

Jan. 7, 1947.

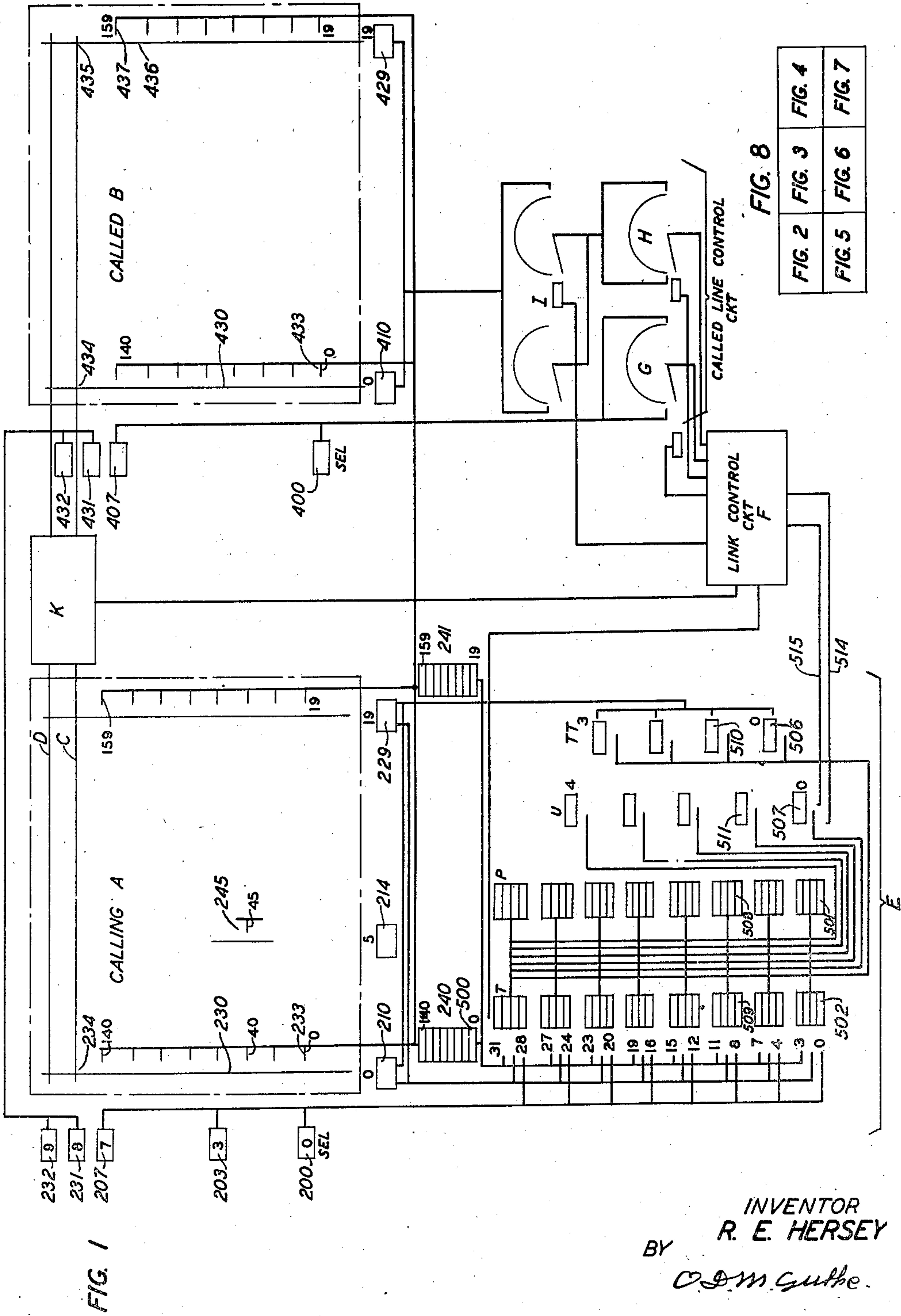
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2,413,708

TELEPHONE SYSTEM

Filed Nov. 9, 1944

7 Sheets-Sheet 1



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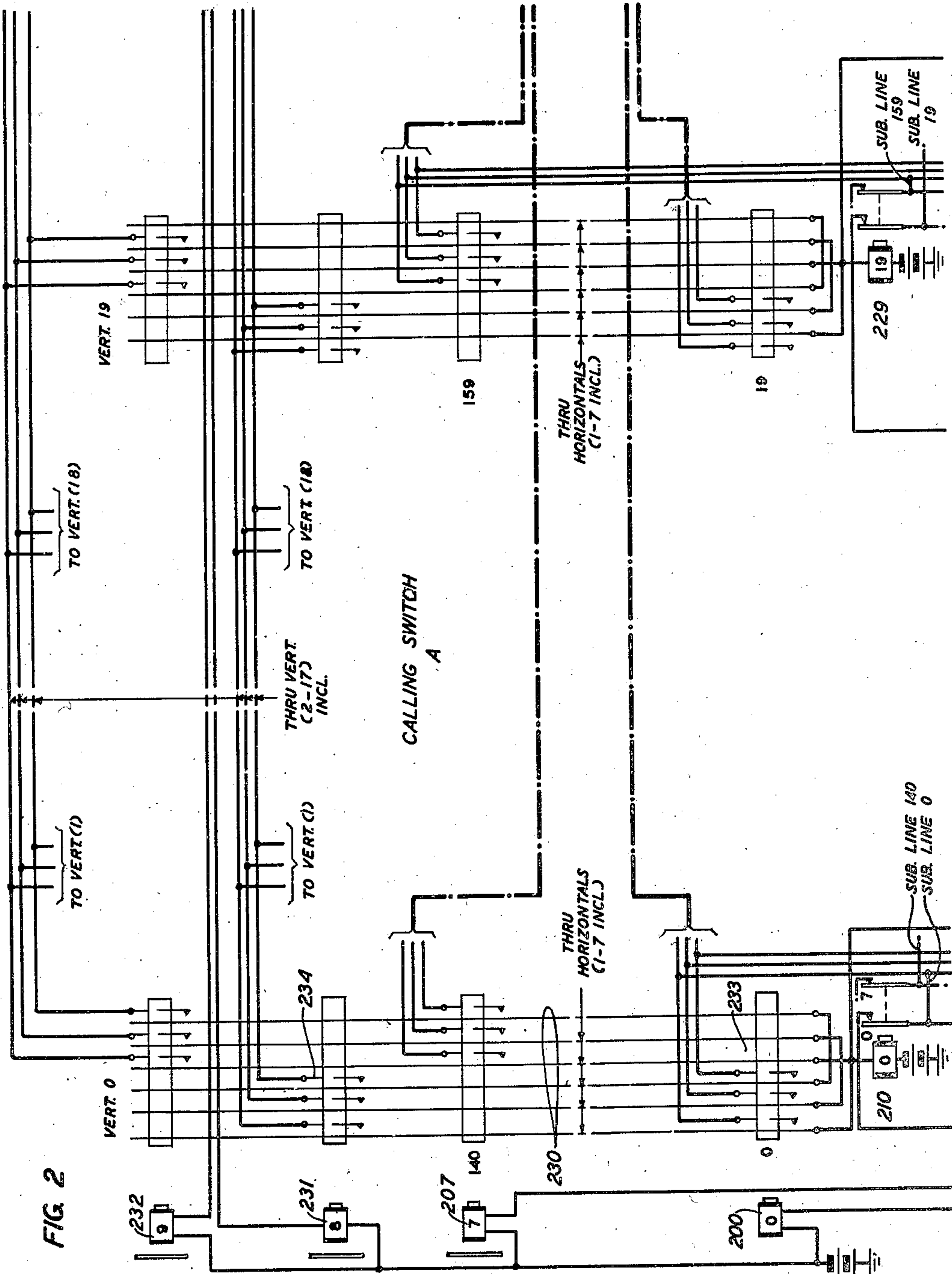
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7 Sheets-Sheet 2



