Feb. 18, 1930. E. E. HINRICHSEN 1,747,241

TELEPHONE SYSTEM

Filed Feb. 28, 1929 3 Sheets-Sheet 1

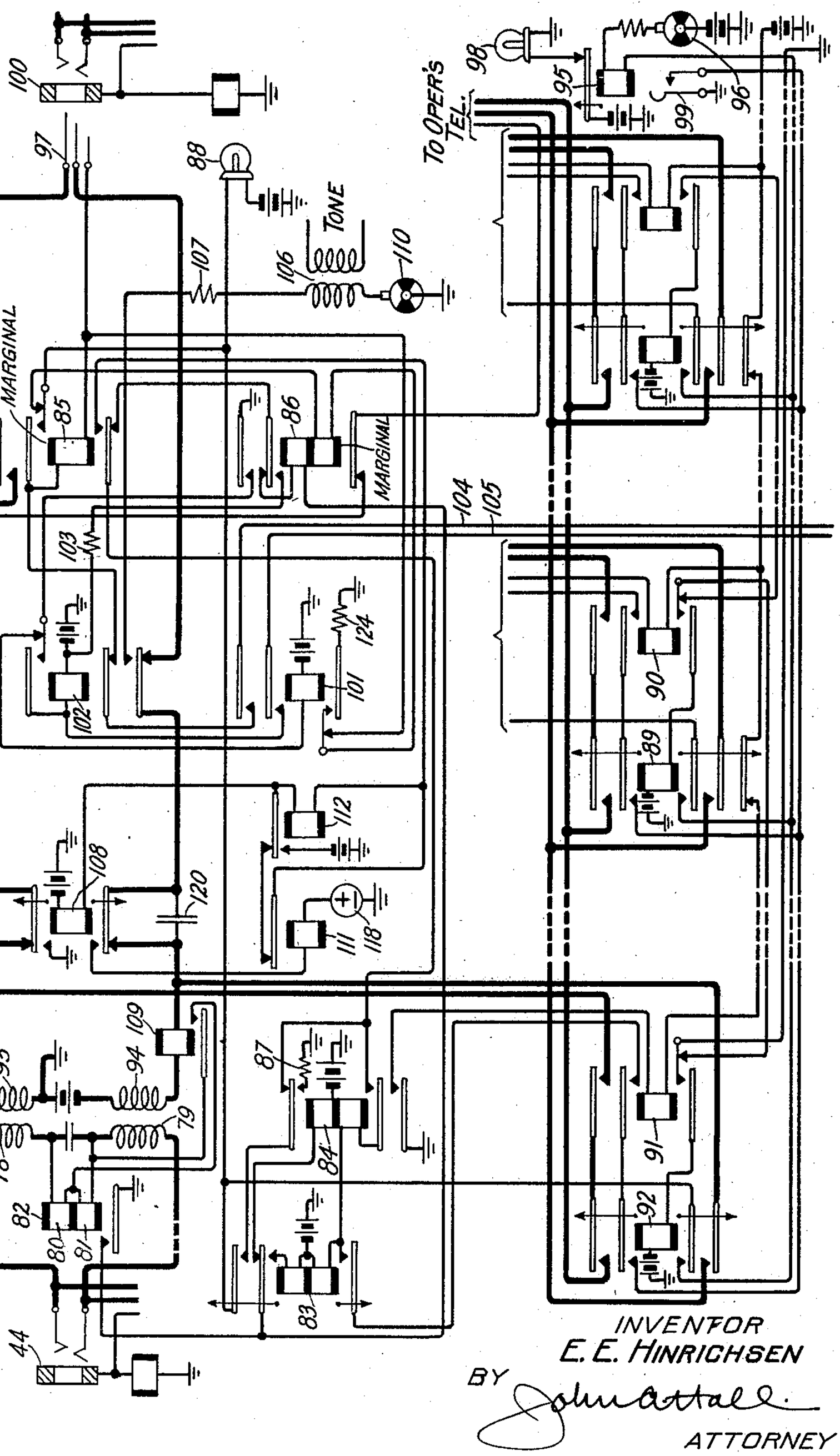

FIG. 1.

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TELEPHONE SYSTEM

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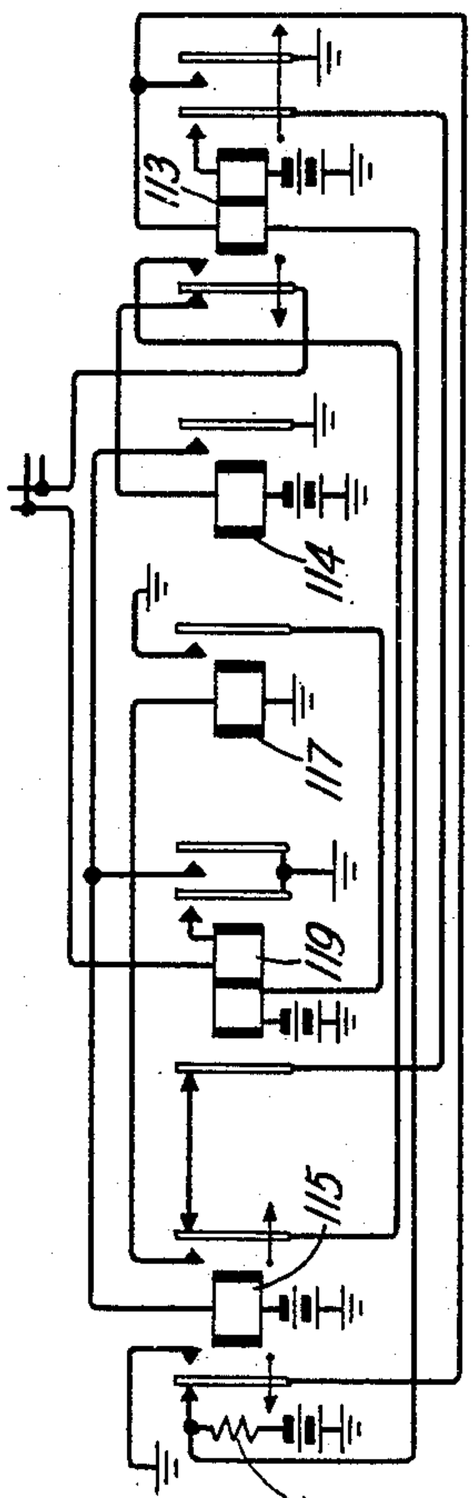

