Oct. 26, 1943. J. H. VOSS 2,333,038

TELEPHONE SYSTEM

Filed April 22, 1940 8 Sheets-Sheet 1

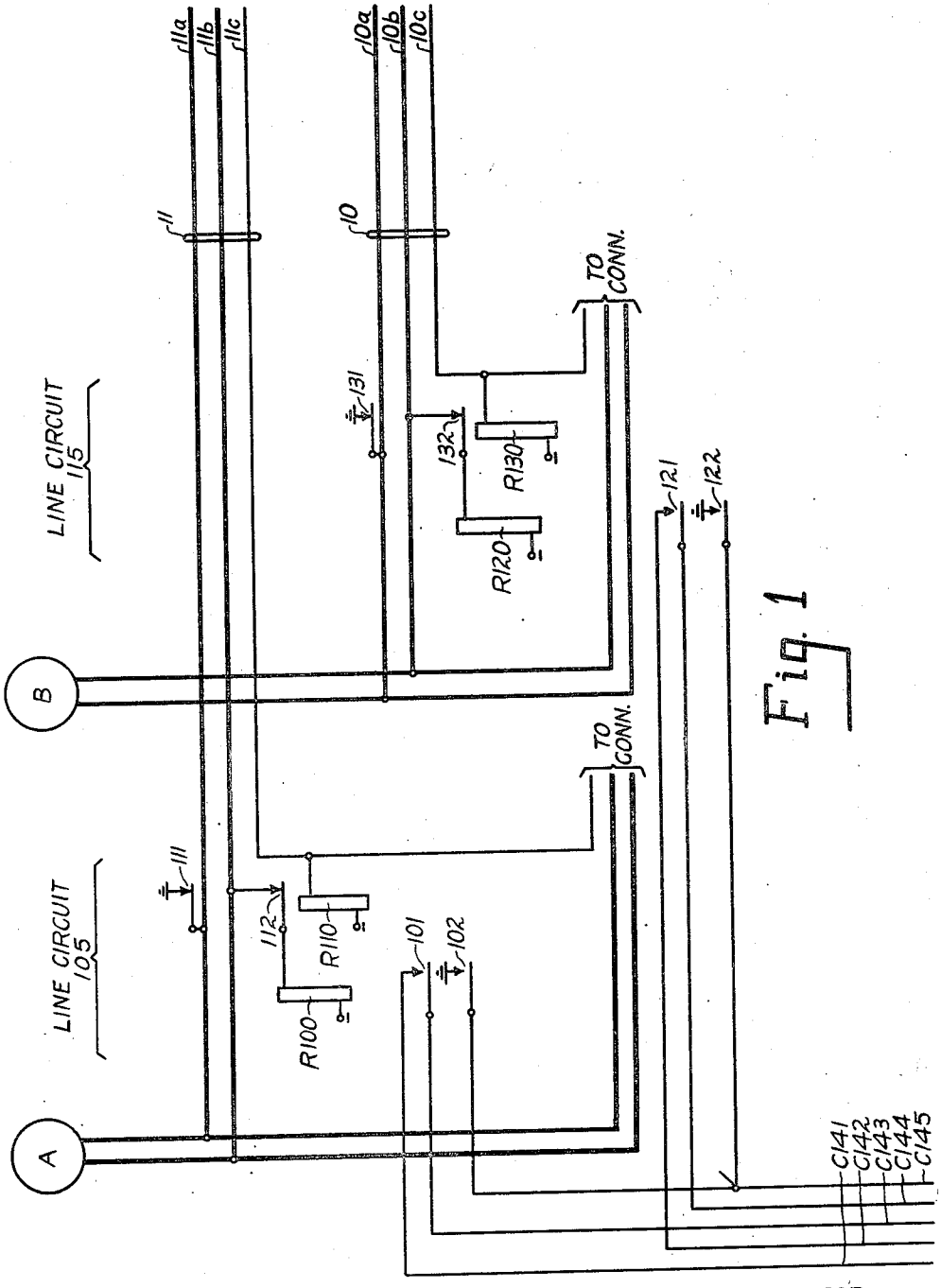


Fig. 1

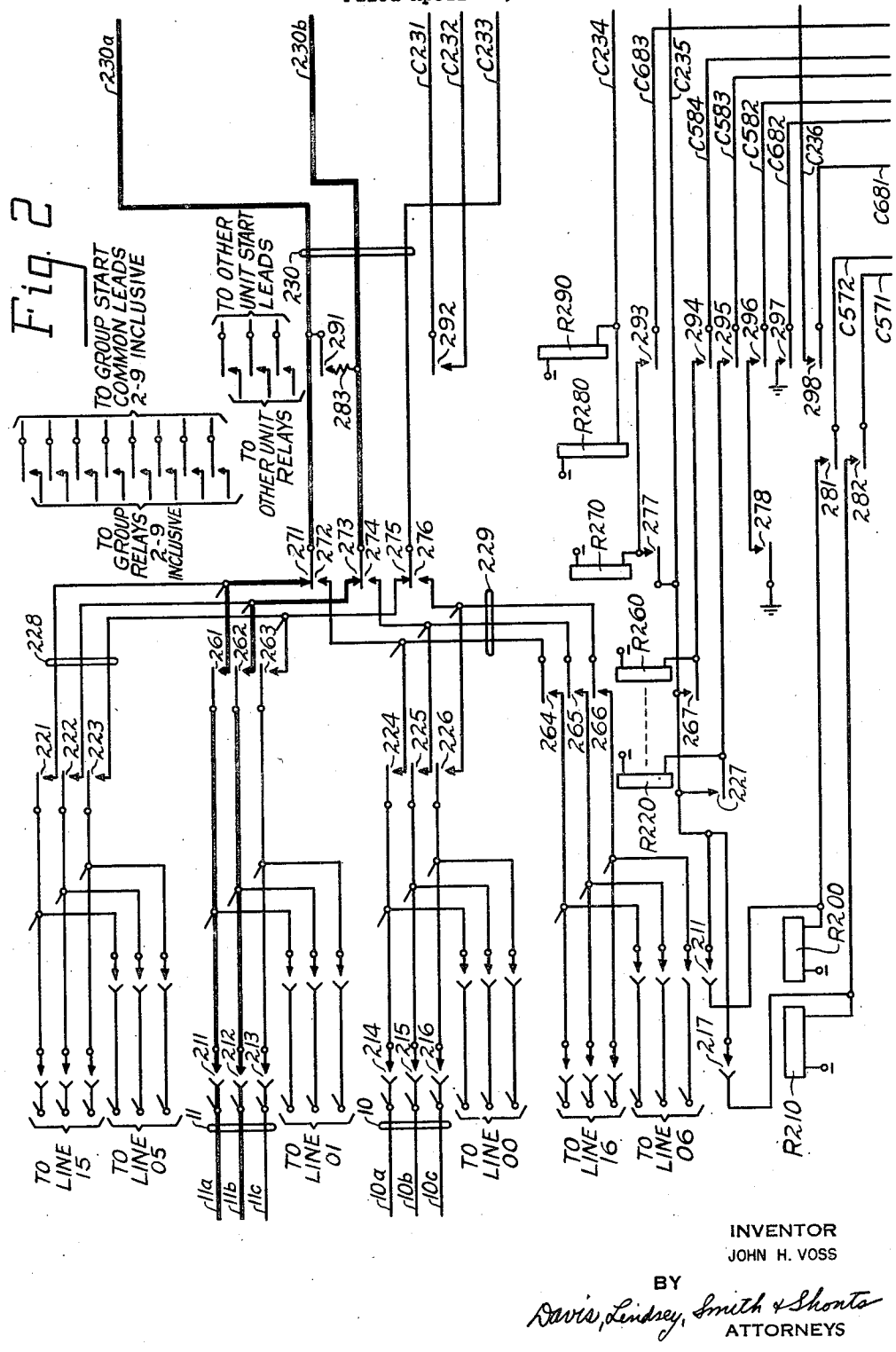
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Fig. 3

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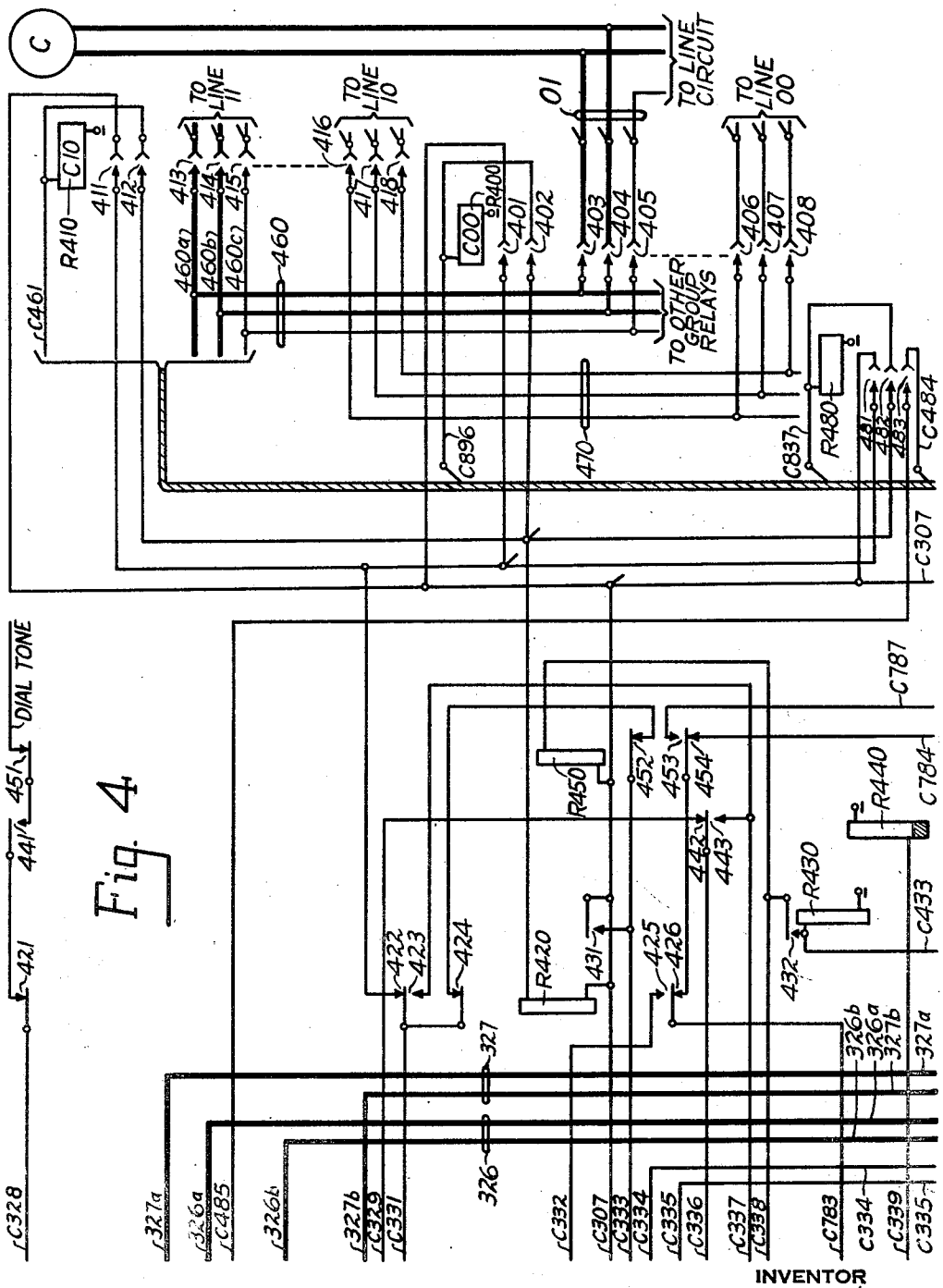


Fig. 4

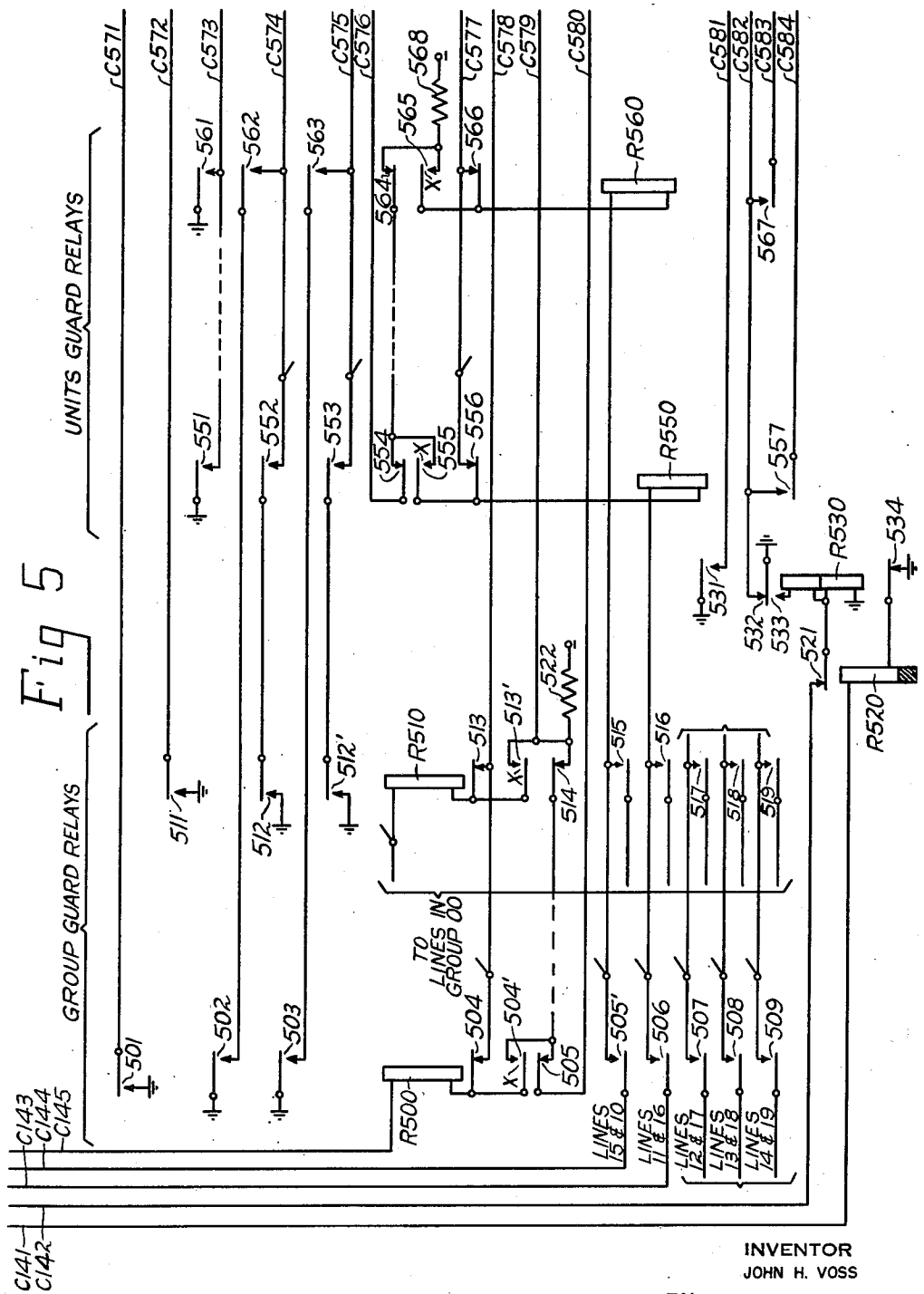
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TELEPHONE SYSTEM

