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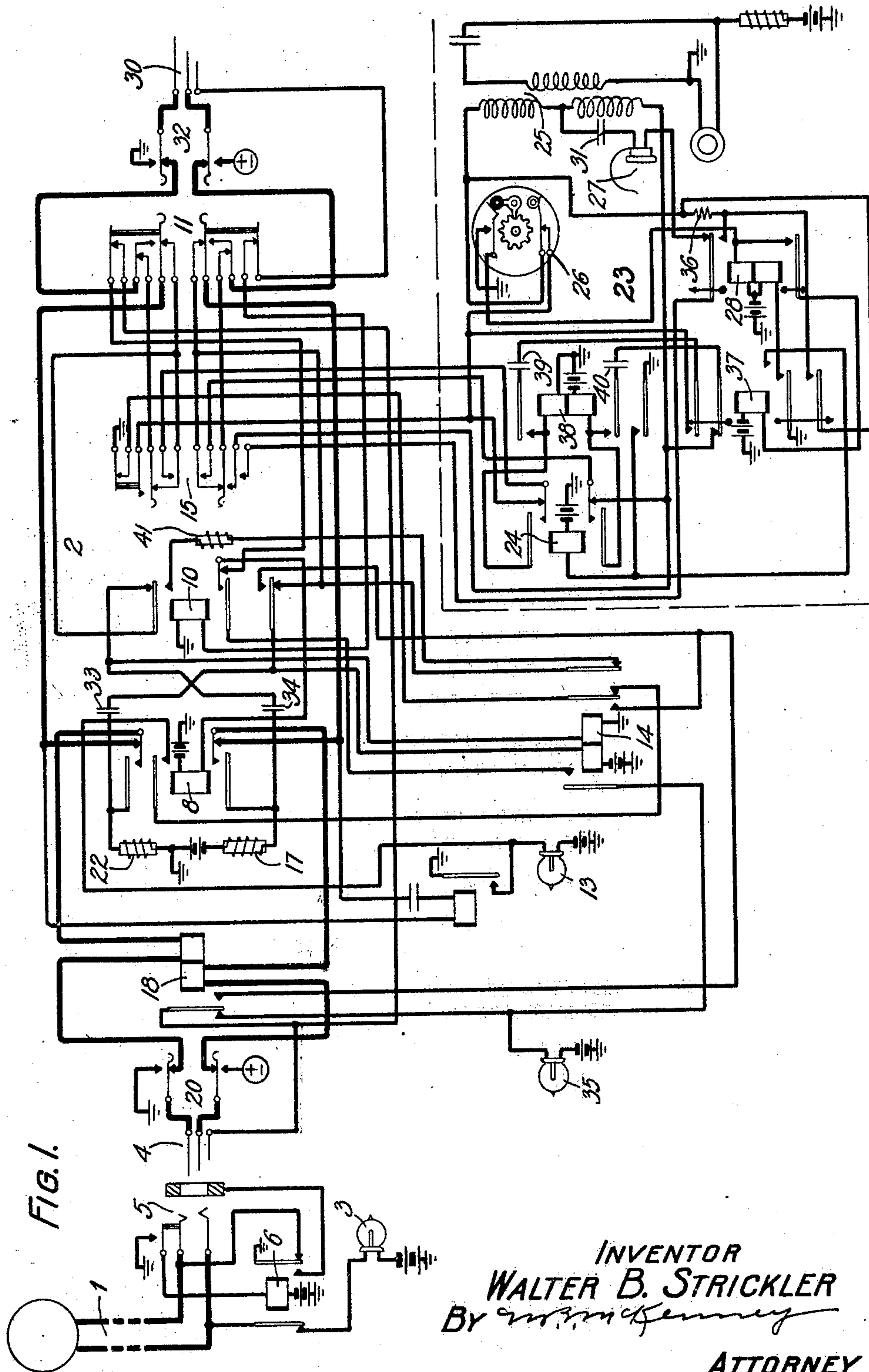
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1,747,849

TELEPHONE SYSTEM

Filed May 27, 1927

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TELEPHONE SYSTEM

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FIG. 2.