FIG. 2.

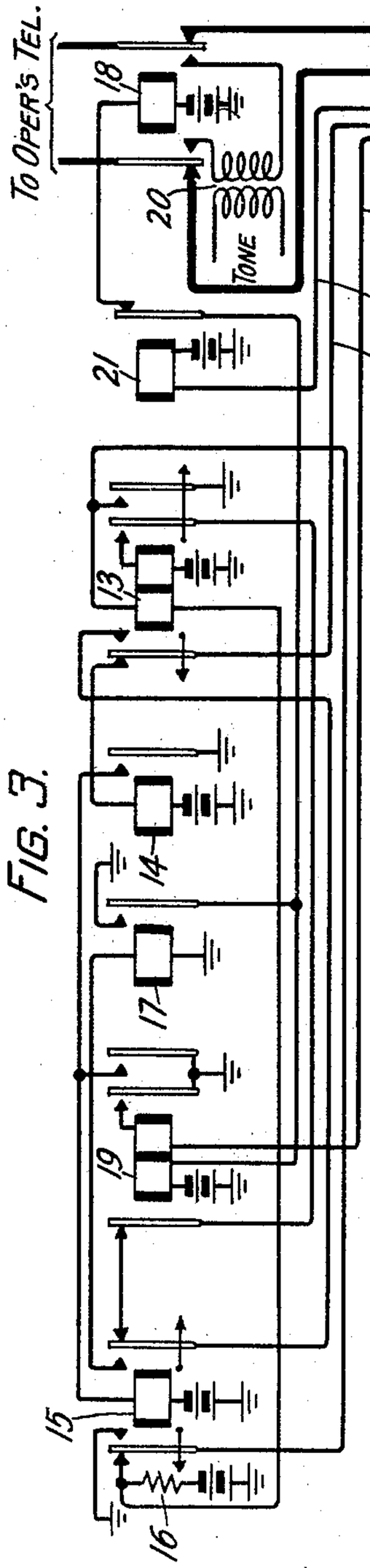

FIG. 3.

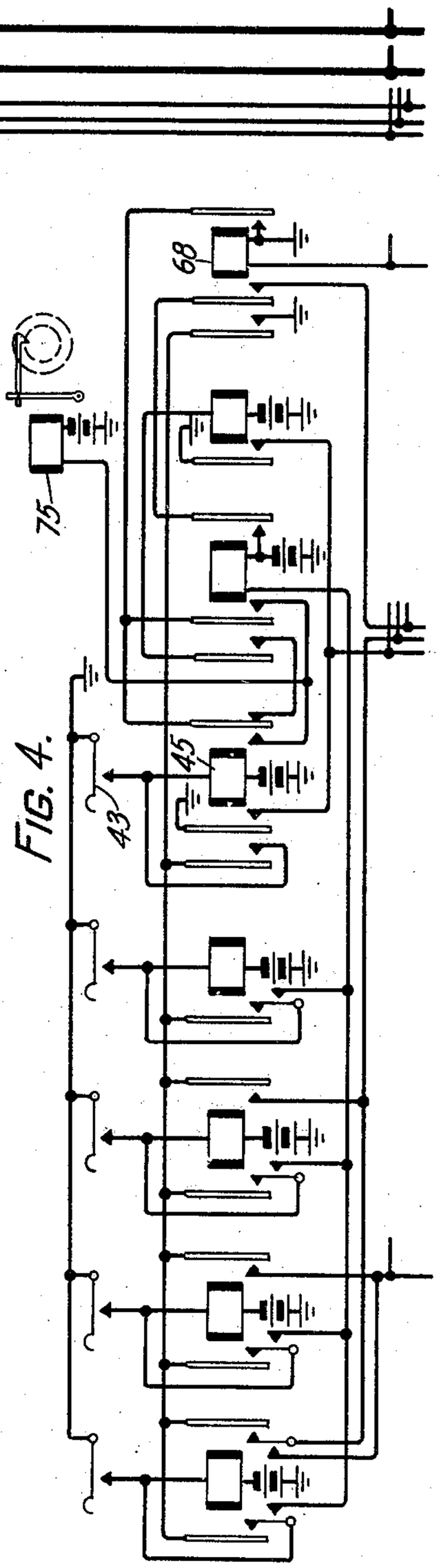

FIG. 4.

