

July 5, 1932.

G. V. KING ET AL

1,866,260

TELEPHONE SYSTEM

Original Filed Nov. 8, 1929

7 Sheets-Sheet 2

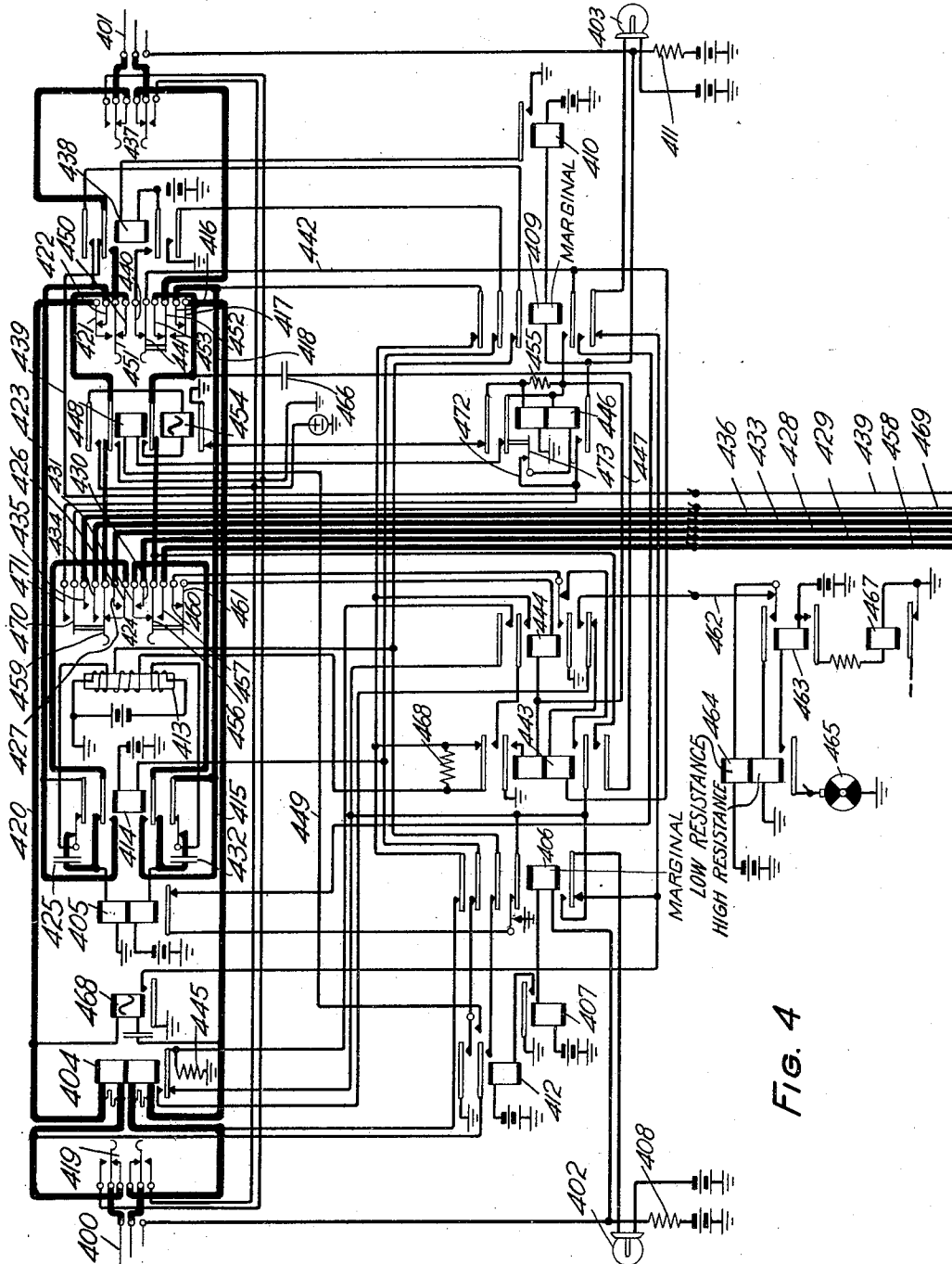


Fig. 4

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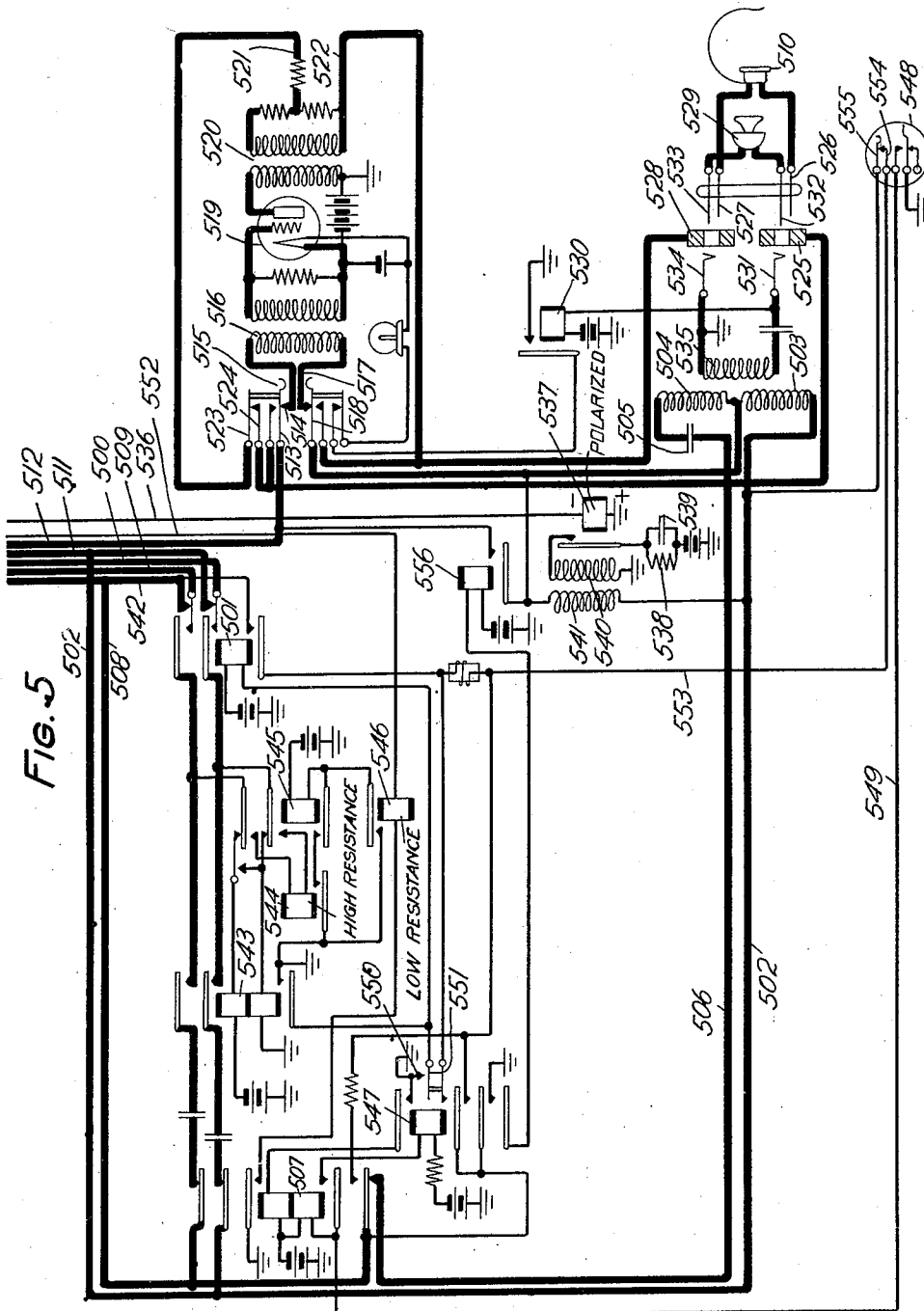
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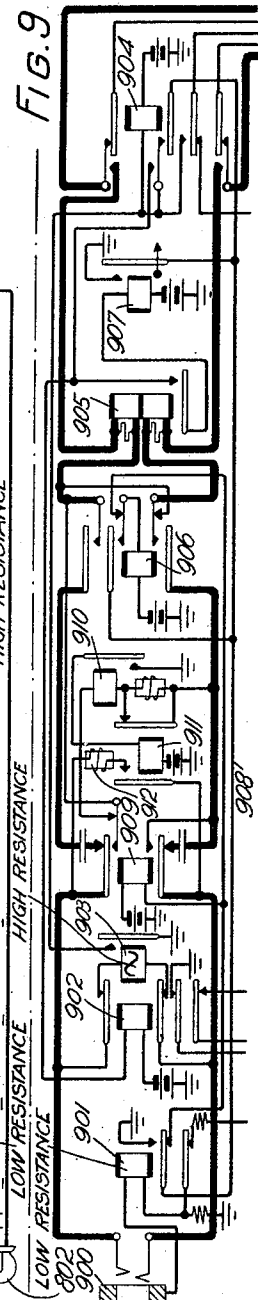
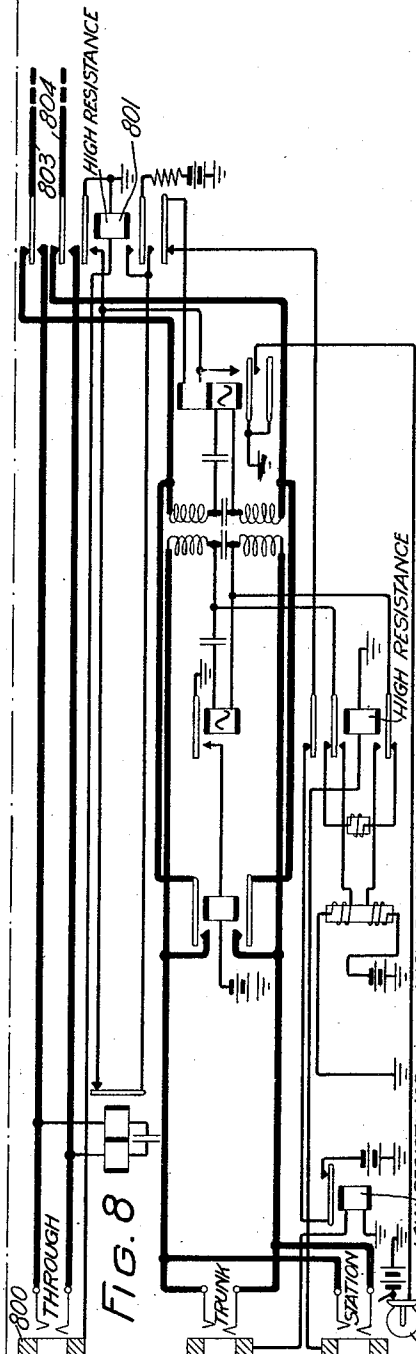
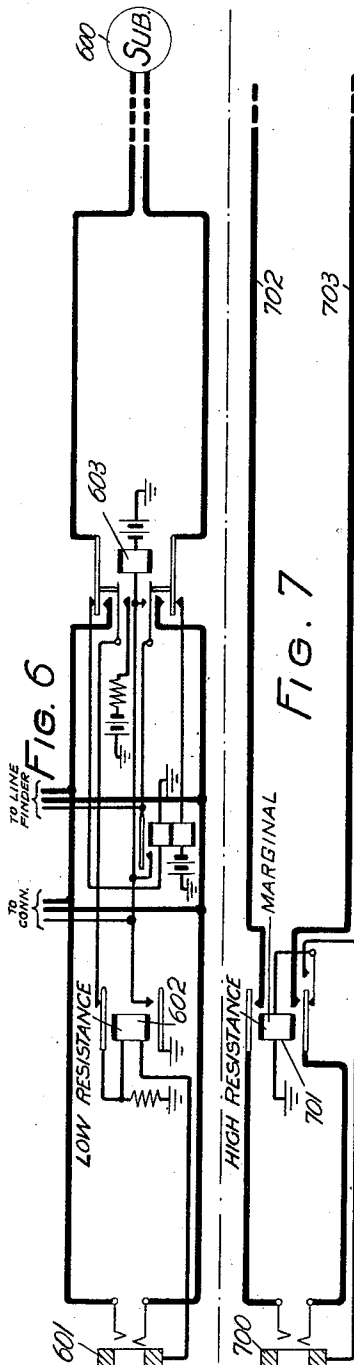
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Original Filed Nov. 8, 1929 7 Sheets-Sheet 5