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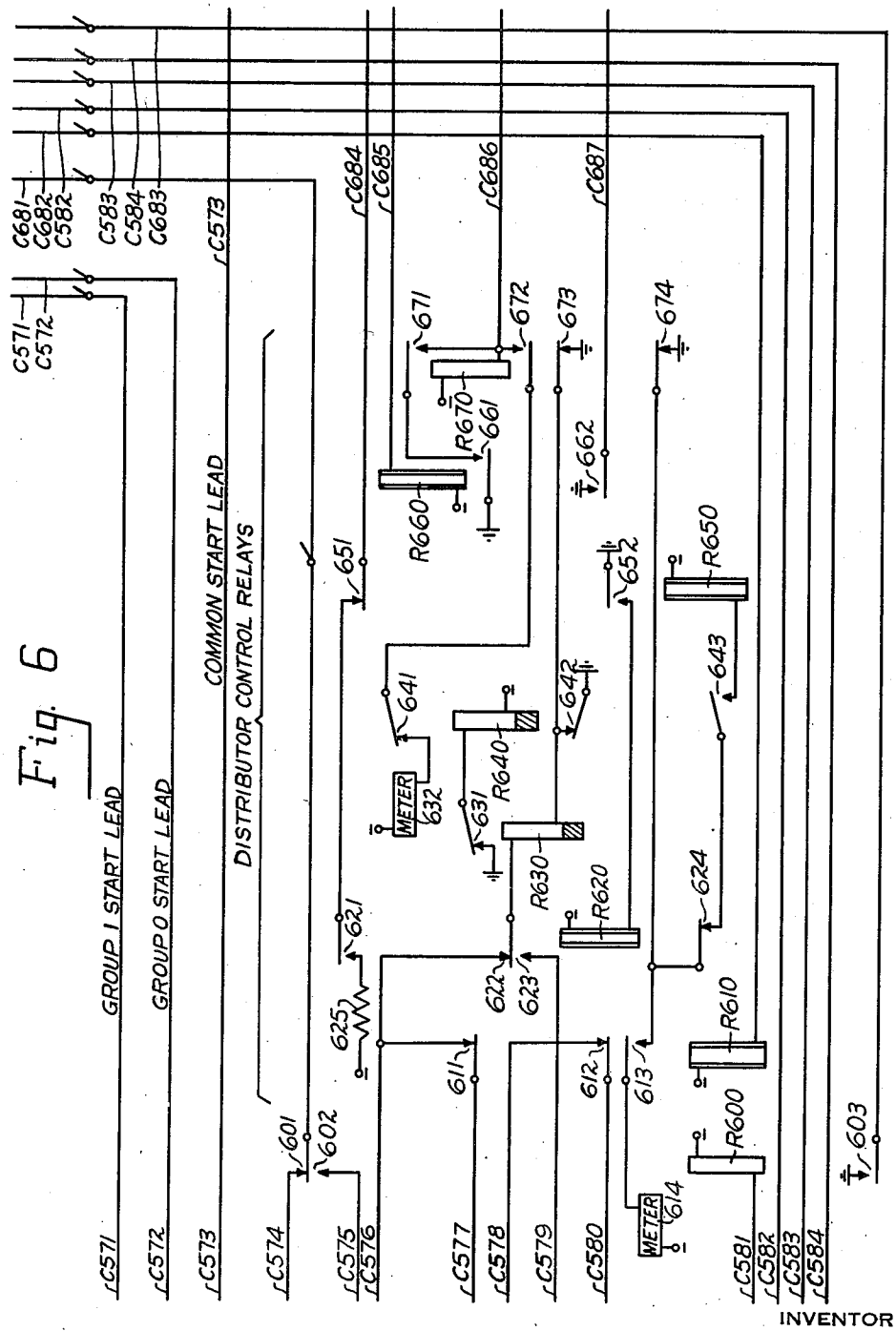


Fig. 6

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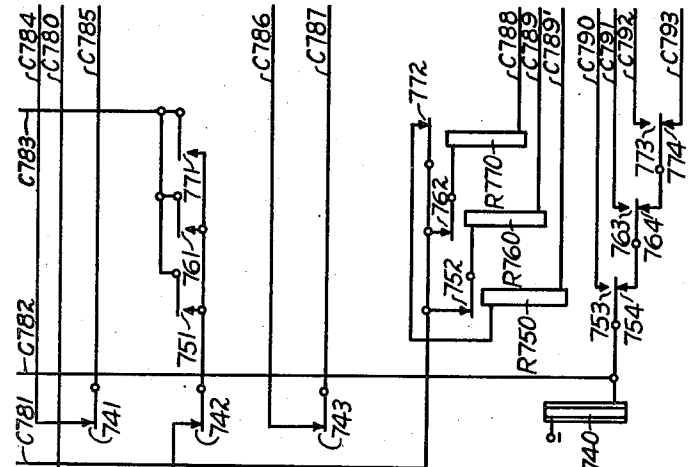


Fig. 7

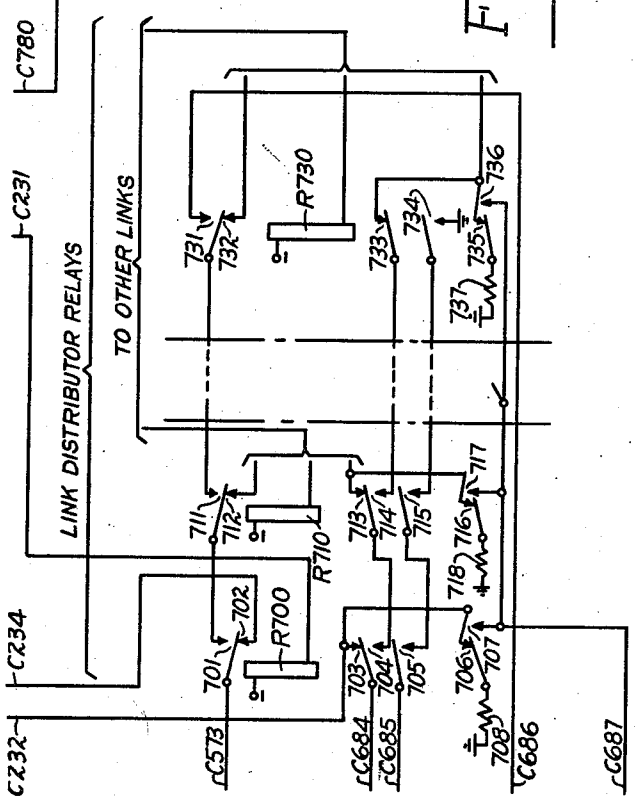


Fig. 9

FIG. 1	FIG. 2	FIG. 3	FIG. 4
FIG. 5	FIG. 6	FIG. 7	FIG. 8

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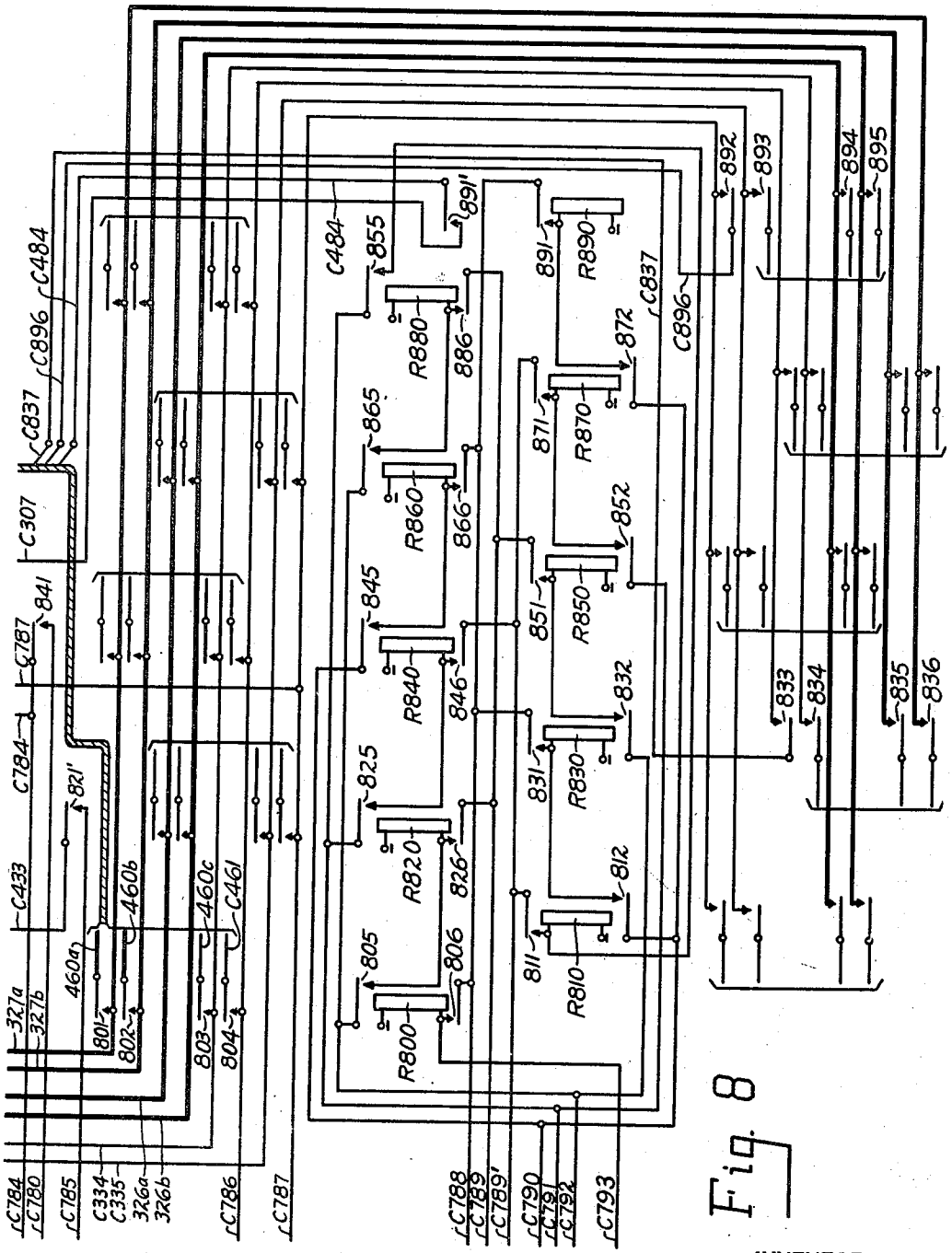


Fig. 8

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

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Application April 22, 1940, Serial No. 330,975

17 Claims. (Cl. 179—18)

The present invention relates to automatic telephone systems and more particularly to improvements in automatic switching apparatus adapted for use in private automatic exchanges.

In private automatic telephone installations serving large commercial organizations or the like, it is frequently desirable to provide facilities whereby the executives of the organization may obtain access to any line of the system at any time. This form of service has been characterized as executive right-of-way service and involves the provision of apparatus for enabling the executive lines to obtain access to busy called lines of the system. Prior arrangements for providing such facilities are exemplified by the disclosures of Stehlik Patent No. 1,924,661, granted August 29, 1933, and Stehlik Patent No. 1,934,384, granted November 7, 1933. In the arrangements disclosed by these patents, provisions are made on a per line basis for marking the executive lines in a special manner in the banks of the rotary finder switches of the system so that the finder-connector link circuits may be controlled from the executive substations to established dry talking circuits to busy called lines of the system.

It is an object of the present invention to provide, in an automatic telephone system of the character indicated, improved apparatus for enabling the executives served by the system to have right-of-way facilities, which is simple and economical in arrangement, requires a minimum of special equipment, and is positive and reliable in operation.

It is a further and more specific object of the invention to provide improved apparatus of the character described, wherein the executive right-of-way facilities are primarily incorporated in the equipment which is common to the switching links of the system.

In the illustrated embodiment of the invention there are provided a plurality of finder-connector links of the all-relay type, which, in conjunction with equipment common to the links and including a link distributor, operate to set up connections between the lines of the system. In accordance with the present invention, provisions are made whereby right-of-way facilities are provided for the executive lines of the system under the control of certain of the apparatus embodied in the equipment common to the finder-connector links. More specifically, this common equipment includes auxiliary group, unit and subgroup relays which correspond to the group, unit and subgroup relays provided in each of the link finders. The group relays also correspond to different groups of lines of the system, the subgroup relays correspond to a particular subgroup of lines in each line group, and the unit relays respectively correspond to the same lines in each group. These auxiliary relays, as incorporated in the common equipment, are arranged selectively to control executive right-of-way circuits which extend to the several links, each link being provided with a right-of-way or special service relay which, when energized over its associated right-of-way circuit, operates in conjunction with the busy test relay of the link to establish a talking circuit to a busy called line selected by the connector portion of the link. With this arrangement the executive lines may be connected in the banks of the link-finder switches to have the same unit directory number designations. With these lines terminated in this manner, the right-of-way circuits may be connected to be set up by a predetermined one or more of the unit relays operating in conjunction with the tens or group relays respectively corresponding to the line groups which include the executive lines. These circuits are also appropriately controlled by the link distributor and the subgroup relay of the common equipment, so that the right-of-way or special service relay of an assigned link will only be operated when the finder portion of the link operates to seize a calling executive line arranged for right-of-way service.

