

W. A. RHODES.
SIGNALING SYSTEM.
APPLICATION FILED MAR 22, 1918.

1,412,490.

Patented Apr. 11, 1922.

2 SHEETS—SHEET 1.

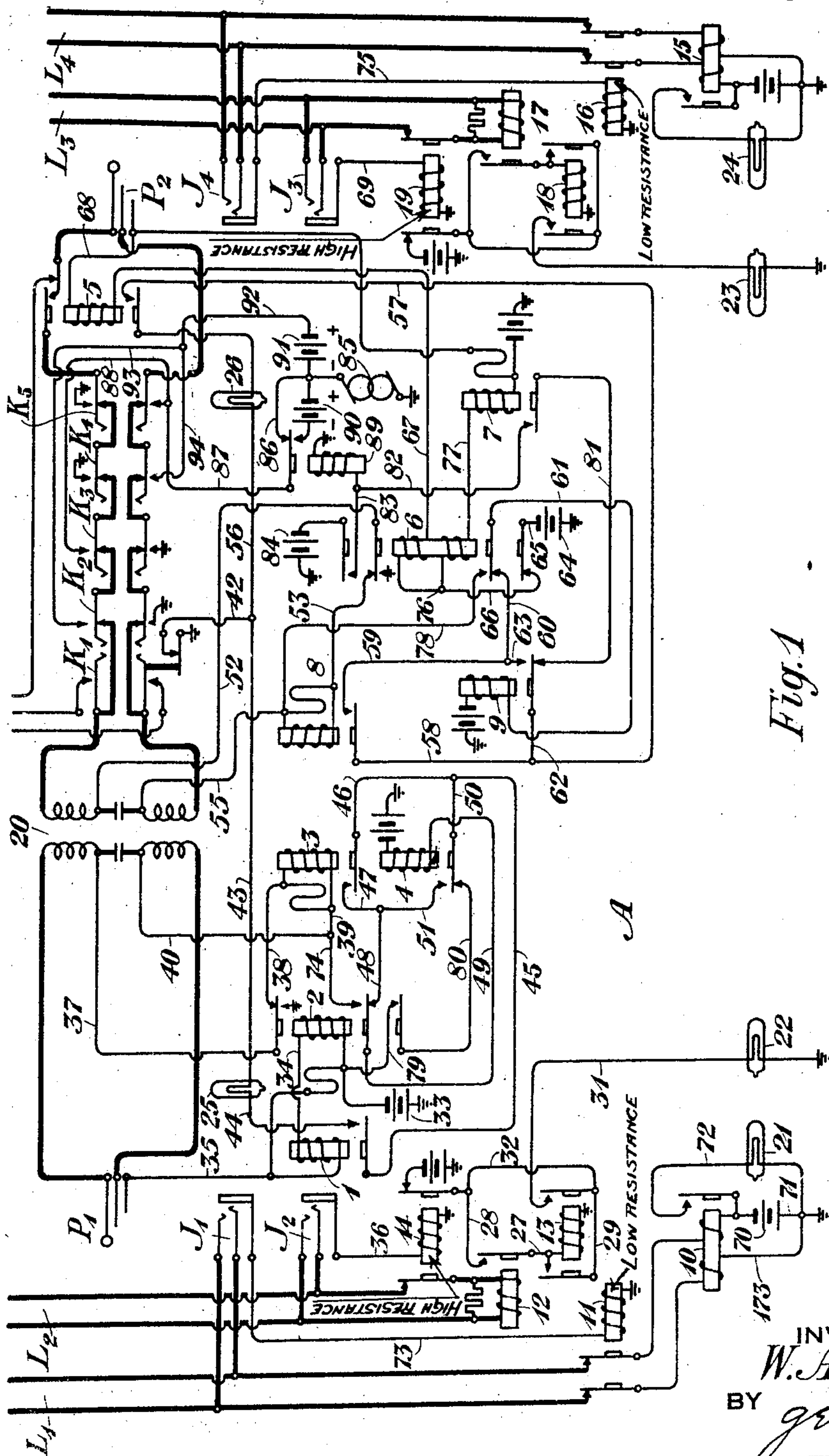


Fig. 1

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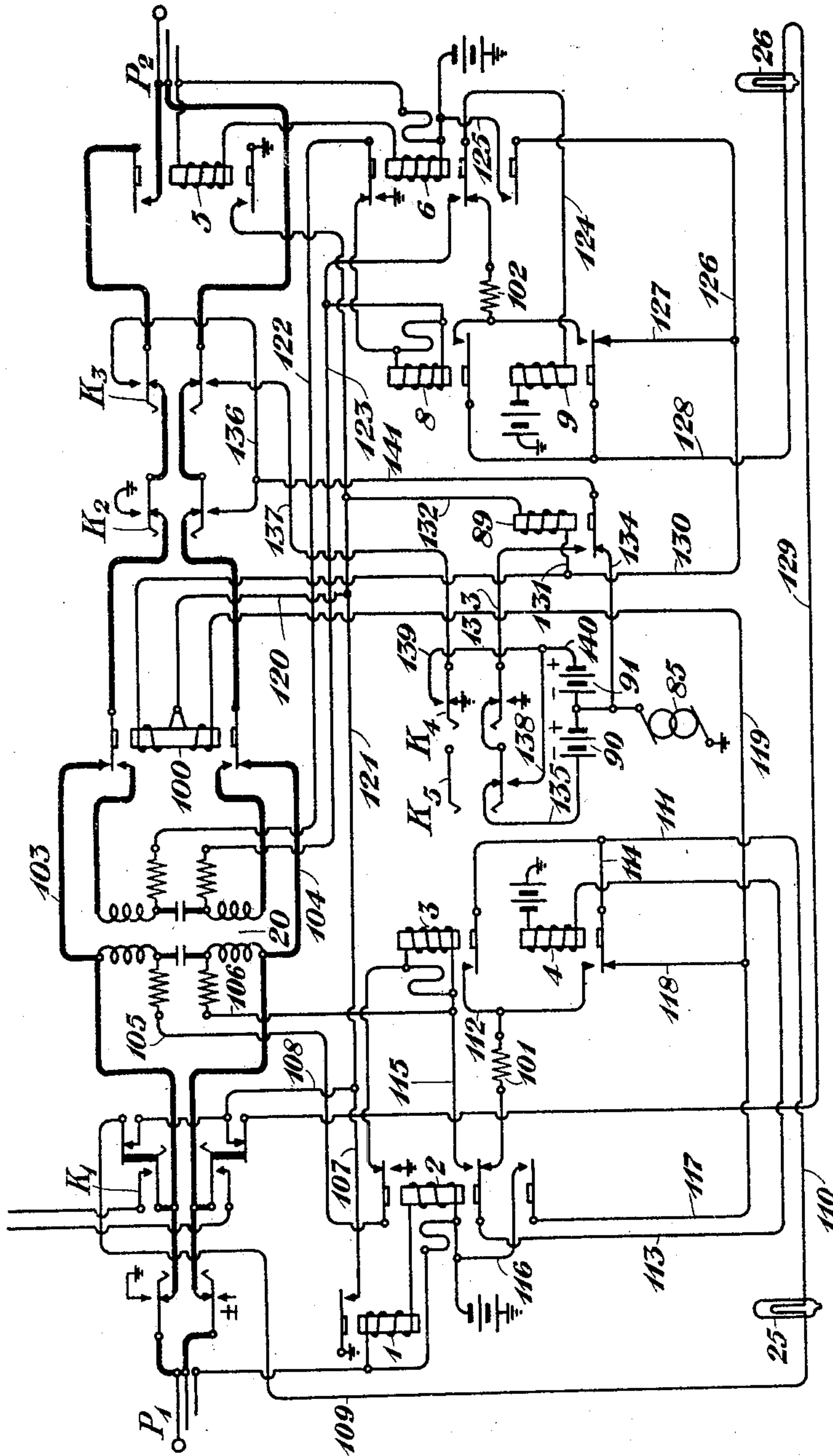


Fig. 2

B

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UNITED STATES PATENT OFFICE.

WILLIAM A. RHODES, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

1,412,490.

Specification of Letters Patent.

Patented Apr. 11, 1922.

Application filed March 22, 1918. Serial No. 223,995.

To all whom it may concern:

Be it known that I, WILLIAM A. RHODES, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Signaling Systems, of which the following is a specification.

This invention relates to telephone systems and more particularly to cord circuits associated therewith.

It is one of the objects of the invention to provide cord circuits which are adapted for making connections between various types of rural, local and long distance lines. A further object consists in associating with such cord circuits supervisory arrangements for informing the operator when a connection has been terminated by either subscriber, and in providing means which will insure the operation of such supervisory signals after the subscriber has ceased ringing. Another object consists in reducing the equipment for controlling the supervisory arrangements. Another object consists in providing such cord circuits with improved ringing arrangements whereby ringing current of different characteristics may be sent out over the various types of lines connected and whereby ringing current may be transmitted selectively over a party line. Other and further objects of the invention may be more fully understood from the detailed description to be given later.

When a connection is made with a rural or magneto line with a universal cord circuit the operator is notified of the termination of the connection by the subscriber transmitting ringing current back over the line and operating a supervisory signal in the cord circuit. In former types of universal cord circuits this signal was controlled by a relay having a double winding, one winding serving to operate the relay when alternating current was sent over the line by the subscriber, and the other winding serving to close a locking circuit through the supervisory signal so that the supervisory signal would remain in operation after the ringing ceased. It has been found in practice that if the subscriber stopped ringing at that point when the magnetic component in the relay from one winding is equal and opposite to the magnetic component due to the locking winding the relay would fail to lock up and the supervisory signal would be extinguished

