon operating, the test relay R270 interrupts, at its contacts 278, the circuit for energizing in series the upper windings of the relays R260 and R280. The relay R260 is deenergized shortly thereafter. However, the relay R280 remains energized over its lower winding in a circuit which includes the contacts 253, 227, 246 and 297 to the grounded hold conductor C207. It will be noted that the delay relay R250 is held operated over a circuit extending from the grounded hold conductor C207 by way of the contacts 296, 313, 308, 270 and 229, and the winding of R250 to battery.

The switch now having tested the first contact sets in the tenth and fifth levels, respectively, and it having been assumed that the trunk

line connected to the first contacts of the fifth level is also found busy, it is necessary to advance the wiper sets to the second contact sets in the contact banks. A circuit is now completed for the rotary magnet 245 by the restoration of relay R260, this circuit extending from the grounded hold conductor C207 by way of the contacts 296, 313, 308, 283, 277 and 263, and the winding of the magnet 245, to battery. Upon energizing, the rotary magnet 245 drives the wipers to the second contact sets in the banks and also interrupts, at the contacts 246, the circuit for energizing the lower winding of the stepping relay R280. Upon restoring to normal, the relay R280 opens, at contacts 281, the test circuit for the upper winding of polar relay R300, and prepares, at contacts 282, a test circuit for the upper winding of polar relay R310, and it opens, at contacts 283, the energizing circuit for the rotary magnet 245. If it be assumed that the third trunk line, which is terminated upon the second contact set in the tenth level, is busy, ground potential will be found upon the control conductor C334 to ground the wipers 320 and 321, whereby the upper winding of the polar relay R310 is short-circuited, over a circuit which may be traced from the grounded wiper 321, normal post springs 315, contacts 274, upper winding of relay R310, contacts 282, 307, 312 and 297, to the grounded conductor C207. When the rotary magnet 245 restores to normal a circuit is again completed, at its contacts 246, for energizing the lower winding of the step relay R280. Relay R280 now energizes again to open the test circuit for polar relay R310, at contacts 282, and to close the test circuit for polar relay R300, at contacts 281. Relay R280, at its contacts 283, again completes a circuit for energizing the rotary magnet 245. If the wiper 323 is in engagement with an idle trunk line, battery potential will be encountered on conductor C335, whereupon relay R300 immediately operates and opens the stepping circuit of the rotary magnet 245, at contacts 308, before this magnet has had an opportunity to be sufficiently energized to rotate the wiper sets an additional step. However, if it be assumed that the above trunk line is busy, the wiper 323 encounters ground potential on conductor C335, whereupon the upper winding of relay R300 is short-circuited, permitting the rotary magnet 245 to completely energize and advance the wiper sets into engagement with the third set of contacts in the banks and to again open, at contacts 246, the energizing circuit for relay R280. It will be seen from the foregoing description of the operation that the contacts in the tenth level are tested for a busy condition and, if found busy, the corresponding contacts in the fifth level are then tested; and if these latter contacts are found busy, the wipers are moved to the succeeding contacts where the next contacts in the tenth level are tested and, if found busy, the corresponding contacts in the fifth level are tested. This interaction of testing contacts in two levels successively continues until an idle line is found.

If, in testing the lines, the connector finds busy the first twelve lines which are terminated upon the first six sets of contacts in the tenth and fifth levels, the wiper sets are driven into contact with the terminals connected to individual lines which are terminated upon the seventh sets of contacts in the tenth and fifth levels of the connector bank. It will have been noted that tests for idle trunk lines are made over the wip-