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TELEPHONE SYSTEM

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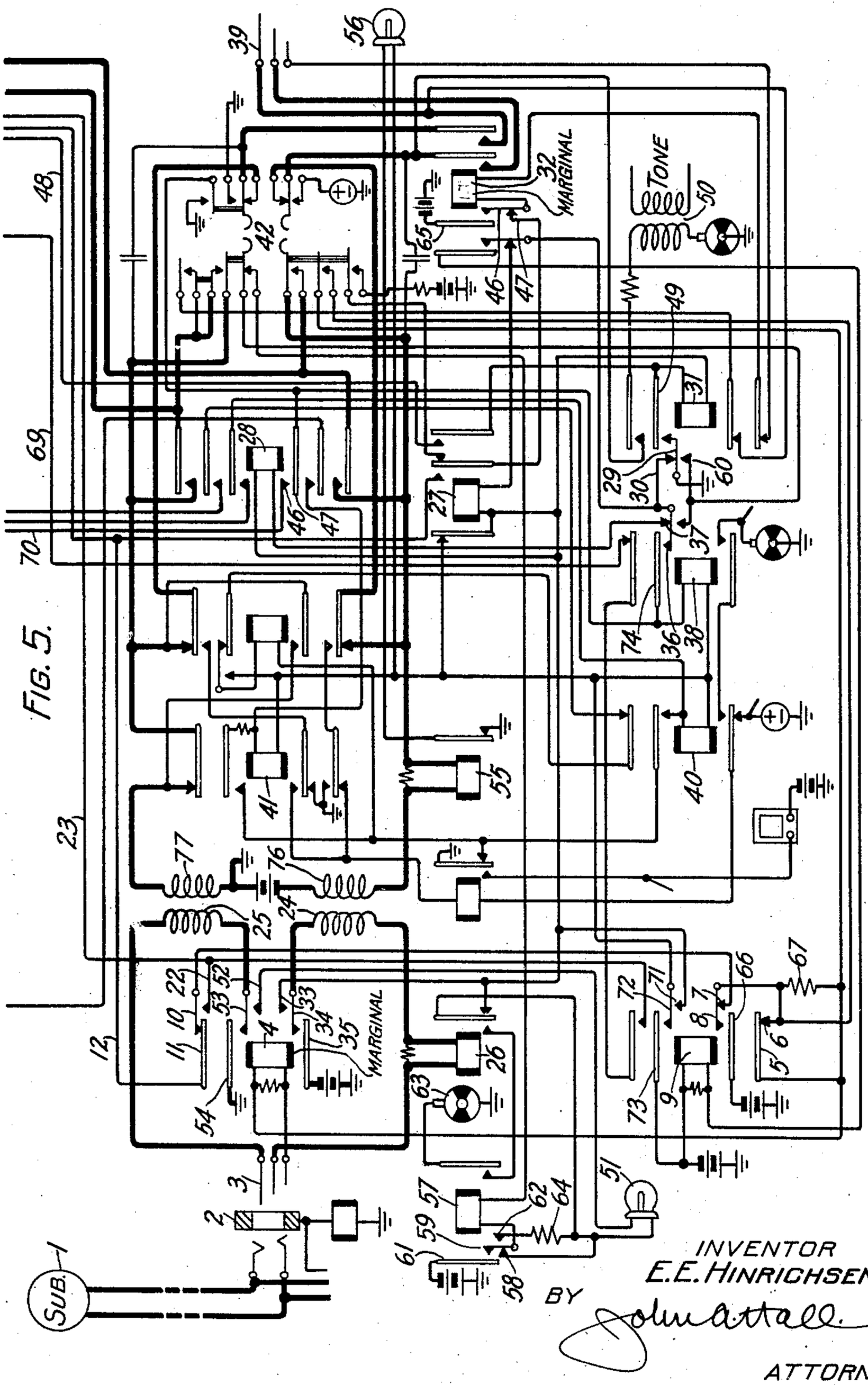

FIG. 5.

Patented Feb. 18, 1930 1,747,241

UNITED STATES PATENT OFFICE

EDWARD E. HINRICHSEN, OF NEW YORK, N. Y., ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

Application filed February 28, 1929. Serial No. 343,521.

This invention relates to telephone systems and particularly to means for automatically determining the busy or idle condition of a line.

A feature of the invention resides in the provision of means common to a plurality of link circuits and responsive to the connection of any one thereof to a line for automatically determinig the busy or idle condition of said line.

When used in connection with the answering cords of "A" cord circuits this invention provides a common non-interfering means so that where a calling line appears in a plurality of operator's positions it is only the first to answer who can set up a talking connection. In each case the common testing relays go through a series of operations and then free themselves whether the line be free or occupied. If the line be idle then a talking connection between the line and the operator is established and if the line be occupied such a connection is prevented and the operator is given a busy signal.

When used in connection with the calling cords of "A" cord circuits or with the outgoing ends of trunks such as the modern straightforward trunks then the test automatically made by these common relays results in rendering either a means for ringing on the called line effective or a means for returning a busy signal to the calling line effective.

A single set of common testing relays may be used in connection with "A" cord circuits for performing the double function of acting as a non-interfering means for the answering cords and as an automatic busy testing means for the calling cords.