Further features of the invention pertain to the particular arrangement of the circuit elements whereby the above and additional operating features are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. 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 to 8, inclusive, when combined in the manner illustrated in Fig. 9 of the drawings, illustrate one link and the common equipment of an all-relay automatic telephone system having incorporated therein the features of the invention briefly outlined above.

Referring to the drawings, the system there illustrated comprises a private automatic exchange at which may be terminated as many as one hundred lines, certain of which have been indicated in the drawings by the directory number designations thereof. More specifically,

these lines are divided into groups of ten each, the line 11 extending to the substation A being the first line of the first group, the line 10 extending to the substation B being the tenth line of the first group, and the line 01, illustrated in Fig. 4 of the drawings, being the first line of the tenth group. For switching purposes, each group of lines is further divided into two subgroups in accordance with the unit designations of the lines therein. Thus, the lines designated by the directory numbers 11, 12, 13, 14 and 15 comprise one subgroup of lines in the first group, and the lines 16, 17, 18, 19 and 10 comprising the second subgroup of lines in the first group.

For the purpose of setting up connections between the various lines of the system, there are provided a plurality of finder-connector links of the all-relay type, one of which is illustrated in Figs. 2, 3, 4, 7 and 8 of the drawings. These links are arranged to be controlled by common equipment which comprises a link distributor, also shown in Fig. 7 of the drawings, a group of distributor control relays illustrated in Fig. 6 of the drawings, and a group of guard or auxiliary relays which are illustrated in Fig. 5 of the drawings. More specifically, the finder portion of the link comprises ten group relays, two of which are indicated at R200 and R210, which respectively correspond to the different groups of lines. These relays are preferably of the character disclosed and claimed in Patent No. 2,135,832 granted November 11, 1938, to Herbert F. Obergfell, and only two thereof have been shown in the interest of simplifying the disclosure. The finder portion of the link also comprises five unit relays, each of which corresponds to two lines in each of the ten line groups. Thus, the relay R220, for example, is operative in conjunction with any one of the group relays to select the lines having the unit designations of 5 and 0 in the selected group of lines. Similarly, the unit relay R260 corresponds to the lines 1 and 6 in each of the ten different groups of lines. It will be understood that with one of the group relays and one of the unit relays operated, two lines are selected from the plurality of lines to which the finder switch has access. In order to select one of the two lines thus selected by the group and unit relays, there is provided a subgroup relay R270 which functions to switch the conductors of the link line 230 between the link lines 228 and 229. For the purpose of associating the selected relays of the finder switch with the common equipment illustrated in Figs. 5, 6 and 7, there are provided a pair of connect relays R280 and R290.

The connector portion of the link is similar to the finder switch just described, in that ten group relays, including the two relays R400 and R410, and each including contacts terminating ten lines of the system, are provided. These relays are also preferably of the construction disclosed and claimed in the above cited patent to Obergfell. The selection of a particular line from a group of lines selected through operation of one of the group relays is accomplished through the operation of a counting relay network which is illustrated in Figs. 7 and 8 of the drawings as comprising ten counting relays R800, R810, R820, R830, R840, R850, R860, R870, R880 and R890, three pulse circuit control relays R750, R760 and R770, and a slow-acting pulse controlled relay R740. This counting chain is further utilized for the purpose of selecting the one of the ten group relays to be operated, and the side of a selected line over which ringing current is to be projected in signaling a desired called substation.

The control equipment of the link comprises a line relay R310, a slow-acting hold relay R320, a right-of-way or special service relay R300, and a battery feed impedance element 330. This apparatus further comprises a slow-acting ring cut-off relay R340, three ringing control relays R350, R370 and R380, a busy test relay R360, a line switching relay R390, three digit transfer relays R420, R430 and R450, and a slow-to-release test circuit control relay R440.

As indicated above, the equipment common to the several links comprises a plurality of guard or auxiliary relays which individually correspond to the relays embodied in each of the finder switches. More specifically, this equipment comprises two group relays R500 and R510 which individually correspond to the finder group relays R210 and R200 of the link illustrated. Eight additional auxiliary group relays are provided, which relays are indicated by the multiple and chain conductors extending between the contacts of the two group relays R500 and R510. Five auxiliary unit relays, including the two relays R550 and R560, are provided, which individually correspond to the five unit relays of the various finder switches. The auxiliary relay equipment further comprises a pair of relays R520 and R530 which function to control the subgroup relays embodied in the finder switches.

The link distributor or allotter equipment is also of the all-relay type, a group of link distributor relays R700, R710, R730, etc., being provided which individually correspond to the links and operate in a cyclic manner to assign the respective associated links for use in a predetermined order. These link distributor relays are arranged to be controlled by a group of control relays which are illustrated in Fig. 6 of the drawings as comprising a slow-acting relay R610 for controlling the start circuits and the call metering device 614, a group of slow-to-release link transfer and distributor control relays R620, R630, R640 and R650, a slow-acting distributor reset relay R660, and an all-links-busy relay R670 which is operated only when an all-busy condition of the respective associated links prevails. The relay R670 is arranged to control an all-busy meter 632 which functions to register those instances when calls fail due to an all-busy condition of the links. The common equipment further includes a control relay R600 which is provided for the purpose of controlling the executive right-of-way circuits, referred to above and described with particularity hereinafter, in accordance with the operation of the two auxiliary sub-group relays R520 and R530.

For the purpose of initiating the operation of the common equipment just described, each line of the system is terminated in a line circuit which conventionally comprises line and cut-off relays. Thus, the line 11, which extends to the substation A, terminates at the exchange in a line circuit 105 which includes a line relay R100 and a cut-off relay R110. Similarly, the line 10, which extends to the substation B, is terminated at the exchange in a line circuit 115, which includes the line and cut-off relays R120 and R130, respectively.

Operation of the system

Referring now more particularly to the operation of the apparatus, a call initiated at the substation A and intended for the substation C may

be considered by way of example. When the party initiating the call at the substation A removes the receiver provided at this substation from its associated switchhook or cradle, a loop circuit is established which includes the exchange battery and the winding of the line relay R100. This circuit extends from ground by way of the contacts 111, the conductor 11a, the direct current bridge across the conductors of the line 11 at the calling substation, the conductor 11b, the contacts 112, and the winding of R100 to battery. In operating, the relay R100 prepares, at its contacts 101, a circuit for energizing the auxiliary unit relay R550 which corresponds to the line 11. At its contacts 102, the relay R100 completes a circuit for energizing the auxiliary group relay R500 which corresponds to the first group of ten lines. This circuit extends from ground by way of the contacts 102, the start conductor C145, the winding of R500, the contacts 504, C578, the contacts 612, C580, the contacts 505 and 514, the chain-connected contacts controlled by the other auxiliary group relays, and the resistor 522 to battery. When energized over this circuit the relay R500 completes, at its X contacts 504', an obvious holding circuit for itself, and opens, at its contacts 505, a point in the common portion of the operating circuits for the ten auxiliary group relays. At its contacts 505', 506, 507, 508 and 509, the relay R500, in operating, prepares the operating circuits for the five auxiliary unit relays. In the present case, however, only the auxiliary unit relay R550 is operated, the circuit for energizing this relay extending from ground by way of the contacts 534, the winding of R520, C141, the contacts 101, C143, the contacts 506, the winding of R550, the contacts 556, C577, the contacts 611, C576, the contacts 554 and 564, similar chain-connected contacts of the other auxiliary unit relays, and the resistor 568 to battery. At its contacts 501, the relay R500 prepares a circuit for energizing the group relay of the assigned link. At its contacts 502 and 503, the relay R500 prepares two of the executive right-of-way control circuits referred to above.

When energized in series with the relay R550 over the above-traced circuit, the slow-to-release relay R520, at its contacts 521, opens a point in the operating circuit for the relay R530, thereby to prevent operation of the latter relay until the call in progress is extended to an assigned link. The auxiliary unit relay R550 also operates when the above-traced circuit is completed, and upon operating, completes, at its X contacts 555, an obvious locking circuit for itself. After this circuit is completed, the relay R550, at its contacts 554, opens a point in the common portion of the operating circuits for all of the auxiliary unit relays. At its contacts 557, the relay R550 prepares a circuit for energizing the unit relay of the assigned link which corresponds to the unit designation of the calling line. At its contacts 552 and 553, the relay R550 prepares certain of the executive right-of-way circuits referred to above. At its contacts 551, the relay R550 completes a circuit for energizing the connect relays of the link previously selected for use by the link distributor relays. Assuming that all of the links are idle, all of the link distributor relays are operated so that the link illustrated is assigned to the use of the calling line 11. In such case the relay R550, upon operating, completes a circuit for energizing the two connect relays R280 and R290 in parallel, this circuit extending from ground by way of the contacts 551, the common start lead C573, the contacts 702, C234, and the windings of the relays R280 and R290 in parallel to battery. The relay R290, in operating, completes, at its contacts 297, a circuit extending by way of the common guard lead C682 for energizing the slow-acting relay R610. The relay R610 now operates to complete, at its contacts 613, a circuit extending from ground at the contacts 674 for energizing the call metering device 614, whereby the call is registered. At its contacts 611, the relay R610 opens another point in the common portion of the operating circuits for all of the auxiliary unit relays. At its contacts 612, the relay R610 opens another point in the common portion of the operating circuits for all of the auxiliary group relays. Thus, the auxiliary relays are prevented from responding to another call until the finder switch illustrated has completed its operation to seize the calling line 11. The relay R280, in operating, prepares, at the contacts controlled thereby, the operating circuits for the ten group relays embodied in the finder switch illustrated. In the case under consideration, only the relay R210, which terminates the first group of ten lines, is energized in response to operation of the relay R280, the operating circuits for the other nine relays being held open at the restored contacts of the other auxiliary group relays. More specifically, the circuit for energizing the relay R210 extends from ground by way of the contacts 501, C571, the contacts 282, and the winding of R210 to battery. This relay, in operating, prepares, at its contacts 211 to 213, inclusive, connections between the conductors of the line 11 and the conductors of the link line 228, and, at its contacts 217, prepares a holding circuit for itself. At the remaining contacts controlled by this group relay, connections are prepared between the other nine lines terminating at these contacts and the two link lines 226 and 229.

The relay R290, upon operating, prepares the operating circuits for the five unit relays of the finder switch. In the case under consideration only the operating circuit for the relay R260 is completed, this circuit extending from ground by way of the contacts 532 and 557, C584, the contacts 294, and the winding of R260 to battery. When energized over this circuit the relay R260 operates to prepare a locking circuit for itself at its contacts 267. At its contacts 261, 262 and 263, the relay R260 connects the conductors of the calling line 11 to the conductors of the link line 228. At its contacts 264, 265 and 266, the relay R260 connects the conductors of the line 16 to the other link line 229. At its contacts 293, the relay R290 prepares a circuit for energizing the subgroup relay R270. In the present case wherein the line 11 is in the first subgroup of the first group of lines, the subgroup relay R530 of the common equipment is not operated and hence the operating circuit for the subgroup relay R270 is held open at the contacts 603 of the restored relay R600. Accordingly, the relay R270 remains in its restored position for the duration of the call under consideration. At its contacts 296, the relay R290 prepares alternative operating circuits for the five unit relays of the finder switch, these alternative circuits being held open at the restored contacts 276 of the subgroup relay R270. At its contacts 292, the relay R290 completes a multiple holding circuit for the link distributor relay R700 individual to the link illustrated, this multiple circuit extending from ground by way of the resistor 708, the contacts

766, C232, the contacts 292, C231, and the winding of R700 to battery. At its contacts 298, the relay R290 prepares the circuit for energizing the special service or executive right-of-way relay R300.

The relay R290, in operating, also completes a circuit for energizing the line relay R310, this circuit extending from ground by way of the upper winding of R310, the conductor 230a, the contacts 291, the resistor 283, the conductor 230b, and the lower winding of R310 to battery. When energized over this circuit the relay R310 operates to complete, at its contacts 312, an obvious circuit for energizing the slow-acting hold relay R320. At its contacts 311, the relay R310 bridges the windings of the battery feed impedance element 330 across the associated line conductors. At its contacts 313, the relay R310 opens a point in the pulsing circuit, traced hereinafter, over which the relays of the counting chain are controlled.

The relay R320, in operating, completes, at its contacts 324, an obvious path for impressing ground potential upon the release conductor C307, thereby to prepare locking circuits, traced hereinafter, for certain of the other control relays embodied in the link. At its contacts 325, the relay R320 prepares the pulsing circuit to the relays of the counting chain illustrated in Fig. 8 of the drawings. At its contacts 321, the relay R320 opens one of the multiple paths included in the normally completed holding circuit for the link distributor relay R700, this circuit now being closed at the operated contacts 292 of the connect relay R290. At its contacts 323, the relay R320 completes the prepared holding circuits for the group and unit relays R210 and R260, respectively. More specifically, the holding circuit for the unit relay R260 extends from ground by way of the contacts 323, the finder hold lead C235, the contacts 267 and the winding of R260 to battery. The holding circuit for the group relay R210 extends by way of the grounded hold lead C235, the contacts 217 and the winding of R210 to battery. At its contacts 322, the relay R320 prepares a circuit for energizing the ringing control relay R370. At the contacts 322, the relay R320 also completes a path for impressing ground potential upon the private conductor 11c of the calling line 11, this path extending from ground by way of the contacts 322, C233, and the contacts 275, 263 and 213, to the conductor 11c.

When the private conductor 11c of the calling line 11 is grounded, this line is marked as busy in the bank contacts of the various connector switches, and the cut-off relay R110 is energized over an obvious circuit. The relay R110, in operating, disconnects the line conductor 11a from ground and disconnects the upper winding terminal of the line relay R100 from the conductor 11b. Thus, the line relay R100 is deenergized and the calling loop circuit is cleared of the impedance represented by the winding of this relay. When thus deenergized, the relay R100 restores to open, at its contacts 101 and 102, the established locking circuits for the operated group and unit relays R500 and R550, respectively. At its contacts 101, the relay R100, in releasing, also deenergizes the slow-to-release relay R520. The relay R500, in releasing, opens, at its contacts 501, the above-traced operating circuit for the relay R210. At its contacts 502 and 503, the relay R500 opens two of the prepared executive right-of-way circuits. At its contacts 504 and 505, the relay R500 reprepares the operating circuits for the ten auxiliary group relays. At its contacts 504', the relay R500 opens a further point in its locking circuit. At its contacts 506, the relay R500 opens a further point in the above-traced circuit for energizing the relays R520 and R550 in series. At the remaining contacts controlled by the relay R500, the prepared operating circuits for the other four auxiliary unit relays of the common equipment are interrupted. The relay R520, in releasing, reprepares the operating circuit for the subgroup relay R530. When the auxiliary unit relay R550 restores, it opens, at its contacts 557, the previously traced operating circuit for the unit relay R260. At its contacts 555, the relay R550 opens a further point in its locking circuit. At its contacts 554 and 556, the relay R550 reprepares the operating circuits for the five auxiliary unit relays. At its contacts 552 and 553, the relay R550 further opens the prepared executive right-of-way circuits referred to above. At its contacts 551, the relay R550 interrupts the above-traced circuit for energizing the two connect relays R280 and R290 in parallel.

