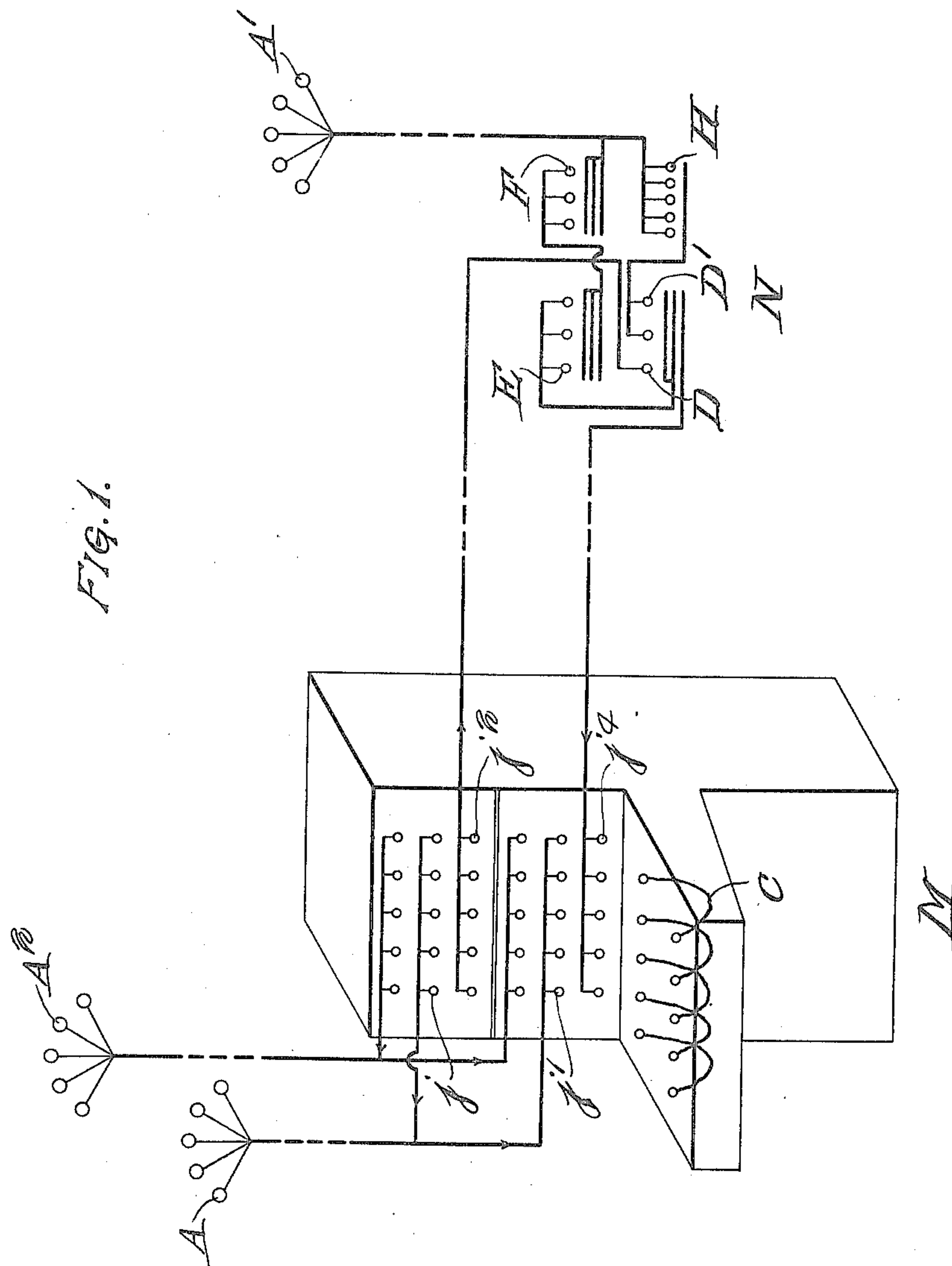


M. L. JOHNSON,
SEMI-AUTOMATIC TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED MAY 6, 1910.

1,248,868.

Patented Dec. 4, 1917.
4 SHEETS—SHEET 1.