when the ringing ceased. In other former types of universal cord circuits this difficulty is obviated by using a relay responsive to ringing current and a second relay for the sole purpose of closing a locking circuit for the supervisory signal upon the operation of the ringing relay. In the arrangements of the cord circuits of the present invention a ringing responsive relay is provided and the relay which normally serves as a supervisory relay on common battery line connections is also used for closing a locking circuit for the supervisory signal on a magneto or rural line connection upon the operation of the ringing relay. This arrangement provides a means for preventing the supervisory signal from becoming extinguished after the subscriber ceases ringing and also serves to reduce the equipment needed.

In the ringing arrangement associated with a universal cord circuit it has been customary to provide apparatus whereby the operator may ring selectively over either side of the called line either with alternating current when a connection is made with a rural or magneto line, or with superimposed current of either polarity when a connection is made with a common battery or local line. By the above arrangements four-party service may be given on common battery or local lines. In former types of universal cord circuits this ringing arrangement necessitated the use of six different ringing keys. In the arrangements of the present invention the number of ringing keys for accomplishing this purpose is reduced to four, two of the keys being suitable for ringing either over local lines or rural lines. This is accomplished by associating with the conductors, which lead from the source of ringing current and normally apply alternating current to these two keys, a relay which operates whenever a connection is made with a local line and switches these conductors to contacts which lead to a source of superimposed current. This arrangement tends to simplify the ringing operation by making it more uniform with the operation and equipment at a position handling connections with common battery lines only.

The invention may now be more fully understood when taken in connection with the accompanying drawing, in the Figures 1 and 2 of which are illustrated the preferred forms of the circuit arrangements of the in-

vention. In the Figure 1 is illustrated a universal rural cord circuit adapted for making connections between local or common battery lines and rural or magneto lines. In

5 Figure 2 is illustrated a universal toll cord circuit adapted for making connections between local or common battery lines, rural or magneto lines, or long distance lines.