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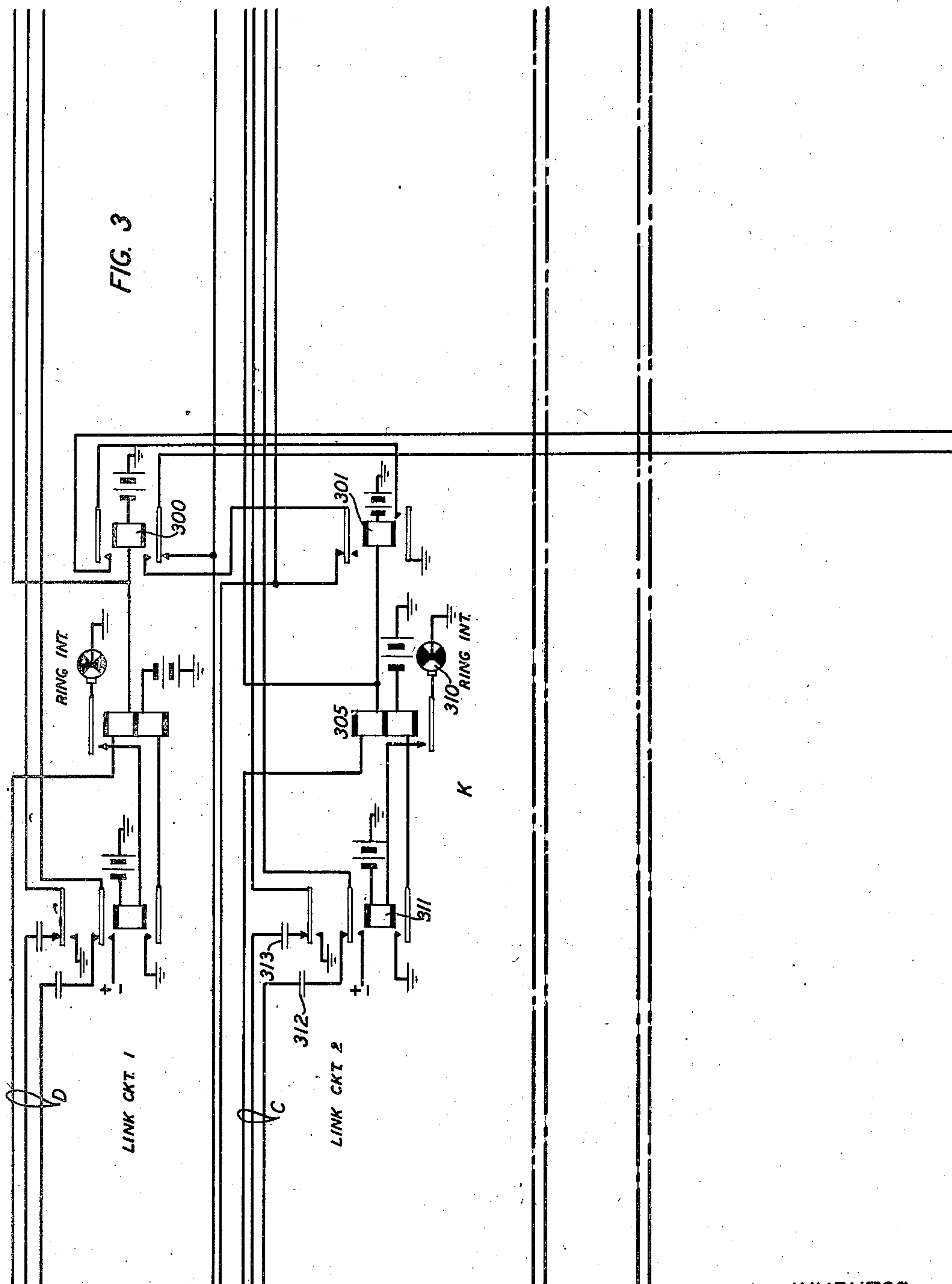
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TELEPHONE SYSTEM

