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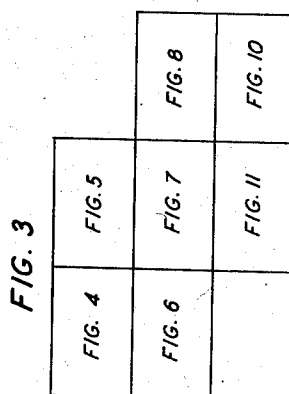
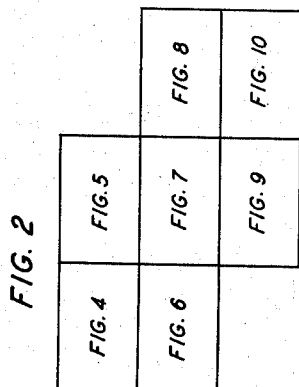
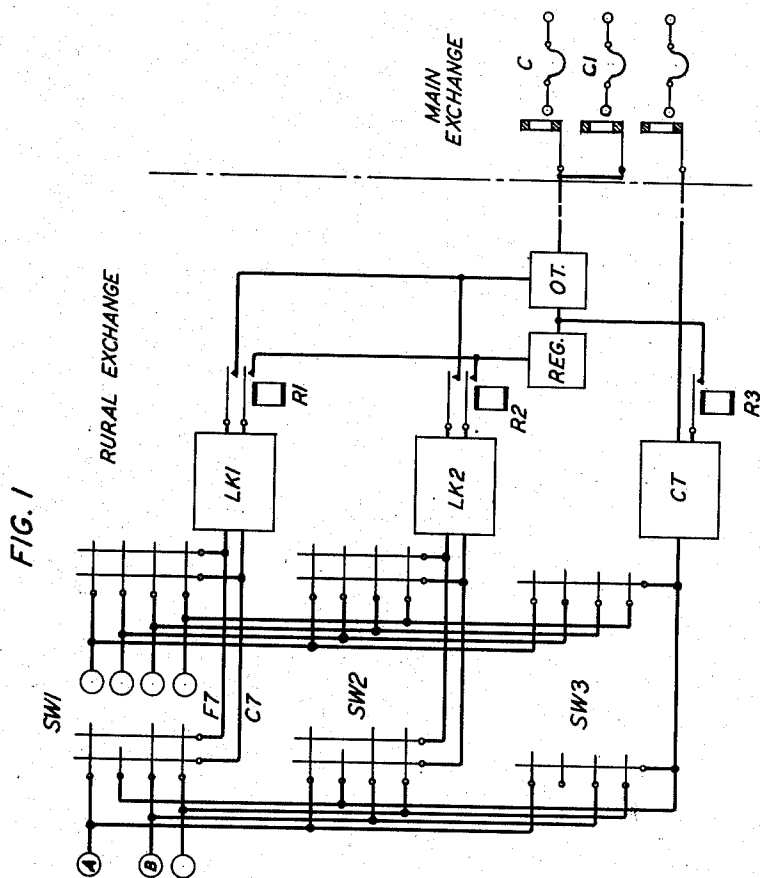
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2,092,465

TELEPHONE SYSTEM

Filed June 22, 1935

9 Sheets-Sheet 1



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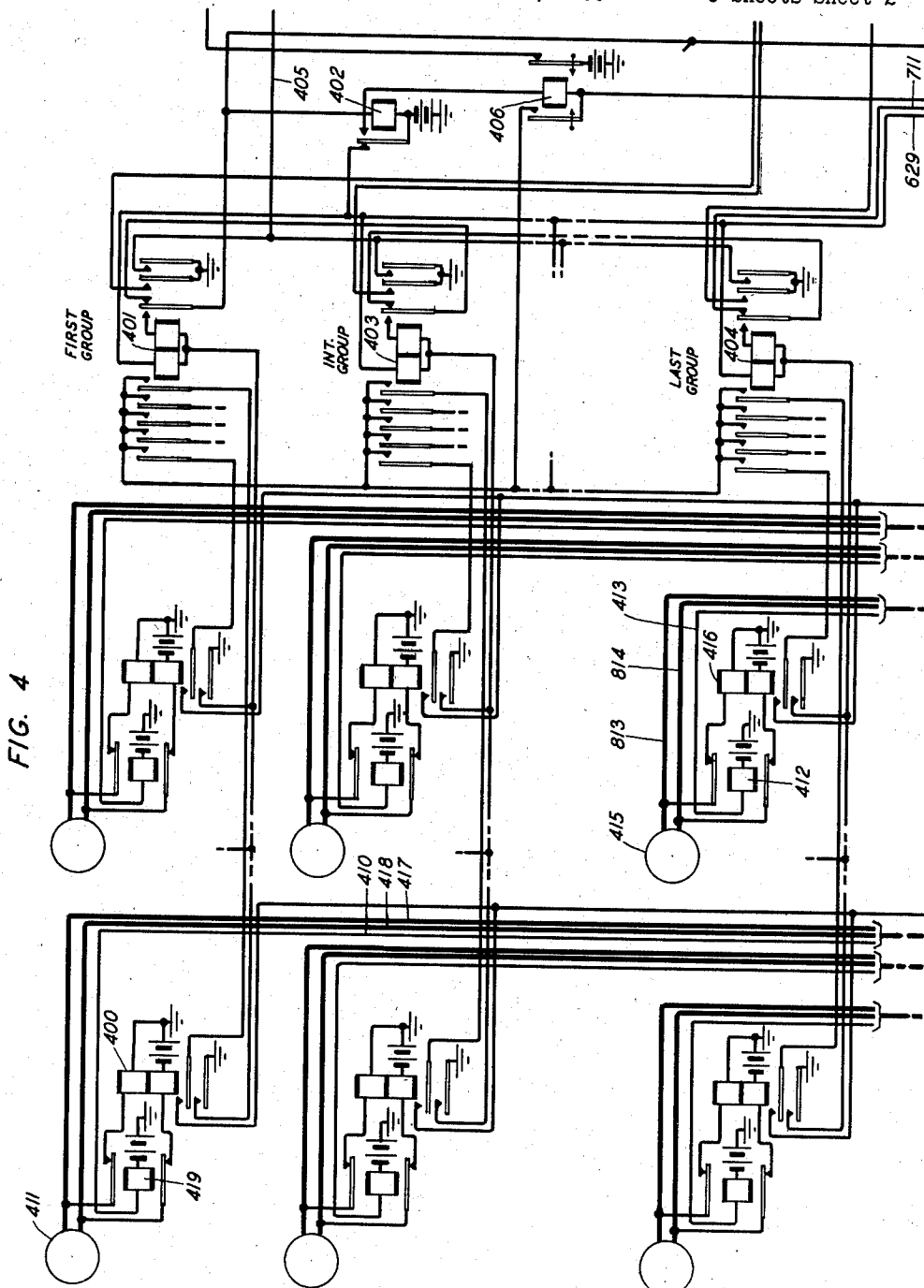
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9 Sheets-Sheet 2



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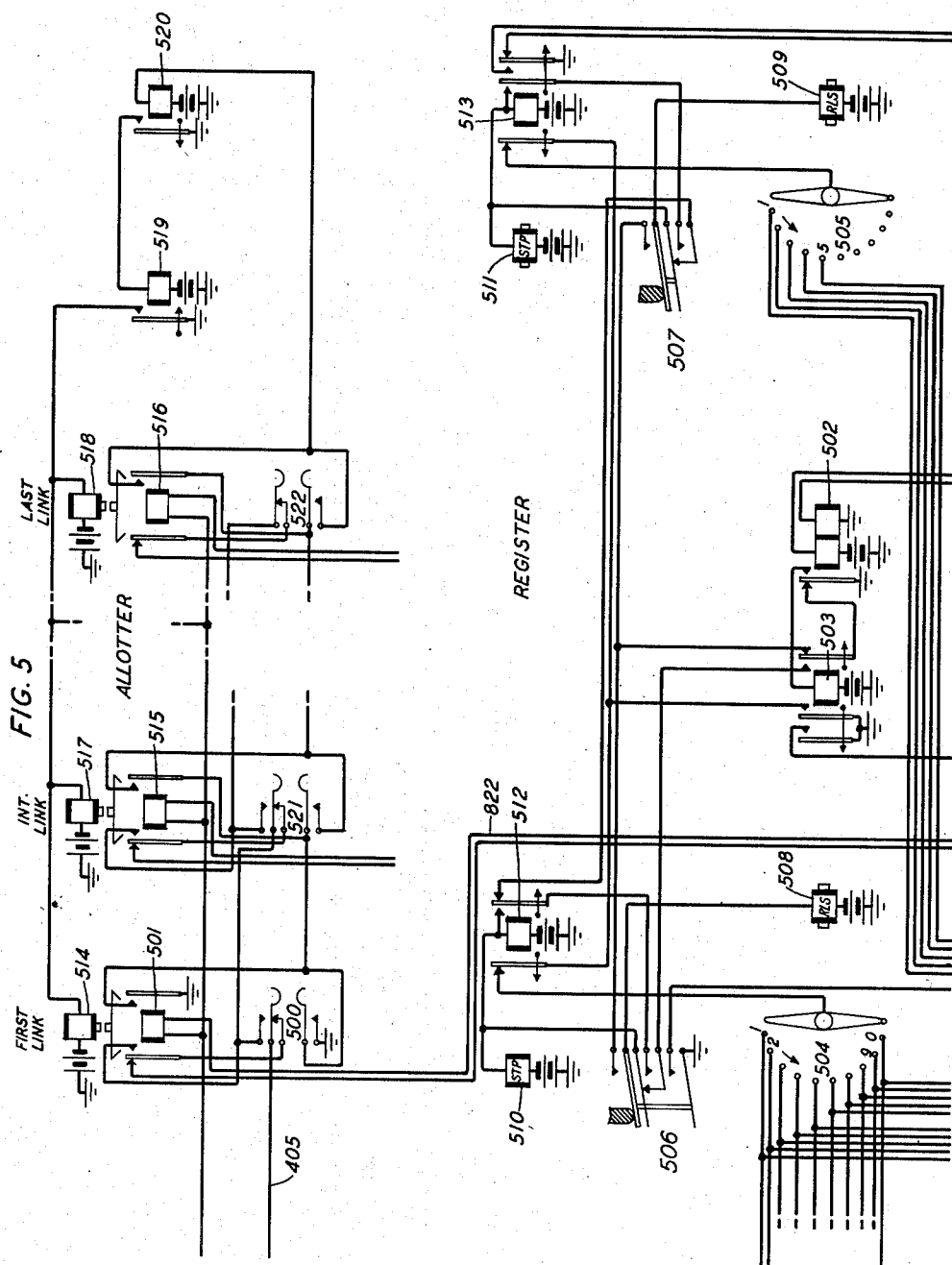
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9 Sheets-Sheet 3