10 In the Figure 1 the lines L_1 and L_4 illustrate local lines terminating at the switchboard in the jacks J_1 and J_4 respectively. Associated with the lines L_1 and L_4 are the usual line signal lamps 21 and 24 respectively, together with the customary apparatus associated therewith. The lines L_2 and L_3 illustrate rural or magneto lines terminating at the switchboard in the jacks J_2 and J_3 respectively. Associated with the lines L_2 and L_3 are the usual line signal lamps 22 and 23 and the customary apparatus associated therewith. The universal rural cord circuit A is shown terminating in the answering and calling plugs P_1 and P_2 respectively. Associated with the sleeve contact of the plug P_1 is the relay 1 and the marginal relay 2. When a connection is made with a rural line, such as the line L_2 , by inserting the plug P_1 in the jack J_2 , the relay 1 will operate but the marginal relay 2 will not be operated because the winding of the relay associated with the sleeve contact of the jack J_2 is of high resistance. When a connection is made with a local line, such as the line L_1 , by inserting the plug P_1 in the jack J_1 , both of the relays 1 and 2 will be operated because the winding of the relay associated with the sleeve contact of jack J_1 is of low resistance. Included in the talking conductors of the cord circuit is the repeating coil 20. Included in a bridge associated with the left-hand windings of repeating coil 20 is the relay 3 which responds to alternating current. When a connection with a rural line has been terminated, the subscriber sends ringing current back over the line and over this bridge, which causes the operation of the relay 3. Under the control of the relay 3 is the relay 4, which serves, upon the energization of relay 3, to close a locking circuit through the signal lamp 25, the operation of which informs the operator of the termination of the connection. When a connection is made with a local line, the relay 2, as has been formerly pointed out, will be operated. This opens the bridge associated with the left-hand windings of repeating coil 20 and applies ground to one side of the line and connects battery to the other side of the line to furnish the talking current for the connection. The winding of the relay 4 is included in this current supply circuit and when the connection is terminated by the subscriber hanging up his receiver, the relay 4 becomes de-energized and allows a circuit to be closed through the signal lamp 25.

The operation of the signal lamp 25 serves to inform the operator that the connection has been terminated. Associated with the sleeve of plug P_2 are the relays 5 and 6. When a connection is made with a rural line, such as the line L_3 , the relay 5 will be operated but the relay 6 will not be operated, as the winding of the relay associated with the sleeve contact of the jack J_3 is of high resistance. When a connection is made with a local line, such as the line L_4 , by inserting the plug P_2 in the jack J_4 , both of the relays 5 and 6 will be operated, as the winding of the relay associated with the sleeve contact of the jack J_4 is of low resistance. Included in a bridge associated with the righthand windings of repeating coil 20 is the alternating current relay 8. When a connection has been terminated by a subscriber on a rural line ringing current is transmitted back over the line and over this bridge and relay 8 is caused to operate. Under the control of relay 8 is the relay 9, which, upon the operation of relay 8, serves to close a locking circuit through the signal lamp 26 and thereby inform the operator that the connection has been terminated. When a connection is made with a local line, the relay 6, as has been formerly pointed out, will be energized. The operation of relay 6 opens the bridge associated with the righthand windings of repeating coil 20 and applies ground to one side of the line and connects battery to the other side of the line to furnish talking current for the connection. The winding of the relay 9 is included in this current supply circuit and, accordingly, when the subscriber terminates the connection by hanging up his receiver, the relay 9 will be de-energized and allow a circuit to be closed through the signal lamp 26, thereby informing the operator of the termination of the connection. Associated with the talking strands of the cord circuit is the listening key K_1 . By throwing the listening key K_1 the operator may extinguish either the signal lamp 25 or the signal lamp 26 by opening the circuit closed therethrough.

Associated with the talking strands of the cord circuit are the ringing keys K_2 , K_3 , K_4 and K_5 . Associated with the ringing keys is a source of ringing current, including the generator 85 of alternating current and the batteries 90 and 91. This source of ringing current is so associated with the ringing keys that superimposed current of a positive polarity is normally applied to keys K_2 and K_4 and alternating current is normally applied to the keys K_3 and K_5 . Under the control of the relay 6 is the relay 89, which operates whenever a connection is made with a local line. The operation of the relay 89 serves to associate the source of ringing current with the ringing keys K_2 and K_5 , so that superimposed current of a negative

polarity will be applied thereto when a connection is made with a local line. The circuit arrangements of the relays associated with the calling end of the cord circuit are slightly different from the arrangements associated with the answering end and illustrate an arrangement desirable for use when a connection is made with an operator at a recording toll board. However, it will be understood that the arrangement illustrated as associated with this answering end of the cord might equally well be employed on the calling end.

