

B. D. WILLIS.
MEASURED SERVICE TELEPHONE SYSTEM.
APPLICATION FILED APR. 17, 1913.

1,130,784.

Patented Mar. 9, 1915.

3 SHEETS-SHEET 1

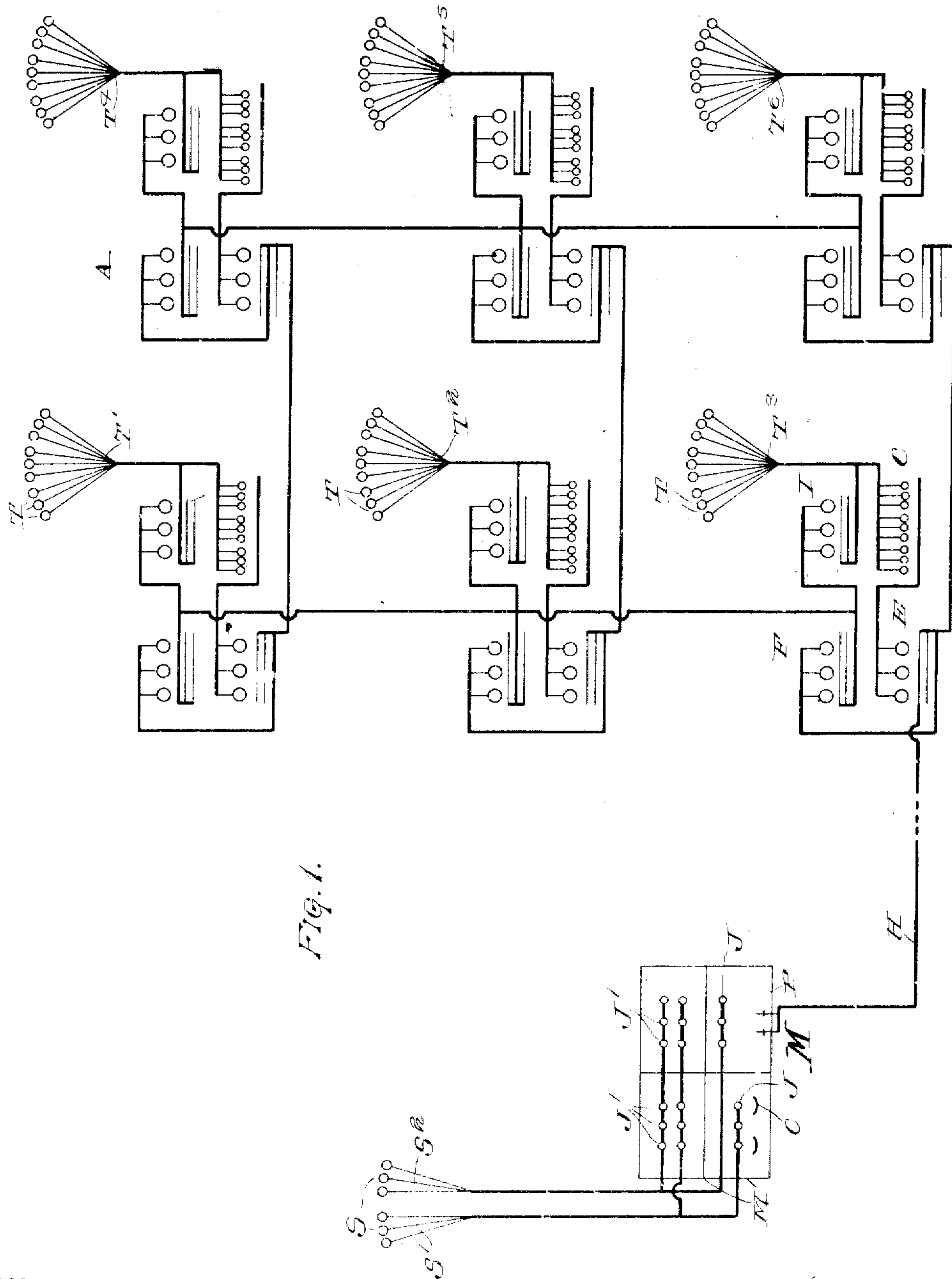


Fig. 1.

WITNESSES

Albert Anderson.

Arthur J. Ray.

