H. G. WEBSTER.

TELEPHONE SYSTEM.

APPLICATION FILED MAR. 19, 1909.

1,038,997.

Patented Sept. 17, 1912.

3 SHEETS—SHEET 1.

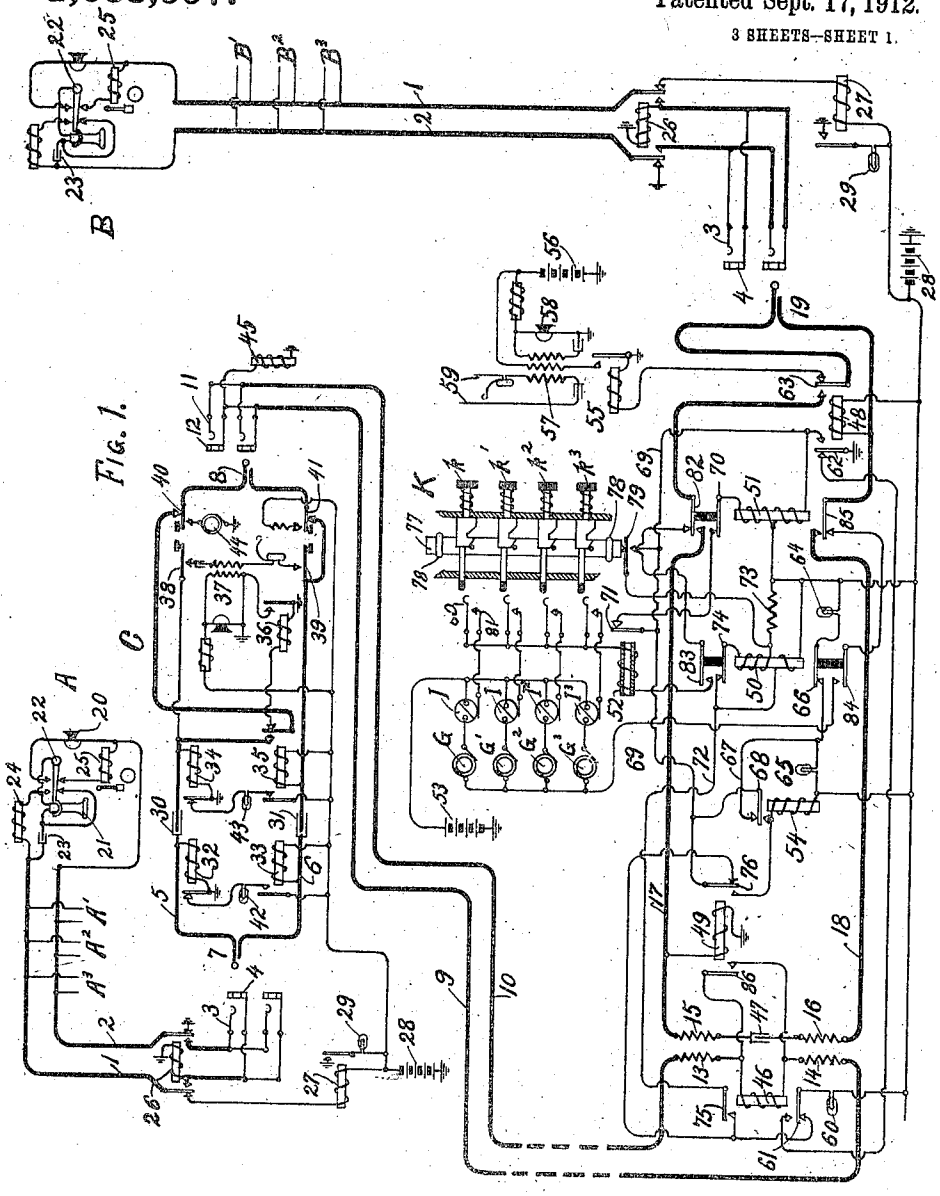


Fig. 1.

WITNESSES

J. G. Kellogg

Carolyn Weber

INVENTOR

Harry G. Webster

by Thomas A. Ferguson

Atty

H. G. WEBSTER.

TELEPHONE SYSTEM.

APPLICATION FILED MAR. 19, 1909.

1,038,997.

Patented Sept. 17, 1912.

3 SHEETS—SHEET 2.

FIG. 2

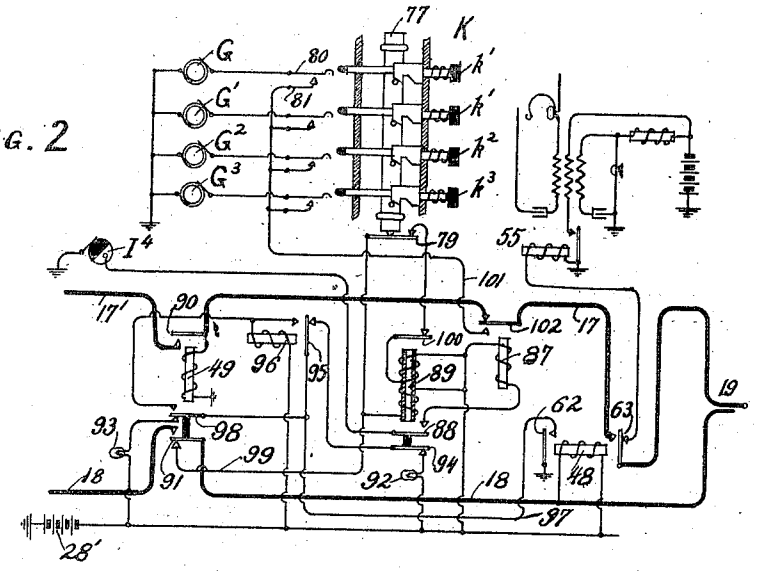
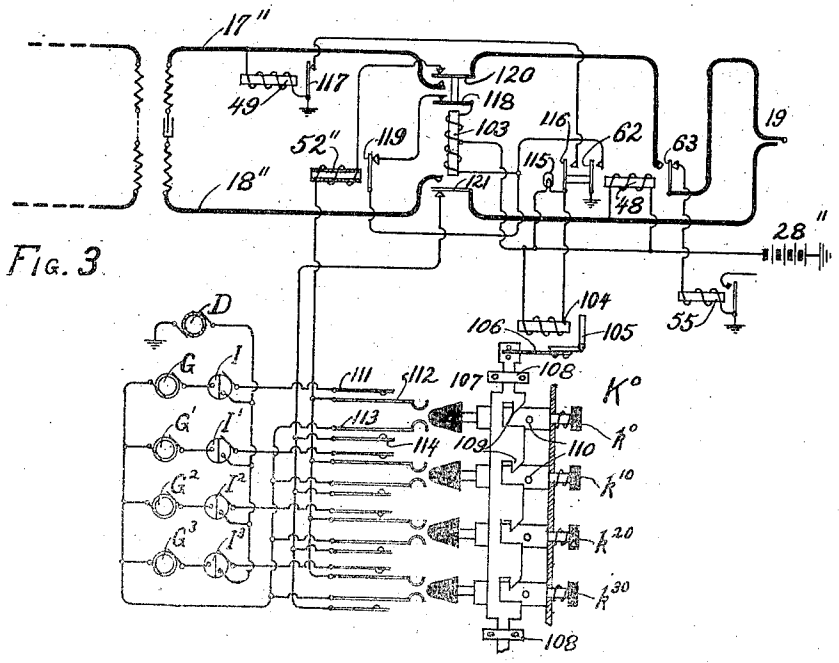