The cord circuit B illustrated in the Figure 2, is adapted for making connections between local or common battery lines, rural or magneto lines and long-distance lines, and as the arrangements associated therewith are in many respects similar to those of the cord circuit A of Figure 1, similar reference numerals have been used to designate similar objects whenever possible. Associated with the sleeve conductor of the answering plug P_1 are the relays 1 and 2, relay 1 operating on connections with magneto lines or long distance lines, and both of the relays 1 and 2 operating when a connection is made with a common battery line. These relays perform functions similar to the relays 1 and 2 of the cord circuit A. Associated with the talking conductors of the cord circuit B is the repeating coil 20, which is so arranged that part of it serves as a retardation coil when connections are made involving rural or magneto lines, or long-distance lines. When a connection is desired involving a common battery line, it is desirable to employ the coil 20 as a repeating coil, and therefore the relay 100, which is controlled by relay 2, is operated and the repeating coil 20 is connected as such. Associated with the left-hand winding of repeating coil 20 is the relay 3, which responds to alternating ringing current transmitted over the line when a connection with a magneto line or long distance line has been terminated. Under the control of the relay 3 is the relay 4, which serves to close a locking circuit through the supervisory signal 25 when a connection has been terminated on a magneto line or long distance line, and which serves as a supervisory relay for the signal lamp 25 when a connection is made with a common battery line. Associated with the answering plug P_2 is the relay 5 and the marginal relay 6, the relay 5 operating when a connection is made with a magneto line or long distance line, and both the relays 5 and 6 operating when a connection is made with a common battery line. Associated with the right-hand windings of the repeating coil 20 is the relay 8 which responds to alternating ringing current transmitted back over a called magneto or long distance line when a connection between such a line and a com-

mon battery line has been terminated. Under the control of the relay 8 is a relay 9, which serves to close a locking circuit through the signal lamp 26 when a connection is terminated between a common battery line and a called magneto or long distance line, and which serves as a supervisory relay for the signal lamp 26, when a connection is made with a called common battery line. As the right-hand winding of the repeating coil 20 is not connected to the cord circuit when a connection is made involving only magneto lines or long distance lines, the termination of such a connection at either end of the line is indicated by the lamp 25.

With cord circuits of this type it is commonly the practice to employ a battery for talking purposes of a comparatively high voltage and signaling lamps constructed to receive their normal current at a lower voltage. With the cord circuit B, illustrated in Fig. 2, the signal lamps on long distance or magneto connections are lighted from the battery which supplies talking current on common battery connections and since the resistance of the windings of relays 4 and 9, in series with the lamps 25 and 26 respectively, is not sufficient to reduce the voltage across the lamp terminals by the necessary amount, the resistance units 101 and 102 are also connected in series with the lamps 25 and 26 when they are lighted on long distance or magneto line connections.

The ringing arrangements associated with the cord circuit B are slightly different from those of the cord circuit A. Included in the talking strands of the cord circuit B are the ringing keys K_2 and K_3 . Associated with these keys are the master keys K_4 and K_5 . Associated with the keys K_2 and K_3 is a source of ringing current, including a generator 85 and the batteries 90 and 91. Alternating ringing current is normally applied from the generator 85 to the keys K_2 and K_3 . When a connection is made with a common battery line and it is desired to use superimposed current of either polarity for ringing purposes, relay 89 will operate and connect the conductors leading from keys K_2 and K_3 to conductors leading to the contacts of keys K_4 and K_5 , to which keys the source of ringing current supplies superimposed current of either polarity.

By the above arrangements alternating ringing current may be transmitted selectively over a called magneto or long distance line by operating either the key K_2 or the key K_3 . By operating different combinations of the keys K_2 and K_3 together with the keys K_4 and K_5 superimposed current of either polarity may be transmitted selectively over a called common battery line.

The operation of cord circuit A upon a connection between two magneto lines is as follows:—When a subscriber on a magneto

line, such as the line L_2 , desires a connection with the central office, he will transmit ringing current over the sides of the line L_2 and through the winding of relay 12. This will energize the relay 12 and close the following circuit: from ground, winding of relay 13, conductor 27, armature and contact of relay 12, conductor 28, armature and contact of relay 14 to battery and ground. The closing of this circuit will energize relay 13 which closes the following circuit: from ground and battery, contact and armature of relay 14, conductor 28, contact and armature of relay 12, conductor 27, lefthand contact and armature of relay 13, conductor 29, righthand armature and contact of relay 13, over conductor 31, filament of signal lamp 22, to ground. At the same time a locking circuit will be closed through the signal lamp 22 over conductors 32 and 29 so that the signal lamp will not be extinguished when the subscriber on line L_2 ceases to ring. Upon the operation of signal lamp 22 the operator will insert the plug P_1 of cord circuit A into the jack J_2 . This will close the following circuit: from ground and battery 33, winding of marginal relay 2, conductor 34, winding of relay 1, conductor 35, contacts of plug P_1 , jack J_2 , conductor 36, winding of relay 14 to ground. The closing of the above described circuit will energize relay 14 which will pull up its armature and open the circuit closed through the line signal lamp 22. The closing of the above mentioned circuit will energize relay 1, but, as the winding of relay 14 is of high resistance, it will not energize the marginal relay 2. After the operator has connected the cord circuit to the line L_1 by inserting the plug P_1 in the jack J_2 , the listening key K_1 is thrown and the operator may ascertain with whom the connection is desired. If a connection is desired with another magneto line such as the line L_3 , the operator inserts the plug P_2 into the jack J_3 . When the plug P_2 is inserted in the jack J_3 the following circuit is closed: from ground and battery 64, conductor 65, armature and contact of marginal relay 6, conductor 66, upper winding of marginal relay 6, conductor 67, winding of relay 5, conductor 68, sleeve contacts of plug P_2 and jack J_3 , conductor 69, winding of relay 19 to ground. The closing of the above described circuit will operate the relay 5 but, as the winding of relay 19 is of high resistance, it will not operate the marginal relay 6. The operation of the relay 5 by pulling up its upper armature completes the talking circuit of the cord circuit and by pulling up its lower armature places the signal lamp 26 under the control of relay 9. The operator may now transmit ringing current to the subscriber selectively over either side of line L_3 by operating either the key K_3 or the key K_5 .