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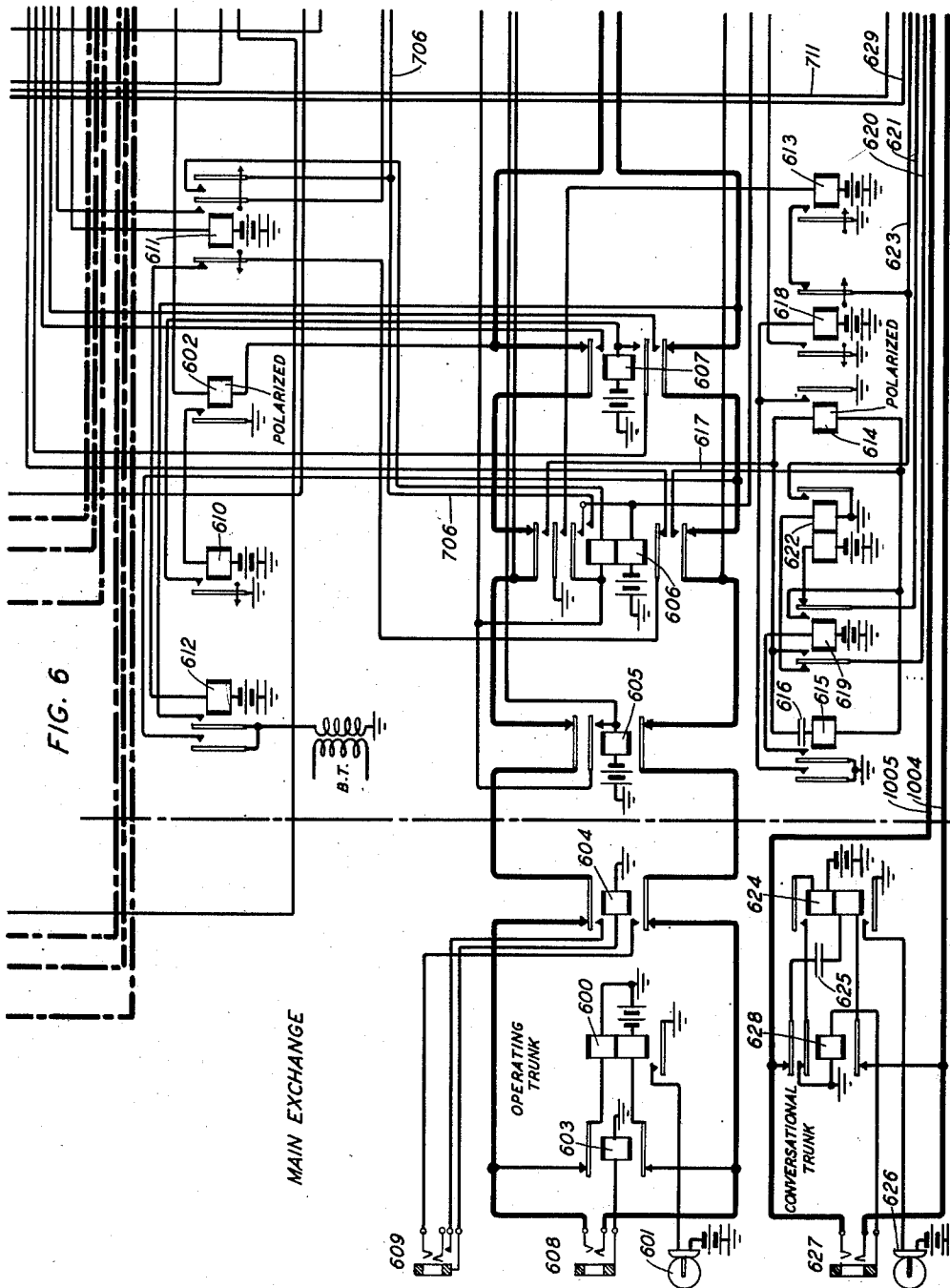
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9 Sheets-Sheet 4



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TELEPHONE SYSTEM

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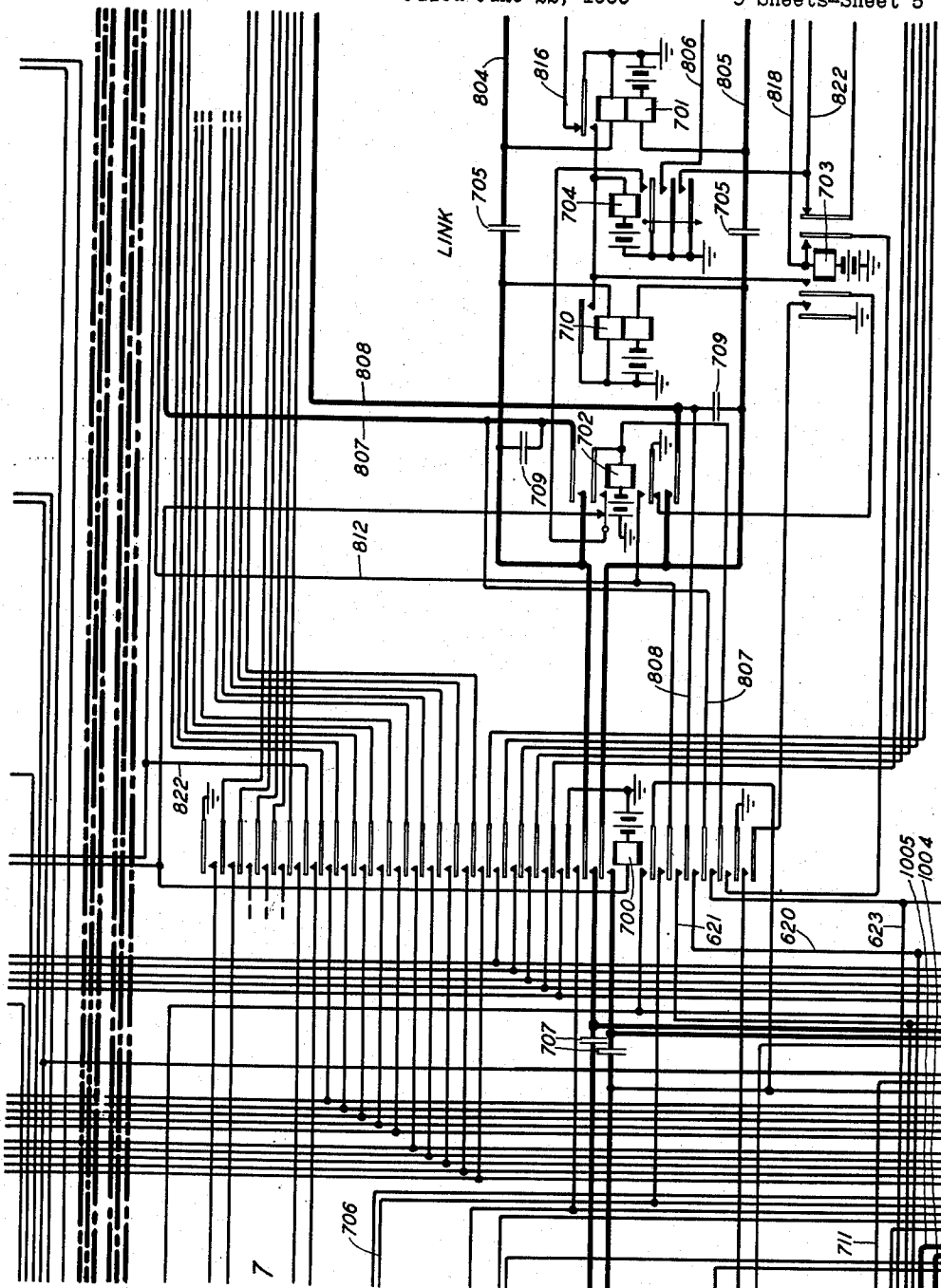