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7 Sheets-Sheet 3



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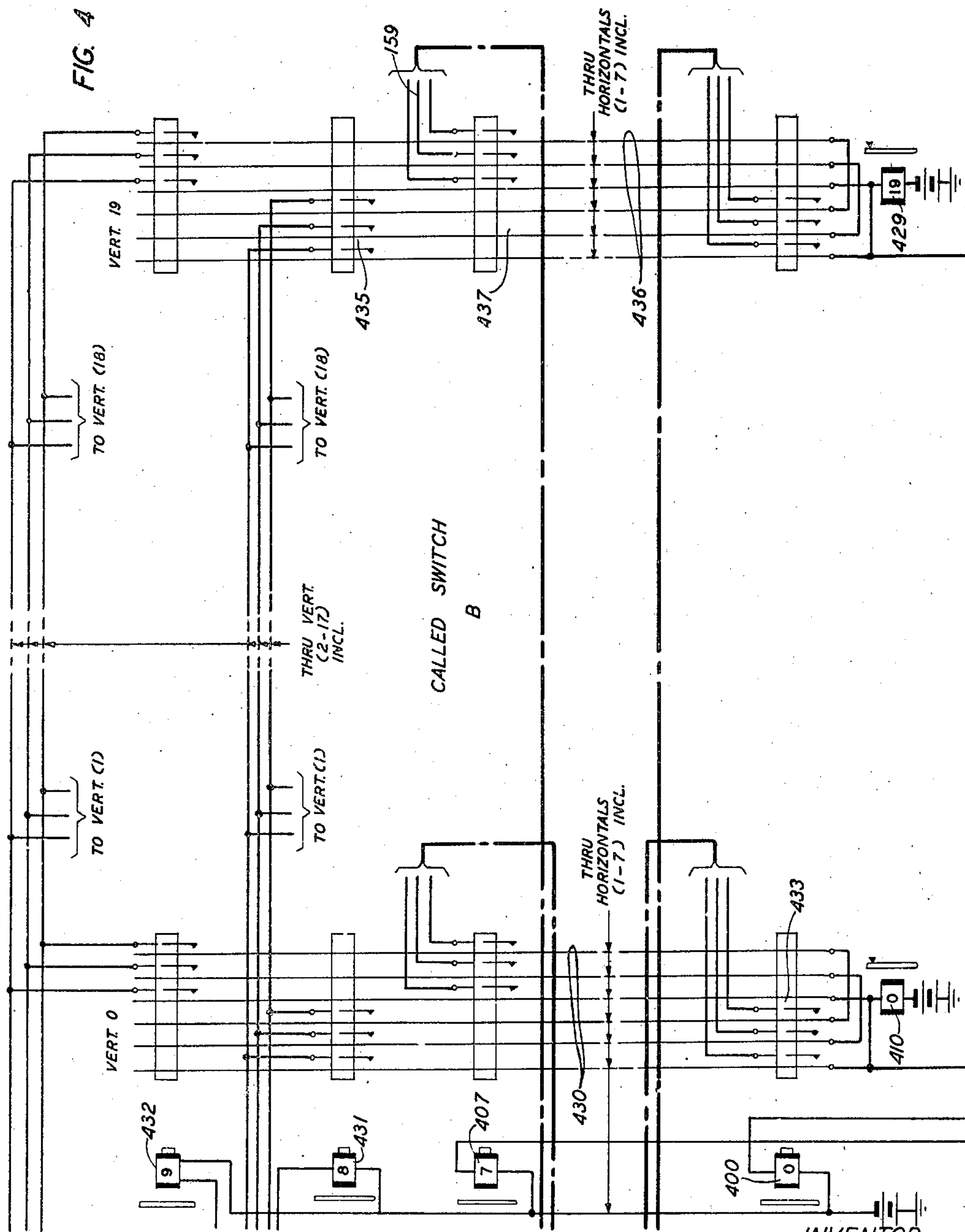
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TELEPHONE SYSTEM

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7 Sheets-Sheet 4



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TELEPHONE SYSTEM

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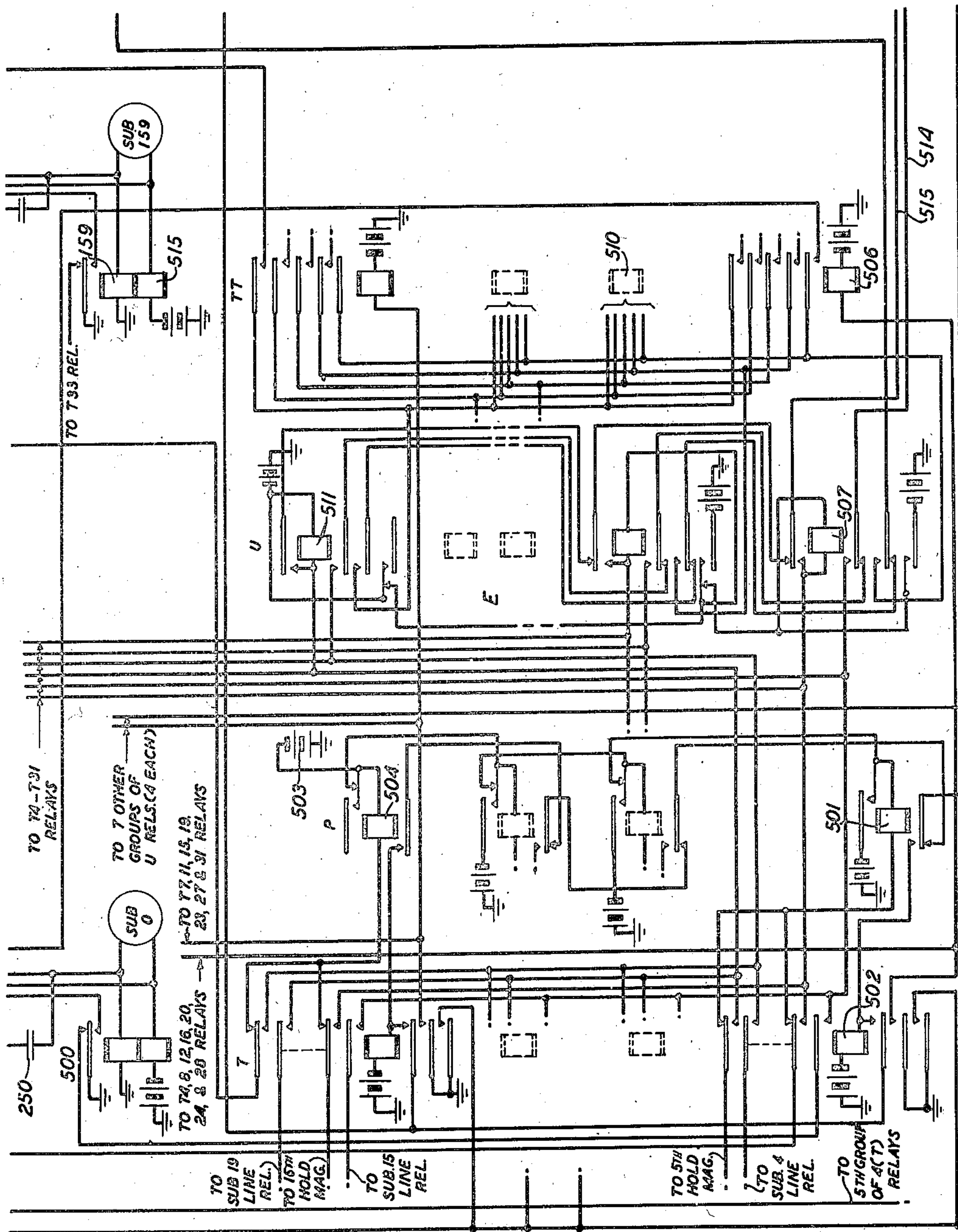


