

June 14, 1938.

R. L. STOKELY

2,120,419

TELEPHONE SYSTEM

Filed Oct. 21, 1936

6 Sheets-Sheet 1

FIG. 3

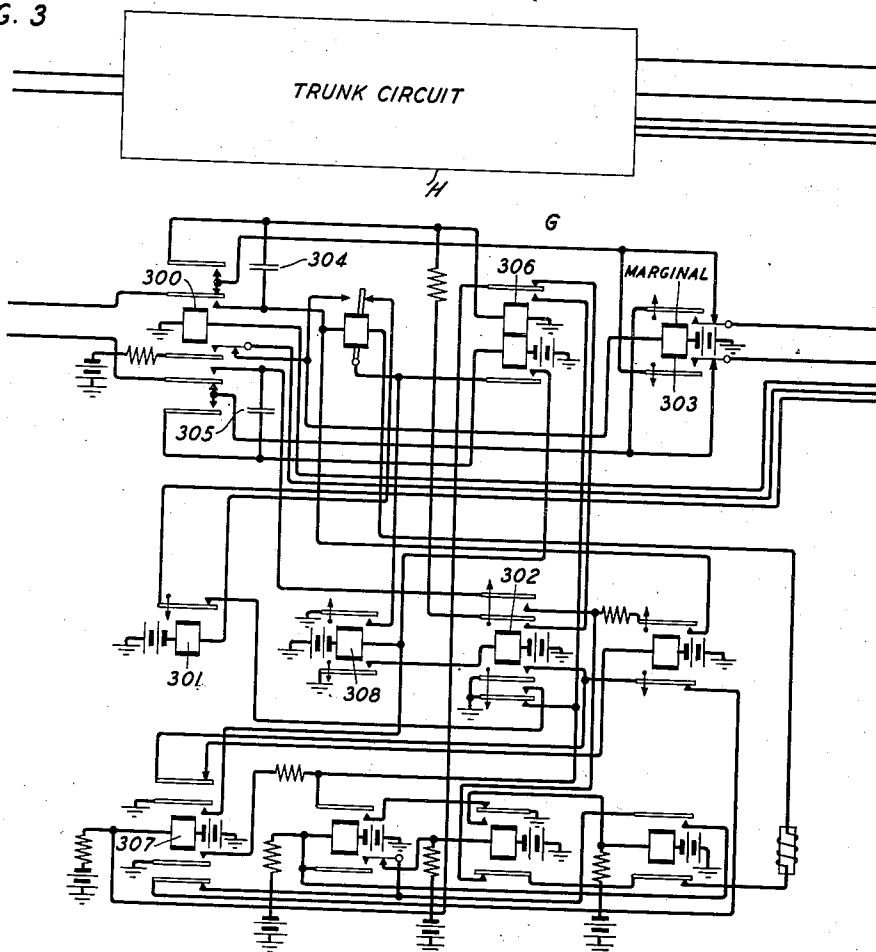
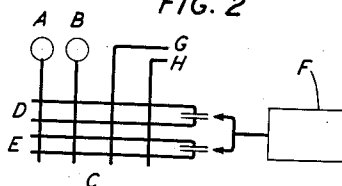


FIG. 1

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

FIG. 2



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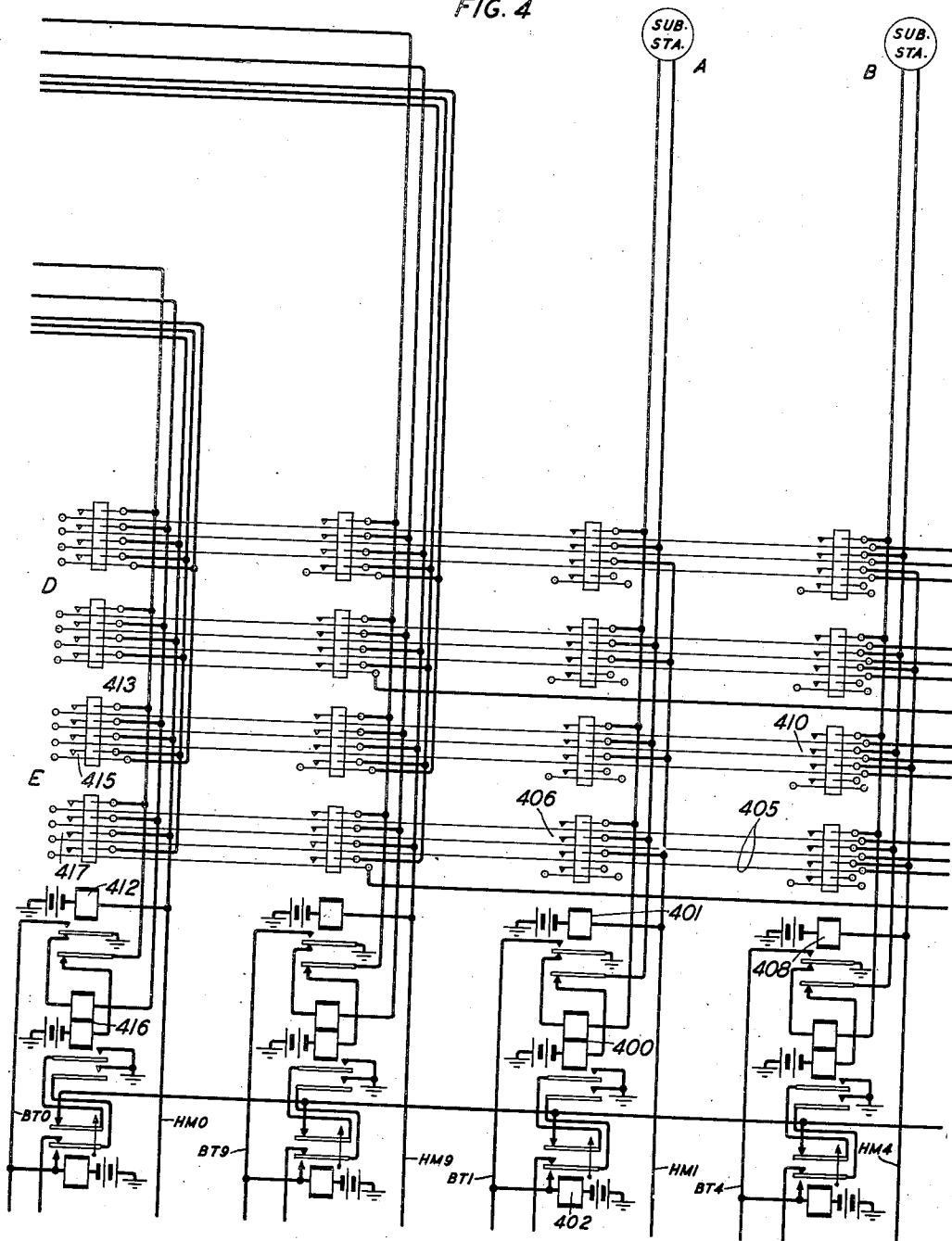
2,120,419

