A. B. SMITH.

AUTOMATIC OR SEMI-AUTOMATIC TELEPHONE SYSTEM.

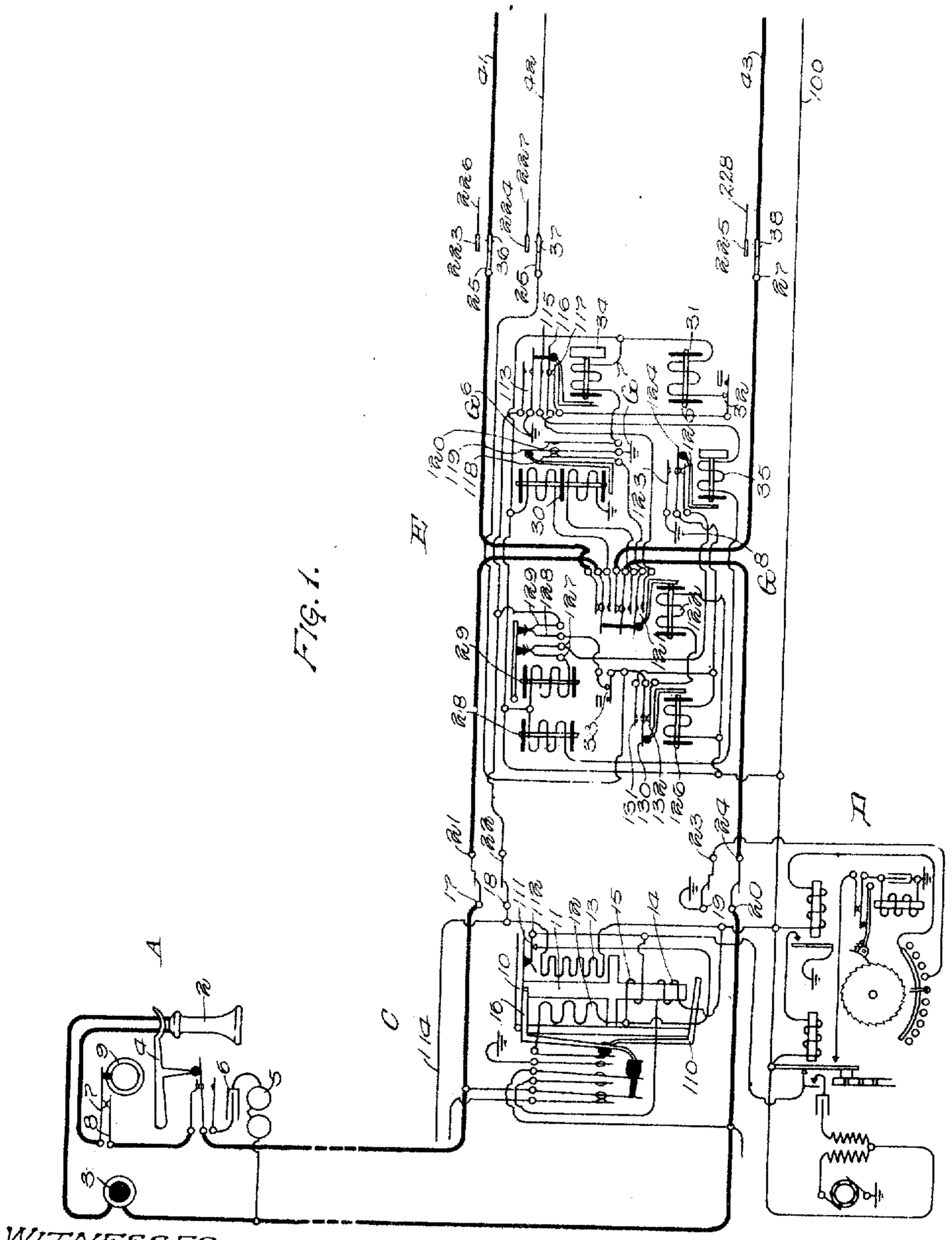
APPLICATION FILED MAR. 25, 1914.

1,267,131.

Patented May 21, 1918.

5 SHEETS—SHEET 1.

FIG. 1.



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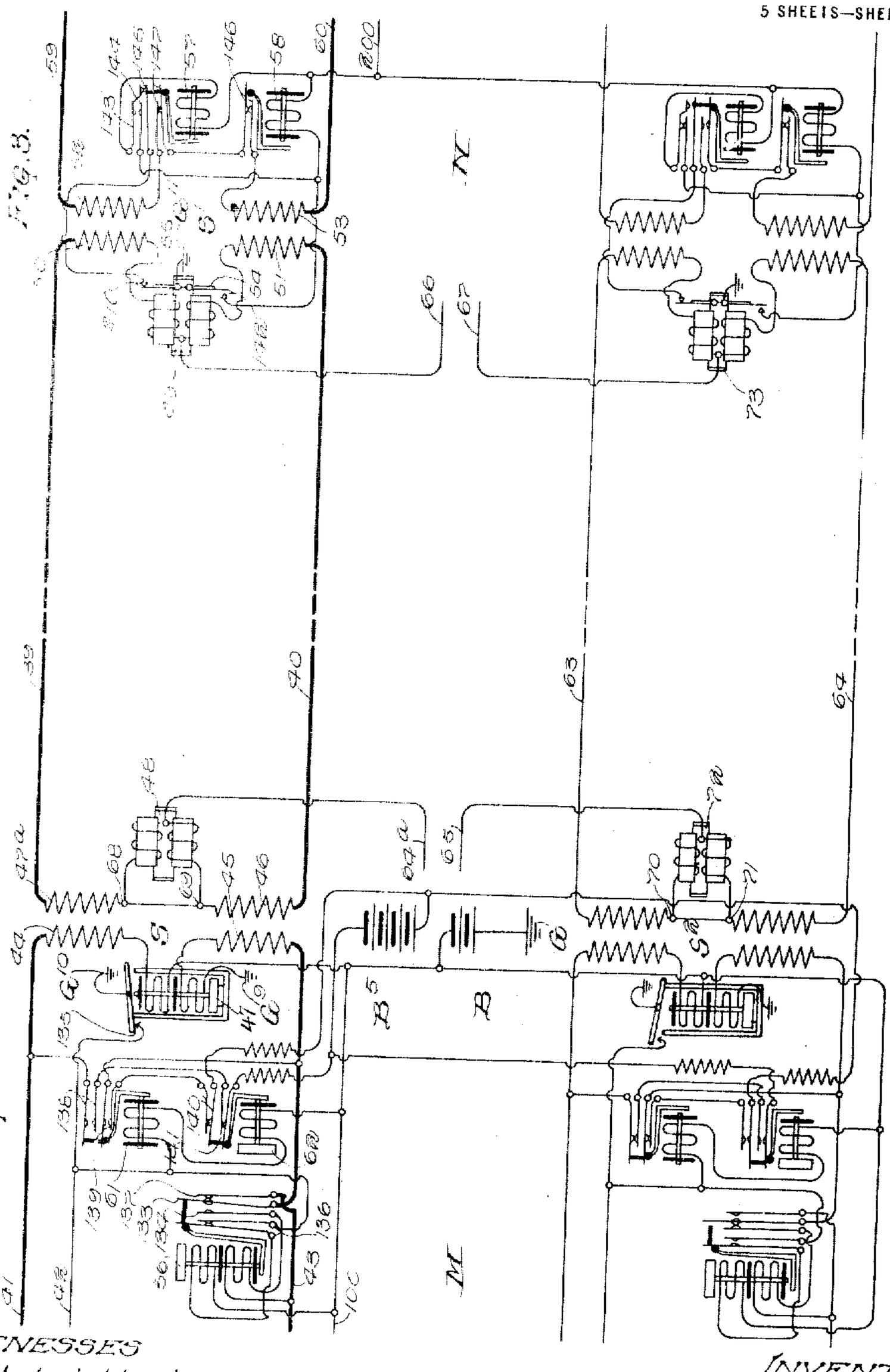

WITNESSES
Herbert W. Kracke
G. Yanchowski

INVENTOR.
ARTHUR B. SMITH
Culley & Sweatman
ATTORNEYS.

