

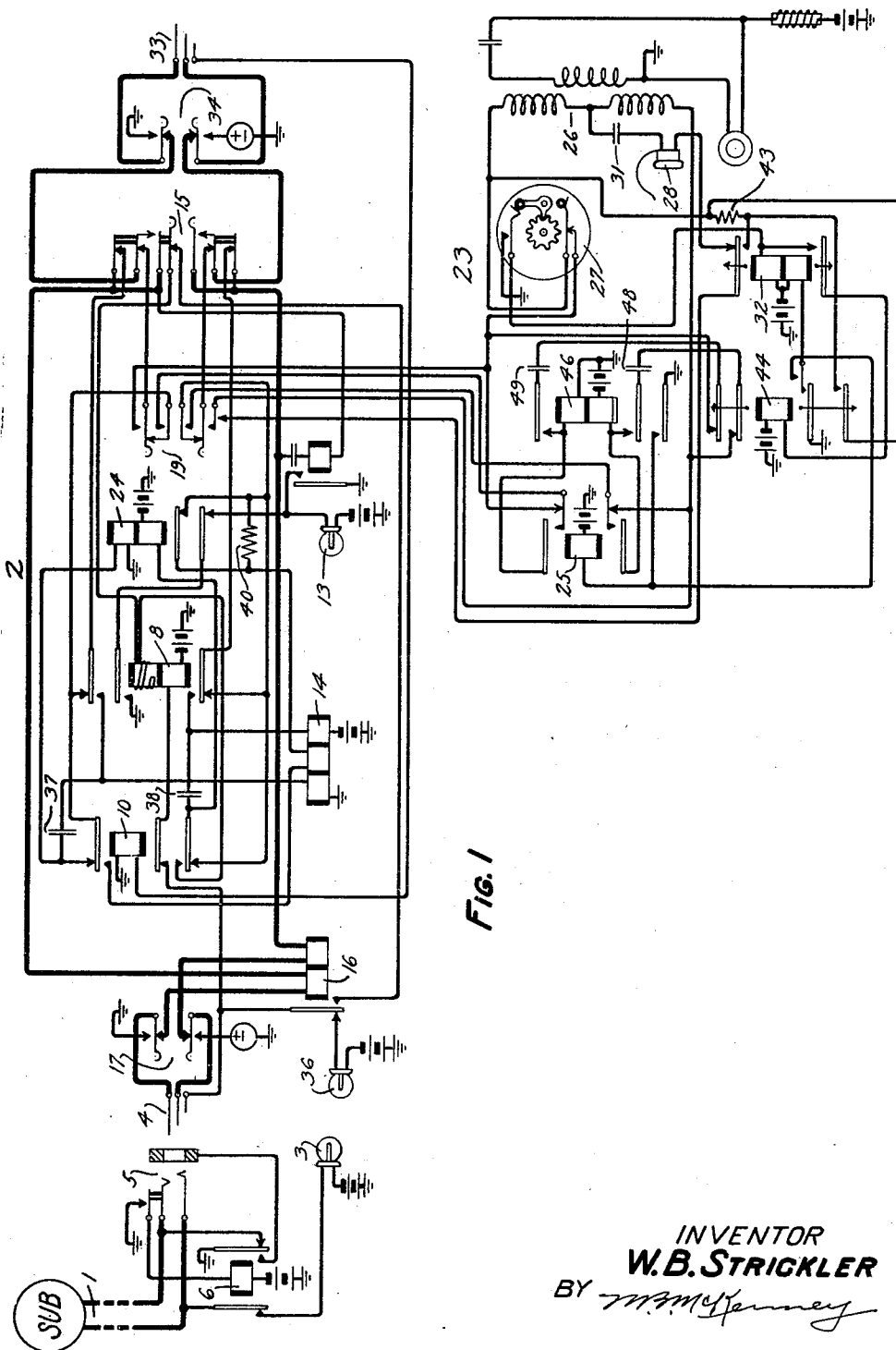
Nov. 17, 1931.