When the key K_3 is operated alternating ringing current will be transmitted over the tip conductor of the cord circuit and over one side of the line as follows: from ground and generator 85, over conductor 86, contact and armature of relay 89, over conductors 87 and 88, contact of key K_3 and thence over the tip conductor of the cord circuit. The ringing circuit is completed by applying ground to the other contact of key K_3 . If it is desired to transmit ringing current over the other side of the line L_3 the key K_5 is operated and ground is applied to the tip conductor of the cord circuit. Alternating ringing current will then be applied to the ring conductor of the cord circuit as follows: from ground, generator 85, conductor 86, contact and armature of relay 89, conductor 87, contact of key K_5 and over the ring conductor of the cord circuit.

When the connection is terminated either the subscriber on the line L_2 or on the line L_3 or both will transmit ringing current over the line and through apparatus associated with the universal cord circuit A in the following manner: When the subscriber on the line L_2 transmits ringing current over the line for the purpose of notifying the operator that the connection has been completed, the ringing current will be transmitted over the talking strands of the cord circuit and through the left hand windings of the repeating coil 20. From this point ringing current will be transmitted over the following circuit; from upper left hand winding of repeating coil 20, over conductor 37, contact and armature of relay 2, conductor 38, winding of relay 3, conductors 39 and 40 to the lower left hand winding of repeating coil 20. This will energize the relay 3 which will pull up its armature and close the following circuit: from ground, contact of listening key K_1 over conductors 42 and 43, filament of signal lamp 25, over conductor 44, contact and armature of relay 1, over conductors 45 and 46, contact and armature of relay 3, conductors 47 and 48, contact and armature of relay 2, conductor 49, winding of relay 4, to battery and ground. The closing of this circuit will light the signal lamp 25 and inform the operator that the call has been completed. The closing of this circuit will also energize the relay 4 which will be locked up over the following circuit: from conductor 45, over conductor 50, contact and armature of relay 4, over conductors 51 and 48, contact and armature of relay 2, over conductor 49, winding of relay 4, to battery and ground. Upon the operation of the signal lamp 25 the operator either by disconnecting the cord circuit from the lines L_2 and L_3 or by throwing the listening key K_1 may open the circuit formerly closed through the signal lamp 25 and allow it to be extinguished. Should

the subscriber on the line L_3 desire to inform the operator that the connection had terminated, ringing current would be transmitted by the subscriber over the line L_3 and over the talking strands of the cord circuit to the right hand windings of repeating coil 20. From this point the ringing current will be transmitted over the following circuit; from the upper right hand winding of repeating coil 20, over conductor 52, armature and contact of relay 6, conductor 53, winding of relay 8, over conductor 55, to the lower right hand winding of repeating coil 20. This will energize the relay 8 which will pull up its armature and close the following circuit: from ground, contact of listening key K_1 , conductors 42 and 56, filament of signal lamp 26, armature and contact of relay 5, conductors 57 and 58, armature and contact of relay 8, conductors 59 and 60, armature and contact of relay 6, conductor 61, winding of relay 9, to battery and ground. The closing of this circuit will operate the signal lamp 26 and inform the operator that the connection has terminated. The closing of this circuit will also energize the relay 9 which will pull up its armature and become locked up as follows: from conductor 57, over conductor 62, armature and contact of relay 9, conductors 63 and 60, contact and armature of relay 6, conductor 61, winding of relay 9 to battery and ground. When the operator has been thus informed that the connection has terminated, she may extinguish the signal lamp 26 by throwing the listening key K_1 and opening the circuit closed therethrough or by disconnecting from line L_3 , thereby releasing relay 5 and thus opening the circuit through lamp 26.

The operation of the cord circuit A upon a connection between two common battery lines or between a common battery line and a magneto line is as follows:—When a subscriber on one of the common battery lines, such as the line L_1 , removes the receiver from the hook, the following circuit will be closed: from ground, conductor 71, battery 70, righthand winding of relay 10, over one side of transmission line L_1 and through the subscriber's telephone set, over the other side of the transmission line L_1 , through the lefthand winding of relay 10, over conductor 173 to ground. The closing of this circuit will energize the relay 10, which will pull up its armature and close the following circuit: from ground, conductor 71, battery 70, armature and contact of relay 10, conductor 72, filament of signal lamp 21 to ground. The closing of this circuit will operate the signal lamp 21. Upon the operation of the signal lamp 21, the operator will insert the plug P_1 of the cord circuit into the jack J_1 and the following circuit will be closed: from ground, battery 33,

winding of marginal relay 2, conductor 34, winding of relay 1, conductor 35, sleeve contacts of plug P_1 and jack J_1 , conductor 73, winding of relay 11 to ground. The closing of this circuit will energize the relay 11, which will pull up its armature and open the circuit formerly closed about the windings of relay 10, which will in turn release its armature and extinguish the signal lamp 21. As the resistance of the winding of the relay 11 is small, the closing of the above described circuit will energize both of the relays 1 and 2. The operation of marginal relay 2 applies ground to its upper armature and conductor 37 and to the upper lefthand winding of repeating coil 20. The energization of marginal relay 2 also applies battery to the lower lefthand winding of repeating coil 20 as follows: from ground and battery, winding of relay 4, conductor 49, armature and contact of relay 2, conductors 74 and 40, to lower lefthand winding of repeating coil 20. The above described arrangements provide a means for supplying the talking current when a connection is made with a common battery line. The operator now throws the listening key K_1 and ascertains with whom a connection is desired. If a connection is desired with a magneto line, such as the line L_3 , the operator inserts the plug P_2 into the jack J_3 . When the plug P_2 is inserted in the jack J_3 the operation is substantially the same as has been already described, and a further description will be omitted. If the operator ascertains that a connection is desired with another common battery line, such as the line L_4 , the plug P_2 is inserted in the jack J_4 and the following circuit is closed; ground and battery 64, conductor 65, armature and contact of marginal relay 6, conductor 66, upper winding of marginal relay 6, conductor 67, winding of relay 5, conductor 68, sleeve contacts of plug P_2 and jack J_4 , conductor 75, winding of relay 16 to ground. As the resistance of the winding of relay 16 is small, the closing of the above described circuit will energize both the relay 5 and the marginal relay 6. The energization of the relay 5 causes it to pull up its upper armature and complete the talking circuit of the cord circuit, and by pulling up its lower armature places the signal lamp 26 under the control of relay 9. The energization of marginal relay 6 causes it to pull up its armature and the circuit formerly completed about the winding of marginal relay 6 is now completed as follows: from upper winding of marginal relay 6 to connecting point 76, thence through the lower winding of relay 6, over conductor 77, winding of relay 7, to battery and ground. The energization of marginal relay 6 applies ground to conductor 52 and to the upper righthand winding of repeating coil 20 and connects to the lower righthand winding of