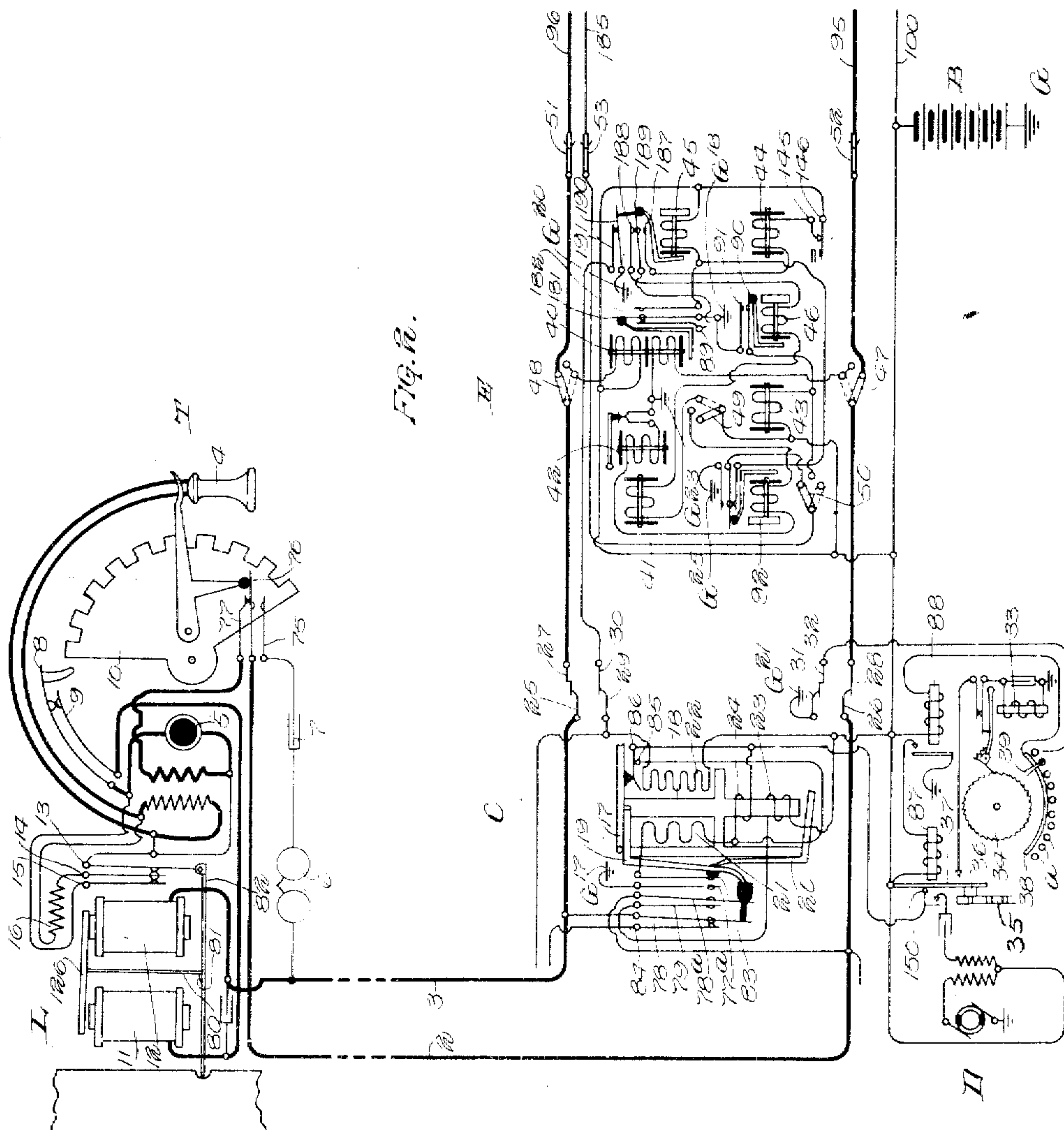
INVENTOR:

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3 SHEETS-SHEET 2



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3 SHEETS-SHEET 3

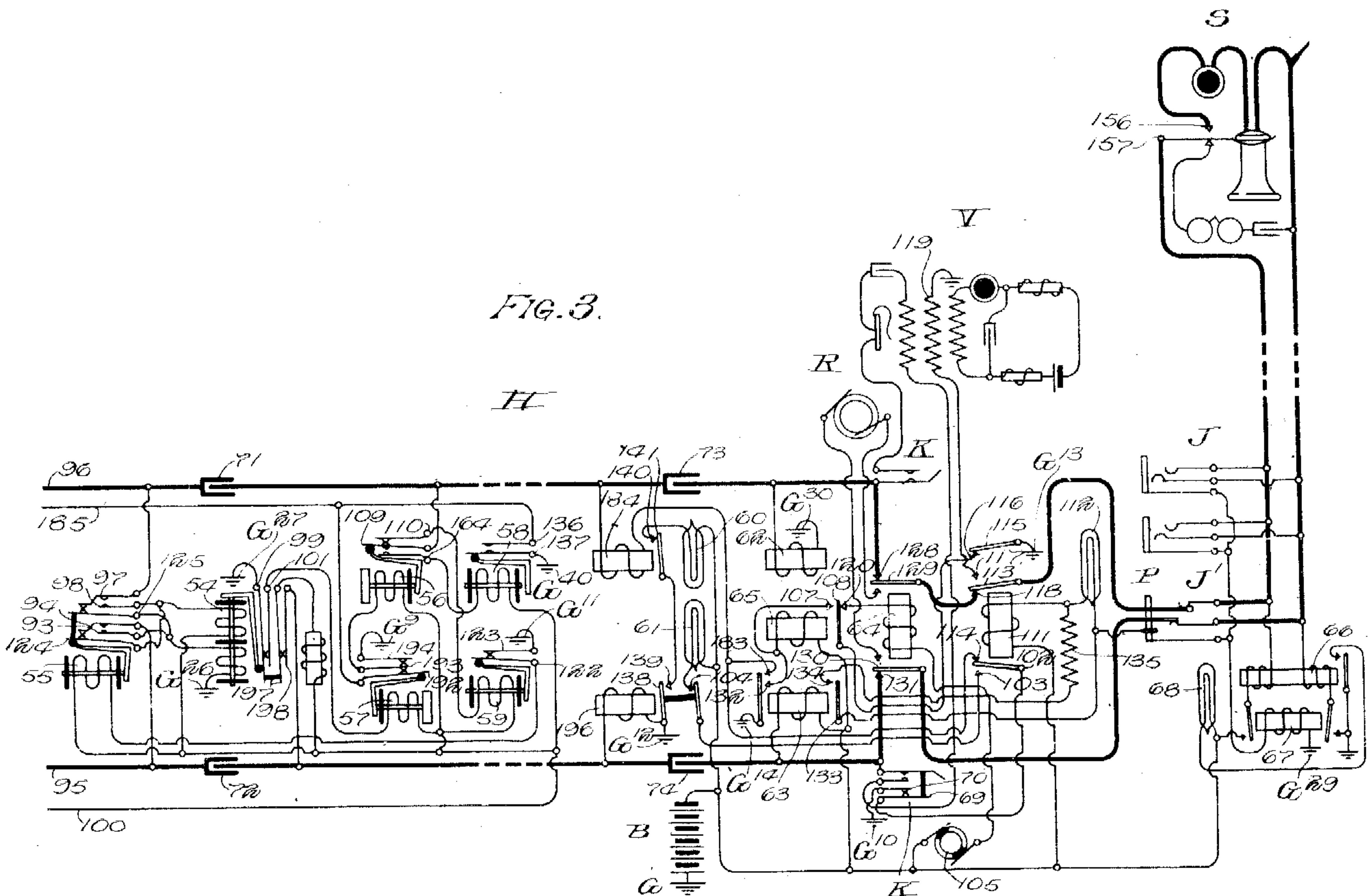


FIG. 3.

WITNESSES

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UNITED STATES PATENT OFFICE.

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MEASURED-SERVICE TELEPHONE SYSTEM.

1,130,784.

Specification of Letters Patent.

Patented Mar. 9, 1915.