A. B. SMITH.

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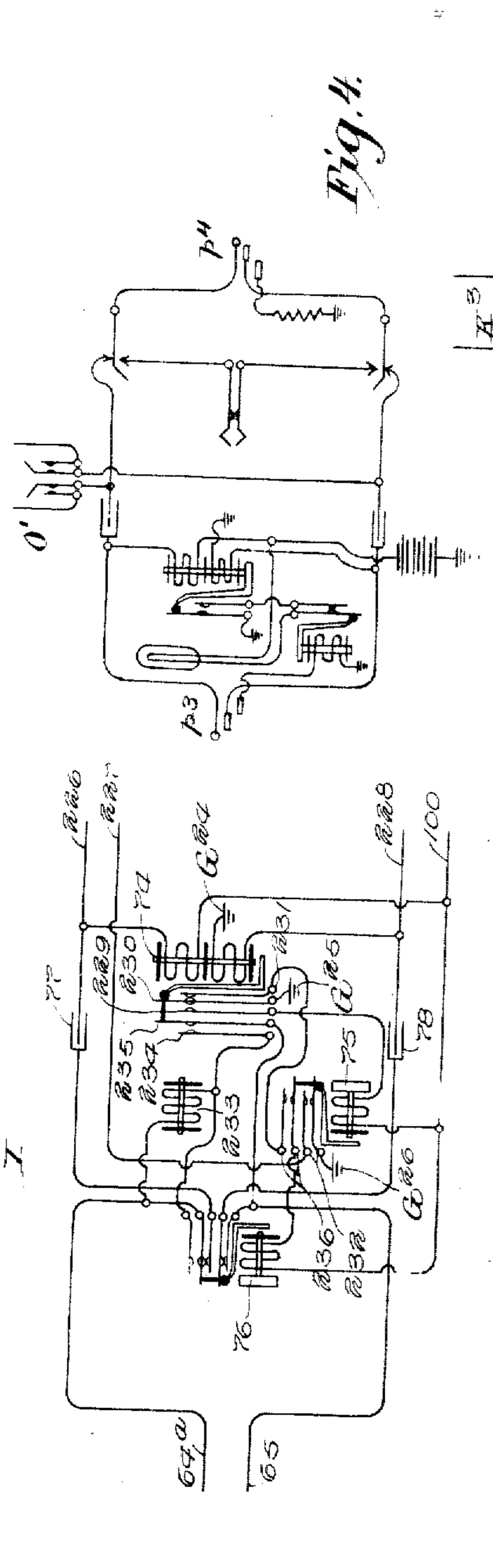
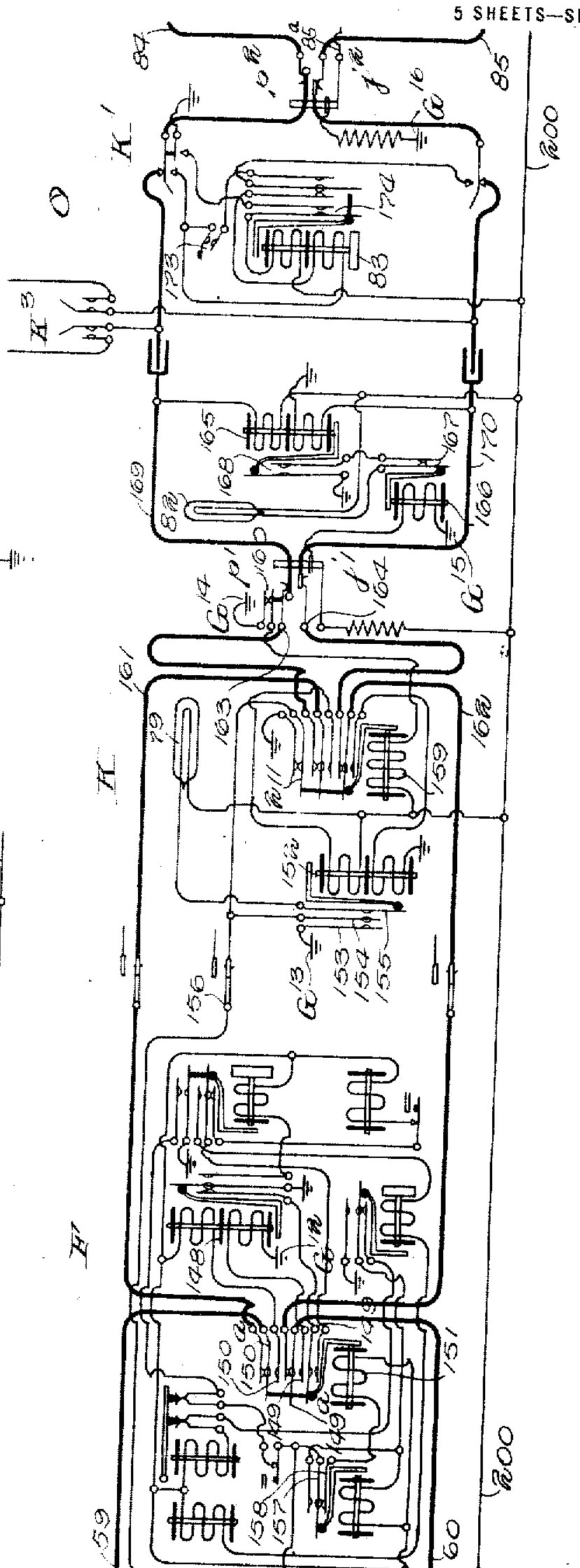


Fig. 4.



WITNESSES

Herbert W. Kracke

G. Yanchenski

INVENTOR:

ARTHUR B. SMITH

Culbert Smith

ATTORNEYS.

A. B. SMITH.

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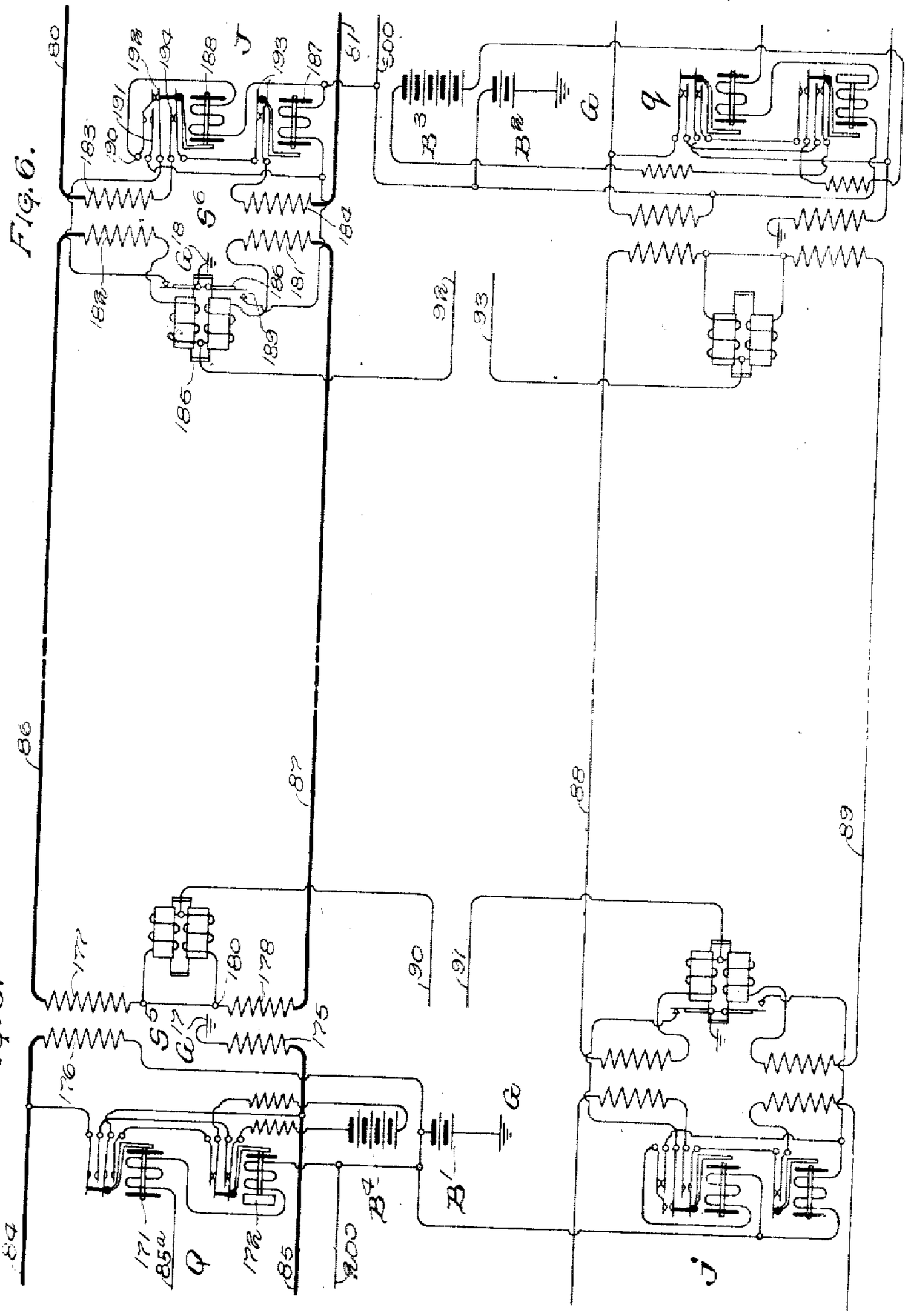

WITNESSES

Hubert W. Hracke

G. Janochowski

INVENTOR:

ARTHUR B. SMITH

By Bulkley & Sweatt

ATTORNEYS.

A. B. SMITH.

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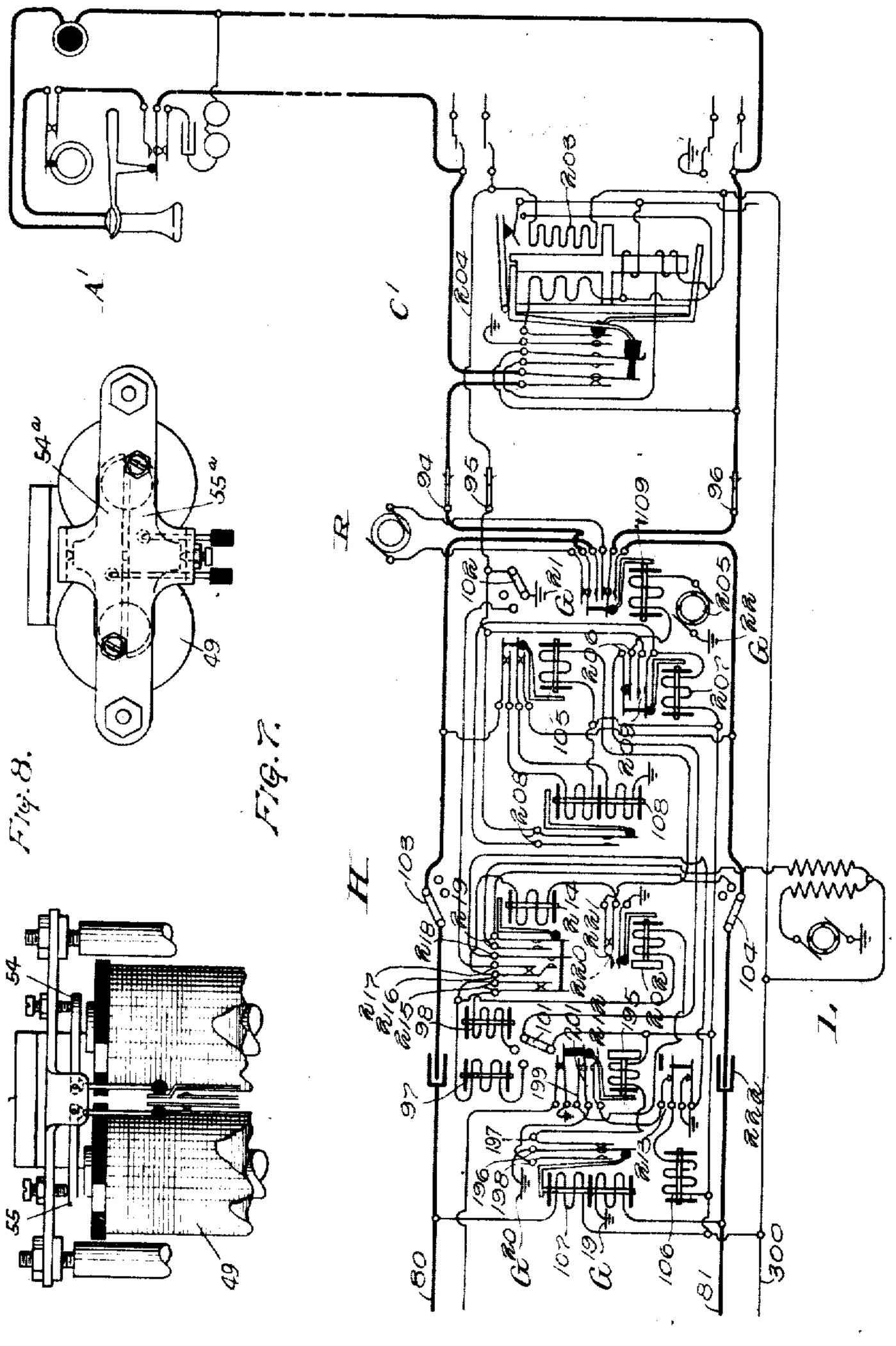

FIG. 7.

