

**Nov. 1, 1927.**

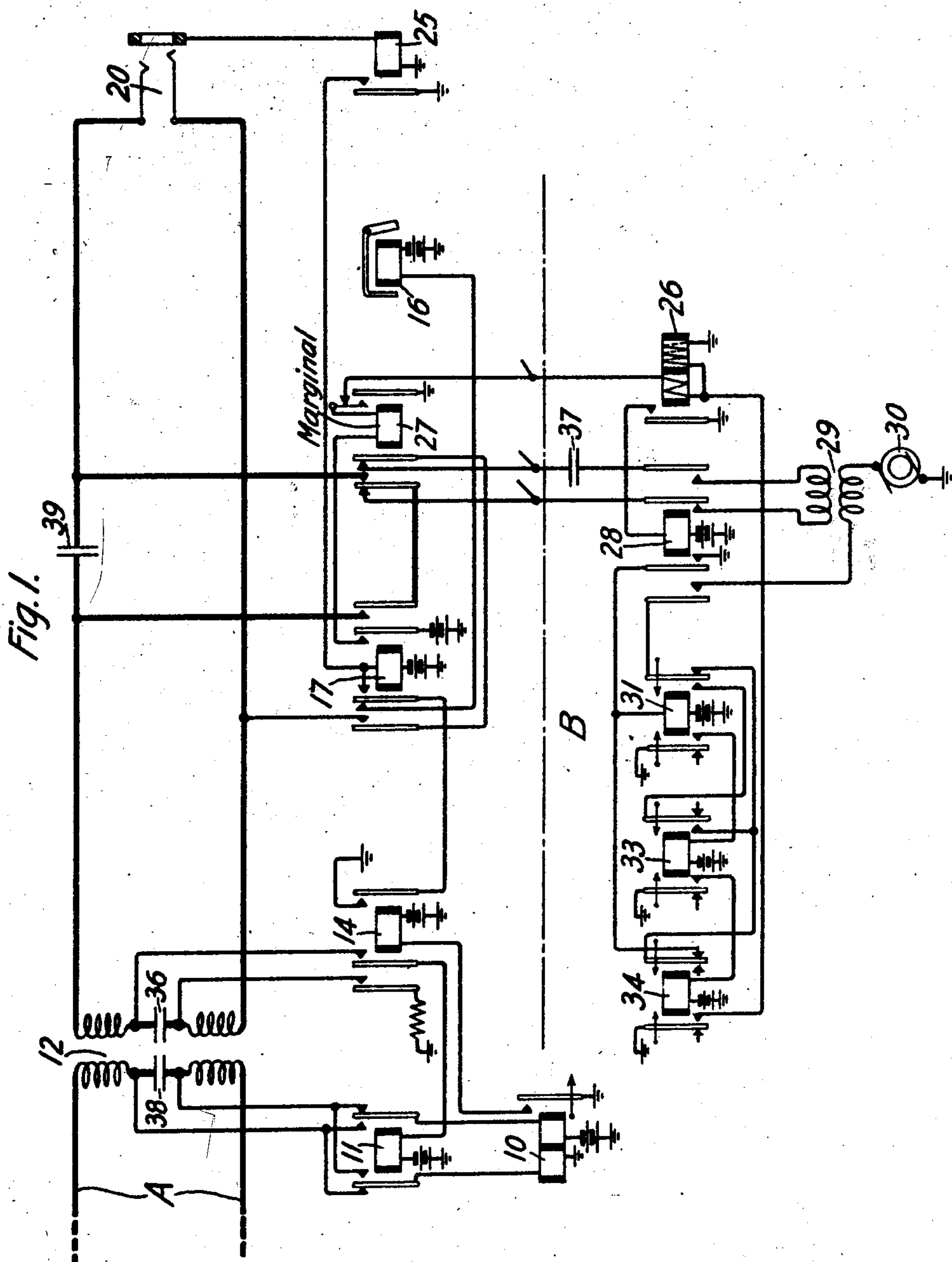
H. W. ULRICH

## TELEPHONE SYSTEM

Filed March 18, 1926

**1,647,258**

2 Sheets-Sheet 1



Inventor:  
Horace W. Ulrich.  
by Jul. L. Palmer Att'y.