ers 321 and 323 and that, as a result of these tests, the wipers are caused to be rotated to succeeding sets of bank contacts when a busy condition is encountered in both levels. However, in the event the wipers are driven into engagement with contacts terminating individual lines, as in the present instance, no potential will be found upon the bank contacts engaged by the wipers 321 and 323, and, as a result, the polar relays R310 or R300 will not operate, but the stepping relay R280 will again operate to complete, at the contacts 283, a circuit including contacts 263, 277, 308, 313 and 296 and the hold conductor C207, for again energizing the rotary magnet 245, whereby the wiper sets are driven a further step into contact with the succeeding sets of bank contacts. Attention is called to the fact that, because the test relay R270 is then in its operated position, the test circuit including the test wiper 320 is ineffective for testing individual lines in the tenth level, since the circuit therefor is interrupted at the contacts 271, and it will also be noted that the corresponding upper and lower test contacts terminating the individual lines are not connected together and, therefore, the wiper 321 is open circuited and, as a result, the relay R310 cannot operate. Attention is also directed to the fact that inasmuch as the test relay R300 is not in its operated position, the test circuit including the test wiper 322 is ineffective for testing individual lines in the fifth level, since the circuit therefor is interrupted at contacts 306, and it will also be noted that the corresponding upper and lower test contacts terminating the individual lines are not connected together and, therefore, the wiper 323 is open circuited and, as a result, the relay R300 cannot operate. With the above condition prevailing, it will be seen that the wipers will be advanced over the contacts terminating individual lines without testing the idle or busy condition thereof, and will be driven into engagement with the next succeeding sets of bank contacts. In the present case, the eighth set of contacts in the tenth level terminate an individual line and the eighth set of contacts in the fifth level are vacant. In either case, the wipers are caused to be moved to the succeeding contacts as no test potential is found upon the contacts which are engaged by wipers 321 and 323. It should be noted that if a trunk line is terminated on the eighth set of contacts in the fifth level, with the upper and lower test contacts thereof strapped together in the manner illustrated in the drawings, the test wiper 323 will make the above-described test operation to determine the idle or busy condition of that trunk line.

Assuming now that the wiper sets are resting upon the ninth set of contacts in the tenth and fifth levels of the banks, and that the ninth contact in the tenth level has been tested and found busy, the ninth contact in the fifth level is now tested and found to be idle. Negative battery potential applied to the control conductor C353, which marks the associated line as idle, then causes the polar relay R300 to operate over a circuit which may be traced from the grounded hold conductor C207 by way of contacts 297, 312, 307, 281, 273, the upper winding of relay R300, and the wiper 323 engaging the bank contact terminating the conductor C353. Due to the pre-energized condition of its lower winding, relay R300 operates exceedingly fast to open, at contacts 308, the circuit of the rotary magnet 245, before the magnet has had sufficient time to completely

energize. As a further result of opening of contacts 308, the holding circuit for the delay relay R250 is opened, whereupon the latter relay slowly restores to normal. Relay R300, upon operating, at its contacts 307, also opens the initial energizing circuit for its upper winding. However, the relay now remains in its operated position under control of the circuit, including its lower winding. The relay R300, upon operating, at its contacts 301 and 303, also disconnects the line wipers 324 and 325 which are now engaging the ninth set of contacts in the tenth level of the bank, while, at contacts 302 and 304, it connects the line wipers 326 and 327 which are engaging the contacts terminating the idle trunk line extending to the P. B. X. Also, upon operating, the polar relay R300, at its contacts 305, opens a point in the test circuit including the wiper 320, and, at the contacts 306, completes an energizing circuit for the upper winding of the switching relay R290, this circuit extending from the negative battery applied to the conductor C353, by way of the bank contact engaged by the wiper 322, the contacts 306, 224, and 272, and the upper winding of the relay R290 to ground.

The switching relay R290 operates over the above traced circuit and opens, at its contacts 296, the holding circuit for the test relay R270, thereby causing that relay to restore, and it opens, at its contacts 297, a point in the circuit for energizing relay R280. The relay R290, in operating, also places ground potential upon the conductor C353 over a circuit extending by way of the contacts 295 and 306, and the wiper 322, thereby marking the associated trunk line as busy. As a further result of the energization of relay R290 a circuit is prepared, at its contacts 292 and 294, for transmitting ringing current over the selected trunk line and, at its contacts 291, ring-back tone is transmitted to the calling line to indicate to the subscriber thereat that the operator at the P. B. X is being signaled. When the slow-to-release delay relay R250 completely restores it completes, at its contacts 252, the previously traced circuit for signaling the selected line. The ringing current transmitted over the selected trunk line causes the associated trunk circuit in the group of trunk circuits 370 to operate and signal the operator at the P. B. X board 372 that a call is to be answered.