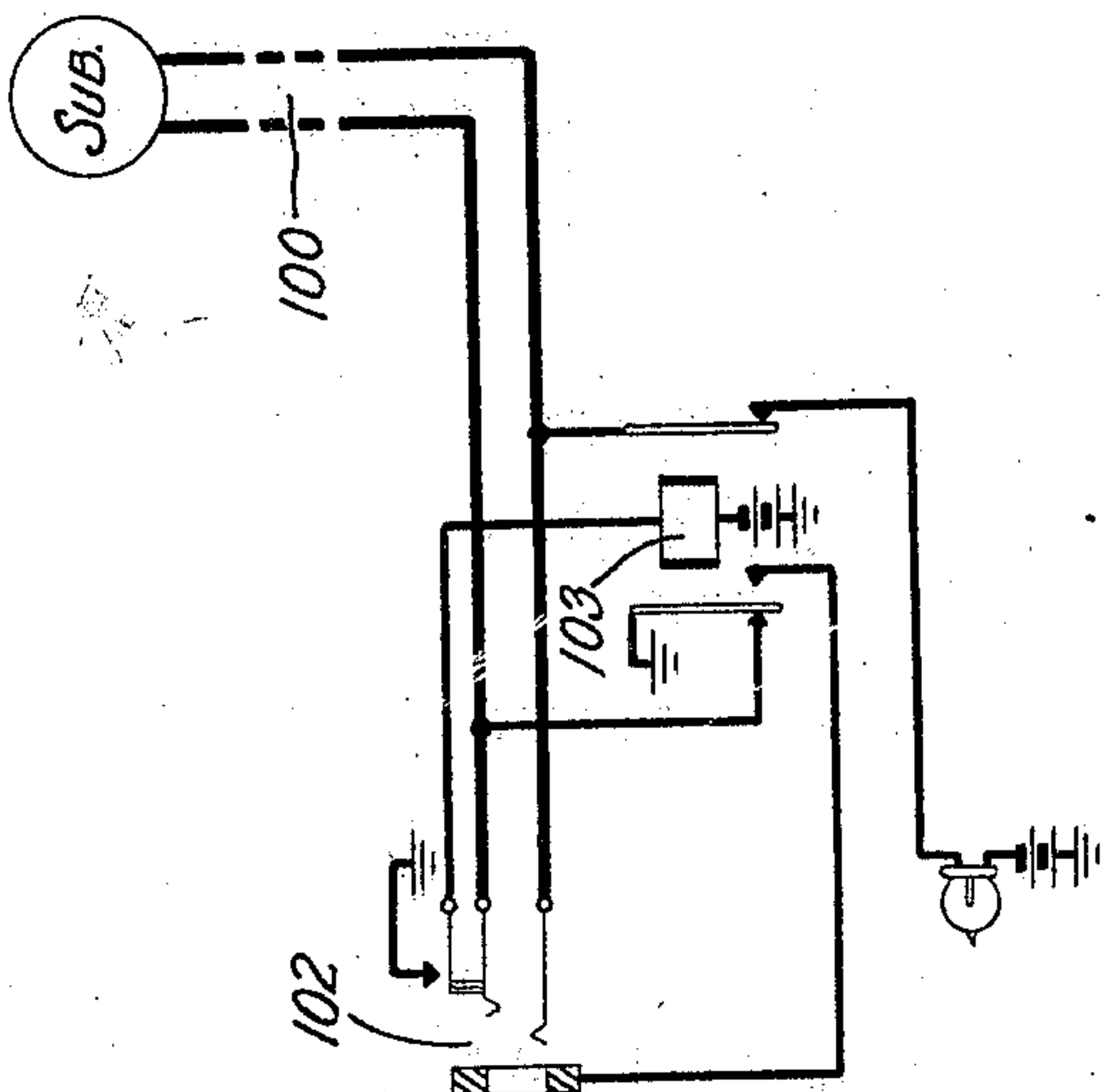
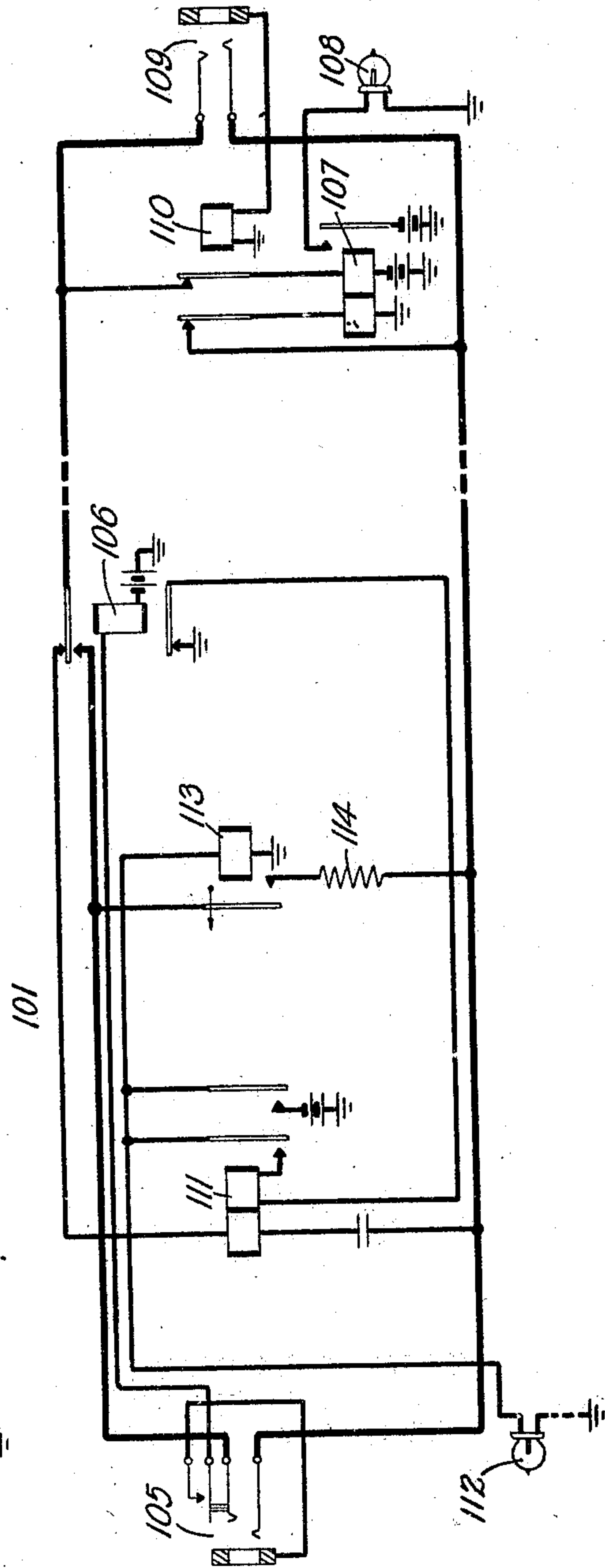


FIG. 3.