FIG. 3



WITNESSES

J. G. Kellogg

Carolyn Weber

INVENTOR

Harry G. Webster

by Thomas A. Ferguson

Atty.

H. G. WEBSTER.

TELEPHONE SYSTEM.

APPLICATION FILED MAR. 19, 1909.

1,038,997.

Patented Sept. 17, 1912.

3 SHEETS—SHEET 3.

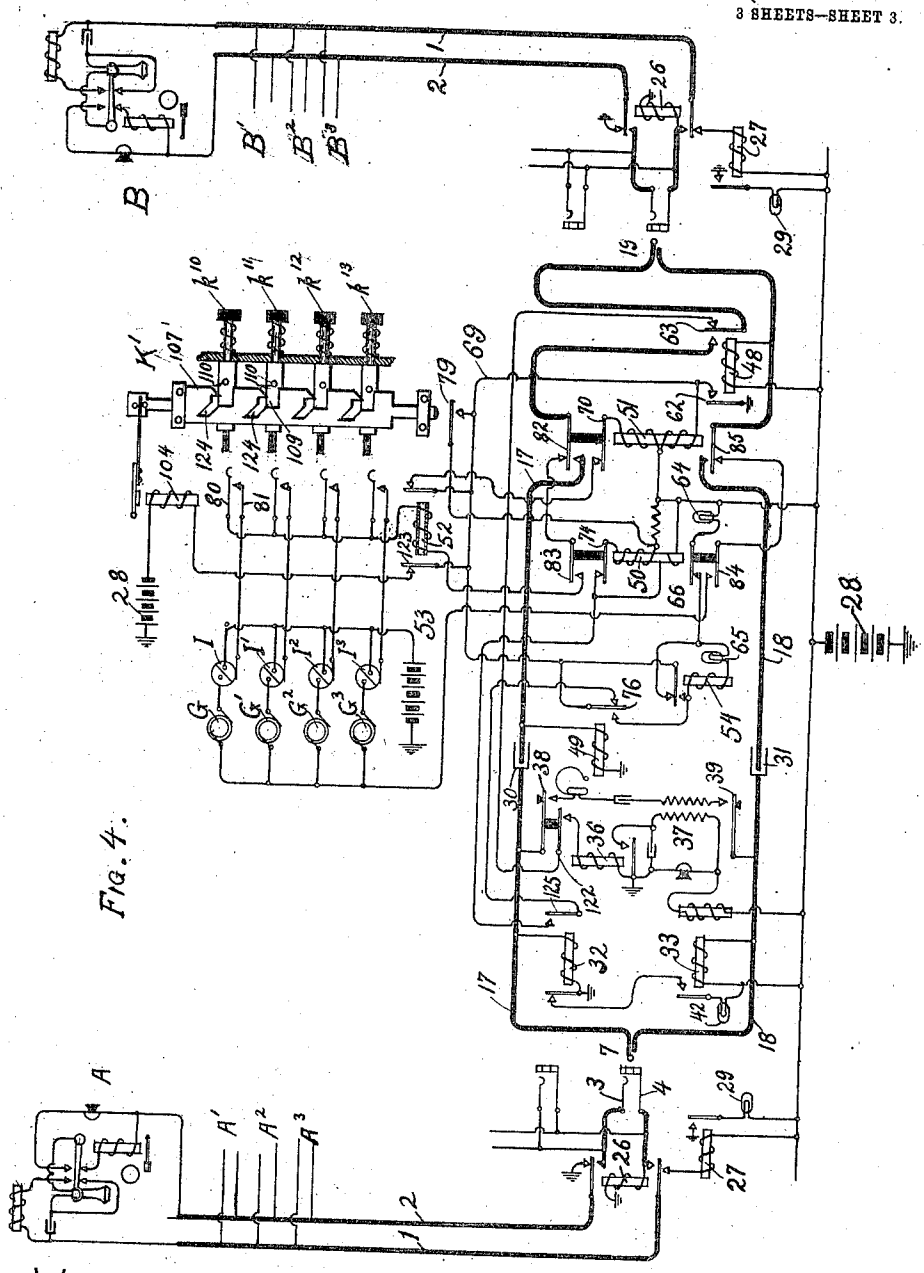


FIG. 4.

WITNESSES

J. G. Kellogg

Carolyn L. Weber

INVENTOR

Harry G. Webster

by Thomas A. Ferguson

atty.

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,038,997. Specification of Letters Patent. Patented Sept. 17, 1912.

Application filed March 19, 1909. Serial No. 484,466.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing in Chicago, county of Cook, State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

The present invention relates to the circuits and apparatus for applying ringing current in telephone systems. In systems of this sort, the connection of a link-circuit to the called line for the purpose of completing the connection from a calling line to the called line is followed by the application of ringing current to actuate the bell of the called party, and such current is applied either continuously or intermittently until the called party responds to the call, whereupon the source of ringing current is disconnected from the circuit.