The drawings comprise three sheets of circuit diagrams and should be placed one below the other so that Fig. 1 is at the top and Fig. 5 is at the bottom. Fig. 1 represents one of a group of straightforward trunks and Fig. 2 represents the common relays cooperating therewith for testing for the busy or idle condition of lines to which this trunk may be connected. Fig. 5 represents one of a group of cord circuits and Fig. 3 represents the common relays cooperating therewith for testing for the busy or idle conditions to which this cord may be connected. Fig. 4 represents a ringing key set common to the cord circuits of Fig. 5. The cord circuit of Fig. 5 will cooperate with the straightforward trunk of Fig. 1 and hence the operation of these circuits will be described as though a connection were being established from the subscriber's station indicated at the left of Fig. 5 through the cord circuit of Fig. 5, thence over the straightforward trunk of Fig. 1 to the telephone line indicated at the right of Fig. 1.

The common testing relays of Fig. 3 cooperate with both the answering and the calling plugs of the cord circuit of Fig. 5, so that with the answering plug they provide a non-interfering feature and with the calling plug an automatic busy test feature. We will first assume that a call has been initiated at substation 1 and has been answered at another position so that when plug 3 is inserted in jack 2 a busy condition will be encountered. As will appear later this will manifest itself as a battery potential on the sleeve of jack 2. A circuit is thereupon established from sleeve of jack 2, sleeve of plug 3, winding of marginal relay 4, contacts 5, 6, 7 and 8 of relay 9, contacts 10 and 11 of relay 4, conductor 12, left hand armature and back contact of relay 13, winding of relay 14 to battery and ground. Marginal relay 4 will not respond to current flowing in this circuit but relay 14 will respond even though the potential on the sleeve of jack 2 has been raised above its normal ground potential. By the response of relay 14 a circuit is closed for the energization of slow releasing relay 15. Relay 15 in turn through its left hand armature and front contact establishes a circuit through the left hand

winding of relay 13, resistance 16 to battery whereupon relay 13 energizes and transfers conductor 12 from the winding of relay 14 to the right hand armature of relay 15 through the associated front contact to the winding of relay 17 to ground. Relay 17 responds to the battery potential on the sleeve of jack 2 and establishes a circuit in one direction for the energization of relay 18 and in the other direction through the left hand winding of relay 19 to battery for the energization of relay 19. Upon the energization of relay 13 relay 14 is released and this in turn would ordinarily release relay 15, but this latter relay being slow to release holds over until relay 19 has become energized and a substitute circuit for relay 15 is established.

Relay 18 upon energizing connects tone source 20 to the operator's telephone set leads whereupon the operator realizing that she has plugged in on a busy line removes plug 3 from jack 2 and opens the circuit for relay 17. Relay 18 and relay 19 release and relay 15 shortly thereafter returns to normal. The left hand winding of relay 13 is now shortcircuited through the left hand armature and back contact of relay 15 and relay 13 releases thus returning the common testing relays to normal.

Let us now assume that plug 3 is inserted into jack 2 while the line is idle, that is, before another operator has taken up the call at some other position. Relay 14 will be operated as before, then relays 15 and 13 will respond and relay 17 will be connected to conductor 12. In this case however relay 17 will not respond and consequently neither relay 18 or relay 19 will be energized. Relay 13 being energized and locked through its outer right hand armature and front contact now provides a circuit which becomes effective upon the release of relay 15 extending from battery, right hand winding front contact and inner right hand armature of relay 13, left hand armature and back contact of relay 19, back contact and right hand armature of relay 15, front contact and left hand contact of relay 13, conductor 12 and thence over the circuit previously traced to ground on the sleeve jack 2. The right hand winding of relay 13 is of low resistance and consequently marginal relay 4 will become energized. The energization of relay 4 transfers the circuit now established from the right hand winding of relay 13 to the winding of relay 21 by shifting the connection through contacts 10 and 11 and thence to conductor 12 to a connection through contacts 10 and 22 and thence over conductor 23 to the winding of relay 21. Thus relay 4 is held in series with relay 21 and the possibility of relay 18 becoming energized is removed until after relay 9 becomes operated as will hereinafter appear. Also the circuit through the right winding of relay 13 is opened and since the left winding is now shortcircuited at the back contact and left hand armature of relay 15, relay 13 will be released.

Upon the operation of relay 4 battery and ground will be connected to the left hand windings 24 and 25 of the repeating coil and thus talking current will be supplied to the subscriber's line. With the receiver off the hook and the subscriber's line loop closed the supervisory relay 26 will be energized. At this same time relays 27 and 28 will be energized. The circuit for relay 27 extends from ground, contacts 29 and 30 of relay 31, normal contacts of the outer left hand armature of relay 32, winding of relay 27, contacts 33, 34 and 35 of relay 4 and thence to battery. The circuit for relay 28 extends from ground, contacts 29 and 30 of relay 31, contacts 36 and 37 of relay 38, winding of relay 28, and thence to battery through contacts 33, 34 and 35 of relay 4.

Relay 27 now transfers the connections of the common testing relays from the answering end of the cord to the calling end so that when the calling plug 39 is inserted in a line or trunk jack the busy or idle condition thereof may be automatically determined. Relay 27 also temporarily removes a battery connection from the winding of relays 38, 40 and 41.

Relay 28 upon energizing connects the operator's set of Fig. 3 to and associates the common ringing keys of Fig. 4 with the cord. The operator now ascertains the number of the wanted party and proceeds to extend the connection accordingly.

