B. D. WILLIS.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED MAY 2, 1914. RENEWED FEB. 23, 1918.

1,280,609.

Patented Oct. 1, 1918.

2 SHEETS—SHEET 1.

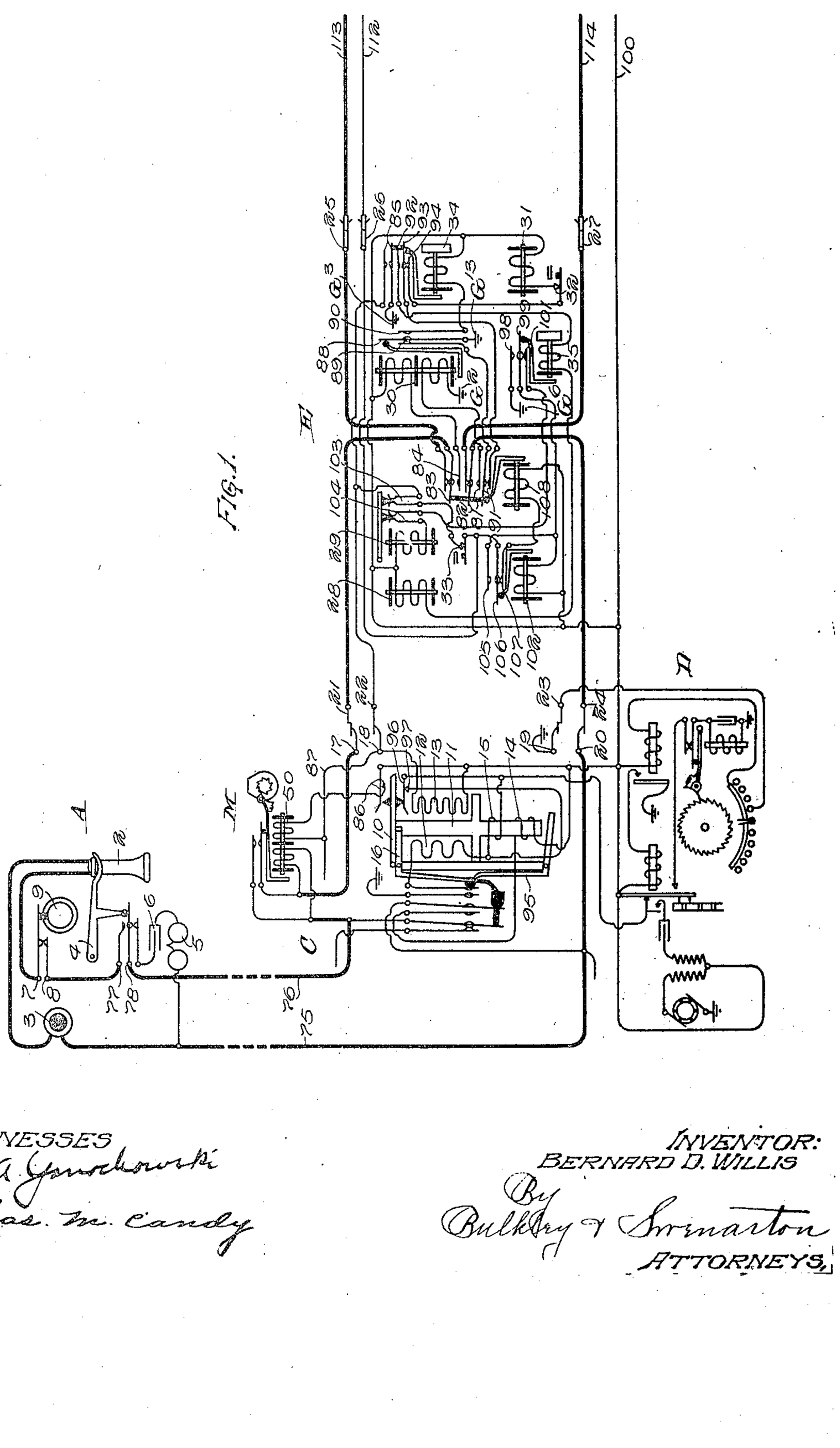

Fig. 1.