The operator at the switchboard 372, in answering the call, causes the associated trunk circuit to complete a loop circuit to the connector, thereby causing the ring cut-off relay R230 to be operated in the manner explained above with respect to answering a call to an individual line. The functions of the connector relative to the conversation period and the release of the connection are the same as described above except that, in the present instance, the relay R300 is operated, so that when the release takes place, this relay also restores along with the relay R290 as they are both held over the same circuit.

Further, let it now be assumed that the connector, in searching for an idle line, encounters as the first idle trunk line in the group of trunk lines the trunk terminating upon the set of contacts in the tenth position in the tenth level. In that event, the test wiper 321, upon engaging the bank contact of the associated line, completes a circuit for energizing the upper winding of the relay R310 over a circuit which may be traced from ground upon conductor C207 by way of the contacts 297, 312, 307, 282, the upper winding of the relay R310, the contacts 274, the nor-

mal post springs 315, the wiper 321 and engaged contact, to negative battery potential applied to conductor C352. Due to the pre-energized condition of its lower winding, relay R310 operates exceedingly fast to open, at contacts 313, the circuit for the rotary magnet 245 and the holding circuit for the slow-to-release delay relay R250. At its contacts 312, the relay R310 also opens the initial energizing circuit for its upper winding. However, relay R310 now remains in its operated position under control of the circuit including its lower winding. In operating, the relay R310 also completes, at its contacts 311, a circuit for energizing the switching relay R290, this circuit extending from ground by way of the upper winding of the relay R290, the contacts 272, 224, 305 and 311, and the wiper 320 to negative battery applied to the control conductor C352. The switching relay R290 operates to perform the functions described above and the operations of the switch are the same with respect to signaling, answering a call and releasing as those heretofore described except that in this case the relay R310 is held until the ground potential is removed from conductor C207.

The control conductor, such as C354, of the last trunk line in any trunk group is not strapped to the adjacent lower bank contact and the latter bank contact is connected either through a relatively high resistance to battery or through a high resistance winding of a traffic meter to battery. In the event that the connector cannot find an idle trunk line in a group of trunk lines, the wipers thereof come to rest upon the last set of contacts, where either the control wiper 321 in the upper set or the control wiper 323 in the lower set engage the bank contact terminating the resistor or meter which is connected to battery. If the last trunk line in the fifth level, as illustrated, is selected, the resistance in series with the battery operates upon the contact engaged by wiper 323 to cause the relay R300 to operate whether the last trunk line in the group is idle or busy. If, however, the last trunk line of the group terminates in the tenth contact set of the tenth level, then when the wiper 321 encounters this last trunk line, battery potential, either through a resistance or through the winding of a traffic meter, applied to the associated bank contact causes the relay R310 to operate whether the selected last trunk line is idle or busy. The relay R300 or the relay R310, in operating, completes, at either the contacts 309 or 314, respectively, a circuit for energizing the busy relay R260, this circuit extending over the conductor C207, the contacts 297, 309 or 314, and 279, and the lower winding of R260 to battery. The relay R260, in operating, completes, at the contacts 261, the circuit for impressing busy tone upon the calling line in the manner heretofore described with respect to making a call to a busy individual line. However, it is to be noted that the busy tone circuit is completed only in the event that the last trunk line of the group is also busy and relay R290 is, therefore, short-circuited in the manner previously described. If the last trunk line in the group is idle and it terminates in the tenth level, battery potential is applied to the bank contact engaged by the test wiper 320 and causes switch relay R290 to energize over a previously traced circuit. However, if the last trunk line of the group terminates in the fifth level, then battery potential is applied to the bank contact engaged by the test wiper 322 and causes switch relay R290 to energize over a pre-