FIG. 8.

WITNESSES
Herbert W. Kracke
B. Yanoshonski

INVENTOR:
ARTHUR B. SMITH
By Bulkley & Sweatt
ATTORNEYS.

UNITED STATES PATENT OFFICE.

ARTHUR BESSEY SMITH, OF EVANSTON, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC OR SEMI-AUTOMATIC TELEPHONE SYSTEM.

1,267,131. Specification of Letters Patent. **Patented May 21, 1918.**

Application filed March 25, 1914. Serial No. 827,063.

To all whom it may concern:

Be it known that I, ARTHUR BESSEY SMITH, a citizen of the United States of America, and resident of Evanston, Cook county, Illinois, have invented certain new and useful Improvements in Automatic or Semi-Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic or semi-automatic telephone systems and has for its object the provision of such a system in which phantom circuits may be employed for establishing connections.

Heretofore attempt has been made to use phantom circuits in telephone systems, but in every instance, as far as I am aware, the physical circuits on which the phantom circuit is superimposed have been used only for establishing manual connections, but I believe that I am the first to employ these physical circuits for the purpose of establishing a call through automatic switches. In order to accomplish this it is necessary that that part of the physical circuits on which the phantom circuit is superimposed should be insulated from the rest of the physical circuits in order to prevent any interference with the phantom circuit.

A feature of my invention, therefore, relates to this insulation of that part of the physical circuit which is employed by the phantom circuit, together with the provision of means whereby a call can be made automatically over such a physical circuit without interfering in any way with the phantom circuit. The phantom circuit can be employed either in connection with a call which is established automatically, or with a call which is established manually, although I have shown specific means whereby this phantom circuit can be employed in an automatic call. Likewise the connection can be made to the physical circuit either automatically or through an operator's manual board.

These and other features and objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated my invention in connection with certain specific means for extending a connection to and from the physical circuits and the phantom circuit of the trunk. As illustrated, these means involve automatic switches of well-known types, and as the specific form of these switches which are employed for extending the connection to and from this trunk line forms no part of my present invention, and as these switches are fully described in the publications and patents hereinafter referred to, a detailed description of these various switches will not be given, except in so far as is necessary for a clear understanding of the various features of my invention.

In the drawings, Figures 1 to 7, inclusive, are diagrammatic representations of a circuit connection established between a calling subscriber in Fig. 1 of one exchange and a called subscriber in Fig. 7 at another exchange in a system embodying the features of my invention. Fig. 8 shows the mechanical details and construction of a polarized relay with modifications which may be used in connection with my system at 49, 73, etc., for repeating impulses over the physical circuit.

Figs. 1 and 2 taken together represent apparatus at the first said exchange. There is herein shown a subscriber's substation A, the line conductors of which terminate in an individual or line switch C. The line switch shown at C is one of a group of similar line switches, the plungers (not shown) of which engage a shaft and are controlled by the operation of the master switch D in such a manner that they are, when in normal position, held directly in front of the terminals of a trunk line leading to a selector E. Certain levels of the said selector banks contain trunk lines which lead through a group of relays M over the trunk lines to the intermediate exchange. It is, of course, understood that certain other levels of said selector banks may lead to various other apparatus in said exchange for completing connections within said exchange.

Figs. 3, 4 and 5 taken together represent apparatus at the intermediate or second exchange. It will, of course, be understood that the subscribers' substations of this exchange may be of any type whatsoever and that the said exchange contains the necessary apparatus (not shown) for completing connections within the exchange. The relays N form the connecting link between the trunk lines leading from the first said exchange to the selector F in the second exchange. Certain levels of the said selector banks terminate in groups of relays K,

which in turn connect with answering jacks j', the said jacks being located in a manual board in said exchange. The said manual board contains, together with other apparatus, the cord circuits O, which cord circuits are adapted for extending connection from jacks j' to jacks j^2. The said jacks j^2 are the terminals of the conductors leading to a group of relays Q (Fig. 5), which relays are connected to trunk lines leading to a third exchange, shown in Figs. 6 and 7. The function of the repeaters I (Fig. 4) will be hereinafter explained.

Figs. 6 and 7 taken together represent apparatus in the third-mentioned exchange. It is, of course, understood that the subscribers' substations of said exchange, as in the above case, may be of any type whatsoever and that the said exchange contains the necessary apparatus (not shown) for completing connection within the exchange. The group of relays J (Fig. 6) form the connecting link between the trunk lines leading from the said second exchange to the connector H in the third exchange. The said connector switches complete the connection to the called substation A' through the medium of the line switch C'.

Figs. 2 and 3 taken together represent three trunk lines connecting the first said exchange with the second exchange, two of the said trunk lines being what are known as physical circuit trunk lines, while the third trunk line is known as a phantom circuit trunk line.

Figs. 5 and 6 taken together represent three trunk lines connecting the aforesaid second exchange with the third exchange. Two of the said trunk lines, like in the above-mentioned case, are what are known as physical circuit trunk lines, while the third trunk line is what is known as a phantom circuit trunk line.

While in these drawings I have indicated the trunk lines terminating in one certain type of automatic switch, it will, of course, be understood that in ordinary practice suitable selector switches may be inserted throughout the system without departing from the principles of my invention. For example: Referring to Fig. 7, instead of connecting the trunk line 80—81 directly to the connector switch H, a suitable selector or a plurality of selector switches, similar to the selector E, may be inserted between the trunk line 80—81 and the connector switch H.

There is shown throughout the drawings a plurality of batteries, namely B, B' and B^2, each having one terminal grounded at G. Each exchange is shown provided with one of said batteries for supplying current for operating the central office equipment and for furnishing talking current. There is likewise shown a plurality of batteries B^3, B^4 and B^5. These are preferably double voltage batteries, *i. e.*, their voltage is higher than the voltage of the before-mentioned batteries. The use of these batteries will hereinafter be explained.

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

The subscriber's individual switch C is of the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, being, however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910. This line switch comprises, among other details, a plunger (not shown) attached to the end of the so-called plunger arm 10, which is controlled by the magnet 11. The magnet 11 comprises four windings, namely, a pull-down winding 12, a cut-off or holding winding 13, a line winding 14 and an auxiliary or holding winding 15. The core of the magnet 10 is so constructed that the magnetic circuit of the windings 12 and 13 is separate from that of the windings 14 and 15. The winding 12 operates both the plunger arm 10 and the armature 16, while the winding 13 is only strong enough to operate the cut-off armature 16 and to hold the plunger arm 10 in its operated position. When the plunger arm 10 is operated, the plunger is forced into a bank of contact springs, forcing the springs 17, 18, 19 and 20 into engagement with the springs 21, 22, 23 and 24, respectively. Although only one set of springs (17—24) is shown, each line switch is provided with a plurality of such sets, each set forming the terminal of a trunk line leading to the selector E. Each trunk line is connected in multiple with the corresponding springs of all the line switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber through the medium of the line relay 14, as will be hereinafter more fully explained.

The master switch D is of the general type disclosed in British Patent No. 26,301 of 1906, hereinabove referred to, being, however, of the particular type disclosed in said British Patent No. 1419 of 1910. The function of the master switch, as is well known, is to maintain the plungers of all the idle

line switches in position to engage the terminals of an idle trunk line.

The selector switch E is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, except that the so-called side switch is omitted and the circuits are modified to adapt the switch to operate in a system in which it is controlled by impulses delivered over two sides of the line in series, in the manner shewn in British Patent No. 10,370 of 1912, granted to T. G. Martin. Among other details, the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 25, 26 and 27 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 28 and a rotary movement controlled by the rotary magnet 29. The operations of various parts of the switch are controlled through the medium of a double-wound line relay 30. Means for permitting the switch to be restored to normal position are provided in the release magnet 31, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 32 and 33 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 34 and 35 are slow acting relays—that is, they deënergize slowly after their energizing circuits are broken.

The group of relays M (Fig. 2) connect the bank terminals 36, 37 and 38 of the selector E with the trunk line 39—40. The battery B is bridged across the conductors 41—43 through the windings of the slow acting polarized relay 47 in series with the windings 44 and 45 of the repeating coil S. The impulses of current transmitted through the windings 44 and 45 of the repeating coil S, due to the momentary separation of the impulse springs 7 and 8 of the substation A, operate to induce impulses of current in the windings 47^a and 46 of the said repeating coil S. The said induced impulses extend from the point 69 through the winding 46 of the repeating coil S, over the trunk conductor 40, windings 51 and 50 of the repeating coil S′ in series with the polarized relay 49, over the return conductor 39 and through the winding 47^a of the repeating coil S back to the starting point. The polarized relay 49 is constructed with two separate armatures, namely, 54 and 55. It is well known that an impulse of current is generated in the secondary of an induction coil when a circuit is established in the primary as well as when the circuit is broken. However, it is also well known that the circuit through the primary of the said coil may be so arranged with regard to resistance and voltage that this impulse which is induced in the secondary when the primary circuit is established is either stronger or weaker than that which is induced when the circuit is broken. Therefore, in my system in which the impulse on the break alone is utilized the primary circuit is so arranged that the impulse induced when the circuit is established is the weaker and the armatures of the polarized relay 49 may be easily adjusted so that this weaker impulse will not affect them. The armature 54 responds to impulses of current transmitted through the relay 49 in one direction, and the armature 55 responds to the impulses transmitted through the relay 49 in the opposite direction. The said relay 49 is so constructed and adjusted as not to respond to battery current over the phantom circuit trunk line. The relays 57 and 58 control the operation of the switches located in the intermediate exchange. The relays 61 and 62 control the application of battery from the high voltage battery B^5 to the conductors 41 and 43 for releasing purposes, which will be hereinafter more fully explained. The operation of the groups of relays M and N of the trunk line 63—64 is similar to the operation of the groups of relays M and N of the trunk line 39—40. The conductors 64^a and 65 and 66 and 67 are the phantom taps of the trunk lines 39—40 and 63—64. I preferably join the points 68—69 and 70—71 of the repeating coils S and S^2, thus short-circuiting the polarized relays 48 and 72, respectively. As it is well known by those versed in the art that there is not any difference of potential between corresponding points on the two conductors forming one limb of the phantom circuit, the balance of my phantom circuit is not affected by connecting said points together, and the resistance of each of my physical circuits is somewhat decreased, thus giving stronger induced impulses to operate the armatures of the polarized relays 49 and 73, respectively.