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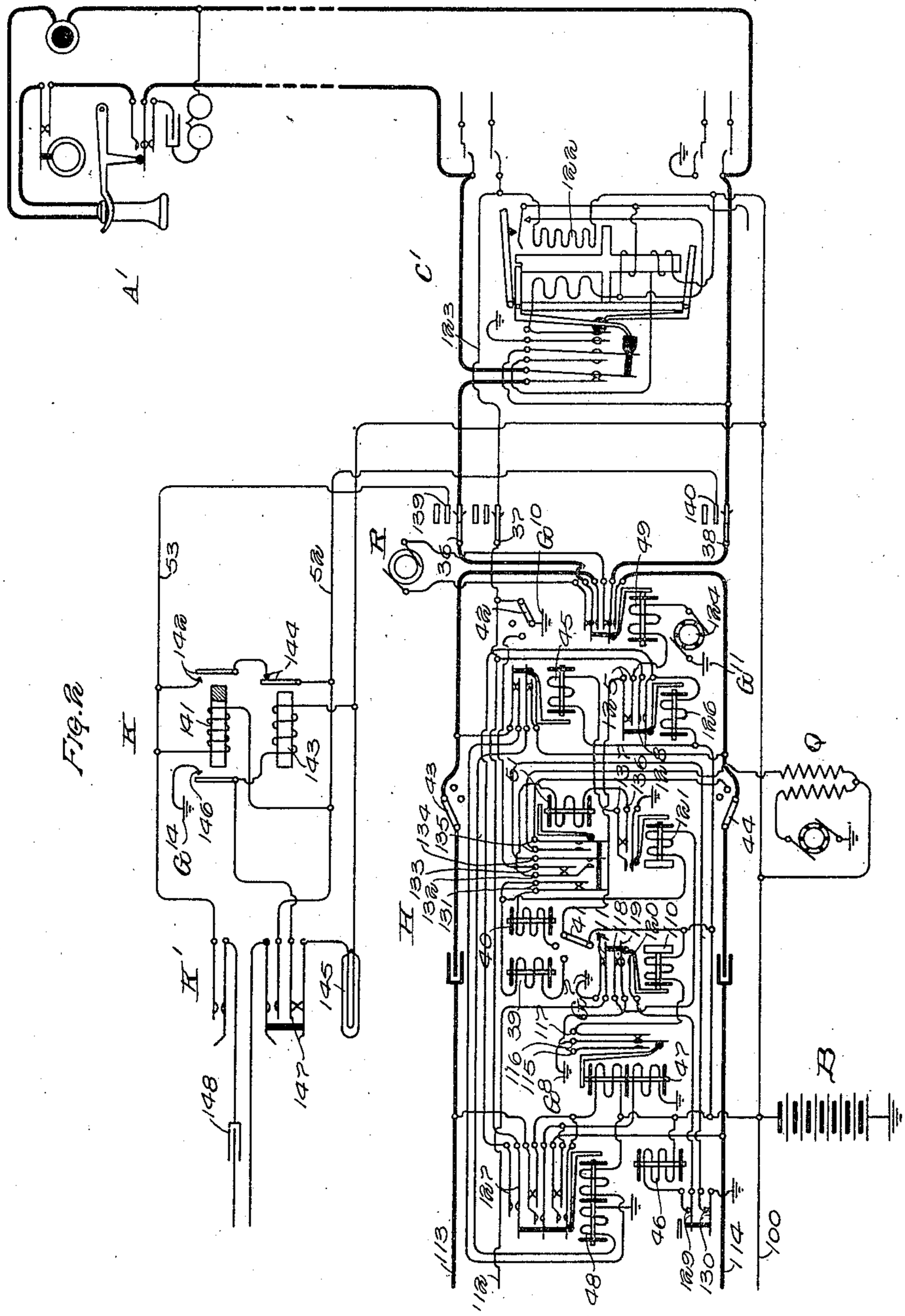
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

BERNARD D. WILLIS, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,280,609. Specification of Letters Patent. Patented Oct. 1, 1918.

Application filed May 2, 1914, Serial No. 835,817. Renewed February 23, 1918. Serial No. 218,898.