WITNESSES
A. Andersen.
J. E. Cooley

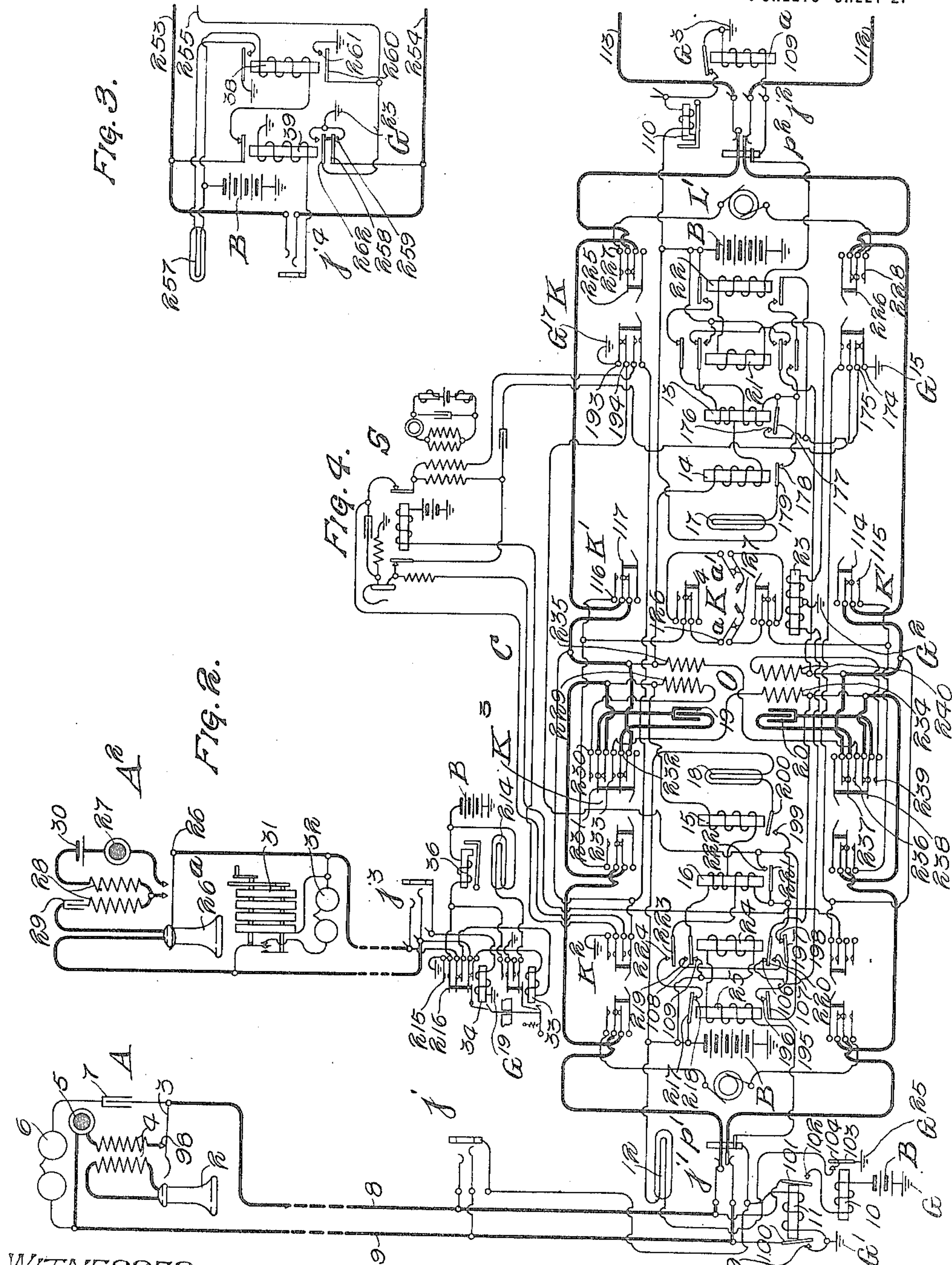
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4 SHEETS—SHEET 3.



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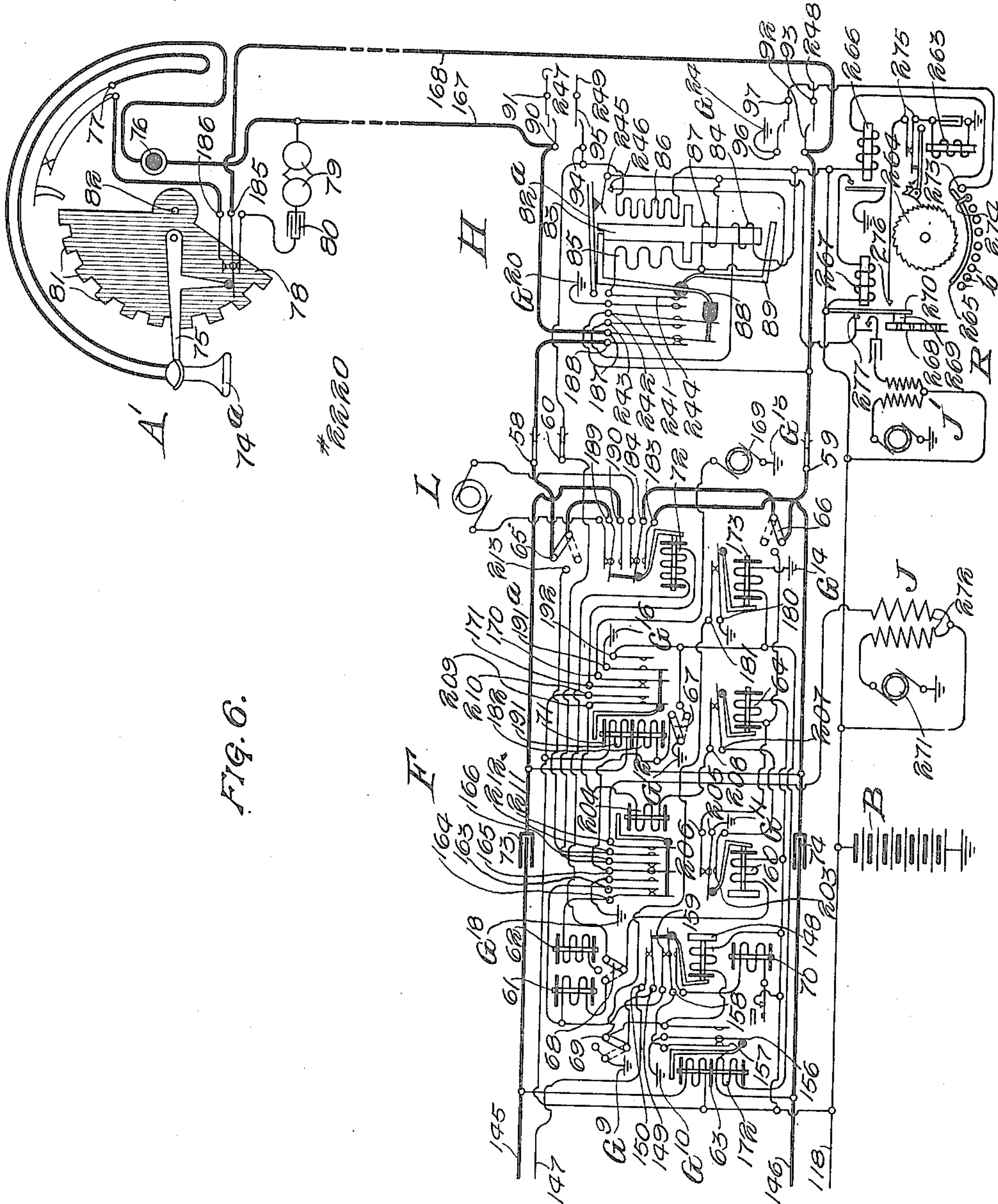


FIG. 6.