The two connect relays R280 and R290 now restore. The relay R280, in releasing, opens the prepared operating circuit for the ten group relays of the finder switch. The relay R290, in restoring, opens the prepared operating circuits for the five unit relays and the subgroup relay R270 of the finder switch. At its contacts 297, the relay R290 opens the above-traced operating circuit for the relay R610, causing the latter relay to release. At its contacts 292, the relay R290 opens the above-traced multiple holding circuit for the link distributor relay R700. The relay R700 now restores, and at its contacts 702, disconnects the common start lead C573 from the start lead C234 extending to the link illustrated. At its contacts 701, the relay R700 connects the common start lead C573 through the contacts 712 of the second link distributor relay R710 to the start lead individual to the second link. At its contacts 706, the relay R700 opens a further point in its locking circuit as traced above. At its contacts 707, the relay R700 prepares an operating circuit for itself. At its contacts 705, the relay R700 prepares a point in the chain circuit for energizing the slow-acting reset relay R660. At its contacts 703 and 704, the relay R700 opens the prepared path for short-circuiting its own winding, and prepares a path extending through the contacts 713 for short-circuiting the winding of the second link distributor relay R710. Following the operations just described, the link illustrated is identified as busy in the link distributor relay group, and the relays of this group are in the position required to assign the second link to the use of the next incoming call. Shortly following the release of the relay R700, the slow-acting relay R610 restores to open, at its contacts 613, the circuit for energizing the metering device 614. At its contacts 611 and 612, the relay R610 reprepares the operating circuits for the auxiliary unit and auxiliary group relays, whereby these relays are conditioned to respond to another call. It will be noted that the operating circuits for these auxiliary relays are held open until all of the other relay operations required incident to the handling of the call in progress are completed, thus positively eliminating the possibility of two calling lines obtaining access to the same link.

As indicated previously, the operation of the common equipment and the finder portion of an assigned link to seize a calling line is different,

depending upon the unit designation of the calling line. The preceding explanation is predicated upon the operation of the apparatus to select a calling line included in the first subgroup of lines of a particular line group. Briefly to consider the operation of the apparatus when a call is initiated upon a line, such, for example as the line 10 included in the second subgroup of a particular line group, it is pointed out that if the line relay R120 individual to this line operates, a circuit is completed for energizing the subgroup relay R530 in series with the auxiliary unit relay R560 corresponding to the line 10. The previously traced operating circuit for the group relay R500 is also completed, at the contacts 122, when the line relay R120 operates. More specifically, the series operating circuit for the two relays R530 and R560 extends from ground by way of the lower winding of R530, the contacts 521, C142, the contacts 121, C144, the contacts 505', the winding of R560, the contacts 556, C577, the contacts 611, C576, the contacts 554 and 564, and corresponding chain-connected contacts of the other three unit relays and the resistor 568 to battery. When energized over this circuit, the relay R560 is locked up in series with the lower winding of the relay R530 over a circuit including the X contacts 565. At its contacts 564, the relay R560 opens a point in the common portion of the operating circuits for the five auxiliary unit relays. At its contacts 562 and 563, the relay R560 prepares certain of the executive right-of-way circuits referred to above. At its contacts 567, the relay R560 prepares a circuit for energizing the unit relay R220 of the first link, assuming that the first link has been selected for use by the link distributor relays. At its contacts 561, the relay R560 completes the previously traced circuit for energizing the two connect relays R280 and R290 in parallel. The relay R280, in operating, completes the previously traced operating circuit for the group relay R210. The relay R290, in operating, prepares the operating circuit for the unit and subgroup relays of the finder switch. The relay R290 also performs the other functions described above with reference to the call initiated on the line 11. The subgroup relay R530, in operating, opens, at its contacts 532, the previously traced operating circuit for the selected unit relay of the finder switch, and completes, at its contacts 533, an obvious circuit for energizing its upper winding in parallel with its lower winding and in series with the winding of the auxiliary unit relay R560. At its contacts 534, the relay R530 opens a point in the previously traced operating circuit for the slow-acting relay R520. At its contacts 531, the relay R530 completes a circuit extending by way of C581 for energizing the relay R600. The relay R600, in operating, opens, at its contacts 601, certain of the prepared executive right-of-way circuits, and, at its contacts 602, prepares certain others of these circuits. At its contacts 603, the relay R600 completes the prepared operating circuit for the subgroup relay R270 of the assigned link, this circuit extending from ground by way of the contacts 603, C683, the contacts 293 and the winding of R270 to battery. When energized over this circuit the relay R270 operates and prepares a locking circuit for itself at its contacts 277. At its contacts 271 to 276, inclusive, the relay R270 disconnects the conductors of the link line 230 from the conductors of the link line 228, and connects the conductors of the first-mentioned link line to the conductors of the link line 229 in preparation for the selection of a line in the second subgroup of the selected group of lines. At its contacts 278, the relay R270 completes the prepared alternative operating circuit for the relay R220, this circuit extending from ground by way of the contacts 278 and 296, C582, the contacts 567, C583, the contacts 295, and the winding of R220 to battery. When energized over this circuit, the relay R220 operates and prepares a locking circuit for itself at its contacts 227. At its contacts 224, 225 and 226, the relay R220 connects the conductors 10a, 10b and 10c of the calling line 10 through to the conductors 230a, 230b and C233 of the link line 230. At its contacts 221 to 223, inclusive, the relay R220 preparts a connection from the line 15 to the conductors of the link line 230, but since the subgroup relay R270 is operated, this connection is held open at the contacts 271, 273 and 275. Thus, it will be apparent that, depending upon the position of the subgroup relay R270, either of two lines may be selected through operation of any one of the five unit relays embodied in the finder switch.

When the connect relay R290 operates, it also functions to complete the operating circuit for the line relay R310, thereby to cause the sequential operation of this relay and the hold relay R320, in the manner pointed out above. The relay R320, in operating, completes the prepared holding circuits for the group relay R210, the unit relay R220, and the subgroup relay R270, these holding circuits commonly extending by way of the grounded hold conductor C235, and branching through the contacts 217, 227 and 277, respectively, to the windings of the respective enumerated relays. The relay R320, in operating, also completes a path extending by way of the contacts 322, C233, and the contacts 276, 226 and 216 for impressing ground potential upon the private conductor 10c of the calling line 10. Thus, the calling line is marked as busy in the contacts of the connector group relays, and the cut-off relay R130 is caused to operate to disconnect the winding of the line relay R120 from across the conductors of the line 10. When the relay R120 releases, it functions to initiate the release of the common equipment in the manner explained above, it being pointed out that the series holding circuit for the two relays R530 and R560 is interrupted, at the contacts 121, when the line relay R120 restores. The relay R530, in restoring, reprepares, at its contacts 532, certain of the operating circuits for the finder unit relays, and at its contacts 534, reprepares the operating circuit for the slow-to-release relay R520. At its contacts 531, the relay R530 interrupts the above-traced operating circuit for the relay R600. The relay R600, in releasing, rearranges the executive right-of-way circuits referred to above, and, at its contacts 603, opens a point in the common portion of the operating circuits for the subgroup relays of the link finder switches.

As indicated above, each time one of the finder-connector links is assigned to the use of a calling line, the link distributor relay corresponding thereto is deenergized and releases. Thus, when the link illustrated is seized, the corresponding distributor relay R700 is caused to restore to extend the control leads C573, C684 and C685 to the contacts of the distributor relay R710 corresponding to the second link. In a similar manner, when the second link is assigned to the use of a

calling line, the relay R710 is caused to release to extend the control circuits to the distributor relay corresponding to the third link. This successive assignment of links continues until the last link, namely that corresponding to the distributor relay R730, is assigned to the use of a calling line. In this regard it is pointed out that in the event the second link corresponding to the distributor relay R710 is occupied with a call at the time the first distributor relay R700 releases, the control circuits are extended through the restored contacts of the relay R710 to the distributor relay corresponding to the third link. Further, if this third link is also occupied with a call, the control circuits are extended through the restored contacts of the corresponding distributor relay to the contacts of the distributor relay corresponding to the fourth link. The arrangement of the distributor is such that the relays thereof are not immediately reoperated in response to the release of the respective associated links. Thus, it will be observed that with the relay R700 in its restored position, no circuit is available for energizing this relay regardless of the position of the hold relay R320. When, however, the last link, corresponding to the distributor relay R730, is assigned for use to cause the release of this distributor relay, a chain circuit is completed for energizing the slow-acting reset relay R660. Under these conditions all of the distributor relays are restored regardless of whether or not the respective associated links are occupied with calls. Accordingly, the circuit for energizing the reset relay R660 may be traced as extending from ground by way of the contacts 734, the chain-connected contacts of the distributor relays other than those illustrated, the contacts 715 and 705, C685, and the winding of R660 to battery. When energized over this circuit the relay R660 operates to prepare, at its contacts 661, a holding circuit for the all-links busy relay R670. At its contacts 662, the relay R660 completes the operating circuits for those of the link distributor relays which are associated with idle links. For example, if the link illustrated has been released prior to the operation of the reset relay R660, the operating circuit for the corresponding link distributor relay R700 is completed, this circuit extending from ground by way of the contacts 662, C687, the contacts 707, C232, the contacts 321, C231, and the winding of R700 to battery. Obviously, if the link illustrated is still occupied with a call, this circuit is held open at the contacts 321, so that the distributor relay R700 is not energized. In a similar manner, if the second link is idle, an operating circuit for the associated distributor relay R710 is completed by way of the grounded conductor C687 and the contacts 717. Similar operating circuits are completed for the other distributor relays which correspond to idle links. In the event the distributor relay R700 is energized over the circuit traced above, this relay operates to complete a locking circuit for itself which extends from ground by way of the resistor 708, the contacts 706, C232, the contacts 321, C231, and the winding of R700 to battery. At its remaining contacts the relay R700 arranges the associated control circuits so that the link illustrated will be assigned to the use of the next calling line. The other distributor relays which correspond to idle links are similarly locked in their respective operated positions. When the distributor relays which correspond to idle links, operate, the chain circuit for energizing the reset relay R660 is broken. The relay R660, accordingly, releases after an interval to open the prepared holding circuit for the relay R670, and to open, at its contacts 662, the respective operating circuits for the distributor relays.

Provisions are made in the link distributing apparatus, whereby in the event an assigned link fails to find and seize a calling line within a reasonable time interval, the assigned link is released and a second link is assigned to the use of the calling line. To this end the common equipment is so arranged that each time a call is initiated upon one of the subscribers lines, the normally energized slow-to-release relay R630 is deenergized. More specifically, the relay R630 is normally energized over a circuit which extends from ground by way of the contacts 673, the winding of R630, the contacts 622, C576, the contacts 554 and 564, the chain-connected contacts of the other unit relays, and the resistor 568 to battery. With the relay R630 energized over this circuit an obvious circuit for energizing the slow-to-release relay R640 is held completed at the contacts 631. With the relay R640 operated, the operating circuit for the overflow meter is prepared at the contacts 641, a multiple circuit for energizing the relay R630 is completed at the contacts 642, and the operating circuit for the slow-acting relay R650 is held open at the contacts 643. When any one of the five auxiliary unit relays is caused to operate in the manner previously explained, the chain portion of the above-traced circuit for energizing the relay R630 is opened at the contacts 554, 564, or the corresponding contacts of one of the other auxiliary unit relays. After an interval determined by the slow-to-release characteristic of the relay R630, this relay restores to open the completed operating circuit for the relay R640. In the event the assigned finder switch successfully operates to seize the calling line in its intended manner, the line circuit associated with the calling line operates to open the start circuits to the auxiliary group and unit relays, in the manner previously explained, before the relay R640 is released. When these start circuits are opened, the operated one of the auxiliary unit relays is released to recomplete the above-traced operating circuit for the relay R630. This relay, in reoperating, recompletes the operating circuit for the relay R640. Thus, under normal operating conditions the relay R640 is not released during the time interval required for an assigned finder switch to seize the calling line to which it has been assigned.

If, for any reason, the finder portion of an assigned link fails to seize the line to which it is assigned, thereby to cause the reoperation of the relay R630 before the relay R640 is released, then the assigned link is released and a second new link is assigned to the use of the calling line. Thus, if the operating circuit for the relay R640 is held open for a sufficiently long interval of time, this relay restores to open, at its contacts 641, the prepared operating circuit for the overflow meter 632, and to open, at the contacts 642, the prepared multiple circuit for energizing the relay R630. At its contacts 643, the relay R640 completes the prepared operating circuit for the slow-acting relay R650, this circuit extending from ground by way of the contacts 674, 624 and 643, and the winding of R650 to battery. The relay R650, in operating, opens, at its contacts 651, the prepared path for short-circuiting the wind-

ing of the link distributor relay corresponding to the first assigned link. At its contacts 652, the relay R650 completes an obvious circuit for energizing the slow-acting relay R620. The relay R620, in operating, further prepares, at its contacts 621, the path for short-circuiting the winding of the distributor relay corresponding to the first assigned link. At its contacts 624, the relay R620 opens the above-traced circuit for energizing the relay R650. At its contacts 622, the relay R620 opens a point in the normally completed circuit for energizing the relay R630. At its contacts 623, the relay R620 completes an alternative circuit for energizing the relay R630, this alternative circuit extending from ground by way of the contacts 673, the winding of R630, the contacts 623, C579, and the resistor 522 to battery. When thus energized, the relay R630 reoperates to complete the operating circuit for the relay R640. The relay R640, in turn, reoperates to reprepare the circuit for energizing the overflow meter 632, to complete a multiple circuit for energizing the relay R630, and to open, at the contacts 643, a further point in the operating circuit for the relay R650. Substantially concurrently with the reoperation of the relay R640, the relay R650 restores to open, at its contacts 652, the operating circuit for the slow-acting relay R620. At its contacts 651, the relay R650 completes the previously mentioned path for short-circuiting the winding of the distributor relay corresponding to the first assigned link.

