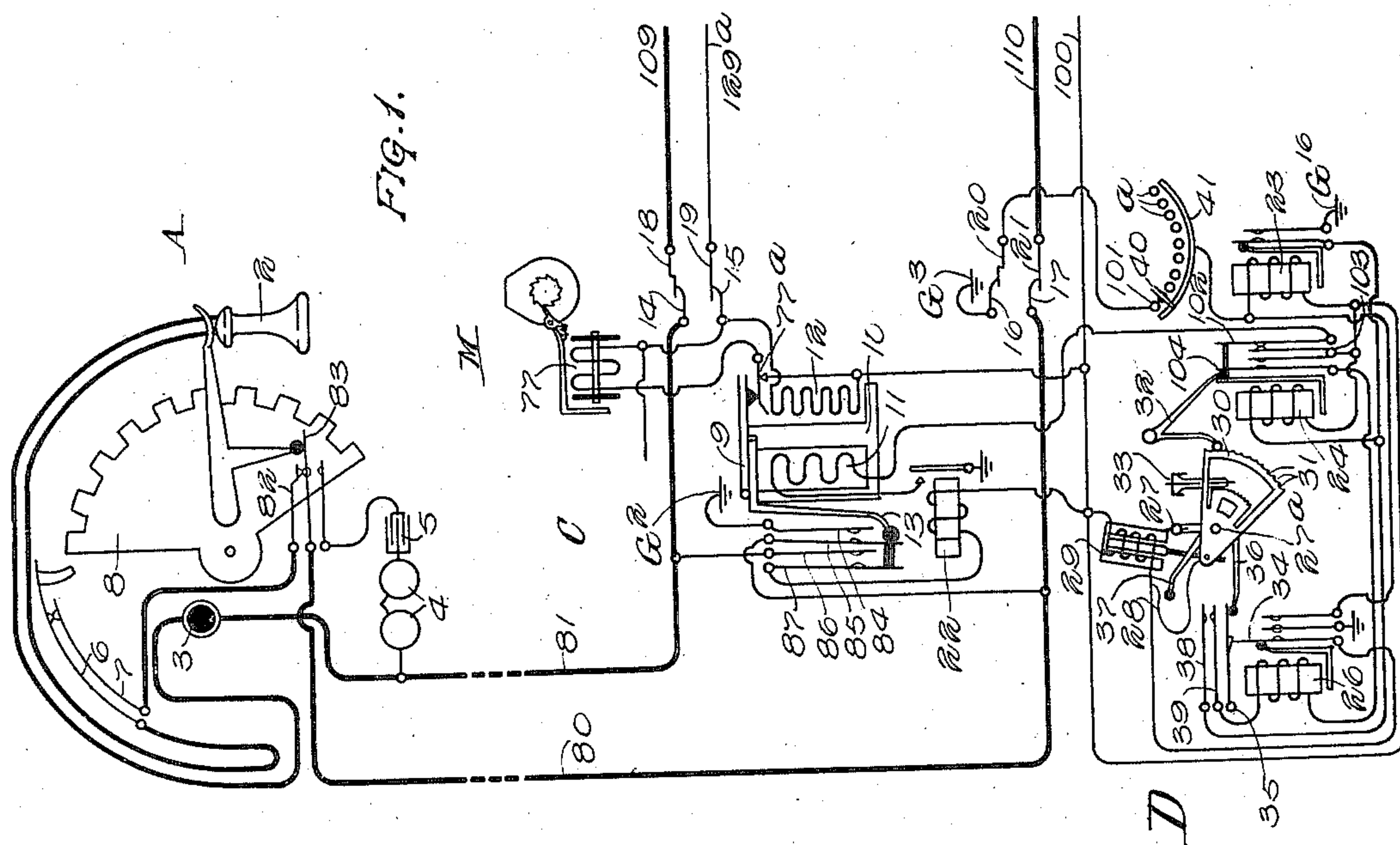


1,186,823.

F. NEWFORTH, JR.
MEASURED SERVICE TELEPHONE SYSTEM.
APPLICATION FILED AUG. 25, 1913.

Patented June 13, 1916.
2 SHEETS—SHEET 1.



WITNESSES

Albert Andersen.
W. E. Hershey.

INVENTOR:

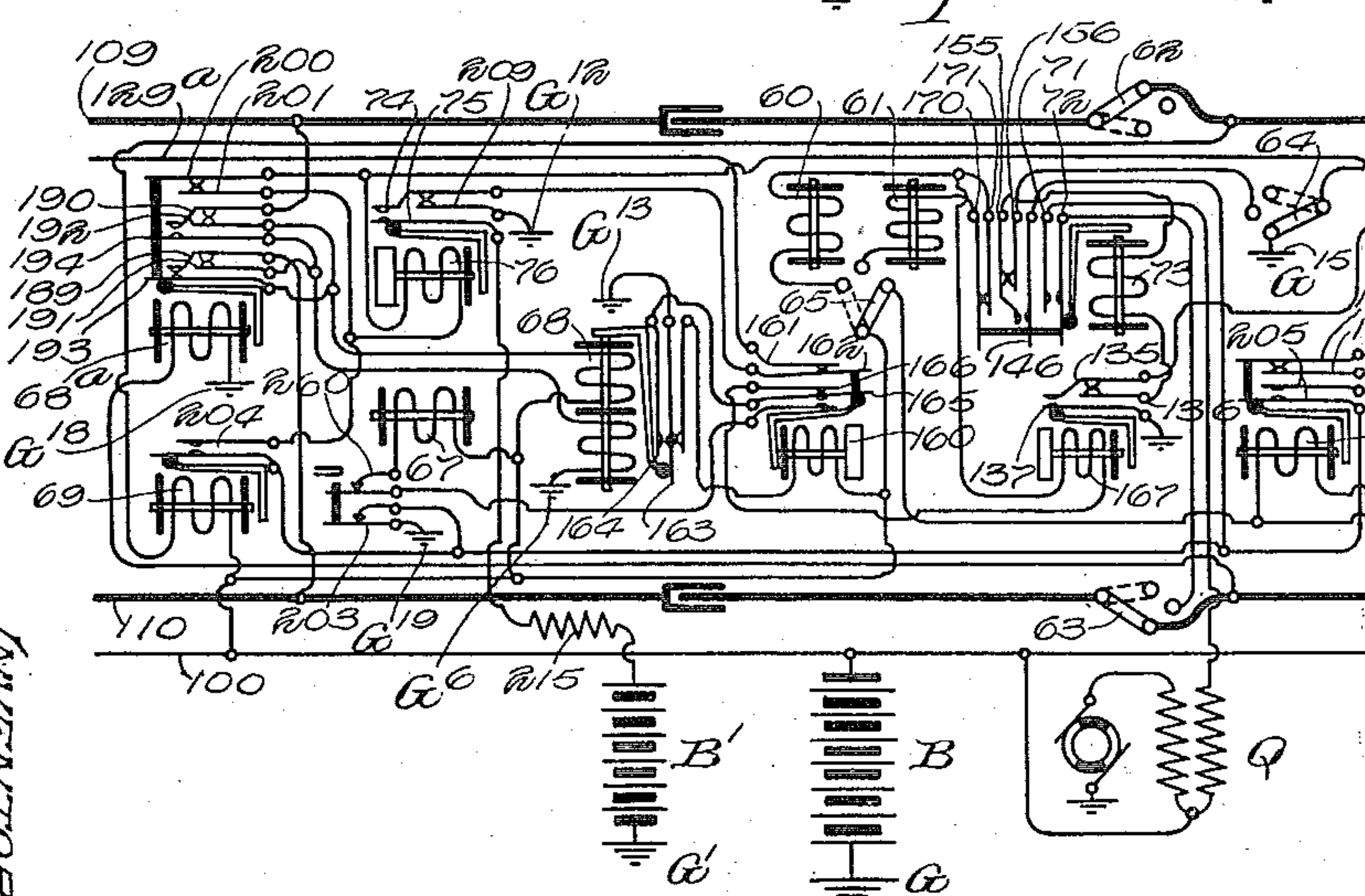
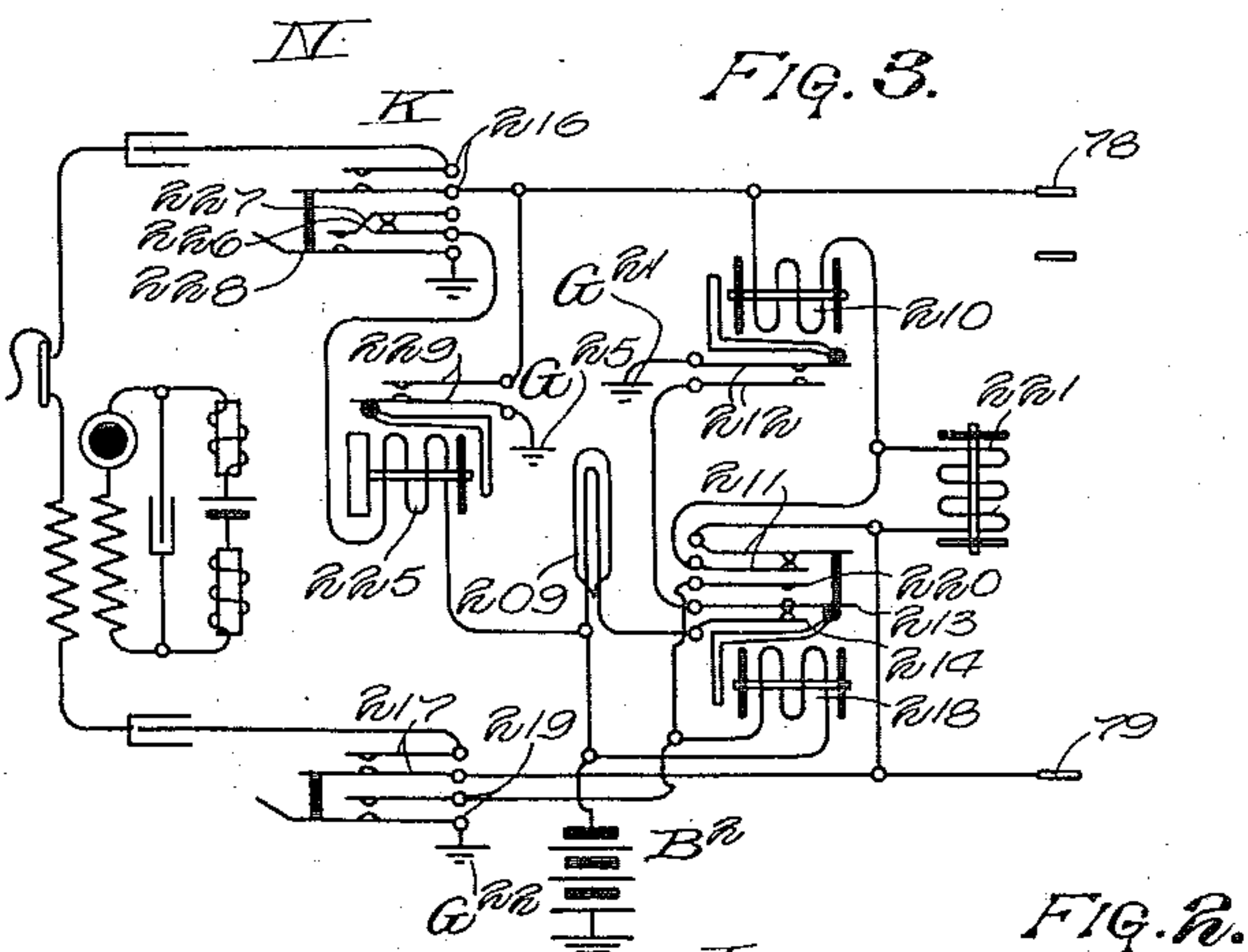
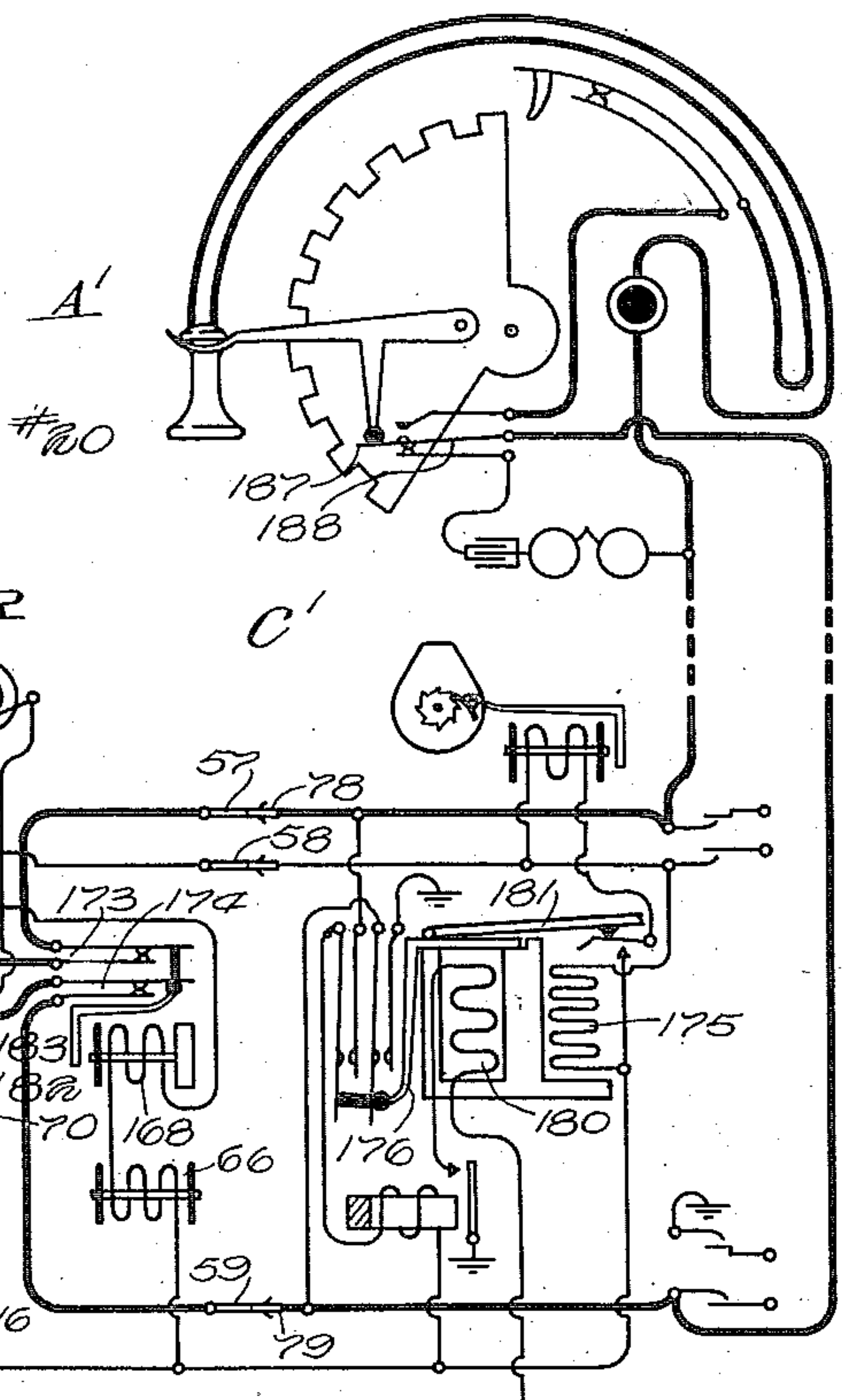
Frank Newforth Jr.
By Bulkeley Swarata
ATTORNEYS.