Application filed April 17, 1913. Serial No. 761,809.

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 a certain new and useful Improvement in Measured-Service Telephone Systems, of which the following is a specification.

My invention relates to improvements in semi-automatic telephone systems, and more particularly to systems in which measured service is employed. In such systems it is customary to reverse the current in the calling line either before or at the time the called subscriber answers, in order to render the calling telephone inoperative until the calling subscriber operates the measured service device. In semi-automatic systems it is preferable and easier to arrange the apparatus so as to obtain this reversal of current in the calling line at the time when the operator inserts the plug of her cord circuit into the jack of the called line, rather than at the time the called subscriber answers. As above pointed out, this reversal of current renders the telephone of the calling subscriber inoperative and thus it is evident that when the apparatus is arranged so as to reverse this current when the plug is inserted in the jack, the operator cannot converse with the calling subscriber until after the called subscriber answers without removing the plug from the jack, so as to restore the current in the calling line to its normal direction. This is an objectionable feature, as it often happens that it is necessary or desirable for the operator to communicate with the calling subscriber during this interval of time.

It is an object of my invention to provide means whereby, when the operator connects her talking set with the trunk extending to the calling subscriber, after she has made connection with the called subscriber, the current in the calling line is automatically restored to its normal direction, so as to render the calling telephone operative for talking purposes. In this manner the operator is enabled to communicate with the calling subscriber without removing the calling plug from the jack of the called line.

A further special object of my invention

is to prevent the operator from restoring the current in the calling line to its normal direction so as to render the telephone operative at any time after the called subscriber answers. In this manner the operator is prevented from rendering the calling telephone operative for talking purposes after the called subscriber has answered, and thus cannot in any way assist the subscribers in carrying on a conversation without having the calling subscriber first operate his measured service device.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated one form of semi-automatic system to which my invention is applied.

In the drawings Figure 1 represents a diagrammatic layout of a telephone system embodying the principles of my invention. Figs. 2 and 3 show a complete connection between an automatic line and a manual line in said system.

The telephone system, as illustrated in Fig. 1, comprises a manual exchange M and an automatic exchange A. In the manual exchange M there is represented a switchboard comprising a plurality of operators' positions M' and showing trunk lines H from automatic selectors E terminating at the switchboard in plugs P. At S' and S² there are shown two groups of subscribers' substations S, each of which is provided at the central office with an answering jack J in one position and multiple jacks J' in the other positions, in the usual manner. Suitable plug cords c are provided for making the desired connection. The automatic exchange A is of a well-known type, comprising subscribers' individual or line switches C, first selectors E, second selectors F and connectors I. In the drawings there are represented two thousands of a ten thousand line capacity exchange on a scale of three to ten. The subscribers' telephones T are divided into groups T', T² and T³, etc., usually one hundred telephones in a group. Therefore, with the above-mentioned scale, the three groups T', T² and T³ represent one thousand lines, and the other groups T⁴, T⁵ and T⁶ represent another thousand. With each group of subscribers' lines there is as-

sociated in the central office a group of the above-mentioned individual switches C, one for each line. The selector and connector switches represented herein comprise banks of contacts arranged in horizontal rows or levels, usually ten in number. These rows are represented diagrammatically by horizontal lines which extend across a group of switches, indicating that the corresponding contacts are all in multiple. All the line or individual switches in one group have access to a group of first selectors E. The bank contacts of all the first selectors of corresponding hundreds are multiplied throughout the different thousands. The bank contacts of the first level of these first selectors are connected to trunk lines leading to second selectors E' associated with the first thousand, and the contacts of the second level are connected to trunk lines leading to second selectors F associated with the second thousand. All the second selectors associated with a given thousand are multiplied together, and the first level is connected to trunk lines leading to connectors which have access to the lines of the first hundred group of that thousand. The second level is connected to trunk lines leading to connectors having access to the lines of the second hundred. This trunking arrangement of an automatic exchange is in general well known in the art and it is thought unnecessary to describe it further. The trunks H which lead from a certain level of the bank of the first selectors E and terminate in ordinary plugs P at the manual switchboard constitute the connecting means between the automatic and manual exchanges.

Referring to Fig. 2, there is shown the usual subscriber's telephone T with which is associated a coin-collecting device L. These are connected with the conductors 2 and 3 which terminate in the line switch C at the central office, by means of which switch the line is extended to the first selector E. The selector E in turn extends the connection over the trunk H to the manual exchange, from which the call is extended to the called line.

The automatic telephone or substation, as herein represented, comprises the usual receiver 4, transmitter 5, ringer 6 and condenser 7. Being an automatic substation it is also provided with an automatic calling device. This calling device may be of the same type as that shown in British patent to S. G. S. Dicker No. 29,651 of 1910. In Fig. 2 the calling device is shown diagrammatically by a pair of impulse springs 8 and 9 and a toothed impulse wheel 10, which latter is controlled by the subscriber through the medium of a dial (not shown) provided with finger holes for convenience in turning. The coin-collecting device is also shown diagrammatically. It consists essentially of a

polarized electromagnet, the coils 11 and 12 of which are connected in series with the telephone. The springs 13, 14 and 15 are so arranged that when their contacts are closed, the transmitter 5 is short-circuited and the receiver 4 is shunted by the resistance coil 16. The coin-collecting device is similar to that described in British Patent specification No. 587 of 1912.