W. B. STRICKLER

1,832,263

TELEPHONE SYSTEM

Original Filed May 27, 1927 2 Sheets-Sheet 1



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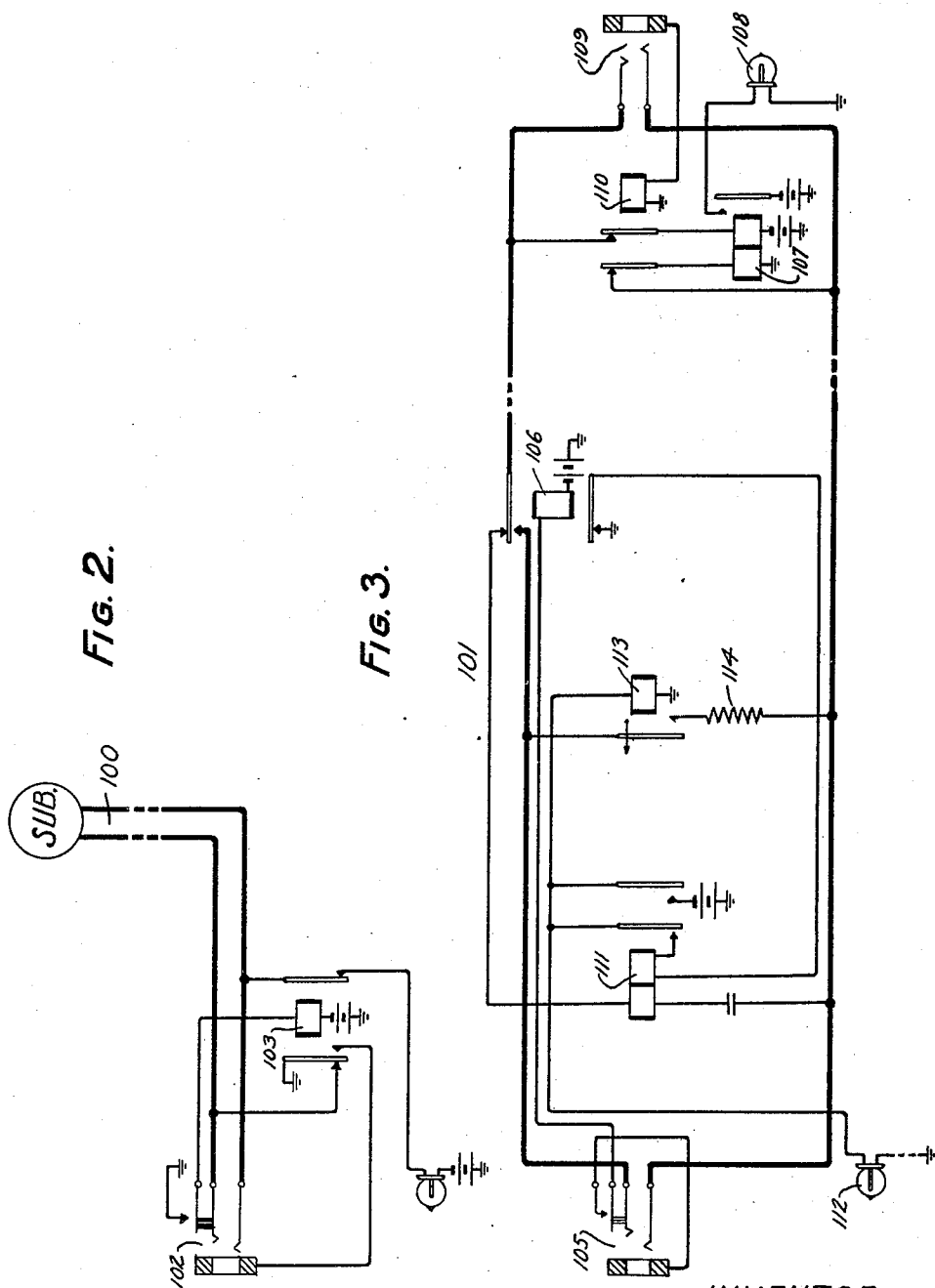
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TELEPHONE SYSTEM

Original application filed May 27, 1927, Serial No. 194,576. Divided and this application filed November 7, 1929. Serial No. 405,299.

This invention relates to telephone systems, and its object is to secure improvements in cord circuits for use in private branch exchange systems.

2 and 3 represent a preferred form of circuit arrangement embodying the features of this invention.