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UNITED STATES PATENT OFFICE.

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SEMI-AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

1,248,868.

Specification of Letters Patent.

Patented Dec. 4, 1917.

Application filed May 6, 1910. Serial No. 559,825.

To all whom it may concern:

Be it known that I, MORTON L. JOHNSON, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Semi-Automatic Telephone-Exchange Systems, of which the following is a specification.

My invention relates to semi-automatic telephone exchange systems of that kind in which an operator's cord circuit is employed for establishing connection between calling and called lines. It relates more particularly to systems of this kind in which the said cord circuit is at the switchboard of the originating operator—that is to say, where the call originates—and in which the said cord circuits is, therefore, desirably provided with means for supervising the call. In such case the originating operator is also provided with a calling mechanism for controlling the switches which are necessary for completing the connection from the cord circuit to the called line. In some cases, however, the said cord circuits are of such character that the calling subscriber may employ the calling mechanism at the substation for controlling the said switches after the latter have been connected with the calling line by the operator. In exchanges of this kind the subscribers' lines are not always of the same character—that is to say, some lines may be provided with one kind of equipment and other lines may be provided with different equipment, so that the system may include two or more different kinds of telephone lines. In such case it has been customary, so far as I am now aware, to provide the operator with key switches for adapting the cord circuit, and especially the supervisory apparatus thereof, for use in connection with different kinds of lines. In other words, the supervisory apparatus which would be suitable for connection between two lines in one case would not be suitable for connection between two lines in some other case. This, as stated, was taken care of by providing the operator with key switches for changing the condition of the circuits to suit the requirements of different kinds of telephone lines.

The object of my invention is, therefore, to provide a cord circuit of universal utility which may be used between different kinds of telephone lines, and which will automati-

cally adjust itself, particularly the supervisory apparatus thereof, to the varying conditions under which it may be called upon to give service between the different kinds of lines, there being one or more relays provided for changing the condition of the circuits to suit the requirements of different kinds of line equipment, whereby the cord circuit automatically adjusts itself for supervision of different kinds of connections, and no key switches are necessary for this purpose.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings Figure 1 is a diagrammatic view of a portion of a manual switchboard M and a section of an automatic exchange N, together with interconnecting trunk lines, in a system embodying the principles of my invention.

Fig. 2 illustrates a local battery manual telephone line, together with its central office equipment.

Fig. 3 represents a manual switchboard jack which is the terminal of a trunk line leading from an automatic exchange.

Figs. 4, 5 and 6 taken together represent a complete circuit connection between a calling manual substation A and a called automatic substation A' in a system embodying the principles of my invention.

Fig. 7 shows additional apparatus of the automatic exchange.

In Fig. 1 there is represented a group of common battery substations similar to the substation A (Fig. 4). From each substation A lines lead to the manual board M, where each line is provided with an answering jack j' and one or more multiple jacks j . Also connected to the manual board is a group of lines leading from local battery lines A². There are also trunk lines connecting the manual board M with the automatic exchange N. The trunk lines over which a connection is extended from the manual board to the automatic exchange terminate on the manual board in jacks j^2 (Fig. 4) and in the automatic exchange in selector switches D (Fig. 5). Connections are extended from the automatic exchange to the manual board over trunk lines which lead from the banks of selector switches D and D' to jacks j^4 (Fig. 3). The lines of the automatic substations A' terminate in

individual switches H and in the bank contacts of connectors F. For the purpose of completing connection between the various lines the manual board M is provided with
 5 a number of operators' cords C (Fig. 4).

The manual substation A (Fig. 4) may be of any suitable type, but, as herein illustrated, comprises the usual receiver 2,
 10 switch hook 3, induction coil 4, transmitter 5, ringer 6 and condenser 7. At the central office the line conductors 8 and 9 are connected to an answering jack j' , and may have one or more multiple jacks j . Associated with the jack j' there are the usual
 15 line and cut-off relays 10 and 11 and the line lamp 12.

The local battery magneto substation A² shown in Fig. 2 may be of any suitable or approved type. As here shown, it is provided with the usual receiver 26^a, switch
 20 hook 26, transmitter 27, induction coil 28, condenser 29, local battery 30, magneto 31 and ringer 32. At the central office the line of substation A² has an answering jack j^3 ,
 25 one or more multiple jacks (not shown), line and cut-off relays 33 and 34, line lamp 214 and a so-called visual busy signal 36 associated with each multiple jack. As here shown, the armature of the line relay 33 is
 30 adapted to be locked in its operated position when attracted, and to be unlocked by the energization of the cut-off relay 34. This particular form of line signal is not essential, so far as the broader aspects of my in-
 35 vention are concerned, as it will be evident that any one of a number of well known types of line signals might be used equally well.

The incoming trunk (Fig. 3) from the
 40 first selector is similar to the terminal of the common battery line in Fig. 4, with the addition of means for grounding the third trunk conductor 255 when either of the relays 38 or 39 is energized.

