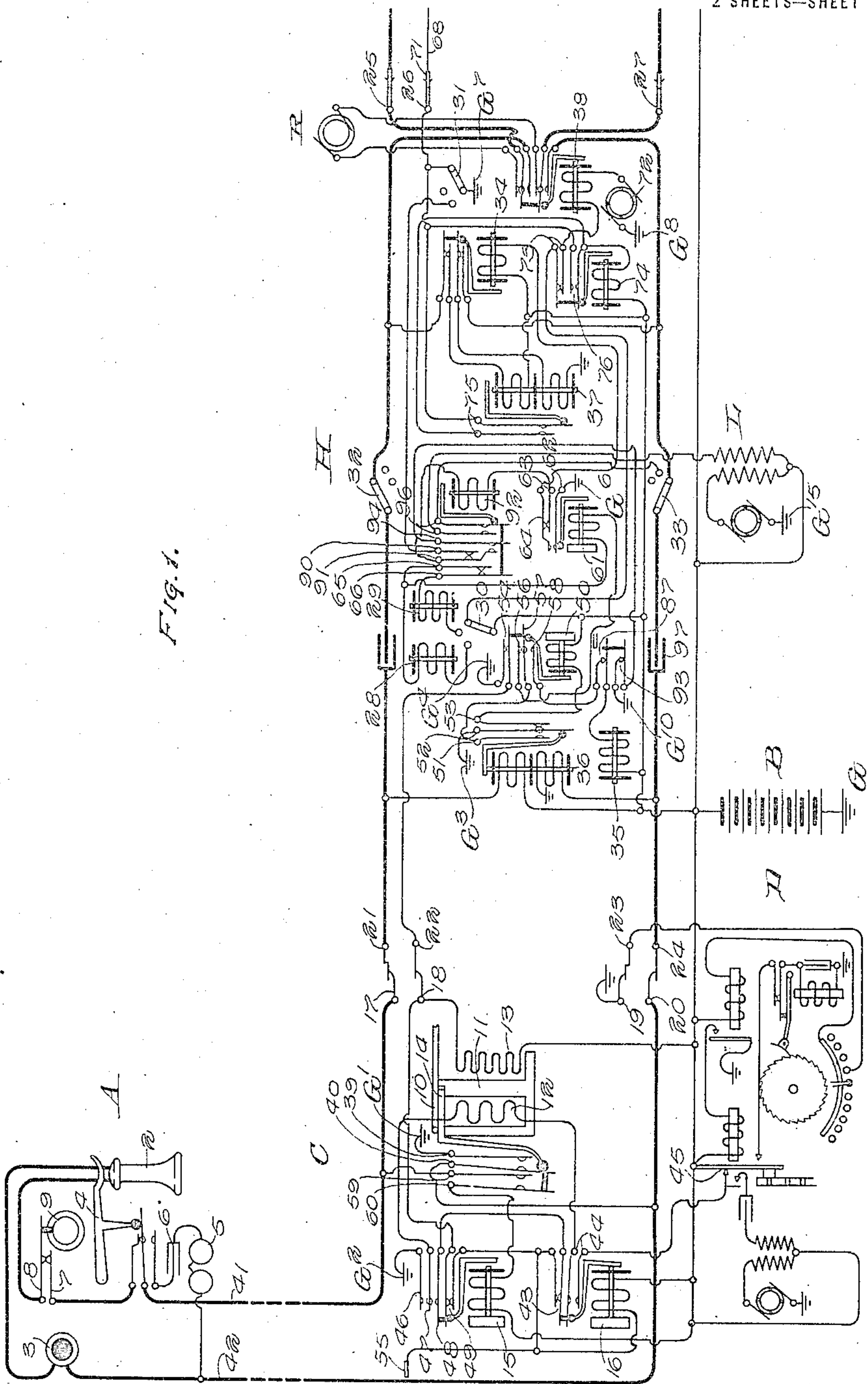


W. T. POWELL.  
 AUTOMATIC TELEPHONE SYSTEM.  
 APPLICATION FILED NOV. 28, 1913.

1,165,709.

Patented Dec. 28, 1915.