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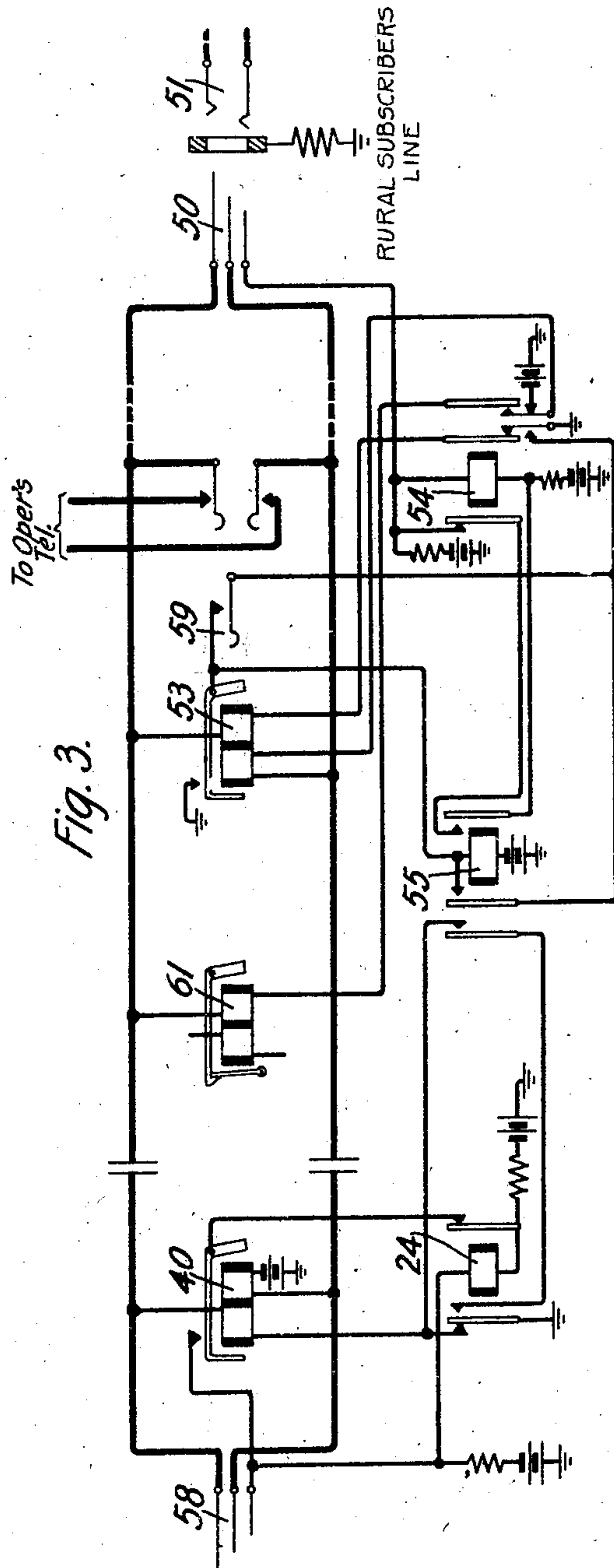
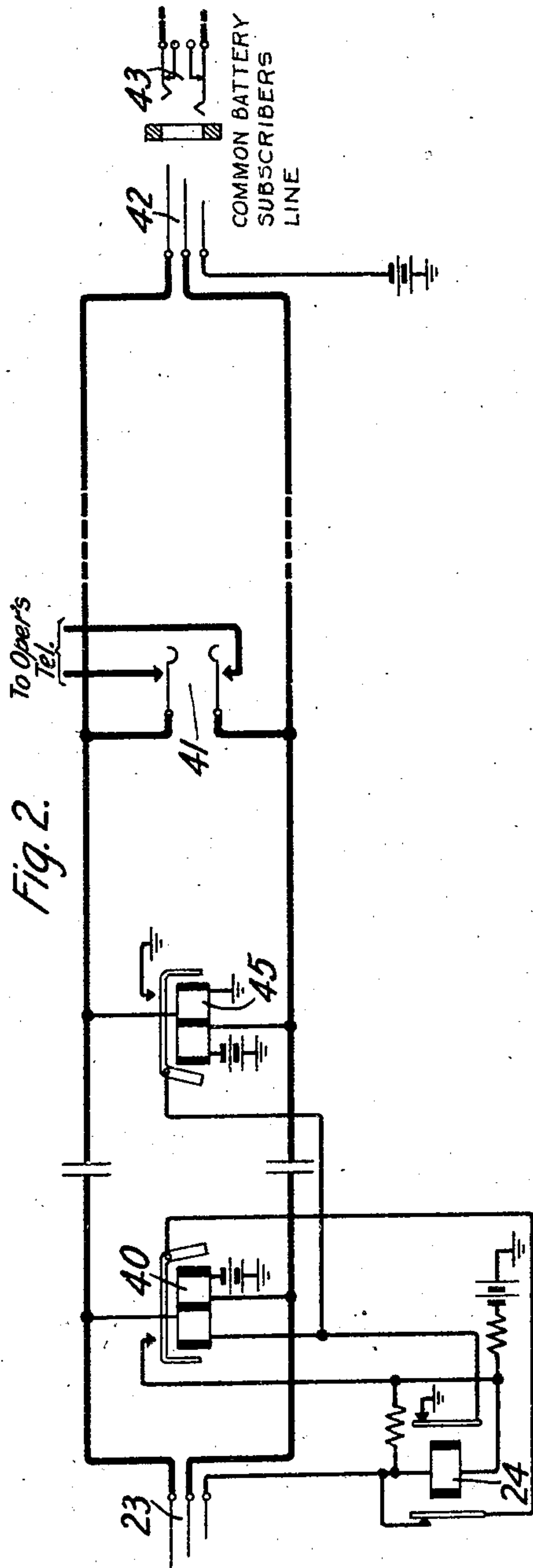
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2 Sheets-Sheet 2