The line switch C and the master switch D are of the general type of line and master switches disclosed in British patent to R. W. James No. 26,301 of 1906, but of the particular form shown in British patent to T. G. Martin No. 1419 of 1910. As herein represented, the line switch comprises, among other details, a plunger (not shown) attached to a so-called plunger arm 17 which is controlled by a plural-wound magnet 18. Besides controlling the plunger arm 17, the magnet also controls the armatures 19 and 20 and is made up of four windings, i. e., the pull-down winding 21, the holding or cut-off winding 22, line winding 23 and an auxiliary winding 24. Of the two windings 21 and 22, only the former is strong enough to attract the plunger arm 17 from its normal position. The winding 22, however, is strong enough to hold the plunger arm in an operated position when once it has been attracted. When the plunger is drawn down by the magnet 18 it is thrust into the bank springs 25, 26, 27, 28, 29, 30, 31 and 32, forcing them together in pairs. Each switch is provided with a plurality of such sets of springs, each forming a terminal of a trunk leading to a selector E. The plungers of the line switches are normally engaged with a so-called plunger guide shaft (not shown), and by means of the master switch D are normally kept opposite an idle trunk line. The master switch comprises essentially a motor magnet 33 for rotating the ratchet wheel 34, which is attached to the plunger guide shaft in such a manner as to give it an oscillatory motion to carry the idle plungers back and forth in front of the trunk terminals. To the plunger guide shaft there is secured a locking plate 35 provided near its outer edge with a number of openings which are adapted to be engaged by a pin 36 upon the end of the armature 37. The openings in the plate 35 are so spaced that when the pin 36 is in engagement with one of them the plungers are standing opposite the terminals of a trunk line. The master switch is also provided with a bank of contacts comprising a common segment 38 and an individual contact *a* for each trunk line to which the line switches have access. The wiper 39 maintains the segment 38 in electrical connection with one of the individual contacts *a*.

The selector E is of the general type of selector switches disclosed in United States Letters Patent No. 815,321, granted March

13, 1906, to Keith, Erickson and Erickson, the circuits being modified, however, as shown in British Patent No. 1419 of 1910, hereinabove referred to, in order to operate
 5 in a two-wire system. The selector comprises, among other details, the line relay 40, vertical and rotary magnets 41 and 42, respectively, private magnet 43, release magnet 44, release relay 45, private control relay
 10 46 and the side switch wipers 47, 48, 49 and 50. The switch shaft (not shown) and the line and private wipers are the direct means of connection between this switch and the trunk H (Fig. 3).

15 The equipment of the trunk comprises a line relay 54, battery reversing relay 55, two slow acting relays 56 and 57, two quick acting relays 58 and 59 and two visual signals 60 and 61. Battery current is supplied to
 20 the called subscriber through the coil 62 and the relay 63. There is also a ringing relay 64 and ringing cut-off relay 65. At R there is shown a ringing current generator and at V an operator's talking set is shown. For
 25 the purpose of indicating when the called subscriber answers after the operator has plugged in, there is provided a visual signal 112. The usual operator's listening key K has a pair of extra springs 69 and 70 for the
 30 purpose of making the calling subscriber's telephone operative for talking purposes should the operator wish to speak to him after she has inserted the plug P into the jack J' to call the called subscriber. The
 35 talking circuit through the trunk H includes the condensers 71, 72, 73 and 74. Further details of this trunk equipment will be explained hereinafter in connection with the description of the operation of the system.

40 At S there is shown an ordinary common battery manual telephone the line conductors of which terminate in the central office in the answering jack J and the multiple jacks J'. The line is also provided with the usual
 45 line and cut-off relays 66 and 67 and the signal lamp 68.

Having given a general description of the apparatus, I will now explain how an automatic subscriber at the substation T may
 50 obtain connection with the manual substation S, and will also describe the manner in which the operator is able to render the calling subscriber's telephone operative or inoperative at will after she has connected
 55 the two lines and before the called subscriber answers. We will assume that in order to gain connection with the trunk H and to signal the manual operator the automatic subscriber has to call the digit O.
 60 Upon the receiver 4 being lifted from the switch hook, the spring 76 breaks away from the spring 75 and makes contact with the spring 77 to cut off the ringer circuit and to bridge the talking circuit across the
 65 line, thereby closing a circuit from ground

G¹⁷ through the springs 77^a and 78^a, line 2, springs 76 and 77, primary winding of the induction coil, transmitter 5, impulse springs 8 and 9, coils 11 and 12, line 3, springs 78 and 79 and through the winding
 70 23 of the switch C to the battery lead 100. At this time the current flowing through the coils 11 and 12 is in the direction to attract the armature to the coil 11 to carry the arm 80 behind the lug 81 on the arm 82. The wind-
 75 ing 23, upon energizing, closes the circuit of the pull-down winding 21, which causes the plunger arm 17 to be attracted to thrust the plunger into the bank terminals and thus extend the line connection through the
 80 springs 25 and 27 and 26 and 28 to the selector E. This circuit extends from ground G¹⁷ through the springs 77^a and 83, through the windings 21 and 24 in series and contact 150 to the battery lead 100. The
 85 winding 21, upon energizing, attracts the cut-off armature 19, in addition to the plunger arm 17. The armature 19 operates to press the springs 78 and 84 together and to separate the springs 78 and 79 and 78^a
 90 and 77^a. The separation of the above-mentioned springs disconnects the winding 23 and ground G¹⁷ from the line conductors. The armature 20 does not fall back immediately however, due to the fact that the wind-
 95 ing 24 is energized in series with the pull-down winding 21. When the plunger arm 17 is operated it not only forces the plunger into the bank terminals to extend the connection, but closes the contact of the springs
 100 85 and 86, which short-circuits the winding 24. This allows the armature 20 to return to its normal position, thereby breaking the circuit of the pull-down winding 21. Before this happens, however, the circuit of
 105 the holding coil 22 is closed in the following manner: When the springs 25 and 26 make contact with the springs 27 and 28, the circuit of the line relay 40 in the selector E is closed by reason of the closed bridge at
 110 the subscriber's telephone. Upon the relay 40 energizing, a circuit is closed for the slow acting relay 45 from ground G¹⁸, contact of springs 181 and 182 and through said relay to the battery lead 100. This relay ener-
 115 gizes and brings together the springs 188 and 189 and 190 and 191, which latter close the circuit of the winding 22 from ground G²⁰. The energization of this winding maintains the plunger arm 17 in an operated
 120 position after the circuit of the winding 21 has been broken. When the springs 31 and 32 are forced together by the plunger, the starting relay 88 of the master switch D is energized over the circuit extending from
 125 ground G²¹ through said springs and through the relay 88 by way of the wiper 39 and common segment 38. Upon the relay 88 energizing, the circuit of the lock magnet 87 is closed, which magnet in turn en-
 130

energizes, attracting its armature to close the circuit of the motor magnet 33. This magnet operates, as has been stated, to impart an oscillatory motion to the plunger guide shaft by means of the ratchet wheel 34, thereby moving all the remaining plungers opposite the next idle trunk terminal. By the attraction of the armature of the lock magnet 87 main battery is taken from the idle line switches of the group to which the switch C belongs as long as the plungers are in motion. This prevents the possibility of any subscriber's switch being operated while its plunger is being moved from one trunk to another.