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WITNESSES
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UNITED STATES PATENT OFFICE.

FRANK NEWFORTH, JR., OF LIVERPOOL, ENGLAND, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

MEASURED-SERVICE TELEPHONE SYSTEM.

1,186,823.

Specification of Letters Patent. Patented June 13, 1916.

Application filed August 25, 1913. Serial No. 786,493.

To all whom it may concern:

Be it known that I, FRANK NEWFORTH, Jr., a citizen of the United States of America, and resident of Liverpool, England, have
5 invented certain new and useful Improvements in Measured-Service Telephone Systems, of which the following is a specification.

My invention relates to measured service
10 telephone systems, and more particularly to systems in which each subscriber's line is provided with a service meter located at the central office.

The object of my invention is to provide
15 such a meter which is operated over the release trunk, and to provide means for preventing the meter from being operated more than once for each call, and to also provide means whereby the meter will not register
20 when connection is made with an operator's set.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which I
25 have illustrated my invention in connection with an automatic telephone system of a particular type, although it will, of course, be understood that my invention is not limited to such a system.

In the drawings Figures 1 and 2 represent
30 a complete connection between a calling telephone at the substation A and a called telephone at the substation A' in a system embodying the principles of my invention.
35 Fig. 3 shows a traffic trunk leading to an operator's talking set comprising the necessary relays and signal.

In Figs. 1 and 2 I have shown the line
40 switch extending connection directly to the connector switch. These connector switches ordinarily have access to but one hundred lines, but if the exchange is of larger size it is merely necessary to insert first, second or
45 third selectors between the subscribers' individual switches and the connectors, in a manner well-known and understood in the art. My improvements are contained solely in the subscriber's individual switch and the connector switch, and accordingly to simplify the disclosure I have merely illustrated
50 these two switches. The automatic substa-

tion A (Fig. 1) comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. Being an automatic substation, it is also provided with a suitable call-sending mechanism for controlling the automatic switches, which mechanism is represented diagrammatically by a pair of impulse springs 6 and 7 and an impulse wheel 8, which latter may be controlled in a well-known manner by a
60 dial provided with finger holes in such a way that the impulse springs may be momentarily separated a number of times corresponding to the respective digits of the number of the called subscriber.