The principal object of the present invention is to provide a novel arrangement of apparatus and circui s for controlling the application of the ringing current, which shall be simple, economical to manufacture, and efficient in operation. In carrying out my invention, I make use of one or more differential relays and associated ringing keys, or their equivalents, in such control. Thus in one form of the invention, two such differential relays are employed, one to connect the ringing source and the other to disconnect it, while in other forms but a single differential relay is employed for this purpose. I also employ a novel key construction by which the key is normally unlatched and in which the latch is thrown into operative position upon the connection of the link-circuit to the called line.

The invention comprises many novel circuit arrangements which will best be understood upon reference to the accompanying drawings and the following detailed description.

The scope of the invention will be particularly pointed out in the appended claims.

In said drawing, Figure 1 is a diagram of a telephone system having a trunking circuit constructed and arranged according to my invention; Fig. 2 is a diagram of a portion of a trunking or cord circuit embodying a modified form of the invention; Fig. 3 is a similar diagram of a third modification; and Fig. 4 is a diagram illustrating the application of the form of the invention illustrated in Fig. 1, to a cord-circuit, rather than a trunking circuit.

In these several views, like parts will be designated by like characters.

Referring to the drawing in detail and at first more particularly to Fig. 1, A and B designate substation circuits of calling and called lines respectively, which extend by line limbs 1 and 2 to different exchanges, where they terminate in the tip and sleeve jack contacts 3—4, respectively. At one exchange a link-circuit C of well known construction is employed. In this circuit, the tip and sleeve strands 5 and 6 terminate at the left in tip and sleeve contacts of the answering plug 7, and at the right in tip and sleeve contacts of the calling plug 8. A trunk, comprising conductors 9, 10, extends between the exchanges. These conductors terminate at their outgoing ends in the tip and sleeve jack contacts 11 and 12 and at their incoming ends in the windings 13, 14, of a repeating coil whose companion windings 15, 16, are connected to the tip and sleeve trunk strands 17, 18 which terminate in the calling plug 19 adapted to be inserted into a jack of the called line. It is in association with this latter section of the trunk that the novel ringing circuits are associated.

It will be understood that the trunking system here depicted is of the usual type and, in so far as its general arrangement is concerned, forms no part of my invention.

The circuit is shown with party lines and station A on the calling line has its circuits shown in full, while those at stations A', A^2, A^3 are merely indicated by the taps running from the line limbs. The called line is similarly provided with stations B, B', B^2, B^3. Each station is provided with the usual transmitter 20, receiver 21, switch-hook 22, condenser 23, induction coil 24, and ringer 25. The latter is shown as a harmonic ringer of the type well known in the art. With such ringers, the ringers at the stations on each party line are designed and adjusted to respond to calling current of certain definite and different frequencies, as is well known. At each substation, a normally closed path for ringing current extends through the condenser 23, switch-hook 22, and call-bell 25, and the transmitter 20 is included in a normally open direct cur-

rent path which also includes the impedance coil 24. At each exchange, line limb 1 is normally connected through the contacts of cut-off relay 26 and the winding of line relay 27 to the live pole of grounded battery 28. Limb 2 is normally connected to the opposite, or grounded, pole of said battery through other normal contacts of the cut-off relay. Line relay 27 controls the lamp 29. Obviously, in the trunking system, the batteries at the different exchanges will be separate and distinct. In the cord-circuit C, the strands 5, 6 are provided with the usual interposed condensers 30, 31, the tip and sleeve answering supervisory relays 32, 33, the calling tip and sleeve supervisory relays 34, 35, the test relay 36, the operator's set 37, the listening key 38—39, and the ringing key 40—41. The relays 32, 33 jointly control the answering supervisory lamp 42, and relays 34, 35 the calling supervisory lamp 43, while the ringing key is adapted to connect the ringing generator 44 in circuit, although the latter is not used when the cord-circuit is connected to an outgoing trunk.

At the outgoing end of the trunk circuit, the sleeve trunk strand 9 is connected to the grounded pole of the battery through impedance coil 45. At the incoming end of the trunk, a trunk relay 46 of high resistance (say, five thousand ohms) is included in circuit between the repeating coil windings 13, 14. A condenser 47 is included between the companion windings 15, 16 and inductively unites strands 17, 18 of the trunk circuit. A sleeve relay 48 and a tip relay 49 are connected to the sleeve and tip strands 18 and 17, respectively. Two differential control relays 50 and 51 control the connections from the ringing generators G, G′, G^2, G^3 to the strands 17, 18. The ringing device K coöperates in this control and causes the operation of relay 50 to apply the ringing current. A relay 52, included in these ringing connections, controls the operation of relay 51 to disconnect the ringing source upon the response of the called party. Interrupters I, I′, I^2, I^3 break the bridge formed between the strands 17, 18, through the generators G, G′, G^2, G^3, at regular intervals, and during such intervals replace the generator connections by a connection to the positive pole of grounded battery 53. An additional control relay 54 is also included in the circuit. A test relay 55 is normally connected to the tip contact of the calling plug 19 and controls a circuit from battery 56, through induction coil 57 associated with an operator's set 58 and an order wire 59, which extends from the operators at the distant exchange in a manner well known in the art.

If it be assumed that a party at substation A desires to converse with a party at substation B, he will remove his receiver 21 and thereby energize his line relay 27 to display line lamp 29. The operator will respond to the call by inserting answering plug 7 into the answering jack of that line, thereby actuating cut-off relay 26 to connect the line limbs 1, 2 to the strands 6, 7, and disconnect the line relay 27. This act also energizes supervisory relays 32, 33, the former over the line circuit, and the latter through the cut-off relay, as is well known. By depressing listening key 38, 39, the operator will learn that connection is desired with a subscriber whose line terminates in the distant exchange, and upon being assigned a trunk over the order wire 59, will immediately insert the calling plug 8 into a jack of that trunk. This act energizes supervisory relay 35 and trunk relay 46. The circuit by which this is accomplished may be traced from the live pole of battery 28, through the winding of relay 35, sleeve strand 6, plug and jack sleeve contacts and impedance coil 45 to the return side of the battery, another path for current extending from the sleeve contact of the jack, through trunk conductor 9, repeating coil winding 14, trunk relay 46, repeating coil winding 13, trunk conductor 10, jack and plug tip contacts, strand 5, and supervisory relay 34 to the return side of the battery. By reason of the high resistance of relay 46, current flowing over this path is insufficient to energize relay 34. Supervisory lamp 43 is thereby energized and remains lighted until, in the subsequent operation, the normally open short-circuit about relay 46 is closed. The energization of trunk relay 46 will close a circuit for guard lamp 60 which may be traced from the live pole of battery 28, through alternate contact 61 of relay 46, and normal contact 62 of sleeve supervisory relay 48 to the return side of the battery. The lighting of this lamp guards against improper connection of the trunk terminals in a manner common in the art. As soon as the operator at the second exchange has designated the trunk for the first operator to plug into, she at once tests the line of the called party by touching the tip contact of plug 19 against contact 4 of the wanted line, and in case the same is busy obtains a circuit through test relay 55, which produces the customary "click" in her receiver as an indication that the line is busy. In such event, the calling party is so advised through the first operator. Upon finding the line idle, however, the second operator will insert plug 19 into a multiple jack of the line running to station B. The establishment of this connection energizes the sleeve relay 48 and the cut-off relay 26 of the called line over a circuit extending from the live pole of battery 28, through relay 48, plug and jack sleeve contacts and relay 26 to the return side of the battery. The operation of relay 26, as before, completes the line limbs to the jack terminals and dis-