Fig. 1 shows a private branch exchange cord circuit and a manual private branch exchange subscriber's line; 55

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 in a manual central office. 60

Referring now to the drawings, descriptions will be made: First, of the operations of the circuits shown when a connection is established between the private branch exchange subscribers' lines 1 and 100 through the cord circuit 2; second, 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; and third, of the operations 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. 75

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 through the lower winding of relay 8, lower inner armature and back contact of relay 10, sleeve terminals of plug 4 and jack 5, right-hand armature and front contact of relay 6 to ground. The operation of relay 8 closes an obvious circuit for the lighting of supervisory lamp 13 and also connects battery and ground through the retardation coil 14 to the tip and ring conductors of the calling subscriber's line. This circuit may be traced from battery, through the right-hand winding of retardation coil 14, lower armature 100

5 This application is a division of my application, Serial No. 194,576, filed May 27, 1927, on which patent 1,747,849 was granted Feb. 18, 1930. This patent discloses a cord circuit for private branch exchange systems in which the tip and ring conductors between the two plugs are normally connected respectively to ground and battery through 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 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. 20

A feature of the present invention is a cord circuit of this general type in which an inductive low resistance bridge is placed across the tip and ring conductors when a connection is established thereby between a trunk from a central office and a private branch exchange subscriber's line, and in which, when the private branch exchange subscriber answers such a call, a non-inductive high resistance bridge is added to the low resistance bridge. This is for the purpose of preventing false momentary release of the supervisory relay at the central office when the private branch exchange subscriber hangs up, preliminary to the release of the connection or when the private branch exchange subscriber wishes to recall the private branch exchange operator. 35

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. 40

The invention has been illustrated in the accompanying drawings; in which Figs. 1, 45

and front contact of relay 8, lower outer normally made contacts of key 15, right-hand winding of supervisory relay 16, lower normally made contacts of ringing key 17, ring terminals of plug 4 and jack 5 through the calling subscriber's loop, tip terminals of jack 5 and plug 4, upper normally made contacts of ringing key 17, left-hand winding of supervisory relay 16, upper outer normally made contacts of key 15, upper outer armature and front contact of relay 8, left-hand winding of retardation coil 14 to ground. This circuit supplies talking battery for the calling subscriber.

The talking and dialing key 19 is now operated to connect the operator's telephone circuit and dialing equipment 23 to the cord 2. The operation of this key connects the operator's telephone set and dial to the cord over a circuit as follows: battery, lower winding of relay 24, lower outer armature of back contact of relay 10, lower inner made contacts of key 19, lower make-before-break contacts of relay 25, primary windings of repeating coil 66, pulsing contacts of dial 27, upper make-before-break contacts of relay 25, upper inner made contacts of key 19, upper armature and back contact of relay 10, upper winding of relay 24 to ground. A circuit is also closed for the operator's receiver 28 in parallel with the lower primary winding of repeating coil 26 through a condenser 31 and the upper armature and back contact of relay 32, and lower outer made contacts of key 19. Relay 24 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 33 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 28 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 26, pulsing contacts of dial 27, upper outer made contacts of key 19, upper middle normally made contacts of key 15, upper normally made contacts of ringing key 34, tip terminal of plug 33, 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 33 in jack 102 and ring the subscriber of line 100 by operating ringing key 34. When the called subscriber answers and the operator removes her telephone set and dialing equipment from the line by releasing key 19, 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 coil 14, while the talking battery for the called subscriber's line will now be supplied as follows: Battery, lower winding of relay 24, lower outer armature and back contact of relay 10, lower inner normally made contacts of key 19, lower middle normally made contacts of key 15, lower normally made contacts of ringing key 34, ring terminals of plug 33 and jack 102, the called subscriber's loop back to the tip terminals of jack 102 and plug 33, upper normally made contacts of ringing key 34, middle upper normally made contacts of key 15, upper inner normally made contacts of key 19, upper armature and back contact of relay 10, upper winding of relay 24 to ground. Relay 24 in operating opens the circuit for lamp 13 and the extinguishing of this lamp indicates to the operator that the called subscriber had answered the call. These two connections to talking battery are joined by means of condensers 37 and 38, to complete the circuits for conversation between the two subscribers.

If the calling subscriber releases by replacing his receiver on the hook, relay 16 is released and lamp 36 is lighted over the sleeve circuit to indicate that disconnection is desired and when the operator removes the cord from the connection, relay 8 is released to return the circuit to normal. If the called subscriber released by replacing his receiver on the hook relay 24 is released and lamp 13 is thereby lighted to indicate that disconnection is desired.