TELEPHONE SYSTEM

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6 Sheets-Sheet 2

FIG. 4



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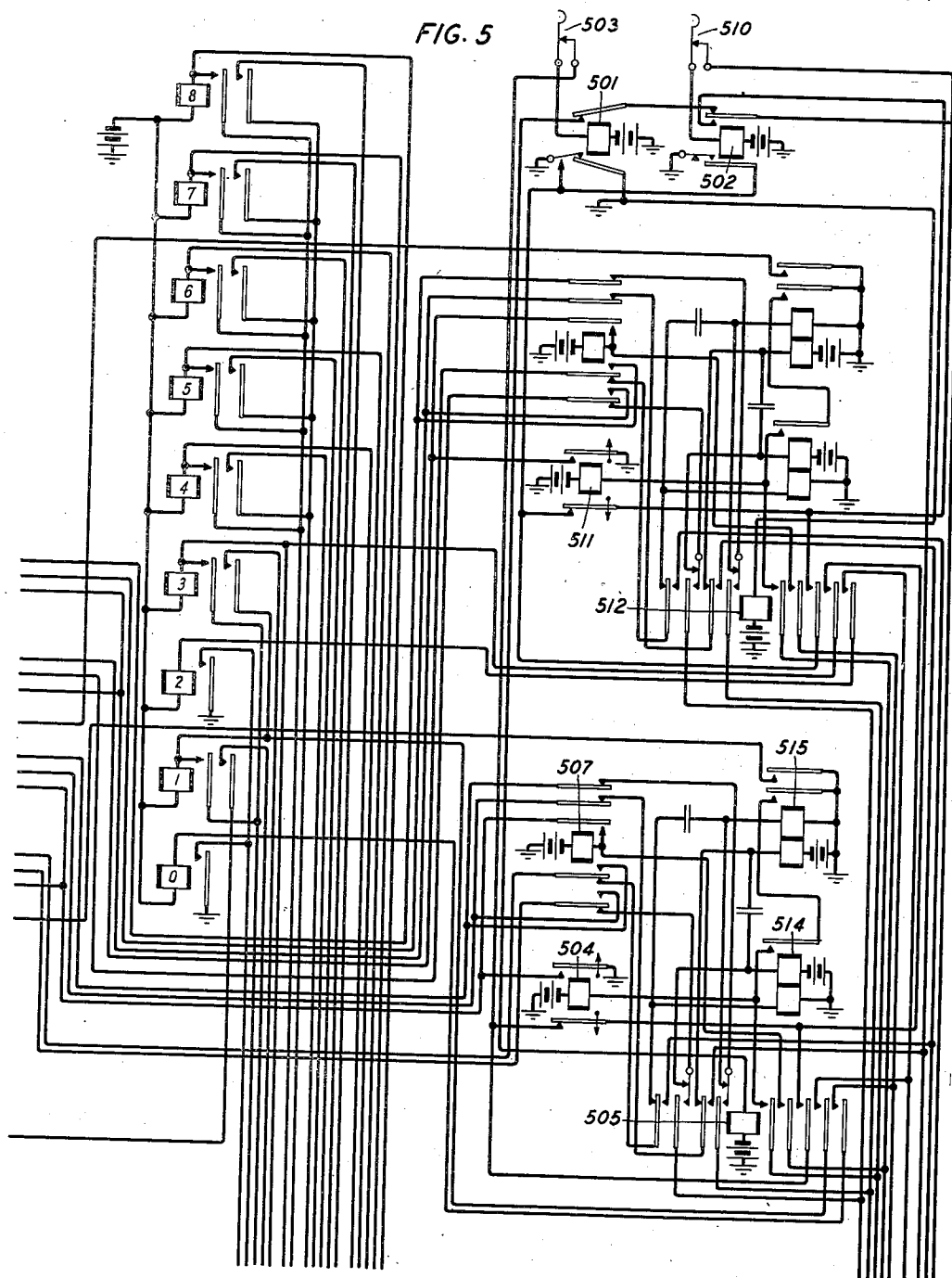
2,120,419

TELEPHONE SYSTEM

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6 Sheets-Sheet 3

FIG. 5



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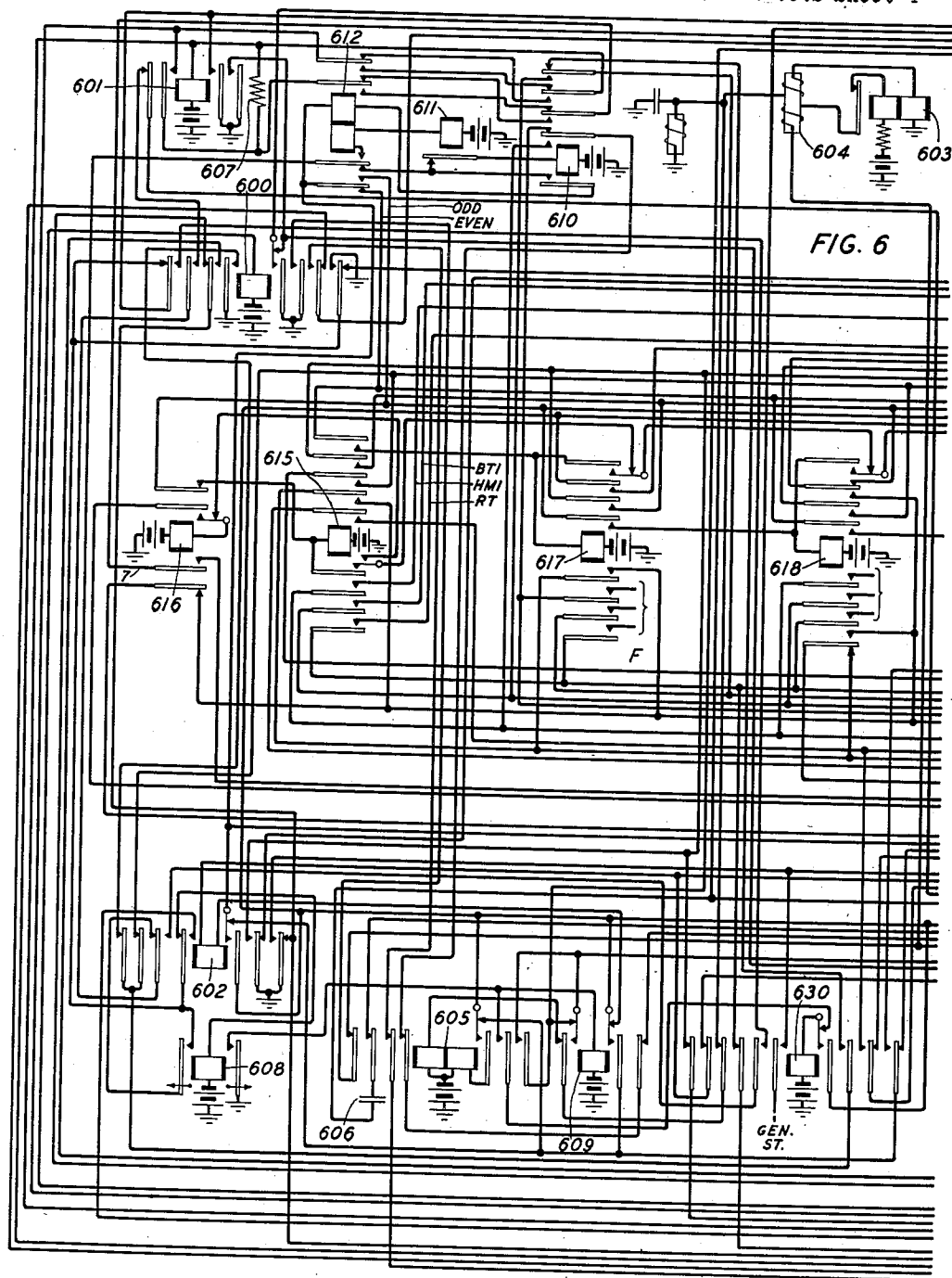
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TELEPHONE SYSTEM