connects the line relay. The operation of relay 48, by its contact 63, disconnects the test relay 55 and completes a section of the tip strand 17 and, by its contact 62, establishes a ground connection which is instrumental in energizing relays 50 and 51 and lighting key lamp 64 and answering lamp 65. The lamp circuits extend from the live pole of battery 28 and thence, on the one hand, through lamp 64, closed contact 66 of relay 50, and on the other hand, through lamp 65 to conductor 67, where both branches unite, thence through normal contact 68 of relay 54, conductor 69, through alternate contact 62 of sleeve relay 48 to the return side of the battery. The circuits through control relays 50 and 51 include the differential windings in parallel and, although energizing the windings, do not operate these relays. One path through relay 51 extends from the live pole of battery 28, through the upper winding of said relay, its closed contact 70, closed contact 71 of relay 52, conductor 69, and alternate contact 62 to ground. The other branch through this relay extends directly from battery, through the lower winding of said relay, and alternate contact 62 to ground. The circuit through relay 50 includes two parallel branches and a common portion. One parallel branch extends from the live pole of battery, through the lower winding of relay 50 to the conductor 72. The other branch extends through resistance 73, the upper winding of relay 50, its closed contact 74, to conductor 72. The common portion of the circuit extends from conductor 72, through closed contact 75 of trunk relay 46, normal contact 76 of tip relay 49, and thence to ground through conductor 69 and alternate contact 62. In the case of relay 51, the magnetic effects of the differential windings substantially balance each other. This is also true of the differential windings of relay 50, but in the case of the latter the upper winding is provided with a relatively larger number of turns than the lower, inasmuch as the current flow through it is cut down by the resistance 73.

The next step in the operation is to apply the ringing current to the called line. The ringing device K includes keys k, k', k^2, k^3, corresponding to the generators G, G', G^2, G^3, and the arrangement is such that if key k is depressed, current from generator G will be applied to the called line and this current will be of the proper frequency to actuate the call-bell at station B. There is a similar correspondence between keys k', k^2, k^3 and stations B', B^2, B^3, respectively. Thus, under the assumption that the party at A desires to converse with a party at B, the operator will depress ringing key k and thereby connect the generator G in bridge of the strands 17, 18. The key K is so constructed that when the plunger k is depressed all the way to its ringing position, the contacts 80, 81 are closed and the bar 77 is moved downward to close the contact springs 79, the plunger k then returning to its indicating position being held there by the pin in the bar 77, and the bar 77 returning upward allows the contact 79 to again open. Thus, it will be seen that the contact 79 is closed only when the plunger k is depressed to its ringing position. The depression of the key k to its ringing position causes the sliding-bar 77 to move downward through its guides 78 to close normally open contact 79, thereby short-circuiting the upper winding of relay 50 and causing said relay to pull up its contacts. The opening of contact 66 puts out the key lamp 64, thus showing that ringing current has been applied. The opening of contact 74 permanently opens the branch through the upper winding of relay 50 and thus leaves said relay locked through its lower winding and the alternate contact of the sleeve relay 48. The movement of the key k also closes its contacts 80—81, thus completing the ringing bridge above referred to. This bridge may be traced from strand 17, through normal contact 82 of relay 51, closed contact 83 of relay 50, relay 52, closed contacts 80—81, interrupter I, generator G, closed contact 84 of relay 50, and normal contact 85 of relay 51, to strand 18. During the ringing interval, the remaining portion of the circuit includes the limbs of the called line and the call-bell 25, switch-hook 22, and condenser 23 at substation B. Thus while interrupter I is in position to include the generator G in circuit, the call-bell 25 is actuated. In response to the ringing of his call-bell, the called party will remove his receiver from its hook and thereby complete a conductive bridge between the line limbs at his substation. This act will close a circuit through relay 52, closed contacts 83, 82 to the tip side of the circuit, thence out over the line through the substation and back over the sleeve side of the circuit, and relay 52 is thereby operated. Its operation will open the path through the upper winding of relay 51 and destroy the balance in that relay and thus actuate it to interrupt the ringing bridge at contacts 82, 85, and complete the strands 17, 18 of the trunk circuit. As soon as the tip strand is thus completed, current will flow through the tip relay 49, and the locking circuit through the lower winding of relay 50 will be interrupted at contact 76, thereby allowing said relay to return to its normal position. The actuation of contact 76 will thereupon complete a circuit for relay 54 through conductor 69 and alternate contact 62. The actuation of relay 54 will then interrupt the circuit of lamp 65 and cause its extinguishment and also complete