2 SHEETS—SHEET 1.



WITNESSES

G. A. Janochowski  
 Harry Musley

INVENTOR:  
 WINFRED T. POWELL,

By Bulkeley & Swenarton

ATTORNEYS



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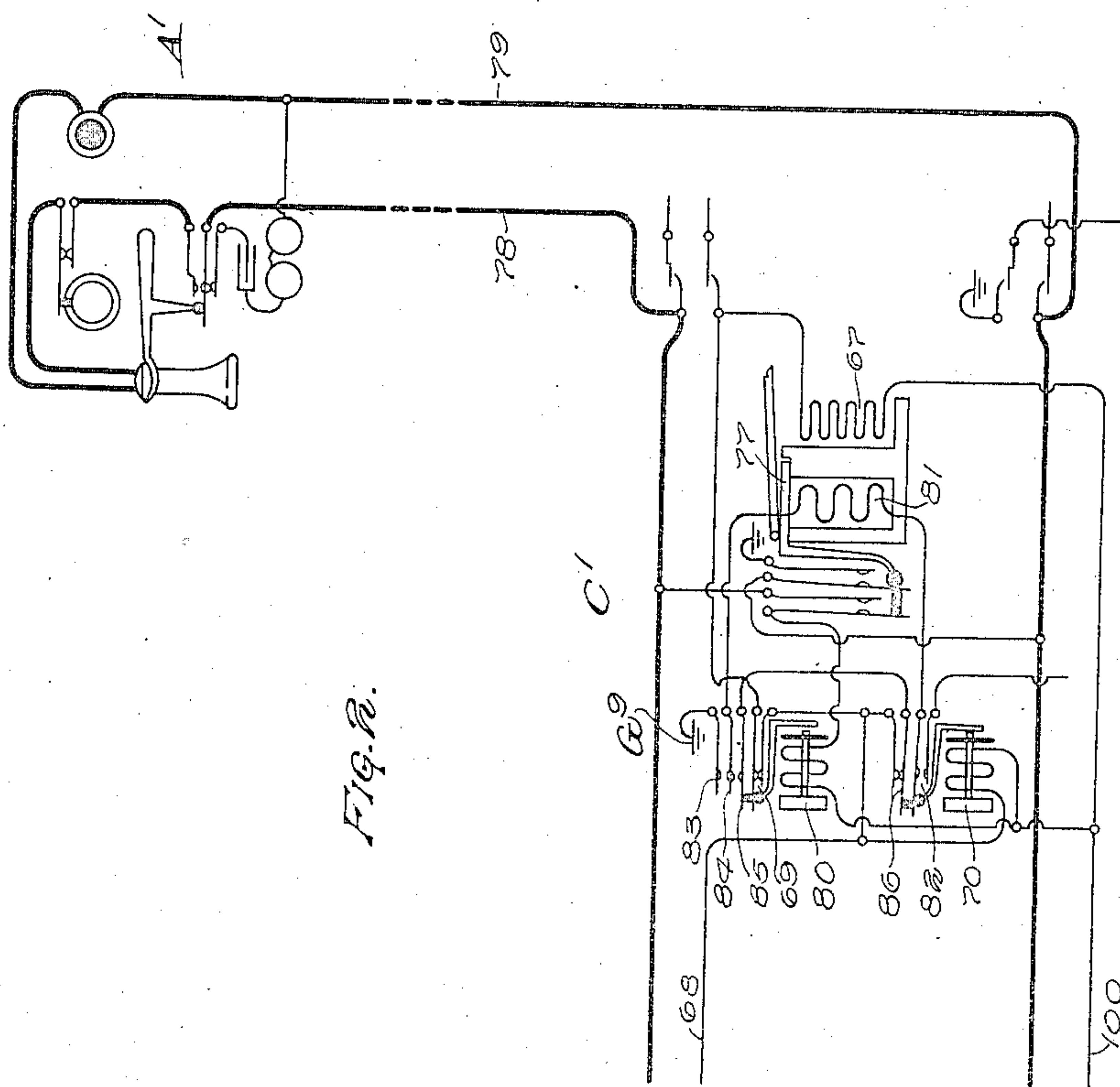


FIG. 2.

WITNESSES  
 G. A. Janochowski  
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# UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

## AUTOMATIC TELEPHONE SYSTEM.

1,165,709.

Specification of Letters Patent.

Patented Dec. 28, 1915.

Application filed November 28, 1913. Serial No. 803,495.