Assuming, for example, that the link illustrated is the first assigned link, and further, that this link has failed to find the calling line to which it was assigned, the link distributor relay R700 is short-circuited when the relay R650 releases in the manner just explained. The path for short-circuiting this distributor relay extends from the negative terminal of the exchange battery through the resistor 625 and by way of the contacts 621 and 651, C684, the contacts 703, C232, the contacts 292, C231, and the winding of R700 back to the negative terminal of the exchange battery. It is noted that the resistance value of the resistor 625 is relatively small as compared with the resistance value of the resistor 708. More specifically, the resistor 708 has a resistance value of approximately 1,000 ohms, whereas the resistor 625 has a resistance value of only 50 ohms. It will be understood, therefore, that when the above-traced path is completed, the relay R700 is effectively short-circuited and caused to release. In releasing, the relay R700, at its contacts 702, disconnects the common start lead C573 from the start lead C234 individual to the link illustrated, whereby the connect relays R280 and R290 are deenergized and restore. At its contacts 701, the relay R700 extends the common start lead to the link start lead individual to the next available idle link. Thus, if the second link is idle, and the relay R710 is operated, the common start lead C573 is connected through the contacts 701 and 712 to the start lead individual to the second link. At its contacts 706, the relay R700, in releasing, opens a point in the common portion of its two locking circuits, as traced previously. At its contacts 707, the relay R700 prepares its own operating circuit. At its contacts 703, the relay R700 opens the path short-circuiting its own winding. At its contacts 704, the relay R700 prepares a path for short-circuiting the winding of the distributor relay corresponding to the next idle link, which, in the case assumed, is the second distributor relay R710. At its contacts 705, the relay R700 prepares the above-traced chain circuit for energizing the reset relay R660. Substantially concurrently with the release of the relay R700, the relay R620 restores to open, at its contacts 621, the above-traced path for short-circuiting the winding of the distributor relay R700, and the prepared path for short-circuiting the winding of the distributor relay corresponding to the second assigned link. At its contacts 624, the relay R620 reprepares the operating circuit for the relay R650. At its contacts 622 and 623, the relay R620 opens the above-traced alternative circuit for energizing the relay R630, and reprepares the initially traced operating circuit for the last-mentioned relay. It will be understood that since one of the auxiliary unit relays illustrated in Fig. 5 of the drawings is at this time still operated, the initially traced operating circuit for the relay R630 is open at the contacts 554, 564, or the corresponding contacts of an operated one of the other auxiliary unit relays. Accordingly, the second timing period is started in response to the release of the relay R620.

When the common start lead C573 is disconnected from the link start lead C234 through the release of the link distributor relay R700, in the manner just explained, the two connect relays R280 and R290 restore to open the operating circuits for the group and unit relays of the finder switch illustrated, and to open the completed operating circuit for the line relay R310. Thus, the line and hold relays R310 and R320 are caused sequentially to restore in an obvious manner. At its contacts 297, the relay R290, in releasing, disconnects the conductor C682 from ground, thereby momentarily to deenergize the relay R610. Since, however, ground potential is impressed upon this conductor through operation of the connect relays embodied in the second assigned link substantially concurrently with the release of the two relays R280 and R290, the relay R610 is held energized and does not restore. The application of ground potential to the link start lead extending to the second assigned link results in the operation of the finder portion of this link to seize the calling line, assuming that the second assigned link is not also deflective. In such case, the operated ones of the auxiliary group and unit relays, illustrated in Fig. 5 of the drawings, are caused to restore so that the operating circuit for the relay R630 is recompleted before the relay R640 is released. Thus, the normal operation of the distributor equipment is resumed. If, however, the second assigned link is also defective or, for some reason, fails to seize the calling line to cause the operation of the line circuit associated therewith, the cycle of operation of the distributor equipment, as described above, is repeated so that the second assigned link is released and a third link is assigned to the use of the calling line. More specifically, the cyclic operation of the distributor equipment continues until the finder portion of one of the assigned links is successful in its operation to seize the calling line, and thus cause the release of the operated ones of the auxiliary group and unit relays illustrated in Fig. 5 of the drawings.

In the event all of the links embodied in the exchange are busy at the time the relay R730, corresponding to the last link, is released to complete the above-traced chain circuit for energizing the relay R660, none of the distributor relays are immediately energized, although the operating circuits for all of these relays are prepared. Accordingly, the relay R660 remains in its oper-

ated position until one of the links is released. With the apparatus in this condition, if a call is initiated upon one of the lines terminating at the exchange, the auxiliary unit relay illustrated in Fig. 5 and corresponding to the calling line, operates to impress ground potential upon the common start lead C573, thereby to complete the operating circuit for the all-links-busy relay R670. This circuit extends by way of the grounded lead C573, the contacts 701, 711, 731, and the other chain-connected contacts controlled by the distributor relays, C686 and the winding of R670 to battery. When thus energized, the relay R670 locks to ground through the contacts 671 and 661. At its contacts 672, the relay R670 completes a circuit extending by way of the grounded conductor C686 and the contacts 641 for energizing the overflow meter 632, whereby the all-busy condition of the links is registered. At its contacts 674, the relay R670 opens a point in the previously traced circuit for energizing the call metering device 614, and a point in the operating circuit for the relay R650. At its contacts 673, the relay A670 opens a point in the multiple operating circuit for the relay R630. Shortly following the initiation of the call, the relays R630 and R640 are caused sequentially to restore in the order named and in the manner previously explained. The relay R640, in releasing, prepares the operating circuit for the relay R650, and opens, at its contacts 641, the circuit for energizing the overflow meter 632. The relay R670 remains in its operated position until the all-busy condition of the links is terminated and one of the links is released. Thus, if the call under consideration is abandoned before one of the links is released, the operated ones of the auxiliary group and unit relays are caused to restore in a manner clearly apparent from the preceding explanation so that ground potential is removed from the common start lead C573 and the operating circuit for the relay R630 is reprepared. Thus, the operating circuit for the all-links-busy relay R670 is opened but this relay remains energized over its locking circuit as traced above. Further, the relay R630 is not caused to operate since its operating circuit is open at the contacts 642 and 673. Accordingly, further calls initiated prior to the release of one of the links to terminate the all-links-busy condition are prevented from causing further operation of the overflow meter 632. It will be apparent from the foregoing description that with the relay R660 operated, the operating circuits for all of the link distributor relays are prepared. Accordingly, when one of the links is released, the link distributor relay corresponding thereto is immediately energized. Thus, if all of the links are busy and the link illustrated is the first link to be released, the operating circuit for the associated distributor relay R700 is completed in response to the release of the hold relay R320 individual to this link. The relay R700, in reoperating, opens its operating circuit and locks to ground in the manner previously explained. At its contacts 702, the relay R700 connects the common start lead to the link start lead C234 so that if a call is waiting the assignment of a link, the connect relays R280 and R290 are immediately energized to cause the operation of the finder switch illustrated in the manner explained above. At its contacts 705, the relay R700 opens the above-traced operating circuit for the relay R660. At its contacts 703, the relay R700 prepares the previously traced path for short-circuiting its own winding. After a time interval determined by the slow-to-release characteristic of the relay R660, this relay restores to open, at its contacts 661, the locking circuit for the relay R670 and to open, at its contacts 662, the prepared operating circuits for the link distributor relays. The relay R670 now releases to open, at its contacts 672, the prepared operating circuit for the overflow meter 632, and to reprepare, at its contacts 673, the operating circuit for the relay R630. At its contacts 674, the relay R670 completes the previously traced operating circuit for the relay R650. Due to the slow-to-release characteristic of the relay R660 and the slow-to-operate characteristic of the relay R650, the operation of the finder switch illustrated, to seize the calling line and thus cause the operation of the line circuit associated therewith to release the operated auxiliary group and unit relays, is completed before the relay R650 can operate. Accordingly, the relays R630 and R640 are caused sequentially to reoperate before the relay R650 operates in response to the release of the relay R670. Thus, the two relays R620 and R650 are prevented from completing the path for short-circuiting the relay R700. In the event these two relays are operated prior to operation of the relay R640, the completion of the path for short-circuiting the winding of the distributor relay R700 is without effect, since, under any circumstances, the finder switch illustrated will complete its operation to seize the calling line before the relay R700 is short-circuited. Accordingly, the short-circuiting path will be opened at the contacts 292 and 321 of the relays R290 and R320, respectively, before the relay R650 is caused to restore in response to release of the relay R620. Thus, even though these two relays may operate, such operation is, in the case under consideration, without effect.

Continuing now with the operation of the link to extend a connection to the called line 01, it is pointed out that when the hold relay R320 operates to impress ground potential upon the release conductor C307, a circuit is completed for energizing the slow-to-release relay R440, this circuit extending by way of the grounded conductor C307, the contacts 399, C339, and the winding of R440 to battery. Upon operating, the relay R440 completes a path for transmitting the usual dial tone signal over the calling end of the connection to inform the calling subscriber that the dialing operation may be started. The path traversed by the dial tone signal current may partially be traced as extending from one terminal of the dial tone current source, not shown, the contacts 451, 441 and 421, C328, the contacts 361, and the condensers 347 and 348, to the negative side of the established loop circuit extending to the calling substation A. After traversing the windings of the receiver provided at this substation, the dial tone current is returned to the opposite terminal of the dial tone source over the positive side of the calling loop circuit, the upper winding of the line relay R310 and ground.

Following the operation of the relay R440, the link circuit apparatus is conditioned to respond to the impulses making up the first digit of the directory number designating the desired substation C. In this regard it is pointed out that the link circuit apparatus is so arranged that the first digit is utilized to determine the side of the called line over which ringing current is to be projected, the second digit is utilized to select the group of ten lines including the called line, and the third digit is utilized to select the particu-

lar called line from the selected group of ten lines. More specifically, a first digit of two impulses conditions the link circuit apparatus for the transmission of ringing current over the negative side of the called line. A first digit comprising three impulses, on the other hand, conditions the equipment for the transmission of ringing current over the positive side of the called line. In the present case, since the line 01 is a single party line and the signal device provided at the called substation C is assumed to be bridged across the conductors of this line in series with a condenser, a first digit of either two or three impulses may be dialed at the calling substation A.

Assuming that a first digit of two impulses is dialed at the calling substation, the relay R310 is twice caused to restore and reoperate. When this relay restores at the beginning of the first impulse, the operating circuit for the hold relay R320 is broken at the contacts 312. At the contacts 313, a circuit is completed for energizing the slow-acting relay R740 in parallel with the first counting relay R800, this circuit extending from ground by way of the contacts 313, 325 and 397' to the conductor C782 where it divides, one branch extending through the winding of R740 to battery, and the other branch extending by way of the contacts 754, 764 and 774, C793, and the winding of R800 to battery. The relay R740, upon operating, opens, at its contacts 741 and 742, two points in the operating circuit for the digit transfer relay R430, and a point in the operating circuit for the ringing control relay R350. At its contacts 743, the relay R740 opens a point in the common portion of the operating circuits for certain of the ten group relays embodied in the connector portion of the link. Due to the slow-to-release characteristics thereof, the relays R320 and R740 remain operated during each series of impulses.

The relay R800, upon operating at the beginning of the first impulse, completes, at its contacts 806, a locking circuit for itself, and in so doing completes a path for short-circuiting the winding of the control relay R770. This locking circuit extends by way of the grounded release conductor C307, the contacts 367, C781, the contacts 762, the winding of R770, C788, the contacts 806, and the winding of R800 to battery. It will be observed that so long as the line relay R310 is restored, both winding terminals of the relay R770 are connected to ground, and accordingly, this relay is short-circuited. At its contacts 805, the relay R800 prepares a circuit for energizing the second counting relay R820. At its contacts 804, the relay R800 prepares a circuit for energizing the group relay R410 embodied in the connector portion of the link and terminating the first group of ten lines. At its contacts 803, the relay R800 prepares a circuit for impressing ground potential on the private conductor of a selected called line. At its contacts 801 and 802, the relay R800 connects the conductors of the link line 327 to the conductors of the link line 460.

At the end of the open circuit period of the first impulse, the line relay R310 reoperates to recomplete the circuit for energizing the hold relay R320 and to open the path short-circuiting the winding of the control relay R770. The relay R770 is thus energized in series with the first counting relay R800 and operates to open, at its contacts 772, a point in the operating circuit for the relay R750. At its contacts 771, the relay R770 further prepares the operating circuits for the digit transfer relay R430 and the ringing control relay R350. At its contacts 774, the relay R770 opens a point in the above-traced operating circuit for the relay R800. At its contacts 773, the relay R770 further prepares the circuit for energizing the second counting relay R820. At the beginning of the open circuit period of the second impulse, when the line relay R310 again restores, the operating circuit for the second counting relay R820 is completed, this circuit extending from ground by way of the contacts 313, 325 and 397', C782, the contacts 754, 764 and 773, C792, the contacts 805, and the winding of R820 to battery. When thus energized the relay R820 operates and locks to ground over a path including the contacts 826, C789, the winding of R760, the contacts 752, C781, the contacts 367, and the release conductor C307. At its contacts 825, the relay R820 prepares the operating circuit for the third counting relay R840. At its contacts 821' the operating circuit for the relay R430 is further prepared. At the remaining contacts controlled by the relay R820, additional circuit control operations are performed which are of no consequence at the present time. At the end of the open circuit period of the second impulse, when the line relay R310 again reoperates, the path short-circuiting the winding of the second control relay R760 is interrupted, permitting this relay to be energized in series with the second counting relay R820. The relay R760 now operates to open, at its contacts 762, the above-traced series locking circuit for the two relays R770 and R800, causing both of these relays to restore. At its contacts 761, the relay R760 prepares an obvious multiple point in the operating circuits for the relays R430 and R350. At its contacts 764, the relay R760 opens a point in the above-traced operating circuit for the second counting relay R820. At its contacts 763, the relay R760 prepares a circuit for energizing the third counting relay R840.