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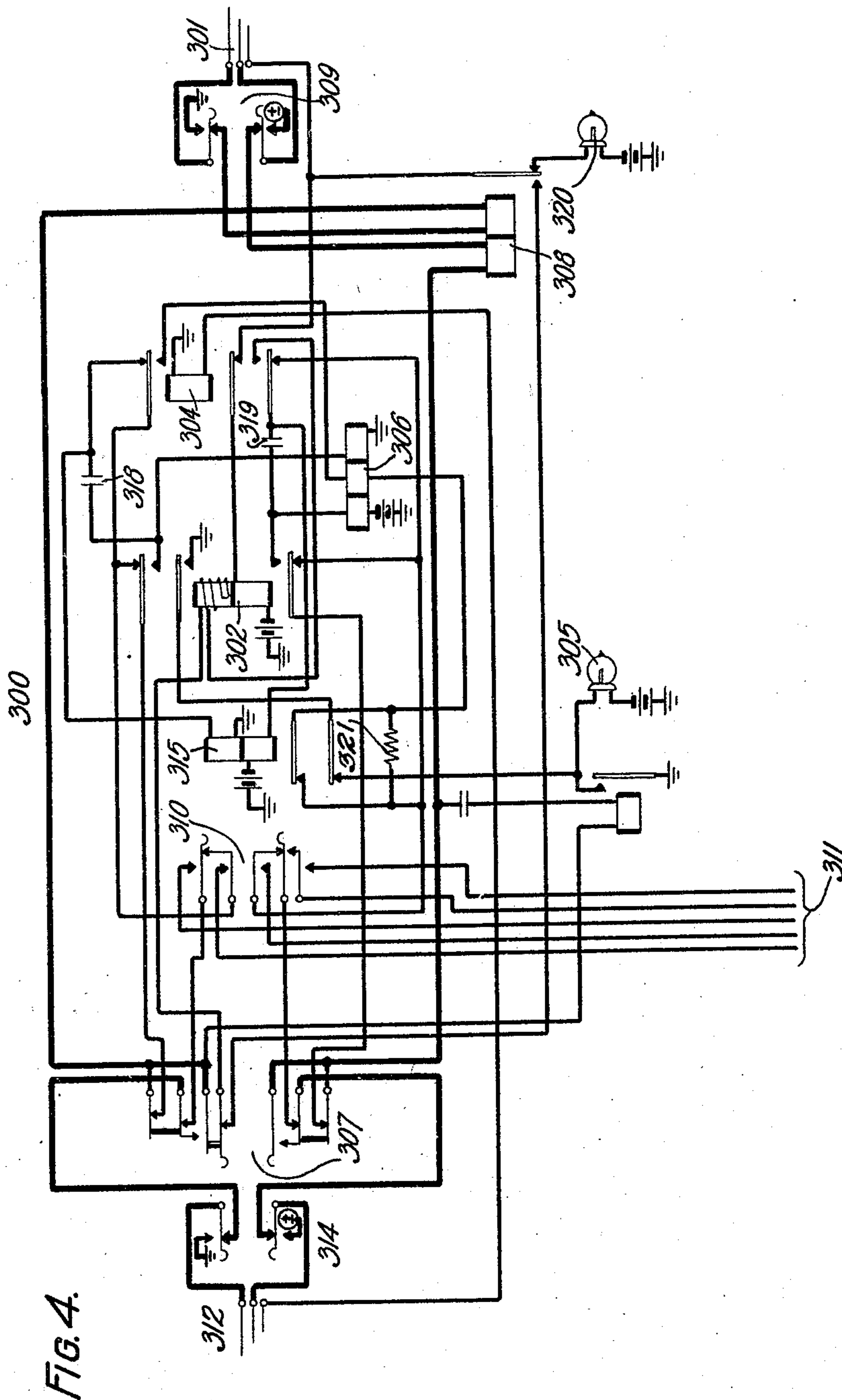
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3 Sheets-Sheet 3



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TELEPHONE SYSTEM

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This invention relates to telephone systems, and particularly to improvements in cord circuits for use in private branch exchange systems.

5 According to one feature of this invention there is provided in a cord circuit of the type in which the tip and ring conductors between the two plugs are normally connected respectively to ground and battery through
10 impedance coils, means whereby when the cord circuit is used for establishing a connection between two local subscribers' lines it is converted into a bridged impedance battery feed cord, and whereby when the cord is
15 used for establishing a connection between a local exchange subscriber's line and a central office trunk it is converted to a circuit through which the battery is fed from the central office source. The bridged impedance
20 type of cord circuit has the tip and ring conductors from both plugs connected independently and respectively to ground and battery through impedances and these two branches are connected together for talking purposes
25 by means of condensers. The cord circuit in which the battery is fed from the central office source has the tip and ring conductors connected from one plug to the other without any direct current encumbrances. By arranging
30 the cord circuit in this manner it may be used for testing busy lines in the usual manner regardless of whether such lines are private branch exchange lines having ground connected to the sleeve circuits when busy or
35 central office trunks having battery connected to the sleeve circuit when busy.

Another feature is a cord circuit in which a relay which is ordinarily used for splitting the tip and ring conductors at certain times
40 is also used to convert the cord circuit to the bridged impedance battery feed type.

Another feature is an operator's telephone set and dialing equipment, suitable for connection with this type of cord circuit, in
45 which the secondary winding of the usual repeating coil, connected between the operator's transmitter and the cord circuit, is used for holding central office apparatus, such as the pulsing relay, actuated between digits during
50 dialing operations, in order to prevent false

operations of such apparatus. By this arrangement, the retardation coil usually employed for this purpose is eliminated.

The invention is applicable to cord circuits for interconnecting two private branch exchange subscribers' lines and for interconnecting a private branch exchange subscriber's line with a central office trunk, and by means of which dialing impulses may be transmitted over such a trunk to select a subscriber's line through switches at an automatic central office.

The cord circuit, by means of which this invention has been illustrated, shows an inductive low resistance bridge placed across
65 the tip and ring conductors when a connection is established thereby between a trunk incoming from the central office and a private branch exchange subscriber's line, and when the private branch exchange subscriber
70 answers such a call, a non-inductive high resistance bridge is added to the low resistance bridge, to prevent false momentary release of the supervisory relay at the central office
75 when the high resistance bridge is added.

The invention has been illustrated in the accompanying drawings; in which Figs. 1, 2 and 3 represent the preferred form of circuit arrangement embodying all of the features of this invention. Fig. 1 shows a private branch exchange cord circuit and a
80 manual private branch exchange subscriber's line; Fig. 2 shows another manual private branch exchange subscriber's line; and Fig. 3 shows the equipment of a trunk line outgoing from a private branch exchange and ending
85 in a manual central office. Fig. 4 represents an alternate form of cord circuit embodying certain features of this invention.

Referring now to the drawings, descriptions will be made first of the operations of the circuits shown in Figs. 1 to 3 when a connection is established between the private branch exchange subscribers' lines 1 and 100 through
90 the cord circuit 2, followed by a description of the operations taking place when a connection is established between the private branch exchange subscriber's line 1 and the trunk 101 through the cord circuit 2. Second,
95 a description will be made of the operations
100

taking place when a connection is established from a central office over trunk line 101 to the private branch exchange subscriber's line 1 through cord circuit 2. Third, a description will be made of the operations of the cord circuit 300 under similar conditions.