The subscriber's individual switch C is of
65 the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, more closely resembling, however, the particular type shown in British patent
70 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 9 which is controlled by a magnet 10, which magnet comprises
75 an operating winding 11 and a holding winding 12. This magnet also controls the cut-off armature 13. The winding 11 operates both the plunger arm 9 and the armature 13, while the winding 12 is strong enough to
80 operate only the armature 13 and to hold the plunger arm 9 in its operated position. When the plunger arm 9 is operated, its plunger is forced into a bank of contact springs, forcing the springs 14, 15, 16 and
85 17 into contact with the springs 18, 19, 20 and 21, respectively. Although only one set of springs (14 to 21) is shown, each line switch is provided with a plurality of such sets, each set forming the terminal of a
90 trunk line leading to a connector switch I. 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
95 C is controlled by the subscriber through the medium of the line relay 22, which relay is preferably slow acting—that is, slow to release its armature upon deenergizing. A metering device is shown at M for the purpose of registering the calls that are completed and answered by the called party.
100

The master switch D comprises a starting relay 23, a locking magnet 24 and a restoring relay 26. The usual plunger guide shaft 27, through the medium of which the master switch controls the plungers, is connected with a rotary shaft 27^a in such a manner that, as said shaft is rotated back and forth, the plunger guide shaft 27 is oscillated about said shaft 27^a as an axis. The shaft 27^a is adapted to be rotated in one direction by a spring 28 and in the other direction against the tension of said spring by a solenoid 29. Secured to the shaft 27^a is a cam member 30 provided along its outer edge with notches 31, one for each trunk line to which the line switches have access. The shaft 27^a is normally locked against rotation in either direction by the engagement of the lever 32 with one of the notches 31. The lever 32 is controlled by the armature of the relay 24 in such a manner that when said relay is energized the lever is withdrawn from the cam 30 so as to unlock the shaft 27^a. The speed of rotation of the shaft 27^a and the plunger guide shaft 27 is regulated by means of a suitable governor 33. The spring 34 of the relay 26 is locked in its operated position by the engagement of the spring 34 with the detent on the under side of the spring 35. The springs are unlocked by the arm 36 when the shaft 27^a has reached the limit of its travel in one direction. When the shaft 27^a reaches the limit of its travel in the other direction, the arm 37 forces the spring 38 into engagement with the spring 39. The master switch D is also provided with a bank of contacts *a*, one for each trunk line. A wiper 40 keeps the common segment 41 in electrical connection with the individual contact *a* corresponding to the trunk line before which the idle plungers are resting. In general, the operation of the master switch is as follows: Whenever a trunk line is seized by a line switch, the relay 24 is energized to unlock the shaft 27^a, the spring 28 thereupon rotating the shaft 27^a to cause the plunger guide shaft 27 to move the idle plungers away from the trunk just seized and to an idle trunk line. When an idle trunk is reached, the relay 24 deenergizes and again locks the shaft. When the plungers reach the last trunk, the arm 37 forces the springs 38 and 39 together, so that when this trunk is seized, the circuit of the relay 26 may be closed. The relay 26 energizes and its springs become locked in their operated positions, thereby closing the circuit of the solenoid 29, which rotates the shaft 27^a back in the opposite direction to bring all the plungers which are in engagement with the plunger guide shaft back to a position opposite the first trunk line and to restore tension to the spring 28. When the plungers reach their starting positions, the arm 36 unlocks the spring of the relay

26, which permits the solenoid to deenergize and the plungers come to rest.

The connector switch I (Fig. 2) is of the same type of connector switch 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 delivered over the two sides of the line in series. The connector is provided with a switch shaft carrying the wipers 57, 58 and 59 controlled by the vertical and rotary magnets 60 and 61. The usual side switch comprising the wipers 62, 63, 64 and 65 is controlled by the private magnet 66 in a well-known manner. The magnet 67 is the usual release magnet and the line relay 68 is connected to the line through the reversing springs of the battery-reversing relay 68^a, through the winding of which, together with the winding of the relay 69, the called line is supplied with talking current. The ringer relay 70 is the means by which the application of ringing current to the called line is controlled.

At Q there is shown a busy signaling machine which is connected through the contact of springs of the relay 73 with the second-position contact of the side switch wiper 63, the function of which machine is to send back a busy tone to the calling subscriber should the line he is calling prove to be busy. For the purpose of supplying battery current for operating the central office apparatus, there is provided a battery B having one pole grounded at G. A second battery B' is also provided and it will be seen that it has the opposite pole grounded to that of the battery B. The function of this battery B' is to be instrumental in operating the meter M (Fig. 1) upon the operation of the springs 74 and 75 of the relay 76, whereby said battery B' is placed in series with the battery B. The meter magnet 77, unlike the usual meter magnet, has but one winding and is operated by an impulse transmitted over the release trunk.

In the event of a subscriber having his telephone removed or taken out of service for nonpayment, or for numerous other reasons, his line, or rather the line that was formerly his, is disconnected from the central office apparatus and the contacts of the connector bank constituting the terminals of said subscriber's line are temporarily wired to what is known as a traffic trunk, said trunk and contact being shown in Fig. 3. Therefore, upon a subscriber attempting to call a subscriber whose telephone instrument has been taken out of service, he will signal the operator at the exchange, who will give him the necessary information. It is not desirable that such a call as this be charged to the calling subscriber. In a sys-

tem of this kind the call is generally registered upon the called subscriber taking his receiver off the switch-hook by the so-called back-bridge relay energizing. Arrangements are therefore made necessary whereby the operator, upon operating her key K to respond to the signal given by a subscriber calling the subscriber whose line has been disconnected, will not operate the meter magnet 77 (Fig. 1).