FIG. 7

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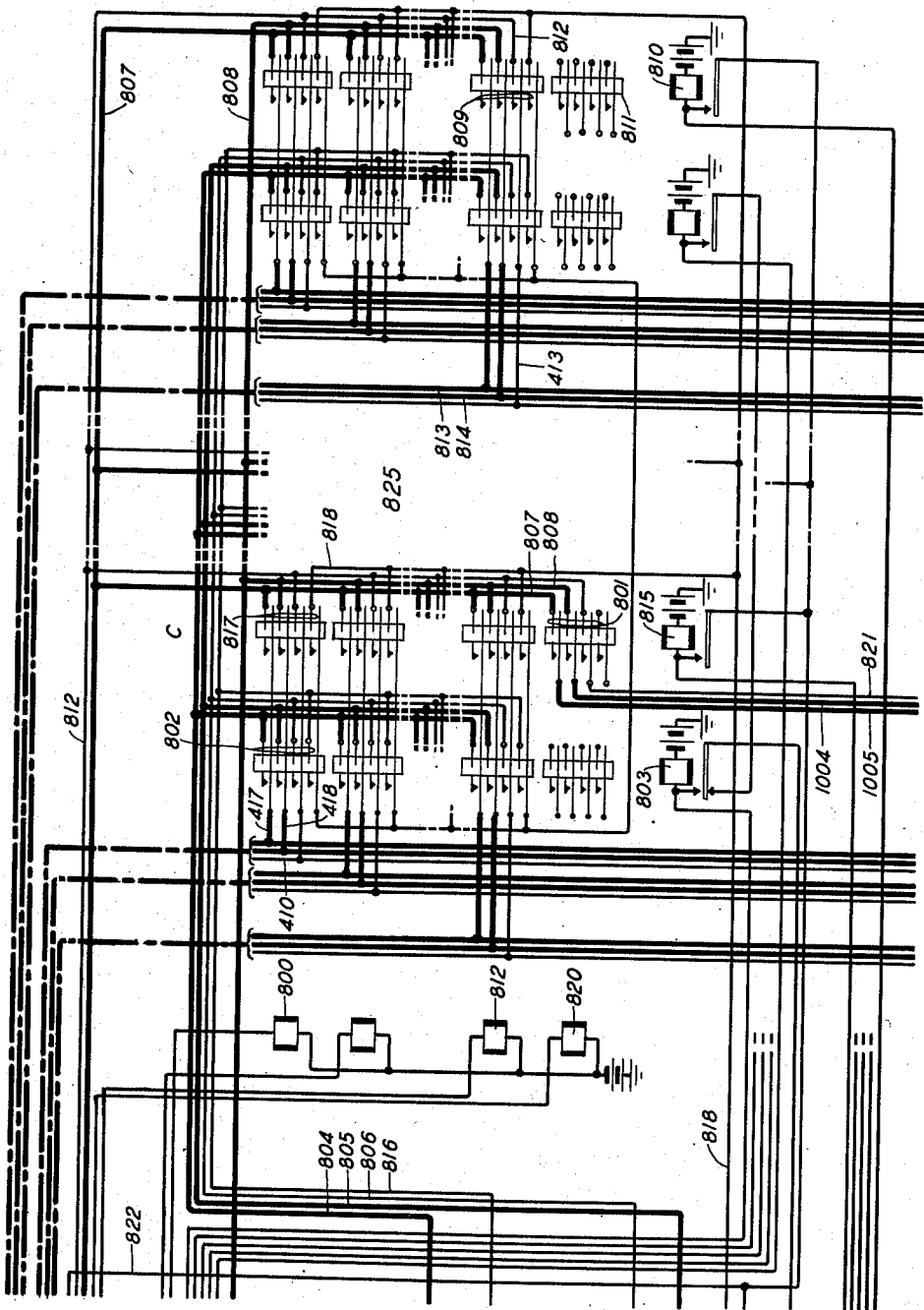
2,092,465

TELEPHONE SYSTEM

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9 Sheets-Sheet 6

FIG. 8



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9 Sheets-Sheet 7

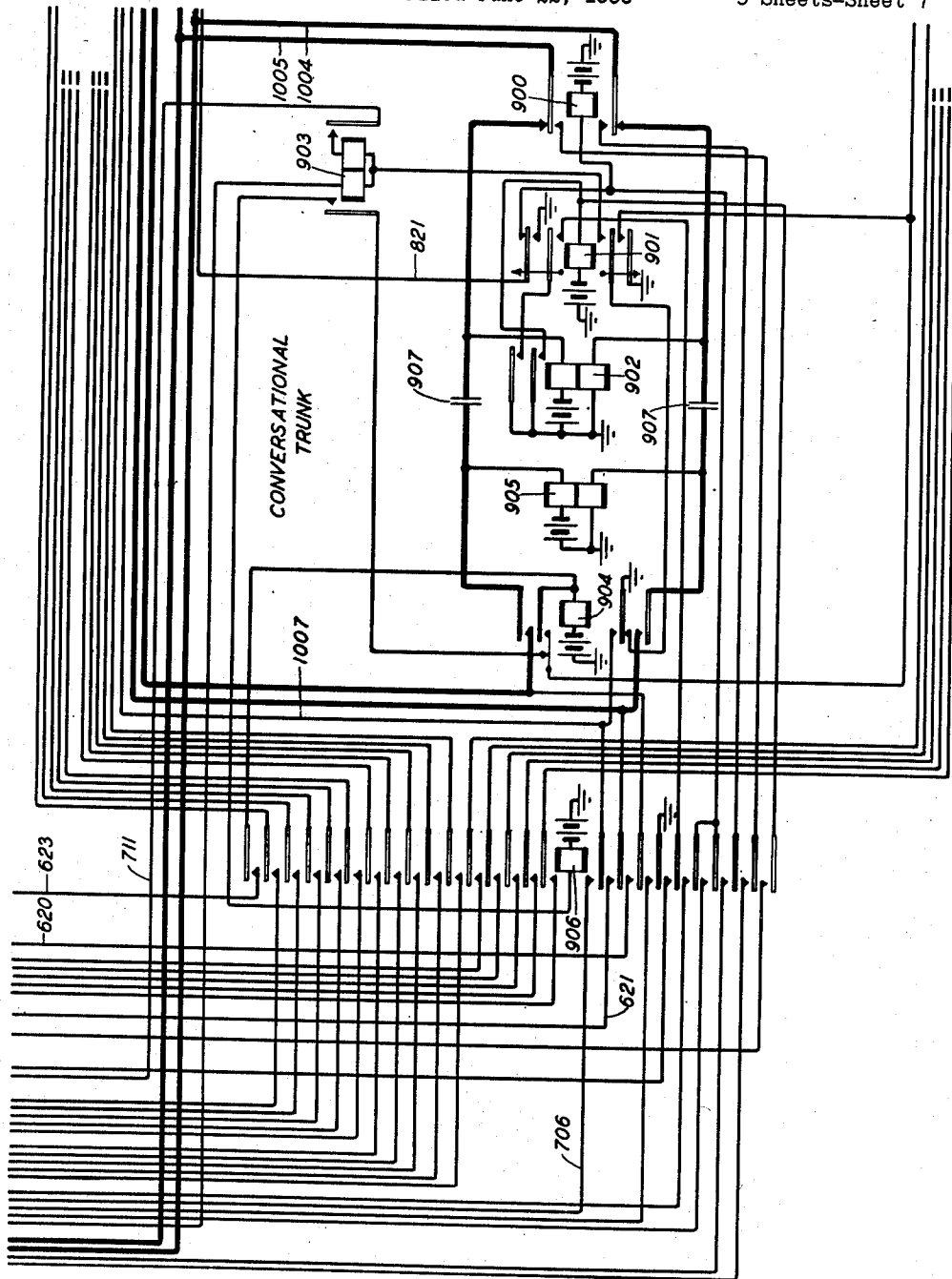


FIG. 9

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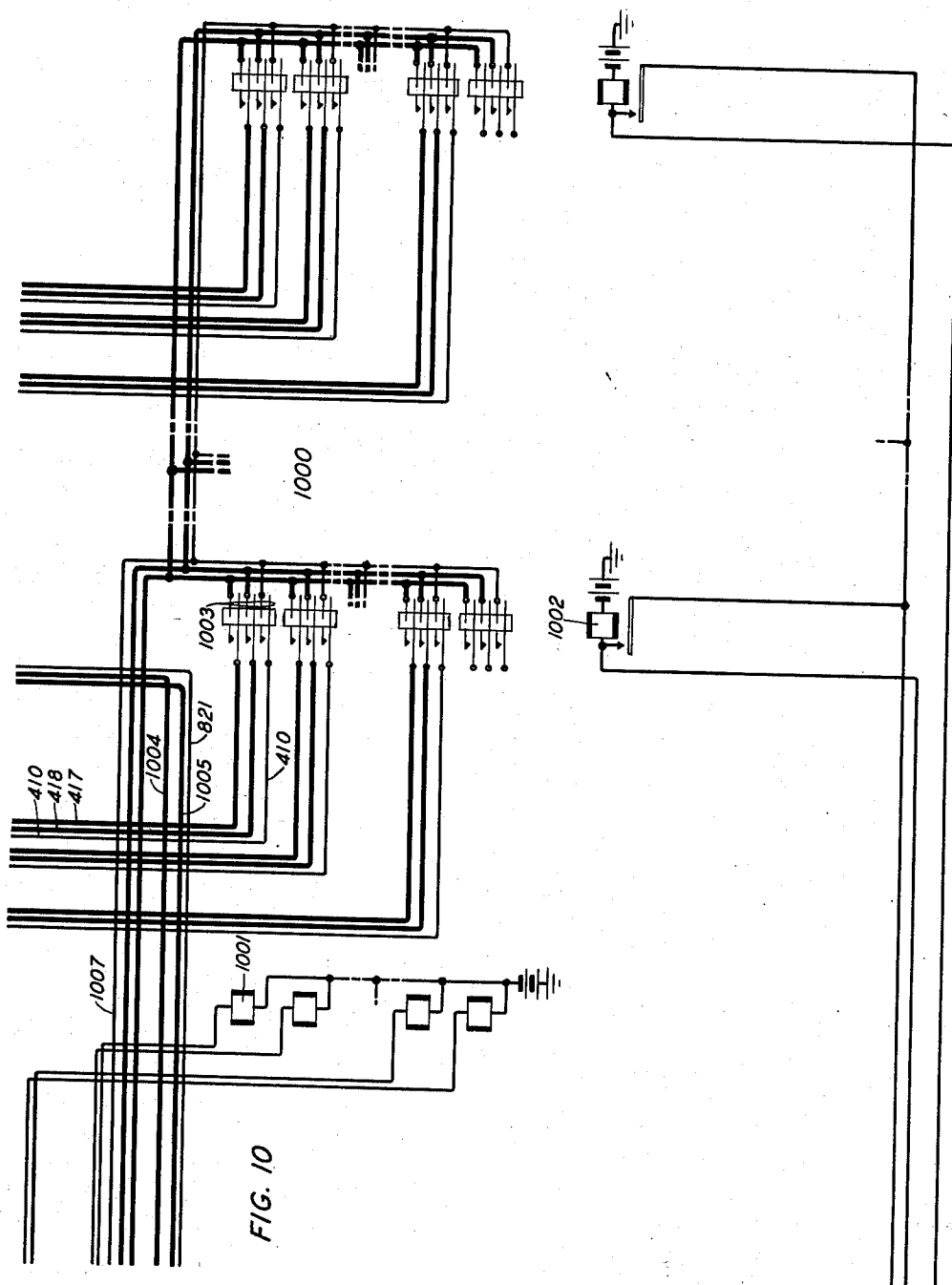
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TELEPHONE SYSTEM