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# UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

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This invention relates to telephone systems and more particularly to systems employing what are generally known as straightforward trunks for extending telephone connections.

In prior systems of this general type, telephone connections may be extended by an "outward" operator at one exchange over a straightforward trunk terminating in a plug at a distant exchange where an "inward" operator usually extends the connection by the aid of inter-position trunks or other similar connecting circuits to another operator who completes the connection to the desired subscriber's line by means of a cord circuit.

It is an object of this invention to provide a circuit arrangement whereby the inward operator may complete connections directly from straightforward trunks terminating at her position to desired subscribers' lines.

To attain this and other objects as will hereinafter appear there is provided in accordance with one feature of the invention an arrangement whereby straightforward trunks may terminate in jacks at the positions of standard switchboards in the same manner as ordinary subscribers' lines and whereby the inward operators at these positions are provided with so-called combination cords for completing connections between straightforward trunks arranged in accordance with this invention and a common battery subscriber's line or rural subscriber's line or between a common battery subscriber's line and another common battery subscriber's line or a rural subscriber's line.

Another feature of the invention is the provision of means whereby on the connection of a straightforward trunk with a combination cord circuit arranged in accordance with this invention, a circuit arrangement common to a plurality of straightforward trunks is actuated to transmit a tone signal, consisting of a plurality of impulses of tone, to the outward operator at the distant end of the trunk, arrangements being made so that this tone is also transmitted to the inward operator's telephone set if it is connected at this time to the cord circuit employed.

Another feature of the invention is the provision of means whereby, if the connection from the straightforward trunk is ex-

tended through a combination cord circuit to a common battery subscriber's line, a signal is automatically transmitted through the cord circuit and over the trunk to the outward operator and whereby, if the trunk is connected through a combination cord circuit to a rural subscriber's line, a signal may be transmitted over the combination cord circuit and the trunk to the outward operator by the actuation of a manually operated key in the cord circuit, and whereby a signal indication is received at the combination cord circuit used when the outward operator disconnects, regardless of the type of subscriber's line connected in the circuit.