The repeater I is adapted to receive impulses from the substation and to repeat them over the phantom trunk line to a second exchange. Among other details, it comprises a double-wound line relay 74 and the slow acting relays 75 and 76. The slow acting relay 76 operates to cut the condensers 77 and 78 out of circuit while the repeater is operating to repeat impulses to the said second exchange.

The selector F is similar in all respects to the selector E.

The device K consists of a plurality of relays, together with the usual line signal lamp 79 and answering jack j'.

The cord circuit O is provided with the usual supervisory signal 82 and the necessary relays for controlling the same. When the key K′ is operated, the slow acting relay 83 operates to transmit an impulse of cur-

rent over the conductors 84 and 85. The function of said preliminary impulse of current will be hereinafter explained.

The trunk lines 86—87 and 88—89 (Figs. 5 and 6) are similar to the trunk lines 39—40 and 63—64, except that they are arranged to be seized manually, *i. e.*, by means of a plug and jack, instead of by an automatic switch. It will also be seen that the trunk line 86—87 is arranged for extending a connection in one direction, while the trunk line 88—89 is arranged for extending a connection in the opposite direction. The conductors 90 and 91 and 92 and 93 form the phantom taps of the trunk lines 86—87 and 88—89, as in the previous case.

The connector H (Fig. 7) is of the same general type of connector 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. Like the selectors, the connector is provided with a shaft (not shown) carrying the wipers 94, 95 and 96, which shaft is controlled by the vertical magnet 97 and the rotary magnet 98. The usual side switch comprising the wipers 101, 102, 103 and 104 is controlled by the private magnet 105 in the usual well-known manner. The magnet 106 is the usual release magnet. The line relay 107 is connected to the line conductors 80 and 81. The so-called back-bridge relay 108 provides talking battery current for the called substation. The ringing relay 109 is the means through which ringing current is applied to the called line. The busy signaling machine I, as herein represented, comprises an induction coil or transformer, the primary winding of which is included in a local circuit with a battery and two interrupters, one of high frequency and one of low frequency. Through the medium of these interrupters an intermittent interrupted current is supplied to the primary winding, which induces an intermittent alternating current in the secondary winding, whereby when said winding is connected with the subscriber's line an intermittent buzzing sound is heard in the receiver.

The substation A′ and the line switch C′ are similar in all respects to the substation A and the line switch C.

A general description of the apparatus having been given, it will now be explained how a connection is extended from a calling substation A, whose lines terminate in one exchange, to a called substation A′, whose lines terminate in another exchange, the connection extending through an intermediate exchange. We will assume that the calling subscriber A must call the number 22 to obtain connection with the operator at the intermediate exchange.

Upon the removal of the receiver from the switch-hook at the substation A preparatory to making a call, an energizing circuit is closed through the line winding 14 of the individual switch C, thereby attracting the line armature 110. The armature 110, upon being attracted, closes a circuit through the pull-down coil 12 in series with the auxiliary winding 15. The pull-down coil, upon energizing, attracts the plunger arm 10 to force the plunger into the bank of springs 17—24, inclusive. It also operates the cut-off armature 16, thereby disconnecting the line winding 14 from the line.

The armature 110 does not fall back immediately, however, owing to the fact that the winding 15 is still in series with the pull-down winding 12. Upon the plunger arm 10 being attracted, the springs 111 and 112 are brought together to short-circuit the auxiliary winding 15, making the same slightly slow acting. The armature 110 being slow to fall back allows sufficient time for a holding circuit to be closed in the switch ahead for the cut-off or holding winding 13. The engagement of the springs 17 and 20 with the springs 21 and 24, respectively, extends the subscribers' lines to the line relay 30 of the selector E. The line relay 30 of the selector switch E is thereupon energized, closing a circuit through the relay 34. The relay 34, upon energizing, closes the above-mentioned holding circuit through the cut-off winding 13 of the line switch C. This circuit extends from ground G^6 through the springs 113, bank springs 22 and 18 and the cut-off winding 13 to the battery lead 100, thence through battery B to ground G. The winding 13, upon energizing, holds the armature 16 and the plunger arm 10 in their operated positions after the circuit of the pull-down winding is broken by the falling back of the line armature 110. A guarding ground potential is supplied to the connector private bank contacts of the calling line as soon as the relay 34 is energized. This circuit extends over the circuit just traced to the bank spring 18, thence over the trunk 114 to said private bank contact. The energization of the relay 34 also prepares a circuit for the vertical magnet by bringing into engagement the springs 115 and 116 and opens the circuit of the release magnet at the springs 116 and 117.

The calling subscriber now operates his calling device for the first digit 2, whereby the substation impulse springs 7 and 8 are operated twice momentarily, each time breaking the circuit of the selector line relay 30. The relay 34 of the selector being slow acting does not deënergize during the momentary interruptions of its circuit by the line relay 30, and consequently each time the latter relay

deënergizes, an impulse is transmitted over the circuit extending from ground G^7, through the contact of springs 119 and 118, springs 121 of the relay 122, springs 116 and 115 of the relay 34, relay 35 and the vertical magnet 28 to the battery lead 100. The vertical magnet receives two impulses of current over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts. The off-normal springs 32 and 33 close as soon as the shaft is raised one step, but the circuit of the release magnet 31 still remains open at the springs 116 and 117. The slow acting relay 35 is maintained in its energized position while impulses are being sent through it to the vertical magnet, and in its energized position closes a circuit extending from ground G^8 through the springs 123 and 124 and the relay 126 to the battery lead 100. The relay 126, upon energizing, closes a locking circuit for itself extending from ground G^6 at the relay 34 through the springs 113, rotary magnet springs 129 and 128, normal springs 33 and the springs 130 and 131 of the relay 126, thence through the said relay 126 to the battery lead 100. Thus, upon the deënergization of the relay 35 after the last impulse is delivered to the vertical magnet, the relay 126 remains energized and the circuit of the rotary magnet is closed. This circuit extends from ground G^6 through the springs 113, springs 129 and 128, normal springs 33, springs 130 and 131, springs 124 and 125, interrupter springs 127 and the rotary magnet 29 to the battery lead 100. The rotary magnet, upon energizing, rotates the wipers one step and, by opening the springs 128 and 129, disconnects ground G^6 from itself and the relay 126. If the first trunk line of the second level is idle, the relay 126 deënergizes as soon as the springs 128 and 129 are opened. If this trunk line is busy, however, the private wiper 26 finds the contact with which it engages provided with a guarding ground potential, which is transmitted to the relay 126 through the springs 130 and 131, thereby preventing it from deënergizing. The rotary magnet, however, deënergizes when the springs 127 separate, regardless of whether the relay 126 remains energized or not. If the relay 126 remains energized, the circuit of the rotary magnet will be again closed as soon as the armature drops back far enough to close the springs 128 and 129. The rotary magnet will therefore operate in the manner of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper 26, whereupon the relay 126 deënergizes. The relay 126, upon deënergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of the magnet 29 and closes the circuit of the switching relay 122. The circuit through said relay 122 extends from ground G^6 through the springs 113, springs 129 and 128, springs 33, springs 130 and 132 and the relay 122 to the battery lead 100. The relay 122, upon energizing disconnects the line relay 30 from the line and extends the line connection over the heavy conductors through the wipers 25 and 27 to the group of relays M (Fig. 2) of the trunk line 39—40. The wipers 25 and 27 making contact with the conductors 41 and 43, respectively, close a circuit through the line relay 47, the said circuit extending from ground G^9 through the lower winding of the relay 47, winding 45 of the repeating coil S, springs 133 and 134 of the relay 56, the lower winding of said relay, conductor 43, wiper 27, over the heavy conductors, through the substation A, over the heavy return conductor, wiper 25, conductor 41, winding 44 of the repeating coil S and the upper winding of the relay 47 to the battery B. The relay 47, upon energizing, provides a holding circuit for the relay 122 of the selector E and the winding 13 of the line switch C. The said circuit for the relay 122 of the selector E extends from ground G^{10} through the contact of springs 135, conductor 42, wiper 26, springs 130 and 132 and the relay 122 to the battery lead 100. The holding circuit for the winding 13 extends over the above-traced circuit through the wiper 26, off-normal springs 33, springs 128 and 129, bank springs 22 and 18 and through the winding 13 to the battery lead 100. A further result of the energization of the relay 47 is to close an energizing circuit through the relays 61 and 62. The said circuit extends from ground G^{10} through the springs 135 and the relays 61 and 62 to the battery B. The relay 61 energizing quicker than the relay 62 opens the contacts of its springs 138 and 139 before the relay 62 closes its contact springs 140 and 141. Therefore the energization of said relays is functionless at this time. The relay 56, upon energizing, completes a locking circuit for itself through the springs 136 independent of its energizing circuit. A further result due to the energization of said relay 56 is to momentarily open the energizing circuit of the relay 47 at the springs 134 and 133, and then to again close said circuit at the springs 133 and 137, thus connecting the conductor 43 direct to one terminal of the winding 45 of the repeating coil S. The said operation of the relay 56 transmits one impulse of current through the windings 45 and 44 of the repeating coil S, which impulse of current induces a corresponding impulse of current in the secondary windings 46 and 47^a of said repeating coil. The induced impulse extends from the point 69 through the winding 46 of the repeating coil S, trunk conductor

40, winding 51 of the repeating coil S', polarized relay 49, winding 50 of the repeating coil S', trunk conductor 39 and the winding 47^a of the repeating coil S back to the point 69. The armature 54 of the polarized relay 49 responds to said impulse and closes a circuit through the relays 57 and 58. The said circuit for the relay 57 extends from ground G^{11} through the contact of springs 142, springs 144 and 143 and the relay 57 to the battery lead 200. The relay 57, upon energizing, closes a locking circuit for itself through the springs 145 and 143 independent of its energizing circuit. A further result of the energization of said relay is to close a bridge across the conductors 59 and 60, thus energizing the line relay 148 of the selector F. The said energizing circuit extends from ground G^{12} (Fig. 4) through the lower winding of the line relay 148, springs 149 and 149^a of the relay 151, trunk conductor 60, winding 53 of the repeating coil S', springs 146, springs 147, winding 52 of the repeating coil S', trunk conductor 59, springs 150 and 150^a of the relay 151 and the upper winding of the relay 148 to the battery lead 200. The apparatus is now in readiness for the operation of the dial at the calling substation for the second digit 2.