vously traced circuit. Energization of relay R290 prevents the transmission of busy tone to the calling subscriber when the busy relay R260 operates. The switching relay R290, in operating, performs the above described functions including that of connecting ringing current to the selected trunk line to signal the operator at the P. B. X switchboard 372. The meter 350, if used, will operate to record the fact that all the trunk lines of the group have been tested and were found busy or that all the trunk lines of the group except the last trunk line have been tested and found busy. This record may be used to indicate, if it is found that the trunk group is busy an excessive number of times, that a greater number of trunk lines are needed to handle the traffic to the P. B. X.

Night service

From the foregoing description of operation of the connector it will be understood that whenever the digits "01" are received in the connector the switch functions to raise its wipers to the tenth and fifth levels respectively, and to rotate the wipers into engagement with the first and second trunk lines in the P. B. X group terminating in the first set of contacts in the tenth and fifth levels, respectively. Accordingly, the wipers are automatically rotated over the remaining sets of contacts in these levels in search of an idle trunk line, it being understood that the wipers will continue to rotate over bank contacts terminating individual lines, whether idle or busy, and over vacant bank contacts of the bank until the last trunk line in the group is reached, whereat the rotary movement of the wipers is terminated regardless of the idle or busy condition of the last trunk. If the last trunk is busy, the calling subscriber is given the usual busy signal and if the last trunk is idle the connection is completed in the usual manner.

Having described the operation of the connector responsive to the dialing of the digits "01" to search for and select an idle trunk line in a group of trunk lines, a brief description will now be given of the operation which takes place when the calling subscriber desires to establish a connection with a particular one of the trunk lines in the P. B. X group of trunk lines. This feature is of value for night time service or at any time that certain specific trunk lines are to be called. For the purpose of this description it will be assumed that the connector has been seized by the calling subscriber, that the first digit received by the connector is the digit "0," and that the final digit "3" has been dialed, indicating that the calling subscriber desires to establish a connection over the third trunk line in the tenth level. The operation of the connector at this time is the same as when a call is extended to an individual line, i. e., the last digit dialed by the calling subscriber rotates the wipers directly to the contact set terminating the desired trunk line. It will be noticed that, while the impulses of the last digit are being received to operate the line relay R120, this relay, at its contacts 122, intermittently applies ground potential to the lower winding of the relay R200 to maintain the latter relay operated, which in turn maintains, at its contacts 202, the circuit for the relay R220. With the two relays R200 and R220 operated during pulsing, the circuit for operating the rotary magnet 245 is maintained at the contacts 204 and 225. In the event that the desired trunk line is found busy, and when the wipers 320, 321, 324 and 325 engage

the associated bank contacts, ground potential, applied to control conductor C375, will be encountered upon the control contact thereof, the ground potential being conducted by way of the associated control wiper 320 to short the upper winding of the switch relay R290, whereupon the busy relay R260 is operated. It will be remembered that the step relay R260 was operated at the termination of pulsing, thereby completing the energizing circuit for the relay R260 from the grounded conductor C207 by way of the contacts 295, 313, 308, 283, 278 and the upper windings of the relays R260 and R280. The busy relay R260, in operating, completes, at its contacts 261, the above-mentioned busy tone circuit extending to the calling telephone to notify the calling party that the desired trunk line is busy and that the call cannot be completed at this time. It should be noted that when a call is extended to a particular trunk line, other than the first trunk in the tenth level, in a group of P. B. X trunks, the test relay R270 is not operated over the circuit, including the wiper 321 and the resistance battery connected by way of conductor C329 to the bank contact engaged by wiper 321, normally completed when the digits "01" are dialed. Since the test relay R270 cannot operate unless the wiper 321 is rotated to the first contact set in the tenth level, the testing circuit for automatically rotating the wiper sets to search for an idle trunk line in the group is not completed when a call is extended to a particular trunk line, other than the first trunk, in the P. B. X group of trunks. Consequently the circuits including the test wipers 322 and 323 are open at contacts 306 and 273, respectively. If the called trunk line is found to be idle, negative battery which is encountered upon the control contact by way of the wiper 320, causing the switching relay R290 to operate. The relay R290, in operating, switches the calling line through to the wipers 324 and 325 engaging the third set of bank contacts in the tenth level terminating the desired trunk conductors C376. The remaining operations of the connector including signaling of the called trunk line, conversation over the established connection, and release of the connection upon the termination thereof, are accomplished in the same manner as have been described hereinbefore.