To all whom it may concern:

Be it known that I, BERNARD D. WILLIS, 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—that is, systems in which one or more switches are employed for establishing connection between subscribers' lines.

One of the features of my invention relates to the provision of a traffic trunk, from which the ringing current is disconnected without reversing the current on the calling line for a sufficient interval of time to cause the operation of the measured service device on that line.

This and other objects of my invention will be more clearly understood by reference to the accompanying drawings, in which I have illustrated my invention in connection with automatic switches of well-known types, together with a certain well-known form of manual apparatus. My invention is, however, equally as well adapted for use with other forms of automatic switches and cord circuits, and the present system is merely for the purpose of illustrating one specific embodiment of my invention.

In the drawings Figures 1 and 2 represent a local circuit connection between a calling substation A and a called substation A'. The connection is completed through the medium of the subscriber's individual switch C, the selector switch E, the connector switch H and the called subscriber's individual switch C' to the said called substation A'.

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 herein 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 subscriber's individual switch C is of the general type of subscriber's individual switch shown in British patent to R. W. James No. 26,301 of 1906, being, however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910. 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 magnet 11. The magnet 11 comprises four windings, namely a pull-down winding 12, a cut-off or holding winding 13, a line winding 14 and an auxiliary winding 15. The core of the magnet 11 is so constructed that the magnetic circuit of the windings 12 and 13 is separate from that of the windings 14 and 15. The winding 12 operates both the plunger arm 10 and the armature 16, while the winding 13 is only strong enough to operate the cut-off armature 16 and to hold the plunger arm 10 in its operated position. 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 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 such sets, each set forming the terminal of a trunk line leading to a selector switch E. Each trunk line is connected in multiple with the corresponding springs of all the line switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber through the medium of the line relay 14, as will be hereinafter more fully explained. Associated with the individual switch C is a meter M, which is controlled by a double-wound meter magnet 50. The windings of the magnet 50 are so proportioned that it requires the energization of both windings in the same direction to attract the armature, said armature being unaffected by the energization of the two windings in opposition to each other.

The master switch D is of the same general type as that disclosed in British Patent No. 26,301 of 1906, referred to above, being, however, of the particular type disclosed in said British Patent No. 1419 of 1910. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position to engage the terminal of an idle trunk line.

The first selector switch E is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, except that the so-called side switch is omitted and the circuits are modified to adapt the switch to operate in a system in which it is controlled by impulses delivered over two sides of the line in series, as shown in British Patent No. 10,376 of 1912, granted to T. G. Martin.

The connector switch H (Fig. 2) is of the same general type of connector switch as disclosed in United States Letters Patent No. 815,176, granted 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 over the two sides of the line in series. Like the selector, the connector is provided with a shaft (not shown) carrying the wipers 36, 37 and 38, which shaft is controlled by the vertical magnet 39 and the rotary magnet 40. The usual side switch comprising the wipers 41, 42, 43 and 44 is controlled by the private magnet 45 in the usual well-known manner. The magnet 46 is the usual release magnet. The line relay 47 is connected with the line through the reversing springs of a so-called bridge relay 48, through the windings of which latter relay the called line is provided with talking current. The ringing relay 49 is the means through which the ringing current is applied to the called line. At Q there is shown a busy signaling machine which provides a busy signal, said busy signal being applied to the calling line through the medium of the busy relay 51 in case the called line is in use.

In the event that a subscriber has his telephone removed or taken out of service for various reasons his line is disconnected from the central office apparatus and the contacts of the connector bank constituting the terminals of said subscriber's line are wired to what is known as a traffic trunk, as shown at K, comprising the trunk conductors 52 and 53. Therefore, upon the subscriber at substation A attempting to call a subscriber whose telephone has been removed and the connector bank normals connected to the said traffic trunk, he will signal an operator who will give him the necessary information. Bridged across this trunk is a slow acting relay 141 which controls the circuit of a second relay 143. These relays cooperate in a manner to be hereinafter more fully described to cut off the ringing current from the line without causing the operation of the meter on the calling line, as it is not desirable that such a call be charged to the calling substation.

The substation shown at A′ and the line switch C′ are similar in all respects to the substation A and the line switch C except that the individual switch C′ is not shown equipped with a meter M.