The foregoing operations follow immediately upon the removal of the receiver from the switch hook preparatory to operating the calling device. When the calling device is operated for the digit 0, the impulse springs 8 and 9 are separated ten times momentarily. Each time these springs are separated, the circuit of the line relay 40 at the switch K is broken, said relay deenergizing accordingly to permit the spring 181 to fall back and make contact with the spring 89 to close a circuit through the vertical magnet 41. The relay 40 being slow acting does not get time to deenergize while its circuit is being momentarily broken. The digit called being 0 there are ten impulses sent through the vertical magnet 41, which operates to raise the switch shaft ten steps opposite the row of contacts in which terminate the trunk lines 11. The circuit of the vertical magnet is traced from ground G^{18} to the contact of the springs 181 and 89, springs 190 and 193, slow acting relay 46, vertical magnet 41 and the side switch wiper 49 to the battery B (Fig. 10). The relay 46 is energized while impulses are passing through it and closes the circuit of the private magnet 43 at the springs 90 and 91 from ground G^{17} which prepares the side switch for escapement to second position. The side switch wiper 47, by passing to second position, transfers battery current from the vertical magnet 41 to the rotary magnet 42, thereby completing an energizing circuit for the latter. This circuit extends from ground G^{17} through the interrupter springs and the rotary magnet, through the slow acting relay 92 and the side switch wiper 49 to battery. The rotary magnet, upon energizing, rotates the wipers 51, 52 and 53 onto the first contact, at which time the side switch will be tripped to third position in a well known manner by the action of the armature of the rotary magnet if the first trunk line is idle. If, however, the first trunk line is busy, the private magnet becomes energized over a circuit extending from the grounded private bank contact of the busy trunk, private shaft wiper 53 and the side switch wiper 50. The magnet 43,

upon energizing, locks the side switch in second position until the wiper 53 finds the non-grounded contact of an idle trunk line. The function of the slow acting relay 92 is to place a guarding potential on the private contact from ground G^{25} by means of the wiper 53 the instant the side switch reaches third position, to insure against any other selector cutting in on the trunk before a guarding potential is sent back from ground G^{18} (Fig. 3). Upon the side switch wipers 47 and 48 passing to third position, the line connection is extended to the conductors 96 and 95, which brings about the energization of the line relay 54. This circuit is traced from ground G^{26} through the lower winding of the relay 54, contact of springs 93 and 94, conductor 95, line wiper 52, side switch wiper 47, bank springs 28 and 26, conductor 2, through the substation and back over the conductor 3, bank springs 25 and 27, side switch wiper 48, line wiper 51, conductor 96, springs 97 and 98 and through the upper winding of the line relay to battery B and to ground G. Upon the relay 54 attracting its armature, a circuit is closed for the slow acting relay 57, said circuit being traced from ground G^{27} through the contact of springs 99 and 101 and through the relay 57 to battery B. A circuit is also closed through the relay 196 from ground G^{19} through said relay, springs 198 and 197 and impedance coil to battery B. Upon the relay 196 energizing, the circuit of the lamp 61 is closed from ground G^{19} at the key K through the contact of springs 70 and 69, 102 and 103, contact 101 and through the lamp to battery B. This lamp acts as a signal to the operator. Upon the relay 57 energizing, its springs 192, 193 and 194 are operated, the operating of the spring 192 sending back over the release trunk 185 the guarding potential from ground G^{18} referred to above, and the spring 193 connecting ground to the relay 56 and thence to battery B. Upon the relay 56 energizing, the springs 109 and 110 are pressed together to prepare a circuit through the relays 59 and 181. This circuit is not closed until the operator inserts the plug P into the jack J' to call the subscriber at substation S. Upon the operator observing the signal, i. e., the lighting of the lamp 61, she operates the key K to bridge her talking set V across the line and ascertains the number required. The lamp 61 is extinguished upon the operation of the key K, as the circuit is broken at the springs 69 and 70.

When the plug P is inserted into the jack J' and the operator restores her key K to normal, the relay 111 is energized and the lamp 112 is lighted over a circuit traced from ground G^{29} through the cut-off relay 67, sleeve of the plug P, lamp 112 and the relay 111 to battery B. Upon the energiza-

tion of this relay, the armatures 102 and 113 are attracted, the former completing the circuit already prepared from ground G^{10} to the contact of springs 70 and 69, 102 and 114, relay 184, springs 109 and 110 and the relay 59 to battery B. The line lamp 61 is extinguished upon the plug being inserted into the jack J' , for its circuit is opened by the armature 102 of the relay 111 breaking away from the spring 103. The armature 113, upon being attracted, breaks contact with the spring 117 and makes contact with the spring 118. The contact with the spring 118 does not accomplish anything at this time, as the line circuit is open at the telephone S. The breaking of the contact with the spring 117 disconnects from the line the tertiary test winding 119 on the induction coil in the operator's talking set V. The spring 115 is also attracted when the relay 111 is energized, thereby closing a circuit from ground G^{13} through the contact of springs 115 and 116, contact of springs 108 and 120, through the relay 64 and the interrupter 105 to battery B. This circuit being intermittently opened and closed causes the relay 64 to alternately disconnect the calling line from the called line and to bridge the ringer generator R across the called line to send out alternating current to ring the bell at the substation S. It will be remembered that upon the operator inserting the plug P into the jack J' a circuit was closed through the relays 184 and 59 at the contact of springs 102 and 103. This circuit causes the armature of the relay 184 to be attracted to prepare a circuit through the supervisory lamp 60. The relay 59, upon energizing, presses together the springs 122 and 123, thereby closing a circuit from ground G^{11} through the contact of said springs and through battery reversing relay 55 to battery B. The battery reversing relay energizes to take the springs 94 and 97 out of engagement with the springs 93 and 98 and place them in contact with the springs 124 and 125. This operation changes the direction of the flow of current through the calling subscriber's telephone and coin-collecting device L by interchanging the connection between the trunk conductors 95 and 96 and the terminals of the battery through the windings of the relay 54. The change of direction of current through the coils 11 and 12 (Fig. 2) attracts the armature 126 to the coil 12, thereby applying pressure against the lug 81 on the arm 82 to carry said arm into the slot of the coin chute and to close the contact of springs 13, 14 and 15, which, as has been stated previously, short-circuits the transmitter 5 and shunts the receiver 4, rendering the telephone T inoperative. This condition is maintained until the calling party drops a coin into the chute, the weight of which coin will knock the lug 81 out of en-

gagement with the arm 80 and restore the transmitter and receiver to their normal condition.