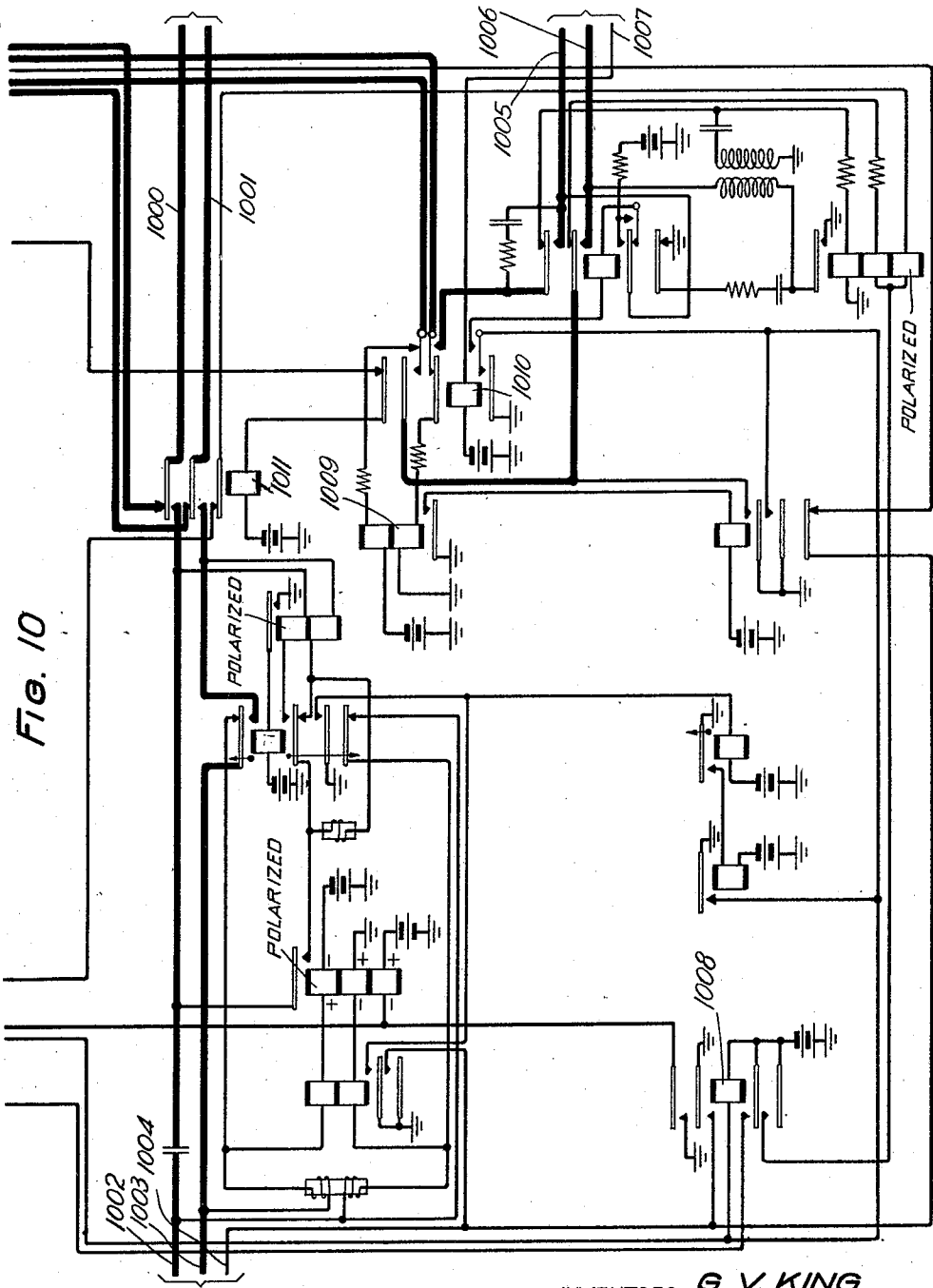


FIG. 10

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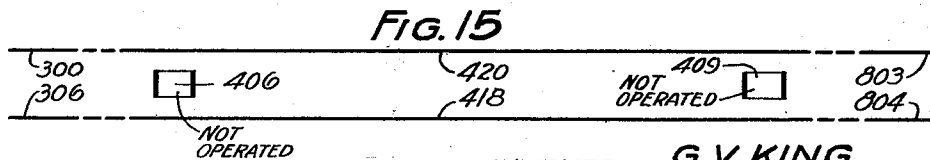
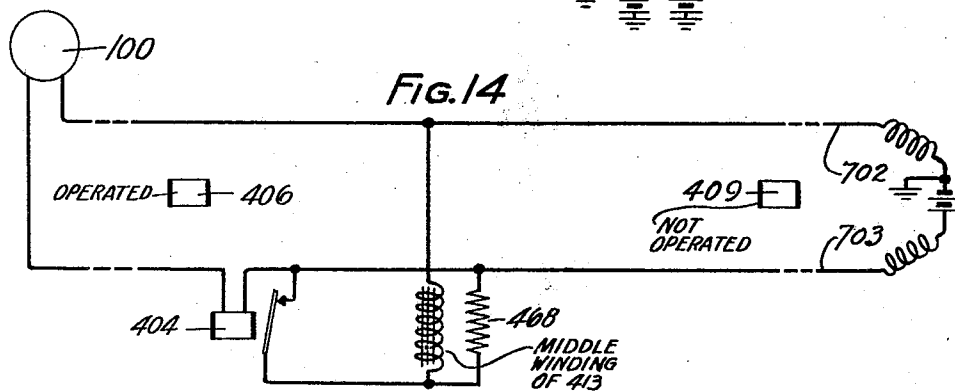
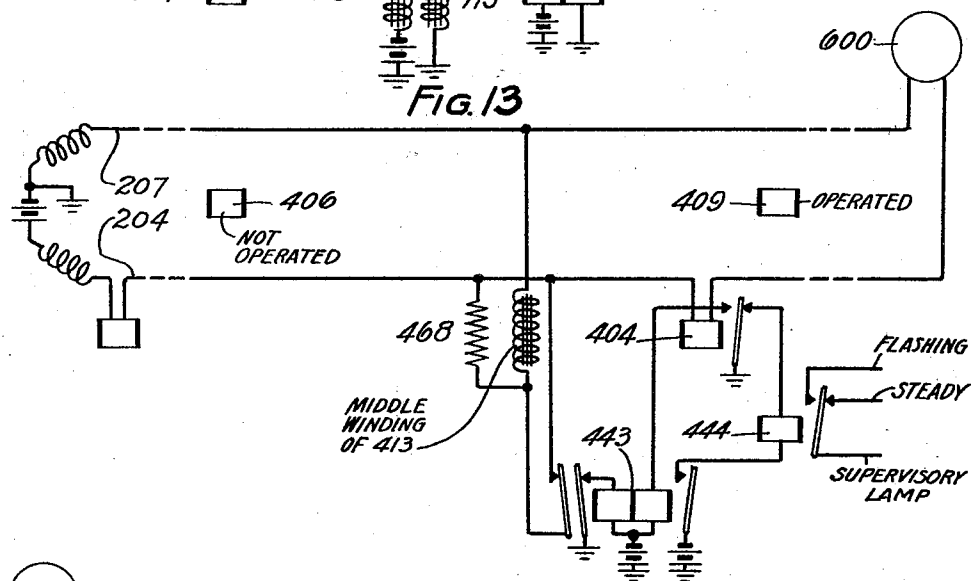
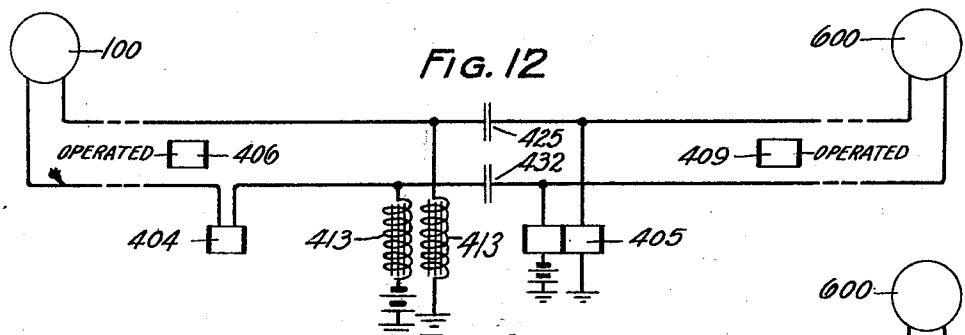
July 5, 1932.