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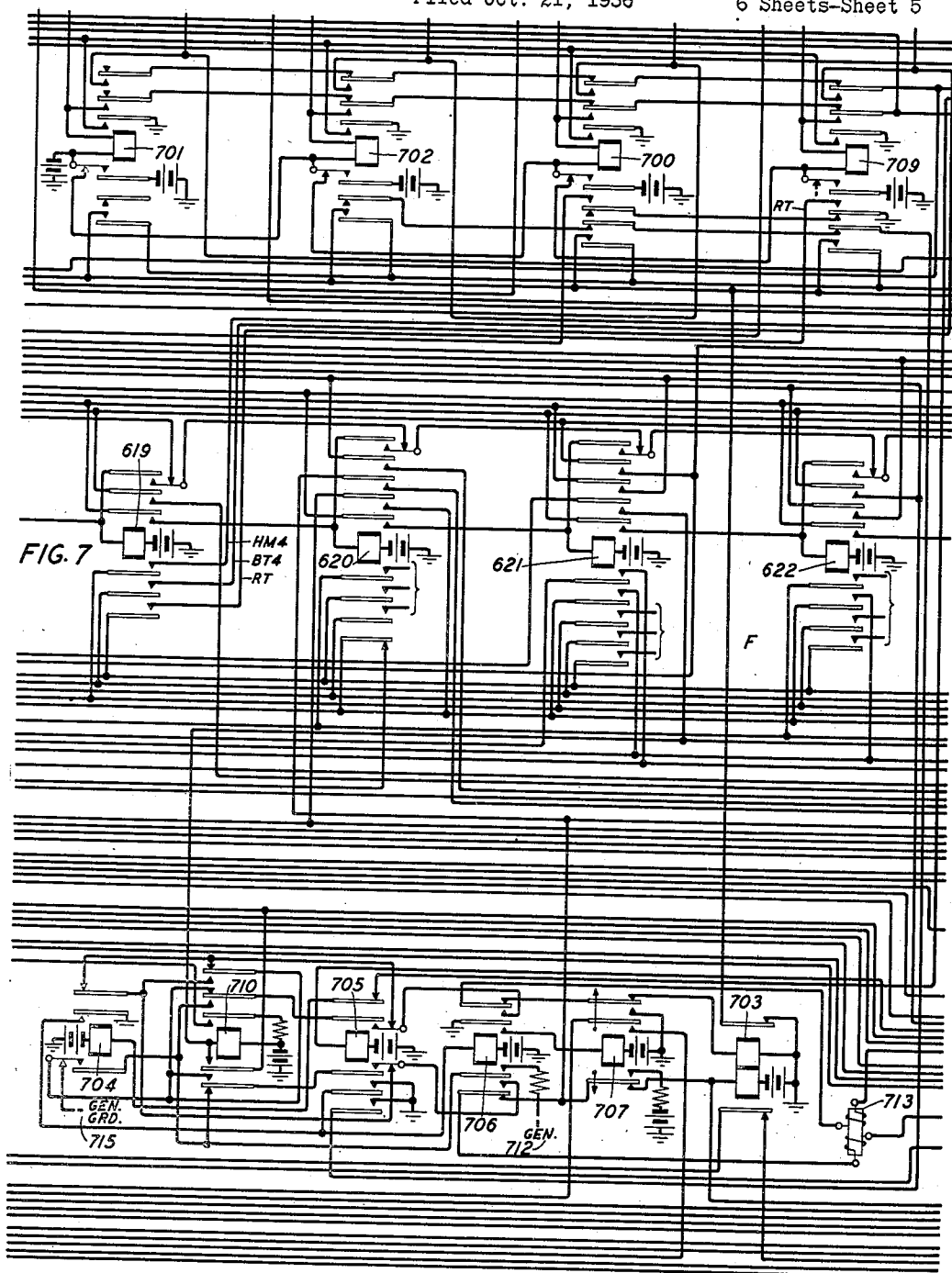
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6 Sheets-Sheet 5



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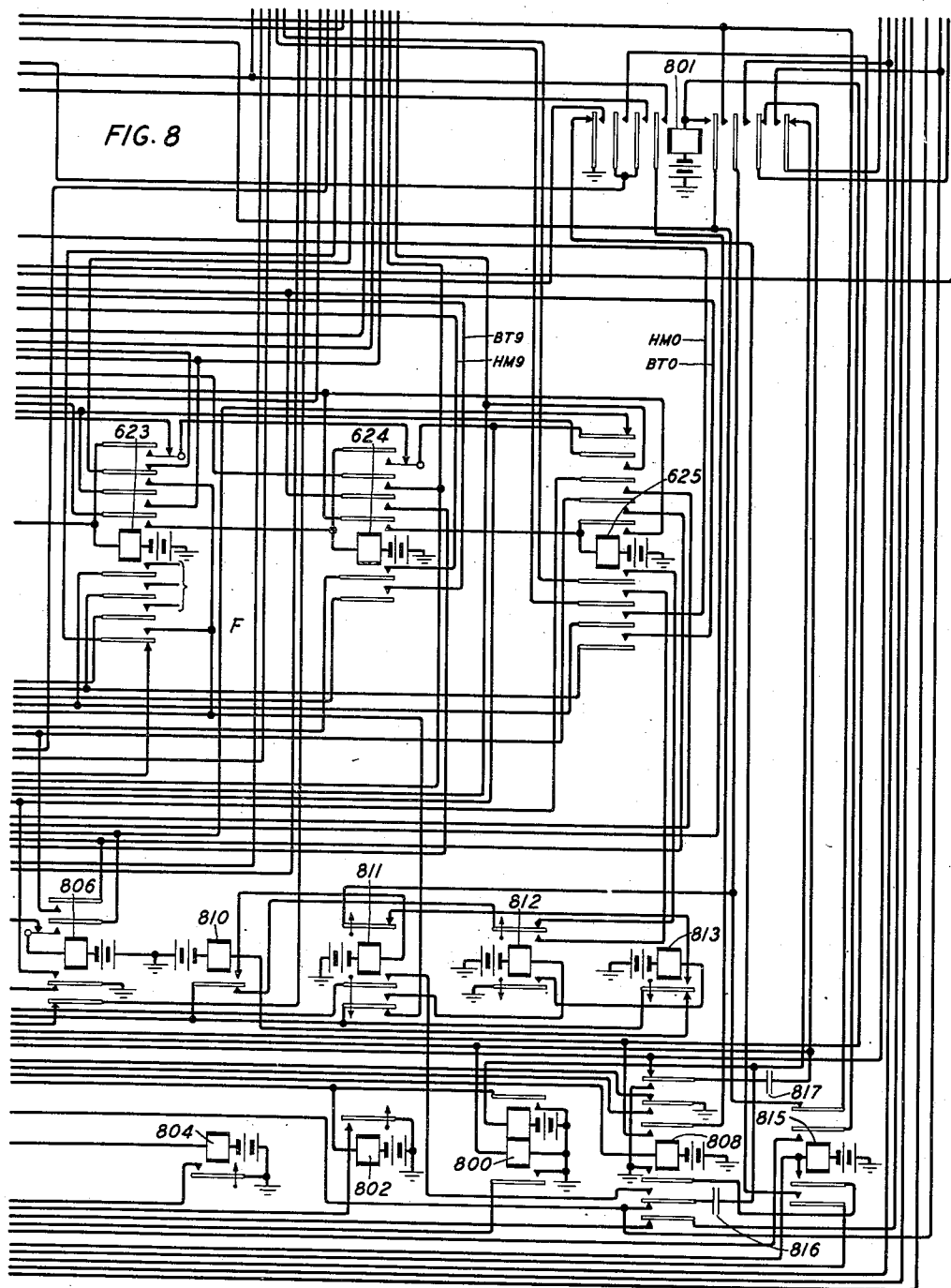
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TELEPHONE SYSTEM

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UNITED STATES PATENT OFFICE

2,120,419

TELEPHONE SYSTEM

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Application October 21, 1936, Serial No. 106,754

13 Claims. (Cl. 179—17)

This invention relates to telephone systems and in particular to small capacity automatic telephone systems.

An object of the invention is to provide improved and economically arranged systems for automatically establishing connections between telephone lines.

Heretofore systems have been provided in which connections may be extended from one subscriber's line to another over a cross-bar switch through a link circuit and in which the removal of a calling subscriber's receiver from the switch-hook causes the calling line to be connected to one branch of a link circuit through the switch and the dialing of the called subscriber's number causes the calling subscriber's line to be connected to the other branch of said link through the switch. A system of this type is disclosed in a patent to L. R. Waller No. 1,567,309 of December 29, 1925. Systems have also been provided in which in addition to connecting subscribers' lines, connections may also be extended from a subscriber's line to a trunk by the aid of a common register. Systems of this type have been disclosed in the patent to E. E. Hinrichsen No. 1,567,365 of December 29, 1925 and the copending application to F. J. Bowne et al., Serial No. 95,530 filed August 12, 1936. In these systems the connections are made by the aid of select and operate magnets and in the patent to R. L. Stokely No. 2,042,562 of June 23, 1936, which discloses a cross-bar system of this character, the select magnets are also used as a register for series of digits.