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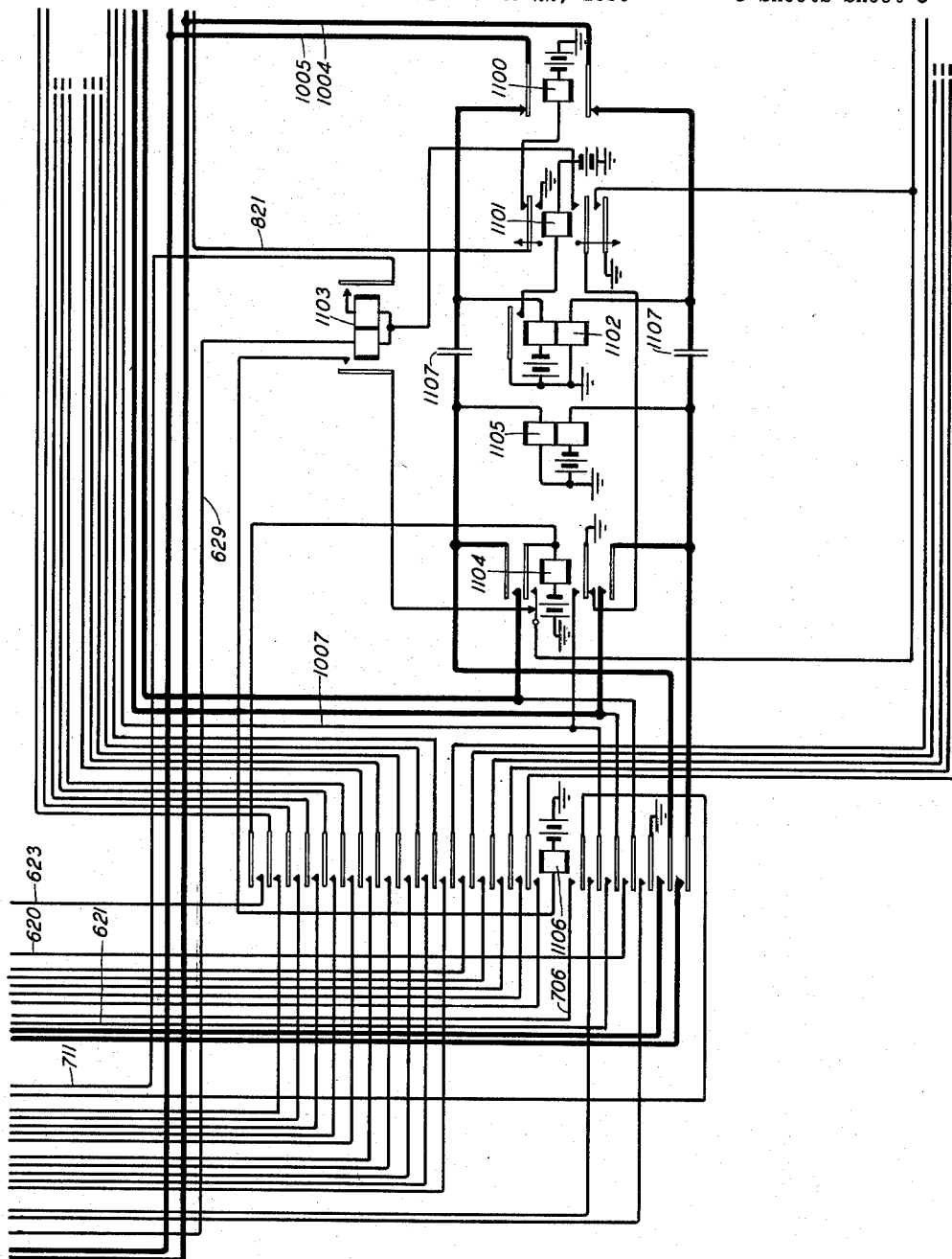


FIG. 11

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UNITED STATES PATENT OFFICE

2,092,465

TELEPHONE SYSTEM

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Application June 22, 1935, Serial No. 27,889

6 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to those in which connections in a local exchange are established by automatic switches under the control of a distant main office.

Objects of the invention are to improve and simplify the equipment needed at the local exchange by making use of a common switch controlling register for setting up both local and trunk calls; to enable the registration of the switch controlling designation over an operating trunk from the main office when one type of connection is required and the registration of such designation over a conversational trunk when another type of connection is required; to enable the use of a more simple and efficient form of selective switch at the local exchange; and to otherwise improve the construction and operation of systems of the foregoing character.

It has been proposed heretofore to complete both local and trunk calls in a small rural exchange by means of automatic switches under the control of an operator's dial at the main exchange. For this purpose an operating trunk is provided between the main and local exchanges over which the local subscriber orally requests the number he desires, and over which the operator sends the designation impulses to complete the connection at the local exchange. In some of these prior systems, switches of the step-by-step type are used and in others relay switches are employed. Where relay switches are used, it is necessary to provide some form of register mechanism for receiving the designation impulses.

According to the present invention advantages are secured over these prior systems by using cross-bar switches at the local exchange for establishing both local and trunk connections and providing a digit receiving register common to all switches and link circuits at the local exchange. When a local subscriber calls, his line is automatically connected through a cross-bar switch to one end of an idle link, and the link is automatically connected to the common register and to the operating trunk leading to the distant operator's position. The operator receives the number from the subscriber and dials back over the operating trunk to set the register which thereupon connects the other end of the link either to a local subscriber's line or to a conversational trunk according to whether the call is a local one or one to the central office.

Another feature is an arrangement in a system of the character above described in which the register in the local exchange is set by im-

pulses sent over the operating trunk from the main office when a call is to be completed between two local subscribers or when the local subscriber is calling the main office, and in which the register is set by impulses sent over the conversational trunk when a call is being extended from the central office to a subscriber in the local office.

These and other features of the invention will be more fully described in the following detailed specification which should be taken in conjunction with the accompanying drawings.

Referring to the drawings:

Fig. 1 is a schematic of the telephone system including a remote control rural exchange and part of a main exchange;

Fig. 2 is a diagram showing how Figs. 4 to 10, inclusive, should be arranged to disclose one embodiment of the invention;

Fig. 3 is a diagram showing how Figs. 4 to 8, inclusive, and Figs. 10 and 11 should be arranged to disclose a second embodiment of the invention;

Fig. 4 shows a plurality of rural exchange subscribers' lines and line circuits, which are associated with the group equipment shown at the right;

Fig. 5 shows in the upper portion thereof the link allotter equipment and in the lower part thereof registering and control equipment common to the links and to the interoffice trunks and responsive to dial impulses from the main exchange to effect the selective operation of the cross-bar switches of Figs. 8 and 10;

Fig. 6 in the left portion thereof shows the main exchange end of both the operating trunk and the conversational trunk. The right portion of this figure shows the rural exchange equipment for the operating trunk;

Fig. 7 in the right portion thereof shows a link circuit and in the left portion thereof shows a relay for associating said link circuit with the registering equipment of Fig. 5 and with the rural exchange end of the operating trunk of Fig. 6;

Fig. 8 shows a portion of a switch of the cross-bar type which is associated with the link equipment;

Fig. 9 in the right portion thereof shows one arrangement of the rural exchange end of the conversational trunk and in the left portion thereof shows a relay for associating said trunk with the rural exchange end of the operating trunk of Fig. 6 and with the registering equipment of Fig. 5;

Fig. 10 shows a portion of a switch of the cross-bar type which is associated with the rural office end of the conversational trunk of Fig. 9 or Fig. 11;

Fig. 11 in the right portion thereof shows a second arrangement of the rural exchange end of the conversational trunk and in the left portion thereof shows a relay for associating said trunk with the rural exchange end of the operating trunk of Fig. 6 and with the registering equipment of Fig. 5.

Referring more particularly to Fig. 1, an exchange system including a remote control rural exchange and part of a main exchange is schematically illustrated. The rural exchange is equipped with selectors SW1, SW2, and SW3 of the cross-bar type, links LK1 and LK2, one for each selector, an operating trunk OT extending to an operator's position in the main exchange and a conversational trunk CT, individual to selector SW3, appearing in selectors SW1 and SW2 and extending to the main exchange, and a register REG common to all of said links and trunks. The main exchange is indicated at the right of the drawings and comprises two operator's cord circuits C and C' and the trunk circuits which form the main exchange ends of the aforementioned trunks at the rural exchange.

Each subscriber's line, such as A or B, appears at two cross-points in each of local selector switches SW1 and SW2; one of the vertical rows of contacts, associated with said cross-points, is provided to extend said lines to the finder end F of the associated link on originating calls; and the other vertical row of contacts is provided for extending the connector end C of said link to said subscribers' lines for completing local calls. The conversational trunk CT, extending to the main exchange also appears at a cross-point associated with the connector end C of SW1 and SW2, for the completion of outgoing trunk connections. In addition to the aforementioned local switches SW1 and SW2 there is provided an additional switch SW3 which is used only for the completion of incoming connections from the main exchange. Each subscriber's line appears at a cross-point of this switch and the vertical rows of contacts, associated with said cross-points, are provided for extending the conversational trunk CT to the subscribers' lines. Relays R1 and R2 are provided to associate the links LK1 and LK2 with the operating trunk OT and with the register REG; relay R3 is provided to associate the conversational trunk CT with the register REG and with the operating trunk OT.

If a call is initiated by a subscriber at station A for a subscriber at station B, for example, a connection is established through selector SW1, finder end F of link LK1, relay R1, operating trunk OT, thence to the main exchange. A signal at the latter office apprises the operator of a waiting call. The operator answers by means of cord circuit C, and determines the number of the called subscriber's line, whereupon a second cord C' is inserted into a dial jack associated with the operating trunk OT, and the called subscriber's number is dialed. The dial pulses are recorded in the register REG, which in turn associates the connector end C of the link LK1, through contacts of the selector SW1, with the called subscriber's line B. The operator then rings the called station and when the subscriber at said station responds the operator at the main exchange disconnects, thereby releasing relay R1 by which the register REG and operating

trunk OT were associated with the link LK1. The operating trunk is restored to normal and may be used for other calls.