G. V. KING ET AL

1,866,260

TELEPHONE SYSTEM

Original Filed Nov. 8, 1929 7 Sheets-Sheet 6



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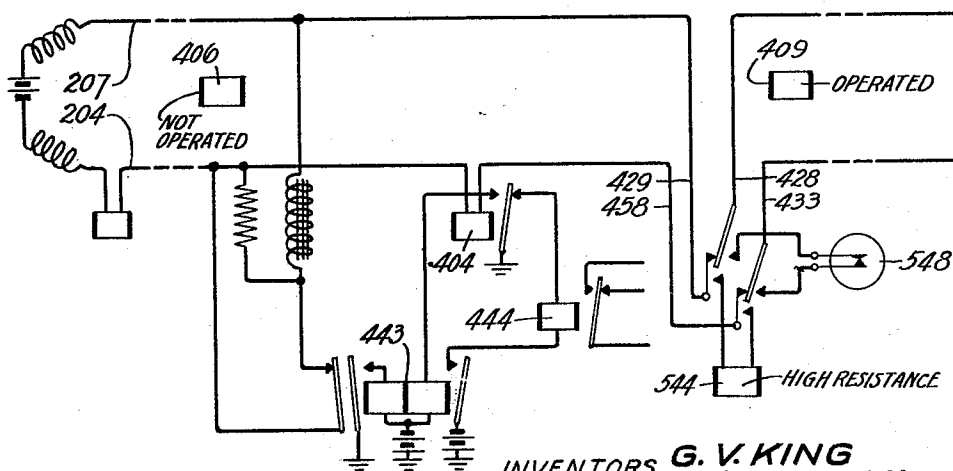
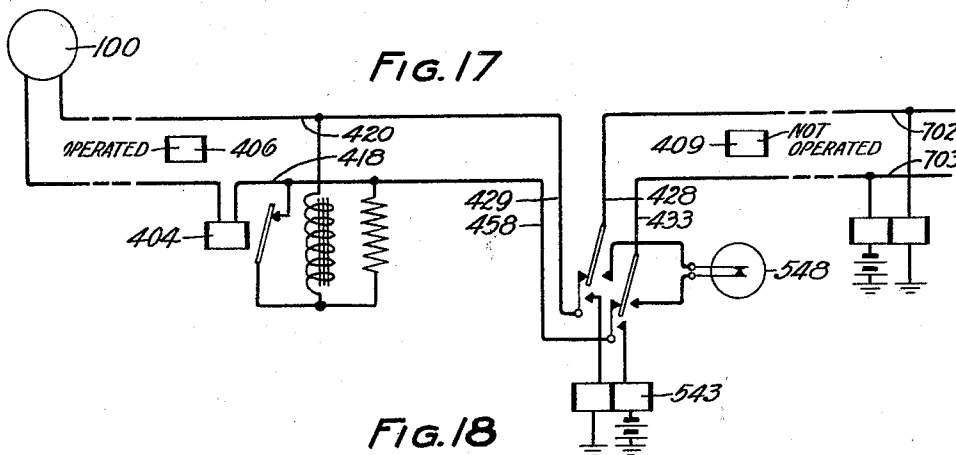
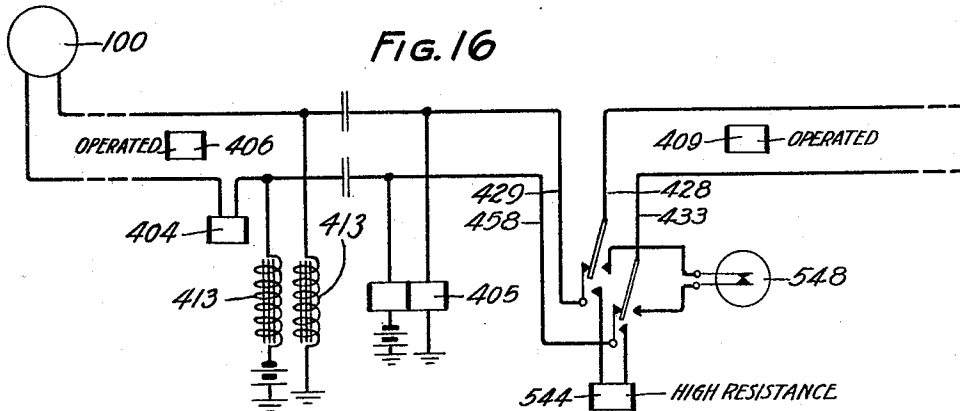
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G. V. KING ET AL

1,866,260

TELEPHONE SYSTEM

Original Filed Nov. 8, 1929 7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed November 8, 1929, Serial No. 405,603. Renewed June 6, 1931.

This application relates to telephone systems and particularly to universal cord circuits for mixed service over lines of different character.

5 In accordance with this invention a universal cord circuit having an answering cord and a calling cord is provided with sleeve relays differently responsive to connection with lines of different character. With such an
10 arrangement the sleeve relays are operated in different combinations, each of which is used to set up a different cord circuit condition. In one instance the cord circuit is maintained in its normal condition as a local battery feed circuit, wherein a local source of
15 battery is connected through supervisory relay to the two cords and the talking circuit is completed from cord to cord by condensers. In another instance the cord circuit is converted into what may be termed a locally
20 supervised distant battery feed type of circuit. In this arrangement a supervisory relay in the cord circuit responds to switchhook operation over one of the cords through
25 the agency of battery supplied from a distant point such as over a central office trunk. The local operation of the supervisory relay affects a local supervisory relay and at the same time controls
30 means to prevent the usual supervisory means at the distant point from being operated. In a third instance the cord circuit is converted into what may be termed a through circuit without series impedance. In this arrangement there is a direct connection from the tip
35 of one cord to the tip of the other and a direct connection from the ring of one cord to the ring of the other. No impedance such as the winding of a supervisory relay or a condenser is included in this direct path.

40 In accordance with another feature of this invention the supervisory relay normally connected to respond to switchhook operation over one cord is transferred under a given
45 combination of sleeve relay operation to respond to switchhook operation over the other cord.

50 In accordance with another feature of this invention a flashing recall means normally arranged to affect the supervisory signal of

one cord is switched to affect the supervisory signal of the other cord under a given combination of sleeve relay operation.

In accordance with still another feature of this invention an audible ringing means is made selective so that upon one kind of connection a ringing tone will be transmitted to the opposite end of the circuit while upon another kind of connection no such ringing tone will be transmitted.

55 In accordance with another feature of this invention the operator's dialing circuit is provided with a means selectively operated in accordance with the kind of connection established for connecting a battery feed bridge or a dry bridge across the answering end of the cord circuit while the cord is split for dialing over the calling end thereof.

60 In accordance with another feature of this invention the ringing current applied from the cord circuit when connected to a tie line that does not require ringing is automatically cut off and the tie line is cut through for dialing in response to the operation of the dial.

65 Other features will be noted in the following description.

The drawings consist of ten figures of circuit diagrams on five sheets which, arranged according to Fig. 11, illustrate the present invention. Fig. 1 shows the details of the switchboard end of a subscriber's line. Fig. 2 shows the switchboard end of an incoming central office line. Fig. 3 shows the arrangement of a tie line used between two private branch exchange switchboards. Fig. 4 shows a cord circuit and Fig. 5 shows the common circuits cooperating therewith, such as the operator's telephone and dialing circuit of the click reduction circuit. Fig. 6 shows the switchboard end of a subscriber's line and is a duplicate of Fig. 1, it being placed opposite Fig. 1 to facilitate the description. Fig. 7 shows the switchboard end of an outgoing central office line. Fig. 8 shows the arrangement of a tie line used between two private branch exchange switchboards and is a duplicate of Fig. 3, it being placed opposite Fig. 3 as Fig. 6 is placed opposite Fig. 1, in order to facilitate the description. Figs. 9 and 10 taken together show a two-way repeating tie

line which can be used either in cooperation with the cord circuit of Fig. 4, or with the automatic switches used in an installation of this nature. There are also two additional sheets of drawings containing seven additional figures numbered 12 to 18, inclusive, each of which is a schematic of different type of connection. Fig. 12 is a schematic of a station to station connection. Fig. 13 is a schematic of a central office to station connection. Fig. 14 is a schematic of a station to central office connection. Fig. 15 is a schematic of a toll connection. Fig. 16 is a schematic of a connection similar to that of Fig. 12 with an indication of conditions set up in the operator's dialing circuit. Fig. 17 is a schematic of a connection similar to that of Fig. 14 with an indication of conditions set up in the operator's dialing circuit and Fig. 18 is a schematic of a connection similar to that of Fig. 13 with an indication of conditions set up in the operator's dialing circuit.

In general, the cord circuit of Fig. 4 consists of an answering plug 400 and a calling plug 401. The answering plug 400 is invariably used to answer an incoming call made over any one of the lines, such as those of Figs. 1, 2 or 3. The calling plug 401 is used to complete the connection to such lines as those illustrated in Figs. 7, 8 and 9. Associated with the answering plug 400 is the answering supervisory lamp 402 and similarly associated with calling plug 401 is the calling supervisory lamp 403. Under circumstances to be hereafter described, relay 404 may be termed the answering supervisory relay and relay 405 may be termed the calling supervisory relay.

The sleeve of the answering plug 400 extends in series through the windings of two sleeve relays 406 and 407. Relay 406 is marginal and will only be energized when the plug 400 is inserted in a jack whose sleeve is connected to a low resistance relay, such as that shown in Fig. 1. When the plug 400 is inserted in a jack whose sleeve is connected to a high resistance relay, such as that shown in Fig. 2, marginal relay 406 will fail to operate. Relay 407, however, operates in either case. It should be noted that a non-inductive resistance 408 is connected in shunt of the two relays 406 and 407. This is the usual arrangement to prevent the operator from being shocked by an inductive discharge when she removes the plug 400 from a line jack.