For the purpose of supplying current for operating the central office apparatus and for talking purposes there is shown in the drawings a battery B having one terminal grounded at G.

A general description of the apparatus having been given, it will now be explained how connection is extended from the calling substation A to the called substation A′, the number of which latter will be assumed to be 220. Since the automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications hereinabove referred to, its operation will be explained in a more or less general manner. Upon the removal of the receiver from the switchhook at the substation A preparatory to making a call, the talking circuit of the substation is bridged across the line conductors 75 and 76, whereby the circuit of the line relay 14 of the line switch C is closed, thereby attracting the line armature 95. The armature 95, upon being attracted, closes a circuit through the pull-down coil 12 in series with the auxiliary winding 15. The pull-down coil, upon energizing, attracts the plunger arm 10 to force the plunger into the bank of contacts 17 to 24, inclusive. It also operates the cut-off armature 16, thereby disconnecting the line winding 14 from the line. The armature 95 does not fall back immediately, however, owing to the fact that the winding 15 is still in series with the pull-down coil 12. Upon the plunger arm 10 being attracted, the springs 96 and 97 are brought together to short-circuit the auxiliary winding 15, making the same slightly slow acting. The armature 95 being slow to fall back allows sufficient time for a holding circuit to be closed in the switch ahead for the cut-off or holding winding 13. The engagement of the springs 17 and 20 with the springs 21 and 24, respectively, extends the subscribers' lines to the line relay 30 of the selector E. The line relay 30 of the selector E is thereupon energized over a circuit extending from ground G^2 through the lower winding of said relay, contact of springs 81 and 82, bank springs 24 and 20, thence over the heavy conductor 75 to and through the substation A, back over the other side of the line through the left-hand winding of the meter magnet 50, bank springs 17 and 21, springs 83 and 84 and the upper winding of the relay 30 to battery B. The relay 30, upon energizing, closes the circuit of the slow acting relay 34, which in turn, upon energizing, closes a circuit extending from ground G^3 through the contact of springs 85, bank springs 22 and 18 and the holding

winding 13 to battery B. The energization of the winding 13 serves to hold the switch C in its operative position after the circuit of the winding 12 is broken by the relay 14, which deënergizes shortly after it is disconnected from the line. The energization of the relay 34 also completes a circuit extending from ground G^3 through the contact of springs 85, bank springs 22 and 18, through the right-hand winding of the meter magnet 50 and springs 86 to battery B. The current in this winding is in opposition to the current flowing through the line winding and the magnet is therefore not operated at this time. Upon the operation of the switch C the connector private bank contacts of the calling line are provided with a guarding potential extending from ground G^3 through the contacts of springs 85, bank springs 22 and 18 and the conductor 87 to the said private bank contacts. Upon the closure of the springs 19 and 23 by the operation of the switch C the master switch D operates in a well-known manner to advance the plungers of the idle line switches to a position opposite an idle trunk line.

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 separated twice momentarily, each time breaking the circuit of the selector line relay 30. The selector thereupon operates in the well-known manner, and as described in the patents referred to, to step the wipers up to the second level and to then cause them to rotate automatically to find an idle trunk, which we will assume is the one extending to the connector H (Fig. 2.) The line relay 47 of the connector thereupon becomes energized and closes the circuit of the relay 110, which in turn, upon energizing, completes a holding circuit extending from ground G^7 through the contact of springs 111, conductor 112 and the wiper 26 of the selector E to the spring 106. Here the circuit divides, one branch extending through the springs 106 and 107 and the relay 108 to battery, the other branch extending through the springs 33, springs 103, bank springs 22 and 18, through the holding winding 13 of the line switch C and the right-hand winding of the meter magnet 50 to battery B. The relay 110 of the connector H also maintains a guarding ground potential upon the private bank contacts of the trunk line in the banks of the first selector switches E which have access thereto.