For emergency purposes a manual busy testing arrangement is provided. The operator may operate the emergency listening key 42 and touch the tip of plug 39 to the sleeve of the wanted line so that if battery potential is present it will produce a small flow of current from the tip of plug 39 through the back contact and inner lower armature of relay 31 thence through the uppermost contacts of listening key 42 to the tip side of the cord which will manifest itself as a click in the operator's telephone, the usual busy indication. Under ordinary conditions however the operator will plug directly into the wanted line and depress the proper ringing key. We will assume in the present case that she inserts the plug 39 into jack 44 and when she finds the trunk idle then depresses the trunk key 43. For purposes of illustration we will first assume that jack 44 is associated with a busy trunk and that there is a battery potential on the sleeve of this jack.

Upon the insertion of plug 39 into jack 44 a circuit is established to apply the battery potential standing on the sleeve of jack 44, over the sleeve of plug 39, back contact and lowermost armature of relay 31, winding of marginal relay 32, contacts 46 and 47, inner

right hand armature and front contact of relay 27, conductor 12 through the left hand armature and back contact of relay 13 to the winding of relay 14 and thence to battery and ground. Relay 32 does not respond but relay 14 becomes energized even though the battery potential standing on the sleeve of jack 44 does reduce the current flowing in the circuit just described. Relay 14 causes the energization of relay 15, relay 15 in turn causes the energization of relay 13 and relays 13 and 15 together connect conductor 12 to the winding of test relay 17. Relay 17 responds to the battery potential on sleeve of jack 44, and causes the energization of tone relay 18 to notify the operator of the busy condition of the trunk. Relay 17 also causes the energization of relay 19. Conductor 12 having been disconnected from the winding of relay 14, this relay becomes deenergized but relay 15 is held by relay 19.

A circuit is now established from ground, the inner right hand armature and front contact of relay 19, right hand winding of relay 19, conductor 48, front contact and outer right hand armature of relay 27, winding of busy back relay 31 to battery through contacts 33, 34 and 35 of relay 9. Relay 31 locks to ground over contacts 29 and 49 and causes the deenergization of relays 27 and 28. Relay 28 disconnects the operator's set leads and the common ringing key leads from the cord so that the common position apparatus is free for use in other connections. Conductor 12 is opened so that relay 17 releases and the common testing relays are returned to normal in the manner hereinbefore explained.

Relay 31 upon energizing connects tone source 50 through the uppermost armature and front contact of relay 31 to the ring conductor of the calling end of the cord, whence by induction the tone is transmitted to the calling subscriber.

The calling subscriber now replaces his receiver on its hook and supervisory relay 26 releases. This establishes a circuit from battery through contacts 35, 34 and 33, back contact and armature of relay 26, answering supervisory signal lamp 51 and thence to ground through contacts 52, 53 and 54 of relay 4, causing the display of the answering supervisory signal. Upon the release of relay 27, heretofore described a circuit was established from ground, the back contact and armature of calling supervisory relay 55, calling supervisory signal lamp 56, back contact and left hand armature of relay 27 to battery through contacts 33, 34 and 35 of relay 4. Thus both supervisory signals are now displayed and the operator will take down the connection and thus restore the cord circuit to normal.

Let us assume that the calling subscribed is not satisfied and wishes to attract the attention of the operator. He will merely depress his hook switch once thus causing the momentary release of answering supervisory relay 26. During this interval supervisory signal 51 will be displayed as explained. In addition the recall relay 57 will be energized in a circuit from battery through contacts 35, 34 and 33 of relay 4, back contact and armature of relay 26, contacts 58 and 59 of relay 57, winding of relay 57, innermost upper contacts of key 42 and contacts 60 and 29 of relay 31 to ground. Relay 57 locks through its contacts 61 and 59. Now when answering supervisory relay 26 again attracts its armature supervisory lamp 51 which is being energized through contacts 61, 59 and 62 will be periodically shunted by interrupter 63, the resistance 64 serving to prevent a direct connection from ground to battery. Hence as long as the calling subscriber holds his receiver off its hook lamp 51 will flash.

The operator will now remove plug 39 from jack 44 and may get into communication with the calling subscriber by momentarily withdrawing plug 3 from jack 2 in order to momentarily open the battery and ground supply connections controlled by relay 4 which in turn will release the busy back relay 31. When plug 3 is reinstated in jack 2, the operations heretofore described will be repeated and the operator will not proceed to extend the connection.

In this instance it will be assumed that jack 44 into which plug 39 is inserted leads to an idle trunk. Therefore the normal ground on the sleeve of jack 44 will be connected to relay 14, relay 14 will become energized, in turn energizing relays 15 and 13 so that testing relay 17 is connected to the sleeve but will not respond. In a short interval relay 15 will release whereupon a circuit is established from battery through the low resistance right hand winding of relay 13, left hand armature and back contact of relay 19, back contact and right hand armature of relay 15, front contact and left hand armature of relay 13, conductor 12, front contact and inner right hand armature of relay 27, contacts 47 and 46 and winding of relay 32, lowermost armature and back contact of relay 31, sleeve of plug 39, sleeve of jack 44 to ground. Relay 32 energizes in this circuit and locks through its contacts 65 and 32 to the sleeve of the plug and trunk jack. This results in the opening of the circuit through the right hand winding of relay 13 and since its left hand winding is now shortcircuited at the back contact and left hand armature of relay 15, relay 13 releases and the common testing relays are returned to normal.