It will now be assumed that the calling subscriber desires to establish a connection with a particular trunk line in the group of P. B. X trunk lines terminating in the fifth level of the associated sets of bank contacts. For the purpose of this description it will be assumed that the connector has been seized by the calling subscriber in the usual manner, that the first digit received by the connector is the digit "5" and that the final digit "1" has been dialed indicating that the calling subscriber desires to establish a connection over the first trunk line in the fifth level. It should be understood that the calling subscriber may also establish a connection with any other trunk line terminating in the fifth level by merely dialing a final digit having a numerical value corresponding to the contact position of the bank terminating the wanted trunk line. The operation of the connector responsive to the receipt of the digits "51" is the same as has been previously described in connection with the call extended to the individual subscriber line 361 extending to substation C. In other words, the wipers 320, 321, 324 and 325 are positioned opposite the fifth level by the dialing of the digit "5"

and are rotated into engagement with the first set of bank contacts in the fifth level when the final digit "1" is dialed. If the control conductor C331 has ground potential applied thereto, indicating that the associated trunk line is busy, the calling subscriber receives the busy tone signal and releases the connection in the usual manner. However, if the control conductor C331 has battery potential applied thereto, indicating that the associated trunk line is idle, the connection is switched through and signaling takes place in the manner previously described. When the conversation is completed and the subscribers replace the handsets upon the associated hook or cradle of their respective telephone instruments, the connection is released in the same manner as has been described hereinbefore.

The arrangement of the group P. B. X trunk lines extending to the trunk circuits 370 need not be confined to the corresponding contact sets in the tenth and fifth levels of the connector bank as is shown in the drawings, and may, for example, be connected to bank contact sets in one level, if ten or less trunks are provided in a group of P. B. X trunks; or, if it is anticipated that the future growth of P. B. X trunk lines in a group will ultimately exceed ten trunks, it may be advisable to connect five trunks of the group to the first five bank contact sets in the tenth level and the remaining five trunks to the first five bank contact sets in the fifth level. Additional trunks may then be added to any vacant bank contact sets in either the tenth or fifth levels, or to vacant bank contact sets in both levels. It should be understood, however, that it is not essential that corresponding bank contact sets in the tenth and fifth levels terminate trunk lines of the P. B. X group of trunks. As a modification of the connector illustrated, it may be of some advantage to space the sets of wipers on the wiper shaft (not shown) one or more step or levels apart instead of five levels apart as is illustrated. For example, the lower wiper set, comprising wipers 322, 323, 326 and 327 may be spaced one step or level apart from the corresponding upper wiper set comprising wipers 320, 321, 324 and 325. With this arrangement, when the upper wiper set is in engagement with the bank contacts in the tenth level, the lower wiper set will be in engagement with corresponding bank contacts in the ninth level, it being understood that with this spacing arrangement of the upper and lower wiper sets the trunk lines of the P. B. X group of trunk lines are to be connected to bank contact sets in the ninth and tenth levels instead of the fifth and tenth levels as is illustrated in the drawings.

While the present invention has been described in relation to a connector switch in a telephone system, it is understood that the invention may be applied to various other switches in other stages of a telephone or switching system and that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, an automatic switch comprising a contact bank having contacts arranged in levels, two sets of wipers operable by said switch to make contact simultaneously with the contacts in two of said levels, a group of trunk lines terminated upon contacts in said two levels, a plurality of individual lines terminated upon contacts interspersed with the contacts upon

which said first-mentioned lines terminate, and means including said wipers for successively testing the busy condition of said trunk lines of said two levels.