If it is assumed then that the private branch exchange subscriber of line 1 desires to communicate with the private branch exchange subscriber of line 100, he will initiate a connection by lifting his receiver from the hook and thus cause the lamp 3 to be lighted in the usual manner. In answering this call, the private branch exchange operator inserts plug 4 into jack 5, thus causing the operation of relay 6 over an obvious circuit to extinguish lamp 3. The establishing of this connection also closes a circuit for the operation of relay 8 as follows: Battery, winding of relay 8, make-before-break contacts of relay 10, upper outer normally made contacts of through dialing key 11, sleeve terminals of plug 4 and jack 5 to ground at the right-hand armature and front contact of relay 6. Relay 8 in operating closes a circuit for the lighting of supervisory lamp 13 over a circuit as follows: battery, lamp 13, upper inner armature and front contact of relay 8, inner right-hand armature and back contact of relay 14, upper outer normally made contacts of talking and dialing key 15, to ground. The operation of relay 8 also connects battery and ground to the tip and ring conductors of cord 2 through the calling subscriber's loop as follows: battery, retardation coil 17, lower armature and front contact of relay 8, left-hand winding of relay 18, lower normally made contacts of ringing key 20, ring terminals of plug 4 and jack 5, over the subscriber's loop, tip terminals of jack 5 and plug 4, upper normally made contacts of ringing key 20, right-hand winding of relay 18, upper outer armature and front contact of relay 8, retardation coil 22, to ground. This circuit supplies talking battery for the calling subscriber.

The private branch exchange operator now connects her telephone circuit and dialing equipment 23 to cord 2 by operating key 15. The operation of this key opens the circuit for lamp 13 which is now extinguished. This key also connects the operator's telephone set and dial to the cord over a circuit as follows: battery, left-hand winding of relay 14, lower outer armature of back contact of relay 10, lower inner made contacts of key 15, lower make-before-break contacts of relay 24, primary windings of repeating coil 25, pulsing contacts of dial 26, upper make-before-break contacts of relay 24, upper inner made contacts of key 15, upper armature and back contact of relay 10, right-hand winding of relay 14 to ground. A circuit is also closed for the operator's receiver 27 in parallel with the lower primary winding of repeating coil

25 through a condenser 31 and the upper armature and back contact of relay 28, and lower outer made contacts of key 15. Relay 14 operates in this circuit but performs no useful function at this time.

The operator now asks the calling subscriber for the number wanted and if another private branch exchange subscriber is wanted, such as the subscriber of line 100, the operator will perform the usual busy test by touching the tip of plug 30 to the sleeve of jack 102 of line 100. If line 100 is busy ground will be connected to the sleeve of jack 102 due to the operation of relay 103. In this case, the operator will receive a click in the receiver 27 due to the fact that direct ground will be connected to one side of the condenser 31 through the upper primary winding of repeating coil 25, pulsing contacts of dial 26, upper middle made contacts of key 15, upper middle normally made contacts of key 11, upper normally made contacts of ringing key 32, tip terminal of plug 30, sleeve terminal of jack 102 to ground at the left hand armature and front contact of relay 103.

On the other hand, if line 100 is idle relay 103 will not be operated at this time. Hence, the operator will insert plug 30 in jack 102 and ring the subscriber of line 100 by operating ringing key 32. When the called subscriber answers and the operator removes her telephone set and dialing equipment from the line by releasing key 15, the connection between the subscriber of line 1 and the subscriber of line 100 will be ready for conversation. It should be noted that the talking battery as hereinbefore described for the calling subscriber of line 1 is supplied through retardation coils 17 and 22, while the talking battery for the called subscriber's line will now be supplied through the windings of relay 14 over a circuit as follows: battery through the left-hand winding of relay 14, lower outer armature and back contact of relay 10, lower inner normally made contacts of key 15, lower middle normally made contacts of key 11, lower normally made contacts of key 32, ring terminals of plug 30 and jack 102 through the called subscriber's loop, tip terminals of jack 102 and plug 30, upper normally made contacts of key 32, upper middle normally made contacts of key 11, upper inner normally made contacts of key 15, upper armature and back contact of relay 10 to ground through the right hand winding of relay 14. These two connections to talking battery are joined by means of condensers 33 and 34, to complete the circuits for conversation between the two subscribers.

If the calling subscriber hangs up his receiver to release the connection, relay 18 will release and a circuit for the lighting of lamp 35 established as follows: from battery through lamp 35, armature and back contact of relay 18, sleeve terminals of plug 4 and

jack 5, to ground at the right hand armature and front contact of relay 6 to indicate that the calling subscriber has hung up his receiver and that disconnection is decided.

5 If the called subscriber hangs up his receiver, relay 14 will release and a circuit for lighting the lamp 13 established as follows: battery, lamp 13, inner upper armature and front
10 contact of relay 8, inner right hand armature and back contact of relay 14 to ground at the upper outer normally made contacts of key 15 to indicate to the operator that the called subscriber has hung up his receiver and that
15 then remove the cord 2 from the connection. The operator may

If now a connection is desired from the private branch exchange subscriber of line 1 to a central office over a trunk such as 101, the connection is extended to the private branch exchange operator as hereinbefore described, by
20 the insertion of plug 4 in jack 5. The functions of the circuit up to the point where the operator tests for an idle line is the same as hereinbefore described. If now the operator
25 tests trunk 101 by touching the tip of plug 30 to the sleeve of jack 105 and this trunk is found busy, battery is connected to the sleeve terminal of jack 105 through the winding of relay 106 and a click will therefore be pro-
30 duced in the operator's receiver.

If on the other hand, trunk 101 is idle the operator will insert plug 30 into jack 105. A circuit for relay 106 is thereby closed from battery through the winding of relay 106,
35 upper closed contacts of jack 105, sleeve terminals of plug 30 and jack 105, lower outer normally made contacts of key 11, winding of relay 10 to ground. Relay 106 in operating completes the connection to the central office
40 by joining the tip conductor at the upper armature and front contact. Relay 10 is included in the above mentioned circuit and will also operate. The operation of relay 10 connects an impedance 41 across the tip and
45 ring conductors at its upper armature and front contact. This circuit is completed through the outer right hand armature and back contact of relay 14. Relay 10 also opens the circuit for relay 8 at the lower make-
50 before-break contacts so that relay 8 will now release and thus reconnect the tip and ring conductors from the calling subscriber's line 1 through the cord circuit from plug 4 to plug 30 at the make-before-break contacts of
55 this relay. The operation of relay 10 also disconnects battery and ground, through the windings of relay 14, from the tip and ring conductors and as the release of relay 8 also disconnects battery and ground, through the
60 retardation coils 22 and 17, from the tip and ring conductors, the connection established through the cord circuit is without any direct current encumbrances, except the bridged impedance 41 or the operator's telephone set and
65 dialing quipment as hereinafter described.