45 The cord circuit C (Fig. 4) is an improvement on the usual forms of cord circuits used in manual switchboard practice, to adapt it for use in establishing connection between lines of different characters.
 50 Among other details the cord C comprises the usual calling and answering plugs p^2 and p' , a combined ringing and listening key K, a calling device key K', a ring-back key K², supervisory relays 13, 14, 15 and 16
 55 and supervisory lamps 17 and 18. Normally the plugs p' and p^2 are connected with each other over the heavy conductors through the condensers 19 and 20, as shown in Fig. 4. By means of the key K³, how-
 60 ever, the cord circuit may be divided into two sections, each of which contains two windings of the repeating coil O. By throwing the key K³ to the left the calling device α may be connected with the answering end
 65 of the cord. The cord is provided with two

calling devices α and α' which are each represented diagrammatically by two springs. These calling devices are for the purpose of making calls through automatic switches and may be common to a number of cords. 70 By means of the key K⁴ either one or the other of these calling devices may be used. The sleeve conductor of the plug p^2 is connected to battery B through the winding of the two relays 22 and 21. The sleeve con- 75 tacts of the jacks of the various lines with which the cord C is intended to operate are connected to ground through relays. It is the function of the relays 21 and 22 to control the circuits of one end of the cord to 80 adapt it for use in the various connections. The relays through which the sleeve contacts of the various line jacks are grounded may have such a resistance, and the relays 21 and 22 may be so adjusted that when the 85 plug p^2 is inserted into a jack neither of the relays 21 and 22 will be energized, both may be energized, or relay 22 may operate alone. When the plug is inserted into the jack j^2 of an outgoing trunk line leading 90 to an automatic exchange, neither of the relays 21 or 22 is operated and the relay 14 and one winding of relay 13 are bridged across the talking circuit in series. When the plug p^2 is inserted into the jack j^3 of a 85 toll or magneto line the relay 22 alone is operated. The energization of relay 22 connects the lower winding of relay 13 with the battery in order that the said relay 13 may be locked in its energized position. 100 When the plug p^2 is inserted into the jack j of a common battery line both relays 21 and 22 are energized, whereby the bridge across the talking circuit is opened and one side of the circuit is connected to ground through 105 a winding of the impedance coil 23, while the other side of the circuit is connected to the non-grounded terminal of the battery B through relay 14 and the upper winding of relay 13. The relays 24 and 25 of the 110 other end of the cord operate in the same manner as the relays 21 and 22.

The first selector switch D (Fig. 5) is of the general type disclosed in United States Letters Patent #815,321, granted March 13, 115 1906, to Keith, Erickson and Erickson, its circuits being modified, however, to adapt it to operate in a system in which the switches are controlled over the two sides of the line in series. Among other details the selector 120 D comprises a set of wipers 40, 41 and 42 which are attached to a shaft (not shown) having a vertical motion controlled by the vertical magnet 43 and a rotary motion controlled by the rotary magnet 44. The side 125 switch comprising the wipers 45, 46, 47 and 48 is controlled by the private magnet 49 in the usual manner. Means for releasing the mechanism of the switch are provided in the release magnet 50. The magnet 50 is 130

connected with the battery B only when the switch shaft is raised one or more steps above its normal position, whereby the arm 51 permits spring 52 to come into engagement with spring 53. The usual vertical and rotary line relays are here replaced by the double-wound relay 54. The relays 55, 56 and 57 are slow acting—that is, slow to deenergize after their energizing circuits have been broken. As represented herein, this slow action is obtained by securing a ring of copper around one end of the core. The selector E (Fig. 5) and the selector D' (Fig. 7) are similar to the selector D (Fig. 5).

The connector switch F (Fig. 6) is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson. Like the selectors, the connector F is provided with a set of wipers 58, 59 and 60, vertical magnet 61, rotary magnet 62, line relay 63, release magnet 70, private magnet 64 and a side switch comprising the wipers 65, 66, 67, 68 and 69. A back-bridge relay 71 is provided, through the windings of which the called line may be provided with talking battery current. After connection is completed with a line the relay 72 operates to connect the generator L with said line. The talking circuit through the connector contains the two condensers 73 and 74, which are in opposite sides of the circuit.

The automatic substation A' may be of any suitable type, and, as here shown, comprises a receiver 74^a, switch hook 75, transmitter 76, impulse springs 77, impulse wheel 78, ringer 79 and condenser 80. The impulse wheel 78 is provided with the impulse teeth 81 and is secured to the shaft 82, to which there is also attached the usual dial (not shown) provided with finger holes.

At the central office there is allotted to the line of substation A' the individual switch H, which is of the general type disclosed in British Patent No. 26,301 of 1906, and in the *American Telephone Journal* of June 6, 1908. This switch is provided with the usual plunger (not shown) attached to the plunger arm, which is adapted to be attracted by the magnet 83. The magnet comprises four windings: a line winding 84, trip or pull-in winding 85, a cut-off winding 86 and an auxiliary winding 87. The magnetic circuit of the windings 85 and 86 is separate from that of the windings 84 and 87, so that the plunger arm 82^a and cut-off armature 88 are affected only by the windings 85 and 86, while the windings 84 and 87 control only the armature 89. The winding 85, when energized, attracts both the plunger arm 82^a and the cut-off armature, while the winding 86 is strong enough to operate only the armature 88. If, however, the winding 86 is energized while the plun-

ger arm 82^a is in an operated position, said arm will be thus held by the winding 86 after the winding 85 has been deenergized. The attraction of the plunger arm 82^a by the magnet 83 causes the plunger of the switch to be thrust into a group of springs to force springs 90, 92, 94 and 96 into engagement with springs 91, 93, 95 and 97, respectively, whereby the line conductors are extended over a trunk line to a selector switch, such as selector D', Fig. 7. Although only one set of springs 90—97 is shown, each switch H is provided with a number of such groups, each group forming the terminal of a trunk line leading to a selector switch. The plungers of a group of line switches H are controlled by a common mechanism R, usually called a master switch, in such a manner that the plungers of all idle line switches always stand in readiness to engage the terminal of an idle trunk line.