In a similar manner the sleeve of plug 401 extends in series through relays 409 and 410. Relay 409 like relay 406 is marginal and will only become energized when the plug 401 is placed in a jack whose sleeve is connected to a low resistance relay, such as that in Fig. 6. Non-inductive resistance 411 is connected in shunt of relays 409 and 410 for the same

purpose as described in connection with resistance 408.

Station to station call

Fig. 12 is a schematic of the type of circuit employed for a station to station connection. It is commonly known as a bridged impedance cord circuit. The battery feed is local, that is current for talking purposes is supplied from within the cord circuit and the talking conductors are conductively separated by condensers.

The subscriber at substation 100 removing his receiver from its hook causes the energization of the usual line relay 101 which in turn causes the illumination of line lamp 102. The operator inserts plug 400 in jack 103 thus completing a circuit through relays 104, 406 and 407. Relay 104 being of low resistance causes the energization of both relays 406 and 407. Relay 104 becoming energized places ground on conductor 105 in order to mark the line as busy in the connector banks to which the conductors 106 extend. At the same time the ground connection on conductor 105 causes the energization of the cut-off relay 107 whereby the line relay is cut off and the talking conductors from the subscriber's station are connected through to the tip and ring contacts of jack 102.

Battery current is supplied to the calling substation 100 over the following path from battery, lower winding of retardation coil 413, back contact and lower outer armature of relay 414, conductor 415, contacts 416 and 417, conductor 418, lower winding of relay 404, normal contacts of the lower contact set of ringing key 419, ring contact of plug 400, ring contact of jack 103, front contact of lower armature of cut-off relay 107, through the loop of substation 100, inner upper armature and front contact of cut-off relay 107, tip contact of jack 103, tip contact of plug 400, normal contacts of the upper contact set of ringing key 419, upper winding of supervisory relay 404, conductor 420, contacts 421 and 422, conductor 423, upper outer armature and back contact of relay 414, upper winding of retardation coil 413 to ground. The receiver being off its hook at substation 100 current flows through this circuit and causes the energization of answering supervisory relay 404.

The operator now establishes a talking connection with the calling subscriber by operating the listening key 424, whereby a connection is made between the conductors of the cord and the operator's telephone set as follows: tip conductor 420, contacts 421 and 422, conductor 423, back contacts of the outer upper armature of relay 414, condenser 425, back contact and inner upper armature of relay 414, contacts 426 and 427 of listening key 424, conductor 428, conductor 500, normal contacts of the inner upper armature of

relay 501, conductor 502, windings 503 and 504 of the operator's telephone set induction coil, condenser 505, conductor 506, back contact and outer lower armature of relay 507, conductor 508, normal contacts of the outer upper armature of relay 501, conductor 509, conductor 429, contacts 430 and 431 of key 424, inner lower armature and back contact of relay 414, condenser 432, back contacts and lower outer armature of relay 414, conductor 415, contacts 416 and 417 and thence to ring conductor 418.

The operator's receiver 510 is effectively bridged across winding 503 of the operator's telephone set induction coil. Such connection may be traced from the lower terminal of winding 503, conductor 502, conductor 511, conductor 433, contacts 434 and 435 of key 424, conductor 436, conductor 512, contacts 513 and 514 of key 515, primary winding 516 of the input transformer for the operator's click reduction circuit, contacts 517 and 518 to the upper terminal of winding 503. Voice currents in transformer winding 516 will be translated through the audion 519 and output transformer 520 to the two output conductors 521 and 522. Conductor 521 extends over contacts 523 and 524, through sleeve of jack 525, sleeve of plug 526, receiver 510, sleeve of plug 527, sleeve of jack 528 to conductor 522.

The transmitter 529 is in a circuit from battery, winding of relay 530, tip of jack 531, tip of plug 532, transmitter 529, tip of plug 533, tip of jack 534 to ground. The winding 535 of the operator's set induction coil is in parallel with the transmitter and will translate voice currents generated by said transmitter into the cord circuit, through the agency of windings 503 and 504 connected over conductors 502 and 506 to the tip and ring conductors of the cord as hereinbefore described.

The operator now challenges the calling subscriber and learning that a connection is desired to the substation 600 makes the usual busy test by touching the tip of plug 401 to the sleeve of jack 601. If the line of substation 600 is idle, ground will be found on sleeve of jack 601 and no busy test indication will be given to the operator. If, however, this line is busy a battery potential will be found on the sleeve of jack 601 which will be communicated over the tip of plug 401, upper normal contacts of ringing key 437, inner upper armature and back contact of relay 438, conductor 439, conductor 536, winding of polarized relay 537 to ground. Relay 537 will respond to this connection and will in turn establish a connection from battery, through resistance 538 shunted by condenser 539, armature and front contact of relay 537, winding 540 of the busy test induction coil to ground. The current built up in winding 540 will induce a transient current in the sec-

ondary winding 541 which being bridged across the winding 503 of the operator's set induction coil will manifest itself as a click in the operator's receiver.

Let it be assumed that the line of substation 600 is found to be idle. Then plug 401 will be inserted in jack 601 and since relay 602 is of low resistance it will become energized along with both relays 409 and 410 in series therewith. Relay 410 becoming energized causes the energization of relay 438 whereupon a circuit is established from battery, inner lower armature and front contact of relay 438, contacts 440 and 441, conductor 442, lower winding of relay 443, back contact and lower outer armature of relay 444, front contact and armature of answering supervisory relay 404, resistance 445 to ground. Relay 443 becomes energized in this circuit.

Since relay 409 has become energized a circuit is now established from battery, calling supervisory lamp 403, lower outer armature and front contact of relay 409, back contact and armature of calling supervisory relay 405, alternate contacts of the innermost upper armature of relay 406 to ground. Supervisory lamp 403 becomes illuminated to indicate that the called party has not yet removed his receiver from its hook.

Relay 443 now becomes locked in a circuit from ground, its inner upper armature and front contact and its upper winding, conductor 447, front contact and inner lower armature of relay 409, conductor 442 and thence to battery over the circuit heretofore traced. At the same time battery on conductor 442 is extended through the inner lower armature and front contact of relay 409, the inner upper armature and back contact of relay 446, winding of relay 448, conductor 449, front contacts and upper outer armature of relay 412 to ground. Relay 448 becomes energized in this circuit and connects ringing current to the called line.

This current flows over a path from ground, front contact and the inner upper armature of relay 448, contacts 450 and 451, front contact and inner upper armature of relay 438, upper normal contacts of ringing key 437, tip of plug 401, tip of jack 601, through the front contact and upper armature of cut-off relay 603, over the loop of substation 600, lower armature and front contact of relay 603, ring contact of jack 601, ring of plug 401, lower normal contacts of key 437, contacts 452 and 453, lower armature and front contact of relay 448, winding of ringing cut-off relay 454, upper outer armature and front contact of relay 448 to the source of ringing current.

It should be noted at this point that relay 446 has a circuit from ground, its upper winding, resistance 455 and thence over the front contact and inner lower armature of relay 409 to battery on conductor 442. However, the upper winding of relay 446 is short-cir-

cuted through its own upper outer armature and back contact and the back contact of relay 454 to ground so that relay 446 cannot become energized until relay 454 has moved its armature.

5 During the transmission of ringing current over the circuit just traced a small amount will be by-passed from the lower armature of relay 448, through condenser 466, outer lower armature and front contact of relay 443, contacts 456 and 457, conductor 458, conductor 542, normal contacts of the upper outer armature of relay 501, conductor 509, conductor 429, contacts 430 and 431, inner lower armature and back contact of relay 414, condenser 432, back contacts and outer lower armature of relay 414, conductor 415, contacts 416 and 417 and thence to conductor 418 from whence it finds a path through the calling substation to ground connected to the upper winding of retardation coil 413 previously described. Thus, during the transmission of ringing current to the called subscriber's line a ringing tone is given to the calling subscriber.

The ringing current flowing in the called subscriber's telephone is insufficient to cause the energization of ringing cut-off relay 454 until the subscriber thereat removes his receiver from its hook. At this time relay 454 becomes energized and removing ground from the back contact of the upper outer armature of relay 456 opens the short circuit across the upper winding of relay 446 so that this relay now becomes energized in series with resistance 455 to battery on conductor 442 through its inner upper armature. Relay 446 opens the circuit of relay 448 and this relay now becomes deenergized.

Thereupon a talking circuit for substation 600 is established from ground, upper winding of answering supervisory relay 405, back contact and inner upper armature of relay 414, contacts 426 and 427, conductor 428, conductor 500, normal contacts of the inner upper armature of relay 501, conductor 511, conductor 433, contacts 434 and 459, back contact and inner upper armature of relay 448, contacts 450 and 451, front contact and inner upper armature of relay 438, upper normal contacts of key 437, tip of plug 401, tip of jack 601, over the loop of substation 600, ring of jack 601, ring of plug 401, lower normal contacts of key 437, contacts 452 and 453, lower armature and back contact of relay 448, contacts 456 and 457, conductor 458, conductor 542, normal contacts of the upper outer armature of relay 501, conductor 509, conductor 429, contacts 430 and 431, inner lower armature and back contact of relay 414, lower winding of answering supervisory relay 405 to battery. The circuit just traced is one which is established while the operator has the listening key 424 op-

erated. When the operator has restored key 424 to normal then the circuit extends directly from contact 426 to contact 459 to the tip of the cord and from the ring of the cord directly from contact 456 to contact 431 so that in either case battery and ground through the windings of relay 405 are connected to the tip and ring of plug 401 and thence to the called subscriber's line.

When the relay 405 becomes energized in the circuit just described, answering supervisory lamp 403 becomes dark thus indicating to the operator that the called subscriber has answered.

When the conversation has terminated and the called subscriber replaces his receiver, relay 405 becomes deenergized and again closes a circuit for lamp 403 which becomes lighted. If at the same time the calling subscriber replaces his receiver, then answering supervisory relay 404 becomes deenergized and returning its armature to normal establishes a circuit from ground, resistance 445, armature and back contact of relay 404, front contact and lower armature of relay 406, answering supervisory lamp 402 to battery. Lamp 402 becomes lighted to indicate that the calling subscriber has hung up. At the same time the ground for the energization of answering supervisory lamp 402 is extended through the lower inner armature and front contact of relay 443, normal contacts of the inner lower armature of relay 444, contacts 460 and 461, winding of relay 444, front contact and inner lower armature of relay 409 to battery on conductor 442. Relay 444 becomes energized in this circuit and locks to ground through its inner lower armature and front contact.