A general description of the central office apparatus having been given, it will now be explained how connection can be made between a calling substation A and a called substation A'. We will assume the number of the called subscriber to be 20. Since the automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications herein referred to, its operations will be explained in a more or less general manner. Upon the removal of the receiver from the switch-hook at the substation A, the talking circuit of the substation is bridged across the line conductors 80 and 81 by the hook-switch springs 82 and 83, whereby the circuit of the line relay 22 of the switch C is closed. This circuit extends from ground G^2 through the springs 84 and 85, substation A, springs 86 and 87, relay 22 and through battery B to ground G. The relay 22, upon energizing, closes the circuit of the operating winding 11, which energizes and disconnects the relay 22 from the line and thrusts the plunger into the bank terminals of the trunk before which it is being held by the master switch. Upon the springs 14 and 18, and 17 and 21 being pressed together, the line connection is extended to the connector switch I, thereby energizing the line relay 68, the circuit being traced from ground G^6 through the lower winding of the relay 68, springs 191 and 189, conductor 110, bank springs 21 and 17, through the telephone at substation A, back over the conductor 81, springs 14 and 18, conductor 109, springs 190 and 192 and through the upper winding of the relay 68 to battery B. After the relay 22 deenergizes, the switch C is maintained in its operated position over a holding circuit closed to ground at the relay 76 of the connector I. This ground is connected to the release trunk 129^a through the springs 161 and 162 of the slow-acting relay 160, which is energized as a result of the energization of the line relay 68. The circuit is as follows: from ground G^{12} through the contact of springs 209 and 74, springs 162 and 161, conductor 129^a, bank springs 19 and 15 of the line switch C, thence through the coil 12 in multiple with the meter magnet 77 and the contact 77^a to the battery lead 100, thence through battery B to ground G (Fig. 2). This circuit through the coil 12 serves to maintain the switch C in its operated position

after the relay 22 at the switch C has deenergized.

Although the meter magnet 77 receives current from battery B over the circuit above traced, it is not operatively energized, because it is so wound and adjusted as not to be operated by the battery B alone. When the springs 16 and 20 are pressed together by the operation of the switch C, a circuit is closed from ground G^3 through said springs, contact point 101, wiper 40, common segment 41 and the relay 23 to the battery lead 100. The relay 23, upon energizing, completes an energizing circuit for the relay 24, which operates to open the springs 102 and 103 and to close the springs 103 and 104. The opening of the springs 102 and 103 disconnects the operating windings of all the switches of the group to which the switch C belongs from the battery lead 100. The closure of the springs 103 and 104 is without any particular function at this time. The relay 24, upon energizing, also operates to withdraw the locking arm 32 from the cam 30, thereby releasing the shaft 27^a and permitting it to be rotated by the spring 28 to cause the plungers of the idle line switches to be moved away from the trunk line seized by the switch C. When the plungers have been moved away from this trunk line, the wiper 41 passes off the contact, and should the next trunk line be idle, the relay 24 deenergizes and permits the arm 32 to drop into the next notch in the cam 30, thereby bringing the shaft to rest with the plungers standing opposite the next trunk line. However, should the next trunk be busy, the relay 23 remains energized until the next notch in the cam 30 is passed. When the plungers of a line switch are carried to the last trunk line terminal, the arm 37 presses the springs 38 and 39 into contact, thereby closing the circuit of the relay 26 as soon as the last trunk is put in use. This circuit extends from ground G^{10} through the contact of the springs of the relay 23, springs 38 and 39, relay 26 and springs 104 and 103 to battery B. The relay 26, upon energizing, closes the circuit of the solenoid 29, which, upon energizing, operates to restore the plunger shaft and plungers back to their starting positions. When the relay 26 is energized, its springs become locked in their operated positions by the spring 35. When the plunger shaft reaches its starting position, the arm 36 unlocks the springs of the relay 26, thereby permitting the solenoid to deenergize. It will thus be seen that the plunger shaft is caused to complete its entire movement once, thereby causing all the idle plungers which it controls to become locked in engagement therewith.

It will be remembered that by the operation of the switch C the line connection has

been extended through to the connector I and the line relay 68 is energized, together with the slow-acting relay 160, which latter operates its springs 161 and 162 to connect
 5 ground G^{12} with the release trunk. Also, the springs 165 and 166 are operated to prepare a circuit for the vertical magnet 60. The subscriber now operates his dial for the first digit 2, whereby the springs 6
 10 and 7 at the calling device are momentarily separated twice, breaking the circuit of the line relay 68 a corresponding number of times. Upon the armature falling back twice, two impulses are sent through the
 15 vertical magnet to raise the switch shaft two steps opposite the row or level of contacts in which the line terminals leading to the subscriber's telephone are situated. This circuit is traced as follows: from
 20 ground G^{13} , contact of the springs 163 and 164, and 165 and 166, through the private control relay 167, vertical magnet 60 and the side switch wiper 65 to battery, thence to ground G. Upon the vertical magnet
 25 being twice momentarily energized, the switch shaft is raised two steps in the usual manner. Upon the relay 167 becoming energized, a circuit is closed through the relay 168 and the private magnet 66 in
 30 series. The relay 167 being slow acting does not deenergize during the momentary interruptions of its circuit. The private magnet 66, as is well known, is energized to prepare the side switch for escapement
 35 to second position, while the relay 168 opens the line while impulses are being delivered. After the last impulse of this series has been transmitted, the private control relay 167 deenergizes and breaks the
 40 circuit of the relay 168 and the magnet 66, thereby allowing the side switch to pass to second position. Upon the side switch wiper 65 passing to second position, battery current is disconnected from the vertical
 45 magnet 60 and connected with the rotary magnet 61. When the calling device is operated for the next digit 0, the relay 68 deenergizes ten times, each time closing the circuit of the rotary magnet 61. This cir-
 50 cuit is traced from ground G^{13} through the springs 163 and 164, 165 and 166, relay 167, springs 171 and 170, rotary magnet 61 and the side switch wiper 65 to battery B. The rotary magnet receives ten impulses to ro-
 55 tate the shaft wipers around ten steps onto the contact of the desired line. The private magnet 66 and the slow acting relay 168 are energized at the first impulse and remain so until the last impulse has been
 60 transmitted, due to the energization of the private control relay 167.