The master switch R is a modified form of the master switches shown in the said British Patent No. 26,301 and in the said *American Telephone Journal*. The master switch comprises essentially a motor magnet 263 for operating the ratchet wheel 264, a bank of contacts comprising a common segment 265 and an individual segment *b* for each trunk to which the switch H has access, and relays 266 and 267. The ratchet wheel 264 is connected with the so-called plunger shaft in such a manner that a continual rotary motion of said wheel gives to said shaft an oscillatory motion to move the idle plungers back and forth in front of their trunk and line terminals. Secured to the plunger shaft there is also a cam 268 having in its surface a number of openings adapted to be engaged by the pin 269 on the armature 270. The openings in the cam 268 are so spaced that the pin 269 may engage one of them only when the plungers that are in locking engagement with the plunger shaft are in a position directly in front of a trunk terminal.

In Fig. 6 there are shown two busy signaling machines J and J', each consisting of a current interrupter 271 and an induction coil 272. There need, however, be but one such machine. Also, in the various drawings there are shown a number of batteries B having one terminal grounded. There need be but one such battery, or preferably one battery in each exchange.

Having given a general description of the system, its mode of operation will be explained somewhat in detail. It will first be explained how the subscriber at substation A may call any other subscriber in the system. The removal of the receiver at substation A, preparatory to making a call, permits the switch hook 3 to engage the contact point 98, whereby a circuit is closed through the line relay 10. This circuit ex-

tends from ground G' through contact 99 and armature 100 of relay 11, line 9, transmitter 5, secondary winding of induction coil 4, contact point 98, switch hook 3, line 8, armature 101, contact point 102 and relay 10 to battery B, and thence through the battery B to ground G. The relay 10, upon energizing, operates to close a circuit extending from ground G^{25} through armature 103, contact point 104 and lamp 12 to battery B. Upon perceiving the signal of lamp 12 the operator inserts the plug p' into the jack j' , whereby a connection is extended from the calling line to the cord C. The engagement of the sleeve conductors of the plug p' and jack j' completes a circuit extending from ground G' through the cut-off relay 11, sleeve conductors of jack j' and plug p' and relays 25 and 24 to the battery B. The energization of relay 11 serves to disconnect the ground G' and relay 10 from the calling line, whereupon the circuit of lamp 12 is also broken. The relay 24, in its energized position, opens the normally closed circuit across the cord through relays 15 and 16, connects the tip strand of the cord to battery through relay 15 and upper winding of relay 16, and also connects the other side of the cord to ground through one winding of the impedance coil 23. The calling substation is thus provided with talking battery current over a circuit extending from ground G^2 through the left-hand winding of the coil 23, contact point 106, armature 107, thence over the ring strand of the cord, through plug p' and jack j' , over line 9, through substation A, back over line 8, through tip of jack j' and plug p' , tip strand of cord C, relay 15, upper winding of relay 16, and through armature 108 and contact point 109 to the battery B. The relays 15 and 16 are both energized over the circuit just traced, the relay 15 serving to prevent the closure of the circuit of lamp 18 upon the energization of relays 24 and 25 or relay 16. After inserting the plug p' into the jack j' the operator throws the key K to the left to connect her talking set S with the line in the usual manner to inquire what line is desired.

It will first be explained how the operator completes connection with the automatic substation A', the number of which will be assumed as 2220. In order to call the automatic substation the operator inserts the plug p^2 into the jack j^2 and operates the key K' to bridge the calling device α across the cord. The engagement of the sleeve conductors of plug p^2 and jack j^2 closes a circuit extending from ground G^3 through relay 109^a, sleeve conductors of jack j^2 and plug p^2 and through relays 22 and 21 to battery B. The relay 109^a is energized over the circuit just traced, but has such a high resistance itself that enough current does not

flow over the circuit to energize the relays 22 and 21. The relay 109^a, upon energizing, operates to close a circuit extending from ground G^3 through each of the busy signals 110 associated with the trunk line. The insertion of the plug p^2 into the jack j^2 also completes a circuit extending from ground G^4 at the selector D (Fig. 5) through the lower winding of the line relay 54, side switch wiper 46, trunk conductor 112, ring contacts of jack j^2 and plug p^2 , ring strand of cord C, springs 114 and 115 of key K', thence through the calling device α , springs 116 and 117 of key K', tip strand of cord C, tip of plug p^2 and jack j^2 , trunk conductor 113, side switch wiper 45 and upper winding of relay 54 to battery lead 118, and thence through the battery B to ground G. The relay 54 is energized upon the closure of this circuit and operates to shift spring 119 out of engagement with spring 120 and into contact with spring 121. The engagement of springs 119 and 121 closes a circuit from ground G^5 through the relay 55 to battery. The relay 55, upon energizing, shifts spring 123 out of engagement with spring 124 and into contact with spring 125, whereby the impulse spring 120 is connected with the vertical magnet 43 through the slow-acting relay 56. The selector D is now in position to receive impulses for the first digit of the desired number.