If the calling subscriber does not again take his receiver off its hook before the operator has taken the connection down, the energization of relay 444 has no effect. If, on the other hand, the calling subscriber wishes to recall the operator, he then removes his receiver from its hook whereupon relay 404 again becomes energized and a circuit is established in parallel with lamp 402, from the armature and front contact of relay 404, the lower outer armature and front contact of relay 444, flashing recall lead 462, normal contacts of the upper armature of relay 463, upper winding of relay 464 to battery. The upper winding of relay 464 is of low resistance and while it is in shunt of lamp 402 it reduces the current flow therethrough below the amount necessary for illumination of the lamp. Relay 464 is energized in this circuit and upon operating its armature closes a circuit for relay 463 through the interrupter 465. When the interrupter closes this circuit, relay 463 will become energized and by moving its upper armature opens the lead 462 so as to remove the shunt from about lamp 402 thereby allowing it to become fully

illuminated. At the same time a circuit is closed through the lower high resistance winding of relay 464 in series with the upper low resistance winding so that relay 464 is maintained energized as long as the circuit through lead 462 is effective. When the interrupter 465 moves to an open segment then relay 463 is deenergized and the lamp 402 is again shunted by the low resistance winding of relay 464. It will thus be seen that relay 463 responds to the interrupter 465 and that the lamp 402 will flash accordingly. Through its lower armature relay 463 closes a circuit for magnet 467 which acts as an audible sounder. Thus on a recall there is both a visible and audible signal given to the operator.

When the operator answers the recall by operating listening key 464, she opens the circuit of relay 444 at contacts 460 and 461 so that this relay now returns to normal and will so remain until the connection has been taken down.

On a recall such as that just described the called party may be signaled by the operation of ringing key 437, or the operator instead may take the plug 401 out of the jack 601 momentarily so as to restore relay 446 to its normal condition.

Central office to station call

Fig. 13 is a schematic of the type of circuit employed on an incoming central office call destined for a local station. This is commonly known as a distant battery feed locally supervised cord circuit. Note that a bridge is interposed between the local supervisory relay and the source of current at the central office. Thus the central office battery is used for talking purposes and for local signaling without disturbing the supervisory relay at the central office. When the local station receiver is off the hook the bridge is increased in impedance so as not to affect transmission.

On a call from the central office over the trunk shown in Fig. 2, ringing current will flow over the upper outer armature and back contact of relay 200, lower winding of ringing relay 201, condenser 202, lower armature and back contact of relay 203 to the line wire 204. Relay 201 responds to this current and locks in a circuit from ground, inner upper armature and back contact of relay 200, upper winding of relay 201, front contact and inner lower armature of relay 201, outer lower armature and contact of relay 201 to battery. Through the front contact and outer lower armature of relay 201 line lamp 205 is energized so as to display a calling signal to the operator. The battery connection for the energization of the upper winding of relay 201 also extends to the winding of relay 203 which now becomes energized and through its lower armature and front con-

tact short-circuits the lower winding of relay 201.

The operator handling the cord circuit of Fig. 4 will insert plug 400 in jack 206 whereupon a circuit is established from ground, winding of relay 200, normal contacts of the lower armature of relay 200, ring contact of jack 206, ring of plug 400, lower normal contacts of ringing key 419, back contact and outermost upper armature of relay 406, back contact and outermost upper armature of relay 409, conductor 415, outer lower armature and back contact of relay 414, lower winding of retardation coil 413 to battery and ground. Relay 200 is energized in this circuit and in moving its armatures to their operated positions, transfers the circuit of relay 200 from the ring of jack 206 to the sleeve of jack 206 so that relay 200 now remains operated in series with relays 406 and 407. Relay 200 being of high resistance limits the current flowing in this circuit so that relay 406 does not become energized.

Upon the energization of relay 200 a circuit is closed from the line conductor 207, outer upper armature and front contact of the relay 200, alternate contacts of the upper armature of relay 203, resistance 208 to conductor 204. Thus a shunt is momentarily placed across the trunk in order to trip the machine ringing arrangement at the central office. The energization of relay 200 at the same time opens the circuit for the upper winding of relay 201 so that this relay becomes deenergized causing in turn the deenergization of relay 203. This relay, however, being slow to release maintains a circuit through resistance 208 just described for a length of time sufficient to insure tripping of the machine ringing. It then becomes deenergized and closes the line wire 207 to the tip of jack 206 and the wire 204 through to the ring of jack 206.

In this instance relay 407 is energized, but relay 406 remains in its normal condition and therefore relay 412 becomes energized and closes a circuit from the outer upper armature and front contact of relay 412, the back contact and next to outermost upper armature of relay 406, winding of relay 414 to battery and ground. Relay 414 becomes energized in this circuit and cuts off relay 405 from the connection to the cord circuit.

When the operator operates her listening key 424 a talking circuit will be established from tip conductor 420, through contacts 421 and 422, conductor 423, front contact and inner upper armature of relay 414, contacts 426 and 427, conductor 428 and thence over the circuit previously described including the windings 503 and 504, back over conductor 429, contacts 430 and 431, inner lower armature and front contact of relay 414, conductor 415, contacts 416 and 417 to ring conductor 418. Thus a talking connection between the

central office trunk and the operator's set is established.

Since battery and ground are supplied from the central office trunk a circuit is established from conductor 207, upper outer armature and back contact of relay 200, normal contacts of the upper armature of relay 203, tip conductor of jack 206, tip contact of plug 400, upper normal contacts of ringing key 419, inner upper armature and front contact of relay 412, the next to innermost upper armature and back contact of relay 406, middle winding of retardation coil 413, upper outer armature and back contact of relay 443, outermost upper armature and back contact of relay 406, lower normal contacts of ringing key 419, ring contact of plug 400, ring contact of jack 206, lower armature and front contact of relay 200, lower armature and back contact of relay 203 to conductor 204. Thus the middle winding of retardation coil 213 is bridged across the central office trunk to operate the supervisory relay at the central office. The answering cord supervisory relay 404 is not operated at this time.

The operator now answers the incoming central office call and learning that the subscriber at substation 600 is wanted, makes the usual busy test by touching the tip of plug 401 to the sleeve of jack 601. Upon learning that the line to substation 600 is idle, she will insert the plug 401 into jack 601 thereby causing the energization of relays 602, 409 and 412. Relay 448 becomes energized as hereinbefore described and applies ringing current to the line of substation 600.

In this case it should be noted that relay 443 has not become energized as yet and hence the ringing current applied to condenser 466 finds no return path so that a ringing tone is not transmitted in this instance.

When the subscriber at substation 600 removes his receiver from its hook, relay 454 is energized and relay 446 responds as before. Relay 448 is returned to normal and a talking circuit is now established from the tip of plug 400, through the upper winding of relay 404, conductor 420, contacts 421 and 422, conductor 423, front contact and inner upper armature of relay 414, contacts 426 and 459 (assuming that the operator has restored key 424), back contact and inner upper armature of relay 448, contacts 450 and 451, front contact and inner upper armature of relay 438, upper normal contacts of ringing key 447, tip of plug 401, tip of jack 601, over the loop of substation 600, ring of jack 601, ring of plug 401, lower normal contacts of ringing key 437, contacts 452 and 453, lower armature and back contact of relay 448, contacts 456 and 431, inner lower armature and front contact of relay 414, conductor 415, contacts 416 and 417, conductor 418, lower winding of

supervisory relay 404, lower normal contacts of ringing key 419 to the ring of plug 400. Thus talking current is supplied to substation 600 from the central office trunk through the windings of supervisory relay 404.

Supervisory relay 404 now becomes energized and establishes a circuit from ground, resistance 445, armature and front contact of relay 404, lower outer armature and back contact of relay 444, lower winding of relay 443, conductor 442, contacts 441 and 440, front contact and inner lower armature of relay 438 to battery. Relay 443 becomes energized in this circuit and inserts resistance 468 in series with the middle winding of retardation coil 413.

It should be emphasized at this point that when the substation 600 is bridged across the line and uses battery from the central office trunk that the bridge also across the line and between the relay 404 and the central office consists of a high impedance including the middle winding of retardation coil 414 and the resistance 468. When, however, the bridge of substation 600 is removed so that supervisory relay 404 cannot be energized by the central office battery, then the impedance of the bridge between relay 404 and the central office is reduced through the short-circuiting of resistance 468.

This type of circuit may appropriately be called "local supervised distant battery feed circuit" since the only result of switch hook movement at substation 600 will be to signal the operator at cord circuit 400 without disturbing the supervisory signal at the central office from which the battery supply is derived.

If after the subscriber at substation 600 has answered and the bridge across the trunk between the supervisory relay 400 and the central office has been increased in its impedance through the introduction of resistance 468, such subscriber wishes to recall the operator he may do so by depressing his receiver hook once.

The depression of the receiver hook at substation 600 results in the deenergization of relay 404 whereupon a circuit is established from ground, resistance 445, armature and back contact of relay 404, inner lower armature and front contact of relay 443, normal contacts of the inner lower armature of relay 444, contacts 460 and 461, winding of relay 444, front contact and inner lower armature of relay 409 to battery on conductor 442. Relay 444 becomes energized in this circuit and locks over its inner armature and front contacts so that when the switch hook at substation 600 is again lifted and relay 404 is again energized, the flashing recall circuit through the front contact and outer lower armature of relay 444 becomes effective. The operator in answering the recall operates key

424 and through the opening of contacts 460 and 461 restores relay 444 to normal.

In connection with this type call from an incoming central office trunk to a station it should be emphasized that the flashing recall circuit operates in response to a recall made over the calling plug 401 instead of over the answering plug 400 as previously described and that the relay 404 which in the first instance responded to switch hook operation over the answering plug 400, in this instance responds to switch hook operation over the calling plug 401.

Station to central office call

Fig. 14 is a schematic of the type of circuit employed in a station to a central office connection. This is an even better illustration of a distant battery feed locally supervised type of cord circuit, for in this case the automatic flashing recall feature is not used. Hence the bridge between the local supervisory relay is changed in direct response to the local supervisory relay.