repeating coil 20 a battery to supply the talking current as follows: from ground and battery, winding of relay 9, conductor 61, armature and contact of relay 6, conductors 78 and 55, to the lower righthand winding of repeating coil 20.

When a connection has been made with a common battery line the operation of relay 6 also closes the following circuit: from ground and battery 84, armature and contact of relay 6, conductor 83, winding of relay 89, to ground. Upon the operation of relay 89 the operator may now transmit superimposed ringing current out over the line L_4 selectively by operating one of the ringing keys K_2 , K_3 , K_4 and K_5 as follows: if it is desired to send superimposed positive current out over the tip conductor of the cord circuit, the key K_2 is thrown. This applies ground to the ring conductor of the cord circuit, and applies superimposed positive current to the tip conductor of the cord circuit as follows: from ground and generator 85, battery 91, conductors 92 and 93, contact of key K_2 and over the tip conductor of the cord circuit. If it is desired to send superimposed positive current out over the ring conductor of the cord circuit the key K_4 is operated. This applies ground to the tip conductor of the cord circuit and applies superimposed positive current to the ring conductor as follows: from ground and generator 85, battery 91, conductors 92 and 94, contact of key K_4 and out over the ring conductor of the cord circuit. If it is desired to send superimposed negative current out over the tip conductor of the cord circuit the key K_3 is operated. This applies ground to the ring conductor of the cord circuit and applies superimposed negative current to the tip conductor of the cord circuit as follows: from ground and generator 85, battery 90, contact and armature of relay 89, conductors 87 and 88, contact of key K_3 and over the tip conductor of the cord circuit. If it is desired to send superimposed negative current over the ring conductor of the cord circuit, the key K_5 is operated. This applies ground to the tip conductor of the cord circuit and applies superimposed negative current to the ring conductor as follows: from ground, generator 85, battery 90, contact and armature of relay 89, conductor 87, contact of key K_5 and over the ring conductor of the cord circuit.

When the subscriber on the line L_1 terminates the connection by hanging up the receiver, the current supply circuit will be broken. As has been formerly pointed out, the winding of the relay 4 was included in the current supply circuit. Accordingly, this relay will be de-energized when the talking circuit is broken and, by allowing its armature to retract, will close the follow-

ing circuit: from ground and battery 33, over conductor 79, contact and armature of relay 2, conductor 80, contact and armature of relay 4, conductors 50 and 45, armature and contact of relay 1, conductor 44, filament of signal lamp 25, conductors 43 and 42, contact of listening key K_1 to ground. The closing of this circuit will operate the signal lamp 25 and inform the operator that the connection has been terminated by the subscriber on the line L_1 . The operator may then throw the listening key K_1 or disconnect and thereby extinguish the signal lamp 25 by opening the circuit closed there-through. When the subscriber on the line L_4 hangs up the receiver, the current supply circuit will be broken. As has been formerly pointed out, the winding of relay 9 is included in this current supply circuit. Accordingly, when the current supply circuit is broken by the subscriber on line L_4 , the relay 9 will be de-energized and the following circuit will be closed; from ground and battery 84, armature and contact of relay 6, conductors 83 and 82, armature and contact of relay 7, conductor 81, contact and armature of relay 9, conductors 62 and 57, contact and armature of relay 5, filament of signal lamp 26, conductors 56 and 42, contact of listening key K_1 to ground. The closing of the above described circuit will light the signal lamp 26 and inform the operator that the connection has been terminated by the subscriber on line L_4 . The operator may extinguish the signal lamp 26 by operating the listening key K_1 and opening the circuit closed therethrough or by disconnecting.

The cord circuit A may also be employed for making connections involving a common battery line and a magneto line, such as a connection between the lines L_1 and L_3 , or between the lines L_2 and L_4 . As the operation of the supervisory and ringing arrangements associated with the cord circuit in such a connection will be the same as formerly described separately no further description thereof will be given.

The operation of the universal toll cord circuit B is as follows: when a connection is made with the cord circuit B between two magneto lines or two long-distance lines, the relays 1 and 5 will be operated, but the marginal relays 2 and 6 will not be operated, as the sleeve circuits associated with the jacks of lines of this type are of high resistance. When a connection between two lines of this type is terminated, the subscriber or the distant operator will transmit alternating ringing current back over the lines and over the talking strands of the cord circuit. This alternating ringing current will be transmitted through the lefthand windings of the repeating coil 20 and over conductors 105 and 106 and through the winding of relay 3. As the relay 3 is responsive to alternating

current, it will be operated, and, together with the aforementioned operation of relay 1, will close the following circuit:—from ground, armature and contact of relay 1, conductors 107 and 108, contacts of key K_1 , conductor 109, filament of signal lamp 25, conductors 110 and 111, armature and contact of relay 3, conductor 112, resistance 101, contact and armature of relay 2, conductor 113, winding of relay 4 to battery and ground. The closing of the above described circuit lights the signal lamp 25 and energizes the relay 4, which pulls up its armature and closes the following locking circuit: from conductor 111, over conductor 114, armature and contact of relay 4, resistance 101, contact and armature of relay 2, conductor 113, winding of relay 4 to battery and ground. The operation of the signal lamp 25 will inform the operator that the connection is terminated. The operator may extinguish the signal lamp 25 by throwing the listening key K_1 and opening the circuit closed therethrough or by disconnecting and thereby removing ground from the locking circuit at relays 1 and 5.