FIG. 5

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TELEPHONE SYSTEM

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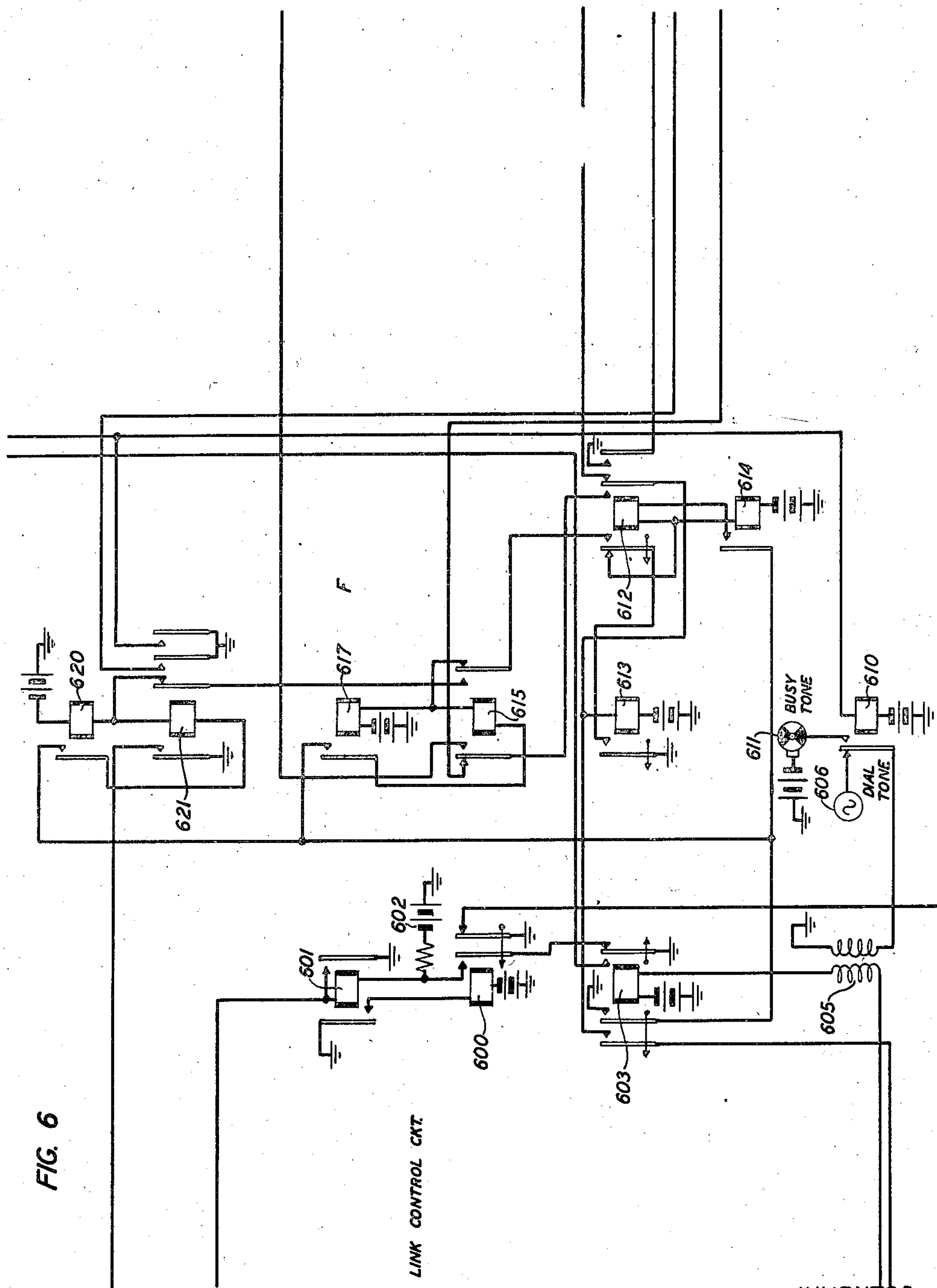


FIG. 6

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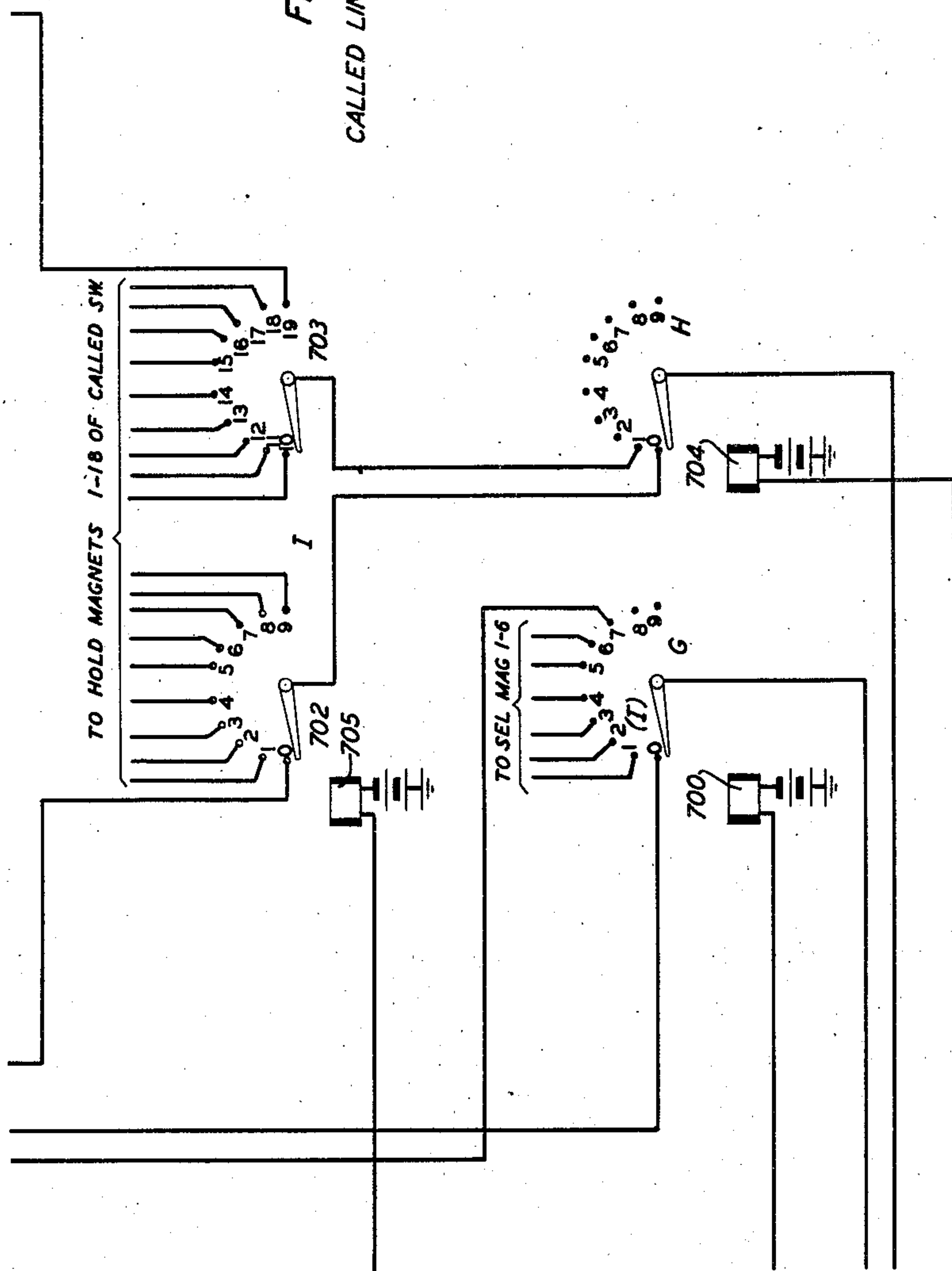
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FIG. 7
CALLED LINE CONTROL CKTS