*To all whom it may concern:*

Be it known that I, WINFRED T. POWELL, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems, and has for its object the prevention of trunk lines being unnecessarily tied up after a connection has been released.

In the ordinary two-wire system each line is provided with a line switch, which line switch is provided with a line relay normally bridged across the line, so that as soon as a subscriber removes his receiver from the hook, this relay is energized and causes the line switch to operate to seize a trunk. When connection is made with a line, a bridge-cut-off relay is provided for cutting off or opening this line relay bridge and thus prevent the line switch from operating when the called subscriber responds. Now if the calling subscriber hangs up his receiver before the called subscriber, he releases all of the switches, and as soon as the connector breaks connection with the called subscriber's line, the bridge-cut-off relay falls back and closes the bridge through the line relay, with the result that the line switch of the called line is operated and occupies a trunk until the called subscriber hangs up his receiver.

The object of my invention is to prevent the line switch of the called line from operating in this manner and thus prevent a trunk line being unnecessarily tied up between the time when the calling and called subscribers hang up their receivers.

These and other objects of my invention will be more clearly and fully understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention in connection with a telephone system of a well-known type.

Figures 1 and 2 taken together show a complete circuit connection between a calling substation A and a called substation A' in a system embodying my invention.

The automatic system represented herein comprises the subscriber's substation A, to-

gether with its individual switch C at the central office, a master switch D, a connector H, the called subscriber's line switch C' and the called substation A'. It will be readily understood by those versed in the art that so-called selector switches may be inserted in the system, thereby increasing the capacity of the exchange without departing from the principles of my invention. The so-called selector switches may be of a type similar to those disclosed in British patent to T. G. Martin No. 1419 of 1910.

The subscriber's substation A is of any suitable or approved type and comprises the usual receiver 2, transmitter 3, switch hook 4, ringer 5 and condenser 6. Being an automatic substation it is also provided with an impulse transmitter or calling device, which is here represented by a pair of impulse springs 7 and 8 and an impulse wheel 9, which latter is assumed to be controlled through the medium of a finger hole dial (not shown) in such a manner that the impulse springs 7 and 8 may be momentarily separated a number of times, corresponding to the digit called.

The line switch C, which is associated with the line of the substation A, is of the general type of line switch shown in British patent to T. G. Martin No. 1419 of 1910, referred to above, with the exception that the line relay and operating magnet are made separate instead of being combined in a single structure. The circuits, of course, are slightly modified to operate in a system embodying my invention. This line switch comprises, among other details, a plunger (not shown) attached to the end of a so-called plunger arm 10 which is controlled by the operating magnet 11. The magnet 11 comprises two windings, namely, the pull-in winding 12 and the holding or cut-off winding 13. The winding 12 operates both the plunger arm 10 and the cut-off armature 14, while the winding 13 is strong enough only to operate the armature 14 and to hold the plunger arm 10 in an operated position after it has once been operated by the pull-in winding 12. The circuit of the pull-in winding 12 is controlled by the relays 15 and 16, both of which I preferably make slow acting, *i. e.*, they are slow to de-energize after their energizing circuit has



been broken. When the plunger arm 10 is operated, the plunger is forced into a bank of contact springs, forcing the springs 17, 18, 19 and 20 into engagement with the  
 5 springs 21, 22, 23 and 24, respectively. Although only one set of springs (17-24) is shown, each line switch is provided with a plurality of said sets, each set forming the terminal of a trunk line leading to a con-  
 10 nector switch H. Each trunk line is connected in multiple to the corresponding springs of all the switches of the group which is controlled by the master switch D. The line switch C is controlled through the  
 15 medium of the line relay 15, as will be hereinafter more fully explained.

The master switch D is of the same general type as that disclosed in British patent to R. W. James No. 26,301 of 1906, being,  
 20 however, of the particular type disclosed in British patent to T. G. Martin of 1910, above referred to. The function of the master switch, as is well known, is to maintain the plungers of all the idle line  
 25 switches in position to engage the terminal of an idle trunk line.

The connector switch H is of the same general character as that disclosed in United States Letters Patent No. 815,176, granted  
 30 March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the  
 35 two sides of the line in series. The connector is provided with a shaft (not shown) carrying the wipers 25, 26 and 27. The shaft is controlled by the vertical magnet 28 and the rotary magnet 29. The usual  
 40 side switch comprising the wipers 30, 31, 32 and 33 is controlled by the private magnet 34 in the usual well-known manner. The magnet 35 is the usual release magnet. The operations of the switch are controlled  
 45 through the medium of the double-wound line relay 36, through which the calling subscriber receives talking current. The called subscriber receives talking current through the so-called back-bridge relay 37.  
 50 The ringing relay 38 is the means through which ringing current is applied to the called line.