In order to call the digit 2 the operator operates the calling device α in the usual manner to separate the springs 126 and 127 twice momentarily. Each time these springs are separated the circuit of the selector line relay 54 is broken, which relay then de-energizes to permit the spring 119 to engage the spring 120. Since the relay 55 is slow acting it does not have time to de-energize during the time its current is interrupted by the momentary deenergization of the relay 54, and consequently the engagement of springs 119 and 120 closes a circuit through the vertical magnet 43. This circuit extends from ground G^5 through the springs 119 and 120, 123 and 125, relay 56, magnet 43 and side switch wiper 48 to the battery lead 118. Since the digit called is 2, the vertical magnet receives two impulses over the circuit just traced, and operates to raise the switch shaft and wipers 40, 41 and 42 two steps. The relay 56, which is included in the energizing circuit of the vertical magnet 43, is energized by the first impulse, but being a slow-acting relay it does not have time to deenergize during the momentary interruption of its circuit between impulses. In its energized position the relay 56 operates to close a circuit extending from ground G^5 through springs 128 and 129, and through private magnet 49 to the battery lead 118. Shortly after

the last impulse is delivered to the vertical magnet the private magnet relay 56 deenergizes, breaking the circuit of the private magnet 49. The private magnet in turn permits its armature to fall back so as to allow the side switch to pass from first to second position. The passage of side switch wiper 48 from first to second position disconnects the battery from the vertical magnet 43 and closes a circuit through the rotary magnet 44. This circuit extends from ground G^4 through the interrupter springs 130, magnet 44, relay 57 and side switch wiper 48 to the battery lead 118. Upon the closure of this circuit the rotary magnet attracts its armature, which rotates the wipers 40, 41 and 42 one step and onto the contacts of the first trunk line leading from the second bank level, presses down the armature of the private magnet and opens the circuit of its own magnet at the interrupter springs 130. When the circuit of the rotary magnet 44 is thus opened its armature falls back, and if the trunk line upon the terminals of which the wipers are rotated by the first step is idle, the armature of the private magnet falls back also, permitting the side switch to pass to third position. If, however, the first trunk line is busy, then the private wiper 41 finds a guarding ground upon the private bank contact, which ground is applied in a manner which will be explained later. The engagement of the wiper 41 with a grounded contact completes a circuit extending over conductor 134, through the side switch wiper 47 (in second position), and through the private magnet 49 to battery lead 118. The private magnet is energized by current flowing over this circuit and prevents its armature from falling back to trip the side switch to third position when the rotary magnet deenergizes. Since the side switch remains in second position, the rotary magnet will be energized again as soon as the interrupter springs 130 come into engagement with each other. Thus, the rotary magnet 44 will be alternately energized and deenergized to advance the shaft wipers step by step until the private wiper 41 finds a non-grounded contact of an idle trunk, whereupon the private magnet will be deenergized to permit the side switch to pass from second to third position. The passage of the side switch from second to third position breaks the operating circuit of the rotary magnet and extends the line connection over trunk conductors 131 and 132 to a second selector E. The relay 57, which is included in the energizing circuit of the rotary magnet 44, is a slow acting relay and remains energized for an instant after the rotary magnet deenergizes the last time and the side switch passes to third position. Thus, at the instant the side switch wiper 47 engages its

third-position contact point, the private bank contacts of the seized trunk are provided with a guarding potential extending from ground G^0 through springs 135 and 136, side switch wiper 47 and shaft wiper 41 to the selector private bank contacts. When the side switch wipers 45 and 46 pass from second to third position, the relay 54 is disconnected from the line and the line connection is extended through the shaft wipers 40 and 42 to the selector E, energizing the relay 137 in the same manner that the relay 54 of selector D was energized. The relay 137, upon energizing, closes a circuit from ground G^7 through springs 138 and 139 and relay 140 to battery lead 118. The relay 140 thereupon energizes and supplies a new guarding ground to the private bank contacts of the first selectors. Also, as soon as the relay 57 of the selector D falls back, a new circuit is closed through the release relay 55. This circuit extends from ground G^8 through side switch wiper 141 of the second selector E, springs 142 and 143 of relay 140, conductor 133, private wiper 41, side switch wiper 47, springs 136 and 144 of relay 57 and through relay 55 to battery lead 118. This circuit is closed before the relay 55 has time to deenergize after its former circuit is opened by the deenergization of the relay 54. It is thus evident that the relay 55 must be slower than the relay 57, the office of which is to provide a guarding potential for the seized trunk between the time when the side switch of the selector D passes to third position and the time when the relay 140 of the selector E energizes. The second selector E is now in position to receive impulses for the second digit and operates in response to these impulses in the same manner as the selector D to extend the connection to the connector F over the conductors 145 and 146.

When the connection is extended to the connector the line relay 63 is energized in the same manner as the relays 137 and 54 of the switches E and D were energized when the connection was extended to their respective switches. The relay 63, upon energizing, closes a circuit through the release relay 148, which operates to close a new circuit through the relays 140 and 55 of the selector switches. This circuit extends from ground G^9 through side switch wiper 69, springs 149 and 150, conductor 147, shaft wiper 151, side switch wiper 152 and springs 153 and 154 to point 155. From point 155 one branch of this circuit passes through the relay 140 to battery and another branch passes through side switch wiper 141 and thence through the relay 55 of the selector D over a circuit already traced.