In the case under consideration, wherein a first digit of two impulses is dialed at the calling substation, no further operation of the counting chain illustrated in Fig. 8 of the drawings occurs. By way of more completely describing the mode of operation of this chain, it is pointed out, however, that in those instances where digits other than the digit two are dialed, the counting relays operate in sequence so that at the end of the digit the counting relay which corresponds to the numerical value of the digit remains in its operated position. Thus, if further impulses are transmitted to the line relay R310, the operating circuit for the third counting relay R840 is completed at the beginning of the open circuit period of the third impulse, this circuit extending by way of the grounded conductor C782, the contacts 754 and 763, C791, the contacts 825, and the winding of R840 to battery. The relay R840, upon operating, locks to the grounded release conductor C307 over a path including the contacts 846, C789', the winding of R750, the contacts 772, C781, and the contacts 367. When this path is completed, the relay R750 is obviously short-circuited. At the contacts 845, the relay R840 prepares the operating circuit for the fourth counting relay R860. At its contacts 841, the relay R840 further prepares the circuit for energizing the relay R350. At the end of the open circuit period of the third impulse, when the line relay R310 again reoperates, the path short-circuiting the winding of the relay R750 is opened,

permitting this control relay to be energized in series with the third counting relay R840. The relay R750 now operates to open the series locking circuit for the two relays R760 and R820, at its contacts 752, thus causing both of these relays to restore. At its contacts 751, the relay R750 prepares an obvious multiple path in the operating circuits for the relays R350 and R430. At its contacts 754, the relay R750 opens a further point in the operating circuit for the relay R840. At its contacts 753, the relay R750 further prepares the operating circuit for the fourth counting relay R860.

The last-mentioned circuit is completed at the beginning of the open circuit period of the fourth impulse, and extends by way of the contacts 313, 325 and 397', C782, the contacts 753, C790, the contacts 845, and the winding of R860 to battery. When energized over this circuit the relay R860 locks to the grounded release conductor C307 over a path including the contacts 866, C788, the winding of R770, the contacts 762, C781, and the contacts 367. When this path is completed, the winding of the relay R770 is obviously short-cuited. At its contacts 865, the relay R860 prepares the operating circuit for the fifth counting relay R880. At the end of the open circuit period of the fourth impulse, when the relay R310 again operates, the path short-circuiting the winding of the relay R770 is interrupted, permitting this relay to be energized in series with the counting relay R860. The relay R770 now operates to open, at its contacts 772, the series locking circuit for the two relays R750 and R840. At its contacts 773, the relay R770 prepares the operating circuit for the fifth counting relay R880. It is believed that the manner in which the remaining counting relays respond to additional impulses transmitted thereto through operation of the line relay R310 will be clearly apparent in view of the preceding explanation. Thus, it will be noted that the relays R810, R830, R850, R870 and R890 sequentially respond to the sixth, seventh, eighth, ninth and tenth impulses of a digit in the order named. It will be further noted that the relays R880 and R850 lock to ground over the lead C789 in series with the control relay R760; the relays R810 and R870 lock to ground over the lead C789' in series with the third control relay R750; and the relays R830 and R890 lock to ground over the lead C788 in series with the control relay R770. The three enumerated control relays operate sequentially in response to succeeding impulses successively to prepare the operating circuits to the various counting relays and successively to release the previously operated counting relay and its associated control relay.

Shortly following the end of the first digit of two impulses dialed at the calling substation A, the relay R740, which is deenergized through operation of the line relay R310, restores to complete the above-mentioned circuit for energizing the relay R430. This circuit extends by way of the grounded release conductor C307, the contacts 742 and 761, C783, the contacts 426 and 454, C784, the contacts 741, C785, the contacts 821', C433, and the winding of R430 to battery. Upon operating, the relay R430 locks to the grounded release conductor C307 over a path including the contacts 432 and the winding of R450. When this locking path is completed, the winding of the relay R450 is obviously short-circuited. At its contacts 431, the relay R430 completes a circuit for energizing the relay R360, this circuit extending by way of the grounded release conductor C307, the contacts 431, 452 and 424, C331, and the winding of R360 to battery. The relay R360 now operates to open, at its contacts 367, a point in the common portion of the above-traced locking circuits for the three control relays R750, R760 and R770, and the ten counting relays illustrated in Fig. 8 of the drawings. In response to this operation the two operated relays R760 and R820 are deenergized and restore. Aside from its function to release the two relays R760 and R820, the operation of the busy test relay R360 is without effect at this time. When the relays R820 and R760 restore, the impulse counting chain and associated control equipment is fully released and is prepared to respond to the impulses of the second digit. Further, these two relays, in releasing, open, at the contacts 761 and 821', two points in the path short-circuiting the winding of the digit transfer relay R450. The relay R450 is thus energized in series with the relay R430 over a circuit extending by way of the grounded release conductor C307, the winding of R450, the contacts 432, and the winding of R430 to battery. Upon operating, the relay R450 opens, at its contacts 451, the above-traced circuit for transmitting dial tone signal current over the calling end of the connection, thereby to terminate the dial tone signal being reproduced by the receiver provided at the calling substation. At its contacts 452, the relay R450 opens the above-traced operating circuit for the busy test relay R360, whereby the latter relay is caused to restore to reprepare, at its contacts 367, the series locking circuits for the counting relays and the associated control relays R750, R760 and R770. At its contacts 454, the relay R450 opens a point in the common portion of the operating circuits for the relays R350 and R430. At its contacts 453, the relay R450 prepares a point in the common portion of the operating circuits for the ten group relays embodied in the connector portion of the link. Following the operation of the relay R450, the connector portion of the link is conditioned to respond to the impulses of the second digit of the directory number designating the desired line.

As indicated above, if a first digit of three impulses is dialed, the ringing circuits are rearranged for the transmission of ringing current over the positive side of the called line. In this case it will be recalled from the preceding explanation that the relay R840 is locked energized in series with the control relay R750 at the end of a first digit of three impulses. With these two relays operated, the operating circuit for the ringing control relay R350 is completed in response to the release of the slow-acting relay R740, which occurs shortly following the end of the digit. The circuit for energizing the relay R350 extends by way of the grounded release conductor C307, the contacts 742 and 751, C783, the contacts 426 and 454, C784, the contacts 841, C780, and the winding of R350 to battery. When energized over this circuit the relay R350 locks to the grounded release conductor C307 over a path including the contacts 356 and the winding of the digit transfer relay R450. At its contacts 355, the relay R350 completes an alternative circuit for energizing the busy test relay R360, this circuit extending by way of the grounded conductor C307, the contacts 355, C333, the contacts 452 and 424, C331, and the winding of R360 to battery. At its contacts 351, 352, 353 and 354, the relay R350 rearranges the ringing circuits for

the transmission of ringing current over the positive side of the called line. The busy test relay R360, in operating, opens, at its contacts 367, the series locking circuit for the two relays R750 and R840, causing both of these relays to restore. Thus, the impulse counting chain and the associated control relays R750, R760 and R770 are fully released. When the two relays R750 and R840 restore, two points are opened, at the contacts 751 and 841, respectively, in the path short-circuiting the winding of the digit transfer relay R450, permitting this relay to be energized in series with the ringing circuit transfer relay R350. The relay R450, in operating, performs the functions described above, among which is the de-energization of the busy test relay R360. The relay R360, in releasing, reprepares the locking circuits for the ten counting relays and their associated control relays, in the manner previously explained.

The impulse counting chain illustrated in Fig. 8 of the drawings, and the associated control relays R750, R760 and R770, respond to the impulses of the second digit in the exact manner described. Further, the slow-acting relay R740 is energized at the beginning of the first impulse of the second digit, and remains operated until shortly after the digit is ended. In the case under consideration, wherein the called line is the first line of the tenth group, the second digit dialed at the calling substation A will necessarily comprise ten impulses. Accordingly, at the end of the digit, the tenth counting relay R890 is energized in series with the control relay R770. Shortly following the end of the digit, the relay R740 restores to complete the prepared operating circuit for the group relay R400, at which are terminated the lines of the tenth group. This circuit extends by way of the grounded release conductor C307, the contacts 742 and 771, C783, the contacts 426 and 453, C787, the contacts 892, C896, and the winding of the group relay R400 to battery. By way of completing the explanation, it is pointed out that the portion of the circuit just traced, which extends to the contacts 892 of the counting relay R890, is common to the operating circuits for all of the even-numbered group relays of the connector portion of the link. The group relays terminating the lines forming the odd-numbered groups are arranged for energization over a slightly different circuit. Thus, if the called line to be selected is included in the first group, for example, such that a second digit of one impulse is dialed, the group select relay R410 is energized over a circuit which extends by way of the grounded release conductor C307, the contacts 742 and 771, C783, the contacts 426 and 453, C787, the contacts 743, C786, the contacts 804, C461, and the winding of R410 to battery. Thus, the odd-numbered group select relays are arranged for energization over a circuit commonly including the conductor C786, and the select relays corresponding to the even-numbered groups of lines are arranged for energization over a circuit including the conductor C787.

When the relay R400 is energized over the circuit traced above, it operates and locks to ground over a path including the contacts 402, the winding of the digit transfer relay R420 and the release conductor C307. When this circuit is completed, ground potential is impressed upon both of the winding terminals of the relay R420 and, accordingly, this relay is short-circuited. At its contacts 401, the relay R400 completes an alternative circuit for energizing the busy test relay R360, this circuit extending by way of the grounded conductor C307, the contacts 401 and 422, C331, and the winding of R360 to battery. At its remaining contacts, the relay R400 connects the conductors of the associated ten lines to the ten link lines corresponding to and including the two lines 460 and 470. Thus, the conductors of the selected ten lines are extended to the contacts controlled by the ten counting relays; the conductors of the first line in the group being connected over the link line 460 to the contacts 801, 802 and 803 of the first counting relay R800, the contacts of the second line in the group being connected over a similar link line to the contacts of the second counting relay R820, and so on.

The busy test relay R360, upon operating in response to operation of the group select relay R400, opens, at its contacts 367, the series locking circuit for the two relays R770 and R890, causing both of these relays to restore. When these relays release, two points are opened at the contacts 771 and 892, respectively, in the path short-circuiting the winding of the digit transfer relay R420, permitting the latter relay to be energized in series with the group relay R400 over a circuit extending by way of the grounded release conductor C307, the winding of R420, the contacts 402, and the winding of R400 to battery. The relay R420 now operates to open, at its contacts 422, the above-traced alternative operating circuit for the busy test relay R360. At its contacts 424, the relay R420 opens a further point in the initially completed operating circuit for the busy test relay. At its contacts 426, the relay R420 opens a further point in the common portion of the operating circuits for the ten group relays embodied in the selector portion of the link. At its contacts 423, the relay R420 prepares alternative operating and locking circuits for the busy test relay. At its contacts 425, the relay R420 prepares a circuit for energizing the line switching and ringing control relay R390. The busy test relay R360, upon restoring in response to the operation of the digit transfer relay R420, reprepares the locking circuits for the impulse counting relays and their associated control relays R750, R760 and R770. Following the release of the busy test relay R360, the connector portion of the link is conditioned to respond to the impulses of the third digit of the directory number designating the called line 01.

The counting relays and their associated control relays operate in the exact manner described above in response to the impulses of the third and final digit. The relay R740 reoperates at the beginning of this digit and remains operated until shortly following the end of the digit. In the present assumed case, wherein the line 01 is the first line of the selected tenth group of lines, the third digit will necessarily comprise only a single impulse, so that the counting relay R800 is locked energized in series with the relay R770 at the conclusion of the digit. Shortly following the end of the digit, the relay R740 releases to complete the prepared circuit for energizing the relay R390, this circuit extending by way of the grounded release conductor C307, the contacts 742 and 771, C783, the contacts 425, C332, and the winding of R390 to battery. The relay R390 now operates further to prepare the desired talking circuit to the selected called line and the circuit for transmitting ringing current over the called line. At its contacts 397', the relay R390 opens

a point in the above-traced pulsing circuit over which impulses are transmitted to the counting relays and the slow-acting relay R740. At its contacts 399, the relay R390 opens the operating circuit for the slow-to-release relay R440. The relay R440 now releases to prepare, at its contacts 442, the operating circuit for the slow-to-operate ringing control relay R370. At its contacts 443, the relay R440 opens a point in one of the previously traced operating circuits for the busy test relay R360. At its contacts 398, the relay R390 completes an alternative circuit for maintaining the operated counting relay R800, and its associated control relay R770, energized. This alternative circuit extends by way of the grounded release conductor C307, the contacts 398, C781, the contacts 762, the winding of R770, C788, the contacts 806, and the winding of R800 to battery. At its contacts 391, the relay R390 prepares a circuit for transmitting busy tone current over the calling end of the connection to energize the receiver provided at the calling substation. At its contacts 396, the relay R390 completes a test circuit including the winding of the busy test relay R360 for determining the idle or busy condition of the selected line. In this regard it will be recalled from the preceding explanation that when a line becomes busy, ground potential is impressed upon the private conductor thereof, for the purpose of guarding the line against seizure by the various connector switches of the system. On the other hand, if a line is idle, the private conductor thereof is marked with negative battery potential through the winding of the cut-off relay embodied in the associated line circuit.

Assuming that the selected 01 is busy, the busy test relay R360 is energized over the test circuit, which circuit extends from ground by way of the contacts 405, the conductor 460c, the contacts 803, C334, the contacts 396, C336, the contacts 443 and 423, C331, and the winding of R360 to battery. This circuit is completed during the interval between the operation of the relay R390 and the release of the slow-to-release relay R440. It will be noted that the portion of this circuit extending from the contacts 803, and including the conductor C334 is common to the odd-numbered lines of each ten line group. On the other hand, if an even-numbered line is selected, the idle or busy condition of the line is tested over a slightly different circuit. More specifically, the common portion of the alternative circuit individual to the even-numbered lines extends by way of the conductor C335, the contacts 397, C336, the contacts 443 and 423, C331, and the winding of the busy test relay R360 to battery. When energized over the first of the above-traced circuits, the busy test relay operates to complete a locking circuit for itself. This locking circuit extends by way of the grounded release conductor C307, the contacts 398, 306 and 366, C337, the contacts 423, C331, and the winding of R360 to battery. At its contacts 365, the relay R360 opens a point in the operating circuit for the ringing control relay R370. At its contacts 363 and 364, the relay R360 prepares a dry talking circuit to the selected called line. At its contacts 362, the relay R360 completes the above-mentioned circuit for transmitting busy tone current over the calling end of the connection to energize the receiver provided at the calling substation. This circuit may partially be traced as extending from one terminal of the busy tone current source by way of the contacts 391, 391 and 362, and the condensers 347 and 348 to the negative side of the established loop circuit extending to the calling substation. The current traversing this circuit is reproduced by the receiver provided at the calling substation to inform the calling subscriber that the desired connection cannot immediately be obtained. At its contacts 367, the relay R360 opens a point in the initially completed series locking circuit for the two relays R770 and R800. These two relays are, however, held energized over the alternative locking circuit traced above. Following the operation of the busy test relay R360, no further operation of the apparatus occurs until the connection is released at the calling substation. The manner in which the link is released when the call is abandoned is described in detail hereinafter.