The circuit for the operator's telephone set and dialing equipment now extends from the upper secondary winding of repeating coil 25 to the tip conductor through the pulsing contacts of dial 26, middle upper made con-
70 tacts of key 15, upper middle normal contacts of key 11 towards the tip terminal of plug 30, while the connection towards the tip terminal of plug 4 extends through the upper
75 make-before-break contacts of relay 24, upper inner made contacts of key 15, upper inner normally made contacts of key 11, upper make-before-break contacts of relay 8, right-hand winding of relay 18 and upper nor-
80 mally made contacts of ringing key 20 to plug 4. The connection for the ring conductors extends through the lower secondary winding of repeating coil 25 and the opera-
85 tor's receiver 27, in parallel through the lower outer made contacts of key 15, middle lower normally made contacts of key 11, lower nor-
90 mally made contacts of ringing key 32 towards the ring terminal of plug 30, while the connection towards the ring terminal of plug 4 extends through the lower make-before-
95 break contacts of relay 24, inner lower made contacts of key 15, lower inner normally made contacts of key 11, lower make-before-break contacts of relay 8, left-hand winding of re-
100 lay 18 and lower normally made contacts of key 20 to plug 4.

If the distant end of the trunk 101 terminates at a manual central office it will be equipped with the apparatus shown in Fig. 3. Assuming that the private branch ex-
105 change operator has established a connection to a manual central office, the fact that the tip and ring conductors are bridged through her telephone set establishes a circuit for the
110 operation of the usual line relay 107. This relay operates and causes lamp 108 to be lighted to indicate to the operator at the central office that a connection is desired over this trunk. The operator answers this call
115 by inserting a plug into jack 109 and thus causes relay 110 to be operated over the usual sleeve circuit to disconnect relay 107 and extinguish lamp 108. The tip and ring conduc-
120 tors are now connected through to the battery and ground in the usual cord and central office operator's telephone set in the usual manner.

The central office operator now receives the wanted subscriber's number from the private branch exchange operator and completes the connection to this wanted subscriber, while
125 the private branch exchange operator removes her telephone set from the cord 2 by releasing key 15. It should be mentioned that the impedance 41 will be removed from across the tip and ring conductors of cord 2 when the
130 connection is completed to relay 107 and later through the central office operator's cord, that is, under these circumstances, relay 18 will operate from the battery at the central office
135 through relay 107 or the central office oper-

ator's cord, and relay 18 in operating completes a circuit for the operation of relay 14 as follows: battery, left hand winding of relay 14, lower outer armature and front contact of relay 10, armature and front contact of relay 18, to ground at the right hand armature and front contact of relay 6. The operation of relay 14 opens the above mentioned bridge at the outer right hand armature and back contact. It also closes the locking circuit for itself through the inner right hand armature and front contact to the ground at the upper outer normally made contacts of key 15 when this key is released. Consequently, the connection from the calling subscriber's line 1 is now completed without direct current encumbrances, except the windings of the usual supervisory relay 18, through the cord 2 and trunk 101 so that talking battery will now be supplied from the operator's cord at the central office.

If the calling subscriber disconnects after the conversation is finished relay 18 will be released. This relay in releasing completes the circuit for the supervisory lamp 35 and also a circuit for the operation of relay 8. The circuit for relay 8 will be completed from battery winding of relay 8, inner lower armature and front contact of relay 10, left hand armature and front contact of relay 14, armature and back contact of relay 18 to ground at the right hand armature and front contact of relay 6. Relay 8 in operating splits the tip and ring conductors at the make-before-break contacts of this relay to cause the release of the central office apparatus for example, the supervisory relay in the central office operator's cord to indicate to this operator that the calling subscriber has hung up his receiver.

The operation of relay 8 connects battery and ground through the retardation coils 17 and 22 to the tip and ring conductors leading to the calling subscriber so that the calling subscriber may recall the private branch exchange operator before plug 4 is removed from jack 5. The private branch exchange operator may now remove plugs 4 and 30 from their respective jacks, thus causing the release of relays 8, 10 and 14 and restore the circuits to normal.

If the trunk 101 is connected to automatic machine switching apparatus in an automatic central office instead of to a manual central office, the seizure of this trunk by cord 2 will, due to the fact that the impedance 41 or the operator's telephone set and dialing equipment are bridged across the tip and ring conductors, cause operations to take place at the central office to connect the usual pulsing relay for controlling the extension of a connection automatically to a wanted subscriber. In this case, the private branch exchange operator dials the number of the wanted subscriber on dial 26 and causes the switches at the central office to complete the connection.

As this invention is not concerned with the operation of such automatic equipments at the central office it has not been shown or described.

The private branch exchange operator in moving his dial 26 from normal closes a circuit through the off normal contacts for the operation of relay 28. The operation of this relay opens the circuit through the receiver 27 at the upper armature and back contact and closes a circuit at this upper armature and its front contact through a resistance 36 in parallel with the secondary windings of repeating coil 25.

The resistance 36, inserted in parallel with the secondary of the repeating coil 25, performs no useful function at this time, but its use later in this circuit will be described hereinafter. The operation of relay 28 causes a circuit to be closed for the operation of relay 37 over a circuit as follows: battery, winding of relay 37, lower armature and front contact of relay 28, off normal contacts of dial 26 to ground. Relay 37 in operating closes an obvious locking circuit for relay 28 and closes at its lower outer armature and front contact a shunt for the resistance 36 so that on the return of the dial 26 to normal the dialing circuit will be free from all impedances during dialing. The operation of relay 37 also closes a circuit for the operation of relay 24 as follows: battery, winding of relay 24, inner lower armature and front contacts of relay 37 to ground. Relay 24 in operating splits the connection between plugs 4 and 30 at the make-before-break contacts of this relay and connects battery and ground through the windings of relay 38 and the upper and lower armatures and front contacts of relay 24 to the tip and ring conductors leading towards plug 4. Relay 38 is thereby operated through the calling subscriber's loop and provides a locking circuit for relay 24. This relay also closes connections at its upper and lower armatures and front contacts through condensers 39 and 40 to complete a circuit to the operator's telephone set so that the operator may be able to talk to the calling subscriber in case the talking and dialing key is not immediately returned after dialing. The tip and ring conductors leading towards plug 30 are of course still connected through the pulsing contacts of dial 26. The release of dial 26 to normal will now open the connection for the tip and ring conductors towards the central office in accordance with the number selected and the central office apparatus are thereby advanced to select the first digit.