When a connection is made with the cord circuit B between two common battery lines, both of the relays 1 and 2 and the relays 5 and 6 will be operated, as the sleeve circuits associated with the jacks of such lines are of small resistance. The operation of the relay 2 serves to open the bridge, including conductors 105 and 106, which is associated with the lefthand winding of repeating coil 20, and applies ground to the conductor 105 and to the other side of the talking circuit a source of current supply as follows: from ground and battery, winding of relay 4, conductor 113, armature and contact of relay 2, conductor 115, conductor 106 and lower lefthand winding of repeating coil 20. This last mentioned circuit includes the winding of the relay 4, which becomes energized until the connection with the common battery line is terminated and the circuit is broken by the subscriber hanging up his receiver. When the circuit is broken, the relay 4 will be de-energized and the following circuit will be closed: from ground and battery, conductor 116, contact and armature of relay 2, conductors 117 and 118, contact and armature of relay 4, conductors 114, and 110, filament of signal lamp 25, conductor 109, contacts of key K_1 , conductors 108 and 107, contact and armature of relay 1 to ground. The closing of this last mentioned circuit operates the signal lamp 25 and informs the operator that the connection has been terminated. When a connection between two common battery lines is made, it is desirable to employ coil 20 as a repeating coil. Accordingly, when the marginal relay 2 is operated, the following circuit is closed: from ground and battery, conductor 116, contact

and armature of relay 2, conductors 117 and 119, lower winding of relay 100, conductors 120, 121 and 107, and contact and armature of relay 1 to ground. The closing of this circuit energizes relay 100, which pulls up its armature; opens a connection between conductors 103 and 104 and the talking strands of the cord circuit; and connects the conductors leading from the righthand winding of repeating coil 20 to the talking strands, and thus connects coil 20 as a repeating coil in the talking circuit. When the calling plug P_2 is inserted in a common battery line, the relay 5 and the relay 6 operate, as has been formerly pointed out, and serve to apply ground to the conductor 122 and thence to one of the talking strands of the cord circuit. A source of current supply is connected to the other of the talking strands of the cord circuit as follows: from ground and battery, winding of relay 9, conductor 124, armature and contact of relay 6, conductor 123, lower righthand winding of repeating coil 20, and thence over the talking strand of the cord circuit. The winding of the relay 9 is included in this current supply circuit, and when the circuit is broken by the subscriber hanging up his receiver and terminating the connection, the relay 9 will be de-energized and the following circuit will be closed: from ground and battery, conductor 125, contact and armature of relay 6, conductors 126 and 127, contact and armature of relay 9, conductor 128, filament of signal lamp 26, conductor 129, contact of key K_1 , conductors 108 and 121, contact and armature of relay 5 to ground. The closing of this circuit will operate the signal lamp 26 and inform the operator that the subscriber has terminated the connection.

If the connection is one involving a common battery line on the calling end of the cord and a magneto or long distance line on the answering end it is found desirable to employ the repeating coil 20. Upon such a connection when the plug P_2 is inserted in a common battery line, the relays 5 and 6 will be operated as has been previously pointed out. The operation of the relays 5 and 6 will close the following circuit; from ground and battery, conductor 125, contact and armature of relay 6, conductors 126 and 130 upper winding of relay 100, conductors 120 and 121, contact and armature of relay 5, to ground. The closing of this circuit will energize the relay 100 which will in a manner previously pointed out include the coil 20 as a repeating coil in the talking circuit of the cord. The supervisory arrangements associated with either side of the cord circuit upon such a connection will function in the same manner as previously described and a further description of the operation may be omitted.

If a connection is one involving a magneto

or long distance line on the calling end of the cord and a common battery line on the answering end, the repeating coil 20 will be cut into service by the apparatus associated with the answering end of the cord as previously pointed out. If the subscriber on the magneto line or the distant operator on the long distance line in such a connection desires to inform the operator that the connection has been terminated, alternating ringing current will be transmitted back over the line and through the right hand windings of the repeating coil 20 and thence over conductors 122 and 123 and the winding of relay 8. The relay 8 responds to alternating current and is energized. The operation of relay 8 serves to close a circuit through the relay 9 and the signal lamp 26 in a manner similar to the operation of the relays 3 and 4 and accordingly a further description of the operation will be omitted.

The operation of the ringing arrangements associated with the cord circuit B is as follows: when a connection is made with the cord circuit B and a magneto line or a long distance line it is desirable to ring selectively over either side of the line with alternating current. This may be accomplished by operating either the key K_2 or the key K_3 . When the key K_2 is operated ground is applied to the tip conductor of the cord and one side of the line. Alternating current is applied to the ring conductor of the cord and the other side of the line as follows: from ground and generator 85, conductor 134, contact and armature of relay 89, over conductor 141, contact of key K_2 and over the ring conductor of the cord circuit. When the key K_3 is operated ground is applied to the ring conductor of the cord circuit and one side of the line as follows: from ground, contact of key K_4 , conductor 137, contact of key K_3 and ring conductor of the cord. Alternating current is applied to the tip conductor of the cord and the other side of the line as follows: from ground and generator 85, conductor 134, contact and armature of relay 89, over conductors 141 and 136, contact of key K_3 , thence over the tip conductor of the cord and the other side of the line.