In the event the selected called line 01 is idle, the busy test relay R360 is short-circuited over the previously traced test circuit and, accordingly, does not operate. Shortly following the end of the third digit, the relay R440 releases, in the manner previously explained, to open the busy test circuit and to complete a circuit for energizing the slow-to-operate ringing control relay R370. In the case under consideration wherein the called line is an odd-numbered line, the circuit for energizing this relay extends from the negative terminal of the exchange battery through the winding of the cut-off relay embodied in the line circuit individual to the called line and by way of the contacts 405, the conductor 460c, the contacts 803, C334, the contacts 396, C336, the contacts 442, C329, the contacts 365, the winding of R370, and the contacts 322 to the grounded positive terminal of the exchange battery. It will be noted that this operating circuit for the ringing control relay R370, as completed through the cut-off relay associated with any odd-numbered line, includes the conductor C334. On the other hand, if an even-numbered called line is selected, the operating circuit for the ringing control relay R370 is slightly different in that it extends from the conductor C336 by way of the contacts 397, C335, and the operated private contacts of the counting relays which correspond to the called lines. Thus, in the case of an odd-numbered called line, the ringing control relay R370 is energized over an operating circuit including the contacts 396 and the conductor C334, and in the case of an even-numbered called line, this relay is energized over a circuit including the contacts 397 and the conductor C335.

When energized over the above-traced circuit, the relay R370 operates after an interval to complete, at its contacts 371, an obvious circuit for energizing the relay R380. The relay R380 now operates and locks to the grounded release conductor C307 through its X contacts 385. At its contacts 383, the relay R380 completes an obvious path for short-circuiting the winding of the relay R370, thereby to render the latter relay slow-to-release and to complete a path for impressing ground potential directly upon the private conductor of the called line 01, which path includes the conductors and contacts of the above-traced operating circuit for the relay R370. When this path is completed, the cut-off relay embodied in the line circuit individual to this line, operates to clear the line of the impedance represented by the windings of the associated line relay. The application of ground potential to the private conductor of the called line 01 also guards this line against seizure by any of the other connector

switches of the exchange. At its contacts **381** and **382**, the relay **R380**, in operating, completes a circuit for transmitting ringing current over the selected line **01**. The path traversed by the ringing current depends upon the type of ringing to be utilized, and whether or not the relay **R350** is operated. Assuming that the ringer provided at the substation C is bridged between the conductors of the line **01** in series with a condenser, and that the relay **R350** occupies its restored position, the ringing current is caused to traverse a circuit which extends from one terminal of the ringing current source, not shown, by way of the contacts **353**, **343**, **382** and **395**, the conductor **327*b***, the contacts **802**, the conductor **460*b***, the contacts **404**, the negative side of the line **01**, the ringer and condenser bridged across this line at the called substation C, the positive side of the line **01**, the contacts **403**, the conductor **460*a***, the contacts **801**, the conductor **327*a***, the contacts **392**, **381**, **341** and **351**, the upper winding of **R340**, and the exchange battery to the opposite terminal of the ringing current source. In the event the ringer provided at the called substation is bridged between the negative conductor of the line **01** and ground in series with a condenser, a ground return path to the ringing current source is utilized in the usual manner. In the event the ringer provided at the called substation is bridged between the positive side of the line **01** and ground, the relay **R350** will necessarily occupy its operated position. In such case, the circuit traversed by the ringing current may be traced as extending from one terminal of the ringing current source by way of the contacts **354**, **341**, **381** and **392**, the conductor **327*a***, the contacts **801**, the conductor **460*a***, the contacts **403**, the positive side of the line **01**, the windings of the ringer provided at the called substation and the condenser connected in series therewith, and the ground return path to the opposite terminal of the ringing current source. In the event the signal device provided at the called substation is bridged between the two conductors of the line **01** and the relay **R350** is operated, the return path of the ringing current extends by way of the negative side of the line, the contacts **404**, the conductor **460*b***, the contacts **802**, the conductor **327*b***, the contacts **395**, **382**, **343** and **352**, the upper winding of **R340** and the exchange battery to the opposite terminal of the ringing current source. The relay **R380**, in operating to complete one of the above-traced ringing current circuits, also completes a path for transmitting ringing current over the calling end of the connection to signal the calling subscriber that the called substation is being rung. This path may partially be traced as extending from the high potential terminal of the ringing current source by way of the condenser **347**, the contacts **346** and **384**, and the condenser **348** to the negative side of the established loop circuit extending to the calling substation A. Thus, ringing current is caused to traverse the calling end of the connection to energize the receiver provided at the calling substation.

The desired conversational circuit between the calling and called substations is completed when the call is answered at the called substation. More particularly, when the receiver provided at the called substation is removed from its supporting hook or cradle, a direct current bridge is connected between the line conductors of the line **01** to complete the operating circuit for the slow-to-operate ring cut-off relay **R340**. Assuming that the relay **R350** is restored, this operating circuit extends from ground through the windings of the ringing current generator or source and by way of the contacts **353**, **343**, **382** and **395**, the conductor **327*b***, the contacts **802**, the conductor **460*b***, the contacts **404**, the negative side of the line **01**, the bridge across the conductors of this line at the called substation, the positive side of the line **01**, the contacts **403**, the conductor **460*a***, the contacts **801**, the conductor **327*a***, the contacts **392**, **381**, **341** and **351**, and the upper winding of **R340** to battery. It will be noted that if the relay **R350** is operated, the contacts **351** and **353**, controlled by this relay, are excluded from the operating circuit for the relay **R340**, and the contacts **352** and **354** are included in this operating circuit in lieu of the two first-mentioned sets of contacts. When energized over the circuit traced above, the relay **R340** locks to the grounded release conductor **C307** through its X contacts **345**. After this locking circuit is completed, the relay **R340** opens, at its contacts **346**, the above-traced path for transmitting ringing current over the calling end of the connection. At its contacts **341** and **343**, the relay **R340** opens two points in the ringing circuits traced above, and two points in its own operating circuit. At its contacts **342** and **344**, the relay **R340** completes the desired talking circuit between the calling and called substations. In this regard it is pointed out that talking battery is impressed upon the calling end of the connection through the windings of the line relay **R310**. Talking battery is impressed upon the called end of the connection through the windings of the battery feed impedance element **330** and the operated contacts **311** of the line relay **R310**. Following the operation of the ring cut-off relay **R340**, no further operation of the apparatus occurs until the connection is released at the calling substation.

From the foregoing explanation and the wiring arrangement of the contacts controlled by the counting relays illustrated in Fig. 8, it will be apparent that the link line **327** is, in all cases, utilized in setting up connections to odd-numbered called lines. When, however, an even-numbered called line is selected through operation of the counting relays in the manner explained above, the link line **326** and the contacts **393** and **394** controlled by the relay **R390**, are utilized in lieu of the link line **327** and the contacts **392** and **395** for the purpose of establishing a connection to the called line. Thus, it will be observed that the line contacts of the odd-numbered counting relays are arranged to set up connections to the link line **327**, whereas the line contacts of the even-numbered counting relays are arranged to set up connections to the link line **326**.

As indicated above, the release of the established connection is entirely under the control of the calling subscriber. More specifically, when the receiver provided at the calling substation is restored to its supporting hook or cradle, the calling loop circuit is opened to cause the de-energization and release of the line relay **R310**. This relay, in restoring, opens, at its contacts **311**, the battery feed circuit to the called substation, and interrupts, at its contacts **312**, the operating circuit for the hold relay **R320**. Shortly thereafter, the relay **R320** restores and opens its contacts **324** to disconnect the release conductor **C307** from ground. When ground potential is removed from this conductor, the op-

erated ones of the relays R340, R350, R360, R480, R390, R750, R760, R770 and the operated counting relay, are all deenergized and restore, it being pointed out in the preceding explanation that the holding circuits for these relays commonly include the grounded release conductor C307. Similarly, the relays R420, R430, R450, and the operated one of the connector group relays, namely, the relay R400, are deenergized and release when the release conductor C307 is disconnected from ground. Thus, all of the relays embodied in the connector portion of the link are released. When the hold relay R320 restores, it also opens, at its contacts 322, the above-traced path for impressing ground potential upon the private conductor of the called line 01, thereby to deenergize the cut-off relay embodied in the line circuit associated with this line. This cut-off relay, in releasing, reconnects the windings of its associated line relay to the conductors of the called line. Assuming that the call has been cleared out at the called substation, this line relay remains in its restored position, and the private conductor of the called line is marked with negative battery potential to identify this line as idle in the contacts of the various connector switches.

At its contacts 322, the hold relay R320, in releasing, also disconnects the conductor C233 from ground, thereby to open the previously traced operating circuit for the cut-off relay R110 embodied in the line circuit 105 individual to the calling line 11. The relay R110 now restores to bridge the winding of the line relay R100 across the conductors 11a and 11b in series with the exchange battery. When the operating circuit for the relay R110 is opened, the private conductor 11c of the calling line 11 is marked with negative battery potential through the winding of the relay R110, whereby the calling line is identified as idle in the bank contacts of the connector switches having access thereto.

At its contacts 323, the relay R320, in releasing, disconnects the finder switch hold lead C235 from ground, whereby the operated relays R210 and R260 are deenergized and restore. It will be understood that in any case the operated relays of the finder portion of the link are deenergized in response to disconnection of the holding lead C235 from ground. At its contacts 321, the relay R320, in releasing, reprepares the previously traced operating circuit for the link distributor relay R700, individually associated with the link illustrated, whereby this distributor relay is caused to operate when the distributor reset relay R660 next operates. Following the operations just described, the link illustrated is fully released and is available for use in setting up other connections.

Executive right-of-way service

As indicated in the introductory portion of the specification, one of the features of the present invention is concerned with the arrangement of the equipment common to the link for controlling the executive right-of-way or special service relays individually provided in the several links. This arrangement is such that the indicated relays are selectively controlled in accordance with the character of the calling lines to establish dry talking circuits to busy called lines. More specifically, in the arrangement illustrated, circuits are provided for giving executive right-of-way service to the substations served by lines 15, 10, 01 and 06. Thus, with the auxiliary group relay R500 and the auxiliary unit relay R560 operated, a path including the contacts 502 and 562, C574 and the contacts 601, is completed for impressing ground potential upon the common executive right-of-way conductor C681. These two auxiliary relays correspond to the line 15. Similarly, if a call originates on the line 10, the auxiliary relays R500, R560 and R600 are operated so that a path including the contacts 503 and 563, C575 and the contacts 602, is completed for impressing ground potential upon the lead C681. In a similar manner, if a call originates on the line 01 to cause the operation of the auxiliary relays R510 and R550, the common right-of-way C681 is grounded over a path including the contacts 512 and 552, C574 and the contacts 601. Finally, if a call is initiated on the line 06 to cause the operation of the auxiliary relays R510, R550 and R600, the lead C681 is grounded over a path including the contacts 602, C575, and the contacts 553 and 512'.

Assuming that the link illustrated is assigned to the use of a calling one of the above-mentioned lines arranged for executive right-of-way service, the special service relay R300 is energized and operates in response to operation of the connect relay R290. The circuit for energizing the special service relay R300 extends by way of the grounded lead C681, the contacts 298, C236, and the lower winding of R300 to battery. When energized over this circuit, the relay R300 prepares a locking circuit for itself at its contacts 304. This locking circuit is completed, at its contacts 324, in response to operation of the hold relay R320 in the manner previously explained. In operating, the relay R300 opens, at its contacts 306, a point in the previously traced locking circuit for the busy test relay R360. At its contacts 305, the relay R300 prepares an alternative locking circuit for the busy test relay. At its contacts 301, the relay R300 opens a point in the previously traced path for transmitting busy tone current over the calling end of the connection to the calling substation. At its contacts 302 and 303, the relay R300 prepares a dry circuit to the line which is to be selected. The relay R300 remains in its operated position for the duration of the call.

With this relay operated, if a connection is routed to a desired called line at a time when the line is busy, the busy test relay R360 is caused to operate in the manner pointed out above. This relay, in operating, locks to the grounded private conductor of the called line over a path which extends by way of the conductor C331, the contacts 423, C337 and the contacts 366 and 305. From this point the locking circuit extends either by way of the contacts 396 and the conductor C334 to the grounded private conductor of the called line, or by way of the contacts 397 and the conductor C335 to the grounded private conductor of the called line, depending upon whether the called line is an odd or even-numbered line. In operating, the busy test relay R360 also opens, at its contacts 365, the operating circuit for the ringing control relay R370. At its contacts 367, the relay R360 opens a point in the common portion of the previously traced locking circuits for the counting relays, shown in Fig. 8, and their associated control relays R750, R760 and R770. At its contacts 362, the relay R360 prepares the above-traced path for transmitting busy tone current over the calling end of the connection. At its contacts 363 and 364, the relay R360 completes the above-mentioned

dry talking circuit to the selected busy line. This circuit includes the contacts **302** and **303**, the condensers **326'** and **327**,' the contacts **363** and **364**, one of the two link lines **326** and **327**, the operated line contacts of the counting relays corresponding to the called line, and one of the link lines **460**, **470**, etc. It will be observed that the condensers **326'** and **327'** are included in the two sides of this circuit so that the voltage of the exchange battery is not impressed upon the line conductors of the busy called line. After a connection including the circuit just described has been completed to the called line, the calling party may monitor the connection involving the called line, and if desired, break in upon the conversation being held over the previously established connection for the purpose of informing the called subscriber to hang up. Assuming that the called subordinate responds to the wishes of his superior and hangs up, the previously traced alternative locking circuit for the busy test relay **R360** is broken when ground potential is removed from the private conductor of the called line. The relay **R360** now restores to open, at its contacts **366**, a further point in its locking circuit, and to complete, at its contacts **365**, the previously traced operating circuit for the ringing control relay **R370**. At its contacts **363** and **364**, the relay **R360** opens two points in the above-described dry talking circuit. When the previously established connection involving the called line is fully released, battery potential is impressed upon the private conductor thereof through the winding of the cut-off relay embodied in the associated line circuit. The relay **R370** is thus energized and operates to complete the operating circuit for the relay **R380**. From this point on, the manner in which ringing current is projected over the called line for the purpose of energizing the signal device provided at the called substation; the desired talking circuit is completed when the call is answered at the called substation; and the operated switching equipment is released under the control of the calling party, is exactly the same as described above with reference to the call routed to the substation C from the substation A. In this regard it will be apparent that the special service or executive right-of-way relay **R300** is deenergized and restores when the hold relay **R320** is released to disconnect the release conductor **C307** from ground.