Referring now to the drawings; Fig. 1 illustrates the circuit arrangement in accordance with this invention at the inward end of a straightforward trunk. Fig. 2 illustrates a combination cord circuit equipped in accordance with this invention for establishing connections between a straightforward trunk, such as is illustrated in Fig. 1, or a common battery subscriber's line at one end of the cord circuit and a common battery subscriber's line at the other end thereof. Fig. 3 illustrates a combination cord circuit equipped in accordance with the invention for connecting a straightforward trunk, such as is shown in Fig. 1, or a common battery subscriber's line at one end thereof with either a common battery subscriber's line or a rural subscriber's line at the opposite end thereof.

To clearly bring forward the various features of this invention a description will first be made of a connection to a common battery subscriber's line including the straightforward trunk shown in Fig. 1 and the combination cord circuit shown in Fig. 2, followed by descriptions of connections to a common battery subscriber's line and to a rural subscriber's line including the straightforward trunk shown in Fig. 1 and the combination cord circuit shown in Fig. 3, and also a résumé of the use of these combination cord circuits for connections between common battery and rural subscribers' lines.

Referring now to Figs. 1 and 2, if the straightforward trunk A is taken for use at an outward operator's position, in a manner well known in the art, slow to release relay 10 will operate over a circuit from battery, right hand winding of relay 10, right hand



armature and back contact of relay 11, lower left hand winding of repeating coil 12, over the ring conductor of trunk A to the outward operator's position at the distant  
 5 exchange, back over the tip conductor of trunk A, upper left hand winding of repeating coil 12, left hand armature and back contact of relay 11, left hand winding of relay 10 to ground. This circuit causes the  
 10 operation of relay 10 which in turn closes an obvious circuit for the energization of relay 14. Relay 14 in energizing closes a circuit for the signal 16 as follows: battery, winding of signal 16, inner left hand armature and back contact of relay 17, right hand  
 15 armature and front contact of relay 14 to ground. Signal 16, which is associated with jack 20 of trunk A, in operating indicates to the operator equipped with the combination  
 20 cord circuits shown in Figs. 2 and 3 that a connection is desired over trunk A.

If the inward operator has only access to common battery subscriber's line she will be equipped with combination cord circuits of the kind shown in Fig. 2. In such a case, to  
 25 answer the call she would insert plug 23 into jack 20. A circuit is thereby established for the actuation of relays 24 and 25 as follows: battery, winding of relay 24, sleeve contacts of plug 23 and jack 20, winding of relay 25  
 30 to ground. Relay 25 in operating closes an obvious circuit for the energization of relay 17. Relay 17 in operating opens the circuit for signal 16 and thus causes the signal to be  
 35 restored to normal. Relay 17 in operating also provides a locking circuit for itself under control of relay 14 through its left hand armature and front contact.

Relay 17 also closes a circuit for the operation of relay 26 of the circuit arrangement B which is common to a plurality of straightforward trunks such as A. The circuit for relay 26 may be traced as follows: battery, inner right hand armature and front  
 40 contact of relay 17, winding of relay 27, left low resistance and right high resistance windings of relay 26 in series to ground. The operation of relay 26 closes an obvious circuit for relay 28. Relay 28 in operating  
 45 completes a connection through the primary of induction coil 29 from the tone source 30 as follows: ground, tone source 30, primary of induction coil 29, outer left hand armature and front contact of relay 28, right hand  
 50 armature and back contact of slow-to-operate relay 31, right hand armature and back contact of slow-to-operate relay 34, inner left hand armature and front contact of relay 28 to ground. Relay 28 also completes a circuit from the secondary of the induction  
 55 coil 29 to the right hand windings of the repeating coil 12 as follows: from one side of the secondary winding of induction coil 29 through the inner left hand armature and front contact of relay 28, outer left hand  
 60 front contact of relay 28, outer left hand