The substation A' and the line switch C' (Fig. 2) are similar in all respects to the  
 55 substation A and the line switch C.

For the purpose of supplying battery current for operating the central office apparatus, and for talking purposes, there is shown a battery B having one terminal  
 60 grounded at G. The busy signaling machine, L, as represented herein, comprises an induction coil or transformer, the primary winding of which is included in a local circuit with a battery and an inter-  
 65 rupter. Through the medium of this inter-

rupter an intermittent current is supplied to the primary winding which induces an alternating current in the secondary winding, whereby when said winding is connect-  
 70 ed with the subscriber's line, a buzzing sound is heard in the receiver.

Having given a general description of the apparatus involved in the system, and in order to give a complete understanding of  
 75 my invention, I will now describe how the subscriber at substation A may call the subscriber at the substation A'. Upon the removal of the receiver from the switch hook at the substation A preparatory to making  
 80 a call, an energizing circuit is closed through the line relay 15 of the line switch C. This circuit extends from ground G' through the springs 39 and 40, over the line 42, through the substation A, line 41, springs 59 and 60  
 85 and the line relay 15 to the battery B, thence through battery B to ground. The line relay 15, upon energizing, operates to close the circuit of the pull-in winding 12. This circuit extends from ground G<sup>2</sup> through the  
 90 contact of springs 46 and 47, pull-in winding 12, springs 44 and the springs 45 to the battery B. The pull-in winding 12 operates to cause the cut-off armature 14 to force the springs 40 and 60 out of engagement with  
 95 the springs 39 and 59, respectively, and also operates to force the plunger on the plunger arm 10 into the bank of contacts 17-24. The disengagement of the springs 40 and 60 from the springs 39 and 59 opens the circuit  
 100 of the line relay 15. The line relay 15 being slow acting does not fall back immediately, however, but holds the plunger arm in an operated position until a holding ground is supplied to the holding winding 13 from the  
 105 connector H. The engagement of the springs 17 and 20 with the springs 21 and 24, respectively, extends the subscriber's line to the line relay 36 of the connector H. The line relay 36 of the connector switch H is thereupon energized, closing a circuit  
 110 through the slow acting relay 50. This circuit extends from ground G<sup>3</sup> through the contact of springs 52 and 53 and the relay 50 to the battery B. The relay 50, upon energizing, closes the above-mentioned circuit  
 115 for the holding winding 13. The said circuit extends from ground G<sup>4</sup> through the contact of springs 54, bank springs 22 and 18 and the holding winding 13 to the battery B. The winding 13, upon energizing, holds  
 120 the armature 14 and the plunger arm 10 in their operated positions after the circuit of the pull-in winding is broken by the opening of the springs 46 and 47 of the line relay 15. The deenergization of the line relay  
 125 15 also closes a circuit through the slow acting relay 16. The said circuit extends from ground G<sup>4</sup> through the contact of springs 54, bank springs 22 and 18, springs 49 and the relay 16 to the battery B. The energiza- 130



tion of said relay is functionless at this time. At the same time that the circuit for the relay 16 is closed, a guarding ground potential is extended to the connector private bank contacts 55, which guards the substation A against being seized by a connector switch. The energization of the relay 50 also prepares a circuit for the vertical magnet 28 by bringing into engagement the springs 56 and 57 and opens the circuit of the release magnet 35 at the springs 57 and 58.

The calling subscriber now operates his calling device for the first digit 2 of the called number, whereby the substation impulse springs 7 and 8 are operated twice momentarily, each time breaking the circuit of the connector line relay 36. The relay 50 of the connector being slow acting does not deenergize during the momentary interruptions of its circuit by the line relay 36, and consequently each time the latter deenergizes, an impulse is transmitted through the vertical magnet 28. This circuit extends from ground  $G^3$  through the contact of springs 52 and 51, springs 57 and 56, relay 61, vertical magnet 28 and the side switch wiper 30 (in first position) to the battery B. The vertical magnet 28 receives two impulses over this circuit and operates to raise the switch wipers 25, 26 and 27 to a position opposite the second level of bank contacts. The relay 61, which is included in series with the vertical magnet, remains energized during the entire time that impulses are being transmitted through it and operates to close the circuit of the private magnet 34. The circuit for the private magnet 34 extends from ground  $G^6$  through the contact of springs 62 and 64 and the said magnet to the battery B. After the last impulse is delivered, the relay 61 opens the circuit of the private magnet 34, which, upon deenergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 30 from first to second position transfers the battery connection from the vertical magnet 28 to the rotary magnet 29.