When the subscriber at substation 100 wishes to get a connection to the central office he removes his receiver as usual and causes the lighting of line lamp 102. The operator inserts plug 400 in jack 103 with the results hereinbefore noted. She will then, upon instruction of the subscriber at substation 100, insert plug 401 in jack 700 of the outgoing central office line. The sleeve relay 701 associated with this outgoing trunk is of high resistance so that relay 410 will become energized in series with relay 701, but relay 409 will fail to operate. Relay 414 operates over the back contact and middle upper armature of relay 409, lower outer armature and front contact of relay 438 to ground. Due to the failure of relay 409 to operate, the ringing relay 448 cannot become energized and hence a bridge will be immediately established across conductors 702 and 703 as follows: conductors 702, front contact and upper armature of relay 701, tip conductor of jack 700, tip conductor of plug 401, upper normal contacts of ringing key 437, inner upper armature and front contact of relay 438, contacts 451 and 450, inner upper armature and back contact of relay 448, contacts 459 and 434, conductor 433, conductor 511, normal contacts of the inner upper armature of relay 501, conductor 500, conductor 428, contacts 427 and 426, inner upper armature and front contact of relay 414, front contact and outer upper armature of relay 438, innermost upper armature and back contact of relay 409, middle winding of retardation coil 413, upper outer armature and back contact of relay 443, outermost upper armature and back contact of relay 409, conductor 415, front contact and inner lower armature of relay 414, contacts 431 and 430, conductor 429, conductor 509, normal contacts of the

upper outer armature of relay 501, conductor 542, conductor 458, contacts 457 and 456, back contact and lower armature of relay 448, contacts 453 and 452, lower normal contacts of ringing key 437, ring of plug 401, ring of jack 700, inner lower armature and front contact of relay 701 to conductor 703. This bridge consisting essentially of the middle winding of retardation coil 413 thrown across conductors 702 and 703 will signal the central office attendant.

When the connection is completed at the central office, battery and ground are connected to conductors 703 and 702 respectively and will flow over a circuit which may be traced from tip of plug 401, upper normal contacts of ringing key 437, inner upper armature and back contact of relay 438, contacts 451 and 450, inner upper armature and back contact of relay 448 (and now assuming that the operator has restored key 424 to normal) through contacts 459 and 426, inner upper armature and front contact of relay 414, conductor 423, contacts 422 and 421, conductor 420, upper winding of supervisory relay 404, upper normal contacts of ringing key 419, tip of plug 400 and thence through the loop of substation 100, ring of plug 400, lower normal contacts of ringing key 419, lower winding of supervisory relay 404, conductor 418, contacts 417 and 416, conductor 415, front contact and inner lower armature of relay 414, contacts 431 and 456 of key 424, back contact and lower armature of relay 448, contacts 453 and 452, lower normal contacts of ringing key 437 to ring of plug 401. Relay 404 will become energized through the current flowing through substation 100 and by operating its armature will establish a circuit from ground, resistance 445, armature and front contact of relay 404, lower armature and back contact of relay 444, lower winding of relay 443, conductor 442, contacts 441 and 440, contact and inner lower armature of relay 438 to battery. Upon the energization of relay 443, resistance 468 is placed in series with the middle winding of retardation coil 413 so that the bridge across the central office line between the supervisory relay 404 and the central office is now of high impedance so as not to interfere with the talking currents.

If the subscriber at station 100 should replace his receiver then relay 443 will be released and the bridge across the central office trunk will be reduced to the middle winding of retardation coil 413 alone. At the same time a circuit will be established from ground, resistance 445, armature and back contact of relay 404, front contact and lower armature of relay 406, supervisory lamp 402 to battery. If the subscriber should recall by again taking his receiver off the hook, relays 404 and 443 will respond and lamp 402 will go out. Thus on this type of connection

tion wherein a subscriber's line is connected to the answering cord and the central office trunk is connected to the calling cord, the supervisory lamp will respond directly to switch hook operation and not to the automatic flashing recall circuit as hereinbefore described.

Toll connection

Fig. 15 is a schematic of a toll type connection into which the present cord circuit may be converted under appropriate circumstances. Note that it is very simple, consisting of a pair of conductors making a through connection from the calling line to the called line.

It may happen with this type of installation that a toll type connection is needed as when a call coming in over a tie line is destined to be extended over another tie line. Let us assume an incoming call on the tie line of Fig. 3. Ringing current coming over conductor 300 passes over the outermost upper armature and back contact of relay 301, winding 302 of repeating coil 303, lower winding of relay 304, lower winding 305 of repeating coil 303, back contact and middle upper armature of relay 301 to conductor 306. Relay 304 is energized in this circuit and through its lower outer armature establishes a connection for signal lamp 307. Relay 304 locks in a circuit from battery, back contact and armature of relay 308, back contact and upper outer armature of relay 309, back contact and lower outer armature of relay 301, upper winding of relay 304, front contact and inner lower winding of relay 304 to ground. Thus line lamp 307 will remain lighted until the call is answered in the usual way.

The operator noting the call will insert plug 400 into the "through" jack 310 whereupon a connection is established from ground through the winding of relay 301, sleeve of jack 310, sleeve of plug 400 and thence through relays 406 and 407. Relay 301 being of high resistance causes the operation of relay 407, but not the operation of relay 406.

The operator learning that a connection is desired to another distant private branch exchange will insert plug 401 into jack 800 whereupon relay 801 will be energized in series with relays 409 and 410 causing the operation of relay 410 alone. Relay 414 is operated over the back contacts of both relays 406 and 409.

Thus in this case neither of the marginal relays 406 or 409 is operated. This results in a toll type cord wherein a direct connection may be traced from the tip of plug 400 to the tip of plug 401 as follows: tip of plug 400, upper normal contacts of ringing key 419, inner upper armature and front contact of relay 412, next to the innermost upper armature and back contact of relay 406, in-

nermost upper armature and back contact of relay 409, outer upper armature and front contact of relay 438, conductor 423, front contact and inner upper armature of relay 414, contacts 426 and 459, back contact and inner upper armature of relay 448, contacts 450 and 451, front contact and inner upper armature of relay 438, upper normal contacts of ringing key 437 to the tip of plug 401.

In a similar manner a direct connection may be traced from the ring of plug 400 to the ring of plug 401 as follows: the ring of plug 400, the lower normal contacts of ringing key 419, back contact and outermost upper armature of relay 406, back contact and outermost upper armature of relay 409, conductor 415, front contact and inner lower armature of relay 414, contacts 431 and 456, back contact and lower armature of relay 448, contacts 453 and 452, lower normal contacts of ringing key 437 to the ring of plug 401.

In a connection of this type, if the operator is needed her attention may be attracted as follows: Let it be assumed that the operator at the distant end of the trunk in Fig. 3 impresses ringing current on the conductors 303 and 306. This ringing current will flow from conductor 300, over the outermost upper armature and front contact of relay 301, conductor 311, winding of relay 312 and condenser 313, conductor 314, front contact and middle upper armature of relay 301 to conductor 306. Relay 312 responds to this ringing current and by operating its armature closes a circuit from ground, inner upper armature and front contact of relay 301, upper winding of relay 304, lower outer armature and front contact of relay 301, front contact and inner lower armature of relay 301, resistance 315 to battery. Relay 304 responds in this circuit and causes the lighting of line lamp 307 as before. This line lamp acts as a supervisory means during the maintenance of a connection over this trunk. As soon as the ringing current applied to conductors 303 and 306 is removed, relay 312 will restore its armature to normal and the upper winding of relay 304 will be short-circuited.

The line lamp 802 may be illuminated in the same manner to call the attention of the operator.

Tie line to station connection

Fig. 13 is a schematic of a tie line to station connection.

In the case of a call coming over the tie line of Fig. 3 intended for a station such as substation 600, such call will be answered as just described. The operator, however, upon being informed that station 600 is wanted will transfer the plug 400 from jack 310 to jack 316. This is for the purpose of getting a better source of talking current than could be supplied over the long loop of the tie line.

The sleeve resistance in the case of jack 316 is the same as that of jack 310, i. e., relay 309 is of high resistance so that the connection in this instance will be the same as a central office to station call. Battery and ground are supplied to the tip and ring of jack 316 as follows: Battery, lower winding of retardation coil 317, front contact and lower armature of relay 309, winding 318 of repeating coil 303, ring of jack 316 and from ground, upper winding of retardation coil 317, front contact and inner upper armature of relay 309, winding 319 of repeating coil 303 to the tip of jack 316.

Tie line to central office line connection

Fig. 14 schematically represents a tie line to central office connection.

Assume an incoming call on the tie line of Fig. 3 destined for the central office over the outgoing trunk of Fig. 7. The operator being told that such a connection is wanted will transfer the plug 400 from jack 310 to trunk jack 320. This jack has a low resistance sleeve in relay 308 so that the connection now set up will be similar to the connection heretofore described between the substation 100 and the central office line, Fig. 7. A bridge consisting of retardation coil 321 will be placed across the line to simulate a receiver off the hook and will cause the energization of the supervisory relay 404 as heretofore described.

Station to repeating tie line connection

Fig. 12 indicates schematically the type of cord circuit employed in a connection from a station to a repeating tie line such as that shown in Figs. 9 and 10. Fig. 16 shows schematically this same circuit when the talking and dialing key has been operated and indicates the changes which will take place when the dial is operated.

The repeating tie line shown in Figs. 9 and 10 is designed for dial operation. Access to this trunk may be gained through jack 900 to extend a connection to a distant exchange over conductors 1000 and 1001. Access may also be gained to this trunk over the tip, ring and sleeve conductors 1002, 1003 and 1004 through automatic switches (not shown) to extend a connection also to a distant exchange over tip and ring conductors 1000 and 1001. Calls incoming from a distant exchange will be extended over the tip, ring and sleeve conductors 1005, 1006 and 1007 to an incoming selector (not shown) from which connection may be established to stations within this PBX.

For purposes of disclosing the present invention only one type of connection will be explained, i. e., a connection from jack 900 extending out over the tip and ring conductors 1000 and 1001 to a distant PBX.

When a subscriber desires a connection to a

distant PBX which will require the use of the trunk of Figs. 9 and 10, plug 400 is inserted in jack 103 and plug 401 is inserted in jack 900. Sleeve relay 901 operates in the sleeve circuit and since this relay 901 is of low resistance the type of cord circuit established will be similar to that of Fig. 12, i. e., both supervisory relays 404 and 405 will become effective and the trunk relay 414 will not operate. As soon as plug 401 is inserted in jack 900 ringing current will be applied to the trunk as hereinbefore described on the operation of relay 448.