If a trunk call is initiated by a subscriber at station A, for example, the connection is extended to the main exchange over the operating trunk OT as described for a local call. In this case it is necessary to connect the line associated with station A with the conversational trunk CT; this connection is effected by the operator at the main office who dials the conversational trunk code, an operation which causes the connector end C of the link LK1 to be associated with said conversational trunk at the contacts of selector SW1. Thus the connection is extended to the main office over the conversational trunk CT and may be completed by means of another cord circuit. The operating trunk OT is released when the operator at the main office removes the cords from the jacks of said trunk.

Calls incoming from the main exchange to stations in the rural exchange may be completed by either of two methods, depending upon whether or not the conversational trunk CT is arranged for dialing. For example, assume that said trunk is not arranged for dialing. The main office operator extends the connection to the conversational trunk by means of a cord circuit C. Relay R3 extends the connection to operating trunk OT and thence back to the main exchange thereby causing a signal to be displayed before the same or a different operator. In either case the operator associates a cord circuit with the associated trunk jack, dials the called subscriber's line number, whereupon the dial pulses are recorded in register REG which in turn actuates the selector SW3 to connect the called subscriber's line to conversational trunk CT. The dialing operator then signals the called station and when the subscriber responds the dialing operator disconnects from the operating trunk thereby releasing said trunk as aforementioned. If the conversational trunk is arranged for dialing the main exchange operator, after having extended the connection thereto, dials the called subscriber's line number directly over said trunk. The dial pulses are recorded in register REG which in turn actuates the switch SW3 to connect the called subscriber's line to the conversational trunk as aforementioned. The called subscriber is signaled in the usual manner.

All of the switches disclosed in this system comprise briefly, a plurality of horizontal selecting members, one for each horizontal row of contacts for preparing said contacts for operation. In addition, there is provided a plurality of vertical operating bars, each individual to one of the vertical rows of contacts for operating said contacts to establish connections. For a more detailed explanation of the construction and operation of these switches, reference may be had to patent application of J. N. Reynolds, Serial No. 702,453, filed December 15, 1933, granted as Patent No. 2,021,329, Nov. 19, 1935.

Having described the trunking schematic of the exchanges in general, and having described generally the various connections which can be established within the system, the operation of the circuits will now be described in detail, first with the drawings placed together in accordance with Fig. 2, and then with the drawings placed together in accordance with Fig. 3.

Let it be assumed that a call is initiated on subscriber's line 411, first for a local connection and then for an interoffice connection. The re-

removal of the receiver from the receiver hook associated with line 411 causes the operation of the associated line relay 400 in an obvious circuit. Relay 400 operates group relay 401, which is common to all of the subscribers' lines associated with the uppermost level of contacts of selector switch 825, and is equipped with an individual set of contact springs for each subscriber's line appearing in said level. The circuit for operating relay 401 may be traced from ground at the lower outer front contacts of relay 400, left winding of relay 401 and through back contact of relay 402 to battery. Relay 401 operated locks through its right winding and right inner front contact to battery through the winding of relay 402. Relay 402, which is common to all of the group relays such as 401, 403 and 404 operates in the aforementioned circuit. Relay 402 operated opens the initial operating circuit for relays 401, 403 and 404 to prevent the operation of another of said relays at this time. The circuit is arranged that in case two or more group relays operated simultaneously only one would lock due to the series locking circuit which extends through the back contacts of said group relays. Group relay 401 also closes a circuit for the operation of relay 700 which is associated with the particular link allotted for completing the call. This circuit may be traced from ground at the right outer front contact of relay 401, conductor 405, closed contact of key 500, back contact of allotter relay 501, associated with the first link, and through the winding of relay 700 to battery. Relay 700 operated causes the operation of selecting magnet 800 of selector switch 825. This magnet is associated with the uppermost level of contacts in which line 411 appears. This circuit is traced from ground at the right middle front contact of relay 401, upper seventeenth front contact from the top of relay 700 and through the winding of magnet 800 to battery. Magnet 800 operates the selecting members associated with the horizontal row of contacts in which the line 411 appears, thus preparing these contacts for operation. Relay 700 also operates relay 406 in a circuit from ground at upper outer front contact of relay 700, winding of relay 406 and through front contact of aforementioned operated relay 402 to battery. Relay 406 operated extends its operating ground, through its front contact, left inner front contact of relay 401, lower inner front contact of relay 400, upper next to outer front contact of relay 700 and through the winding of selector holding magnet 803 to battery. Magnet 803 operates the bar associated with the vertical row of contacts thus engaging the contacts at cross-point 802 and extending the conductors 417, 418 and 410 of line 411 to conductors 804, 805 and 806 respectively of the link. Due to the fact that relay 406 is slow in operating it does not close its front contact, to operate the aforementioned holding magnet 803, until sufficient time has elapsed for the operation of the aforementioned selecting magnet 800. The association of the line 411 with the link closes a circuit for operating relay 701 which may be traced from ground through upper winding of relay 701, conductor 804, contact of cross-point 802 of selector switch 825, conductor 417, through subscriber's set of line 411, conductor 418, contact of cross-point 802 of selector switch 825, conductor 805 and through the lower winding of relay 701 to battery. Relay 701 operates slow-to-release relay 704 in an obvious circuit. Relay 704 operated, operates cut-off relay

419 from ground at lower middle front contact of relay 704, sleeve conductor 806, contact of cross-point 802 of selector switch 825, conductor 410 and through the winding of relay 419 to battery. The sleeve conductor 806 also appears in the connector end of the selector switch 825 and the ground connected thereto guards the calling line from seizure by another link. The operation of relay 704 furnishes a holding ground for relays 700 and 402 and holding magnet 803. The holding circuit for relay 700 is traced from lower inner front contact of relay 704, upper back contact of relay 702 and thence through the winding of relay 700 to battery; and the holding circuit for relay 402 and magnet 803 is traced from ground at lower outer front contact of relay 704, thence in parallel one path extending through back contact of relay 703, front contact and winding of hold magnet 803 to battery; and the other extending over conductor 822, seventh from top front contact of relay 700 and thence through the winding of relay 402 to battery. The operation of cut-off relay 419 disconnects the line relay 400 from the line 411 and the latter relay releases. Relay 400 released, releases group relay 401 thereby releasing the selecting magnet 800. With the selecting magnet 800 released the connection through the contacts of cross-point 802 of selector switch 825 is maintained by the energization of the holding magnet 803.

Relay 700 operated as aforementioned closes a circuit to operate the line relay 600 and thereby signal the operator at the main exchange. This circuit is traced from ground through the upper winding of relay 600, upper outer back contacts of relays 603, 604, 605, 606 and 607, winding of polarized relay 602, lower inner front contact of relay 700, lower outer back contacts of relays 607, 606, 605, 604 and 603 and through the lower winding of relay 600 to battery. Line relay 600 operates in this circuit but relay 602, which is of the polarized type, does not operate due to the battery polarity. Relay 600 operated lights lamp 601 to apprise the main exchange operator of a waiting call. The operator responds by associating a cord circuit (not shown) with jack 608 thereby operating relay 603 and causing the release of relay 600 and the subsequent effacement of lamp 601. There is now established a talking connection from subscriber's line 411 to the operator at the main exchange. This connection was partially traced from the subscriber's line 411 to the tip and ring conductors 705 of the link. From the latter conductors, the tip and ring conductors extend through contacts of relay 700, talking condensers 707, upper and lower outer back contacts of relays 607, 606, 605 and 604, respectively, tip and ring springs of jack 608 and thence to the cord circuit. The talking connection thus established enables the calling subscriber to inform the operator at the main exchange as to the details of the desired connection.

Assume that the call is for a station associated with subscriber's line 415 and that the operator at the main exchange has associated a second cord circuit (not shown) with the dialing and ringing jack 609 associated with the operating trunk, thereby operating relay 604. Relay 604 disconnects the tip and ring conductors of the operating trunk from jack 608 and connects the tip and ring conductors from the dialing and ringing jack 609 thereto in a manner so that the polarity of the current through polarized relay 602 is in the proper direction to cause the operation of said

relay. Relay 602 operated operates slow-to-release relay 610 which in turn operates relay 607 in an obvious circuit. Relay 607 operated disconnects the tip and ring conductors, associated with the main office portion of the operating trunk, from the tip and ring conductors extending to the calling subscriber's line, and connects the pulsing relay 502, of the register, thereto. Pulsing relay 502 operates from the dialing cord and operates slow-to-release relay 503, which provides a locking ground for relay 607 in a circuit traced from ground at left outer front contact of relay 503 and through lower inner front contact and winding of relay 607 to battery. Relay 607 operated, also releases aforementioned relay 602 thereby releasing relay 610. Relay 610 aforementioned is slow-to-release in order to maintain relay 607 energized until relay 503 provides relay 607 with an independent holding ground. The two rotary switches 504 and 505 associated with the register circuit are set by impulses, caused by the operator's dial at the main exchange, and cause the operation of a selector switch such as 825 to effect a connection with the called subscriber's line. The first train of impulses causes the rotary switch 504 to be positioned for operating a selecting magnet in the switch level in which the called subscriber's line terminates, and the second impulse train positions the rotary switch 505 for operating the hold magnet to associate the connector portion of the link with that particular set of line terminals. From inspection it is obvious that the called subscriber's line 415 appears in the selector level of switch 825 with which selecting magnet 812 is associated and that the particular terminals in that level may be associated with the link by the operation of holding magnet 810.

When the operator at the main exchange transmits the first or tens series of pulses the pulsing relay 502 is released upon the opening of the line circuit for the first pulse. Relay 502 released closes a circuit for slow-to-release relay 512 from ground at back contact of relay 502, front contact of relay 503, normally closed contact of off-normal springs 506 and thence in parallel one path extending through stepping magnet 510 to battery and the other extending through relay 512 to battery. The operation of the stepping magnet 510 advances the brush of switch 504 to terminal 1 thereby operating the off-normal springs 506. Relay 512, which is slow-to-release, remains energized through its right front contact and the middle closed contact of off-normal springs 506 until the series of pulses has been transmitted. Relay 503 also being slow-to-release remains operated during the transmission of impulses. For each successive opening and closure of the line, the brush of switch 504 is advanced one step until it reaches the 9th terminal. After an interval has elapsed, following the series of impulses, relay 512 releases thereby closing a circuit for the operation of selecting magnet 812. This circuit is traced from ground at left inner front contact of relay 503, left back contact of relay 512, brush and terminal 9 of switch 504, ninth contact from the top of relay 700 and through the winding of selecting magnet 812 to battery. Magnet 812 operates the selecting bar associated with the horizontal row of contacts in which subscriber's line 415 appears, thus preparing these contacts for operation.