The calling subscriber now operates his calling device for the last digit O, in response to which the connector line relay operates to transmit ten impulses through the rotary magnet 29 in series with the relay 61, whereby the shaft wipers are rotated onto the contacts of the desired line. The said circuit extends from ground  $G^3$  through the contact of springs 52 and 51, springs 57 and 56, relay 61, springs 65 and 66, rotary magnet 29 and the side switch wiper 30 (in second position) to the battery B. The relay 61 operates in response to the impulses for this digit in the same manner as for the previous digit to cause the private magnet 34 to advance the side switch one more posi-

tion, *i. e.*, from second to third position. By the engagement of the side switch wipers 32 and 33 with their third-position contact points, the connection is completed with the called substation, and by the engagement of the side switch wiper 31 with its third-position contact point a circuit is established for the bridge-cut-off winding 67 of the line switch  $C'$  as well as for the slow relay 70. The circuit for the bridge-cut-off winding 67 extends from ground  $G^7$  through the side switch wiper 31 (in third position), private wiper 26, conductor 68, springs 69 and the cut-off winding 67 to the battery lead 100. The slow acting relay 70 of the line switch  $C'$  is also energized at this time, but the operation of said relay is functionless at this time. A guarding ground potential is supplied to the connector private bank contact 71 of the called line which prevents the same from being seized by some other connector switch. By the engagement of the side switch wiper 30 with its third-position contact point, the circuit of the ringer relay 38 is closed. This circuit extends from ground  $G^8$  through the interrupter 72, relay 38, contact of springs 73 and the side switch wiper 30 (in third position) to the battery B. The ringer relay disconnects the calling line from the called line and bridges the ringing current generator R across the called line to signal the called subscriber. The ringer relay is energized only intermittently through the medium of the interrupter 72. Upon the response of the called subscriber, his line is provided with talking current through the windings of the back-bridge relay 37, which relay, upon energizing, closes the circuit through the ringer cut-off relay 74. The said circuit extends from ground  $G^7$  through the side-switch wiper 31 (in third position), contact of springs 75 and the said relay 74 to the battery B. The relay 74, upon energizing, interrupts the circuit of the ringer relay 38 at the springs 73 and closes a locking circuit for itself through the springs 76 independent of the springs 75. After the conversation is completed, the connection is released by the hanging up of the receiver at the calling substation in the following manner: When the receiver at the substation A is restored to the switch-hook, the separation of the hook-switch springs destroys the energizing circuit of the connector line relay 36. The relay 36 is thereupon deenergized and opens the circuit of the relay 50. The relay 50, upon deenergizing, completes a circuit extending from ground  $G^3$  through contact of springs 52 and 51, springs 57 and 58, off-normal springs 87 and the release magnet 35 to the battery B. The magnet, upon energizing, restores the switch shaft and side switch to normal position and its own circuit is broken at the off-normal springs 87 when the shaft reaches its lowest



position. The relay 50, upon deenergizing, also opens the holding circuit for the winding 13 and the relay 16 of the line switch C at the springs 54. The line switch C, upon becoming deenergized, allows the plunger arm 10 to return to normal position.