When the dial returns to normal the off-normal contacts open and cause the release of relays 28 and 37. These relays are slow in releasing, but relay 28 is slower than relay 37, so that the resistance 36 will remain bridged across the secondary of the repeating coil 25, a short period after the shunt therefor is re-

moved by the release of relay 37. The purpose of the momentary insertion of the resistance 36 across the tip and ring conductors at this time is to prevent false operation of the central office pulsing relays between digits that is, prevent the secondary of the repeating coil 25 from momentarily shunting the central office apparatus due to its high impedance. In other words, the non-inductive resistance 36 remains in circuit until the current through the secondary winding of repeating coil 25 is sufficiently built up to hold the central office apparatus actuated through the bridge formed by the secondary windings. It will be noted that the release of relay 37 closes connections through the condensers 39 and 40 between the calling subscriber's line and the secondary windings of the repeating coil 25 and the release of relay 28 reinserts the receiver in parallel with the lower primary winding of repeating coil 25 so that the conversation between the operator and the calling subscriber may take place in case the dialing key is not immediately released after dialing. When the desired number has been selected by the private branch exchange operator she will remove her telephone set and dialing equipment from cord 2 by releasing key 15 and conversation between the calling subscriber through the automatic central office apparatus may now take place. It should be understood that in this case the private branch exchange operator need not ring the wanted subscriber as he is automatically called through the automatic equipment of the central office as is well known in the art. If the wanted subscriber is busy the operator will receive a signal in the usual manner. The release of the connection in this case is identical with the release of a manual connection as hereinbefore described.

If a call is incoming over trunk 101 from either a manual or automatic central office relay 111 will operate by ringing current therefrom. A circuit is thereby closed for the lighting of lamp 112 and the operation of relay 113. Relay 111 is locked in operated position from ground connected at the lower armature and back contact of relay 106. The private branch exchange operator in this case will answer the call by inserting plug 30 into jack 105. The operations of the circuits for establishing a connection to a wanted subscriber in the private branch exchange are identical with the operations as hereinbefore described in connection with the call originating at the private branch exchange, except that in this case relay 8 will not operate due to the fact that relay 10 is already operated before plug 4 is inserted in the jack of the wanted subscriber's line. Relay 106 in operating releases relay 111 to extinguish lamp 112 and release relay 113. This relay however is slow to release so that a circuit through the non-inductive resistance 114 will be closed

across the tip and ring conductors of the trunk 101. This bridge will trip the ringing at the central office in a manner well known in the art.

If the cord circuit of Fig. 4 is used in place of cord circuit shown in Fig. 1 for establishing connections between two private branch exchange subscribers such as those of lines 1 and 100, this cord circuit will function as follows: If the call originates with the subscriber of line 1, plug 301 will be inserted in jack 5 and lamp 3 will be extinguished while a circuit for the operation of relay 302 will be established from battery through the lower winding of relay 302, lower inner armature and back contact of relay 304, sleeve terminals of plug 301 and jack 5, right hand armature and front contact of relay 6 to ground. The operation of relay 302 closes an obvious circuit for the lighting of lamp 305 and also connects battery and ground through the retardation coil 306 to the tip and ring conductors of the calling subscribers' lines. This circuit may be traced from battery; through the left-hand winding of retardation coil 306, lower armature and front contact of relay 302, lower outer normally made contacts of key 307, left-hand winding of supervisory relay 308, lower normally made contacts of ringing key 309, ring terminals of plug 301 and jack 5 through the calling subscriber's loop, tip terminals of jack 5 and plug 301, upper normally made contacts of ringing key 309, right hand winding of supervisory relay 308, upper outer normally made contacts of key 307, upper outer armature and front contact of relay 302, right hand winding of retardation coil 306 to ground. The talking and dialing key 310 is now operated to connect the operator's telephone set and dialing equipment such as the equipment 23 shown in Fig. 1 to the leads terminating in this figure at the point 311.

The private branch exchange operator now receives the number of the wanted subscriber from the calling subscriber and proceeds to test the jack 102 of the wanted subscriber's line 100 with plug 312 in the same manner as hereinbefore described in connection with the establishing of a connection over cord circuit 2. If the wanted line is idle the operator inserts plug 312 into jack 102 and this causes the operation of relay 103 which connects ground to the sleeve terminal of jack 102, but no effect is produced by this connection at the present time as the connection from the sleeve of plug 312 through the winding of relay 304 is also connected to ground. The operator now actuates the ringing key 314 to ring the wanted subscriber in the usual manner and when the called subscriber answers the operator removes his telephone set and dialing equipment from the cord by releasing key 310. A connection is established from battery and ground through the windings of

relay 315, to the called subscriber's loop over a circuit as follows: Battery, lower winding of relay 315, lower outer armature and back contact of relay 304, lower inner normally made contacts of key 310, lower middle normally made contacts of key 307, lower normally made contacts of ringing key 314, ring terminals of plug 312 and jack 102, the called subscriber's loop back to the tip terminals of jack 102 and plug 312, upper normally made contacts of ringing key 314, middle upper normally made contacts of key 307, upper inner normally made contacts of key 310, upper armature and back contact of relay 304, upper winding of relay 315 to ground. Relay 315 in operating opens a circuit for lamp 305 and the extinguishing of this lamp indicates to the operator that the called subscriber has answered the call.

Talking battery for the calling subscriber is now therefore provided from battery and ground through the left and right hand windings of retardation coil 306, while talking battery for the calling subscriber is provided from battery and ground through the windings of relay 315. The two parts of the cord circuit are as noted connected for talking purposes through condensers 318 and 319. Conversation between the subscribers may now take place.