The transmission of the units digit releases pulsing relay 502 upon the opening of the line circuit for the first pulse thereby operating step-

ping magnet 511 and relay 513. This circuit may be traced from ground at back contact of relay 502, front contact of relay 503, middle closed contacts of off-normal springs 506, right back contact of relay 512, normally closed contact of off-normal springs 507, thence in parallel, one path extending through the winding of stepping magnet 511 to battery and the other extending through the winding of relay 513 to battery. The operation of the stepping magnet 511 advances the brush of switch 505 to terminal 1 thereby operating the off-normal springs 507. Relay 513, which is slow-to-release, remains energized through its right inner front contact and lower closed contact of off-normal springs 507 until the series of pulses has been transmitted. Relay 513 also operates slow-to-release relay 611 in an obvious circuit. For each successive opening and closure of the line, the brush of switch 505 is advanced one step until it reaches the 5th terminal. After an interval has elapsed, following the series of impulses relay 513 releases thereby closing a circuit for the operation of holding magnet 810 of selector 825. This circuit is traced from ground at the left inner front contact of relay 503, back contact of relay 513, brush and terminal 5 of switch 505, eighteenth from the top front contact of relay 700 and thence through the winding of holding magnet 810 to battery. Magnet 810 operates in the above traced circuit and actuates the associated bar, thus engaging the contacts at cross point 809 and extending the conductors 807, 808 and 812 of the link to conductors 813, 814 and 413, respectively, of line 415. Holding magnet 810 also locks to ground at the lower outer front contact of relay 704. The aforementioned relay 611 which is slow-to-release remains operated, following the release of relay 513 after the unit train of impulses has been transmitted, for a sufficient length of time to test the called subscriber's line 415. If the said line is idle relays 606 and 412 operate in a circuit traced from battery through the winding of cut-off relay 412 associated with line 415, conductor 413, contact at cross-point 809 of switch 825, conductor 812, lower next to inner front contact of relay 700, conductor 706, right outer front contact of relay 611, upper winding of relay 606, and through upper twenty-third front contact from top of relay 700 to ground. Relay 606 operated locks in a circuit from battery through its lower winding and its upper next to inner front contact to its aforementioned operating ground; and connects said operating ground at upper inner front contact of relay 606 to conductor 706 for maintaining the operation of cut-off relay 412. When slow-to-release relay 611 releases the initial operating circuit for relays 412 and 606 is opened.

If the called subscriber's line 415 is busy its associated sleeve conductor 413 is grounded thereby preventing the aforementioned operation of relay 606 due to ground at both terminals of its upper winding. In this case the release of relay 611 closes a circuit for the operation of relay 612 in a circuit traced from battery through winding of relay 612, left back contact of relay 611, lower inner back contact of relay 606, to ground at lower closed contact of off-normal springs 506. Relay 612 operated connects a source of busy tone BT to the ring conductor of the operating trunk and also to the ring conductor of the link thereby apprising both the operator and the calling subscriber of a busy line.

Let it be assumed that the called line 415 is idle in which case relays 412 and 606 are oper-

ated as aforementioned. Relay 412 disconnects the line relay 416 from the tip and ring conductors of line 415. Relay 606 opens the operating circuit for the busy tone relay 612 thereby preventing said relay from operating, operates relay 613 in an obvious circuit, disconnects the pulsing relay 502 from the tip and ring conductors of the operating trunk and connects relays 614 and 615 thereto. Relay 502 releases and causes the release of relay 503, thereby releasing relay 607. Relay 503 released causes the release magnets 508 and 509 to energize and restore register switches 504 and 505 to normal. Relay 503 also removes ground from the brush of switch 504 thereby causing the release of selecting magnet 812. Polarized relay 614 operates in a circuit traced from ground on tip conductor of "dial and ring" cord (not shown) tip of jack 609, lower inner front contact of relay 604, lower back contact of relay 605, lower outer front contact of relay 606, through winding of relay 614, upper outer front contact of relay 606, upper back contact of relay 605, upper front contact of relay 604, contact and ring conductor of jack 609 to battery on ring conductor of "dial and ring" cord. Relay 614 operated operates relay 618 in an obvious circuit. Relay 613 aforementioned is slow-to-operate and does not close its front contact until relay 618 has operated thereby preventing a premature operation of relay 702 as will be described presently.

The called subscriber is signaled by the operator at the main exchange by the manual application of ringing current to the tip and ring conductors of the operating trunk. The circuit for projecting ringing current to the subscriber's line 415 follows: ring spring and contact of jack 609 to upper outer front contact of relay 606 in an aforementioned circuit, through condenser 616, winding of relay 615, lower outer front contact of relay 606 and thence to the tip spring of jack 609 in an aforementioned circuit. Relay 615 operates in the above circuit and provides a holding circuit for relay 618 as well as an obvious operating circuit for relay 619. Relay 619 extends the ringing circuit to the called subscriber's line 415. This circuit extends from condenser 616 through left front contact of relay 619, conductor 620, lower fourth from bottom front contact of relay 700, conductor 807, contact of cross-point 809 of switch 825, conductor 813, over subscriber's line 415 to conductor 814, through contact of cross-point 809 of switch 825 to conductor 808, lower fifth from bottom front contact of relay 700 to conductor 621, right front contact of relay 619, and thence to the winding of relay 615. Condensers 709 are provided in the link to furnish the calling subscriber with the usual revertive ringing signal. After each application of ringing current to the line, relays 615, and 619 release. The release of relay 619 connects the windings of relay 622 to the aforementioned conductors which extend to the called subscriber's line so that when the receiver is removed from the switchhook at the called station relay 622 will operate. The operation of relay 622 operates relay 702 in a circuit from ground at the front contact of relay 622, conductor 623, lower third from bottom front contact of relay 700 and through the winding of relay 702 to battery. Relay 702 operated, connects ground through its lower inner front contact to aforementioned conductor 812 to maintain the operation of cut-off relay 412; connects the winding of relay 710 to the tip and ring conductors 807 and 808 which extend to the called subscriber's line; opens the

holding circuit for relay 700 thereby causing its release; and closes a locking circuit through its upper inner front contact to ground at the inner front contact of relay 704. The condensers 705 complete a talking connection between the calling and called subscriber's lines. The release of relay 700 opens all connections between the link and operating trunk and between the link and the register thereby releasing relays 402 and 406 and disconnecting relay 602 from across the tip and ring conductors of the operating trunk. The release of relay 402 reestablishes the operating circuit for group relays 401, 403 and 404 and the release of relay 602 causes the supervisory lamp associated with the operator's "dial and ring" cord to light as a disconnect signal. Whereupon the operator removes the cords from the jacks 608 and 609 thereby restoring the operating trunk apparatus to normal. Relay 710 aforementioned operates in series with the called subscriber's line and closes a second holding circuit for relay 704. Thus the connection is controlled jointly by the calling and called subscribers.

The aforementioned release of relay 406 closes a circuit for the operation of allotter relay 501 in a circuit traced from battery at back contact of relay 406, winding of relay 501, conductor 822 to ground at the lower outer front contact of relay 704. Relay 501 operated locks mechanically under control of relay 514 and preselects the link for use on the next cell by associating the common start lead 405 with said link. When all links have been allotted relays 501, 515 and 516 will have operated and locked mechanically thereby causing the operation of slow-to-release relay 520 in a circuit from ground at right front contact of relay 501, right front contact of relay 515, right front contact of relay 516 and through winding of relay 520 to battery. Relay 520 operated operates slow-to-operate relay 519 which, in turn, operates release relays 514, 517, and 518 thereby mechanically releasing relays 501, 515, and 516, respectively, for another link allotment cycle. The release of any relay in the chain consisting of relays 501, 515 or 516 opens the circuit for relay 520 causing the release of said relay which, in turn, releases relay 519 to restore relays 514, 517, and 518. The combination of slow-to-release relay 520 and slow-to-operate relay 519 insures that release relays 514, 517, and 518 have sufficient time to energize and release allotter relays 501, 515, and 516, respectively, before relays 520 and 519 are released by the release of any one of said allotter relays. Each link is provided with a key such as 500, 521, and 522 so that any link may be taken out of service by the operation of its associated key.

When both subscribers disconnect, relays 701 and 710 release thereby releasing relay 704. Relay 704 released releases relay 702 thereby releasing cut-off relay 412 associated with the called subscriber's line. Relay 704 also releases the cut-off relay 419 associated with the calling subscriber's line and also causes the release of the holding magnets 803 and 810 associated with selector switch 825. The circuits are thus restored to normal.

The operation of the system will now be described wherein the called subscriber is a party on the calling subscriber's line 411. Assume that the call has been extended to the main exchange as hereinbefore described and that the operator at said exchange has dialed the called subscriber's number. When the selecting magnet 800 and the holding magnet 815 have operated the selector

bar engages the contacts at cross-points 817 to associate the conductors 807, 808, and 812 of the link with the conductors 417, 418 and 410, respectively, associated with line 411. Due to a ground on sleeve conductor 410, relay 606 is prevented from operating, thereby causing the operation of relay 612 in an aforementioned circuit. Relay 612 operated returns a busy tone to both the calling subscriber and the operator as aforementioned. The subscriber recognizing the busy tone as originating from a revertive call condition will restore the receiver on the switchhook and the operator also knowing that the call is a revertive one will ignore the busy tone.