Ringing current will flow over the tip of jack 900, the upper armature and back contact of relay 902, high resistance ringing relay 903, back contact and inner lower armature of relay 902 to the ring of jack 900. Relay 903 will be energized in this circuit and will cause the operation of relay 904. Upon the operation of relay 904 a circuit will be established from ground, the front contact and inner lower armature of relay 901, conductor 908, innermost lower armature and front contacts of relay 904, winding of relay 904 and in parallel therewith the winding of relay 902 to battery and ground. This operates the cut-off relay 902 and causes the de-energization of relay 903. Relay 902 in operating establishes a circuit from ground, through its front contact and middle lower armature, the winding of relay 1008 to battery. Relay 1008 operates and places a ground on conductor 1004 to mark this trunk in the switches having access to conductors 1002, 1003 and 1004 as busy.

Assuming that the tie line at the distant end of this trunk is a duplicate of the one shown in Figs. 9 and 10, a circuit will now be established from battery, through the upper winding of the relay such as 1009, the normal contacts of the middle upper armature of the relay such as 1010, the outermost lower armature and back contact of relay such as 904, back contact and middle upper armature of relay such as 1011, ring conductor 1001, thence through the middle upper armature and back contact of relay 1011, alternate contacts of the outermost lower armature of relay 904, lower winding of relay 905, normal contacts of the lower armature of relay 906, upper winding of relay 905, alternate contacts of the upper armature of relay 904, back contact and outermost upper armature of relay 1011, conductor 1000 and thence at the distant end from the outermost upper armature and back contact of relay such as 1011, back contact and upper armature of relay such as 904, back contact and inner upper armature of relay such as 1010, lower winding of relay such as 1009 to ground. Thus by the operation of relay 904 a bridge including the two windings of supervisory relay 905 is thrown across the trunk to operate the line relay at the distant end. Relay

905 by operating its contact extends ground to the winding of relay 907 which being a slow-to-release relay will maintain a ground on the conductor 908 during the dialing period.

The operator of Fig. 5, we will assume, has operated the talking and dialing key 424 and established a condition schematically shown in Fig. 16. She now operates the dial 548, whereupon the off-normal contact will establish a connection from ground to conductor 549, lower winding of relay 507 to battery. Relay 507 operates and extends the ground on conductor 549 to the winding of relay 547 which now becomes operated and through its front contact and upper armature grounds the upper winding of relay 507. Relay 547 also closes a circuit from ground, through its contacts 550 and 551 to the winding of relay 501.

A connection is now established from ground, innermost upper armature and front contact of relay 507, winding of low resistance relay 546, conductor 552, conductor 469, contacts 470 and 471, contacts 472 and 473 controlled by relay 446, lower winding of relay 446, front contact and inner lower armature of relay 409 to battery on conductor 442. Relay 446 becomes operated in this circuit and by opening the circuit for the winding of relay 448 at the upper inner armature and back contact cuts off ringing current being transmitted to the trunk of Fig. 9. Upon the operation of relay 446, the connection from the relay 546 is extended through the front contact and lower armature of relay 446 to the sleeve conductor of plug 401. This connection maintains relays 409 and 410 operated and throws a low resistance ground connection in parallel with the winding of relay 901 so that this relay now being practically short-circuited restores its armatures to normal.

A circuit may now be traced from ground, front contact and armature of relay 907, conductor 908, inner lower armature and back contact of relay 901 to the windings of relays 909 and 906 in parallel. Relay 909 operates directly in this circuit and relay 906 locks through its front contact and inner upper armature directly to conductor 908 so that when relay 901 again becomes operated relay 906 will remain actuated and relay 909 will restore its armatures to normal.

Relay 546 has become operated in the circuit described and closes a circuit from ground, front contact and armature of relay 546, winding of relay 545 to battery and ground. Relay 545 connects the winding of relay 544 to the two upper armatures of relay 501 so that the condition now obtained is as follows; the windings of relay 405 are connected through the winding of relay 544, and a bridge including the dial contacts of

dial 548 is thrown across the tip and ring conductors 1000 and 1001.

The circuit for relay 405 may be traced from ground, the upper winding of relay 405, the back contact and inner upper armature of relay 414, contacts 426 and 427 of key 424, conductor 500, front contact and inner upper armature of relay 501, inner upper armature and front contact of relay 545, winding of relay 544, front contact and upper outer armature of relay 545, upper outer armature and front contact of relay 501, conductor 509, conductor 429, contacts 430 and 431 of key 424, inner lower armature and back contact of relay 414, lower winding of supervisory relay 405 to battery. The winding of relay 544 is of high resistance and while it responds to the current flowing in this circuit will not cause the operation of supervisory relay 405. Relay 544 in operating locks relay 545 in a circuit independent of the contact controlled by relay 546.

The dialing circuit may be traced from the ring conductor 1001, middle upper armature and back contact of relay 1011, alternate contacts of the outermost lower armature of relay 904, lower winding of relay 905, front contact and lower armature of relay 906, front contact and lower armature of relay 909, ring contact of jack 900, ring contact of plug 401, lower normal contacts of ringing key 437, contacts 452 and 453, lower armature and back contact of relay 448, contacts 456 and 457, conductor 458, conductor 542, front contact and armature of relay 501, front contact and innermost lower armature of relay 547, middle lower armature and front contact of relay 547, conductor 553, dialing contacts 554 and 555, conductor 502, conductor 511, conductor 433, contacts 434 and 459, back contact and inner upper armature of relay 448, contacts 450 and 451, front contact and inner upper armature of relay 438, upper normal contacts of ringing key 437, tip of plug 401, tip of jack 900, upper armature and front contact of relay 909, upper winding of supervisory relay 905, alternate contacts of the upper armature of relay 904, back contact and outermost armature of relay 1011 to tip conductor 1000. Supervisory relay 905 remains operated in this circuit and holds relay 907 operated. When the dial is released and contacts 554 and 555 are momentarily and intermittently opened to effect the distant incoming selector in a well-known manner, relay 905 will respond to these impulses, but relay 907 being slow to release will maintain its armature attracted and therefore maintain a ground on conductor 908.

During the dialing period a circuit is established from ground, the front contact and outermost lower armature of relay 547, winding of relay 556 to battery and ground. Relay 556 short-circuits the input of the operator's click reduction circuit and therefore ef-

fectively short-circuits the operator's receiver so that she will not be annoyed by the clicks produced during the dialing.

When the dial 548 has returned to normal, relays 501, 507, 543 to 547 inclusive and 556 will all return to normal and the circuit will assume the condition schematically shown in Fig. 16. When the dialing has been completed and the distant connector switch has been set on the terminals of the called line, such called line will be signaled in the usual manner and when the party thereat answers a reversal of current will take place whereupon polarized relay 910 will be operated. Relay 910 causes the operation of relay 911 which in turn bridges impedance coil 912 across the tip and ring conductors of jack 900 and therefore across the windings of supervisory relay 405. Impedance coil 912 is of low enough resistance to cause the operation of relay 405 to perform its usual function of controlling the supervisory lamp 403.

Station to dial central office trunk

Fig. 14 is a schematic of the cord circuit established in a station to central office trunk connection. Fig. 17 is a schematic of this same type cord circuit with the dialing and talking key operated indicating the changes which take place during the dialing period.

Assuming that the trunk of Fig. 7 extends to a dial office, then, when the plug 400 is inserted in jack 700 a bridge including the middle winding of relay 413 is thrown across the conductors 702 and 703 to operate the distant line relay.

In this case since relay 409 is not operated there will be no circuit through the lower winding of relay 446 for the operation of relay 546 in the dialing circuit and hence relay 545 will not become operated as before. Therefore, instead of having a bridge such as the winding of relay 544 connected to the two upper armatures of relay 501 there will now be a battery and ground connection through the two windings of relay 543 connected to such upper armatures of relay 501. Therefore, during the dialing period when the cord circuit is split by the operation of relay 501, battery and ground are still supplied to the calling station through the windings of relay 543 in place of the battery and ground originally supplied from the central office trunk. The further operations are in accordance with circuits hereinbefore described.

Trunk to repeating tie line connection

Fig. 18 is a schematic drawing of a connection which might be established from an incoming trunk such as that of Fig. 2 to a tie line such as that of Figs. 9 and 10. The only thing to be noted in this connection is that since the marginal relay 409 is operated the low resistance relay 546 of the dialing circuit

will become operated and the high resistance bridge 544 will be used instead of the battery and ground connection from the windings of relay 543. The bridge 544 being of high resistance will not cause the operation of supervisory relay 404 since it is not wished to bring this relay up until a response is had from the called party.

What is claimed is:

1. A universal cord circuit having means responsive to a first type of connection for providing local battery feed, said means being responsive to a second type of connection for providing locally supervised distant battery feed and said means being responsive to a third type of connection for providing a through path without series impedance.

2. A universal cord circuit having an answering cord and a calling cord, a relay for each cord and means responsive to the operation of said relays in a first combination for maintaining said cord circuit as a local battery feed circuit, in a second combination for converting said cord circuit into a locally supervised distant battery feed circuit and in a third combination for converting said cord circuit into a through path without series impedance.

3. A universal cord circuit having an answering cord and a calling cord and normally arranged as a local battery feed circuit, a relay for each cord and means responsive to the operation of said relays in a first combination for maintaining said normal arrangement, in a second combination for rearranging said cord circuit as a locally supervised distant battery feed circuit and in a third combination for rearranging said cord circuit as a through path without series impedance.

4. A universal cord circuit having an answering cord and a calling cord, a talking path from cord to cord normally arranged as a local battery feed circuit, a signaling path for each cord and a relay for each cord in said signaling path, and means responsive to the operation of said relays in a first combination for maintaining said talking path in its normal condition, in a second combination for converting said talking path into a locally supervised distant battery feed circuit and in a third combination for converting said talking path into a through path without series impedance.

5. A universal cord circuit having an answering cord and a calling cord, a talking path from cord to cord normally arranged as a local battery feed circuit, a signaling path and a marginal relay therein for each said cord and means responsive to the operation of said marginal relays in one combination for maintaining said talking path in its normal condition, in a second combination for converting said talking path into a locally supervised distant battery feed circuit and in a third combination for converting

said talking path into a through path without series impedance.