When a connection is made with the cord circuit B and a common battery line, it is desirable to ring selectively over either side of the line with superimposed current of either polarity, where such lines are provided for four-party service. This is accomplished by operating either the key K_2 or the key K_3 , together with the key K_4 or the key K_5 . When a connection is made with a common battery line and the calling plug P_2 is inserted in the jack of such a line, the relays 5 and 6 will be operated, as has been previously pointed out. The operation of the relay 6 closes the following circuit:

ground and battery, conductor 125, contact and armature of relay 6, conductors 126, 130, 131, winding of relay 89, conductor 132, conductor 121, contact and armature of relay 5 to ground. Accordingly, whenever a connection is made with a common battery line and the relay 6 is operated, the relay 89 will be operated. By now throwing the key K_2 , ground will be applied to the tip conductor of the cord and superimposed current of a negative polarity will be applied to the ring conductor of the cord as follows: from ground generator 85, battery 90, conductor 135, contacts of key K_5 and key K_4 , conductor 133, contact and armature of relay 89, conductor 141, contact of key K_2 and over the ring conductor of the cord. By operating the key K_3 , ground may be applied to the ring conductor of the cord as follows: from ground and contact of key K_4 , conductor 137 and contact key K_3 . Superimposed current of a negative polarity may be applied to the tip conductor of the cord as follows: from ground and generator 85, battery 90, conductor 135, contacts of key K_5 and K_4 , conductor 133, contact and armature of relay 89, conductors 141 and 136, contact of key K_3 and over the tip conductor of the cord. By operating the key K_3 and the key K_5 , ground will be applied to the ring conductor of the cord as follows: from ground and contact of key K_4 over conductor 137 and contact of key K_3 . Superimposed current of a positive polarity will be applied to the tip conductor of the cord as follows: from ground and generator 85, battery 91, conductors 140 and 138, contacts of key K_5 and key K_4 , conductor 133, contact and armature of relay 89, conductors 141 and 136, contact of key K_3 and over the tip conductor of the cord. By operating the keys K_3 and K_4 , ground will be applied to the tip conductor of the cord as follows: from ground, contact of key K_4 , conductor 133, contact and armature of relay 89, conductors 141 and 136, contact of key K_3 , to tip of cord. Superimposed current of positive polarity will be applied to the ring conductor of the cord as follows: from ground and generator 85, battery 91, conductors 140 and 139, contacts of key K_4 , conductor 137, contact of key K_3 and over the ring conductor of the cord.

While this invention has been disclosed as embodied in certain specific arrangements which have been deemed desirable, it will be understood that it is capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a telephone system, a cord circuit adapted to interconnect common battery lines, magneto lines, or long distance lines,

a supervisory signal, a relay exercising direct control over said signal when a connection is made with a common battery line, and a relay responsive to alternating current and closing a circuit through said signal when a connection is made with a magneto or long distance line, said first mentioned common battery relay serving as a lock up relay for said circuit.

2. In a telephone system, a cord circuit adapted to interconnect lines of different types, a relay responsive to ringing current associated with said cord circuit, a supervisory lamp, a supervisory relay, and means whereby when said cord circuit is associated with one type of line and ringing current is transmitted over said line said first mentioned relay is actuated to close a circuit for said supervisory lamp and supervisory relay, said supervisory relay then closing a locking circuit for said lamp.

3. In a telephone system, a cord circuit adapted to interconnect lines of different types, a relay responsive to ringing current associated with said cord circuit, a supervisory lamp, a supervisory relay, means whereby when said cord circuit is associated with one type of line and ringing current is transmitted over said line said first mentioned relay is actuated to close a circuit for said supervisory lamp, and a locking circuit for said supervisory lamp including said supervisory relay.

4. In a telephone system, a cord circuit adapted to interconnect lines of different types, a relay responsive to ringing current associated with said cord circuit, a supervisory lamp, a supervisory relay, means whereby when said cord circuit is associated with one type of line and ringing current is transmitted over said line said first mentioned relay is actuated to close a circuit for said supervisory lamp and supervisory relay, said supervisory relay then closing a locking circuit for said lamp, and means whereby when said cord circuit is associated with a line of another type, said first mentioned relay is disconnected from the cord circuit and a source of battery supply current is connected thereto through said supervisory relay, said supervisory relay when so related to the cord circuit exercising direct control over the supervisory lamp.

5. In a telephone system, a cord circuit including switching means, a source of current, means normally applying alternating current from said source to said switching means when the cord circuit is associated with a line of one type, and means operating when said cord circuit is connected with another type of line to superimpose direct current on said alternating current.

6. In a telephone system, a cord circuit including four ringing keys, a source of current, means operating when the cord circuit is associated with a line of one type for applying alternating current from said source to all of said keys and for superimposing direct current on the alternating current applied to two of said keys, and means operating when said cord circuit is connected with another type of line for superimposing direct current on the alternating current applied to all of said keys.

7. In a telephone system, a cord circuit including four ringing keys, a source of current, means operating when the cord circuit is associated with a line of one type for applying alternating current from said source to two of said keys and to one side of the line and to the other two keys and the other side of the line and for superimposing direct current of one polarity on the alternating current applied to one of said first mentioned two keys and for superimposing direct current of an opposite polarity on the alternating current applied to one of said second mentioned two keys, and means operating when the cord circuit is connected with another type of line for superimposing direct currents of opposite polarity on the alternating current applied to said remaining two keys.

8. In a telephone system, a cord circuit, a plurality of keys, a source supplying currents of different characteristics means normally applying current of one character from said source to said keys, and means operating automatically when said cord circuit is connected to a certain type of line to apply current of a different character from said source to said keys.

In testimony whereof I have signed my name to this specification this 18th day of March, 1918.

WILLIAM A. RHODES.