When the calling subscriber restores the receiver on the switchhook relay 701 releases thereby opening the circuit for relay 704 and closing a circuit from ground at back contact of relay 701, conductor 816, contacts of selector cross-point 802, contacts of selector cross-point 817, conductor 818 and through relay 703 to battery. Relay 703 operated locks to ground at the lower next to outer front contact of relay 700, opens the holding circuit for holding magnet 803 and closes a holding circuit for slow-to-release relay 704 in a circuit traced from ground at lower back contact of relay 702, left inner front contact of relay 703 and through the winding of relay 704 to battery. Relay 703 also closes an operating circuit for relay 606 in a circuit from ground at left outer front contact of relay 703, lower outer front contact of relay 700 and through the lower winding of relay 606 to battery. Relay 606 operated releases the busy tone relay 612 and otherwise functions as aforementioned. The release of the aforementioned holding magnet 803, disengages the contacts at selector cross-point 802 thereby disconnecting the finder portion of the link from the subscriber's line. The cut-off relay 419 does not release when holding magnet 803 releases since said relay is now held in a circuit traced from ground at the left outer front contact of relay 703, lower outer front contact of relay 700, upper inner contacts of relay 606, conductor 706, lower next to inner front contact of relay 700, conductor 812, contacts of selector cross-point 817, conductor 410 and through the winding of cut-off relay 419 to battery. Ringing current is applied to the line in an aforementioned manner and when either the called or calling subscriber removes the receiver from the switchhook relay 622 operates causing the operation of relay 702 as aforementioned. Relay 702 operated causes the release of relay 700 together with all other operated relays required for establishing the connection as aforementioned. Relay 702 operated also closes an aforementioned operating circuit for relay 710. Relay 710 operated provides a holding circuit for relay 704.

When both the calling and called subscribers disconnect, following a completed connection, relay 710 releases followed by the release of relay 704 thereby restoring the circuits to normal in an aforementioned manner.

In the event that neither the calling nor called subscriber responds the operator will disconnect in the usual manner thereby causing the release of relay 614 followed by the release of 618. Relay 618 released closes a circuit from ground at the front contact of relay 613, back contact of relay 618, conductor 623, lower third from outer front contact of relay 700 and through the winding of relay 702 to battery. Relay 702 operates in this circuit and releases all operated relays thereby restoring the circuit to normal.

Assume now that a subscriber associated with line 411 desires a connection with a subscriber in the main exchange, that the call has been extended to the main exchange in a manner previously set forth and that the operator has responded. The operator upon learning the details of the call dials a code which causes the selector 825 to associate the calling subscriber's line 411, with a conversational trunk to the main exchange and extending to selector 825 over conductors 1004, 1005 and 821. In order to associate the calling subscriber's line with the conversational trunk it is necessary for the main exchange operator to dial a code so that the register will be positioned to operate a selecting magnet and a holding magnet of selector 825 that will cause the engagement of contacts at cross-point 801 since the subscriber's line and conversational trunk are associated with said cross-point. Assume then that the operator has dialed the proper code and that the register has been positioned to operate select magnet 820 and holding magnet 815, in order to cause the engagement of contacts at cross-point 801. Magnet 820 operates in a circuit traced from battery through its winding, upper eight contact from top of relay 700, terminal 0 and brush of register switch 504, back contact of relay 512 to ground at left inner front contact of relay 503. Magnet 815 operates in a circuit from battery through winding of said magnet, upper twenty-second contact from top of relay 700, terminal 1 and brush of switch 505, left back contact of relay 513 to ground at left inner front contact of relay 503. The operation of the aforementioned magnets engages the contacts at cross-point 801 thereby extending the conductors of line 411 with the conductors of the conversational trunk extending to the main exchange. Magnet 815 operated locks to ground at the lower outer front contact of relay 704. Cut-off relay 900, in the conversational trunk, and relay 606, in the operating trunk, operate in a circuit traced from ground at upper twenty-third contact from top of relay 700, upper winding of relay 606, front contact of relay 611, conductor 706, lower next to inner front contact of relay 700, conductor 812, closed contact at cross-point 801 of switch 825, conductor 821, upper outer back contact of relay 901 and through winding of relay 900 to battery. Relay 900 operated disconnects the line relay 902 from the tip and ring conductors 1005 and 1004, respectively, of the conversational trunk. Relay 606 operated functions as aforementioned. The operator at the main exchange applies ringing current to the operating trunk in a manner similar to that described for a local call thereby causing the operation of ringing relay 624 associated with the conversational trunk at the main exchange. This circuit extends from the operator's cord (not shown) to the switch 825 via conductors 807 and 808 as previously set forth and thence through the contacts of switch 825 at cross-point 801, conductors 1005 and 1004 of the conversational trunk; the condenser 625 and lower winding of relay 624 completing the circuit. Relay 624 operated locks in an obvious circuit and also lights lamp 626. The same or another operator at the main exchange, depending on the position at which the conversational trunk terminates, responds to the lighted lamp by inserting a cord (not shown) into the jack 627 thereby causing the operation of relay 628 and connecting battery and ground to the conductors 1004 and 1005, respectively, of the conversational trunk.

Relay 628 operated releases relay 624 and disconnects the lower winding of relay 624 from the trunk conductors 1004 and 1005. Relay 624 released extinguishes the lamp 626. When battery and ground are applied to the conductors of 1004 and 1005 two circuits are closed for the operation of relay 622. One of these circuits may be traced from ground on the tip conductor of operator's cord, tip conductor of jack 627, conductor 1005, closed contact of switch 825, at cross-point 801, conductor 808 and thence to battery through the left winding of relay 622 as previously set forth; and the other circuit may be traced from battery on the ring conductor of the operator's cord, ring conductor of jack 627, conductor 1004, closed contact of switch 825, at cross-point 801, conductor 807 and thence to ground through the right winding of relay 622 as previously set forth. Relay 622 operated causes the operation of relay 702 in the link thereby causing the release of the register and operating trunk apparatus as aforementioned for a local call. The originating operator or the calling subscriber then passes the details of the call to the completing operator who completes the call in the usual manner. The originating operator then disconnects from the operating trunk jacks 608 and 609 thereby restoring the operating trunk apparatus to normal at both the main and rural exchanges.

When both the calling and called subscribers disconnect the circuits are restored to normal as previously set forth.

A call incoming from the main exchange to a subscriber at the rural exchange will now be described in detail. This circuit arrangement embodies a conversational trunk between the main and the rural exchange wherein incoming calls to the rural exchange are completed by dialing over the conductors of said trunk.

The main exchange operator, upon learning that a connection is desired with a subscriber at the rural exchange, inserts a cord (not shown) into jack 627 associated with the conversational trunk thereby operating relay 628 and closing two circuits for the operation of line relay 902. One of these circuits extends from ground on the tip conductor of the operator's cord, tip conductor of jack 627, conductor 1005, upper back contact of relay 900 and thence to battery through the upper winding of relay 902; and the other extending from battery on the ring conductor of the operator's cord, ring conductor of jack 627, conductor 1004, lower back contact of relay 900 and thence to ground through the lower winding of relay 902. Sleeve relay 628 operated functions as aforementioned and relay 902 operated closes an obvious circuit for the operation of slow-to-release relay 901. Relay 901 operated connects ground to the sleeve conductor 821 of the conversational trunk thereby guarding said trunk against a subsequent seizure by a link. Relay 901 also closes a circuit for the operation of relay 903 from ground at the lower back contact of relay 904, lower inner front contact of relay 901, left winding of relay 903, conductor 629 to battery at the back contact of relay 402. Relay 903 operated closes a circuit through its right winding and front contact, conductor 711, right back contact of relay 404, right back contact of relay 403, right back contact of relay 401, to battery through the winding of relay 402. Relay 903 locks and relay 402 operates in the above circuit. The operation of relay 402 prevents any other group relays, such as 401, 403

or 404, from being energized at this time by removing the source of battery from their respective windings. Relay 903 operated also closes a circuit for the operation of relay 906, which associates the conductors of the conversational trunk with the conductors of the dial register and with the conductors of the operating trunk. The circuit for operating relay 906 is traced from ground at the lower outer front contact of relay 901, upper back contact of relay 904, front contact of relay 903, and through the winding of relay 906 to battery. Relay 906 operated closes a circuit for the operation of pulsing relay 502 associated with the register. This circuit is traced from ground at the upper outer front contact of relay 902, upper inner front contact of slow-to-release relay 901, lower sixth contact from bottom of relay 906 and through the left winding of relay 502 to battery. Relay 502 operated operates relay 503 as aforementioned.

The operator at the main exchange now dials the called subscriber's number and the interruptions of the line, caused by the dial, alternately release and operate relay 902 in turn alternately releasing and operating relay 502. The register is thus positioned as aforementioned for operating the selecting and holding magnets of the switch 1000 for associating the conversational trunk with the called subscriber's line. Assume that the called subscriber is associated with line 411, which extends to switch 1000 via conductors 417, 418, and 410. In order to associate the conversational trunk conductors 1005, 1004 and 821 with the conductors of said line it is obvious that the contacts at cross-point 1003 must be engaged. This cross-point is common to selecting magnet 1001 and holding magnet 1002. Magnet 1001 operates in a circuit from battery through winding of said magnet, upper eleventh contact from the top of relay 906, terminal 1 and brush of switch 504, back contact of relay 512 to ground at left inner front contact of relay 503. Magnet 1002 operates in a circuit from battery through winding of said magnet, upper twelfth contact from top of relay 906, terminal 5 and brush of switch 505, back contact of relay 513 to ground at left inner front contact of relay 503. Holding magnet 1002 operated engages the contacts at cross-point 1003 and locks to ground at the lower outer front contact of relay 901. The cut-off relay 419 associated with the called subscriber's line operates in a circuit from ground at the lower seventh from bottom contact of relay 906, upper winding of relay 606, right outer front contact of relay 611, conductor 706, lower inner front contact of relay 906, conductor 1007, contact of cross-point 1003 of switch 1000, conductor 410 and thence to battery through the winding of relay 419 to battery. Relay 606 also operates in the above circuit and extends a ground to maintain the operation of relay 419 and to guard the line against seizure in a circuit from aforementioned ground at upper inner armature and front contacts of relay 606, to conductor 706 and thence to the winding of relay 419 in an aforementioned circuit. Other functions of relay 606 are the same as previously set forth. When relay 513 releases following the dialing of the final digit, relay 605 and 900 operate in a circuit traced from ground at the back contact of relay 573, right inner front contact of relay 611, lower fifth contact from bottom of relay 906 thence in parallel one path extending through the winding of relay 900 to battery; and the other extending through lower fourth contact from bottom of

relay 906 and through winding of relay 605 to battery. Relay 605 operated opens the tip and ring conductors of the operating trunk, extending to the main exchange, and locks to ground at the lower seventh from bottom contact of relay 906. Relay 900 operated, disconnects relay 902 from conductors 1004 and 1005 of the conversational trunk and connects relay 614, associated with the tip and ring conductors of the operating trunk thereto. This circuit extends from tip conductor 1005 extending to the main exchange, upper front contact of relay 900, lower second from bottom contact of relay 906, lower front contact of relay 606, winding of relay 614, upper outer front contact of relay 606, lower third from bottom contact of relay 906, lower front contact of relay 900 to the ring conductor 1004 extending to the main exchange. Battery and ground from the operator's cord causes the operation of polarized relay 614 thereby causing the operation of relay 618 as aforementioned. Relay 618 operated closes a circuit for maintaining the operation of relay 901 which otherwise would release due to the release of relay 902 when relay 900 operated as aforementioned. This circuit may be traced from ground at the front contact of relay 618, lower outer front contact of relay 906 and thence through the winding of relay 901 to battery.