When the private magnet 66 finally deenergizes, the side switch passes to third position. The relay 168 being slow acting
 65 does not deenergize immediately when its

circuit is broken. Therefore the lines are kept open at the springs 173 and 174 a short time after the side switch passes to third position. The object of this is to eliminate
 70 the possibility of the ringing current operating the plunger of the called subscriber's line switch C' . The movement of the side switch wipers 62 and 63 to third position extends the line connection through the
 75 wipers 57 and 59 to the called line. When the side switch wiper 64 passes to third position, a guarding potential is placed on the private contacts of the called line and a circuit is closed through the cut-off winding
 80 175 at the line switch C' . This circuit extends from ground G^{15} through the side switch wiper 64, private wiper 58 and the winding 175 to battery B. The winding
 85 175, upon energizing, attracts the armature 176, which operates to disconnect the switch C' from the line. Upon the side switch wiper 65 passing to third position, battery current is supplied to the ringing
 90 relay 70. This circuit is traced from ground G^{16} through the interrupter 177, ringing re- lay 70, springs 178 and 179 and the side switch wiper 65 to battery B. The relay 70
 95 has its circuit intermittently opened and closed by the interrupter 177 to alternately disconnect the called line from the calling line and to throw out over the called line
 100 alternating current from the ringing generator R to ring the called subscriber's bell.

When the called subscriber removes his receiver from the switch-hook, or as soon
 105 thereafter as the ringing relay 70 deenergizes if it is energized at the time, a circuit is closed from ground G^{18} through the back-bridge 68^a, springs 182 and 183 and 174, line wiper 59, springs 187 and 188 at the
 110 substation A', line wiper 57, springs 173, 184 and 185 and the relay 69 to battery B. Upon the back-bridge relay 68^a becoming energized, the springs 189 and 190 are separated from the springs 191 and 192,
 115 respectively, and make contact with the springs 193 and 194. This operation, it will be seen, transposes the negative side of the line to the positive pole of battery and the positive side of the line to the negative pole
 120 of the battery through the respective windings of the line relay 68. This operation can be utilized in a semi-automatic system to operate the supervisory signals, or for any other purpose. Upon the springs 204
 125 being pressed together by the relay 69, a circuit is closed through the ring cut-off relay 202 and the relay 76 in series, which circuit extends from ground G^{19} through the shaft-controlled contact 203, relay con-
 130 tact 204, relays 76 and 202 and the side switch wiper 65 to the battery lead 100. The relay 76, upon energizing, disconnects ground G^{12} from the holding circuit extending back through the preceding switches
 135

and at the same time connects said circuit with ground G' through battery B' . A circuit now extends from ground G' through battery B' , resistance 215, springs 75 and 74, 162 and 161, thence back over the third conductor of the trunk, through the holding winding 12 of the switch C in multiple with the meter magnet 77 (Fig. 1) and contact 77^a to the battery lead 100, thence through battery B to ground G. Since the ground pole of the battery B' is of the opposite polarity to that of the battery B, the two batteries are connected in series over the circuit traced. This increases the current in the meter magnet 77 of the calling line sufficiently to cause it to attract its armature to advance the meter one step to register the call.

The relay 202 at the connector switch, upon energizing in series with the relay 76, operates to open the circuit of the ringing relay 70 at the springs 178 and 179 and closes a locking circuit for itself from ground G^{19} through the shaft-controlled contact 203, springs 205 and the winding of the relay 202 to the battery lead 100. The closing of the spring contact 205 of the relay 202 also short-circuits the relay 76, which deenergizes to disconnect battery B' from the holding circuit and the meter magnet 77 and restore the connection to ground G^{12} . It is thus seen that the relay 76 operates to transmit only a momentary impulse from battery B' through the meter magnet of the calling subscriber, said magnet, however, being so adjusted that after it has once been energized it may be held up by the battery B alone, so that it does not fall back after battery B' is disconnected, but remains in an energized position until the connection is released, thereby eliminating any possibility of the meter being operated more than once for each call. The magnet 76 of the connector is preferably rendered slow to deenergize by a ring of copper around one end of its core, or by any other desired means, so as to transmit a sufficiently long impulse from battery B' to insure that the meter shall be fully operated. Since the relay 202 remains locked up and the contact 205 closed until the connection is released, it is now impossible for the called subscriber to operate the relay 76 more than once by moving his receiver up and down, and consequently no more than a single impulse can be transmitted from battery B' for each call. The resistance 215 is included in the lead of the battery B' simply as a protective means to prevent short-circuiting the battery when all three springs of the relay 76 are in contact while it is energizing and deenergizing.

In order to release the connection the calling subscriber hangs up his receiver, thereby breaking the circuit of the line relay 68

(Fig. 2) at the springs 82 and 83. The line relay 68 deenergizes and breaks the circuit of the slow-acting relay 160 at the spring 163. Upon the relay 160 deenergizing, a circuit is closed through the release magnet 67. This circuit is traced from ground G^{13} , through spring 163 and 164, back contact of the spring 165, normal spring 260 and through the release magnet 67 to battery B. The release magnet, upon energizing, withdraws the holding pawl from the switch shaft, allowing same to return by means of a spring and gravitation to its normal position. The deenergization of the relay 160 also takes ground off the release trunks by the opening of the springs 161 and 162, thereby breaking the circuit of the holding winding 12 of the line switch C. When the winding 12 deenergizes, the plunger is retracted from the bank terminals, restoring the switch C to normal position.