A feature of the present invention is an arrangement in a system of this character in which register relays and select magnets are used for producing and transmitting ringing codes for calling subscribers on single or party lines arranged so that when the ringing digit is dialed a proper register relay operates causing a corresponding select magnet to be operated to select the ringing code. The operation of this select magnet and the subsequent automatic operation of the register relays causes the actuation of the usual code ringing relay to take place in accordance with the selected code to transmit this code to the called line.

Another feature relates to the use of the register relays and select magnet for controlling the following action: If a second calling subscriber calls while a called subscriber is being rung by a first calling subscriber, this ringing is discontinued as soon as the ringing code has been repeated four times at least and then a short time

thereafter measured by the time interval it takes to repeat the code impulses once, a common control circuit including the register relays is released and the second calling subscriber's line is connected through an idle link to this control circuit. This enables the called subscriber to answer even after ringing has stopped.

In the system employed for illustrating these features of the applicant's invention, a single cross-bar switch is used with a capacity for eight lines and two trunks arranged vertically and two links arranged horizontally with a common control circuit which includes the register relays. Two digits may be dialed, one to select the line and the other to select the code ringing.

Referring now to the drawings, the various figures thereof may be arranged in accordance with Fig. 1;

Fig. 2 shows in diagrammatic form the arrangement in a small exchange of subscribers' lines and trunks in a system embodying the applicant's invention;

The succeeding Figures, 3 to 8, show the details of a complete system with the circuits for one trunk shown in detail and another trunk partially disclosed and two of the eight subscribers' lines all terminating in a switch with the detail circuits of two links, an allotter circuit and a common register circuit including the usual register or counting relays.

Referring now to Fig. 2, connections may be established between subscribers' lines A and B through the cross-bar switch C over a link D or E, depending on which one is idle or allotted with the temporary aid of the register F. A connection may be established through the switch C by a calling line A seizing one end of an allotted link D or E and dialing the desired subscriber's line which is connected to the other end of the allotted link. The connection to the desired line requires the dialing of a single digit and selection of the desired ringing code and ringing of the called subscriber requires the dialing of an additional digit. Cross-bar switches of any well-known type such as are disclosed in the above-mentioned prior art may be used and in which the operation of a horizontal and a vertical bar causes connections to be established at the intersecting points. Connections may also be made from a subscribers' line such as A to a trunk F or G in the same manner as between two subscribers' lines.

A connection will now be described with the aid of the detail drawings shown in Figs. 3 to 8 from

the subscriber of the line A to the subscriber of the line B.

If the calling subscriber at A lifts his receiver from the switchhook a circuit is completed for the operation of the line relay 400 from battery through the lower winding of this relay, contacts of the holding magnet 401, over the subscriber's loop, back through the upper winding of relay 400 to ground at contacts of the holding magnet 401. This causes the operation of relay 700 from battery, contacts of relays 701 and 702, winding of relay 700, contacts of relays 402 and 400 to ground. Relay 700 is locked from battery through its lower inner armature and front contact through its winding to a ground at relay 400. The effect of the operation of relay 700 will be the selection of the common control circuit F and an allotted link. The links are allotted alternately by relays 501 and 502. Relay 501 when operated causes the allotting of link E and when relay 502 is operated link D is allotted. If it is assumed that relay 501 is operated and link E is free, the circuit for this relay may be traced from battery, through the winding of this relay, manual contacts 503, contacts of relay 504 to ground. Now, therefore, when relay 700 operates a circuit is closed for the operation of relay 505 from battery through the winding of this relay, contacts of relays 501, 502 and 700 to ground at relay 703. Relay 505 in operating closes a circuit for the operation of the first select magnet 0 for the selection of the incoming branch of link E. The circuit for magnet 0 may be traced from battery, through the winding of this magnet, contacts of relays 505, 600, and 700 to ground. As long as relay 501 is operated, relay 502 cannot operate and therefore no other subscriber's line can call while the subscriber at A is engaged to the control circuit F and the called subscriber has been rung at least four times by a code signal as will hereinafter be described. Returning now to the operation of the select magnet 0, a circuit is completed by the operation of this magnet for the operation of relay 704 from battery through the winding of this relay, contacts of relay 705, select magnet 0 to ground. This relay in turn causes the operation of relay 706 from battery through the winding of this relay and contacts of relay 704. The relay 706 in turn closes an obvious circuit for the operation of relay 707. Relay 707 closes a circuit for the operation of relay 601 from battery, through the winding of this relay, contacts of relays 707 and 600 to ground at relay 602. Relay 601 closes a circuit for relay 504 from battery, winding of this relay, contacts of relays 505, 703 and 600 to ground at relay 601. A circuit is also closed by relay 601 for the holding magnet 401 of the calling subscriber's line from battery, through the winding of this magnet, contacts of relays 700, 703, and 600 to ground at relay 601. The operation of the holding magnet 401 causes the switch C to establish a connection between the calling subscriber's line and the incoming branch 405 of link E at cross-connecting point 406. As this connection at point 406 is made, a locking circuit for magnet 401 is provided to ground at contacts of relay 504, through resistance 607. A circuit is also completed for the operation of relay 800 from battery, through the upper winding of this relay, contacts of relays 801, 505, 507, contacts at 406 through the subscriber's loop and back over the contacts at 406, contacts of relays 507, 505, 801, through the lower winding

of relay 800 to ground. This relay closes an obvious circuit for the operation of relay 802 and a holding circuit for relay 601. Relay 802 closes an obvious circuit for the operation of relay 600. Relay 600 closes an obvious circuit for holding relay 504 operated and opens the circuit for the select magnet 0 which now is released while the select magnet 1 is energized over the connection to ground at relay 700. Magnet 0 in releasing causes the release of relays 704, 706, and 707. The circuit is now ready for the calling subscriber to dial the desired number and he receives a dial tone by the operation of relay 603 from battery, through the left-hand winding of this relay and its self-interrupting contacts, retardation coil 604, contacts of relay 605 to ground at contacts of relay 600. Relay 603 alternately operates and releases thereby inducing a tone through its right-hand winding in a circuit from ground, through coil 604, condenser 606, contacts of relay 605 to the called subscriber's line over the circuit hereinbefore traced from the windings of relay 800.

A timing means for releasing the connection in case the calling subscriber does not dial within a certain period, is also started to function by the operation of relay 804 from battery, through the winding of this relay, contacts of relay 600 to ground at relay 602. This relay is adjusted to operate in about 30 seconds. If the control circuit does not function properly or the call is not completed to the called line within a 30-second interval, relay 804 will operate and close a circuit for relay 703 which will operate and open a holding circuit for relay 505 which will release and cause the calling line to be locked out and the control circuit released. It should be noted that on the operation of the holding magnet 401, relay 402 is operated, this in turn causing the release of the line relay 400. Therefore, when relay 703 operates and relay 505 releases relay 504 will release causing the release of the holding magnet 401, as the holding magnet 401 releases relay 400 is reoperated and holds relay 402 operated. The calling line cannot therefore seize another link and the control circuit until the subscriber has again replaced the receiver on the switchhook when relay 402 will be released and establish a connection for the operation of relay 700. The relays in the control circuit that were operated are released on the release of relay 505 as follows—800, 802, 601, 600, and 700.

It should now be noted that due to the operation of relay 504, as described, the original energizing circuit for the allotter relay 501 is opened at its lower armature and back contact. Then when relay 505 is released, the substitute circuit that was closed through the third right-hand armature and front contact of this relay for the operation of relay 501 is opened. The release of relay 501 will then take place momentarily. This causes the allotter relay 502 to operate from battery, through the winding of this relay, manual contacts 510, contacts of relay 511 to ground at contacts of relay 501 and lock at its own contacts. Relay 504 is slow in closing the original operating circuit for relay 501 so as to permit relay 502 to operate as described. Link D will therefore be the next link to be seized as when relay 700, or relay 709 for some other subscriber operates, a circuit will be closed to cause the operation of relay 512 through contacts of relay 502 to connect the link D and the control circuit for use with this call. When a connection has been completed through

link D for another call, relay 512 will release in the same manner as was relay 505 causing relay 502 to release so that the next call will be allotted to link E as relay 501 is operated. Thus, it will be seen that relays 501 and 502 will allot the links D and E alternately.