If a connection is desired from the private branch exchange subscriber of line 1 to a central office over a trunk such as 101 and to a wanted subscriber's line in this office the operations of the cord circuit 2 are practically identical with the operations thereof when used for connecting two private branch exchange subscribers, except that in this case when plug 33 is inserted in jack 105 a circuit through the sleeve terminals of plug 33 and jack 105 will be completed for the operation of relays 106 and 10 as follows: Battery, winding of relay 106, upper outer closed contacts of jack 105, sleeve terminals of jack 105 and plug 33, winding of relay 10 to ground. The operation of relay 106 closes a connection to relay 107 and this relay operates as hereinafter described and for a purpose as will presently be set forth. Relay 10 in operating opens the energizing circuit for relay 8 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 14

for the calling subscriber's line. Relay 10 also removes battery and ground supplied through the winding of relay 24 toward the trunk. The operation of relay 10 and the release of relay 8 will now connect the plugs 33 and 4 together without battery connections. It should be noted that relay 16 is now operated since a circuit is established through the cord and the calling subscriber's loop from battery and ground through the windings of relay 107, which is operated as hereinafter described in connection with a call to a manual central office over trunk 101. Operation of relay 16 causes relay 24 to re-operate over a circuit from battery, lower winding of relay 24, lower outer armature and front contact of relay 10, upper winding of relay 8, upper inner normally made contacts of key 15, armature and front contact of relay 16 to ground at relay 6. The operation of relays 10 and 24 establishes a bridge through the inductive low resistance middle winding of retardation coil 14 and non-inductive high resistance 40 across the tip and ring conductors of the cord, through the upper armature and front contact of relay 10 for a purpose as hereinafter described. This bridge will remain in the circuit as long as the connection between the two subscribers remains intact. The purpose of including the high resistance in the bridge is to improve the transmission characteristics for the talking current between the subscribers as is well known in the art.

The circuit for the operator's telephone set and dialing equipment in this case extends, for the tip conductors, from the upper secondary winding of repeating coil 26 to the tip conductor through the pulsing contacts of dial 27, upper outer made contacts of key 19, upper middle normal contacts of key 15, upper normally made contacts of ringing key 34 to the tip terminal of plug 33, while the connection to the tip terminal of plug 4 extends through the upper make-before-break contacts of relay 25, upper inner made contacts of key 19, upper outer armature and back contact of relay 8, upper outer normally made contacts of key 15, left-hand winding of relay 16 and upper normally made contacts of ringing key 17 to plug 4. The connection for the ring conductors extends through the lower secondary winding of repeating coil 26 and the operator's receiver 28 in parallel through the lower outer made contacts of key 19, middle lower normally made contacts of key 15, lower normally made contacts of ringing key 34 to the ring terminal of plug 33, while the connection to the ring terminal of plug 4 extends through the lower make-before-break contacts of relay 25, inner lower made contacts of key 19, lower armature and back contact of relay 8, lower outer normally made contacts of key 15, right-hand wind-

ing of relay 16 and lower normally made contacts of key 17 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 exchange operator has established a connection to a manual central office, the fact that the tip and ring conductors are bridged through the private branch exchange operator's telephone set and through the calling subscriber's loop and that relay 106 is operated, causes a circuit to be established for the operation of the 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 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 conductors 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 the private branch exchange operator moves her telephone set from the cord 2 by releasing key 19. 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 16, 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 16 will be released. This relay in releasing completes the circuit for the supervisory lamp 36 to indicate to the private branch exchange operator that the calling subscriber has disconnected. It should be noted that on the release of relay 16 the circuit for relay 24 is opened causing this relay to release. The high non-inductive resistance 40 in the bridge across the tip and ring conductors is thereby short circuited to prevent the release of the connection to the called subscriber by maintaining, for example, the usual supervisory relay in the central office operator's cord operated.

It should, however, be observed from the time the receiver is replaced and the relay 24 is released, the high resistance bridge is the only bridge in the circuit, and while this period is short, false release of the supervisory relay at the central office may occur at this time. It is therefore essential that although the calling subscriber may have hung up the receiver for the purpose of releasing the connection, the supervisory relay at the central office must be held operated until the private

branch exchange operator actually removes the cord in response to the disconnect signal. To prevent such false signaling the high resistance 40 has been made non-inductive so that the sudden removal of the low resistance bridge by the subscriber hanging up his receiver and the replacing of the high resistance bridge will not cause any sudden momentary decrease in the current through the line prior to the release of relay 24 when the new low resistance bridge comprising the middle winding of coil 14 is substituted. Had this high resistance 40 been of the inductive type the momentary decrease in the current caused thereby, when the low resistance bridge through the subscriber's loop was removed, may have had the effect of momentary releasing the supervisory relay at the central office to give a false signal indication. When the operator removes the cord from the connection the supervisory relay at the central office operator's cord is released to indicate to this operator that the calling subscriber has hung up his receiver and that the connection has been broken down by the private branch exchange operator.