It is sometimes necessary or desirable for the operator to communicate with the calling subscriber after she has inserted the plug into the jack of the called line and while the called subscriber's receiver is on its switch hook. Since the calling telephone is rendered inoperative for talking when the plug P is inserted into the jack J' , and remains so as long as the called subscriber's receiver remains on its switch hook, it is evident that unless the operator is provided with some other means for rendering the calling telephone operative, she cannot converse with the calling subscriber during this time without removing the plug from the jack. It is the object of the extra springs 69 and 70 of the key K to enable the operator to render the calling telephone operative by the simple act of connecting the talking set V into circuit. Upon the operation of the key K to connect the talking set into circuit, the separation of the springs 70 and 69 opens the circuit of the relays 184 and 59. The relay 59, upon deenergizing, opens the circuit of the relay 55, which in turn deenergizes and restores the current in the calling line to its normal direction, whereupon the armature of the coin-collecting device is again attracted toward the coil 11, whereby the springs 13, 14 and 15 are opened. When the operator restores her key K, the current in the calling line is again reversed and the substation T is returned to its inoperative condition.

Upon the called subscriber removing his receiver to answer the call, a bridge is closed across the line at the subscriber's station including the spring 156 and the switch hook 157. This closes a circuit from ground G^{20} through the impedance coil 62, contacts of the springs 128 and 129 (when the ringer relay is deenergized), contact of springs 118 and 113, tip of the plug P and jack J' , through the switch hook contact at the telephone, ring of the plug P, contact of springs 130 and 131 and through the relay 63 to battery B. Upon the relay 63 energizing, the circuit of the ringing cut-off relay 65 is closed, which circuit can be traced from ground G^{14} to the contact 132 and through said ringing cut-off relay to battery B. Upon the relay 65 energizing, the armature 108 breaks contact with the spring 120 and makes contact with the spring 107, the breaking of the contact between the armature 108 and the spring 120 being the means of permanently deenergizing the ringing relay 64 to disconnect the ringing generator R from the line. The bringing of the armature 108 into contact with the spring 107 closes a locking circuit for the relay 65 from ground G^{18} through

the springs 115 and 116, springs 108 and 107, through said coil 65 to battery B. It will be seen that the coil is locked from the time the call is answered until the operator disconnects, at which time the circuit is broken at the springs 115 and 116. The relay 63 is also the means of shunting out the supervisory lamp 112 through the springs 133 and 134 and resistance coil 135. The closing of the contact 183 short-circuits the springs 69 and 70, so that the operator cannot affect the calling telephone after the called subscriber has answered.

After the conversation is completed, the calling subscriber, by hanging up his receiver, releases the automatic part of the connection and gives the operator one disconnect signal. Upon the return of the receiver to the switch hook, the springs 76 and 77 are separated, thereby opening the bridge across the line and deenergizing the line relay 54 in the trunk H. Upon the energization of this relay, the springs 99 and 101, and 197 and 198 are separated, thereby breaking the circuit of the relays 57 and 196. The relay 57, upon deenergizing, disconnects ground G^2 from the release trunk 185 and breaks the circuit of the relay 56, the armature of which relay is released to disconnect the spring 109 from the spring 110 to connect it with the spring 164. This action breaks the circuit of the relay 59 and closes the circuit of the relay 58. The relay 59, upon deenergizing, breaks the circuit of the battery reversing relay 55 at the springs 122 and 123 to revert the direction of flow to normal. The relay 58 is energized by a circuit traced from ground G^{14} through the spring contact point 183, relay 184, springs 109 and 164 and through the relay 58 to battery B, which relay energizes, closing the contact of springs 136 and 137 to place a ground potential from ground G^{10} on the release trunk 185 in lieu of the ground G^2 which was taken off when the relay 57 deenergized. Owing to the fact that the relay 56 is slow acting, a short period of time elapses between the deenergization of the relay 57 and the energization of the relay 58, during which time the ground connection is removed from the release trunk conductor 185. This length of time is sufficient to permit the relay 45 of the selector E (Fig. 2) to deenergize. Although the relay 45 is itself slow acting, the relay 56 may be made still slower. The relay 45, upon deenergizing, opens the circuit of the winding 22 of the switch C at the springs 190 and 191, and closes the circuit of the release magnet 44 at the springs 189 and 187. The latter circuit extends from ground G^{12} through the springs 181, 89, 189 and 187, magnet 44 and the springs 145 and 146 to the battery lead 100. The magnet 44, upon energizing, restores the switch E to normal position and

its circuit is broken at the springs 145 and 146 when the switch shaft comes to rest. The plunger arm 17 of the switch C is released by the deenergization of the winding 22. The grounding of the conductor 185 by the relay 58 (Fig. 3) after the automatic switches have been released is for the purpose of providing a guarding potential at the selector private bank contacts of the trunk H to prevent it from being seized after the automatic connection is released and before the operator has withdrawn the plug P.

The deenergization of the relay 196, when the calling subscriber hangs up his receiver, closes the circuit of the supervisory lamp 60 from ground G^{12} through the springs 138, 139, 140 and 141 and said lamp to the battery lead 100.