If the calling subscriber releases by replacing his receiver on the hook relay 308 is released and lamp 320 is lighted over the sleeve circuit and when the operator removes the cord from the connector, relay 302 is released to return the circuit to normal. If the called subscriber releases by replacing his receiver on the hook relay 315 is released and lamp 305 is thereby lighted to indicate that disconnection is desired.

If cord circuit 300 is used for establishing a connection from the private branch exchange subscriber of line 1 over trunk 101 to a wanted subscriber's line, the operations of the cord circuit is practically identical with the operations thereof when used for connecting his private branch exchange subscribers, except that in this case when plug 312 is inserted in jack 105 a circuit through the sleeve terminals of plug 312 and jack 105 will be completed for the operation of relays 106 and 304 as follows: battery, winding of relay 106, upper outer closed contacts of jack 105, sleeve terminals of jack 105 and plug 312, winding of relay 304 to ground. This latter relay in operating opens the energizing circuit for relay 302 at its lower inner armature and back contact so that this relay will now release and remove the battery and ground supplied through the windings of retardation coil 306 from the calling subscriber's line. This relay 304 also removes battery and ground supplied through the winding of relay 315 toward the trunk. The operation of relay 304 and the release of relay 302 will

now connect the plugs 312 and 301 together without battery connections. However, the operation of relay 304 establishes a bridge through the inductive low resistance middle winding of retardation coil 306 and non-inductive high resistance 321 across the tip and ring conductors of the cord, through the upper armature and front contact of relay 304 for the purpose as hereinbefore described. It should be noted that in this case relay 315 is operated, since the connection is established between the cord and the calling subscriber and due to the operation of relay 308 at that time by a circuit from battery and ground at the outer windings of retardation coil 306 through the tip and ring conductors and the calling subscriber's loop. This bridge will therefore as stated include both the middle winding of retardation coil 306 and the resistance 321 and will remain in the circuit as long as the connection between the two subscribers remains intact.

When the operator now actuates his dial 26 the telephone and dialing equipment 23 operates as hereinbefore described to split the tip and ring conductors between the two plugs and connect battery and ground through relay 38 for the calling subscriber's loop over a circuit as follows: from battery, through the lower winding of relay 38, lower armature and front contact of relay 24, lower inner made contacts of key 310, lower armature and back contact of relay 302, lower outer normally made contacts of key 307, left hand winding of relay 308, lower normally made contacts of ringing key 309, ring terminals of plug 301 and jack 5, subscriber's loop back through the tip terminals of jack 5 and plug 301, upper normally made contacts of key 309, right hand winding of relay 308, upper outer normally made contacts of key 307, upper outer armature and back contact of relay 302, upper inner made contacts of key 310, upper armature and front contact of relay 24, upper winding of relay 38 to ground. The dialing circuit from dial 26 will be completed through plug 312 to the tip and ring conductors of trunk 101 and the machine switching apparatus or manual equipment at the distant central office as follows: from the dial contacts of dial 26, upper outer made contacts of key 310, upper middle normally made contacts of key 307, upper normally made contacts of key 314, ring terminals of plug 312 and jack 105 through the pulse relay or pulsing relay at the central office, back through the ring terminals of jack 105 and plug 312, lower normally made contacts of key 314, middle lower normally made contacts of key 307, inner lower made contacts of key 310, back through the pulsing contacts of the dial 26. It will be noted that the bridge across the tip and ring conductors of the middle winding of retardation coil 306 and resistance 321 is connected across the

tip and ring conductors to the portion of the tip and ring conductors of the subscriber's loop and removed from the portion of the tip and ring conductors leading to the central office so that the pulsing relay at the central office is now held as hereinbefore described between dialing impulses by the secondary windings of repeating coil 25.

When dialing is completed and key 310 is returned to normal this bridge through the middle winding of retardation coil 306 and resistance 321 is reconnected across the tip and ring conductors which are now also completed from the calling subscriber's line to the called subscriber's line. The connection for the tip and ring conductors from plug 301 to 312 may be traced as follows: from tip terminal of plug 301, upper normally made contacts of key 309, right hand winding of relay 308, upper outer normally made contacts of key 307, upper outer armature and back contact of relay 302, upper inner normally made contacts of key 310, upper middle normally made contacts of key 307, upper normally made contacts of key 314 to tip terminal of plug 312, while the circuit for the ring conductor may be traced from ring terminal of plug 301, lower normally made contacts of key 309, left hand winding of relay 308, lower outer normally made contacts of key 307, lower armature and back contact of relay 302, lower inner normally made contacts of key 310, middle lower normally made contacts of key 307, lower normally made contacts of key 314 to the ring terminal of plug 312.

It will be noted that the windings of the usual supervisory relay 308 are connected in the tip and ring conductors of this circuit so that on the release of the connection this relay will release if calling subscriber hangs up his receiver thereby causing lamp 320 to be lighted to indicate that disconnection is desired.

If a call is incoming over trunk 101 from either a manual or automatic central office and the cord circuit shown in Fig. 4 is used, the relay 111 will operate, lamp 112 light, and relay 113 operate as hereinbefore described. The private branch exchange operator in this case will answer the call by inserting plug 312 into jack 105 and the operations of the circuits for establishing a connection to a wanted subscriber in the private branch exchange are identical with the operations as hereinbefore described in connection with the calls originating at the private branch exchange except that in this case relay 302 will not operate due to the fact that the relay 304 is already operated before plug 301 is inserted into the jack of the wanted subscriber's line. Relay 106 operates with relay 304 causing the release of relay 111, the extinguishing of lamp 112 and the

tripping of the ringing at the central office as hereinbefore described.