2. In a telephone system including separate lines extending to individual substations and a group of trunk lines extending to another exchange, an automatic switch comprising a contact bank terminating said lines, said contacts being arranged in levels, said switch having two sets of wipers adapted to engage simultaneously contacts in two of said levels, means for automatically moving said wipers progressively over said contacts in search of an idle trunk line when a call is made to another exchange and thereby testing the corresponding contacts in the two levels for busy condition alternately, and means for directly moving said wipers to any desired contacts in said bank when a call is made to a substation or to a particular trunk line.

3. In a telephone system, an automatic switch having two sets of wipers, a contact bank having contacts arranged in two levels, each level comprising a plurality of similarly arranged contacts, a group of trunk lines divided into two subgroups, the trunk lines of one subgroup terminating upon contacts of one of the said levels and the trunk lines of the other of said subgroups terminating upon contacts of the other of said levels, individual lines terminating upon contacts of the said two levels, said contacts terminating said individual lines being commingled among said contacts terminating trunk lines of said group, means for operating said switch to position one of said sets of wipers into engagement with the contacts of one of said levels terminating the first trunk of said group and simultaneously to position the other of said sets of wipers into engagement with the contacts of the other of said levels, and means in said switch for advancing the wiper sets over the successive contacts in said two levels to test the idle or busy condition of only the contacts in both levels terminating said subgroups of trunk lines.

4. In a telephone system, a plurality of trunk lines, an automatic switch comprising a contact bank and a plurality of wipers, said contact bank comprising a plurality of contacts arranged in horizontal levels, certain of said contacts being adapted to be engaged simultaneously by a plurality of said wipers, a plurality of telephone lines, a first set of said contacts terminating a single telephone line, a second set of said contacts being contacts upon which no line terminates, a group of said contacts including contacts in two of said levels of contacts terminating a group of said trunk lines, said first and second sets of said contacts being disposed between said contacts of said group of contacts, means for designating the contacts associated with busy lines as busy and for designating the contacts associated with idle lines as idle, means controlled by said switch for operating said wipers to make contact with said contacts to test the busy or idle condition of each of the associated trunk lines, means for testing the corresponding contacts in said levels sequentially before the wipers are operated by said switch to test the next succeeding contacts in the group, and means in said switch for controlling said wipers to pass over said first and second sets of contacts regardless of their busy or idle condition.

5. In a telephone system, a selecting switch comprising a contact bank having contacts arranged in a plurality of levels, a group of trunk

lines terminating upon contacts in two of said levels, individual lines terminating upon other contacts in said two levels, two sets of contact wipers included in said selecting switch operable to engage successively the contacts in the said two levels, and means in said switch for establishing connections with trunk lines in said group over either one of said wiper sets and for establishing connections with said individual lines over a particular one of said wiper sets.

6. In a telephone system, a selecting switch comprising a contact bank having contacts arranged in a plurality of levels, each level including sets of contacts, a group of trunk lines terminating upon some of the contacts in two of said levels, a first individual line terminating upon a set of contacts in a first level of said two levels, a second individual line terminating upon a set of contacts in a second level of said two levels, a first and a second set of wipers included in said selecting switch directly controlled and arranged to pass over contacts terminating said trunk lines in said two levels and operative to select the contact set in said first level terminating said first individual line by said first set of wipers, and means controlled in said switch for moving only said first set of wipers over said second level of said two levels of contacts and operative to select the set of contacts in said second level terminating said second individual line.