a locking circuit for itself through alternate contact 68, conductor 69, and alternate contact 62 of relay 48. The closing of contact 86 of relay 49 will short-circuit the trunk relay 46 and interrupt the previous traced circuit through the lower winding of relay 50 at an additional point, namely, at contact 75 of relay 46. This will bring the trunk lamp 60 into a circuit which is directly under control of the tip and supervisory relays 48 and 49, and upon the deenergization of the former at the end of conversation, will display the lamp as a signal for disconnection. The short-circuiting of trunk relay 46 upon the energization of tip relay 49 causes sufficient current to flow through tip relay 34 associated with the cord-circuit to energize that relay to extinguish supervisory lamp 43, thus indicating to the first operator that the connection has been completed through to the called line and that the called party has responded. At the end of conversation, the restoration of the calling party's receiver displays supervisory signal 42, while the restoration of the called party's receiver deënergizes tip relay 49 opening the contact 86 and allowing the relay 46 to again energize over the previously traced path, from the cord circuit C. The relay 34 is now deënergized due to the cutting in of the high resistance winding of relay 46, lighting the disconnect signal 43 of the cord circuit C. The operator now observing the two signals 42 and 43, disconnects the plug 8 from the jack, thereby again opening the circuit for the relay 46 which now deënergizes. A circuit for the trunk disconnect lamp 60 is now closed from battery 28, through the said lamp 60, normal contact 61, normal contact 76 of relay 49 to ground at alternate contact 62 of relay 48. The operator now withdraws the plug 19 from the jack. The removal of the plugs 7, 8 and 19 restores the parts to normal position. The key k, having been depressed, remains in this condition until one of the other keys k', k^2, k^3 is operated, whereupon the movement of the sliding-bar 77 releases key k and allows it to return to normal.

In Fig. 2, I have illustrated the right-hand portion of either a trunk-circuit or a cord-circuit which is provided with a modified circuit arrangement employing a differential relay for controlling the connections from the ringing generators. In this instance, the ringing device K is of the same construction as that of Fig. 1 and controls a similar contact 79 which in this instance, however, is normally closed. It likewise controls the connection of the generators G, G', G^2, G^3 to the strand 17'. In this instance, however, the interrupters I, I', I^2, I^3, and the battery 53 of Fig. 1 are omitted and in lieu thereof a "flip flop" relay 87 is adapted to be included in circuit with an interrupter I^4 by a contact 88 of the differential control relay 89. The tip relay 49 is here provided with normally open contacts 90 91, which include the strands 17', 18'. A key lamp 92 and a supervisory lamp 93 are also provided. In this instance, the sleeve relay 48, by its contact 63, normally includes the test relay 55 in circuit with the tip contact of the plug 19 and completes this portion of the strand 17' upon the energization of the relay, as in the case of Fig. 1. The contact 62 of relay 48 provides circuits for the lamps 92, 93; the former extending from the live pole of battery 28', through lamp 92, contact 94 of relay 89, normal contact 95 of relay 96, conductor 97, and closed contact 62 to the return side of the battery; and the latter from the live pole of the same battery, through lamp 93, normal contact 98 of relay 49, conductor 97 and closed contact 62 to ground. Relay 89 has its two windings energized over the sleeve side of the circuit, through the cut-off relay of the called line. In operation, if it be assumed that the operator has learned the number of the called line, she will test in the usual way and the calling party will be notified of the busy condition of the line, or she will insert the plug 19 into the jack of the called line, as in the case of Fig 1. This latter act will actuate relay 48 over a circuit including the cut-off relay of the called line. The test relay will thereupon be disconnected and the strand 17' closed at alternate contact 63. The closing of contact 62 will light lamps 92, 93 over the paths previously traced. The act of plugging in, in addition to energizing sleeve relay 48, will energize the windings of differential control relay 89, but without causing its actuation. The circuit through the lower winding extends from the live pole of battery 28', through said winding, conductor 99, normal contact 91 of relay 49, sleeve strand 18', plug and jack sleeve contacts, through the winding of the cut-off relay of the called line, to the return side of the battery. The circuit through the upper winding of relay 89 will extend from the live pole of the battery through said winding, closed contact 100 of said relay, closed contact 79 of the key, thence via conductor 99 and sleeve strand 18, through the cut-off relay to ground, as in the case of the lower winding. Ringing current will be applied by depressing one of the keys k, k', k^2, k^3 as before, according to the party to be called. If it be assumed that key k is depressed, the sliding-bar 77 will open contact 79 and thereby destroy the balance in the windings of relay 89 and energize said relay to attract its armature. This will result in the permanent opening of contact 100 and the continued energization of said relay over the sleeve side of the circuit and through the

cut-off relay. The depressing of key k will also close its contacts 80, 81, to connect the grounded generator G to conductor 101 which is adapted to be intermittently connected to tip strand 17′ by contact 102 of "flip flop" relay 87. A circuit is completed through this latter relay and the interrupter I^4 upon the actuation of relay 89. The action of the interrupter will intermittently energize relay 87, and during such energized condition, conductor 101 will be connected to tip strand 17′ and ringing current will be projected out over the tip side of the called line, back over the sleeve side to ground, through the cut-off relay and the relay 89 and the circuit of battery 28′. Thus the called party's bell will be intermittently rung. Upon his response, he will close a conductive bridge at his substation, and then, as soon as relay 87 is deënergized, a path for current will extend from the live pole of battery 28′, through sleeve relay 48, and thence to ground through the cut-off relay of the called line, and in parallel with the path to ground through the cut-off relay, out over the line, through the subscriber's station, and back over the tip side of the circuit, through the tip relay 49 to the return side of the battery. As soon as tip relay 49 is thus energized, relay 89 will be deënergized by reason of the opening of its circuit at contact 91, and thus the "flip flop" relay will be deënergized, leaving the strand 17′ closed at alternate contact 102. The same strand will be closed at contact 90 of tip relay 49, while strand 18′ will be similarly closed at alternate contact 91. Contact 98 of tip supervisory relay 49 will interrupt the circuit of supervisory lamp 93 to cause its extinguishment and will connect relay 96 to ground through conductor 97 and closed contact 62 of sleeve relay 48. The energization of relay 96 will open the original circuit through lamp 92 at its contact 95, thereby preventing the illumination of such lamp upon the deënergization of control relay 89, it being noted that the lamp 92 was extinguished upon the energization of the latter relay. With the circuit in this condition, conversation may be carried on. At the end of conversation, the restoration of the called party's receiver deënergizes tip supervisory relay 49 and thereby lights lamp 93 as a disconnect signal. The connection will then be taken down in the usual way.