The connector F now responds to the impulses for the last two digits to extend the connection to the substation A'. When the

substation calling device is operated for the third digit 2 the line relay 63 of the connector is deenergized twice momentarily. Each time the relay 63 deenergizes a circuit is closed extending from ground G^{10} through springs 156 and 157, 158 and 159, vertical magnet 61, side switch wiper 68 and private magnet relay 160 to battery lead 118. The vertical magnet receives two impulses over this circuit and operates to raise the shaft and wipers two steps. The private magnet relay 160 is energized by the first impulse to the vertical magnet and remains in its operated position until after the last impulse is delivered. In its energized position the relay 160 closes a circuit extending from ground G^{11} through springs 205 and 206 and private magnet 64 to the battery lead 118. When the private magnet relay 160 deenergizes after the last impulse is delivered to the vertical magnet it breaks the circuit of the private magnet 64, which in turn deenergizes and allows the side switch to pass to second position. When the side switch wiper 68 reaches second position it connects the rotary magnet 62 with the battery lead 118 through the private magnet relay 160. When the calling device is operated for the last digit 0 the relay 63 deenergizes ten times, each time closing a circuit through the rotary magnet 62. This circuit extends from ground G^{10} through springs 156 and 157, 158 and 159, 163 and 164, rotary magnet 62, side switch wiper 68 and relay 160 to battery lead 118. Since the digit called is 0, the rotary magnet receives ten impulses over this circuit and operates to rotate the wipers ten steps and onto the terminals of the line #2220. The private magnet relay 160 is energized by the first one of this series of impulses and again closes the circuit of the private magnet 64. The relay 160 deenergizes after the last impulse is delivered to the rotary magnet, and opens the circuit of the private magnet 64, which thereupon allows its armature to fall back to trip the side switch from second to third position. The movement of the side switch wipers 65 and 66 to third position extends the connection through the wipers 58 and 59 to the line of the called substation. When the side switch wiper 67 engages its third position contact point it establishes a guarding potential at the connector private bank contacts of the called line and closes a circuit through the cut-off winding 86 of the line switch H. This circuit extends from ground G^{12} through side switch wiper 67, springs 165 and 166, private wiper 60 and bank contact with which it is in engagement, and through winding 86 to battery lead 118. The winding 86, upon energizing, attracts the armature 88, which operates to disconnect the switch H from the called line and to connect the line conductor 167 with the connector

bank contact which is engaged by wiper 58. When the side switch wiper 68 engages its third-position contact point a circuit is closed extending from ground G^{13} through interrupter 169, springs 170 and 171, ringer relay 72, side switch wiper 68 and relay 160 to battery lead 118. The relay 72, upon energizing, disconnects the calling and called lines and connects the ringer generator L with the called line to ring the bells 79. Since the circuit of the ringer relay includes the interrupter 169, the said relay is energized only intermittently so as not to ring the called subscriber continuously. It will be noted that as long as the side switch wiper 67 is in first or second position, the winding 172 of the line relay 63 is connected to ground directly at G^{12} . However, when the side switch passes to third position the ground G^{12} is disconnected from the relay 63, and the only remaining ground connection for the winding 172 extends through the relay 173 to ground G^{14} .

After the operator has completed the call the key K' is restored to normal position, whereby the calling device a is disconnected from the cord, and a bridge consisting of relay 14 and the upper winding of relay 13 is substituted therefor. The relay 14 and upper winding of relay 13 are thus included in a circuit in series with relays 63 and 173 at the connector F. The relay 173 has a comparatively high resistance, and the relays 13 and 14 of the cord circuit C are so adjusted that only the relay 13 is energized by the current which flows over this circuit. The energization of relay 13 while the relay 14 remains deenergized closes a circuit through the lamp 17. This circuit extends from ground G^{15} through springs 174 and 175 of key K, contact point 176 and armature 177 of relay 13, contact point 178 and armature 179 of relay 14, and through lamp 17 to battery B. At the connector F the relay 173 is energized when it enters the circuit above pointed out, and by pressing springs 180 and 181 into contact provides a new ground connection for the relay 148, to prevent its deenergization in case the relay 63 should be deenergized by the reduced flow of current through it when said relay 173 enters the circuit.

When the subscriber at the called substation removes his receiver in answer to the signal from the bell 79, or as soon thereafter as the ringer relay 72 deenergizes if it happens to be energized at the time, the called substation is provided with talking battery current. This current is supplied over a circuit extending from ground G^{12} through the side switch wiper 67, winding 182 of relay 71, ringer relay springs 183 and 184, side switch wiper 66, shaft wiper 59, line 168, hook switch springs 185 and 186, receiver 74^a, transmitter 76, line 167, 130

springs 187 and 188, shaft wiper 58, side switch wiper 65, ringer relay springs 189 and 190 and winding 191 of the relay 71 to battery lead 118. The relay 71 is energized by this talking current, and by separating the springs 170 and 171 breaks the energizing circuit of the ringer relay 72 to prevent further application of ringing current to the called line. The closure of contact between the springs 191^a and 192 by the energization of the relay 71 short-circuits the supervisory relay 173 by connecting the winding 172 of the relay 63 to ground directly at G¹⁶. This short-circuit of the relay 173 permits sufficient current to flow through the relays 63, 13 and 14 to insure the energization of all of said relays. The energization of the relay 14 at the cord C breaks the circuit of the lamp 17, which indicates to the operator that the called subscriber has answered.

When the called subscriber restores his receiver to the switch hook upon the termination of the conversation the energizing circuit of the connector back-bridge relay 71 is broken by the separation of the hook switch springs 185 and 186. The deenergization of the relay 71 again removes the short-circuit from the relay 173 by permitting the spring 191^a to disengage spring 192. When the short-circuit is thus removed from the relay 173 the current through the relay 14 of the cord circuit C is reduced sufficiently to allow said relay to deenergize again to close the circuit of the lamp 17. When the receiver at the calling substation is restored to the switch hook the energizing circuit of the supervisory relays 15 and 16 is broken. The deenergization of relay 15 closes the circuit of lamp 18, which circuit extends from ground G¹⁷ through springs 193 and 194 of key K, armature 195 and contact point 196 of relay 25, armature 197 and contact point 198 of relay 24, armatures 199 and 200 of relay 15 and through lamp 18 to battery B. The simultaneous glowing of lamps 17 and 18 indicates to the operator that the lines may be disconnected. The removal of plug *p*¹ from jack *j*¹ destroys the circuit of relays 24 and 25, which deenergize to extinguish lamp 18. The removal of the plug *p*² from the jack *j*² allows the relay 13 to deenergize to extinguish lamp 17, and also initiates the release of the automatic switches by breaking the energizing circuits of the connector relays 63 and 173 (Fig. 6). The deenergization of both of these relays destroys the energizing circuits of the release relays 148, 140 and 55 of the switches F, E and D, respectively. The deenergization of the relays 148, 140 and 55 close the energizing circuits of the release magnets of their respective switches. The energizing circuit of the release magnet 50 of the selector D extends