7. In a telephone system, a calling line, a final selecting switch having access to groups of trunk lines and to telephone lines, said switch including a contact bank having a plurality of contacts arranged in levels, a group of trunk lines terminating upon contacts in two of said levels, said trunk lines normally marked as idle, means for individually marking said lines as busy when seized, said switch including a plurality of wiper sets, means in said switch for positioning said wiper sets into engagement with the contacts in said two levels and for selecting an idle trunk line in said group, means for controlling said last-mentioned means thereby to position one of said wiper sets into engagement with the contacts of either one of said levels terminating a particular trunk line in said group, means for seizing the selected particular trunk line in the event it is idle, and means for transmitting a busy signal in the event said particular trunk is marked busy unless said selected particular trunk is the first trunk in said group.

8. In a telephone system, an automatic switch comprising a contact bank having contacts arranged in levels, two sets of wipers operable by said switch to make contact simultaneously with the contacts in two of said levels, a group of lines terminated upon corresponding contacts in said two levels, means including said wipers for testing the busy condition of lines terminating at corresponding contacts in said two levels alternately, and automatic means for progressively advancing said wipers over the contacts of said levels regardless of the position of said lines in said levels until a contact terminating a non-busy line is encountered.

9. In a telephone system, an automatic switch comprising a contact bank having contacts arranged in levels, two sets of wipers operable by said switch to make contact simultaneously with the contacts in two of said levels, a group of lines, certain of said lines terminated at contacts in one of said levels, certain other of said lines terminated at contacts in the other of said levels,

vacant contacts in both of said levels interspersed between some of the contacts terminating said lines, means for testing the busy condition of lines in said two levels, and means for progressively advancing said wipers over busy and vacant contacts of said two levels whether or not said lines terminated at contacts of said levels are in corresponding contact positions of said levels.

10. In a telephone system, a final selecting switch comprising a contact bank, said contact bank including a control section and a line section, each of said sections including a plurality of contacts arranged in levels, said selecting switch having sets of wipers operative to engage in unison the contacts in a plurality of levels in each section, a group of trunk lines each having control and line conductors terminating upon contacts in a plurality of levels respectively in said control and line sections, a plurality of individual telephone lines each having control and line conductors terminated upon contacts interspersed with the contacts in the levels which terminate said trunk lines, vacant contacts in the levels terminating said trunk lines, means in said switch for positioning said wipers upon the first contacts in said levels terminating said group of trunk lines and for automatically advancing said wipers over contacts associated with busy trunk lines, busy or idle individual telephone lines, and vacant contacts, and means in said switch for causing one of said sets of wipers to selectively engage with contacts associated with an idle trunk line.

11. In a telephone system, a final selecting switch comprising a contact bank, said contact bank including a control section and a line section, each of said sections including a plurality of contacts arranged in levels, said selecting switch having sets of wipers operative to engage in unison the contacts in a plurality of levels in each section, a group of trunk lines each having control and line conductors terminating upon contacts in a plurality of levels respectively in said control and line sections, a plurality of individual telephone lines each having control and line conductors terminated upon contacts which are intermixed with the contacts in the levels which terminate said trunk lines, vacant contacts intermixed with the contacts in the levels terminating said telephone lines and said trunk lines, means in said switch for positioning said sets of wipers upon the first contacts in said levels terminating said group of trunk lines, means for thereafter automatically advancing said sets of wipers over contacts terminating busy trunk lines, busy or idle individual telephone lines, and vacant contacts, and means in said switch for terminating the automatic advancement of said wiper sets and for causing one of said wiper sets selectively to engage the contacts associated with the first idle trunk line in said group.

12. In a telephone system, a calling line, a final selecting switch having access to groups of trunk lines and to telephone lines, said selecting switch including a contact bank having a plurality of contacts arranged in levels, a group of trunk lines terminating upon some of the contacts in two of said levels, telephone lines terminating upon some of the other contacts in said two levels, vacant contacts in said two levels, said trunk lines and telephone lines normally marked as idle, means for individually marking said lines as busy when seized, said selecting switch including a plurality of wiper sets operative to select the

contacts in said two levels, means in said selecting switch for directively positioning one of said wiper sets upon the first contacts of said levels terminating the first trunk in said group of trunk lines, means for thereafter automatically advancing said plurality of wiper sets over contacts in said levels terminating busy trunk lines, busy or idle telephone lines, and vacant contacts, and means in said switch controlled when the contacts terminating the last trunk in said group is encountered by one of said wiper sets and found busy for terminating further advancement of said wiper sets and for transmitting a busy signal to indicate that all of the trunks in said two levels are busy.