Upon the energization of relay 32 the circuit for relay 27 is opened and this relay releases. At the same time a circuit is established from ground contacts 29 and 30 of relay 31, alternate contacts of the outer left hand armature of relay 32, winding of relay 9

to battery and ground resulting in the energization of relay 9. Relay 9 provides a holding circuit for relay 4 from battery, contacts 66 and 8 of relay 9, resistance 67, winding of relay 4 and thence to ground over the sleeve of the plug 3 and jack 2. At the same time a circuit is established for maintaining relay 21 energized and for energizing relay 68, from battery, winding of relay 68, conductor 23, uppermost contact and armature of relay 9, uppermost armature and back contact of relay 38, conductor 69, winding of relay 68 to ground. Relay 68 provides a holding ground for the relays of the common ringing keys. It is assumed that in this case the trunk key 43 will be depressed whereupon relay 45 will respond and lock through its outer left hand armature and front contact to the ground supplied over the front contact and outer left hand armature of relay 68. Key 43 is non-locking and its contact is only closed so long as the key is depressed.

A circuit is now established from ground, inner left hand armature and front contact of relay 45, conductor 70, contacts 46 and 47 of relay 28, winding of relay 38 to battery either over contacts 71, 72 and 73 of relay 9, or over the back contact and left hand armature of relay 27 and thence over contacts 33, 34 and 35 of relay 4. Relay 38 becomes energized and locks to ground over contacts 29 and 30 of relay 31 and contacts 36 and 74 of relay 38. Ground is thus removed from the winding of relay 28, resulting in the disconnection of the operator's set, the common ringing key set and the release of relays 68 and 21. During the operation of relays 45 and 68 a circuit is established for peg count meter 75 whereby another completed cord circuit connection is recorded.

Relay 32 also cuts through the talking conductors of the cord circuit so that battery and ground are now supplied through windings 76 and 77 of the repeating coils of the cord circuit to windings 78 and 79 of the repeating coil of the trunk and thence in series through the low resistance winding 80 and the high resistance winding 81 of relay 82. The calling supervisory relay 55 will not respond due to the high resistance winding 81. Therefore the calling supervisory signal 56 will be displayed.

Upon the energization of relay 82 a circuit is established from ground, the armature and contact of relay 82, the inner upper armature and back contact of relay 83, the middle winding of relay 84 to battery and ground. Relay 84 responds and establishes a circuit from battery, the lower winding of relay 83, the lower winding of relay 84, inner lower armature and front contact of relay 84, lower armature and back contact of relay 85, upper inner armature and back contact and upper winding of relay 86 to ground at the armature and contact of relay 82. Relay 83 operates in this circuit, relay 84 holds but relay 86 does not become energized. Relay 83 then locks through its upper winding to the ground supplied at the contact and armature of relay 82. A circuit is now established from ground, resistance 87, front contact and upper armature of relay 84, front contact and uppermost armature of relay 83, signal lamp 88 to battery, thus causing the display of a calling signal.

At the bottom of Fig. 1 are shown the sequence relays for the group of trunks of which that of Fig. 1 is the first. There is a group of two relays individual to each trunk, those for the first trunk, those for an intermediate trunk and those for the last trunk in the group being shown. If we should assume that at the instant the circuit condition just described had been attained the operator was busily engaged in connection with an intermediate trunk then we would find relay 89 and 90 energized and hence the circuit of relay 91 open. As soon as the operator is free relays 89 and 90 are restored to normal and a circuit is established from ground, lowermost armature and front contact of relay 84, winding of relay 91, and thence through a chain circuit comprising the back contacts and lowermost armatures of all relays such as 89 from there on to battery beyond the relay group for the last trunk of the group. Relay 91 becomes energized and through its lower armature and alternate contact completes a circuit from the winding of relay 92 to ground whereby relay 92 is energized. With both relays 91 and 92 energized the talking conductors of the trunk leading from windings 93 and 94 of the repeating coil are connected to the operator's telephone. At the same time a connection is established from the signal lamp 88 through the inner lower armature and front contact of relay 92, winding of relay 95 and interrupter 96 to battery whereby signal lamp 88 is periodically shunted so that it flashes as an indication to the operator that the trunk ending in plug 97 associated with lamp 88 is the particular one to which she is at present connected. Relay 95 operates periodically with interrupter 96 and causes pilot lamp 98 to flash.

Let us assume for a moment that the operator finds that she cannot get the proper information for extending the connection as when the calling subscriber has in the meantime abandoned the call. By momentarily depressing key 99, the operator may establish a circuit from ground through the front contact and inner upper armature of relay 92, inner upper armature and front contact of relay 91, lower armature and front contact of relay 83. A ground connection at this point short-circuits the lower winding of relay 84 and the upper winding of relay 86. Relay 84 releases, causing in turn the

release of relays 91 and 92 whereby the operator is freed. The trunk is now left in the condition with only relays 82 and 83 operated and lamp signal 88 dark. The calling subscriber may recall the operator handling the cord circuit of Fig. 5 and that operator by momentarily taking plug 39 out of jack 44 may deenergize relays 82 and 83. When plug 39 is reinserted in jack 44 the operations heretofore described are repeated and the operator's telephone is again connected to the trunk.