When the substation calling device is operated for the second digit 2, the circuit of the connector line relay 47 is broken twice. Since the relay 110 is slow acting it does not deënergize during the momentary interruptions of its circuit by the relay 47, so that each time the latter relay is deënergized, a circuit is closed extending from ground G^8 through the springs 116 and 115, springs 119 and 118, relay 121, vertical magnet 39 and the side switch wiper 41 (in first position) to battery B. The vertical magnet 39 receives impulses over this circuit and operates to raise the switch shaft wipers 36, 37 and 38 to a position opposite the second level of bank contacts. The relay 121, which is included in series with the vertical magnet, remains in its energized position during the entire time that impulses are being transmitted through it and operates to close the circuit of the private magnet 45. After the last impulse is delivered, the relay 121 opens the circuit of the private magnet, which, upon deënergizing, permits the side switch to advance from first to second position. The movement of the switch wiper 41 from first to second position transfers the battery connection from the vertical magnet 39 to the rotary magnet 40. The calling subscriber now operates his calling device for the last digit 0, in response to which the connector line relay 47 operates to transmit ten impulses through the rotary magnet 40 in series with the relay 121, whereby the shaft wipers are rotated over the contacts of the desired line. The relay 121 operates in response to this operation in the same manner as for the previous digit to cause the private magnet 45 to advance the side switch one more position—that is, from second to third position—after the last impulse for the digit is transmitted. By the engagement of the side switch wipers 43 and 44 with their third-position contact points, and by the energization of the bridge-cut-off winding 122 of the line switch C′, the line connection is finally completed with the called substation, as shown by the heavy conductors. The circuit for the bridge-cut-off winding 122 extends from ground G^{10} through the side switch wiper 42 (in third position), wiper 37, conductor 123 and the said bridge-cut-off winding to battery B. The connection of ground G^{10} with the connector private bank contacts of the called line over the circuit just traced provides the said contacts with a guarding potential to prevent the busy line from being seized by some other connector switch. By the engagement of the side switch wiper 41 with its third position contact point the circuit of the ringing relay 49 is closed. This circuit extends from ground G^{11} through the interrupter 124, relay 49, springs 125 and the said side switch wiper to battery B. The ringing relay 49, upon energizing, 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 ringing relay is energized only intermittently through the medium of the interrupter 124. Upon the response of the called subscriber his line is provided with talking

current through the windings of the back-bridge relay 48 of the connector switch, which relay, upon energizing, closes the circuit of the ringing cut-off relay 126. The said circuit extends from ground G^{10} through the side switch wiper 42, springs 127 and the relay 126 to battery B. The relay 126, upon energizing, interrupts the circuit of the ringing relay 49 at the springs 125 and closes a locking circuit for itself through the springs 128 independent of the springs 127. A further result of the energization of the relay 48 upon the response of the called subscriber is the transposition of the connections between the windings of the line relay 47 and the trunk conductors 113 and 114, whereby the direction of current in the calling line is reversed. This reversal of the current in the left-hand winding of the subscriber's meter relay 50 causes the two windings to assist one another and the armature is thereby attracted to operate the meter to register the call.

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 77 and 78 destroys the energizing circuit of the connector line relay 47. The relay 47 thereupon deënergizes and opens the circuit of the relay 110. The relay 110, upon deënergizing, opens the holding circuits of the relays 13 and 108 of the line switch C and the selector E, respectively, at the springs 111 and closes the circuit of the connector release magnet 46. The latter circuit extends from ground G^{8} through the contacts of the springs 116 and 115, springs 119 and 120, off-normal springs 129 and the release magnet 46 to battery B. The magnet 46, upon energizing, restores the connector side switch and switch shaft to normal position and its own circuit is interrupted at the springs 129 when the shaft reaches its lowest position. The deënergization of the relay 108 of the selector E closes a circuit through its release magnet 31 at the springs 91. This circuit extends from ground G^{13} through the springs 88 and 89, springs 91, springs 93 and 94, springs 32 and the magnet 31 to battery B. The magnet 31, upon energizing, restores the selector to normal and its own circuit is broken at the springs 32 when the switch shaft reaches its lowest position. The deënergization of the winding 13 of the line switch C permits the plunger arm 10 to return to normal position.