armature and back contact of relay 27, outer right hand armature and front contact of relay 17, upper right hand winding of repeating coil 12, condenser 36, lower right  
 70 hand winding of repeating coil 12, outer left hand armature and front contact of relay 17, inner left hand armature and back contact of relay 27, condenser 37, outer right hand armature and front contact of relay 28 to the other side of the secondary  
 75 winding of induction coil 29. A tone from source 30 is now therefore transmitted inductively from the primary winding of induction coil 29 to the above traced circuit and inductively from this circuit, through the left hand windings of repeating  
 80 coil 12 and condenser 38, to line A. It will be noted that this tone will after a short interval be cut off by the operation of relay 31 which is energized through an obvious circuit on the operation of relay 28. The period of application of tone to trunk  
 85 A will be determined by the slow operating characteristics of relay 31. On the operation of relay 31 it will be noted that the circuit for the primary of the induction coil 29 is opened at the right hand armature and back contact of relay 31. The operation of relay 31 now closes an obvious circuit for the energization of the slow-to-operate relay  
 90 33 so that the period of absence of tone from the trunk A will be determined by the slow operating characteristic of relay 33. On the operation of this relay 33 the circuit from the source 30 through the primary of the induction coil 29 is again closed at the right hand armatures and front contacts of relays 31 and 33 so that this latter relay in  
 95 operating again applies tone from the source 30 to trunk A. This second application of tone to trunk A will remain until the slow operating relay 34 is actuated, which will take place within a certain period after the operation of relay 33 through an obvious circuit. On the operation of relay 34, the circuit from the source 30 through the primary of the induction coil 29 is again opened, this time through the opening of the circuit at right hand armature and back contact of relay 34. The operation of relay 34 closes  
 100 a short circuit to ground for the right hand high resistance winding of relay 26 at the left hand armature and front contact of this relay 34. When this takes place, the marginal relay 27 operates and in operating opens the circuit through the left hand low resistance winding of relay 26 at its make-before-break contacts so that relay 26 will now release and cause the release of relays 28, 31, 33 and 34 in succession. Relay 27 in  
 105 operating provides a locking circuit for itself through its right hand armature and front contact from battery supplied at the inner right hand armature and front contact of relay 17. By means of this common  
 110 115 120 125 130



circuit arrangement B, therefore, two short impulses of tone from the source 30 are transmitted to trunk A. These two impulses of tone indicate to the outward operator at the distant exchange that the inward operator at the exchange in which trunk A terminates has connected a cord circuit to jack 20 of this trunk. It should be noted that in case the inward operator's telephone set is already connected to the cord circuit these two impulses of tone will be heard in her receiver due to the capacity effect through the condenser 39 inserted in the tip conductor of the trunk A.

On the insertion of plug 23 into jack 20 a circuit was completed for the operation of the signal 40 as follows: battery, right hand winding of signal 40, ring terminals of plug 23 and jack 20, lower right hand winding of repeating coil 12, outer left hand armature and front contact of relay 14 to ground. The operation of signal 40 indicates to the inward operator that the cord circuit shown in Fig. 2 is engaged in the connection. The inward operator now establishes a connection from her telephone set, by operating the usual talking key 41, to the outward operator at the distant exchange.

On receiving the number of the desired subscriber from this operator the inward operator inserts the plug 42 into jack 43 of the desired common battery subscriber's line. When the inward operator now rings the subscriber on this line, through the operation of the usual ringing key (not shown), and the subscriber answers by removing his receiver from the hook a circuit is completed for the operation of signal 45 as follows: battery, left hand winding of signal 45, ring terminals of plug 42 and jack 43 through the subscriber's loop, back over the tip terminals of jack 43 and plug 42, through the right hand winding of signal 45 to ground. This circuit causes the operation of signal 45 which indicates to the inward operator that the wanted subscriber has answered. The operation of this signal 45 also closes a circuit for the transmission of a signal over the trunk A to indicate to the outward operator that the connected subscriber has answered the call. The circuits for transmitting this signal may be traced as follows: battery, winding of relay 11, inner left hand armature and front contact of relay 14, upper right hand winding of repeating coil 12, around the condenser 39 through the outer right hand armature and front contact of relay 17, and outer left hand armature and front contact of relay 27, through the tip terminals of jack 20 and plug 23, left hand winding of signal 40, armature and front contact of signal 45 to ground. This circuit causes the operation of relay 11 which now reverses the connection from battery and ground through the windings of relay 10

to the trunk A. As is well known in the art, this reversal of current over trunk A establishes a signal indication at the outgoing end of the trunk to notify the outward operator that the wanted subscriber has answered the call. Conversation between the calling and called subscribers, through well known circuit connections established by the outward operator, may now take place over trunk A and the cord circuit shown in Fig. 2.