The operation of the calling device for the second digit 2 opens the energizing circuit of the relay 47 twice, but as the said relay is slow acting it does not deënergize during the momentary interruption of its circuit at the substation, thereby preventing the first selector E and the line switch C from releasing. The opening and closing of the said impulse springs at the substation causes the windings 44 and 45 of the repeating coil S to induce impulses of current in the secondary windings 47^a and 46 of said repeating coil. The armature 54 of the polarized relay 49 responding to said induced impulses operates to repeat the said impulses to the relay 58 over a circuit extending from ground G^{11} through the contact of springs 142 and the relay 58 to the battery lead 200. The relay 58 responding to said impulses repeats the same to the line relay 148 of the selector F. The operations of the selector F that are brought about by the line relay 148 are similar in all respects to the operations of the first selector E. The selector F, upon being thus operated, extends the line connection to the group of relays K. The relay 152 of the said group of relays thereupon becomes energized and closes a holding circuit for the relay 151 of the selector F and also causes the line lamp 79 to glow. The holding circuit for the said relay 151 extends from ground G^{13} through the contact of springs 153 and 154, wiper 156, contact of springs 157 and 158 and the relay 151 to the battery lead 200.

The operator at the manual board noticing the lamp 79 glowing inserts the plug p' of the cord circuit o into the jack j'. The insertion of the plug p' into the jack j' causes the relays 159, 166 and 165 to energize. The energizing circuit for the relay 159 extends from ground G^{14} through the contacts of the springs 160 and the relay 159 to the battery lead 200. The relay 159, upon energizing, operates to close a new holding circuit for the relay 151 of the selector F and to disconnect the conductors 161 and 162 from the line relay 152 and to connect the said conductors with the jack springs 163 and 164, respectively. The energizing circuit for the relay 166 extends from ground G^{15} through the said relay, sleeve of the jack j' and the bushing of the plug p' to the battery lead 200. The relay 166, upon energizing, operates to close a circuit through the springs 167 to cause the lamp 82 to glow, but the said circuit is immediately opened at the springs 168 by the energization of the relay 165. The operator now operates the key K^3 to bridge her talking set across the line conductors 169 and 170 and receives the calling subscriber's order. Upon learning that the subscriber at substation A', whose line terminates in a distant exchange, is wanted, she inserts the plug p^2 into the jack j^2. We will assume that the called substation's number is 20. The insertion of the plug p^2 into the jack j^2 causes the relays 171 and 172 (Fig. 5) to energize over a circuit extending from ground G^{16} through the sleeve of the plug p^2, bushing of the jack j^2 and the relays 171 and 172 in series to the battery B'. The energization of said relays is functionless at this time. The operator now throws the key K', bridging her calling device 173 across the conductors 84 and 85, thus energizing the relay 83. The relay 83, upon energizing, completes a locking circuit for itself through the springs 174 independent of its energizing circuit, and also operates to transmit one impulse of current over the conductors 83 and 84 in the same manner as the relay 56 (Fig. 2) operated in the previous instance. The said impulse of current extends from ground G^{17} through the winding 175 of the repeating coil S^5 over the conductor 85, through the cord circuit o, over the return conductor 84 and winding 176 of the repeating coil S^5 to battery B'. This impulse of current induces a corresponding impulse of current in the windings 177 and 178 of said repeating coil S^5. The induced impulse extends from the point 180 through the winding 178 of the repeating coil S^5, conductor 87, winding 181 of the repeating coil S^6, polarized relay 185, winding 182 of the repeating coil S^6, conductor 86 and the winding 177 of the repeating coil S^5 to the point 180. The armature 186 of the polarized relay 185 responds to said impulse and closes a circuit through the relays 187

and 188. The said circuit for the relay 188 extends from ground G^{18} through the contact of springs 189, springs 191 and 190 and the relay 188 to battery B^2. The relay 188, upon energizing, closes a locking circuit for itself through the springs 190 and 192 independent of its energizing circuit. A further result of the energization of said relay is to close a bridge across the conductors 81 and 80, thus energizing the line relay 107 (Fig. 7) of the connector H. The said energizing circuit extends from ground G^{19} through the lower winding of the line relay 107, conductor 81, winding 184 of the repeating coil S^5, springs 193, springs 194, winding 183 of the repeating coil S^6, conductor 80 and the upper winding of the line relay 107 to the battery lead 300. The said relay, upon energizing, closes an energizing circuit through the relay 195 from ground G^{20} through the contact of springs 196 and 197 and the relay 195 to the battery lead 300. The apparatus is now in readiness for the operation of the dial at the operator's calling device for the first digit 2.

The operation of the said calling device for the first digit 2 closes and opens the aforesaid circuit through the windings 175 and 176 of the repeating coil S^5, thus transmitting two impulses of current through the said windings. The said impulses of current induce corresponding impulses of current in the windings 178 and 177 of the repeating coil S^5. The armature 186 of the polarized relay 185 responding to said induced impulses operates to repeat the impulses to the relay 187 over a circuit extending from ground G^{18} through the contact of springs 189 and the relay 187 to battery B^2. The relay 187 responding to said impulses repeats the same to the line relay 107 of the connector H. Since the relay 195 is slow acting it does not deënergize during the momentary interruptions of its circuit by the relay 107, so that each time the latter relay is deënergized a circuit is closed extending from ground G^{20} through the contact of springs 196 and 198, springs 201 and 199, relay 202, vertical magnet 97 and the side switch wiper 101 (in first position) to the battery lead 300. The vertical magnet 97 receives two impulses over this circuit and operates to raise the switch wipers 94, 95 and 96 to a position opposite the second level of bank contacts. The relay 202, which was included in series with the vertical magnet, remains in its energized position during the entire time that impulses are being sent through it and operates to close the circuit of the private magnet 105. After the last impulse is delivered, the relay 202 opens the circuit of the private magnet 105, which, upon deënergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 101 from first to second position transfers the battery connection from the vertical magnet 97 to the rotary magnet 98. The operator now operates her calling device for the last digit 0, in response to which the connector line relay operates to transmit ten impulses through the rotary magnet 98 in series with the relay 202, whereby the shaft wipers are rotated onto the contacts of the desired line. If the called line is idle, the private magnet 105 deënergizes when its circuit is broken by the relay 202 after the last impulse is delivered to the rotary magnet. The deënergization of the said private magnet 105 allows the side switch to advance one more position—that is, from second to third position. By the engagement of the wipers 103 and 104 with their third-position contact points, and by the energization of the bridge-cut-off winding 203 of the line switch C', the connection is completed over the heavy conductors shown to the called substation. The circuit for the bridge-cut-off winding 203 of the line switch C' extends from ground G^{21} through the side switch wiper 102 (in third position), private wiper 95, conductor 204 and the winding 203 to the battery lead 300. A guarding ground potential is supplied to the connector private bank contact of the called line, which prevents the called line from being seized by some other connector switch. By the engagement of the side switch wiper 101 with its third-position contact point, the circuit of the ringing relay 109 is closed. This circuit extends from ground G^{22} through the interrupter 205, relay 109, springs 206 and the side switch wiper 101 (in third position) to the battery lead 300. The ringing relay, upon energizing, disconnects the calling line from the called line and bridges the ringing current generator R across the called line to signal the called subscriber. The ringing relay 109 is energized only intermittently through the medium of the interrupter 205. Upon the response of the called subscriber his line is provided with talking current through the windings of the back-bridge relay 108, which relay, upon energizing, closes the circuit of the ringing cut-off relay 207. The said circuit extends from ground G^{21} through the side switch wiper 102 (in third position), springs 208 of the relay 108 and the ringer cut-off relay 207 to the battery lead 300. The relay 207, upon energizing, interrupts the circuit of the ringing relay 109 at the springs 206 and closes a locking circuit for itself through its own springs 209 independent of the springs 208 of the back-bridge relay 108. The operator now restores the key K' to normal, thus connecting the calling and called substations over the heavy conductors shown.