6. A universal cord circuit having an answering cord and a calling cord, a talking path from cord to cord normally arranged as a local battery feed circuit, a signaling path and a marginal relay therein for each said cord and means responsive to the operated condition of both of said relays for maintaining said cord circuit in its normal condition, responsive to the operated condition of either one of said relays only for converting said talking path into a locally supervised distant battery feed circuit and responsive to the operated condition of neither of said relays for converting said talking path into a through path without series impedance.

7. A universal cord circuit having an answering cord and a calling cord, a talking path from cord to cord normally arranged as a local battery feed circuit, a signaling path and a marginal and non-marginal relay therein for each cord, and means responsive to the operation of said relays in a first combination for maintaining said talking path in its normal condition, in a second combination for converting said talking path into a locally supervised distant battery feed circuit and in a third combination for converting said talking path into a through path without series impedance.

8. A universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, and means responsive to the establishment of one type of connection for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and responsive to the establishment of another type of connection for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord.

9. A universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, a sleeve relay for each said cord, and means responsive to the operation of said sleeve relays in one combination for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and in another combination for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord.

10. A universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, a local battery feed supply, a sleeve relay for each said cord, and means responsive to the operation of said sleeve relays in one combination for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and said local battery feed supply and

in another combination for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord and for excluding said local battery feed supply.

11. In a telephone system, a trunk circuit, line circuits, a universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, a local battery feed circuit in said cord circuit and a distant battery feed circuit accessible over said trunk circuit, and means responsive to a line to line connection by said cord circuit for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and said local battery feed supply and responsive to a trunk to line connection by said cord circuit for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord and said distant battery feed supply.

12. In a telephone system, a trunk circuit, line circuits, a universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, a local battery feed supply in said cord circuit and a distant battery feed supply and supervisory means accessible over said trunk circuit, and means responsive to a line to line connection by said cord circuit for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and said local battery feed supply and responsive to a trunk to line connection by said cord circuit for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord and said distant battery feed supply without affecting said supervisory means associated with said distant battery feed supply.

13. In a telephone system, lines of different character, a universal cord circuit having an answering cord and a calling cord, an answering supervisory relay and a calling supervisory relay, a local battery feed supply in said cord circuit and a distant battery feed supply accessible over certain of said lines, sleeve relays for said cords operable in accordance with the character of said lines and means responsive to the operation of said sleeve relays in a first combination for rendering said answering supervisory relay responsive to hookswitch operation over said answering cord and said local battery feed supply and said calling supervisory relay responsive to hookswitch operation over said calling cord and said local battery feed supply, in a second combination for rendering said answering supervisory relay responsive to hookswitch operation over said calling cord and said distant battery feed supply and for excluding said calling supervisory relay and in a third combination

for excluding both said answering and said calling supervisory relays.

14. In a telephone system, lines of different character, a link circuit having an incoming end and an outgoing end, a source of ringing current, means responsive to the connection of the incoming end of said link circuit to one of said lines for automatically connecting said source of ringing current to the said line, a circuit for by-passing a small amount of ringing current to the said outgoing end of said link circuit, and means responsive to the character of the said lines for differently affecting said by-passing circuit.

15. In a telephone system, lines of different character, a cord circuit having an answering cord and a calling cord, a source of ringing current, means responsive to the connection of said calling cord to one of said lines for automatically connecting said source of ringing current to the said line, a circuit for by-passing a small amount of ringing current to the said answering cord, and means responsive to the character of the said lines for differently affecting said by-passing circuit.

16. In a telephone system, lines of different character, a cord circuit having an answering cord and a calling cord for interconnecting said lines, a relay for each of said cords, said relays being differently responsive to connection with said lines of different character, a source of ringing current, means responsive to the connection of said calling cord to one of said lines for automatically connecting said source of ringing current to the said line, a circuit for by-passing a small amount of ringing current to the said answering cord, and means responsive to the different operation of said cord relays for differently affecting said by-passing circuit.

17. A universal cord circuit having an answering cord and a calling cord, a relay for each said cord, a source of ringing current, a relay for splitting the cord circuit and applying said source of ringing current to the said calling cord, a circuit for by-passing a small amount of ringing current around the contacts of said ringing relay, and means responsive to the operation of said cord relays in one combination for operating said ringing relay and closing said by-passing circuit, in a second combination for operating said ringing relay and maintaining said by-passing circuit open and in a third combination for opening the circuit of said ringing relay.

18. A universal cord circuit having an answering cord and a calling cord, a marginal and a non-marginal relay for each said cord, a source of ringing current, a relay for splitting the cord circuit and applying said source of ringing current to the said calling cord, a circuit for by-passing a small amount of ringing current around the contacts of said ringing relay, and means responsive to the operation of said cord relays in one combina-

tion for operating said ringing relay and closing said by-passing circuit, in a second combination for operating said ringing relay and maintaining said by-passing circuit open and in a third combination for opening the circuit of said ringing relay.

19. A universal cord circuit having an answering cord and a calling cord, a relay for each said cord, a source of ringing current, a relay for splitting the cord circuit and applying said source of ringing current to the said calling cord, a circuit for by-passing a small amount of ringing current around the contacts of said ringing relay and means responsive to the operated condition of both said cord relays for operating said ringing relay and closing said by-passing circuit, responsive to the operated condition of one of said cord relays only for operating said ringing relay and maintaining said by-passing circuit open, and responsive to the operated condition of neither of said cord relays for opening the circuit of said ringing relay.

20. A universal cord circuit having an answering cord and a calling cord, an answering cord supervisory relay and a calling cord supervisory relay, an answering cord supervisory signal and a calling cord supervisory signal, sleeve relays for said cords, means responsive to a first energization followed by a deenergization of said answering cord supervisory relay for establishing a recall circuit, and means responsive to the operation of said sleeve relays in one combination for connecting said recall circuit to said answering cord supervisory signal and in another combination for connecting said recall circuit to said calling cord supervisory signal.

21. A universal cord circuit having an answering cord and a calling cord, an answering cord supervisory signal and a calling cord supervisory signal, an answering cord supervisory relay and a calling cord supervisory relay, sleeve relays for said cords, means responsive to a first energization, followed by a deenergization of said answering cord supervisory relay for establishing a recall circuit, and means responsive to the operation of said sleeve relays in a first combination for connecting said recall circuit to said answering cord supervisory signal, in a second combination for connecting said recall circuit to said calling cord supervisory signal and in a third combination for rendering said recall circuit establishing means ineffective.

22. A universal cord circuit having an answering cord and a calling cord, an answering cord supervisory relay and a calling cord supervisory relay, an answering cord supervisory signal and a calling cord supervisory signal, lines of different character, sleeve relays for said cords operable in accordance with the character of the lines to which said cords may be connected, means responsive to a first energization followed by a deenergiza-

tion of said answering cord supervisory relay for establishing a recall circuit, and means responsive to the operated condition of the sleeve relays of both said cords for connecting said recall circuit to said answering cord supervisory signal, responsive to the operated condition of the relay of but one of said cords for connecting said recall circuit to said calling cord supervisory signal and responsive to the operated condition of the relays of neither of said cords for rendering said recall circuit establishing means ineffective.

23. A universal cord circuit having an answering cord and a calling cord, an answering cord supervisory relay and a calling cord supervisory relay, an answering cord supervisory signal and a calling cord supervisory signal, sleeve relays for said cords, a first relay responsive to the energization of said answering cord supervisory relay and a second relay responsive to a subsequent deenergization of said answering cord supervisory relay, said first and second relays acting to establish a recall circuit, and means responsive to the operation of said sleeve relays in a first combination for connecting said recall circuit to said answering cord supervisory signal, in a second combination for connecting said recall circuit to said calling cord supervisory signal and in a third combination for rendering said recall circuit establishing relays ineffective.

24. A universal cord circuit having an answering cord and a calling cord, a dialing circuit associated with said cord circuit having means for splitting said cord circuit, connecting dialing contacts to said calling cord and connecting a bridge to said answering cord, and means responsive to the establishment of one type of connection for inserting a battery feed connection for said bridge, and responsive to the establishment of another type of connection for inserting an impedance for said bridge.

25. A universal cord circuit having an answering cord and a calling cord, a sleeve relay for each said cord, a dialing circuit associated with said cord circuit, said dialing circuit comprising a dial, a splitting relay, a battery feed bridge and a dry bridge, means responsive to the operation of said dial for operating said splitting relay, connecting the dialing contacts of said dial to said calling cord and connecting one of said bridges to said answering cord, and means responsive to the operation of said sleeve relays in one combination for effectively connecting said battery feed bridge in said dialing circuit and in another combination for effectively connecting the other of said bridges in said dialing circuit.

26. In a telephone system, a cord circuit including a ringing source, a dial associated with said cord circuit, a tie line, means for establishing a connection between said cord

circuit and said tie line, means responsive to the establishing of said connection for applying ringing current from said source to said tie line, and means responsive to the operation of said dial for disconnecting ringing from the tie line and establishing a dialing path through said tie line.

27. In a telephone system, a cord circuit including a ringing source, a dial associated with said cord circuit, a tie line, means for establishing a connection between said cord circuit and said tie line, means including a relay responsive to the establishing of said connection for applying ringing current from said source to said tie line, and means including another relay responsive to the operation of said dial for disconnecting ringing from the tie line by the release of said first mentioned relay and for establishing a dialing path through said tie line.

28. In a telephone system, a cord circuit including a ringing source, a dial associated with said cord circuit, a tie line, means for establishing a connection between said cord circuit and said tie line including a sleeve circuit, means responsive to the establishing of said connection for applying ringing current from said source to said tie line, means including a relay responsive to the operation of said dial for disconnecting ringing current from said tie line and for applying a ground connection to said sleeve circuit, and means responsive to the application of said ground connection for establishing a dialing path through said tie line.

29. In a telephone system, a cord circuit including a ringing source, a dial associated with said cord circuit, a tie line, means for establishing a connection between said cord circuit and said tie line, a relay in said tie line operated in response to the establishing of said connection between the cord circuit and the tie line, means responsive to the establishing of said connection for applying ringing current from said source to said tie line, means responsive to the operation of said dial for disconnecting ringing current from said tie line and for releasing said relay and tie line, and means responsive to the operation and release of said relay and the tie line for establishing a dialing path to said tie line.

In witness whereof, we hereunto subscribe our names this 6th day of November, 1929.

GERALD V. KING.
FELIX A. BONOMI.