Returning now to the call in progress, when the calling subscriber hears the dial tone he will proceed to dial the number of the called line which consists, as stated, of one digit for the selection of the called line and another for the selection of the ringing code. Assuming then that the calling subscriber dials before the timing out equipment has operated to release the connection, the actuation of the dial causes the following operations. At the return of the dial to normal for the first digit and the first opening of the dial impulse springs, relay 800 will release and this relay in releasing opens the locking circuit which was closed for relay 601. Relay 601 in releasing opens the circuit for relay 802 at its outer right-hand armature and front contact, but this relay is slow in releasing and does not restore on the short time its circuit is opened due to a dial pulse. Relay 601 closes a circuit for the operation of relay 608 from battery through the winding of this relay, contact of relays 602, 600, 601 to ground at contacts of relay 806. Relay 608 in turn closes an obvious circuit for the operation of relay 609 and also a circuit for the operation of relay 610 from battery through the winding of this relay, contact of relays 611, 612, 602, 608, 600, 601 to ground at relay 806. Relay 610 prepares a circuit for relay 612 but this relay does not operate at this time. On the other hand relay 610 closes points in the circuits for the various H, M, and BT leads of the odd number lines as will hereinafter be more fully described. When the first impulse ceases, relay 800 is again operated causing the operation of relay 601 from battery through the winding of this relay, contact of relays 610, 612 and 800 to ground. Relay 612 now operates in series with relay 610 from battery through the winding of relay 610, contacts of relay 611, upper winding of relays 612, 602, 605 to ground at relay 600. Relay 612 in operating closes a circuit for the operation of the first counting relay 615 from battery through the winding of this relay, contact of relay 616, the odd lead, contacts of relay 612 to the above-mentioned ground at relay 60. On the next release of relay 800 at the reception of the second impulse, relay 601 releases causing the operation of relay 611 from battery through the winding of this relay, lower winding of relay 612 and its inner lower armature and front contact, contacts of relays 602, 608, 600, 601, 806 to ground. Relay 611 in operating opens the circuit for relay 610 which now releases. At the end of the second impulse relays 800 and 601 reoperate which causes the release of relays 611 and 612. Relay 610 in releasing closes a point in the various circuits for the H, M, and BT leads of the even numbered lines as hereinafter described. Further pulses from the release and operation of relays 800 and 601 will operate the above-mentioned relays 610, 611, and 612 in the same manner. At the end of each odd impulse, relays 610 and 612 will remain operated and at the end of each even impulse, relays 610, 611, and 612 will be in normal position. Relay 612, therefore, when operated grounds the leads for operating the counting relays which are to be operated on the odd numbered pulses and when relay 612 is normal it grounds the lead for operating the counting relays which are to be operated on even impulses. Relay 610 when op-

erated prepares the point in the circuits for the H, M, and BT leads for odd number lines and when relay 610 is released it closes a point in the circuits for the H, M, and BT leads for even number lines. The purpose of controlling the reoperation of relay 601 through contacts of relays 610 and 612 is to prevent relay 601 from reoperating thus terminating a pulse for relay 610 or 612 as the case may be, as might occur if relay 800 reoperated very quickly due to a low insulation resistance on the calling line. The purpose of controlling the release of relay 601 through contacts of relays 610 and 612 is to prevent relays 601 from releasing on another pulse before relay 610 or relay 612 has completed its operation on the previous pulse as might occur if relay 800 released very quickly due to a high resistance on the calling line. Relay 808 is operated on the first pulse and remains operated until the pulse of the digit dialed ceases when it releases. The delaying of closing the pulsing lead from relay 601 through to relay 610 until relay 608 has operated permits relay 608 to become better saturated before its circuit is opened by relay 601 operating at the end of the first pulse that might be the case if relays 608 and 610 started to operate at the same time.

As already described, the first counting relay 615 operates at the end of the first impulse when relay 612 operates. This relay 615 is locked from battery through its winding and lower inner armature and a front contact through make-before break contacts of succeeding counting relays 617 to 624 and the last counting relay 625 through its upper outer armature and front contact, contacts of relays 602, 605 to ground at contacts of relay 600. Relay 615 closes a circuit for the operation of relay 616 from battery through the winding of this relay and its make-before-break contacts and a lower inner contact, through relay 615 to the ground at relay 600. Relay 616 locks through its upper inner armature and front contact and the upper outer armature and back contact of relay 625 to ground at relay 600 and opens the operating circuit for relay 615 at its upper outer armature and back contact so that this relay will not be operated on succeeding ground pulses on the odd pulsing lead. When relay 612 releases in response to the second pulse, it grounds the even pulsing lead. This causes counting relay 617 to operate from battery through the winding of this relay, contacts of relay 615, the even pulsing lead to the ground at relay 600 before described. Relay 617 locks through its upper outer armature and front contact through the locking circuit previously described to ground at relay 600 and opens this locking circuit for relay 615 which now releases. On the third dial pulse, the odd pulsing lead is again grounded and relay 618 operates and locks causing the release of relay 617. On succeeding impulses the other counting relays are operated in like manner and on the tenth pulse relay 625 is operated and relay 624 is released. At this time relay 616 is also released. Since the tenth impulse is the last impulse from the dial, relay 612 will not remove ground from the even pulse lead, and consequently relay 625 will remain held operated until relay 605 is operated opening the holding circuit to ground at contacts of relay 600 as will hereinafter be described.

If now it is assumed that the line B which may be the fourth line is dialed, four impulses would be transmitted to operate the four first counting relays 615, 617, 618, and 619. At the end of

the fourth impulse, if this line is busy there will be ground on the BT4 lead and the busy test relay 808 will be operated from battery through the winding of this relay, contacts of relays 609, 620, 610, 619, BT4 lead to ground at the holding magnet 408 of line B. Then when relays 608 and 609 are released which were held up during pulsing, relay 608 will be locked in operated position through contacts of relays 609, 808 to ground at relay 600. Relay 609 in releasing transfers a ground from the BT4 lead to relay 605 which now operates from battery through the left-hand winding of this relay, contacts of relays 609, 620, 610, 619 to ground at contacts of magnet 408. Relay 605 opens the circuit for the dial tone relay 603 at its outer left-hand armature and back contact thus removing the dialing tone from the calling line. It should be noted that relay 605 in operating provides a multiple point in the holding circuit for relay 808 at its outer right-hand armature and front contact so that relay 808 will not be released when relay 609 is operated on the next digit. This relay 605 also opens the holding circuit for the counting relays that are operated, in this case relay 619, so that relay 619 will now release. Relay 605 is locked through its right-hand winding and inner right-hand armature and front contact to ground at relay 600. By closing a circuit for relay 603 at its middle upper armature and front contact, relay 808 also prepares the circuit for supplying busy tone which will be received by the calling subscriber after he has transmitted his second digit as will hereinafter be described.

If the line dialed is not busy there will be no ground on the BT4 lead and consequently relay 808 will not be operated. The holding magnet 408 will, therefore, be operated from battery, winding of this magnet, the HM4 lead, contacts of the operated counting relay 619, contacts of relays 610, 605, 609, 808 to ground. The operation of magnet 408 thus closes a connection at the cross-connecting point 410 for the calling branch of the link E and the magnet is thereby locked to ground at relay 304 over the sleeve magnet 408, closing the BT4 lead which causes the operation of relay 605 as hereinbefore described. Relay 605 opens the circuit for magnet 1.

After the line B has been selected as described, another digit is dialed that selects a ringing code which is to be applied to the line and selects the side of the line to which the ringing current is to be applied. The length and number of rings and the side of the line to which they are applied in ringing different stations on a line are as follows:

Digit dialed	Code	Ringing current applied to
1	1 long ring	Ring side.
2	2 short rings	Ring side.
3	3 short rings	Ring side.
4	4 short rings	Ring side.
5	1 long, 1 short ring	Ring side.
6	1 long ring	Tip side.
7	2 short rings	Tip side.
8	3 short rings	Tip side.
9	4 short rings	Tip side.
0	1 long, 1 short ring	Tip side.