After the conversation is completed, the connection is released by the hanging up

of the receiver at the calling substation in the following manner: When the receiver at the substation A is restored to the switch-hook, the separation of the hook-switch spring destroys the energizing circuit of the relay 47 of the group of relays M. The relay 47, upon deënergizing, opens the holding circuits for the relay 122 of the selector E, the holding winding 13 of the line switch C and the relays 61 and 62 of the group of relays M. The deënergization of the relay 122 of the selector E closes the circuit of the release magnet 31 of said selector. The said circuit extends from ground G^7 through the contact of springs 119 and 118, springs 121, springs 116 and 117, off-normal springs 32 and the release magnet 31 to the battery lead 100. The magnet 31, upon deënergizing, restores the switch shaft to normal position and its own circuit is broken at the off-normal springs 32 when the shaft reaches its lowest position. The winding 13 of the line switch C, upon becoming deënergized, allows the plunger arm 10 to return to normal position. The relay 61 deënergizing quicker than the relay 62 operates to transmit an impulse of current through the windings 45 and 44 of the repeating coil S. The said impulse of current extends from the positive pole of the high voltage battery B^5 through the contact of springs 140, springs 139, winding 45 of the repeating coil S, lower winding of the relay 47, the positive pole of battery B, through battery B, upper winding of the relay 47, winding 44 of the repeating coil S, springs 138 and the springs 141 to the opposite pole of battery B^5. As shown in the drawings the relay 47 is a polarized relay, and although current at this time passes through the winding of said relay its armature will not be attracted as the current in the above traced circuit from the high voltage battery B^5 is flowing in the opposite direction from that which is required for the operation of this relay. The said impulse of current induces a corresponding impulse of current in the windings 46 and 47^a of the repeating coil S extending from the point 68 through the winding 47^a of the repeating coil S, conductor 39, winding 50 of the repeating coil S', polarized relay 49, winding 51 of the repeating coil S', conductor 40 and the winding 46 of the repeating coil to the point 68. The armature 55 of the polarized relay responding to said impulse opens the holding circuit of the relay 57 at the springs 210. The relay 57, upon deënergizing, opens the bridge across the conductors 59 and 60, thus allowing the line relay 165 of the cord circuit O to deënergize. The relay 165, upon deënergizing, closes a circuit through the supervisory lamp 82, thus signaling the operator that the connection has been terminated. The operator removing the plug p' from the jack j' destroys the energizing circuit of the relays 166 and 159. The relay 159, upon deënergizing, opens the holding circuit of the relay 151 of the selector F at the springs 211, which allows the selector to return to normal position in a manner similar to that hereinbefore described for the selector E. The relay 166, upon deënergizing, opens the circuit of the supervisory lamp 82 at the springs 167. The operator then removes the plug p^2 from the jack j^2, which destroys the holding circuit of the relays 171 and 172 of the group of relays Q (Fig. 5). The said relays, upon deënergizing, cause the relay 188 (Fig. 6) to open the energizing circuit of the line relay 107 of the connector H in the same manner that the relay 57 (Fig. 3) opened the energizing circuit of the relay 165 of the cord circuit O. The relay 107, upon deënergizing, opens the circuit of the relay 195, thus completing a circuit extending from ground G^{20} through the contact of springs 196 and 198, springs 201 and 212, off-normal springs 213 and the release magnet 106 to the battery lead 300. The magnet, upon energizing, restores the switch shaft and side switch wipers to normal position and its own circuit is broken at the springs 213 when the shaft reaches its lowest position.

If the number called is busy, there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. The connector private wiper 95, upon engaging this guarding contact, and before the side switch wipers have passed to third position, completes an energizing circuit through the busy relay 214. This circuit extends from ground at the private wiper through the side switch wiper 102 (in second position), springs 217 and 216, relay 214, springs 220 and 221 and the private magnet 105 to the battery lead 300. The private magnet is thus held energized and retains the side switch in second position. The relay 214, upon energizing, opens the circuit of the rotary magnet 98 at the springs 215, and also forms a locking circuit for itself and the magnet 105 by bringing the spring 218 into contact with the spring 216, thereby disconnecting the spring 216 from the spring 217. The engagement of the springs 219 serves to close a circuit for the busy tone extending from the busy machine L through the said springs 219, side switch wiper 104 (in second position), condenser 222, over the heavy conductor, through the calling telephone and over the return conductor to the busy machine L. The calling subscriber, upon receiving the busy signal, replaces his receiver upon the receiver hook, thereby releasing the connection in the manner above described.

It having been explained how a connection is completed from the subscriber A to

the subscriber A′ by means of physical circuit trunk lines, it will now be explained how the subscriber A may call the subscriber A′ over phantom circuit trunk lines. We will assume that the calling subscriber must call the number 32 to obtain connection with the operator at the intermediate exchange over a phantom circuit trunk line. Since the operations of the line switch C and the selector E have hereinbefore been described, we will assume that the subscriber A has removed his receiver and rotated his dial for the first digit 3, connecting the wipers 25, 26 and 27 of the first selector E with the bank contacts 223, 224 and 225. As soon as the connection is completed to the conductors 226, 227 and 228, the line relay 74 of the repeater I (Fig. 4) is energized, said circuit extending from ground G^{24} through the lower winding of the relay 74, conductor 228, through the substation A, over the return conductor 226 and through the upper winding of the relay 74 to the battery lead 100. The relay 74, upon energizing, closes a circuit through the relay 75 and bridges the impedance coil 233 across the trunk conductors 39—40 and 63—64. The energizing circuit for the relay 75 extends from ground G^{25} through the contact of springs 230 and 229 and the relay 75 to the battery lead 100. The relay 75, upon energizing, completes a holding circuit for the relay 122 of the selector E and the holding winding 13 of the line switch C. The said holding circuit for the relay 122 extends from ground G^{26} through the contact of springs 232, conductor 227, wiper 26, springs 130 and 132 and the relay 122 to the battery lead 100. The holding circuit for the winding 13 of the line switch C extends over the above-traced circuit to the wiper 26. From here the circuit extends through the contact of springs 33, springs 128 and 129, bank springs 22 and 18 and through the winding 13 to the battery lead 100. The terminal conductors 66 and 67 of the phantom circuit trunk may terminate in a selector switch in the intermediate exchange (not shown) similar to the selector F.

When the calling device at the substation is operated, the separation of the impulse springs 7 and 8 allows the line relay 74 of the repeater I to deënergize. Each time the relay 74 deënergizes, the spring 230 momentarily disengages the spring 229 and engages the spring 231 and the spring 234 disengages the spring 235. The operation of the springs 234 and 235 opens the bridge across the conductors 64^a and 65, thus repeating the impulses from the substation to the selector switch at the intermediate exchange. Since the relay 75 is slow acting it does not deënergize during the momentary separation of the springs 229 and 230. Consequently the engagement of the springs 230 and 231 closes a circuit through the relay 76. This circuit extends from ground G^{25} through the contact of springs 230 and 231, springs 236 and the relay 76 to the battery lead 100. The relay 76 is energized by the first impulse and, being slow acting, remains in its operated position until all the impulses for the digit are delivered. In its energized position the relay 76 operates to disconnect the conductors 64^a and 65 from the condensers 77 and 78 and to short-circuit the impedance coil 233 to prevent its interference with the operation of the switches at the distant exchange.

When the substation calling device is operated for the second digit 2, the repeater I operates in the manner explained to repeat two impulses over the trunk conductors 39—40 and 63—64 to a selector in the intermediate exchange. This selector operates in the same manner as the selector F to extend the connection to a group of relays similar to the group of relays K. The operator answers by means of a cord circuit O′ similar to the cord circuit O, except that the preliminary impulse relay 83 is dispensed with. The operator, upon receiving the calling subscriber's order, inserts the plug p^4 into a jack connected to the phantom tap conductors 90 and 91 of the trunk lines 86—87 and 88—89, which extends the connection to the third exchange. The phantom tap conductors 92 and 93 (Fig. 6) of the said trunk lines 86—87 and 88—89 terminate in a connector switch (not shown) in the third exchange similar in all respects to the connector switch H. The operator then bridges her calling device (the impulse springs being normally closed) across the phantom tap conductors 90 and 91 and operates the dial in accordance with the desired number to complete the connection to the called subscriber, as hereinbefore described.

The release of the apparatus is practically the same as hereinbefore mentioned and is initiated by the calling subscriber A′ replacing his receiver upon the receiver hook.

It will thus be seen that I have devised a very efficient form of automatic telephone system in which a phantom circuit can be superimposed on trunk lines over which an automatic connection is established, this being brought about in such a manner that neither one of these connections interferes in any way with the other. Furthermore, it will be seen that the connection can be extended to the physical circuit either directly through automatic switches, or the connection can be extended through a manual operator's board.

While I have illustrated a certain specific embodiment of my invention, and have shown these physical and phantom circuits adapted to be seized by automatic switches of well-known types, it will, of course, be

understood that other suitable forms of switches can be employed without in any way departing from the spirit and intent of my invention. Various other changes and modifications can be made in the particular circuit arrangement employed and still come within the contemplated scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a plurality of subscribers' lines, means including a trunk line and automatic switches for extending a connection between two of said lines, means including a second trunk line for extending a second connection between two of said subscribers' lines, and a phantom signaling circuit superimposed on said trunk lines.

2. In a telephone system, a plurality of subscribers' lines, means including a trunk line and automatic switches controlled over said trunk line for extending a connection between two of said lines, a second trunk line and automatic switches controlled thereover for establishing a second connection between two of said lines, and a phantom signaling circuit superimposed on said trunk lines.

3. In a telephone system, a plurality of subscribers' lines, means including a trunk line and automatic switches for extending a connection between two of said lines, means including a second trunk line for extending a second connection between two of said subscribers' lines, a phantom circuit superimposed on said trunk lines, and means including automatic switches for establishing a talking circuit including said phantom circuit.

4. In a telephone system, a plurality of subscribers' lines, means including a trunk line and automatic switches controlled over said trunk line for extending a connection between two of said lines, a second trunk line and automatic switches controlled thereover for establishing a second connection between two of said lines, a phantom circuit superimposed on said trunk lines, and means including automatic switches for establishing a talking circuit including said phanton circuit.

5. In a telephone system, a pair of physical trunk circuits, means for controlling automatic switches over either of said physical circuits, and a phantom signaling circuit superimposed on said physical circuits.

6. In a telephone system, a pair of physical trunk circuits, means for controlling automatic switches over either of said physical circuits, and a phantom signaling circuit superimposed on a portion of said physical circuits, said portion of the physical circuits being conductively insulated from the remaining portion of said circuits.

7. In a telephone system, a pair of physical trunk circuits, means for controlling automatic switches over either of said physical circuits, a phantom circuit superimposed on said physical circuits, and means for controlling automatic switches over said phantom circuit to establish a talking circuit.

8. In a telephone system, a pair of physical trunk circuits, means for controlling automatic switches over either of said physical circuits, a phantom circuit superimposed on a portion of said physical circuits, said portion of the physical circuits being conductively insulated from the remainder of said circuits, and means for controlling automatic switches over said phantom circuit to establish a talking connection.

9. In a telephone system, a trunk line, a normally inoperative trunk extending therefrom, means for establishing connection with said first trunk, and means controlled by the establishment of said connection for transmitting a preliminary impulse over said first trunk to render said second trunk operative.