The operator is given a second disconnect signal at the lamp 112 when the receiver at the called telephone is restored to its hook. The hanging up of the receiver at the telephone S destroys the circuit of the relay 63. This relay deenergizes, allowing the armature to fall back. Upon the contact of springs 134 and 133 breaking, the shunt around the lamp 112, consisting of the resistance 135, is removed, thereby permitting sufficient current to flow through said lamp to light it, which indicates that the called subscriber has hung up. Upon the contact 183 breaking, ground G^{14} is taken from the relay 184, but this has no effect at this time, owing to the ground at G^{10} . The breaking of the contact 132 also has no effect, as the circuit of the relay 64 is locked through the springs 107 and 108 from ground G^{13} . The disk connection being completed and the receiver returned to normal, the operator removes the plug P from the jack J' , thereby deenergizing the relays 111 and 67. Upon the relay 111 deenergizing, the circuits of the relays 184 and 58 are broken and the guarding potential G^{10} is removed from the release trunk 185, and the whole apparatus is in readiness for another call.

It will thus be seen that I have devised a very efficient arrangement whereby the operator can communicate with the calling subscriber at any time by merely operating her calling key. It will, furthermore, be seen that the group of relays 54, 55, 56, 57, 58 and 59, shown at the left-hand end of the trunk line H in Fig. 3, can all be located at one end of the trunk—that is, the end terminating in the automatic exchange,—while the remaining relays can be located at the manual end of the trunk. In this manner the trunk which extends between the two exchanges is a simple two-conductor trunk, it being unnecessary to employ any third conductor associated with the same, as all the circuits for controlling the relays at the manual end of the trunk and which pass

over this trunk include one of the talking conductors.

While I have illustrated and described one particular embodiment of my invention, it will, of course, be understood that many changes and modifications can be made without departing from the spirit and scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a plurality of subscribers' lines, means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, means for rendering the calling telephone inoperative upon completion of the connection with the called line, and means for rendering the calling telephone again operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers.

2. In a telephone system, a plurality of subscribers' lines, means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, means for rendering the calling telephone inoperative upon completion of the connection with the called line, means for rendering the calling telephone again operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, and means for preventing the operator from rendering the calling telephone operative after the called subscriber answers.

3. In a telephone system, a plurality of subscribers' lines, means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, means for rendering the calling telephone inoperative upon completion of the connection with the called line, means for rendering the calling telephone operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, and means for rendering the calling telephone operative upon the response of the called subscriber, and means for preventing the operator from rendering the calling telephone operative after the called subscriber answers.

4. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said

trunk circuit and adapted to be connected thereto, means for rendering the calling telephone inoperative when connection is completed with the called line, and means for rendering said telephone operative when said operator connects the talking set with said trunk circuit.

5. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, means for rendering the calling telephone inoperative when connection is completed with the called line, and means for rendering said telephone operative when said operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers.

6. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, means for rendering the calling telephone inoperative when connection is completed with the called line, means for rendering said telephone operative when said operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers, and means for preventing the operator rendering the calling telephone operative after the called subscriber answers.

7. In a telephone system, a plurality of subscribers' lines, means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, means for reversing the current in the calling line to thereby render the calling telephone inoperative upon completion of connection with the called line, and means for again reversing the current in the calling line to render the calling telephone operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers.

8. In a telephone system, a plurality of subscribers' lines, means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, means for reversing the current in the calling line to thereby render the calling tele-

phone inoperative upon completion of connection with the called line, means for again reversing the current in the calling line to render the calling telephone operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, and means for preventing the operator from reversing the current in the called line to render the calling telephone operative after the called subscriber answers.

9. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, and means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit.

10. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, and means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers.

11. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers, and means for

preventing the operator from reversing the current in the called line to render the calling telephone operative after the called subscriber answers.

12. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, means for energizing said relay when connection is made with the called line to reverse the current in the calling line, and means controlled by the operation of said listening key for deenergizing said current-reversing relay, so that the current flows over the calling line in the normal direction.

13. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, means for energizing said relay to reverse the current in the calling line when connection is completed with the called line, means operated by said reversal of current for rendering the calling telephone inoperative, and means controlled by the operation of said listening key for deenergizing said current-reversing relay to thereby render said calling telephone operative, whereby the operator can communicate with the calling subscriber.

14. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, means for energizing said relay to reverse the current in the calling line when connection is completed with the called line, means operated by said reversal of current for rendering the calling telephone inoperative, means controlled by the operation of said listening key before the called subscriber has answered for deenergizing said current-reversing relay to thereby render said calling telephone operative, and means for preventing the operation of said listening key from rendering said calling telephone operative after the called subscriber has answered.

15. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a bridge across the conductors of the talking circuit, said bridge including a line relay and a battery connected to said bridge for

supplying current to the calling line, a current-reversing relay, means for energizing said relay when connection is made with the called line to reverse the battery connections in said bridge to thereby reverse the current in the calling line, means controlled by said reversal of current for rendering the calling telephone inoperative, and means controlled by the operation of said listening key for de-energizing said current-reversing relay, whereby the current flows over the calling line in the normal direction.

16. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a bridge across the conductors of the talking circuit, said bridge including a line relay and a battery connected to said bridge for supplying current to the calling line, a current-reversing relay, means for energizing said relay when connection is made with the called line to reverse the battery connections in said bridge to thereby reverse the current in the calling line, means controlled by said reversal of current for rendering the calling telephone inoperative, means controlled by the operation of said listening key before the called subscriber has answered for de-energizing said current-reversing relay to thereby render said calling telephone operative, and means for preventing the operation of said listening key from rendering said calling telephone operative after the called subscriber has answered.

17. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay for reversing the current in the calling line, means controlled by said reversal of current for rendering the calling telephone inoperative, and a circuit for controlling said current-reversing relay, said circuit including normally open contacts adapted to be closed when connection is made with the called line and normally closed contacts controlled by said listening key.

18. In a telephone system, a plurality of subscribers' lines, means including a trunk circuit terminating in an operator's link circuit for establishing a connection between two of said lines, an operator's talking set associated with said link circuit, a listening key for connecting said set with said link circuit, a current-reversing relay, and means for energizing said relay, said means including a circuit passing over one side of the trunk circuit and having normally open

contacts adapted to be closed when connection is made with the called line and normally closed contacts controlled by said operator's key.

19. In a telephone system, a plurality of subscribers' lines, automatic means and an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, automatic means for rendering the calling telephone inoperative upon completion of the connection with the called line, and automatic means for rendering the calling telephone again operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers.