The pulses of the second digit actuate relays 800, 601, 610, 611, 612, 608, and 609 and the corresponding counting relays in the same manner as they were on the first digit. Relay 608 operates on the first pulse to close a circuit for relay 620 from battery through the winding of this relay

and its make-before-break contacts, contacts of relays 605 and 608 to ground. Relay 620 locks through its inner right-hand armature and front contact to ground at relay 600. Relay 620 prepares the circuit from ground at contacts of relay 602 for the starting of the generator at the inner left-hand armature and front contact to the start lead generator ST. The ringing generator may be any well-known arrangement. If the counting relay 615 or 621 is operated, 615 by dialing one impulse and 621 by dialing six impulses, the select magnet 4 will operate from battery through the winding of this magnet, contacts of relays 615, 602, 620, 601 to ground. If relay 621 operates a circuit may be traced from battery through the winding of the select magnet 4, contacts of relays 621, 602, 620 to ground at 601 so that the select magnet will be operated when relay 601 reoperates at the conclusion of the first or sixth pulse and if either of these pulses is the last pulse of the digit dialed, a circuit is established through contacts on the operated select magnet for operating relay 602 when relay 609 is released. This circuit may be traced from battery, through the winding of select magnet 4 and its inner right-hand armature and front contact, through the winding of relay 602, make-before-break contacts of relay 609 to ground at relay 600. Relay 609 in releasing opens a holding circuit for relays 610, 611, 612 and the counting relay operated, in this case, 615 or 621. It should be observed that in case relay 621 was operated, it closes before relay 609 releases a circuit for operating relay 710 from battery, through the winding of this relay, contacts of counting relay 621, contacts of relays 620, 609 to ground at relay 600. Relay 710 locks immediately through its inner lower armature and front contact and directly to the ground at relay 600. Relay 710 reverses the ringing supply so that ringing generator current will be applied to the tip of the line instead of the ring. Thus, in the same manner, the operation of the counting relays 617, 618, 619, and 620 will cause the selection, operation and locking of the select magnets 5, 6, 7, and 8, respectively, and similarly, counting relays 622, 623, 624, 625 will select, operate and lock corresponding magnet 5, 6, 7, or 8 and the counting relay 621, as noted, will shift the ringing from the ring to the tip side of the line. The select magnet operated therefore determines the code to be transmitted.

The actual ringing interruptions for transmission to the called line will take place as follows: On the operation of relay 602, as described, relay 810 is operated from battery, through the winding of this relay, contacts of relays 813 and 602 to ground. Relay 810 operates relay 811 which in turn operates relay 812 and this relay in turn operates relay 813 as is obvious. Relay 813 in operating opens the operating circuit for relay 810 which in turn in releasing, releases relays 811, 812, and 813 and the cycle of operations just described is then begun again. These relays have a time cycle of approximately one second and produce ground pulses for actuating relays 610, 611, and 612 which in turn actuate the counting relays. The counting relays will now be used for sending the code by the operation of the relays 610, 611, and 612 and the code will be determined by the operation of a particular select magnet 4 to 8. It will be remembered that in the case assumed, the select magnet 4 was operated so that now when relays 810 to 813 go through their cycles of operation, the relays 610, 611, and 612

will be operated to operate in succession the counting relays 616 to 625 and the code will be repeated twice during the operation of the counting relays 616 to 625. For example, when relay 310 releases and before relay 813 is released, a circuit is completed for relay 610 from battery, through the winding of this relay, contacts of relays 611, 612, 602, 620, 815, 811, 813 to ground at relay 602. Then when relay 813 has released, relay 612 is operated from battery, through the winding of relay 610, contacts of relays 611 and 610, upper winding of relay 612, contacts of relay 602 to ground at relay 600. Then, on the second cycle of operations of relays 810 to 813, when relay 811 releases, relay 611 will be operated from battery, through the winding of this relay, lower winding of relay 612, contacts of relays 612, 602, 620, 815, 811, 813 to the above-mentioned ground at 602. On the operation of relay 611, relay 610 releases and upon the release of relay 813, relays 612 and 611 are released. The operation of these relays 610, 611, and 612 are repeated in the same manner as the cycle of operations of relays 810 to 813 is repeated and for each succeeding operation of these relays 610, 611 and 612, a counting relay is operated in the usual manner over the odd and even leads. When the last counting relay 625 is operated on the tenth impulse from the relays 810 to 813, it causes, of course, the release of relay 624 and also relay 616. Relay 625, however, does not release, since it is locked to ground on the even pulsing lead which remains until the tenth impulse ends and the eleventh impulse begins. Then relay 625 will release and the counting relays begin another cycle. The counting relays are wired so that they produce, as mentioned, two code cycles for each cycle of the counting relays. The codes produced by the counting relays are five in number and consist of ground interruptions which are selected and connected, as previously described, by select magnets and the operation of relay 705. These ground interruptions cause relay 705 to operate and release in accordance with the code selected to ring the bell on the connected line in accordance with this code. It should be observed that relay 705 is operated in case the select magnet 4 is operated over a circuit from battery, through the winding of this relay, contacts of relay 806, contacts of select magnet 4, contacts of counting relay 615 to ground at relay 602. It should be noted that relay 705 is also maintained operated while relay 617 is operated over the same circuit through contacts of this relay. Thus, relay 705 will be operated while the first two counting relays are operated. The same will occur when the two counting relays 621 and 622 are operated over a similar circuit, that is, relay 705 is operated over similar contacts of these two counting relays. This relay will, therefore, control the sending of a long code impulse twice during the operation of the counting relays once. The manner in which the pulses are sent is as follows: Relay 706 is operated over an obvious circuit on the operation of relay 705 and this relay in turn closes an obvious circuit for the operation of relay 707. Relays 706 and 705 when operated connect the ringing current to the called line from the ringing current generator at 712 through contacts of relay 706 and in this case as relay 710 is not operated over the lower outer armature and back contact of relay 710, contacts of relays 705 and 706, one winding of retardation coil 713, contacts of relay 808, contacts of relays 801, 505, 507, through the cross-connecting point 410 over the

subscriber's loop at B through his bell, back through the cross-connecting point 410, contacts of relays 507, 505, another winding of retardation coil 713, contacts of relays 706, 705, 710, 704 to the generator ground at 715. If relay 710 had been operated, the ringing current from the generator at 712 would have been transmitted through the second upper armature and front contact of relay 710, in reverse direction over the subscriber's line at B, that is, in case the subscriber's line at B instead of being a single line is a ten-party line, code selections may be transmitted with the generator battery on either side of the line with five codes for each side of the line. The calling subscriber receives a ringing tone over condensers 816 and 817. Relay 707 operated over an obvious circuit on the operation of relay 706. Therefore, when relay 705 releases, between codes, relay 706 also releases and after an interval also relay 707. This connects first battery and ground through contacts of relay 707 to the line, after ringing current has been disconnected, and then transfers the called line to battery and ground through the windings of relay 703. Relay 707 is slow to release in order to hold the called line in contact with the battery and ground for a short impulse before it is connected to relay 703 in order to remove any charge which may have been left on the line by the application of ringing current and to adjust the potential on the line with that of relay 703 so that relay 703 will not be falsely operated due to such a charge.

One more example of a code selection may be mentioned, as for example, two short rings which require the operation of select magnet 5. In this case when relay 616 operates, relay 705 operates over a circuit from battery contacts of relay 806, magnet 5, contacts of relays 616, 811, 602 to ground. Then when relay 811 operates on the second cycle of the operation of the relays 810 to 813 the circuit for relay 705 is opened so that relay 705 will transmit a short impulse of ringing current. Then when relay 617 is operated on the second impulse on the release of relay 612, relay 705 will again be operated over a circuit, in this case through contacts of relay 617 and when relay 811 is again operated on the third cycle of the operation of the relays 810 to 813, relay 705 is released so that relay 705 will therefore at this time transmit a second short impulse. Thus two short impulses of each signal will be sent twice during the operation of the counting relays, the first series will be transmitted due to the operation of relays 616 and 617 and the second series due to the operation of relays 721 and 722.