10. In a telephone system, a trunk line terminating in the primary winding of an induction coil, a second trunk terminating in the secondary of said induction coil, a relay at the opposite end of said second trunk, and means for automatically transmitting an impulse through the primary of said induction coil when connection is made with said first trunk to thereby induce an impulse of current by electromagnetic induction in said second trunk to thereby operate said relay.

11. In a telephone system, a trunk line terminating in the primary winding of an induction coil, a second trunk terminating in the secondary of said induction coil, a relay at the opposite end of said second trunk, means for automatically transmitting an impulse though the primary of said induction coil when connection is made with said first trunk to thereby induce an impulse of current in said second trunk to thereby operate said relay, a third normally inoperative trunk inductively associated with said second trunk, and means controlled by the initial operation of said relay for rendering said third trunk operative.

12. In a telephone system, a trunk line, a relay in said trunk, means inductively related to said trunk for transmitting a series of induced impulses over said trunk to operate said relay, and an automatic switch controlled by said relay.

13. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line conductively insulated from the remainder of said connection, and automatic switches for use in establishing said connection controlled by induced impulses transmitted over said conductively insulated portion of said trunk line by electromagnetic induction.

14. In a telephone system, a plurality of subscribers' lines, a trunk line, a second trunk inductively related to said first trunk, a relay in said second trunk, means for extending a connection from a calling line to said first trunk, means for transmitting a plurality of series of impulses to said first trunk, means for thereby inducing a corresponding series of impulses in said second trunk and through said relay by electromagnetic induction, and means including an automatic switch controlled by said relay for completing the connection to a called line.

15. In a telephone system, a polarized relay, an automatic switch, and means for operating said relay by induced impulses of one direction to operate said switch and by induced impulses of the opposite direction to control the release of said switch.

16. In a telephone system, a trunk line, a polarized relay in said trunk, means inductively related to said trunk to transmit a series of induced impulses over said trunk in one direction to operate said relay, an automatic switch controlled by said operation of said relay, means for transmitting an induced impulse over said trunk in the opposite direction to again operate said relay, and means controlled by the latter operation of said relay to release said automatic switch.

17. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line conductively insulated from the remainder of said connection, and automatic switches for use in establishing said connection controlled by induced impulses transmitted in one direction over said conductively insulated portion of said trunk line and released by an induced impulse transmitted in the opposite direction over said portion of said trunk line.

18. In a telephone system, a plurality of subscribers' lines, a trunk line, a second trunk inductively related to said first trunk, a polarized relay in said second trunk, means for extending a connection from a calling line to said first trunk, means for transmitting a plurality of series of impulses in one direction over said first trunk, means for thereby inducing the corresponding series of impulses in said second trunk through said relay, an automatic switch controlled by said operation of said relay, means for transmitting an inductive impulse of the opposite direction through said relay, means controlled by this last operation of the relay to control the release of said switch, and means controlled by said switch for completing the connection to a called line.

19. In a telephone system, a trunk line, a normally inoperative trunk extending therefrom, means for establishing connection with said first trunk, means controlled by the establishment of said connection for rendering said second trunk operative, a third trunk line, and a phantom signaling circuit superimposed on said first and third trunk lines.

20. In a telephone system, a trunk line, a normally inoperative trunk extending therefrom, means for establishing connection with said first trunk, means controlled by the establishment of said connection for transmitting a preliminary impulse over said first trunk to render said second trunk operative, a third trunk line, and a phantom signaling circuit superimposed on said first and third trunk lines.

21. In a telephone system, a trunk line, a second normally open trunk inductively associated with said first trunk, means for establishing a connection with said first trunk, means controlled by the establishment of said connection for closing said second trunk, a third trunk line, and a phantom signaling circuit superimposed on said first and third trunk lines.

22. In a telephone system, a trunk line terminating in the primary winding of an induction coil, a second trunk terminating in the secondary of said induction coil, a relay at the opposite end of said second trunk, means for automatically transmitting an impulse through the primary of said induction coil when connection is made with said first trunk to thereby induce an impulse of current in said second trunk to thereby operate said relay, a third trunk line, and a phantom signaling circuit superimposed on said second and third trunk lines.

23. In a telephone system, a trunk line terminating in the primary winding of an induction coil, a second trunk terminating in the secondary of said induction coil, a relay at the opposite end of said second trunk, means for automatically transmitting an impulse through the primary of said induction coil when connection is made with said first trunk to thereby induce an impulse of current in said second trunk to thereby operate said relay, a third normally inoperative trunk inductively associated with said second trunk, means controlled by the initial operation of said relay for rendering said third trunk operative, a fourth trunk line, and a phantom signaling circuit superimposed on said second and fourth trunk lines.

24. In a telephone system, a trunk line, a relay in said trunk, means inductively related to said trunk for transmitting a series of induced impulses over said trunk to operate said relay, an automatic switch controlled by said relay, a second trunk line, and a phantom signaling circuit superimposed on said trunk lines.

25. In a telephone system, a plurality of subscribers' lines, means for establishing a

connection between two of said lines, said means including a trunk line conductively insulated from the remainder of said connection, automatic switches for use in establishing said connection controlled by induced impulses transmitted over said conductively insulated portion of said trunk line, a second trunk line, and a phantom signaling circuit superimposed on said trunk lines.

26. In a telephone system, a plurality of subscribers' lines, a trunk line, a second trunk inductively related to said first trunk, a relay in said second trunk, means for extending a connection from a calling line to said first trunk, means for transmitting a plurality of series of impulses to said first trunk, means for thereby inducing a corresponding series of impulses in said second trunk and through said relay, means including an automatic switch controlled by said relay for completing the connection to a called line, a third trunk line, and a phantom signaling circuit superimposed on said second and third trunk lines.

27. In a telephone system, a trunk line, a polarized relay in said trunk, means inductively related to said trunk to transmit a series of induced impulses over said trunk in one direction to operate said relay, an automatic switch controlled by said operation of said relay, means for transmitting an induced impulse over said trunk in the opposite direction to again operate said relay, means controlled by the latter operation of said relay to release said automatic switch, a second trunk line, and a phantom signaling circuit superimposed on said trunk line.

28. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line conductively insulated from the remainder of said connection, automatic switches for use in establishing said connection controlled by induced impulses transmitted in one direction over said conductively insulated portion of said trunk line and released by an induced impulse transmitted in the opposite direction over said portion of said trunk line, a second trunk line, and a phantom signaling circuit superimposed on said trunk lines.

29. In a telephone system, a plurality of subscribers' lines, a trunk line, a second trunk inductively related to said first trunk, a polarized relay in said second trunk, means for extending a connection from a calling line to said first trunk, means for transmitting a plurality of series of impulses in one direction over said first trunk, means for thereby inducing the corresponding series of impulses in said second trunk through said relay, an automatic switch controlled by said operation of said relay, means for transmitting an inductive impulse of the opposite direction through said relay, means controlled by this last operation of the relay to control the release of said switch, means controlled by said switch for completing the connection to a called line, a third trunk line, and a phantom signaling circuit superimposed on said first and third trunk lines.

30. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between a pair of said lines, means for establishing a second connection between another pair of said lines, both of said means including a trunk line, together with a normally inoperative trunk extending therefrom, means for establishing connection with either of said first trunks, means controlled by the establishment of said connections for rendering the corresponding second trunk operative, and a phantom signaling circuit superimposed on said first trunks.

31. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between a pair of said lines, means for establishing a second connection between another pair of said lines, both of said means including a trunk line, together with a normally inoperative trunk extending therefrom, means for establishing connection with either of said first trunks, means controlled by the establishment of said connections for transmitting a preliminary impulse over the corresponding first trunk to render the corresponding second trunk operative, and a phantom signaling circuit superimposed on said first trunks.

32. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between a pair of said lines, means for establishing a second connection between another pair of said lines, both of said means including a trunk line, a second normally open trunk inductively associated with each of said first trunks, means for establishing a connection with either of said first trunks, means controlled by the establishment of said connections for closing the corresponding second trunk, and a phantom signaling circuit superimposed on said first trunks.

33. In a telephone system, a pair of trunk lines, a relay in each of said trunks, means inductively related to each of said trunks for transmitting a series of induced impulses over said trunks to operate the corresponding relay, an automatic switch controlled by each of said relays, and a phantom signaling circuit superimposed on said trunks.

34. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, means

for establishing a second connection between two other of said lines, each of said means including a trunk line conductively insulated from the remainder of the corresponding connection, automatic switches for use in establishing said connections controlled by induced impulses transmitted at the conductively insulated portion of the corresponding trunk line, and a phantom signaling circuit superimposed on the conductively insulated portions of said two trunks.

35. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, means for establishing a second connection between two other of said lines, each of said means including a trunk line conductively insulated from the remainder of the corresponding connection, automatic switches for use in establishing said connections controlled by induced impulses transmitted at the conductively insulated portion of the corresponding trunk line, a phantom signaling circuit superimposed on the conductively insulated portions of said two trunks, and means for controlling automatic switches to establish a third talking circuit over said phantom circuit.

36. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, means for establishing a second connection between two other of said lines, each of said means including a trunk line conductively insulated from the remainder of the corresponding connection, automatic switches for use in establishing said connections operated by induced impulses transmitted in one direction over said conductively insulated portion of the corresponding trunk line and released by induced impulses transmitted in the opposite direction, and a phantom signaling circuit superimposed on said conductively insulated portions of said two trunks.

37. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, means for establishing a second connection between two other of said lines, each of said means including a trunk line conductively insulated from the remainder of the corresponding connection, automatic switches for use in establishing said connections operated by induced impulses transmitted in one direction over said conductively insulated portion of the corresponding trunk line and released by induced impulses transmitted in the opposite direction, a phantom signaling circuit superimposed on said conductively insulated portions of said two trunks, and means for controlling automatic switches to establish a third talking circuit over said phantom circuit.

38. In a telephone system, a trunk line, means for extending a connection to said trunk, a generator at one end of said trunk, a polarized relay at the opposite end of said trunk, a normally open circuit for extending a connection from said trunk, means for causing the generator to produce a preliminary impulse to operate said polarized relay to close said normally open trunk when connection is established with said first trunk, means for subsequently controlling the generator to send a series of impulses through said relay, and an automatic switch connected to the opposite end of said second trunk controlled by said relay.