It may further be observed in this connection that the calling subscriber may wish to recall the private branch exchange operator and it is of course equally essential that the condition at the central office should not be disturbed under these circumstances. To call this operator the subscriber will alternately replace and remove his receiver a number of times. This will cause relay 16 to be alternately released and operate to flash signal 36. Relay 24 will also be alternately released and operate in unison with relay 16 and consequently remove and replace the high resistance 40 in the bridge across the line. Were it not for the fact that this resistance is of the non-inductive type false release of the supervisory relay at the central office may occur during the recalling procedure.

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 middle winding of retardation coil 14 and resistance 40 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 27 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 27 from normal closes a circuit through the off-normal contacts for the operation of relay 32. The operation of this relay opens the circuit through the receiver 28 at the upper armature and back contact and closes a circuit at this upper armature and its front contact through a resistance 43 in parallel with the secondary windings of repeating coil 26. The resistance 43, inserted in parallel with the secondary of the repeating coil 26 performs no useful function at this time, but its use later in this circuit will be described hereinafter. The operation of relay 32 causes a circuit to be closed for the operation of relay 44 over a circuit as follows: battery, winding of relay 44, lower armature and front contact of relay 32, off-normal contacts of dial 27 to ground. Relay 44 in operating closes an obvious locking circuit for relay 32 and closes at its lower outer armature and front contact a shunt for the resistance 43 so that on the return of the dial 27 to normal the dialing circuit will be free from all impedances during dialing. The operation of relay 44 also closes a circuit for the operation of relay 25 as follows: Battery, winding of relay 25, inner lower armature and front contacts of relay 44 to ground. Relay 25 in operating splits the connection between plugs 4 and 33 at the make-before-break contacts of this relay and connects battery and ground through the windings of relay 46 and the upper and lower armatures and front contacts of relay 25 to the tip and ring conductors leading towards plug 4. Relay 46 is thereby operated through the calling subscriber's loop and provides a locking circuit for relay 25. This relay also closes connections at its upper and lower inner armatures and front contacts through condensers 49 and 48 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 33 are, of course, still connected through the pulsing contacts of dial 27. This dialing circuit may be traced to the tip and ring conductors of trunk 101 and the machine switching apparatus at the distant central office as follows: from the dial contacts of dial 27, upper outer made contacts of key 19, upper middle normally made contacts of key 15, upper normally made contacts of key 34, ring terminals of plug 33 and jack 105 through the pulse relay or pulsing relay at the central office, back through the ring terminals of jack 105 and plug 33, lower normally made contacts of key 34, middle lower normally made contacts of key 15, inner lower made contacts of key 19, back through the pulsing contacts of the dial 27.

It will be noted that the bridge across the tip and ring conductors of the middle wind-

ing of retardation coil 14 and resistance 40 is connected across the tip and ring conductors to the portion of the tip and ring conductors of the calling 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 26. The release of dial 27 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 32 and 44. These relays are slow in releasing, but relay 32 is slower than relay 44, so that the resistance 43 will remain bridged across the secondary of the repeating coil 26, a short period after the shunt therefor is removed by the release of relay 44. The purpose of the momentary insertion of the resistance 43 across the tip and ring conductors at this time is to prevent false operation of the central office pulsing relays between digits, that is, to prevent the secondary of the repeating coil 26 from causing a false pulse indication to the central office apparatus due to the high impedance of this coil. In other words, the non-inductive resistance 43 remains in circuit until the current through the secondary windings of repeating coil 26 is sufficiently built up to hold the central office apparatus actuated through the bridge formed by these windings. It will be noted that the release of relay 44 closes connections through the condensers 47 and 48 between the calling subscriber's line and the secondary windings of the repeating coil 26 and the release of relay 32 reinserts the receiver in parallel with the lower primary winding of repeating coil 26 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 19 and conversation between the calling subscriber through the automatic central office apparatus may now take place.