When the called subscriber at B answers, relay 703 will operate as soon as a code signal is completed and open the connection to ground at its upper armature and back contact which causes the relay in the link which is holding the line connected to this circuit, to release, disconnecting the lines from this circuit and connecting them to the link circuit. The first relay that is released is relay 505. This relay in turn closes a circuit from the calling subscriber's loop through the windings of relay 514 which now operates and from the called subscriber's loop through the windings of relay 515. Relay 504 is maintained operated through contacts of relays 514 and 515 to maintain the holding magnets 401 and 403 operated and the connection between the calling and called subscribers, therefore, now is completed through the link E with

the battery for the calling subscriber applied through the windings of relay 514 and battery for the called subscriber provided through the windings of relay 515. It should be noted that relay 505 in releasing, opens the circuit for the allotter relay 501 and this in turn causes a circuit to be closed for the operation of allotter relay 502 which is locked through its own lower armature and front contact to ground so that on the next call, link D will be selected by the operation of relay 512 through contacts of allotter relay 502. As relay 505 releases, relay 800 will release and this in turn causes the release of relays 601, 802, and 600. Relay 600 causes the release of relays 700 and 620. Relay 620 causes the release of relay 602 and relay 710, if operated, will also be released while the operation of relays 810 to 813, inclusive, will be discontinued.

Referring now to the arrangement in these circuits whereby if the called line does not answer after four code rings have been transmitted and another line initiates a call, the first call is released and the circuits made available for the second call. This operates as follows: When the counting relays function as a code interrupter as hereinbefore described and complete the first cycle of operations, the select magnet 3 is operated over a circuit from battery, through the winding of this magnet, contacts of counting relay 625, contacts of relays 812, 810 to ground at contacts of relay 602. Magnet 3 is locked over its inner right-hand armature directly to ground at relay 602. At the end of the second cycle of operations of the counting relays, functioning as a code interrupter, the select magnet 1 is operated from battery, through the winding of this magnet, contacts of select magnet 3, contacts of counting relay 625, contacts of relays 812, 810 to ground at relay 602. If a second call originates during this sending of code signals to a called line, then when these code signals have been repeated four times, that is, when the counting relays have been operated twice and a third cycle is started by the operation of the counting relay 615, a circuit will be closed for the operation of relay 806 from battery, through the make-before-break contacts of this relay, contacts of relay 620, contacts of the counting relay 615, contacts of select magnet 1 through contacts of a relay such as 402 to ground at a line relay such as 400 if it is assumed that the line A is the one from which the second call originates. Relay 806 locks through the common locking circuit for the counting relays and opens the operating circuit for the code impulse relay 705 at its lower outer armature and back contact thus stopping any further transmission of code signals to the called line. The counting relays, however, continue to operate in succession as usual until counting relay 620 is operated, when relay 703 operates from battery through the lower winding of this relay, contacts of relay 707, contacts of counting relay 620, contacts of relay 806 to ground. The operation of relay 703 releases the control circuit from the first calling line and is made available for use by the second calling line. It should be noted, therefore, that ringing is discontinued at the beginning of the third cycle of operations of the counting relays, but the control circuit is not disconnected from the calling line until one-half of the counting relays has operated. This gives the called subscriber who did not answer during the ringing of the code four times, a further period within

which to answer before the connection is broken down, this period being equal to the time it takes to transmit a code signal once. If the called subscriber answers within this period, the control circuit will, of course, release in the usual manner.

In case one subscriber on a line calls another subscriber on the same line in a revertive call, not only the busy test relay 808 operates but also relay 815. The circuit for this latter relay may be traced from battery through the winding of this relay, contacts of relay 620 through contacts of the operative counting relay which represents the calling as well as the called line and from there through the second lower armature and front contact of relay 700 if the calling line and called line are located on the subscriber's line A to ground on the corresponding contacts of other relays in this case, through contacts of relays 709. Relay 815 locks through its lower inner armature and front contact to ground at relay 808 which also locks as hereinbefore described and the calling subscriber will hear the busy tone and hang up his receiver. In doing so relays 800 and 601 are restored. Relay 601 closes a circuit for operating relay 801 from battery, winding of this relay, contact of relays 815, 602, 600, 601 to ground at relay 806. Relay 808 in operating opens the circuit for the timing relay 804 and locks to ground at relay 600. Relays 808 and 601 in releasing open the circuit for relay 302 and this relay releasing causes release of relay 600. Relay 600 removes the ground which it has provided for holding relays 709 and 801 but these relays do not release, nor does the holding magnet 401 release, as a ground from the upper armature and front contact of relay 504 is supplied through the cross-connecting point 406 for this holding magnet and through contacts of relays 700 and 709, and the lower inner armature and front contact of relay 801 to battery. This connection for the control circuit is therefore held under the control of relay 703 which at its lower armature and back contact extends the circuit for relay 504. Ringing on the line will then begin as in the case of a subscriber on one line to a subscriber on another line except when the code interrupter will cause relay 704 to be operated between each code cycle on the release of relay 616. Relay 704 when operated applies ringing current to the opposite side of the line from that to which the regular code ringing is being applied as a signal to the calling subscriber that ringing is taking place should his bell be located on the opposite side of the line. Relay 704 may be traced from battery through the winding of this magnet, contact of relay 705, 801, contacts of relays 616 and 811 to ground at the contacts of relay 602. The ringing generator battery at 712 will then be applied through contacts of relay 706, 704, and 710 on either side of the line depending on whether relay 710 is operated or not and on the side opposite to that on which the ringing code is applied. Now when a receiver on the line is removed from the switch-hook, relay 703 operates as usual and opens the circuit for relay 505 and after an interval the control circuit and switch C are restored to normal. The line circuit, however, is held locked out so that it will not be seized until this circuit is again cleared and a new call originated. The release of the holding magnet 401 reoperates line relay 400 which provides a locking circuit for relay 402 before it has time to release and

thus makes the line busy and prevents the operation of the line relay 700 to seize a link.

In case a calling subscriber desires to make an outside connection, he will dial the digit zero which connects him to a trunk such as G or F. When two trunks are provided, one trunk is connected to the line circuit whose BT and HM leads are connected to counting relays 625 and the second trunk is connected to the line circuit whose BT and HM leads are connected to counting relays 624 as shown in the drawings. The line circuits used on trunks have no RT leads as reverberative calls are not possible on trunks. The trunk G is called when the counting relay 625 operates, but should this trunk be busy the trunk F will be called by the operation of counting relay 624 as will be described later. As the subscriber dials the digit zero and relay 625 is operated, it connects the BTO and HMO leads of the trunk through contacts of relays 625 for testing if the trunk is idle. If the trunk is busy relay 808 will operate and lock and cause the operation of relay 605 as usual. Relay 625 also closes a circuit for operating relay 710. This circuit will be traced from the winding of relay 710, contacts of relay 625, contacts of relay 605 to ground at relay 600 before relay 605 operates and this relay locks as usual to the same ground. Relay 710 closes a circuit for the operation of relay 602 from battery through a resistance, upper inner armature and front contact of relay 710, contacts of relay 720, winding of relay 602, contacts of relay 609 to ground at relay 600. Relay 602 operates relay 810 which starts the cycle of operations of relays 811, 812, 813. Relay 811 will be operated one-half of the time of the cycle of operation of these four relays. When it is operated it connects the tone lead from the retardation coil 604, contacts of relay 808, condenser 816 to the calling line indicating that the called trunk is busy. The calling subscriber on hearing the busy tone will hang up his receiver provided there is only one trunk. In case there are two trunks as shown in the drawings, and the first trunk is not busy, then it will be selected by the operation of the holding magnet 412 which closes a connection at the cross-connecting point 413 between the trunk G and the calling line. If, however, the first trunk is busy as described, there will be a ground on the BTO lead and when relay 824 operates in response to the ninth digit this ground will cause relay 806 to operate from battery through the winding of this relay and its make-before-break contact, contact of relay 620, 624, the BTO lead to ground at the holding magnet 412 of the first trunk G. Relay 806 locks to ground through its upper inner armature and front contact, contact of relay 602, to ground at relay 600. Relay 806 removes the ground for actuating relays 610, 611, and 612 and these relays will not respond to the tenth dial pulse. Consequently, relay 625 will not operate and relay 624 will not release. The second choice trunk F, the BT9 and HM9 leads of which are connected into this circuit by the operate relay 624, will be tested and seized if idle. If it is busy, the calling line will receive a busy tone as previously described. If the trunk terminates in a dial office in which further dialing is required in order to complete the connection, then when an idle trunk is seized, the operation of relay 602 grounds a lead to the link circuit causing the operation of relay 507 from battery, winding of this relay, contact of relay 505, 308, 620 to ground at relay 602. The operation of re-