In the form of the invention illustrated in Fig. 3, a third arrangement of circuits and a slightly different key device is illustrated. In this figure, the same portion of an interconnecting link-circuit is shown as in Fig. 2 and, as in that figure, may form either the end of a cord-circuit or a trunking circuit. Here the strands 17″, 18″ extend through normally open contacts of differential control relay 103, to the calling plug 19, tip strand 17″ being also normally interrupted at contact 63 of sleeve supervisory relay 48. A test relay 55 with the same connections as before is employed. A relay 52″, similar to the relay 52 of Fig. 1, is located in the ringing connections. In addition, a tip supervisory relay 49 and a locking magnet 104 for the ringing device K are provided. In this instance, the control relay 103 has its windings differentially energized by a circuit which extends through closed contact 62 of relay 48 to ground, instead of through the sleeve side of the circuit as in Fig. 2. In the ringing device K°, the keys k^0, k^{10}, k^{20}, k^{30} are normally free and cannot be locked until magnet 104 is actuated. The armature 105 of this magnet is provided with a spring 106 which engages the end of the locking bar 107. When magnet 104 is energized, bar 107 is moved through its guides 108 so as to bring its catch projections 109 into position to engage the pins 110 on the keys. By reason of the yielding connection between the bar 107 and the armature 105, the depression of a key forces the bar 107 back against the tension of the spring 106 until its pin 110 has passed beyond the coöperating projection 109, whereupon the bar springs back into position and holds the key depressed. In this instance, the contacts 111—112, 113—114, connect the genrators G, G′, G^2, G^3 with their interrupters I, I′, I^2, I^3 in circuit. Considering the operation and assuming that the operator has tested the called line and found it idle, the insertion of plug 19 into a jack of the called line will actuate sleeve supervisory relay 48 in the usual way over the sleeve side of the circuit and through the cut-off relay. This will close tip strand 17 at alternate contacts 63 and will light supervisory lamp 115 over a path extending from the live pole of battery 28″, through lamp 115, closed contact 116, and closed contact 117 to the return side of the battery. At the same time, the locking magnet 104 will be included in parallel with the lamp 115 and thereby energized to throw the locking bar 107 into locking position. The closing of contact 62 of relay 48 will also energize both windings of relay 103, but without causing its actuation. The path for the lower winding thus established extends from the live pole of battery 28″, through said winding, and closed contact 62 to ground. The path through the other winding extends from the live pole of the same battery, through said winding, closed contact 118 of said relay, closed contact 119 of relay 52″, and, as before, through closed contact 62 to ground. With the parts in this condition, the operator will depress one of the keys as k^0, and thereby connect the generator G with the interrupter I in bridge of the strands 17″, 18″, through the nor-

mal contacts 120 and 121 of relay 103, thereby intermittently projecting ringing current out over the called line and through the called station. During the non-ringing interval, the tip side of the circuit will be connected to ground through the direct current generator D. The opposite side of the circuit will be connected to ground, or the return side of this generator, through the cut-off relay of the called line and through sleeve relay 48 and battery 28″. As soon as the called party removes his receiver from its hook and thereby conductively unites the limbs of his telephone line, current will flow through relay 52″, out over the called line, through the substation, back over the sleeve side of the circuit. As a result, relay 52″ will be actuated to interrupt the branch through the upper winding of relay 103, thereby destroying the balance in its windings and causing it to interrupt that branch permanently at its contact 118 and to disconnect the ringing bridge at normal contacts 120, 121, and complete the link-circuit strands 17″, 18″ at alternate contacts 120, 121. The resulting closure of the tip strand 17″ will provide a path for current from battery 28″, through sleeve relay 48 and out over the sleeve side of the circuit to ground through the cut-off relay and to ground over the tip side of the circuit and through tip relay 49. The resulting energization of relay 49 will interrupt the circuit of lamp 115 and locking-relay 104, thereby indicating the completion of the connection to the operator and freeing the key k°. With the parts in this condition, conversation may be carried on. At the termination of conversation, the restoration of the called party's receiver will interrupt the path for current through tip relay 49 and its resulting deenergization will light supervisory lamp 115 as an indication to the operator of the condition of the circuit. Upon taking down the connection, the parts will be restored to normal.

In Fig. 4 I have shown the ringing circuits of Fig. 1 applied to a cord-circuit instead of a trunk-circuit, as in the latter figure. In such instance, the circuit through contact 75 of the trunk relay 46 extends through normally open contacts of answering supervisory relay 32. In this figure, I have also illustrated a ringing device K′, which provides for the same operation as the ringing device K in Fig. 1 and is provided, in addition, with the locking bar construction and control of the ringing device K° of Fig. 3. In this instance also, the operator's set 37 and test relay 36 are located at the answering end of the link-circuit and the ringing key is provided with an additional contact 122 by which the test relay 36 is brought into circuit with the tip contact of the calling plug 19 when the ringing key is depressed to bring the operator's set into circuit. The operation will be readily understood from the previous description of the operation of the trunking circuit of Fig. 1 and therefore need not be set out at this point. It will suffice to point out that the actuation of relay 48, upon being plugged into the called line, will complete a circuit for locking magnet 104 through closed contact 123 of relay 52 and contact 62 of relay 48. This will operate magnet 104 to bring the latch-bar 107′ into operative position. Upon the response of the called party, the energization of relay 52 will interrupt this circuit at contact 123 and allow the parts of the ringing device K′ to return to normal. The bar 107′ is provided with the projections 109 like the bar 107 of Fig. 3 and these projections coöperate with pins 110 as in that case. In addition, it is provided with slots 124 which coöperate with the pins 110 upon the complete downward movement of the keys k^{10}, k^{11}, k^{12}, k^{13} to close the normally open contact 79 to actuate differential control relay 50, as explained in connection with Fig. 1. The normally open contact 125 of the tip supervisory relay of this figure corresponds to the normally open contact 75 of the trunk relay 46 in the control of the circuit through the windings of control relay 50.

In carrying out my invention, it will be apparent that many alterations and modifications may be made in the circuit arrangements and in the apparatus employed in those circuits without departing from the spirit and scope of my invention. Thus in many instances, the several batteries may be one and the same, the contacts for applying ringing current may be operated by other devices than the ringing devices K, K°, K′, and other changes may be made. I therefore do not wish to be limited to the specific matter herein disclosed, but aim to cover by the terms of the appended claims all such alterations and modifications.

I claim:—

1. A telephone system comprising a telephone line, a link-circuit for connecting with said line, a source of ringing current, two control relays, connections from said source through normally open contacts of one of said relays, means dependent upon the connection of said link-circuit to said line to operate said relay to connect said source to said line, means controlled over the line circuit to operate said second relay to directly disconnect said ringing source, and means responsive to such operation to restore said first relay to normal.