13. In a telephone system, a rotary connector switch including two sets of wipers and an associated contact bank, a group of lines accessible to said sets of wipers in two levels of said bank, each line having a regular and a special test contact in said bank, means for directively operating said switch to select a particular one of the lines in said group over one set of said wipers, and means in said switch controlled over said regular and said special test contacts of the selected line and effective to cause said switch to search for an idle line alternately in said two levels only in the event the selected line is the first line of said group.

14. In a telephone system, a switch having two sets of wipers, each set of wipers including a regular and a special test wiper, a group of trunk lines, each line having test contacts accessible to a regular test wiper of one of said sets of wipers, means for operating said switch to position the first set of said wipers into engagement with a first trunk line in said group and for simultaneously positioning the second set of said wipers into engagement with a second trunk line of said group, automatic means in said switch controlled over said regular and special test wipers of the first set of wipers for starting said sets of wipers rotating in search of an idle line if said first trunk line is found busy, and means controlled over the special test wiper of the second set of wipers for preventing the actual rotation of said sets of wipers in the event said second trunk line in said group is found to be idle.

15. In a rotary connector, two sets of wipers, each set including a test wiper, a test relay for each set of wipers, a step relay, means for operating said switch to position the wipers thereof into engagement with two trunk lines of a group of trunk lines, means for completing a test circuit including one of said test wipers and one of said test relays thereby to test the idle or busy condition of one of said trunk lines, means for operating said step relay, means controlled by said step relay for completing a stepping circuit thereby to advance said sets of wipers to search for an idle trunk line in said group, and means controlled by said step relay for disconnecting said test circuit from said first test wiper and for completing a test circuit for said second test wiper and its associated test relay thereby to determine the idle or busy condition of said sec-

ond trunk line before said sets of wipers are advanced by said stepping circuit.

16. In a rotary connector, two sets of wipers, each set including a test wiper, a test relay for each set of wipers, a switch relay for both sets of wipers, a step relay, means for operating said switch to position the wipers thereof into engagement with two trunk lines of a group of trunk lines, means for completing a test circuit including one of said test wipers and one of said test relays thereby to test the idle or busy condition of one of said trunk lines, means for operating said step relay, means controlled by said step relay for completing a stepping circuit thereby to advance said sets of wipers to search for an idle trunk line in said group, means controlled by said step relay for disconnecting said test circuit from said first test wiper and for connecting a test circuit for said second test wiper and its associated test relay thereby to determine the idle or busy condition of said second trunk line before said sets of wipers are advanced by said stepping circuit, and means controlled by said test relays for operating said switch relay thereby to establish a connection including either of said sets of wipers and an idle trunk line in said group.

17. In a telephone system, an automatic switch having a first and a second set of wipers, means for moving said wiper sets simultaneously, a plurality of levels of contacts available to said first wiper set, certain of said plurality of levels of contacts available to said second wiper set after they have become available to said first wiper set, a group of trunk lines, said trunk lines terminating at certain contacts in at least two of said levels, certain other of said contacts in said two levels being unwired and commingled with said contacts terminating said trunk lines, means for operating said wiper moving means to directively operate said first wiper set into engagement with the contacts terminating any particular one of said trunk lines in either level, means controlled in the event said first wiper set is directively operated into engagement with the contacts of a level terminating the first trunk line in said group for causing said first and said second wiper sets to sequentially test for an idle trunk line in said levels, and means for automatically advancing said wiper sets over the contacts of said levels in the event said first and said second wiper sets encounter either busy trunk lines or said unwired contacts in said levels.

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