lay 507 closes a locking circuit for itself to ground established over the sleeve lead through contacts of cross-connecting points 413, contacts of relays 301, and 302 to ground. It will be noted that this ground will be furnished as soon as the trunk is seized when there will be a connection at the cross-connected point 413 for the operation of relay 300 from battery through the winding of relay 303 which is marginal and does not operate, make-before-break contact of relay 300, the connection established at the cross-connecting point 413 through the contacts 415, winding of relay 300 to ground. The operation of relay 300 closes an impedance bridge circuit to condensers 304, 305 to the trunk and connects the tip and ring conductors from the calling subscriber's line to battery and ground through the winding of relay 306 over contacts of relays 300 and 303. The control circuit is now released by the release of relays 505 and 504. Relays 514 and 515 are not operated as relay 507 is operated, which connects the calling line directly through to the trunk so that talking battery for the calling subscriber will be provided from battery and ground through the windings of relay 306 of the trunk. Relay 306 operates over the subscriber's loop and closes a circuit for the operation of relay 307 from battery, winding of this relay, contacts of relay 306 to ground at relay 302. Relay 307 in operating closes a circuit for the operation of relay 308 which locks to ground at its own contacts through contacts of relay 306. Relay 308 closes an obvious circuit for the operation of relay 302. Relay 307 now locks over its own contacts through contacts of relay 306. It should be noted that relay 302 provides a locking ground extending over the sleeve lead for holding the holding magnet 401 of the calling subscriber's line and the holding magnet 412 of the trunk line operated through contacts at the cross-connecting points 413 and 417. Conversation may now take place. When the calling subscriber releases, relay 306 is released causing the release of relays 302, 307, and 308, and the release of relay 302 releases the holding magnets 412 and 401 to release the connection at the switch through link E whereupon relays 300 and 507 are released. In case of calls from a distant office over trunk D, the connection is established directly to the tip and ring conductors for the operation of the corresponding line relay 416, the same as in the case of a calling subscriber's line and the connection is established in the same manner. With the connection from the trunk established at the switch at the cross-connecting point 417, when the called subscriber answers, relay 303 in the trunk is operated to reverse the connection to the distant office to notify it that the called subscriber has answered. The circuit for relay 303 in this case extends from battery, winding of this relay, contact of relay 300, contact at the cross connecting point 417 to ground at contacts of relay 515.

What is claimed is:

1. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing a connection between a calling line and a called line through said switch, and means including said select magnets and register relays for thereafter transmitting ringing signals to the called line.

2. In a telephone system, a cross-bar switch including select magnets, lines terminating in

- said switch, register relays, means including said select magnets and register relays for establishing a connection between a calling line and a called line through said switch, means including
- 5 the temporary operation of a select magnet and the repeated operation of the register relay for thereafter transmitting different code ringing signals to the called line, the code transmitted being determined by the operation of a corresponding select magnet.
- 10 3. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing
- 15 a connection between a calling line and a called line through said switch, and means for transmitting various code ringing signals to called lines including the operation of a select magnet to determine the code and the operation
- 20 of the register relays to produce the code.
4. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing
- 25 a connection between a calling line and a called line through said switch, means for transmitting various code ringing signals to called lines a definite number of times including the operation of a select magnet to select the code
- 30 and the repeated operation of the register relays to produce and repeat the code.
5. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing
- 35 a connection between a calling line and a called line through said switch, and means for transmitting various code ringing signals to called lines and repeating a code at least four times, including
- 40 the operation of a select magnet to select a code and the operation of the register relays twice in succession to produce and repeat the code four times.
6. In a telephone system, a cross-bar switch
- 45 including select and hold magnets, lines terminating in said switch, links terminating in said switch, register relays, means responsive to the seizure of a calling line for establishing a connection from said line to an idle link through
- 50 said switch including the operation of a select magnet and a hold magnet, means responsive to the dialing of a digit over said calling line for establishing a connection from said idle link to a corresponding called line through said switch including
- 55 the operation of a select magnet, a definite register relay and a corresponding hold magnet, and means responsive to the dialing of a second digit for thereafter transmitting a corresponding code ringing signal including the operation of a
- 60 definite register relay and a corresponding select magnet to select and determine the code and including the operation thereafter of the register relays in succession a number of times to produce the selected code twice during each successive
- 65 operation of the register relays.
7. In a telephone system, a switch, lines, means for establishing a connection from one line to another through said switch, means for thereafter ringing the connected called line repeatedly by a definite code until the subscriber
- 70 of the called line answers, and means responsive to a call incoming over a third line before the called line answers for stopping the ringing of said called line and for thereafter releasing said first established connection.
8. In a telephone system, a switch, lines, means for establishing a connection from one line to another through said switch, means for thereafter ringing the connected called line repeatedly by a definite code until the subscriber
- 5 of the called line answers, and means responsive to a call incoming over a third line before the called line answers for stopping the ringing of said called line and for releasing the first established connection a definite time interval thereafter.
9. In a telephone system, a switch, lines, means for establishing a connection from one line to another through said switch, means for thereafter ringing the connected called line repeatedly by a definite code until the subscriber
- 15 of the called line answers, and means responsive to a call incoming over a third line before the called line answers for stopping the ringing after it has been repeated a definite number of times or after it has been repeated a number of times that is a multiple of said definite number of times and for thereafter releasing the first established connection.
- 10 10. In a telephone system, a switch, lines, a common equipment for use in the establishing of connections between lines through said switch, and for ringing a called line by code signals, means responsive to a call incoming over a line
- 25 for seizing said common equipment and for controlling it to establish a connection to a called line and ringing said called line with code signals repeated a number of times, and means responsive to a call incoming over another line
- 30 for stopping said ringing after it has been repeated a definite number of times, and releasing the first established connection and seizing said common equipment for the establishing of another connection from said second calling line
- 35 to a desired called line.
11. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing
- 40 a connection between a calling line and a called line through said switch, means including said select magnets and register relays for thereafter transmitting ringing signals to the called line, means including said select magnets and register relays for stopping the ringing and disconnecting the calling and called lines from each
- 45 other in response to the seizure of a second calling line for the establishing of a connection.
12. In a telephone system, a cross-bar switch including select magnets, lines terminating in said switch, register relays, means including said select magnets and register relays for establishing
- 50 a connection between a calling line and a called line through said switch, means including said select magnets and register relays for thereafter transmitting ringing code signals and repeating them a definite number of times to the called line, means including said select magnets and register relays for stopping the transmission
- 55 of ringing code signals after they have been repeated said definite number of times and thereafter disconnecting the called line from the calling line a definite time interval after said ringing has stopped, said means being responsive to the seizure of a second calling line for the establishing
- 60 of a second connection.
13. In a telephone system, a cross-bar switch, subscriber's lines terminating in said switch, links terminating in said switch, a common control circuit including a set of register relays, means
- 65 75

responsive to a subscriber of a line lifting his receiver from the switchhook for connecting his line to one end of an idle link and seizing the control circuit, means responsive to said subscriber dialing a digit for operating said register relays and for connecting a corresponding called line to the other end of said link, means responsive to the dialing of a second digit by said subscriber for actuating said register relays and for ringing the called line in a code corresponding to the digit dialed and for repeating said code a definite number of times, means responsive to the lifting of the receiver off the switchhook by

a second calling subscriber before the above-mentioned called subscriber answers for disconnecting the ringing, for releasing the control circuit and for establishing a connection between the second calling line and one end of another idle link and for seizing the control circuit for use in establishing a connection from said second calling subscriber to a desired called subscriber.

GRACE MACDONALD STOKELY,
Executrix of the Estate of Ray L. Stokely, Deceased.