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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

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Application November 9, 1944, Serial No. 562,598

7 Claims. (Cl. 179—22)

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This invention relates to telephone systems and particularly to systems in which cross bar switches are employed to automatically establish connections between subscribers' lines.

An object is to simplify and improve the operating characteristics of systems of this kind and to reduce the individual equipment required for the subscribers' lines and to reduce and utilize to the fullest extent such common equipments as are required for controlling the establishing of connections between subscribers' lines.

Heretofore cross bar switches have been used in small capacity systems for establishing connections between subscribers over interconnecting links by the aid of control relay groups or marker circuits and minor switches which select and operate the individual select and hold magnets in such switches.

The present invention relates to small capacity systems of this general type and an inventive feature thereof is an arrangement of a so-called calling line cross bar switch and a called line cross bar switch in which each subscriber's line appears once in each switch and interconnecting links which appear in both switches for the connection of calling lines with called lines. A common marker circuit is provided and operative when a subscriber calls for identifying the calling line in the calling line switch, for seizing an idle link and for extending a pulsing circuit from the calling line relay through this marker circuit to minor switches. Said minor switches in turn are responsive to dial pulses received over said pulsing circuit, to select any called line in the called line switch. Additional circuits are also provided and connected through said marker circuit and minor switches for thereafter establishing a connection between a calling subscriber's line and a called subscriber's line through said switches over the chosen link.

Another feature is an arrangement whereby the line relay of the called subscriber's line serves as a ringing trip relay.

Another feature is an arrangement whereby the talking battery for the calling line and for the called line is supplied through their respective line relays. These circuits are also arranged to eliminate the use of cut-off relays.

The invention has been illustrated in the accompanying drawings in which Fig. 1 shows in diagrammatic form a typical arrangement of the applicant's invention in a system employing the two switches, while Figs. 2 to 7 when arranged in accordance with Fig. 8, illustrate in more detail the applicant's invention with the circuits re-

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quired for the establishing of a connection between a particular calling subscriber's line and a particular called subscriber's line.

Reference is now made to the drawings and particularly to Fig. 1 where the general plan is shown to indicate the calling line cross bar switch A and the called line cross bar switch B, and interconnecting links C and D between said switches. The calling cross bar switch A is arranged with eight select magnets 200 to 207 and switch B with eight select magnets 400 to 407 for selecting levels in which subscriber's lines appear and hold magnets 210 to 229 in switch A and hold magnets 410 to 429 in switch B for connecting subscriber's lines to vertical contact rows. In switch A are also shown two select magnets 231 and 232 for the two links C and D and similar select magnets 431 and 432 for these links in switch B. As stated, each subscriber's line is represented once in each of these two switches and the numbering at the subscriber's lines may be as follows. For example, the first twenty subscribers 0 to 19 will be connected on the first level and succeeding numbers of subscribers in groups of twenty will be appearing in the succeeding eight levels so that, for example, in the eighth level the subscriber's numbers 140 to 159 will appear in the succeeding twenty rows in this level. That is to say, line 0 is represented at the cross-points 233 and 433 in switches A and B and a vertical contact row is provided for each hold magnet, for example, the vertical contact row 230 is provided for hold magnet 210 in switch A and the vertical contact row 430 is provided for hold magnet 410 in switch B. Thus, if a connection is desired from subscriber 0 as a calling subscriber in switch A over the idle link C, for example, the connection will be established at the cross-point 233 between the calling subscriber 0 and the contact row 230 and at cross-point 234 between this row 230 and link C, and similarly if a connection is to be established between this link and, for example, subscriber 159, as the called subscriber, a connection is established through the cross-point 435 between link C and the row 436 and at the cross-point 437 between the row 436 and the subscriber's line 159. This connection is effected by the operation of select magnets 200 and 231 in switch A and select magnets 431 and 407 in switch B and the hold magnet 210 in switch A and hold magnet 429 in switch B.

The control or marker circuit and other circuits have been illustrated diagrammatically in Fig. 1. For example, E indicates the marker circuit with relays arranged in groups as follows:

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One group comprises thirty-two relays marked T divided in eight sub-groups of four each and another group of thirty-two relays marked P divided in eight sub-groups of four each, while a group of five relays is marked U and a group of four relays is marked TT. These relays and their circuits are for identifying and establishing connections in the calling switch A and for extending the pulsing circuits. For controlling the connections in the switch B, over the link C or D in switches A and B, a group of relays is provided and indicated by a box marked F. A minor switch G is provided for controlling the select magnets for the called subscriber's line in switch B and minor switches H and I are provided for selecting the hold magnets in switch B. The circuits for the line links C and D are indicated by a box marked K. The subscriber's line relays, for the sake of clearness, may be considered as arranged in groups of eight associated with each vertical row of contacts. One group of eight line relays for lines 0, 20, 40, 60, 80, 100, 120 and 140 has been indicated at 240 and similar groups of groups are arranged for the succeeding vertical rows, that is 160 line relays would be arranged in twenty groups, the last eight relays for lines 19, 39, 59, 79, 99, 119, 139 and 159 being indicated at 241.