When key 19 was returned to normal it should be observed that the bridge through the middle winding of retardation coil 14 and resistance 40 was reconnected across the tip and ring conductors. The connection for the tip and ring conductors from plugs 4 to 33 may be traced as follows: From tip terminal of plug 4, upper normally made contacts of key 17, right-hand winding of relay 16, upper outer normally made contacts of key 15, upon outer armature and back contact of

relay 24, upper inner normally made contacts of key 19, upper middle normally made contacts of key 15, upper normally made contacts of key 34 to tip terminal of plug 33, while the circuit for the ring conductor may be traced from ring terminal of plug 4, lower normally made contacts of key 17, left-hand winding of relay 16, lower outer normally made contacts of key 15, lower armature and back contact of relay 8, lower inner normally made contacts of key 19, middle lower normally made contacts of key 15, lower normally made contacts of key 34 to the ring terminal of plug 33.

It will be noted that the windings of the usual supervisory relay 16 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 36 to be lighted to indicate that disconnection is desired. It should be understood that 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 and the cord circuit shown in Fig. 1 is used, the relay 111 will be operated by ringing current therefrom. Obvious circuits are 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 33 into jack 105 and the operation 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 a call originating at the private branch exchange except that in this case relay 8 will not operate due to the fact that the relay 10 is already operated before plug 4 is inserted into the jack of the wanted subscriber's line. Relay 106 operates with relay 10 causing the release of relay 111, the extinguishing of lamp 112 and release of relay 113. Relay 113 is slow in releasing 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.

When relay 10 operates it should be noted that the inductive low resistance bridge through the middle winding of retardation coil 14 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 15, upper normal contacts of key 19, upper armature and front contact of relay 10, middle winding of retardation coil 14, inner lower armature and back contact of relay 24, lower normal contacts of key 19, middle lower contacts of key 15 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 16 is operated and closes a circuit from the ground on the sleeve of plug 4 through the armature and front contact of relay 16, upper inner normal contacts of key 15, the upper winding of relay 8, lower outer armature and front contact of relay 10, lower winding of relay 24 to battery. Relay 24 operates and opens the shunt around the non-inductive high resistance 40 so that the bridge across the tip and ring conductors of the cord will now extend through this non-inductive high resistance 40 in addition to the inductive low resistance middle winding of retardation coil 14. It is, however, as described above, 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 still in the circuit. While this invention has been illustrated by means of a cord circuit of but a simple type, 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 an application of the invention.

What is claimed is:

1. In a telephone system, two lines, a link circuit for connecting said lines, means responsive to the establishing of such a connection for placing a low resistance bridge across the talking conductors of said link circuit, and means for later including a non-inductive high resistance in said bridge.

2. In a telephone system, two lines, a link circuit for connecting said lines, means responsive to the establishing of said connection for placing an inductive resistance bridge across the talking conductors of said

link circuit, and means for later including a non-inductive resistance in said bridge.

3. In a telephone system, a called subscriber's line, a trunk line, a cord circuit for establishing a connection between said lines, means responsive to the establishing of said connection for placing an inductive resistance bridge across the tip and ring conductors of said cord circuit, and means responsive to the subscriber answering a call for including in said bridge a non-inductive resistance.

4. In a telephone system, a called subscriber's line, a trunk line, a cord circuit for establishing a connection between said lines, means responsive to the establishing of said connection for placing an inductive low resistance bridge across the tip and ring conductors of said cord circuit, and means responsive to the subscriber answering a call for including in said bridge a non-inductive high resistance.

5. In a telephone system, a called subscriber's line, a trunk line, a cord circuit for establishing a connection from said trunk line to said called subscriber's line, means responsive to the establishing of said connection for placing an inductive low resistance bridge across the talking conductors of said cord circuit, and means responsive to the called subscriber answering a call for including in said bridge a non-inductive high resistance.

6. In a telephone system, two lines, a link circuit for connecting said lines, means responsive to the establishing of such a connection for placing a direct current resistance bridge across the talking conductors of said link circuit, and means for later including a non-inductive high resistance in said bridge.

7. In a telephone system, two lines, a link circuit for connecting said lines, means responsive to the establishing of such a connection for placing a direct current low inductive resistance bridge across the talking conductors of said link circuit, and means for later including a non-inductive resistance in said bridge.

8. In a telephone system, a called subscriber's line, a trunk line, a cord circuit for establishing a connection from said trunk line to said called subscriber's line, a relay in said cord circuit, means responsive to the establishing of said connection for actuating said relay, means responsive to the operation of said relay for placing an inductive low resistance bridge across the talking conductors of said cord circuit, a supervisory relay in said cord circuit operative in response to the called subscriber answering a call, and means responsive to the actuation of said supervisory relay for including a non-inductive high resistance in said bridge.

In witness whereof, I hereunto subscribe my name this 4th day of November, 1929.

WALTER B. STRICKLER.