As has been heretofore stated, should a subscriber's telephone be put out of service, his line switch is disconnected from the line and the contacts of the connector bank representing his number are wired to what is known as a traffic trunk (shown in Fig. 3) terminating at the information desk. Assuming now that a subscriber at the station A is calling a subscriber whose telephone has been disconnected, the wipers 57, 58 and 59 coming to rest on the desired contacts and the side switch wipers passing to third position, the line connection, instead of being cut through to the telephone, would light the lamp 209 at the operator's desk (Fig. 3) in the following manner: When the wipers 57 and 59 stop on the contacts 78 and 79, a circuit is closed through the relay 210, part of which has already been traced through the back-bridge relays 68^a and 69. The resistance of the relay 210 is high enough to prevent sufficient current flowing through these relays to operatively energize them. Therefore, the direction of the flow of current over the calling line is not reversed, neither is the relay 76 energized to register the call. One side of the relay 210 is wired to a normally closed contact. Upon this relay energizing, the circuit of the lamp 209 is closed from ground G^{21} through contact of the springs 212 and springs 213 and 214, through said lamp 209 to battery B^2 . When the operator sees the signal she operates her key K during one of the pauses between application of ringing current to the line to bridge her telephone set across the line at the springs 216 and 217 and asks what number the subscriber is calling and thus closes the circuit of the relay 218. This circuit is traced from ground G^{22} through the springs 219 and through said relay to battery B^2 . Upon the relay 218 energizing, the circuit of the lamp

209 is broken upon the separation of the springs 213 and 214. When once the relay 218 is energized, it remains so all the time the relay 210 is energized, for a circuit is
 5 formed from ground G^{21} through the contacts 212, springs 213 and 220 and through said relay to battery B^2 . Upon the springs 211 breaking contact the resistance coil 221 is included in the bridge across the line, to
 13 increase its impedance while conversation is being carried on. Also, upon the key K being operated, an impulse is sent through the relay 225 by means of the springs 226, 227 and 228, which momentarily energizes
 15 said relay to place a direct ground connection on the contact 78, thereby closing an energizing circuit for the connector back-bridge relay 69 without energizing the relay 68^a. The relay 225 being slow-acting
 20 maintains its magnetism for an appreciable length of time to give the back-bridge relay 69 a chance to operatively energize. The circuit of the back-bridge relay is traced from ground G^{25} through contact of the
 25 springs 229, contact 78, springs 173 and 185 (when the ringing relay is deenergized) and through the relay 69 to battery B . Upon the relay 69 momentarily energizing, a circuit is closed from ground G^{19} through
 30 the normal springs 203, contact of springs 204, springs 201 and 200, through the ring cut-off relay 202 and the side switch wiper 65 to battery B . It will be seen that this circuit does not pass through the relay 76
 35 as it does when a called subscriber answers, owing to the fact that the relay 68^a is not energized and the relay 76 is therefore short-circuited at the springs 200 and 201. Therefore, no impulse is transmitted over the
 40 holding trunk from battery B' to operate the calling subscriber's meter when the operator answers the bell, but the relay 202 is energized in the usual manner to open the circuit of the ringing relay 70. It is
 45 thus seen that upon a party calling a subscriber whose line leads to the information desk, he signals the information operator, and when the operator answers, the ringing current is cut off without operating the calling
 50 subscriber's meter, whereas, when the connection is obtained with a subscriber's line as has been already explained, the act of the called subscriber removing his receiver from the switch-hook to answer a call
 55 both operates the meter and cuts off the ringing current.

Whenever a line is busy, either by reason of having made a call or by reason of having been called, there is a guarding ground
 60 potential upon its connector private bank contacts. When the wipers of a connector are rotated onto the contacts of a busy line, a ground potential is extended from the grounded private bank contact of said line
 65 through the private wiper 58, side switch

wiper 64 (which is then in second position), springs 156 and 155 and relay 73 to the spring 136 of the private magnet relay 167. When the relay 167 deenergizes after the last impulse for the last digit is delivered,
 70 it permits the spring 135 to engage the spring 136 before the springs 137 and 135 separate, whereby the ground potential applied to the spring 136 from the guarded
 75 contact of the busy line provides a holding circuit for the private magnet 66 and does not permit it to deenergize, while at the same time the relay 73 becomes energized in series with the private magnet 66
 80 does not deenergize after the last digit is called, the side switch remains locked in second position and no connection is completed between the calling line and the busy called
 85 line. The relay 73, upon energizing, transfers the locking ground for itself and the private magnet from the guarded private bank contact of the busy line to the ground
 90 G^{19} by way of the springs 203, 146 and 155. The relay 73, upon energizing, also completes a connection from the busy signaling machine Q through the springs 71 and 72
 95 and the side switch wiper 63 to the calling line to notify the calling subscriber that the called line is busy. After having called a
 100 busy line, the switches are released by the hanging up of the receiver at the calling substation in the same manner as if an idle line had been called.

It will thus be seen that I have devised a
 105 very efficient measured service system in which the service meter is operated over the release trunk and in which, when the traffic trunk leading to an operator's position is called, the ringing current is cut off with-
 110 out operating the subscriber's meter. Furthermore, it will be seen that this cutting off of the ringing current is not dependent in any way upon the differences in time required to operate various relays, as has heretofore
 115 been the case, but is provided by the provision of two back-bridge relays, both of which are required to be energized to operate the meter, while only one need be energized to cut off the ringing current. When
 120 a subscriber answers, he operates both relays, and when the operator answers, she operates but one.

While I have illustrated one specific embodiment of my invention, it is, of course, to
 125 be understood that I do not wish to be limited to the exact construction shown and described, but my invention is capable of use in connection with other automatic or semi-automatic systems.

What I claim as my invention is:—

1. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said
 130 lines, a release circuit in said switches, a

meter for registering the calls controlled over said circuit, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of said connection, and means for inserting another battery in said release circuit for transmitting a strengthened impulse through said magnet to operate the same.

2. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said lines, a release circuit in said switches, a meter for registering the calls controlled over said circuit, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of said connection, and means for inserting another battery in said release circuit for transmitting a strengthened impulse through said magnet to operate the same upon the response of the called subscriber.

3. In a telephone system, a plurality of subscribers' lines, a trunk-selecting switch individual to each of said lines, automatic means for extending a connection from the trunk-selecting switch of any line to a desired called line, a release circuit for said means, a meter for registering the calls associated with each line controlled over said release circuit, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of said connection, and means for inserting another battery in said release circuit for transmitting a strengthened impulse through said magnet to operate the same.

4. In a telephone system, a plurality of subscribers' lines, a trunk-selecting switch individual to each of said lines, automatic means for extending a connection from the trunk-selecting switch of any line to a desired called line, a release circuit for said means, a meter for registering the calls associated with each line controlled over said release circuit, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of said connection, and means for inserting another battery in said release circuit for transmitting a strengthened impulse through said magnet to operate the same upon the response of the called subscriber.

5. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said lines, a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of said connection, and means for opening the first circuit of said magnet and for closing a second circuit through said magnet to transmit

a strengthened impulse through the same to cause its operation.

6. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said lines, a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of said connection, and means for opening the first circuit of said magnet and for transmitting a strengthened impulse through the same to operate said magnet upon the response of the called subscriber.

7. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet in the establishment of said connection, a relay associated with said connector, means for momentarily energizing said relay upon the response of the called subscriber, means controlled by the energization of said relay for transmitting a strengthened impulse through said magnet to operate the same, and means for then short-circuiting said relay to prevent a second operation of said magnet.

8. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, a meter for registering the calls, an operating magnet therefor, a relay associated with said connector, means for momentarily energizing said relay upon the response of the called subscriber, means controlled by the energization of said relay for operating said magnet, and means for then short-circuiting said relay to prevent a second operation of said magnet.

9. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, two back-bridge relays for said connector, a service meter, a source of ringing current, means for connecting said ringing current with the called line, means controlled by the energization of both of said relays for operating said meter, and means controlled by the energization of but one of said relays for cutting off said ringing current.

10. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, two back-bridge relays for said connector, a service meter, a source of ringing current, means for connecting said ringing current with the called line, means controlled by the energization of both of said relays for oper-

ating said meter, means controlled by the energization of but one of said relays for cutting off said ringing current, an operator's set to which said connector switch is adapted to extend connection, means controlled upon the response of the called subscriber for operating both of said relays, and means controlled upon the response of the operator for operating but one of said relays, whereby the response of the operator does not operate said meter.

11. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of a connection, and means for transmitting a strengthened impulse over said release trunk through said magnet to operate the same.

12. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, and means for opening the first circuit of said magnet and closing a second circuit through said magnet over said release trunk to transmit a strengthened impulse through the magnet over said release trunk to transmit a strengthened impulse through the magnet to cause its operation.

13. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of a connection, a relay associated with said connector, means for momentarily energizing said relay upon the response of a called subscriber, and means controlled by the energization of said relay for transmitting a strengthened impulse over the release trunk through said magnet to operate the same.

14. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector

switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of a connection, a relay associated with said connector, means for momentarily energizing said relay upon the response of a called subscriber, means controlled by the energization of said relay for transmitting a strengthened impulse over the release trunk through said magnet to operate the same, and means for then short-circuiting said relay to prevent a second operation of said magnet.

15. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, a relay associated with said connector, means for momentarily energizing said relay upon the response of the called subscriber, means controlled by the energization of said relay for transmitting an impulse over said release trunk to operate said magnet, and means for then short-circuiting said relay to prevent a second operation of said magnet.

16. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing connection between two of said lines, two back-bridge relays for said connector, a service meter, an operating magnet therefor, a source of ringing current, means for connecting said ringing current with the called line, means controlled by the energization of but one of said relays for cutting off said ringing current, and means controlled by the energization of both of said relays for transmitting a momentary impulse through said operating magnet to thereby operate said service meter.

17. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing connection between two of said lines, two back-bridge relays for said connector, a service meter, an operating magnet therefor, a source of ringing current, means for connecting said ringing current with the called line, means controlled by the energization of but one of said relays for cutting off said ringing current, means controlled by the energization of both of said relays for transmitting a momentary impulse through said operating magnet to thereby operate said service meter, an operator's set to which said connector switch is adapted to extend connection, means controlled by the response of a subscriber for operating both of said

relays, and means controlled by the response of the operator for operating but one of said relays, whereby the response of the operator does not operate said meter.

18. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said lines, a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of said connection, and means for opening the circuit of said magnet and for transmitting current of different strength through the same to operate said magnet upon the response of the called subscriber.

19. In a telephone system, a plurality of subscribers' lines, automatic switches for establishing connection between two of said lines a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet during the establishment of said connection, and means for momentarily opening the first circuit of said magnet and for closing a second circuit through said magnet to transmit a current of different strength through the same to cause its operation.

20. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, a meter for registering the calls, an operating magnet therefor, means for transmitting current of one strength through said magnet in the establishment of said connection, a relay associated with said connector, means for momentarily energizing said relay upon the response of the called subscriber, means controlled by the energization of said relay for transmitting current of different strength through said magnet to operate the same, and means for short circuiting said relay to prevent a second operation of said magnet.

21. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of a connection, and means for inserting another battery in said release trunk for transmitting current of different strength over said release trunk through said magnet to operate the same.

22. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending con-

nection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, a circuit for said magnet and means for momentarily opening said circuit and closing a second circuit through said magnet over said release trunk to transmit a current of different strength through the magnet to cause its operation.

23. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, means for transmitting current from a battery through said magnet during the establishment of a connection, a relay associated with said connector, means for momentarily energizing said relay upon the response of a called subscriber, and means controlled by the energization of said relay for inserting another battery in said release trunk for transmitting current of a different strength over said release trunk through said magnet to operate the same.

24. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing connection between two of said lines, two back-bridge relays for said connector, a service meter, an operating magnet therefor, a source of ringing current, means for connecting said ringing current with the called line, means controlled by the energization of but one of said relays for cutting off said ringing current, and means controlled by the energization of both of said relays for transmitting current of a different strength to said operating magnet to thereby operate the said service meter.

25. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from the calling line to said connector switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, a first circuit for said magnet, means for closing a second circuit through said magnet and for opening said first circuit to transmit a current of different strength through said magnet to cause its operation.

26. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing connection with the called line, automatic switches for extending connection from a calling line to said connector

switch, a release trunk extending to said connector over which said automatic switches are released, a meter for registering calls, an operating magnet therefor, a
5 first circuit for said magnet, means for closing a second circuit through said magnet over said release trunk and for opening said first circuit to transmit a current of differ-

ent strength through said magnet to cause its operation.

Signed by me at Liverpool, England, this 31st day of July, 1913.

FRANK NEWFORTH, JR.

Witnesses:

ALEX. E. WALKER,
H. WATSON.