20. In a telephone system, a plurality of subscribers' lines, automatic means and an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, automatic means for rendering the calling telephone inoperative upon completion of the connection with the called line, automatic means for rendering the calling telephone again operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, and automatic means for preventing the operator from rendering the calling telephone operative after the called subscriber answers.

21. In a telephone system, a plurality of subscribers' lines, automatic means and an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, automatic means for rendering the calling telephone inoperative upon completion of the connection with the called line, electrical controlled means for rendering the calling telephone again operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, automatic means for rendering the calling telephone operative upon the response of the called subscriber, and automatic means for preventing the operator from rendering the calling telephone operative after the called subscriber answers.

22. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, circuit means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for render-

ing the calling telephone inoperative when connection is completed with the called line, and automatic means for rendering said telephone operative when said operator connects the talking set with said trunk circuit.

23. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, circuit means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for rendering the calling telephone inoperative when connection is completed with the called line, and automatic means for rendering said telephone operative when said operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers.

24. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, automatic means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for rendering the calling telephone inoperative when connection is completed with the called line, automatic means for rendering said telephone operative when said operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers, and automatic means for preventing the operator rendering the calling telephone operative after the called subscriber answers.

25. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, automatic means for reversing the current in the calling line to thereby render the calling telephone inoperative upon completion of connection with the called line, and automatic means for again reversing the current in the calling line to render the calling telephone operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers.

26. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's connecting link for establishing a connection between two of said lines, an operator's talking set associated with said link, automatic means for reversing the current

in the calling line to thereby render the calling telephone inoperative upon completion of connection with the called line, automatic means for again reversing the current in the calling line to render the calling telephone operative without breaking the connection between said operator's link and the called line when said operator's set is connected with the connecting link before the called subscriber answers, and automatic means for preventing the operator from reversing the current in the called line to render the calling telephone operative after the called subscriber answers.

27. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, and automatic means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit.

28. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, circuit means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, and automatic means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers.

29. In a telephone system, a calling and a called subscriber's line, an operator's trunk circuit adapted to be connected with the called line, circuit means including automatic switches for extending a connection from the calling line to said trunk circuit, an operator's talking set associated with said trunk circuit and adapted to be connected thereto, automatic means for reversing the current in the calling line to render the calling telephone inoperative when connection is completed with the called line, automatic means for again reversing the current in the calling line to render the telephone operative when the operator connects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers.

nects the talking set with said trunk circuit without breaking the connection with the called line and before the called subscriber answers, and automatic means for preventing the operator from reversing the current in the called line to render the calling telephone operative after the called subscriber answers.

30. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, automatic means for energizing said relay when connection is made with the called line to reverse the current in the calling line, and circuit means controlled by the operation of said listening key for deenergizing said current-reversing relay, so that the current flows over the calling line in the normal direction.

31. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, automatic means for energizing said relay to reverse the current in the calling line when connection is completed with the called line, automatic means operated by said reversal of current for rendering the calling telephone inoperative, and means controlled by the operation of said listening key for deenergizing said current-reversing relay to thereby render said calling telephone operative, whereby the operator can communicate with the calling subscriber.

32. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay, automatic means for energizing said relay to reverse the current in the calling line when connection is completed with the called line, automatic means operated by said reversal of current for rendering the calling telephone inoperative, automatic means controlled by the operation of said listening key before the called subscriber has answered for deenergizing said current-reversing relay to thereby render said calling telephone operative, and automatic means for preventing the operation of said listening key from rendering said calling telephone operative after the called subscriber has answered.

33. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's link circuit for establishing a

connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a bridge across the conductors of the talking circuit, said bridge including a line relay and a battery connected to said bridge for supplying current to the calling line, a current-reversing relay, automatic means for energizing said relay when connection is made with the called line to reverse the battery connections in said bridge to thereby reverse the current in the calling line, means controlled by said reversal of current for rendering the calling telephone inoperative, and means controlled by the operation of said listening key for deenergizing said current-reversing relay, whereby the current flows over the calling line in the normal direction.

34. In a telephone system, a plurality of subscribers' lines, means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a bridge across the conductors of the talking circuit, said bridge including a line relay and a battery connected to said bridge for supplying current to the calling line, a current-reversing relay, automatic means for energizing said relay when connection is made with the called line to reverse the battery connections in said bridge to thereby reverse the current in the calling line, automatic means controlled by said reversal of current for rendering the calling telephone inoperative, circuit means controlled by the operation of said listening key before the called subscriber has answered for deenergizing said current-reversing relay to thereby render said calling telephone operative, and automatic means for preventing the operation of said listening key from rendering said calling telephone operative after the called subscriber has answered.

35. In a telephone system, a plurality of subscribers' lines, circuit means including an operator's link circuit for establishing a connection between two of said lines, an operator's talking set, a listening key for connecting said set with said link circuit, a current-reversing relay for reversing the current in the calling line, automatic means controlled by said reversal of current for rendering the calling telephone inoperative, and a circuit for controlling said current-reversing relay, said circuit including normally open contacts adapted to be closed when connection is made with the called line and normally closed contacts controlled by said listening key.

36. In a telephone system, a plurality of subscribers' lines, circuit means including a trunk circuit terminating in an operator's

link circuit for establishing a connection between two of said lines, an operator's talking set associated with said link circuit, a listening key for connecting said set with said link circuit, a current reversing relay, and circuit means for energizing said relay, said means including a circuit passing over one side of the trunk circuit and having normally open contacts adapted to be closed

when connection is made with the called line and normally closed contacts controlled by said operator's key.

Signed by me at Chicago, Cook county, Illinois, this 11th day of April, 1913.

BERNARD D. WILLIS.

Witnesses:

ALBERT ANDERSEN,

ARTHUR J. RAY.

It is hereby certified that in Letters Patent No. 1,130,784, granted March 9, 1915, upon the application of Bernard D. Willis, of Chicago, Illinois, for an improvement in "Measured-Service Telephone Systems," an error appears in the printed specification requiring correction as follows: Page 6, line 80, and page 9, line 113, for the word "subscribed" read *subscriber*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of May, A. D., 1915.

[SEAL.]

R. F. WHITEHEAD,
Acting Commissioner of Patents.