When the conversation is terminated between the two subscribers, either the outward operator may disconnect by releasing trunk A or the called subscriber may disconnect by hanging up his receiver. If the outward operator disconnects, relay 10 releases and this relay in turn releases relay 14. The release of relay 14 causes the release of relay 11 and the restoration of signal 40. Signal 40 in restoring indicates to the inward operator that the outward operator has disconnected and she may then remove plugs 23 and 42 from jacks 20 and 43 respectively. The removal of plug 23 from jack 20 releases relays 25 and 24. The release of relay 25 causes the release of relays 17 and 27 while the removal of plug 42 from jack 43 causes the restoration of signal 45. If the called subscriber releases, by placing his receiver on the hook, signal 45 will be restored to indicate to the inward operator that disconnection is desired. On the restoration of signal 45, the release of relay 11 will again reverse the battery and ground connection for trunk A to indicate to the outward operator that the called subscriber has disconnected. The inward operator may now either wait for the restoration of the signal 40 on the release of the connection by the outward operator before removing plug 23 from jack 20, or if it is not necessary to wait she may release the connection as soon as signal 45 is restored.

If the inward operator has access to both common battery subscribers' and rural subscribers' she will be equipped with combination cord circuits of the type shown in Fig. 3. To establish connections using this kind of cord circuit with trunk A, the operations are practically the same as when connections are established by means of combination cord circuits of the type shown in Fig. 2. The difference in the functions of the combination cord circuit shown in Fig. 3 are as follows:

If the wanted subscriber is a common battery subscriber the insertion of plug 50 into jack 43, associated with such subscriber's line, and the operation of signal 53, when this subscriber answers, will automatically cause the transmission of a signal to the outward operator on trunk A. Signal 53 operates over a circuit as follows: battery, outer right hand make-before-break contacts of relay 54, left hand winding of signal 53, ring



terminals of plug 50 and jack 51 through the subscriber's loop back through the tip terminals of jack 51 and plug 50, right hand winding of signal 53, inner right hand armature and back contact of relay 54 to ground. The operation of signal 53 closes an obvious circuit for the operation of relay 55. Relay 55 in operating closes a circuit for relay 11 as follows: battery, through the winding of relay 11 over the circuit previously traced to the tip terminal of jack 20 and from there to the tip terminal of plug 58, left hand winding of signal 40, left hand outer armature and front contact of relay 55, left hand armature and front contact of relay 24 to ground. The operation of relay 11 causes the reversal of battery and ground connections to trunk A which, as stated, indicates to the outward operator that the called subscriber has answered.

On the other hand, should a connection be desired to a rural subscriber, it is well known in the art that the conditions on the sleeve terminal of the rural subscriber's jack are such that relay 54 will operate and signal 53 will consequently not operate when the rural subscriber answers. Jack 43 represents the common battery subscriber's line and the sleeve thereof is opened, the cut-off function being performed by the ordinary cut-off springs of the line jack. Jack 51, however, represents a rural subscriber's line and the sleeve thereof has a connection through a resistance to ground in the same manner as jack 20 of the trunk line in Fig. 1. In this case, the inward operator will notify the outward operator that the subscriber has answered by actuating the key 59. It should be understood that the inward operator may determine whether the rural subscriber answers the call by leaving her telephone set on the line until she receives such indication. The operation of key 59 completes a circuit for the operation of relay 55 as follows: battery, winding of relay 55, contacts of key 59, inner right hand make-before-break contacts of relay 54 to ground. The operation of relay 55 as in the previous case causes a signal to be transmitted to the outward operator on trunk A. In this case a locking circuit is provided for relay 55 through its inner left hand armature and front contact to the ground at the inner right hand make-before-break contacts of relay 54.