The operator ascertains the number of the wanted line and inserts plug 97 in jack 100 leading thereto. A circuit is now established from ground on the sleeve of jack 100, through sleeve of plug 97, normal contacts of the lower armature of relay 101, lower winding of relay 86, normal contacts of the inner upper armature of relay 85 to the lead to signal lamp 88, either through which or through interrupter 96 sufficient current will flow to cause the energization of relay 86. By moving its inner upper armature, relay 86 switches the circuit leading from the lower windings of relays 83 and 84 from a connection to ground at the contact of relay 82 to the lower winding of relay 102 and thence to battery thus causing the release of relay 84. The return of relay 84 to normal opens the circuits of relays 91 and 92 and these releasing cut off the operator from connection to the trunk. Signal lamp 88 becomes dark through the opening of both its connections to the contacts of relays 84 and 92 and the establishment of a shunt. leading from the signal lamp 88, the uppermost armature and front contact of relay 83, the upper armature and back contact of relay 84, the lower armature and back contact of relay 85, the inner upper armature and front contact of relay 86, resistance 103 to battery. The energization of relay 86 also causes the operation of relay 101 through a circuit from ground, the uppermost armature and front contact of relay 86, the normal contacts of the upper armature of relay 102, winding of relay 101 to battery. Relay 86 is now held in a circuit from ground, resistance 124, lower armature and alternate contact of relay 101, lower winding of relay 86, normal contacts of the inner upper armature of relay 85 to the conductor leading to signal lamp 88 and thence over the path just traced through resistance 103 to battery. Relay 101 in operating establishes a circuit from the sleeve of jack 100, through the sleeve of plug 97, winding of relay 85, back contact and inner lower armature of relay 102, front contact and uppermost armature of relay 101, conductor 104, left hand armature and back contact of relay 113, winding of relay 114 to battery and ground. Relay 114 becomes energized in this circuit but relay 85 being marginal does not. Relay 114 closes a circuit for the energization of relay 115 and this in turn closes a circuit through its front contact and left hand armature, the left hand winding of relay 113, resistance 116 to battery causing the operation of relay 113. Relay 113 now transfers conductor 104 from the winding of relay 114, through the right hand armature and front contact of relay 115, to the winding of testing relay 117 to ground.

Let us now assume that jack 100 is associated with a busy line. This will be denoted by a battery potential standing on the sleeve of jack 100 which will operate relay 117. Relay 117 becoming energized establishes a circuit for the operation of relay 119 through its left hand winding. This relay in turn maintains relay 115 operated and establishes a connection from ground, the inner right hand armature and front contact of relay 119, the right hand winding of relay 119, conductor 105, inner upper armature and front contact of relay 101, winding of relay 102 to battery and ground. Relay 102 becomes operated and locks through its upper armature and alternate contact and thence through the front contact and uppermost armature of relay 86 to ground. At the same time relay 102 opens conductor 104 so that relay 117 becomes deenergized. Relay 102 also opens the energizing circuit for relay 101 so that this returns to normal and by opening the connection through conductor 105 allows relay 119 to return to normal. Relay 115 now releases and when its left hand armature makes connection with its back contact, short-circuits the left hand winding of relay 113 so that this now releases and the common testing relays are returned to normal. Busy back relay 102 in operating connects the source of tone 106 through resistance 107, front contact and lowermost armature of relay 102, lower armature and back contact of relay 108, supervisory relay 109, to winding 94 of the repeating coil, whence by induction the busy tone is returned to the calling subscriber. Supervisory relay 109 is also periodically energized in this circuit through the ground connected to interrupter 110 and this relay in return periodically short-circuits the high resistance winding 81 of the relay 82. Each time winding 81 is short-circuited the current flowing through calling supervisory relay 55 of the cord circuit of Fig. 5 is operated with the result that signal lamp 56 is periodically flashed. When the A operator removes plug 93 from jack 44, relay 82 releases, releasing in turn relay 83. The release of this latter relay opens the circuit from the signal lamp 88 through resistance 103 to battery as hereinbefore described so that signal lamp 88 is now energized through a circuit including the normal contacts of the inner upper armature of relay 85, the lower winding of relay 86, normal contacts of the lower armature of relay 101, sleeve of plug 97, sleeve of jack 100 to

the ground connection thereat. Signal lamp 88 lights as a disconnect signal. The operator having charge of the trunk of Fig. 1 now removes plug 97 from jack 100, thus releasing relay 86 and returning the trunk circuit to normal condition.

If on the other hand it is assumed that the line connected to jack 100 is idle then when the connection is established to relay 117 this relay will fail to operate. Shortly thereafter the relay 115 releases and although it short-circuits the left hand winding of relay 113, this relay remains operated in a circuit from battery, through its right hand winding the front contact and inner right hand armature of relay 113, the left hand armature and back contact of relay 119, back contact and right hand armature of relay 115, the front contact and left hand armature of relay 113, conductor 104, uppermost armature and front contact of relay 101, inner lower armature and back contact of relay 102, through the winding of relay 85, sleeve of plug 97, the sleeve of jack 100 to ground. The right hand winding of relay 113 is of low resistance and hence marginal relay 85 becomes operated. Relay 85 now locks to the sleeve of the line through its inner upper armature and alternate contact, the uppermost armature and front contact of relay 83, the upper armature and back contact of relay 87, the lower armature and front contact of relay 85, the armature and back contact of relay 111, the back contact and armature of relay 112, winding of relay 108 to battery and ground. Relay 108 becomes operated in this circuit with results which will be stated shortly.