2. A telephone system comprising a telephone line, a link-circuit for connecting with said line having tip and sleeve strands, tip

and sleeve relays connected with said strands, a source of ringing current, two control relays, connections from said source through normally open contacts of one of said relays, means for actuating said control relay by closing a circuit through contacts of said tip and sleeve relays to connect said source to said line, and means for actuating the second control relay to disconnect said source by a circuit through contacts of said tip relay.

3. A telephone system comprising a telephone line, a link-circuit for connecting with said line having tip and sleeve strands, tip and sleeve relays connected with said strands, a source of ringing current, two control relays, contacts for closing an actuating circuit for the first control relay through contacts of said sleeve relay, to connect said source to said line, and contacts for changing the second control relay connections to actuate it to disconnect said source by a circuit through contacts of said sleeve relay.

4. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, normally open connections from said source to said line through contacts of said relays, means for energizing said windings of both relays differentially, means for subsequently destroying the differential action of the windings of one of said relays to apply ringing current to the line, and means for subsequently destroying the differential action of the windings of said other relay to disconnect said source from said line.

5. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, normally open connections from said source to said line through contacts of one of said relays, means for energizing said windings of both relays differentially, means for opening the circuit of one differential winding of said relay to apply ringing current to said line, and means for subsequently opening the circuit of one differential winding of the other of said relays to disconnect said source from said line.

6. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, two differential control relays, normally open connections from said source to said line through contacts of said relays, means dependent upon the connection of said line and link-circuit to energize said windings of both relays differentially, a ringing device for destroying the differential action of the windings of one of said relays to apply ringing current to said line, and a switch in bridge of the limbs of said line for subsequently opening a circuit to destroy the differential action of the windings of the other of said relays to disconnect said source from said line.

7. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, two differential control relays, normally open connections from said source to said line through contacts of said relays, means dependent upon the connection of said line and link-circuit to energize said windings of both relays differentially, a ringing device for short-circuiting a differential winding of one of said relays to apply ringing current to said line, a third relay having contacts included in the energizing circuit of a differential winding of the other of said differential relays, and a switch in bridge of the limbs of said line for subsequently closing a circuit through said third relay to operate the second differential relay to disconnect said source from said line.

8. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, two differential control relays, normally open connections from said source to said line through contacts of said relays, means dependent upon the connections of said line and link-circuit to energize said windings of both relays differentially, a ringing device for short-circuiting a differential winding of one of said relays to operate it to apply ringing current to said line, contacts actuated thereby to interrupt the circuit of said winding, a third relay having contacts included in the energizing circuit of a differential winding of the other of said differential relays, and a switch in bridge of the limbs of said line for subsequently closing a circuit through said third relay to operate the second differential relay to disconnect said source from said line.

9. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, normally open connections from said source to said line through contacts of said relays, means for energizing said windings of both relays differentially, a ringing device for short-circuiting a differential winding of one of said relays to operate it to apply ringing current to said line, contacts actuated by such operation to interrupt the circuit of such short-circuited winding, means for subsequently destroying the differential action of the windings of said other relay to disconnect said source from said line.

10. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, nor-

mally open connections from said source to said line through contacts of said relays, means for energizing the windings of both relays differentially, a ringing device for short-circuiting a differential winding of one of said relays to operate it to apply ringing current to said line, contacts actuated by such operation to interrupt the circuit of such short-circuited winding, means for subsequently opening the circuit of one winding of the other of said relays to operate it to disconnect said source from said line.

11. In a telephone system, the combination of two differential control relays, a connection extending through normally open contacts of the first of said relays and normally closed contacts of the second, means for energizing the windings of both relays differentially, a switch for subsequently short-circuiting a differential winding of the first relay to operate it to close said normally open contacts, other contacts actuated by such operation to open the circuit of said short-circuited winding, and switch contacts for subsequently destroying the differential action of the windings of said second relay to open said normally closed contacts.

12. In a telephone system, the combination of two differential control relays, a connection extending through normally open contacts of the first of said relays and normally closed contacts of the second, means for energizing the windings of both relays differentially, a switch for subsequently short-circuiting a differential winding of the first relay to operate it to close said normally open contacts, other contacts actuated by such operation to open the circuit of said short-circuited winding, and switch contacts for subsequently interrupting a differential winding of said second relay to actuate it to open said normally closed contacts.

13. In a telephone system, the combination of two differential control relays, a connection extending through normally open contacts of the first of said relays and normally closed contacts of the second, means for energizing the windings of both relays differentially, a switch for subsequently short-circuiting a differential winding of the first relay to operate it to close said normally open contacts, other contacts actuated by such operation to open the circuit of said short-circuited winding, switch contacts for subsequently interrupting a differential winding of said second relay to actuate it to open said normally closed contacts, and other contacts actuated by such operation of said second relay to interrupt the circuit of its said differential winding at another point.

14. In a telephone system, the combination of two differential control relays, a connection extending through normally open contacts of the first of said relays and normally closed contacts of the second, means for energizing the windings of both of said relays differentially, contacts for interrupting the circuit of a differential winding of the first relay to operate it to close said normally open contacts, and contacts for subsequently interrupting the circuit of a differential winding of the second relay to operate it to open said normally closed contacts.

15. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line having normally open talking strands, a source of ringing current, two relays for controlling the continuity of said strands and the application of ringing current to the line, means for operating the first of said relays to apply ringing current to the line, means for subsequently operating the second relay to disconnect said ringing source and complete the normally open talking strands, and means responsive to such operation of the second relay to restore the first relay to normal.

16. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, a connection from said source to said line through normally open contacts of the first relay and normally closed contacts of the second, normally open contacts for the second relay included in the talking strands of said link-circuit, means dependent upon the connection of said link-circuit to said line to energize the windings of both relays differentially, means for subsequently destroying the differential action of the windings of the first relay to apply ringing current to the line, and means for subsequently destroying the differential action of the windings of the second relay to disconnect said source and complete the talking strands at said normally open contacts.

17. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, a connection from said source through normally open contacts of the first relay and normally closed contacts of the second, normally open contacts for the second relay included in the talking strands of said link-circuit, means dependent upon the connection of said link-circuit to said line to energize the windings of both relays differentially, a ringing device for subsequently interrupting the circuit of one differential winding of the first relay to apply ringing current to the line, and means for subse-

quently interrupting the circuit of one differential winding of the second relay to disconnect said source and complete the talking strands at said normally open contacts.

18. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a source of ringing current, two differential control relays, a connection from said source through normally open contacts of the first relay and normally closed contacts of the second, normally open contacts for the second relay included in the talking strands of said link-circuit, means dependent upon the connection of said link-circuit to said line to energize the windings of both relays differentially, a ringing device for subsequently interrupting the circuit of one differential winding of the first relay to apply ringing current to the line, and a switch associated with said line and suitable connections for subsequently interrupting the circuit of one differential winding of the second relay to disconnect said source and complete the talking strands at said normally open contacts.

19. A telephone system comprising a calling telephone line, a called telephone line, a link-circuit included in circuit between said lines, a source of ringing current, two control relays, connections from said source to the called line including normally open contacts of the first relay and normally closed contacts of the second, means for operating the first relay and locking it in actuated position to apply ringing current to the called line, means controlled over the answering end of the link-circuit to operate said second relay to disconnect said ringing source, and means controlled over the calling end of the link-circuit for restoring said first relay to normal to disconnect said source.

20. A telephone system comprising a calling telephone line, a called telephone line, a link-circuit included in circuit between said lines, a source of ringing current, two control relays, connections from said source to the called line through normally open contacts of the first relay and normally closed contacts of the second relay, contacts and connections for operating said first relay to apply ringing current to the called line, a third relay and connections for operating said first relay to disconnect said source, a control circuit for said third relay including conductors of the answering end of said link-circuit, a fourth relay and connections for operating said second relay to disconnect said source, and a control circuit for said fourth relay including conductors of the calling end of said link-circuit.

21. In a telephone system, a source of current, a relay for controlling a circuit from said source having two energizing windings, a circuit including two parallel branches, one including one winding and the other including the second winding and normally closed contacts of said relay, means for closing said circuit to energize said windings differentially, a normally open short-circuiting branch about said second winding and normally closed contacts, means for closing said short-circuiting branch to actuate said relay, whereby the branch through said second winding is broken at said normally closed contacts.

22. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a relay operated upon the establishment of such connection, two differential control relays differentially energized by the operation of said relay, a source of ringing current, connections from said source to the connected line controlled by said differential relays, means for operating one of said differential relays to connect said source to said line, and means for subsequently operating the other differential relay to disconnect said source from said line.

23. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a relay operated upon establishing such connection, a differential control relay and connections for energizing its windings differentially upon the operation of said first relay, a source of ringing current and ringing connections therefrom through normally closed contacts of said differential relay, other contacts for closing said ringing connections to apply ringing current to said line, and a relay for destroying the differential action of the windings of said differential relay to disconnect said source from said line.

24. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, a source of ringing current and ringing connections through normally closed contacts of said relay, other contacts for closing said ringing connections to apply ringing current to said line, and a relay for destroying the differential action of the windings of said relay to disconnect said source from said line.

25. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially dependent upon the establishment of such connection, a source of ringing current and ringing connections through normally closed contacts of said relay, other contacts for closing said ringing

connections to apply ringing current to said line, a relay for destroying the differential action of the windings of said relay to disconnect said source from said line, and a switch associated with said line and operative to close a circuit to operate said last-mentioned relay.

26. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon establishing such connection, a source of ringing current and ringing connections including contacts of said relay, and means for operating said relay by opening the circuit of one of said windings.

27. A telephone system comprising a telephone line, a link-circuit for establishing connection to said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, a source of ringing current, ringing connections including normally open contacts of said relay, contacts for destroying the balance in said differential windings to operate said relay to apply ringing current to said line, and contacts for subsequently interrupting the circuit of the other winding of said relay to disconnect said source from said line.

28. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, a source of ringing current, ringing connections including normally closed contacts of said relay, other contacts for closing said ringing connections to connect said source in circuit with said line, and contacts for destroying the balance in said windings to operate said relay to disconnect said source from said line.

29. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, said relay having normally open contacts included in the talking strands of said link-circuit, a source of ringing current, ringing connections including normally closed contacts in said relay, other contacts and connections for including said source in circuit with said line to apply ringing current thereto, and contacts for destroying the balance in said windings to operate said relay to disconnect said source and complete said talking strands.

30. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, a source of ringing current, ringing connections from said source to said line through normally closed contacts of said relay, other contacts for closing said ringing connections to connect said source in circuit with said line, a second relay in said ringing circuit, means for rendering said second relay unresponsive to ringing current and responsive to direct current, a source of direct current, a circuit including said latter source, second relay and line, a switch for closing said last circuit to energize said second relay, and contacts on said second relay and connections for destroying the balance in the windings of said differential relay, whereby the operation of said second relay operates said differential relay to disconnect said ringing current source from said line.

31. A telephone system comprising a telephone line, a link-circuit for establishing connection with said line, a differential control relay and connections for energizing its windings differentially upon the establishment of such connection, said relay having normally open contacts included in the talking strands of said link-circuit, a source of ringing current, ringing connections from said source to said line through normally closed contacts of said relay, other contacts for closing said ringing connections to connect said source in circuit with said line, a second relay in said ringing circuit, means for rendering said second relay unresponsive to ringing current and responsive to direct current, a source of direct current, a circuit including said latter source, second relay and line, a switch for closing said last circuit to energize said second relay, and contacts on said second relay and connections for destroying the balance in the windings of said differential relay, whereby said differential relay is operated to disconnect said ringing current source from said line and complete said talking strands.

32. A telephone system comprising a telephone line, a link circuit for connecting with said line, a source of ringing current, two control relays, connections from said source through normally open contacts of one of said relays, means dependent upon the connection of said link circuit to said line to operate said relay to connect said source to said line, electromagnetic means controlled by current over the line circuit to operate said second relay to directly disconnect said ringing source, and means responsive to such operation to restore said first relay to normal.

33. A telephone system comprising a telephone line, a link circuit for connecting with said line, a source of ringing current, a control relay, connections from said source

through normally open contacts of said control relay, means dependent upon the connection of said link circuit to said line to operate said control relay to connect said source to said line, a disconnect relay, a source of direct current controlled over the line circuit to operate said disconnect relay to disconnect said ringing source, and means responsive to such operation to restore said control relay to normal.

In witness whereof, I hereunto subscribe my name this 17th day of March, 1909.

HARRY G. WEBSTER.

Witnesses:
CAROLYN WEBER,
A. H. DYSON.