A description will now be made in general in connection with Fig. 1 of how a connection is established between the calling subscriber 0 and the called subscriber 159. When the calling subscriber's line relay 500 is operated, the marker relays E will be operated as follows. For example, the relay 501 in the first sub-group of four in the P group will be operated causing the operation of the corresponding relay 502 in the first sub-group of four in the T group which causes the operation of relays 506 in group TT and 507 in group U, that is, these relays in operating indicate that the calling subscriber's line is located in the lower or first horizontal level and in the first vertical row; that the first select magnet 200 and the first hold magnet 210 should be operated and that the select magnets for an idle link should be operated in both switches A and B. What actually takes place when the subscriber calls due to the operation of the above-mentioned relays is that the select magnet 200 is operated as well as the select magnets for an idle link, such as, for example, select magnets 231 and 431 for link C, if this link is idle. The above-mentioned relays in the marker circuit E also extend a pulsing circuit 514 and a dial tone circuit 515 to the circuit arrangement F over these relays from the calling subscriber's line relay 500. A dial tone will now be transmitted over circuit 515 to the calling subscriber indicating that he may begin to dial the desired number. If the subscriber 159 is desired, the first digit dialed will be 8 to cause the switch G to select and operate select magnet 407 in the switch B to indicate that the called subscriber's line is located in the eight level. The second digit will then be dialed and as the subscriber 159 is the one desired, the switch H will be operated to take two steps to select one of the switches I, to wit, the second switch as the subscriber's line 159 is located in the second or right-hand half section of switch B. The third impulse will then be dialed for the operation of the hold magnet 429. The circuit arrangement is such that at this time the hold magnet 210 is also operated. Thus, it will be seen that a connection is now established from the subscriber 0 to the sub-

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scriber 159 over link C through the cross-points 233 and 234 in switch A, and cross-points 435 and 437 in switch B. When this takes place, the circuit arrangement K common to links C and D will operate to apply ringing current to the called subscriber's line and when the called subscriber answers this call, the ringing will cease and the talking connection through link C will be established between the two subscribers.

To perhaps describe in more detail the arrangement of the marker relays, it should be again noted in this Fig. 1 that the T and P relays are divided in eight sub-groups, each containing four relays and that a group of eight line relays is associated with each hold magnet. For example, the first eight line relays 240 are associated with the hold magnet 210 and in turn associated through contact of this hold magnet with the first sub-group of four relays at the bottom of the groups T and P and also the first or lower relay 507 of the U relays and 506 of the TT relays. Thus, U relays preselect one out of five groups of hold magnets, each group consisting of four hold magnets and the TT relays determining the individual hold magnet to be operated in the preselected group. If it is assumed, for example, that the subscriber 45, located in the sixth vertical row and the third horizontal level is calling, the relays 508 and 509 of the third group of P and T relays and the second TT and U relays 510 and 511 will be operated to indicate that the third select magnet 203 should operate to designate the level in which subscriber 45 is located and the sixth hold magnet 214 should be operated to indicate that the calling subscriber is located in the sixth vertical row to establish the connection for this subscriber's line 45 through switch A at cross-point 245.

Referring now to Figs. 2 to 7, which show the system in more detail, a description will be made of a call from subscriber 0 to subscriber 159. Fig. 2 shows the calling switch A; Fig. 3 the circuits K for the two links C and D; Fig. 4 the called switch B; Fig. 5 the marker circuit E for the calling lines; Fig. 6 the link control circuit F and Fig. 7 the called line control switches G, H and I. If now the subscriber 0 calls, the line relay 500 operates from battery and ground through the windings of this relay and the subscriber's station loop. The operation of this line relay closes a circuit for the operation of P relay 501 in the marker circuit E from battery, winding of this relay, contact of T relay 502, contacts of hold magnet 210 and contacts of line relay 500 to ground. Relay 501 closes a circuit for relay 502 from battery, winding of this relay, contacts of relay 501 and 600 to ground. As the subscriber 0 is located in the lower or first level of the switches A and B, the select magnet 200 operates over an obvious circuit by the operation of relay 502. Relay 502 closes a circuit for the operation of TT relay 506 from battery, winding of this relay, contacts of relay 502 to ground. The operation of relay 506 marks or signifies that the calling subscriber is one of the first five subscribers' lines terminating in the first or lower level in the switch A. Relay 502, in operating, also closes a circuit over its lower inner armature and front contact and through the winding of relay 601 through a resistance to battery at 602 causing relay 601 to operate. Relay 601 in operating closes a locking circuit for itself and also a locking circuit for relay 502 to ground at the right-hand armature and front contact of this relay 601. Relay 601 in operating closes an obvious circuit

for relay 600 which, however, is slow to operate to permit relay 603 to operate first as will presently be described. It should be noted that if any of the other P relays have been operated at the time subscriber 0 calls, the battery 503 would have been opened from relay 501 and consequently, prevents subscriber 0 from calling at this stage of the operation. Thus, if relay 504 is operated the battery 503 is cut off from the chain circuit leading to the other P relays. It should now be noted that relay 507 also operated on the operation of relay 502 from battery through a chain circuit from relay 511 the winding of this relay, contacts of relay 502, contacts of hold magnet 210 to ground at contacts of the line relay 500. Relay 507 in operating closes at its upper armature and front contact a circuit for the operation of the above-mentioned relay 603 from battery through the winding of this relay, dial tone coil 605, lead 515, upper armature and front contact of relay 507 to the above-mentioned ground at the line relay 500. This causes the operation of relay 603, that is, relay 603 operates before relay 600 operates for reasons as will become apparent at the time of release of the marker circuit. A circuit is now closed for the operation of the select magnets of an idle link circuit, for example, if link C is idle and link D is busy a circuit will be completed from battery through the select magnet 231 of switch A and also from battery through the select magnet 431 of switch B, contacts of relay 301 of link C, contacts of the operated relay 300 of link D and contacts of relay 603 to ground.