When relay 304 operates it should be noted that the inductive low resistance bridge through the middle winding of retardation coil 306 will be established across the tip and ring conductors of the cord. The circuit for this bridge may be traced from the tip conductor, middle upper contacts of key 307, upper normal contacts of key 310, upper armature and front contact of relay 304, middle winding of retardation coil 306, inner lower armature and back contact of relay 315, lower normal contacts of key 310, middle lower contacts of key 307 to the ring conductor. This inductive low resistance bridge causes the supervisory relay in the cord circuit at the central office to be operated to extinguish the usual supervisory signal. The cord circuit at the central office has not been shown as it is well-known in the art how this signal is actuated and that an inductive low resistance bridge has to be provided across the tip and ring conductors for the trunk in order that sufficient current will be supplied for the operation of the supervisory relay. When the called private branch exchange subscriber answers the call and completes a low resistance loop across the tip and ring conductors by removal of the receiver from the switchhook, relay 308 is operated and closes a circuit from the ground on the sleeve of plug 301 through the armature and front contact of relay 308, upper inner normal contacts of key 307, the upper winding of relay 302, lower outer armature and front contact of relay 304, lower winding of relay 315 to battery. Relay 315 operates and opens the shunt around the non-inductive high resistance 321 so that the bridge across the tip and ring conductors of the cord will now extend through this non-inductive high resistance 321 in addition to the inductive low resistance middle winding of retardation coil 306. The purpose of including this high resistance 321 in the bridge is to improve the transmission characteristics for the talking current between the subscribers as is well-known in the art. It is, however, important that this high resistance bridge should be of such nature as to prevent a momentary release of the supervisory relay in the cord circuit at the central office when the bridge is established. Such momentary release might occur in case this high resistance bridge is of the inductive type and may have a disturbing effect on the supervisory functions of the circuits, particularly in cases where the cord circuit at the central office is of the so-called flashing recall type in which a momentary release of the supervisory relay causes the signal to flash as is well-known in the art. To avoid this condition and to make the cord circuit

of universal utility the resistance 321 has been made non-inductive.

While this invention has been illustrated by means of cord circuits of two similar types, it should be understood that the features thereof are applicable to many other circuit arrangements without departing from the spirit of the invention and that the above disclosures should only be taken as illustrative of two possible applications of the invention.

What is claimed is:

1. In a telephone system, lines of two different characters, a cord circuit for interconnecting said lines, means associated with said cord circuit responsive to the interconnection of two lines of one character by the cord for converting said cord into a bridged impedance battery feed type of cord, and means associated with said cord circuit responsive to the interconnection of two lines each of a different character from the other by the cord for converting said cord to receive its battery feed from one of said lines.

2. In a telephone system, lines of two different characters, a cord circuit for interconnecting said lines normally arranged to feed ground and battery through impedance to the tip and ring conductors, respectively, impedance coils, condensers, means for converting the cord to feed ground and battery through said impedance coils to each end of the cord independently and connect said ends by means of said condensers in response to the interconnection of two lines of one character by said cord, and means for converting said cord to connect the tip and ring conductors through from one end to the other without any ground, battery or impedance in response to the interconnection of two lines each of a different character from the other by said cord.

3. In a telephone system, lines having a connection to ground on the sleeve, lines having a connection to battery on the sleeve, a cord circuit for interconnecting said lines, means associated with said cord responsive when two of said first mentioned lines are interconnected by said cord and through the presence of the ground on the sleeve on one of said lines for converting said cord into a bridged impedance battery feed type of cord, and means associated with said cord circuit responsive when a line of the first mentioned type and a line of the second mentioned type are interconnected by said cord and through the presence of the battery connection on the sleeve of the second type of line for converting said cord to receive its battery feed from the connected second type of line.

4. In a telephone system, lines, a cord for interconnecting two lines, an operator's telephone set and dialing equipment connectible to said cord circuit, means responsive to the actuation of the dial of said equipment when

connected to the cord circuit for splitting said cord, an impedance element, means for connecting battery and ground through said impedance element to the end of the cord connected with a calling line, means for connecting the other end of the cord to the dial, means responsive to the release of the dial to normal to interrupt the corresponding connection through the cord circuit, and means responsive on the return of the dial to normal for connecting a bridge across the conductors of the end of the cord leading to the called line through the secondary windings of the repeating coil of the operator's telephone set.

5. In a telephone system, lines, a cord for interconnecting two lines, an operator's telephone set and dialing equipment connectible to said cord, means responsive to the actuation of the dial of said equipment when connected to the cord for splitting said cord for connecting battery and ground through an impedance to the end of the cord connected with a calling line, means for connecting the other end of the cord to the dial, means responsive to the release of the dial to normal to interrupt the connection through the cord, means responsive on the return of the dial to normal for connecting a bridge across the conductors of the end of the cord leading to the called line through the secondary windings of the repeating coil of the operator's telephone set, and means responsive to the disconnection of the telephone set and dialing equipment from the cord for reconnecting the tip and ring conductors between the calling line and the called line.

6. In a telephone system, lines, a cord for interconnecting said lines, means responsive to the interconnection of two lines by said cord for connecting a bridge through an impedance across the tip and ring conductors of said cord, an operator's telephone set and dialing equipment connectible to said cord, means responsive to the actuation of the dial of said equipment for splitting said cord for disconnecting said impedance bridge for connecting battery and ground through impedance to the tip and ring conductors of the end of the cord leading to the calling line, means to connect the tip and ring conductors of the other end of the cord through the pulsing contacts of said dial, means responsive to the release of the dial to interrupt said connection through the pulsing contacts, and means responsive each time the dial has returned to normal for connecting a bridge in place of the connection through the pulsing contacts, said bridge including the secondary windings of the repeating coil of the operator's telephone set.

7. In a telephone system, lines of two different characters, a cord for interconnecting two of said lines, means associated with said cord responsive to the interconnection of two lines of one character by said cord for con-

verting said cord into a bridged impedance battery feed type cord, means associated with said cord responsive to the interconnection of two lines of different character for converting said cord to the type where battery feed is received from one of said lines, and means for utilizing the first mentioned means to split the connection through the cord in response to the removal of the battery feed when the cord is converted to the last mentioned type.

8. In a telephone system, lines without battery feed on the tip and ring conductors, lines with battery feed on the tip and ring conductors, a cord circuit for interconnecting two of said lines, means associated with said cord circuit responsive to interconnection of two of the first mentioned lines by said cord for converting said cord into a bridged impedance battery feed type of cord, means associated with said cord responsive to the interconnection of one of each of said types of lines by said cord for converting said cord into the type where its battery is supplied from the second mentioned type of line, and means for utilizing the first mentioned means for splitting the connection through the cord in response to the removal of the battery feed when the cord is converted to the second mentioned type.

In witness whereof, I hereunto subscribe my name this 24th day of May, A. D. 1927.

WALTER B. STRICKLER.