Code call service

Provisions are made in the various connector switches of the exchange for transmitting the impulses of predetermined code call numbers to code call equipment which is accessible to the connector switches over the tenth set of line contacts of the seventh group of lines. The arrangement and mode of operation of the code call circuit may be entirely conventional, and, accordingly, this circuit has not been illustrated in the drawings. With the arrangement illustrated it is necessary, in order to obtain access to the code call circuit, to dial the directory number 270 or 370. Assuming that the link illustrated is seized on a call of this character, the first digit is utilized for the purpose of causing the operation of the digit transfer relay **R450** in the manner explained above. At the end of the second digit of seven impulses, the seventh counting relay **R830** is locked energized in series with the associated control relay **R770**. Shortly following the end of this digit, the relay **R740** restores, in the manner previously explained, to complete the operating circuit for the group relay **R480** terminating the lines of the seventh group. This operating circuit extends by way of the grounded release conductor **C307**, the contacts **742** and **771**, **C783**, the contacts **426** and **453**, **C787**, the contacts **743**, **C786**, the contacts **833**, **C837**, and the winding of **R480** to battery. When energized over this circuit the relay **R480** locks to ground through its contacts **482** and the winding of the digit transfer relay **R420**, and in so doing short-circuits the winding of the latter relay. At its contacts **481**, the relay **R480** completes the previously traced circuit for energizing the busy test relay **R360**. The busy test relay, in operating, releases the operated counting relay **R830** and its associated control relay **R770**, in the manner previously explained. These relays, in releasing, open the path short-circuiting the winding of the transfer relay **R420**, whereby the last-mentioned relay is energized in series with the group relay **R480** and operates to open the operating circuit for the relay **R360**. Following the release of the relay **R360**, the connector switch is conditioned to respond to the impulses of the third digit. At the end of the third digit of ten impulses, the tenth counting relay **R890** is locked energized in series with the relay **R770** in the manner previously explained. In operating, the relay **R890** connects the conductors of the link line **326** through the operated contacts of the group relay **R480** to the line conductors of the trunk extending to the code call equipment, and completes, at its contacts **891'**, a circuit for energizing the ring cut-off relay **R340**. This circuit extends by way of the grounded release conductor **C307**, the contacts **891'**, **C484**, the contacts **483**, **C485**, and the two windings of **R340** in series to battery. When energized over this circuit the relay **R340** operates and locks to the grounded release conductor **C307** through its contacts **345**. At its contacts **342** and **344**, the relay **R340** prepares a loop circuit to the code call equipment.

Following the operations just described, the code call circuit is tested to determine the idle or busy condition thereof, and if busy the busy test relay **R360** is caused to operate to return busy tone to the calling subscriber in the manner previously explained. On the other hand, if the code call circuit is idle, the relays **R370** and **R380** are caused sequentially to operate, in the manner previously described, to complete a loop circuit which extends from the windings of the battery feed impedance element **330** by way of the link line **326**, the operated line contacts of the relay **R890**, and the operated contacts of the group relay **R480** to the trunk conductors extending to the code call circuit. As explained previously, the relay **R390** is energized shortly following the end of the third digit, and upon operating, opens, at its contacts **397'**, the pulsing circuit to the counting relays and their associated control relays. Accordingly, further impulses transmitted to the connector portion of the link are without effect insofar as the control equipment of the connector switch is concerned. The line relay **R310** follows the additional impulses of the digits making up the code call directory number, and, at its contacts **311**, repeats the impulses over the established loop circuit to the code call equipment. Thus, the code call equipment is directively controlled in accordance with the code call number dialed, so that it will operate at the conclusion of the dialing operation to transmit the

coded ringing current designating the desired party over a group or all of the lines terminating at the exchange. The manner in which the link illustrated is released under the control of the calling party, is exactly the same as set forth above with reference to the call routed from the substation A to the substation C.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is contemplated 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 exchange which terminates a plurality of lines certain of which are arranged for special service, a plurality of links for setting up connections between said lines, apparatus common to said links and including means for controlling said links in setting up connections between said lines, and means controlled in accordance with the operation of said last-named means for causing talking circuits to be completed by way of said links between calling lines arranged for special service and busy called lines of the system.

2. In a telephone exchange which includes a plurality of lines certain of which are arranged for special service, a plurality of links each including a finder switch having access to said lines, apparatus common to said links and including means for controlling said finder switches to seize calling ones of said lines, and means in said apparatus controlled in accordance with the operation of said last-named means for causing talking circuits to be completed by way of said links between calling lines arranged for special service and busy called lines of the system.

3. In a telephone exchange which terminates a plurality of lines certain of which are arranged for special service, a plurality of links for setting up connections between said lines, equipment common to said links and including means controlled over calling lines of the system for controlling the operation of said links to set up connections between said lines, and means included in said links and controlled in accordance with the operation of said last-named means for completing talking circuits to busy called lines only when the calling lines are arranged for special service.

4. In a telephone system, a plurality of lines, certain of which are arranged for special service, a plurality of links each including a finder switch comprising group relays and unit relays, equipment common to said links and including auxiliary group and unit relays operative to control the group and unit relays of said links and a link distributor, means including said links and said common equipment for setting up connections between said lines, and means included in said links and controlled by said auxiliary relays for completing talking circuits to busy called lines when the calling lines are arranged for special service.

5. In a telephone system, a plurality of lines certain of which are arranged for special service, a plurality of links each including a finder switch having access to said lines, each of said finder switches including a plurality of group and unit relays, equipment common to said links and including auxiliary group and unit relays individually corresponding to the group and unit relays of said links and operative to control the corresponding link relays, means including said links and said common equipment for setting up connections between said lines, and means controlled by the auxiliary group and unit relays which correspond to the special service lines for completing talking circuits between said special service lines and busy called lines of the system.

6. In a telephone system, a plurality of lines certain of which are arranged for special service, a plurality of links for setting up connections between said lines and each including a finder switch having access to said lines, each of said finder switches including a plurality of group and unit relays, equipment common to said links and including a link distributor and auxiliary group and unit relay corresponding to the group and unit relays of said links, the auxiliary group and unit relays corresponding to a calling one of said lines being operative to cause the operation of the corresponding relays in an assigned one of said links, and means controlled by said auxiliary relays and operative if the operated relays correspond to a calling line arranged for special service for completing a talking circuit by way of the assigned link to a busy called one of said lines.

7. In a telephone system, a plurality of lines divided into groups, a plurality of links for setting up connections between said lines and each including a finder switch having access to said lines, each of said finder switches including group relays individually corresponding to said groups of lines and unit relays individually corresponding to the lines of said groups, equipment common to said links and including a link distributor and auxiliary group and unit relays individually corresponding to the group and unit relays of said links, the auxiliary group and unit relays corresponding to calling ones of said lines being operative to cause the operation of the corresponding relays of the links assigned to said calling lines by said distributor, right-of-way control circuits extending to said links, means comprising said auxiliary relays for selectively controlling said circuits in accordance with the directory number designations of said calling lines, and means controlled over said circuits for causing talking circuits to be set up by way of the respective assigned links to busy called lines of the system.

8. In a telephone system, a plurality of lines divided into groups, a plurality of links for setting up connections between said lines and each including a finder switch having access to said lines, each of said finder switches including group relays individually corresponding to said groups of lines and unit relays individually corresponding to the lines of said groups, equipment common to said links and including a link distributor and auxiliary group and unit relays individually corresponding to the group and unit relays of said links, the auxiliary group and unit relays corresponding to calling ones of said lines being operative to cause the operation of the corresponding relays of the links assigned to said calling lines by said distributor, right-of-way control circuits extending to said links, means comprising one of said auxiliary group relays and one of said auxiliary unit relays for completing the one of said circuits extending to an assigned link in response to a call initiated on the line having the units designation corresponding to said one auxiliary units relay and the group designation corresponding to said one auxiliary group relay, and means in said assigned link and controlled over

said one circuit for causing a talking circuit to be set up by way of the assigned link to a busy called line of the system.

9. In a telephone system, a plurality of lines divided into groups each including two subgroups, a plurality of links for setting up connections between said lines and each including a finder switch having access to said lines, each of said finder switches including group relays individually corresponding to said groups of lines, a subgroup relay individually corresponding to a subgroup of lines in each group and unit relays individually corresponding to two lines in each group, equipment common to said links and including a link distributor and auxiliary group, subgroup and unit relays individually corresponding to the group, subgroup and unit relays of said finder switches, the auxiliary group and unit relays and said subgroup relay being operative to cause the operation of the corresponding relays of assigned ones of said links in response to calls initiated upon the respective corresponding lines, right-of-way control circuits extending to said links, means comprising one of said auxiliary group relays, one of said auxiliary unit relays and said subgroup relay for completing the ones of said circuits extending to assigned links in response to calls initiated on the lines having the units designations corresponding to said one auxiliary units relay and the group designation corresponding to said one auxiliary group relay, and means individual to the assigned links and controlled over said circuits for causing talking circuits to be set up by way of the assigned links to busy called lines of the system.

10. In a telephone exchange which terminates a plurality of lines certain of which are arranged for special service, a plurality of finder-connector links for setting up connections between said lines, each of said links including a special service relay operative to cause a special service circuit to be set up in the link, and common equipment including a link distributor and means controlled over a calling one of said special service lines for causing the finder portion of an assigned link to seize the calling line and for energizing the special service relay of the assigned link.

11. In a telephone exchange which terminates a plurality of lines certain of which are arranged for special service, a plurality of finder-connector links for setting up connections between said lines, each of said links including a busy test relay, a circuit for transmitting a busy signal through the finder end of the link to a calling line and a special service relay operative to open said circuit and to prepare a talking circuit through the contacts of said busy test relay to a busy called line, and common equipment including a link distributor and means controlled over a calling one of said special service lines for causing the finder portion of an assigned link to seize the calling line and for energizing the special service relay of the assigned link.

12. In a telephone system, a plurality of lines certain of which are arranged for special service, a plurality of links for setting up connections between said lines and each including an all-relay finder switch, each of said links further including a special service relay operative to cause a talking circuit to be set up to a busy called line, common equipment including a link distributor, auxiliary group and unit relays and circuits controlled by said auxiliary relays for energizing the special service relays of assigned ones of said links, certain of said auxiliary relays being operative in response to the initiation of a call on one of said special service lines to cause the corresponding finder relays of an assigned link to operate, whereby the calling line is seized by the finder switch of the assigned link, and means included in said assigned link and operative in response to the operation of the auxiliary relays corresponding to said calling line for completing the circuit for energizing the special service relay of the assigned link.

13. In a telephone system, a plurality of lines certain of which are arranged for special service, a plurality of links for setting up connections between said lines and each including an all-relay finder switch, each of said links further including a special service relay operative to cause a talking circuit to be set up to a busy called line, common equipment including a link distributor, auxiliary group relays individually corresponding to different groups of said lines and auxiliary unit relays individually corresponding to different lines of said groups, circuits controlled by said auxiliary relays for energizing the special service relays of said links, means comprising a control relay individual to an assigned link and controlled through said distributor to operate in response to the operation of the group and unit relays corresponding to a calling special service line for causing the operation of the corresponding finder relays of the assigned link, whereby the calling line is seized by the finder switch of the assigned link, and means comprising said control relay and the operated auxiliary group and unit relays for completing the circuit for energizing the special service relay of the assigned link.

14. In combination with a plurality of links arranged to serve a plurality of lines divided into groups, equipment common to said links and including a link distributor and auxiliary group and unit relays respectively corresponding to said line groups and said lines, right-of-way control circuits extending to said links, means comprising said auxiliary relays for selectively controlling said circuits in accordance with the directory number designations of calling ones of said lines, and means individual to said links and controlled over said circuits for causing talking circuits to be set up by way of the respective associated links to busy called lines.

15. In combination with a plurality of links arranged to serve a plurality of lines divided into groups, equipment common to said links and including a link distributor and auxiliary group and unit relays respectively corresponding to said line groups and said lines, right-of-way control circuits extending to said links, means comprising one of said group relays and one of said unit relays for completing the one of said circuits extending to an assigned link in response to a call initiated on a line having the units designation corresponding to said one units relay and the group designation corresponding to said one group relay, and means included in said assigned link and controlled over said one circuit for causing a talking circuit to be set up by way of the assigned link to a busy called line of the system.

16. In combination with a plurality of links arranged to serve a plurality of lines arranged in groups each including two subgroups, equipment common to said links and including a link distributor, group relays corresponding to said groups of lines, a subgroup relay and unit relays individually corresponding to a line in each of said subgroups, right-of-way circuits extending

to said links, means comprising one of said group relays, one of said unit relays and said subgroup relay for completing the one of said circuits extending to an assigned link in response to a call initiated on the line having one of the units designations of said one units relay and the group designation corresponding to said one group relay, and means including in said assigned link and controlled over said one circuit for causing a talking circuit to be set up by way of the assigned link to a busy called line of the system.

17. In a telephone exchange which terminates a plurality of lines certain of which are arranged for special service, a plurality of links each including a finder switch having access to said lines, equipment common to said links and including means controlled over calling lines of the system for controlling the operation of said finders to seize the calling lines, and means controlled in accordance with the operation of said last-named means for causing talking circuits to be completed by way of said links between calling lines arranged for special service and busy called lines of the system.

JOHN H. VOSS.

CERTIFICATE OF CORRECTION.

Patent No. 2,333,038. October 26, 1943.

JOHN H. VOSS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 18, first column, line 8, claim 16, for "including" read --included--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of December, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)