As the circuits are now ready for the dialing of the desired number, 159, dial tone will be transmitted through the dial coil 605 from source 606 over the dial tone lead 515, contacts of relays 507 and 502, contacts of hold magnet 210, condenser 250 to one side of the subscriber's line number 0. Had links C and D been busy, the busy relay 510 would have been operated from battery, winding of this relay, contacts of relay 300 of link D and 301 of link C to ground. Relay 610 in operating would have applied busy tone from the source 611 through the tone coil 605 over lead 515 to the calling subscriber 0. It will be explained hereinafter how relays 300 and 301 of links C and D will be operated when these links are engaged.

If now it is determined that the calling subscriber desired to call subscriber 159, he must, of course, as the first digit, dial the digit 8 to reach the level in which this called subscriber's line is located. With the line relay 500 serving as the pulsing relay and with the pulsing circuit extended through the common pulsing lead 514, on the first release of the relay 500, a circuit is completed for the operation of the stepping magnet 700 for switch G from battery through the winding of this magnet, contacts of relays 612 and 603, pulsing lead 514, contacts of relays 507 and 502 to ground at contacts of relay 500. Each pulse will advance the switch one step. It should be noted also that the first impulse caused the operation of relay 613 over an obvious circuit and this relay operates relay 614 from battery, winding of this relay, contacts of relays 612 and 613. Relay 613 is maintained operated during the succeeding pulses, as it is slow in releasing. The magnet 700 steps the brush of switch G to succeeding terminals until eight steps have been taken. At this time, relay 613 will release permitting relay 612 to operate over a circuit from battery over the winding of relays 614 and 612, contacts of relays 614 and 603 to ground. This

opens the pulsing circuit for the stepping magnet 700 which now releases. The operation of relay 612 closes a circuit over the brush of switch G to operate select magnet 407 in switch B which thereby prepares this switch for the selection of a subscriber's line in the eighth level. The arrangement of the switches H and I are such that the switch H will take one or two steps to establish connections for the brushes in bank 702 or 703 for the selection and operation of hold magnets in switch B in the first group of ten or in the second group of ten. As the second digit in this case will be 2 the called subscriber line being located in the second part of the switch B, the switching bank 703 of switch I will be selected. These two impulses are received at the dialing of the second digit through the pulsing circuit now extended to stepping magnet 704 for switch H over contacts of relays 612 and 615. As relay 613 is again operated on the receiving of the first impulse, a circuit will at this time be completed for the operation of relay 617 from battery, winding of this relay, contacts of relays 615, 612 and 613 to ground. After these two impulses have been received and advanced the brush of switch H to the second position, relay 613 releases and the circuit is now completed for the operation of relay 615 from battery through the windings of relays 617 and 615, contacts of relays 617 and 603 to ground. The third digit will now consist of ten impulses as the twentieth hold magnet 429 must be operated in order to establish a connection in switch B for the subscriber 159. On the first impulse of this last digit the pulsing circuit extends as before from the pulsing relay 500 over contacts of relays 502, 507, 603, 612 and 615 to the select magnet 705 for the switch I. Relay 613 is operated by this circuit and relay 620 is then operated from battery through the winding of this relay, contacts of relays 621, 615, 612 and 613 to ground. The stepping magnet 705 will now be advanced to have its brush land on the tenth terminal in the two banks 702 and 703. At the end of this series of impulses, relay 613 will release and permit relay 621 to operate from battery through the windings of relays 620 and 621, contacts of relay 620 and 603 to ground. The operation of relay 621 closes a circuit for the operation of the hold magnet 429 from battery winding of magnet 429, tenth contact of bank 703, second contact of switch H, contacts of relay 621 to ground. This causes a connection to be established in switch B between the idle link C and the subscriber's line 159 at the cross-points 435 and 437 over the vertical row of contacts 436. The operation of relay 621 also closes a circuit for the hold magnet 210 from battery through the winding of this magnet, contacts of relays 506 and 621 to ground. Magnet 210 now closes a connection between the calling subscriber over the vertical row of contacts 230 at the cross-points 233 and 234 to link C so that this link C is now connected both to the calling subscriber's line 0 and the called subscriber's line 159. The two hold magnets 210 and 429 are now connected over the sleeve connection at cross-points 233 and 234 and 435 and 437 to the ground at the line relay 500 and held operated by this ground. It should be noted that this sleeve circuit also passes through a relay 305 in link C which at the right-hand end of this sleeve is connected to the ground at relay 500, and in the link circuit is connected to battery through the relay 301. Relays 305 and 301 will now operate from this ground. The operation of this relay 301 releases select mag-

nets 231 and 431 and closes a connection from ground to a contact of relay 300 so that if link D is busy, the associated busy relay 610 will operate to indicate that both links are busy. The operation of relay 305 closes a connection from ringing interrupter 310 through contacts of this relay and winding of the ringing relay 311 to battery. This relay 311 is thereby alternately operated and released to apply ringing current to the tip and ring conductors at intervals over the connection at cross-points 435 and 437 to the called subscriber's line 159. When the called subscriber 159 answers the call, he will operate his line relay 515, thereby applying ground to the sleeve of the link C and this causes the release of relay 305 at the end of a ringing period as it should be noted that this relay is maintained operated while relay 311 is operated. This ground will also hold the link busy relay 301 operated as long as link C is occupied. Ringing will now cease and the two subscribers' lines are connected together through the condensers 312 and 313 for talking. As the hold magnet 210 was operated, it should be observed that the pulsing circuit is broken at its armature and front contact for this line so that the ground will be removed from the circuit for relay 603 causing this relay to release. Relay 603 in releasing, applies ground at its right-hand armature which releases relay 601. Relay 601 releases relay 600. Relay 601 then releases the marker circuit relays operated such as 502, which cause the release of relays 506 and 507 and the select magnet 200. Relay 603 also releases relays 612, 614, 617, 615, 620 and 621. Relay 612 causes the release of select magnet 407 and relay 621 opens the original energizing circuit for hold magnet 429. Any well-known arrangement may be provided for the release of switches G, H and I at this time. When the subscribers hang up relays 500 and 515 release causing the release of hold magnets 210 and 429 to release the connection through link C in which relay 301 is now released.

What is claimed is:

1. In a telephone system, a calling cross bar switch, a called cross bar switch, subscribers' lines each terminating in a correspondingly located cross-point in each of said switches, links between said switches, a line relay for each subscriber's line, control means including a series of relays and minor step-by-step switches associated with said lines and links, operative in response to the seizure of a calling line and operation of the associated line relay in response to dial pulses for automatically establishing a connection from the calling line to an idle link in the calling switch and selectively establishing a connection to the called line from said link in the called switch, ringing the called line and when the called subscriber answers establishing a talking circuit over said link between the calling subscriber and the called subscriber and releasing said control means.