When conversation between the parties connected terminates, the rural subscriber signifies this fact by operating his ringing generator. An alternating current signal is therefore received over the tip and ring terminals of the plug 50 to actuate the signal 61. The circuit for this signal is as follows: from one side of the rural subscriber's generator, tip terminal of his jack, tip terminal of plug 50, right hand winding of signal 61, outer right hand armature and front contact

of relay 54, left hand winding of signal 53, the ring terminal of plug 50 and then back through the ring terminal of the rural subscriber's jack to the other side of the generator. Signal 61 in operating indicates to the inward operator that conversation on the line has ceased and she may now either wait for the restoration of signal 40 or remove the plugs 58 and 50 from jack 20 and the rural subscriber's jack immediately as desired.

It will be noted that the combination cord circuits shown in Figs. 2 and 3 may be employed in connecting ordinary subscriber lines terminating directly in jacks at the inward operator's position. The characteristics of the ordinary common battery subscriber's sleeve circuits are such that, on the insertion of the plug 23 or 58 into the jack of such a subscriber's line as in jack 43, relay 24 will not operate. Talking battery will therefore be supplied through the windings of signal 40 and this signal will operate. In operating it provides a short circuit across the winding of relay 24 so that this relay cannot be operated on busy tests, by other operators, on the connected subscriber's multiple jacks.

What is claimed is:

1. In a telephone system, a jack ended trunk line, a subscriber's line, a link circuit for interconnecting the trunk and the subscriber's line, the connection between the trunk and the link circuit being established through the jack of said trunk, a source of current connected to the trunk, means responsive to the removal of the receiver from the hook by the subscriber for reversing the current supplied to said trunk from said source, said means being controlled through the tip conductors of the trunk and the link circuit.

2. In a telephone system, a jack ended trunk line, a subscriber's line, a link circuit for interconnecting said trunk and the subscriber's line, the connection of the trunk to the link circuit being established through the jack associated with said trunk, means responsive to the connection of the link circuit to the trunk for transmitting a plurality of successive tone signals over said trunk, and means responsive to the removal of the receiver from the hook by the subscriber for transmitting a signal over said trunk, said last mentioned means being controlled over the tip conductors of the trunk and the link circuit.

3. In a telephone system, a plurality of jack ended trunks, a subscriber's line, a link circuit for interconnecting any one of said trunks with said subscriber's line, the connection between a trunk and the link circuit being established through the associated jack, a device common to said trunks for producing a plurality of successive tone signals, means responsive to the connection of a



trunk with said link circuit for actuating said common device to transmit said signals both to the connected trunk and to the link circuit, said means being controlled through  
5 the sleeve conductors of the connected trunk and the link circuit, means responsive to the removal of the receiver from the hook by the subscriber for transmitting a signal over the connected trunk, said last men-  
10 tioned means being controlled over the tip conductors of the connected trunk and the link circuit.

4. In a telephone system, a trunk line, a link circuit for extending said trunk line,  
15 means associated with the incoming end of said trunk line responsive to the connection of said link circuit to said trunk line for transmitting a definite plurality of successive signals to the outgoing end of said  
20 trunk line.

5. In a telephone system, a plurality of trunk lines, a link circuit for extending said trunk lines, means common to the incoming  
ends of said trunk lines responsive to the  
25 connection of said link circuit to one of said trunk lines for transmitting a definite plu-

ality of successive signals to the outgoing end of said one of said trunk lines.

6. In a telephone circuit, a trunk line, a subscriber's line, a link circuit for intercon- 30  
necting said lines, a signal in said link circuit responsive to the act of the subscriber in removing his receiver from its hook, and means responsive to the actuation of said  
signal for transmitting a signal over said 35  
trunk.

7. In a telephone circuit, a trunk line having its incoming end inductively coupled to its outgoing end, a source of battery and ground connected to the outgoing end sec- 40  
tion of said trunk line, a subscriber's line, a link circuit for interconnecting said lines, a signal in said link circuit responsive to the act of the subscriber in removing his receiver from its hook, and means respon- 45  
sive to the actuation of said signal for reversing said battery and ground con-  
nections.

In witness whereof, I hereunto subscribe my name this 16th day of March A. D., 1926. 50

HORACE W. ULRICH.