The operation of relay 85 opens the circuit for relay 86 which now becomes deenergized and in turn releases relay 101. Relay 101 in returning to normal opens both conductors 104 and 105 so that the right hand winding of relay 113 now being opened this relay returns to normal and thus restores the common testing relays for use in some other connection.

A ringing circuit is now established from source of alternating current 118 through the winding of tripping relay 111, front contact and lower armature of relay 108, lowermost armature and back contact of relay 103, ring of plug 97, ring of jack 100, out over the subscriber's loop including his call bell thence back over the tip of plug of jack 100, tip of plug 97, uppermost armature and front contact of relay 85, upper armature and front contact of relay 108 to ground. Current from this circuit is insufficient to cause the energization of relay 111. Condenser 120 bypasses a small amount of ringing current through the winding 94 of the repeating coil of the trunk whereby through induction the calling subscriber is notified that the called line is being rung.

When the called subscriber, whose line terminates in jack 100, responds, tripping relay 111 is energized. This opens the original circuit to relay 108 and inserts therein the winding of relay 112 which now becomes operated. This relay in turn locks through a battery connection at its front contact which at the same time short-circuits relay 108 thus putting the trunk in condition for talking purposes. The loop of the subscriber's line now being closed, supervisory relay 109 becomes operated and by short-circuiting the high resistance winding 81 of relay 82 causes the operation of calling supervisory relay 55 in the cord circuit with the result that signal lamp 55 becomes dark. The operator handling the cord circuit of Fig. 5 observing the darkening of signal 55 knows that the called subscriber has answered.

At the termination of the conversation relay 109 releases in turn releasing relay 55 whereby the lamp 56 is again illuminated. When the calling subscriber hangs up the answering supervisory lamp 51 becomes illuminated in the manner hereinbefore described and the A operator takes down the connection. Lamp 88 thereupon becomes illuminated in the manner hereinbefore described and the B operator removes plug 97 from jack 100 and the circuits are thus returned to normal condition.

What is claimed is:

1. In a telephone system, link circuits, ringing means associated with said link circuits, busy signaling means associated with said link circuits, a called line, means for connecting one of said link circuits to said called line, and a set of testing relays common to said link circuits responsive to the said connection of one of said link circuits to said called line for rendering either said ringing means or said busy signaling means effective.

2. In a telephone system, a plurality of plug ended link circuits, ringing means associated with said link circuits, busy signaling means associated with said link circuits, a called line having a jack terminal for cooperation with said plug ended link circuits, and a set of testing relays common to said link circuits responsive to the establishment of a connection between one of said link circuits and said called line for rendering either said ringing means or said busy signaling means effective.

3. In a telephone system, link circuits, ringing means associated with said link circuits, busy signaling means associated with said link circuits, a called line, means for connecting one of said link circuits to said called line, and a testing means common to said link circuits comprising a relay responsive to the establishment of a connection between one of said link circuits and said called line, and a relay responsive to the busy con-

dition of said called line for rendering either said busy signaling means or said ringing means effective.

4. In a telephone system, link circuits, busy signaling means associated with said link circuits, a called line having a third conductor comprising a test circuit for indicating the busy or the idle condition of said line, means for connecting one of said link circuits to said called line, and a testing means common to said link circuits comprising a relay responsive to the establishment of a connection between one of said link circuits and said called line, a relay responsive to the busy condition of said called line and unresponsive to the idle condition of said called line, a slow releasing relay responsive to the actuation of said first relay for momentarily closing one point in a connection between said second relay and the test circuit of said called line, a slow releasing relay initially responsive to the actuation of said third relay for releasing said first relay and for momentarily completing the said connection between said second relay and the test circuit of said called line, and a relay responsive to the actuation of said second relay for rendering said busy signaling means effective.

5. In a telephone system, link circuits, busy signaling means associated with said link circuits, a line having a third conductor comprising a test circuit for indicating the busy or the idle condition of said line, means for connecting one of said link circuits to said line, a testing means common to said link circuits, comprising means responsive to the busy condition of said line for rendering said busy signaling means effective and means individual to said link circuit for disconnecting said test circuit from said common testing means.

6. In a telephone system, link circuits, busy signaling means associated with said link circuits, a line having a third conductor comprising a test circuit for indicating the busy or the idle condition of said line, means for connecting one of said link circuits to said line, a testing means common to said link circuits comprising means responsive to the busy condition of said line for rendering said busy signaling means effective, and a slow releasing relay responsive to the connection of said link circuit to said line for thereupon limiting the duration of the individual association of said common testing means with said link circuit.

7. In a telephone system, link circuits, lines, means common to said link circuits for automatically testing for the busy or idle condition of said lines and means individual to each of said link circuits for transferring the connection of said common means from one end to the other of said link circuits.

8. In a telephone system, link circuits each having an answering end and a calling end, lines, means common to said link circuits for automatically testing for the busy or idle condition of said lines, said common means being normally associated with the answering ends of said link circuits and means in each of said link circuits for temporarily associating said common means with the calling end of said each of said link circuits.

In witness whereof, I hereunto subscribe my name this 26th day of February 1929.

EDWARD E. HINRICHSEN.