If the called line is busy there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. The connector private wiper, upon engaging this guarding contact, and before the side switch wipers have passed to third position, completes an energizing circuit through the busy relay 51 and the private magnet 45 in series. This circuit extends from ground at the private wiper through the side switch wiper 42 (in second position), springs 133 and 132, relay 51, springs 136 and 137 and the magnet 45 to battery B. The magnet 45 thus stays energized and holds the side switch in second position and disconnects the back-bridge relay 48 from the line wipers. The relay 51, upon energizing, opens the circuit of the rotary magnet 39 to prevent further rotation and closes a locking circuit for itself and the magnet 45 through the springs 132 and 134 independent of the ground at the private wiper. The engagement of the springs 135 serves to close a circuit for the busy tone, which circuit extends from the busy machine Q through said springs, side switch wiper 44 (in second position), over the conductor 114 to and through the substation A, return conductor 113 and the upper winding of the relay 47 to battery B. The calling subscriber, upon receiving the busy signal, hangs his receiver upon the switch-hook, thereby releasing the connection in the manner above described.

Whenever a telephone is removed from service, or is temporarily disconnected for any reason, the lines leading to the central exchange are disconnected and the connector bank contacts are connected to the conductors 52 and 53 in the same manner that the connector bank contacts 139 and 140 are shown in Fig. 2. The conductors 52 and 53 terminate in a group of relays K situated at an information desk or manual operator's board. It will now be explained how the substation A, in attempting to call a substation (not shown), will effect connection with the operator at the said manual board and receive the necessary information without having the call registered upon his meter M. As soon as the calling substation has caused the line wipers 36 and 38 of the connector H to make contact with the bank contacts 139 and 140, the relay 141, which is bridged across the conductors 52 and 53, will immediately energize, or as soon after as the ringing relay 49 deënergizes. The relay 141 is of high resistance and does not permit sufficient current to flow through its winding for the back-bridge relay 48 to operatively energize. Also, the said relay 141 will not energize when the ringing relay 49 is energized, as the said relay is not responsive to ringing current. The relay 141, upon energizing, closes a short-circuit across the conductors 52 and 53 at the springs 142 and at the same time closes a circuit through the relay 143, which, upon energizing, removes the short-circuit across said conductors at the springs 144 an instant later. A further

result of the energizing of the relay 141 is to close a circuit through the signal lamp 145. This circuit extends from ground G^{14} through the contact of springs 146, springs 147 and the lamp 145 to battery B. The short-circuiting of the conductors 52 and 53 for an instant causes the back-bridge relay 48 to energize for an instant and cut off the ringing current, as hereinbefore described, but it is not held energized long enough to allow the meter M to be operatively energized. The operator, noticing the lamp 145 glowing, immediately operates the key K′, bridging her head set through the condenser 148 across the said conductors and causing the lamp 145 to cease glowing. The calling subscriber, after receiving the necessary information, replaces his receiver upon the receiver hook and causes the switches to release in a manner hereinbefore described.

In connection with the traffic trunk, it will be seen that I provide very efficient means for disconnecting the ringing current from this trunk without causing the operation of the meter on the calling line.

While I have thus illustrated and described my invention in connection with one particular type of automatic system and in connection with automatic switches and manual apparatus of a particular character, it will, of course, be understood that I do not wish to be limited to the exact construction shown and described, but that various changes and modifications will readily suggest themselves to those skilled in the art and come within the spirit of my invention.

What I claim as my invention is:—

1. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a measured service device associated with said subscriber's line, a device in said connector for preventing the operation of said equipment, said devices having different time constants, a relay in said connector for operating said devices, a normally open bridge across said trunk, a pair of relays, one for closing said bridge and the other for opening said bridge, and means for operating the relays of said pair in rapid succession upon the connection with said trunk by said connector, whereby a circuit is closed momentarily for the relay in said connector to operate one of said devices without operating the other.

2. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a measured service device associated with said subscriber's line, a device in said connector for preventing the operation of said equipment, said devices having different time constants, a relay in said connector for operating said devices, a high resistance relay in bridge of said trunk line and adapted to be connected in series with the said first relay upon the seizure of the trunk line by said connector, said first relay remaining inoperative, means controlled by said second relay for closing a low resistance bridge across said trunk line to operate said first relay, and means for opening said low resistance bridge to deënergize said first relay before the slower of said devices has operated.

3. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a measured service device associated with said subscriber's line, a device in said connector for preventing the operation of said equipment, said devices having different time constants, a relay in said connector for operating said devices, a high resistance relay in bridge of said trunk line and adapted to be connected in series with the said first relay upon the seizure of the trunk line by said connector, said first relay remaining inoperative, means controlled by said second relay for closing a low resistance bridge across said trunk line to operate said first relay to operate one of said devices, and means for opening said low resistance bridge to deënergize said first relay before the other of said devices has operated.

4. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a measured service device associated with said subscriber's line, a device in said connector for preventing the operation of said equipment, said devices having different time constants, a relay in said connector for operating said devices, a high resistance relay in bridge of said trunk line and adapted to be connected in series with the said first relay upon the seizure of the trunk line by said connector, said first relay remaining inoperative, means controlled by said second relay for closing a low resistance bridge across said trunk line to operate said first relay to operate one of said devices, and a relay controlled by said high resistance relay for opening said low resistance bridge to deënergize said first relay before the other of said devices has operated.

5. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a meter associated with said subscriber's line, a relay in said connector for preventing the operation of said equipment, said relay operat-

ing more rapidly than said meter, a second relay in said connector for operating said meter and for initiating the operation of said first relay, a normally open bridge across said trunk, a pair of relays, one for closing said bridge and the other for opening said bridge, and means for operating the relays of said pair in rapid succession upon the connection with said trunk line by said connector, whereby a circuit is closed momentarily for the said second relay without operating said meter.

6. In a telephone system, a subscriber's line, a trunk line, a connector switch accessible to said line for connecting with said trunk line, automatic ringing equipment in said connector switch, a meter associated with said subscriber's line, a relay in said connector for preventing the operation of said equipment, said relay operating more rapidly than said meter, a second relay in said connector for operating said meter and for initiating the operation of said first relay, a high resistance relay in bridge of said trunk line and adapted to be connected in series with the said second relay when said lines are connected by said connector, said second relay remaining inoperative, means controlled by said high resistance relay for closing a low resistance bridge across said trunk line to operate said second relay, and means for immediately opening said low resistance bridge to deënergize said second relay, whereby said first relay may be operated without actuating said meter.

7. In a telephone system, the combination with a calling subscriber's line and a measured service device associated therewith, of a trunk line leading to an operator's position, a link circuit for connecting said line and trunk line, automatic ringing equipment associated with said link circuit, a relay associated with said link for preventing the operation of said ringing equipment, a second relay associated with said link for operating said device and for initiating the operation of said first relay, said first relay adjusted to operate more quickly than said device, a normally open bridge across said trunk, a pair of relays, one for closing said bridge and the other for opening said bridge, and means for operating the relays of said pair in rapid succession upon the connection of said link circuit to said trunk line, whereby a circuit is closed momentarily for the said second relay to operate said first relay without operating said device.

8. In a telephone system, the combination with a calling subscriber's line and a measured service device associated therewith, of a trunk line to an operator's position, a link circuit for connecting said line and trunk line, automatic ringing equipment associated with said link circuit, a relay associated with said link for preventing the operation of said ringing equipment, a second relay associated with said link for operating said device and for initiating the operation of said first relay, said first relay adjusted to operate more quickly than said device, a high resistance relay in bridge of said trunk line and adapted to be connected in series with the said second relay when said lines are connected by said link circuit, said second relay remaining inoperative, means controlled by said high resistance relay for closing a low resistance bridge across said trunk line to operate said second relay, and means for immediately opening said low resistance bridge to deënergize said second relay, whereby said first relay may be operated without actuating said device.

9. In a telephone system, the combination with a subscriber's line and a measured service device associated therewith, of a trunk line, a connector switch, means for operating said switch over said line to connect with said trunk line, a source of ringing current, a relay in said connector for applying said source to said trunk line when connection is established therewith, a second relay in said connector for preventing the operation of said first relay, a third relay in said connector for operating said device and for initiating the operation of said second relay, means in said trunk for closing a bridge across the same to operate said third relay and for then opening said bridge at a different point to deënergize said third relay before said device has operated.

Signed by me at Chicago, Cook county, Illinois, this 27th day of April, 1914.

BERNARD D. WILLIS.

Witnesses:
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CHAS. M. CANDY.