The main exchange operator projects ringing current to the operating trunk thereby operating relays 615 and 619 in order to signal the called subscriber as hereinbefore described for the completion of a local call. When the called subscriber answers, relay 622 operates in a circuit closed by the removal of the subscriber's receiver from the switchhook. Relay 622 operated closes a circuit for operating relay 904 from ground at front contact of relay 622, conductor 623, upper outer front contact of relay 906 and through the winding of relay 904 to battery. Relay 904 operated locks in an obvious circuit, releases relays 903, 402 and 906, and connects a ground to sleeve conductor 1007 for maintaining the operation of cut-off relay 419. Relay 906 released disconnects the register and operating trunk from the conversational trunk thereby restoring the register and operating trunk apparatus to normal as aforementioned. Relay 906 released also releases relay 900 thereby extending the tip and ring conductors 1005 and 1004, respectively, of the conversational trunk to the tip and ring conductors associated with subscriber's line 411. Relay 902 reoperates over the conversational trunk conductors and a talking connection is established by means of condensers 907. Battery for the called subscriber line is furnished through the windings of relay 905.

When the operator at the main exchange disconnects relay 902 and 628 release. Relay 628 restores the main exchange end of the conversational trunk to normal and relay 902 causes the release of 901. Relay 901 released releases relay 904 and holding magnet 1002 thereby restoring the circuits to normal.

The operation of the system will now be described in detail with the drawings placed together in accordance with Fig. 3. The system as shown by the drawings of Fig. 3 differs from the system as shown by the drawings of Fig. 2 only with respect to the conversational trunk equipment at the rural exchange shown by Fig. 11. Since the equipment of Fig. 11 is required only for the completion of calls incoming from the main to the rural exchange the operation

of the system will be described only for this class of connection.

Assume that an operator at the main exchange desires to complete a connection to a subscriber associated with line 411 at the rural exchange and that a cord circuit (not shown) has been associated with jack 627 for the completion of said connection. Battery and ground from the cord circuit is connected to the ring and tip conductors 1004 and 1005, respectively, as aforementioned and is extended through the back contacts of relay 1100, lower and upper windings of relay 1102 to ground and battery respectively thereby operating relay 1102. Sleeve relay 628 associated with jack 627 operates as aforementioned. The operation of relay 1102 operates slow-to-release relay 1101 in an obvious circuit. Relay 1101 disconnects relay 1100 from aforementioned sleeve conductor 821 and connects ground thereto to guard the trunk against subsequent seizure by a link. Relay 1101 also closes a circuit for the operation of relay 1103 from ground at the lower back contact of relay 1104, lower inner front contact of relay 1101, left winding of relay 1103, conductor 629 and thence to battery at the back contact of relay 402. Relay 1103 operated locks through its right winding and front contact, conductor 711 and through the winding of relay 402 to battery in an aforementioned circuit. Relay 402 operates in the above circuit and disconnects battery from the operating windings of all group relays to prevent double connections in the event that two or more group relays are energized at the same time. Relay 1103 operated also operates relay 1106 in a circuit from ground at the lower outer front contact of relay 1101, upper back contact of relay 1104, left front contact of relay 1103 and through the winding of relay 1106 to battery. Relay 1106 operated associates the equipment of the conversational trunk at the rural exchange with the common register equipment and the equipment of the operating trunk at the rural exchange. Relay 1106 specifically connects the winding of polarized relay 602 across the tip and ring conductors of the operating trunk extending to jack 608 at the main exchange. This circuit is closed at the lower inner contact of relay 1106 and extends to the main exchange in a manner previously set forth.

The operation of the circuit at this point is exactly the same as aforementioned for the completion of a local call. A signal is displayed before the same or another main exchange operator who, after inserting a cord into jack 608, obtains the details of the call. A second cord is then associated with jack 609, the called subscriber's line is dialed and the associated station is signaled in an aforementioned manner. When the called subscriber answers relay 622 operates thereby operating relay 1104 in a circuit traced from ground at the front contact of relay 622, conductor 623, upper outer contact of relay 1106 and thence to battery through the winding of relay 1104. Relay 1104 operated locks to ground at the lower outer front contact of relay 1101 and connects ground to sleeve conductor 1007 for maintaining the operation of the cut-off relay 419. Relay 1104 operated also releases relay 1103, 402 and relay 1106. Relay 402 released connects battery to all group relays so that said relays may operate on other calls; and relay 1106 released disconnects the conversational trunk apparatus from the register and operating trunk apparatus. The operator at the main exchange

disconnects the cords from jacks 608 and 609 thereby restoring the operating trunk apparatus to normal. The holding magnet 1002, associated with switch 1000 by which connection was established with the caller subscriber's line 411, is held from ground through the lower outer front contact of relay 1101. Relay 1104 operated connects the tip and ring conductors of the called subscriber line to the tip and ring conductors 1005 and 1004, respectively, of the operating trunk, the talking connection being established through condensers 1107.

When the operator at the main office disconnects from jack 627 relay 1102 releases thereby releasing relay 1101. Relay 1101 disconnects ground from the holding magnet 1002, by which the trunk was associated with the called subscriber's line, thereby disconnecting said line from the conversational trunk. Relay 1101 released also releases relay 1104 thereby restoring the conversational trunk to normal ready for use on another connection.

What is claimed is:

1. In a telephone system, a main office, a local exchange having subscriber's lines terminating therein, automatic switches and link circuits in said local exchange, a register device in said local exchange common to said switches and link circuits, an operating trunk interconnecting the main office and the local exchange, means for operating one of said switches to connect a calling subscriber's line to a particular one of said link circuits, means for connecting said link to the register device and to said operating trunk, means controlled over the operating trunk for setting said register device according to the called designation, and circuit means controlled by said register and extending through said connecting means for operating one of said switches to connect said link circuit to the called subscriber's line.

2. In a telephone system, a main exchange, a local exchange, automatic switches in said local exchange, subscribers' lines multiplied to appear in the terminals of said automatic switches, link circuits, one for each of said automatic switches, a number receiving register common to all of said link circuits, an operating circuit interconnecting the main office and the local exchange, means responsive to a call on one of said subscribers' lines for operating a particular one of said switches to connect the calling line to the link circuit individual to such switch, means for connecting said link circuit to said operating circuit, means controlled from the main office over said operating circuit for setting said register in accordance with the called designation, and means controlled by said register for operating said switch to connect said link circuit to the called subscriber's line.

3. In a telephone system, a main office and a local exchange, a number of cross-bar selector switches in said local exchange, subscribers' lines multiplied to appear in all of said selector switches, link circuits, one for each of said selector switches, a digit receiving register in said local exchange common to all of said link circuits, an operating trunk interconnecting the main office and the local exchange, means for allotting an idle link circuit for use, means responsive to a call on one of said lines for operating the selector switch individual to the allotted link circuit for connecting the calling line to such link, means for sending designation impulses over said operating

trunk from the main office to set said register, and means for operating said switch in accordance with the setting of the register to connect the allotted link circuit to a called subscriber's line.

4. In a telephone system, a central office and a local exchange, automatic switches in said local exchange, subscribers' lines appearing in said automatic switches, a trunk line appearing in said automatic switches, a register common to said switches, an operating circuit interconnecting the central office and the local exchange, means responsive to a call on one of said lines for operating one of said switches to connect the calling line to said operating circuit, means for setting said register by impulses transmitted over said operating circuit from the central office, and means controlled by said register for establishing a connection either to a called subscriber's line or to said trunk line according to the setting of said register.

5. In a telephone system, a main office, and a local exchange, subscribers' lines in said local exchange, automatic switches in said local exchange, a register common to said automatic switches, a conversational trunk interconnecting the main office and the local exchange, an operating trunk interconnecting the main office and the local exchange, means responsive to a call on one of said lines for operating one of said switches to connect the calling line to said operating trunk, means for setting said register by impulses transmitted over said operating trunk, means controlled by the register in accordance with such setting for establishing a connection between the calling line and a called line in said local exchange, means for setting said register by impulses transmitted over said conversational trunk when a call is extended from the main office to the local exchange, and means for operating one of said switches in accordance with such setting to connect said conversational trunk to the called subscriber's line in the local exchange.

6. In a telephone system, a main office and a local exchange, a plurality of selector switches in the local exchange, link circuits, one for each of said switches, subscribers' lines appearing in said selector switches, a conversational trunk extending from the main office and appearing in said selector switches in the local exchange, a trunk switch at the local exchange in which said conversational trunk also appears, a register common to said link circuits, means responsive to a call on one of said subscribers' lines for operating a particular selector switch to connect such line to the link circuit individual to such switch, an operating trunk interconnecting the main office and the local exchange, means for setting said register by impulses transmitted over the operating trunk from the main office, means for operating said particular selector switch in accordance with the setting of the register to connect said link circuit either to a called subscriber's line in the local exchange or to said conversational trunk extending to the main office, means for setting said register by impulses transmitted over said conversational trunk on an incoming call from the main office to a called line in the local exchange, and means controlled by the register in accordance with such setting for operating said trunk switch to connect the conversational trunk to the called subscriber's line in the local exchange.

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