39. In a telephone system, a calling and a called subscriber's line, means for extending a connection between said lines, said means including a physical phantom circuit, automatic switches for extending a connection from a calling line to said circuit, an operator's board, means for extending a connection from said physical phantom circuit to said operator's board, a second physical phantom circuit, means for extending a connection from said operator's board to said second physical phantom circuit, and automatic switches for extending a connection from said second physical phantom circuit to the called line.

40. In a telephone system, a section of a talking circuit, a bridge across said section, a second talking circuit passing through a point in said bridge, a second bridge across said section, said second talking circuit passing also through a point in said second bridge, and an automatic progressively movable switch associated with said second bridge and controllable thereby.

41. In a telephone system, a section of a talking circuit, a bridge across said section, a second talking circuit passing through a point in said bridge, a second bridge across said section, said second talking circuit passing also through a point in said second bridge, an inductive winding in said first bridge, a relay in said second bridge, and an automatic switch controllable through the medium of said relay.

42. In a telephone system, a section of a talking circuit, a bridge across said section, a second talking circuit passing through a point in said bridge, a second bridge across said section, said second talking circuit passing also through a point in said second bridge, an inductive winding in said first bridge, a relay in said second bridge, and an automatic progressively movable switch associated with said second bridge and controllable thereby.

43. In a telephone system, a section of a talking circuit, a bridge across said section, a second talking circuit passing through a point in said bridge, a second bridge across said section, said second talking circuit passing also through a point in said second bridge, an inductive winding in said first

bridge, a relay in said second bridge, and an automatic progressively movable switch associated with said second bridge and controllable through the medium of said relay.

44. In a telephone system, a pair of conductors for talking purposes, a pair of bridges across said conductors, a second talking circuit passing through a point in each of said bridges, and an automatic switch associated with one of said bridges and controllable thereby.

45. In a telephone system, a pair of conductors for talking purposes, a pair of bridges across said conductors, a second talking circuit passing through a point in each of said bridges, an inductive winding in one of said bridges and a relay in the other, and an automatic switch controllable through the medium of said relay.

46. In a telephone system, a pair of conductors for talking purposes, a pair of bridges across said conductors, a second talking circuit passing through a point in each of said bridges, an inductive winding in one of said bridges and a relay in the other, a line, means for extending the two sides of said line into inductive relation with said winding, and means controlled over said line for inducing current in said winding to operate said relay.

47. In a telephone system, a pair of conductors for talking purposes, a pair of bridges across said conductors, a second talking circuit passing through a point in each of said bridges, an inductive winding in one of said bridges and a relay in the other, a line, means for extending the two sides of said line into inductive relation with said winding, means controlled over said line for inducing current in said winding to operate said relay, and an automatic switch controllable through the medium of said relay.

48. In a telephone system, a pair of conductors for talking purposes, a pair of bridges across said conductors, a second talking circuit passing through a point in each of said bridges, an inductive winding in one of said bridges and a relay in the other, a line, means for extending the two sides of said line into inductive relation with said winding, means controlled over said line for inducing current in said winding to operate said relay, other lines, and an automatic switch controllable through the medium of said relay to extend connection to one of said other lines.

49. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, a third talking circuit passing through a point in each of said bridges, an automatic switch associated with a bridge at each of said sections and controllable thereby.

50. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, a third talking circuit passing through a point in each of said bridges, and an automatic switch controlled by each of said relays.

51. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, the other bridge in each of said pairs comprising an inductive winding, a third talking circuit passing through a point in each of said bridges, and an automatic switch controlled by each of said relays.

52. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, the other bridge in each of said pairs comprising an inductive winding, a third talking circuit passing through a point in each of said bridges, an automatic switch controlled by each of said relays, and means for inducing currents in one of said windings to operate the associated relay for controlling its associated automatic switch.

53. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, a third talking circuit passing through a point in each of said bridges, an automatic switch associated with a bridge at each of said sections and controllable thereby, other automatic switches, and means for controlling one or more of said other switches over said third talking circuit.

54. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, a third talking circuit passing through a point in each of said bridges, an automatic switch controlled by each of said relays, other automatic switches, and means for controlling one or more of said other switches over said third talking circuit.

55. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, the other bridge in each of said pairs comprising an inductive winding, a third talking circuit passing through a point in each of said bridges, an automatic switch controlled by each of said relays, other automatic switches, and means for controlling one or more of said other switches over said third talking circuit.

56. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a pair of bridges for each of said sections, one bridge in each of said pairs including a relay, the other bridge in each of said pairs comprising an inductive winding, a third talking circuit passing through a point in each of said bridges, an automatic switch controlled by each of said relays, means for inducing currents in one of said windings to operate the associated relay for controlling its associated automatic switch, other automatic switches, and means for controlling one or more of said other switches over said third talking circuit.

57. In a telephone system, a pair of conductors for talking purposes, a second pair of conductors for talking purposes, a pair of bridges for each of said conductor pairs, a circuit passing through a point in each of said bridges and an automatic switch controllable over said circuit.

58. In a telephone system, a pair of conductors for talking purposes, a second pair of conductors for talking purposes, a pair of bridges for each of said conductor pairs, a circuit passing through a point in each of said bridges, a subscriber's line, an automatic switch, means for extending said line by way of said circuit into connection with said switch, another subscriber's line accessible to said switch, and means for controlling said switch over said circuit to connect the two subscribers' lines.

59. In a telephone system, a pair of conductors for talking purposes, a second pair of conductors for talking purposes, a pair of bridges for each of said conductor pairs, automatic progressively movable means for establishing a pair of talking connections each of which connections includes one of said conductor pairs, a circuit passing through a point in each of said bridges, and an automatic switch controllable over said circuit.

60. In a telephone system, a section of a talking circuit, a winding included in said section, a second talking circuit including said winding, a relay in said section, said second talking circuit including also the coils of said relay, and an automatic switch controlled by said relay.

61. In a telephone system, a section of a talking circuit, a winding included in said section, a second talking circuit including said winding, a relay in said section, said second talking circuit including also the coils of said relay, an automatic switch controlled by said relay, and means for inducing current impulses in said winding to operate said relay.

62. In a telephone system, a section of a talking circuit, a winding included in said section, a second talking circuit including said winding, a relay in said section, said second talking circuit including also the coils of said relay, an automatic switch controlled by said relay, a plurality of extensions for said section associated with said switch, and means for inducing current impulses in said winding to operate said relay, whereby said switch is controlled to extend the said section via one of said extensions.

63. In a telephone system, a section of a talking circuit, a winding included in said section, a second talking circuit including said winding, a relay in said section, said second talking circuit including also the coils of said relay, an automatic switch controlled by said relay, a plurality of extensions for said section associated with said switch, means for inducing current impulses in said winding to operate said relay, whereby said switch is controlled to extend the said section via one of said extensions, and means for inducing a different current impulse in said winding to operate said relay in a different manner to release said switch.

64. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a winding and a relay in each of said sections, a third circuit including all of said windings and all of said relays, and an automatic switch associated with each of said relays and controllable thereby.

65. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a winding and a relay in each of said sections, a third circuit including all of said windings and all of said relays, and an automatic switch controlled over said third circuit.

66. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a winding and a relay in each of said sections, a third circuit including all of said windings and all of said relays, an automatic switch associated with each of said relays and controllable thereby, and an automatic switch controlled over said third circuit.

67. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a winding and a relay in each of said sections, a third circuit including all of said windings and all of said relays, an automatic switch associated with each of said relays and controllable thereby, another section for each of said first and second talking circuits inductively related to the windings therein, and means for effecting current changes in one of said last sections whereby one of said relays is operated by currents induced in its associated winding.

68. In a telephone system, a section of a talking circuit, a section of a second talking circuit, a winding and a relay in each of said sections, a third circuit including all of said windings and all of said relays, an

automatic switch controlled over said third circuit, another section for each of said first and second talking circuits inductively related to the windings therein, and means for effecting current changes in one of said last sections whereby one of said relays is operated by currents induced in its associated winding.

69. In a telephone system, a section of a talking circuit including a winding at each end, a section of a second talking circuit including a winding at each end, a third circuit including all of said windings, a plurality of lines, an automatic switch associated with said third circuit and having access to said lines, and means for controlling said switch over said third circuit to connect the said third circuit with one of said lines.

70. In a telephone system, a section of a talking circuit including a winding at each end, a section of a second talking circuit including a winding at each end; a third circuit including all of said windings, a line, means for extending said line into connection with said third circuit, another line, and an automatic switch associated with said third circuit and controllable thereover to connect with said other line, whereby a connection is established between said lines via said third circuit and said switch.

71. In a telephone system, a plurality of lines at each of two points, a pair of trunk lines extending between the two said points and adapted for interconnecting said lines, a circuit including conductors of both of said trunk lines also adapted for interconnecting said lines, and automatic switches for interconnecting lines via said circuit, one of which switches is controllable over said circuit.

72. In a telephone system, the four limbs of a Wheatstone bridge, a talking circuit in two sections inductively connected through the medium of said bridge limbs, the four limbs of a second Wheatstone bridge, a second talking circuit in two sections inductively connected through the medium of said second bridge limbs, a third talking circuit passing through limbs of both bridges in series, and an automatic progressively movable switch controllable over said third circuit.

73. In a telephone system, the four limbs of a Wheatstone bridge, a talking circuit in two sections inductively connected through the medium of said bridge limbs, the four limbs of a second Wheatstone bridge, a second talking circuit in two sections inductively connected through the medium of said second bridge limbs, bridges for said Wheatstone bridges having common conductors, and an automatic progressively movable switch controllable over said conductors.

74. In a telephone system, the four limbs of a Wheatstone bridge, a talking circuit in two sections inductively connected through the medium of said bridge limbs, the four limbs of a second Wheatstone bridge, a second talking circuit in two sections inductively connected through the medium of said second bridge limbs, a third circuit connecting said Wheatstone bridges in such manner that the limbs of each Wheatstone bridge comprise a bridge for the other of said Wheatstone bridges, and an automatic progressively movable switch controllable over said third circuit.

Signed by me at Chicago, Cook county, Illinois, this 12th day of March, 1914.

ARTHUR BESSEY SMITH.

Witnesses:

GEORGE YONOCHOWSKI,

HERBERT W. KRACKE.