Heretofore in systems of this character, if the calling subscriber hung up his receiver and thus released a connection before the called subscriber hung up his receiver, then the circuit of the pull-in winding of the called subscriber's line switch would be closed and this switch operated to seize a trunk. As before stated, the object of my invention is to prevent a trunk being seized and occupied in this manner. This is accomplished as follows: Assuming that the calling subscriber has replaced his receiver upon the receiver hook, and that the called subscriber still has his receiver off the receiver hook. The connector switch, upon releasing, opens the circuits of the cut-off winding 67 and the slow acting relay 70 of the line switch C'. The cut-off winding 67, upon deenergizing, closes an energizing circuit through the line relay 80 of the said line switch, thus causing it to energize. The relay 70 being slow acting does not deenergize immediately when its circuit is broken, and consequently the circuit of the pull-in winding 81 is retained opened at the springs 82 as long as said relay is energized. The line relay 80, upon energizing, closes a holding circuit for the slow acting relay 70. The said circuit extends from ground G<sup>9</sup> through the contact of springs 83, 84 and 85, springs 86 and the relay 70 to the battery lead 100, thus retaining the relay 70 energized, which in turn retains the circuit of the pull-in winding 81 opened at the springs 82. The circuit of the pull-in winding being thus held open, the line switch C' is prevented from operating and thus occupying a trunk. If the called line had been busy when the connector attempted to make connection therewith, the busy signal would be sent back to the calling subscriber in the well-known manner. This, however, forms no part of my present invention and is well understood in the art, and a detailed description of the same is accordingly thought unnecessary.

While I have illustrated my invention in connection with one particular type of automatic system, it will, of course, be understood that it is capable of use with many other forms of systems and is equally as well adapted for use in connection with semi-automatic systems—that is, systems in which a manual link circuit is employed in combination with automatic means for establishing a connection between two subscribers' lines.

It will thus be seen that I have provided very efficient means for preventing the line

switch of the called line being unnecessarily operated to seize a trunk when the calling subscriber hangs up his receiver and releases the connection before the called subscriber has hung up his receiver.

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What I claim as my invention is:

1. In a telephone system, a subscriber's line, a line switch individual thereto, a line relay for said switch normally bridged across said line, a trip magnet controlled by said line relay, a bridge-cut-off relay, means for energizing said cut-off relay when connection is made with said line, means controlled thereby for opening the circuit of said line relay, a second relay adapted to be energized in multiple with said cut-off relay, and a normally closed contact in the circuit of said trip magnet controlled by said second relay.

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2. In a telephone system, a subscriber's line, a line switch individual thereto, a line relay for said switch normally bridged across said line, a trip magnet controlled by said line relay, a bridge-cut-off relay, means for energizing said cut-off relay when connection is made with said line, means controlled thereby for opening the circuit of said line relay, a second relay adapted to be energized in multiple with said cut-off relay, a normally closed contact in the circuit of said trip magnet controlled by said second relay, and a locking circuit for said second relay for maintaining it energized after the first energizing circuit is broken.

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3. In a telephone system, a calling and a called line, a line switch for each line including a line relay normally bridged across the line and a trip magnet controlled thereby, means for cutting off the line relay on the called line when connection is extended thereto, and means including a relay for preventing said trip magnet of the called line switch energizing when the connection is disconnected before the called subscriber hangs up his receiver.

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4. In a telephone system, a line, a circuit controller for said line, means for extending a connection to said line and for disconnecting therefrom, trunking equipment responsive over said line to said circuit controller for making a call from said line, means for rendering said trunking equipment non-responsive to said circuit controller and for maintaining it so after the connection is discontinued.

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5. In a telephone system, a calling line, a called line, means for connecting the two and means for releasing the connection, trunking equipment associated with the called line for enabling the called line to make a call, said equipment responsive to the closure of the circuit of the called line, means for rendering said equipment inoperative when the second line is called, and means for maintaining said equipment non-

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responsive to the closure of the circuit of the second line after the first line releases the connection.

6. In a telephone system, a line, automatic trunking equipment for extending a connection from said line, a relay for said line for controlling said equipment, a circuit for energizing said relay when a call is initiated, said equipment operated over said line when the line is closed, means in the line for closing said circuit, and means for rendering said equipment inoperative when the line is called and for maintaining it inoperative after the calling line releases.

7. In a telephone system, a calling line, a called line, a relay for the called line, trunking equipment controlled thereby for ex-

tending calls from the called line, means for connecting the said calling line to the said called line, means controlled thereby for rendering said relay inoperative when the connection is made to render said equipment inoperative, means for releasing the connection and for maintaining said equipment inoperative after the connection is released, whereby the equipment is rendered non responsive to said relay after the release.

Signed by me at Chicago, Cook county, Illinois, this 14th day of November, 1913.

WINFRED T. POWELL.

Witnesses:

G. A. YANOCBOWSKI,  
HARRY E. HERSHY.