2. In a telephone system, a calling cross bar switch, a called cross bar switch, said switches including select magnets and hold magnets, subscribers' lines each terminating in a correspondingly located cross-point in each of said switches, links between said switches, a line relay for each line, means responsive to the operation of a subscriber's line relay when the subscriber calls for operating the select magnet in the calling switch for the level in which the calling line is located and the select magnets in both switches for the level in which a first idle link is located and for

marking the hold magnet in the calling switch for establishing subsequently a connection between the calling line and said idle link, means responsive to the operation and release of the line relay of the calling line in response to a first digit dialed by the calling subscriber for actuating the select magnet in the called switch for the level in which the called line is located, means responsive to a second and a third digit on the actuation and release of the called subscriber's line relay in response thereto for actuating at the end of the third digit the marked hold magnet in the calling switch to connect the calling line to the idle link, and for selecting and actuating a hold magnet in the called switch representing the called line for connecting this called line to said link, means operative when said connection through the called switch is completed, for ringing the called subscriber's line and releasing said select magnets and associated control means for use in establishing other connections through said switches, and means controlled by the called subscriber's line relay when it operates in response to the called subscriber answering the call for tripping the ringing and establish a talking connection between the calling subscriber's line and the called subscriber's line through said switches over said link with the line relays of said subscribers' lines holding the hold magnets operated.

3. In a telephone system, two cross bar switches, subscribers' lines appearing in both switches, links appearing in and connecting both switches, a line relay for each line, means responsive to the operation of a calling subscriber's line relay on the seizing of the corresponding line for marking the connection between the calling line and an idle link in one switch, means thereafter responsive to the release and operation of said line relay in response to dial pulses for connecting said link to a called line in the other switch and when said connection is made for then connecting in accordance with said marking the calling line in the first-mentioned switch to said link and ringing the called line, means responsive to the operation of the line relay of the called line when the called subscriber answers the call for tripping the ringing and completing a talking connection through said link between said subscriber's line with their respective line relays maintaining the connection.

4. In a telephone system, a calling cross bar switch, a called cross bar switch, subscribers' lines each terminating at one position in each of said switches, a line relay for each subscriber's line, an individual pulsing lead controlled by each line relay, interconnecting links having an outgoing branch terminating in the calling switch and an incoming branch terminating in the called switch, vertical links in said switches, select magnets and hold magnets in said switches, means operative in response to a call from one of said lines for actuating two select magnets and marking a particular hold magnet in the calling switch for the subsequent connection of the calling line to a particular vertical link in the calling switch and a subsequent connection of said vertical link to the outgoing branch of an idle interconnecting link, and for actuating the select magnet associated with the incoming branch of said interconnecting link for the subsequent connection of said incoming branch to a vertical link in the called switch, stepping switches, means for extending the individual pulsing circuit from the calling subscriber's line relay to said stepping switches for the control thereof in response to impulses transmitted

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by the calling subscriber's line relay over said extended pulsing circuit to actuate a select magnet and a hold magnet corresponding to a called line in the called switch and to thereupon actuate the particular marked hold magnet in the calling switch to establish a connection from said calling line over a particular vertical link in the calling switch, over the chosen interconnecting link and a particular vertical link in the called switch to the called line, means thereafter responsive for ringing the called subscriber's line and means responsive to the called subscriber's answering said ringing for discontinuing the ringing and closing a talking connection through the chosen intermediate link between said calling subscriber's line and said called subscriber's line.

5. In a telephone system, a calling cross bar switch, a called cross bar switch each having select magnets and hold magnets, subscribers' lines each terminating in both switches, links terminating in and connecting both switches, a line relay for each line, a pulse circuit for each line relay, a marking circuit including relays operative in response to the operation of a line relay on the seizure of the corresponding line by a subscriber for operating a select magnet in the calling switch indicating the level in which the calling line is located, for operating select magnets in both said switches indicating the level in which the idle link is located in said switches and for marking the hold magnet in the calling switch, which when operated connects the calling line to an idle link, for extending the individual pulsing circuit of the calling line relay through said marking circuit, a common circuit including relays and minor step-by-step switches, said common circuit and step-by-step switches being so arranged as to respond to impulses transmitted over said extended pulsing circuit by the operation and release of the calling subscriber's line relay for actuating the select magnet indicating the level in which the called line is located and for thereafter actuating a hold magnet in the called switch to connect the called subscriber's line to said idle link and to actuate the particular marked hold magnet in the calling switch, to connect the calling line to said idle link and means operative on the operation of said hold magnet in the calling switch for releasing the common circuit and minor switches and marker circuit and for ringing the called line from this seized link and means whereby when the called subscriber answers the call by the operation of his line relay to trip the ringing and connect the calling line with the called line for talking over said seized

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link, and means for holding said hold magnets operated under control of said line relays of the calling line and called line.

6. In a telephone system, a calling cross bar switch, a called cross bar switch, subscribers' lines each terminating in a correspondingly located cross-point in each of said switches, links between said switches, a line relay and a source of current connected through said line relay for each subscriber's line, control means including a series of relays and step-by-step switches associated with said lines and links operative in response to the seizure of a calling line and operation of the associated line relay from the associated source of current in response to dial impulses for automatically establishing a connection from the calling line to an idle link in the calling switch and selectively establishing a connection to the called line from said link in the called switch for ringing the called line and when the called subscriber answers by operating the called line relay from the associated source of current for establishing a talking connection over said link between the calling subscriber's line and the called subscriber's line with the respective sources of current through the corresponding line relays serving as the respective talking batteries for said lines and for releasing said control means.

7. In a telephone system, two cross bar switches, subscribers' lines appearing in both switches, links appearing in and connecting both switches, a line relay and a source of current connected through said line relay for each line, means responsive to the operation of a calling subscriber's line relay from the associated source of current on the seizure of the corresponding line for marking the connection between the calling line and an idle link in one switch, means thereafter responsive to the release and operation of said line relay in response to dial pulses for connecting said link to a called line in the other switch and when said connection is made for then connecting in accordance with said marking the calling line in the first-mentioned switch to said link and ringing the called line, means responsive to the operation of the line relay of the called line from the associated source of current when the called subscriber answers the call for tripping the ringing and completing a talking connection through said link and said line relays between said subscribers' lines with the associated sources of current serving as talking batteries for the respective lines and with the said line relays holding the established connection.

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