from ground G⁵ through springs 119 and 120, 123 and 124, magnet 50 and off-normal springs 53 and 52 to battery lead 118. The release circuits for the switches E and F are similar to that traced for the selector D. The release magnets 50, 201 and 70, upon energizing, release the mechanisms of their respective switches, allowing them to return to normal position. As the shaft of each switch reaches its lowest position it opens the circuit of its release magnet by separating the off-normal springs (see springs 52 and 53 of the selector D, Fig. 5) and all the apparatus employed in the connection is left in normal position.

If the substation A' had already been in use when called by the operator at the cord C through the medium of the connector F, then connection with said line would not have been completed, and the calling subscriber would have received the busy signal in the following manner: Whenever a line is busy there is a guarding ground potential upon the private contacts of this line in the bank of all connectors which have access to it. Whenever the private wiper 60 encounters the guarded contact of a busy line a circuit is extended from said contact through wiper 60, springs 166 and 165, winding 182 of relay 71, ringer relay springs 183 and 184, side switch wiper 66 (which is now in second position) and through the private magnet 64 to battery lead 118. The current flowing over this circuit maintains the private magnet 64 energized and also energizes the relay 71 when the private magnet relay 160 deenergizes after the wipers have been brought into contact with a busy line. Since the private magnet 64 remains energized, the side switch remains locked in second position, thus preventing completion of connection with the busy line through side switch wipers 65 and 66. The deenergization of relay 160, together with the energization of relay 71 and magnet 64, establishes a circuit for the busy locking relay 204. This circuit extends from ground G¹¹ through springs 205 and 203, 207 and 208, relay 204 and springs 209 and 210 to the battery lead 118. The relay 204, upon energizing, disconnects the rotary magnet 62 from the impulse spring 157, shifts the holding ground of the private magnet 64 and relay 71 from the guarded bank contact to ground G¹⁸, and connects the busy machine J with the line. The circuit over which the calling subscriber receives the busy signal extends from battery lead 118 through one winding of the induction coil of the busy machine J, springs 211 and 212 of relay 204, contact point 213, side switch wiper 65, thence over the heavy conductors shown in Figs. 3, 2 and 1 to and through substation A and back over the other side of the line to and

through the winding 172 of the connector line relay 63 to ground G^{12} , and thence through the battery B back to the starting point. The automatic switches are released from this position by the removal of the plug p^2 from the jack j^2 in the same manner as previously explained.

In case the subscriber at a magneto substation, such as the substation A^2 , desires to make a call, the operation of the system is as follows: In order to signal the operator the subscriber at substation A^2 rotates the crank of the generator 31, whereby ringing current is projected over the line and through the line relay 33 in the usual manner. The relay 33 is energized by this current and its armature is locked in its operated position. In this position the armature of the relay 33 operates to close the circuits of the lamp 214 and of the busy signal 36 associated with each of the multiple jacks of the line. When the operator inserts the plug p' into the jack j^3 to answer the call a circuit is completed extending from ground G^{19} through the cut-off relay 34, sleeve conductor of the jack j^3 and plug p' and through the relays 25 and 24 to the battery B. The relays 34 and 25 are energized by the closure of this circuit, but sufficient current does not flow to operate the relay 24. The relay 34, upon energizing, unlocks the armature of the relay 33, disconnects the relay 33 from the line and maintains the circuit of the busy signal 36 through the springs 215 and 216. The energization of the relay 25 of the cord C serves to connect the lower winding of the relay 16 to the battery B through the armature 217 and contact point 218. The upper winding of the relay 16 remains bridged across the talking circuit, the said bridge extending from the tip strand through the relays 15 and 16, armature 108 of relay 24, contact point 219, contact point 220 and armature 107 to the ring strand of the cord.

The operator is given the disconnect signal from substation A^2 by the operation of the generator 31. Current flows from this generator over the line, through jack j^3 and plug p' and through the relays 15 and 16. The relay 16 is energized by this current and by attracting its armature 221 forms a locking circuit for itself and closes a circuit through the lamp 18. The locking circuit for the relay 16 extends from ground G^{17} through springs 193 and 194 of key K, contact point 222, armature 221, and lower winding of relay 16, armature 223 and contact point 224, contact point 218 and armature 217 to the battery B. The circuit of the lamp 18 extends from ground G^{17} through the armature 221, as just traced, and thence through the lamp 18 to battery. The lamp will thus continue to glow until the plug p' is removed, whereupon the relay

25 deenergizes and breaks the locking circuit of the relay 16.

When the substation A^2 is called the calling plug p^2 is inserted into one of the jacks of that line. The relays 14, 13, 21 and 22 then operate in the same manner as the relays 15, 16, 24 and 25 when substation A^2 is the calling substation. In order to signal a manual substation the operator operates the key K to force the springs 225 and 226 into contact with the springs 227 and 228, respectively, whereby the calling and called lines are disconnected and the generator L' is bridged across the called line in the usual manner. Normally the talking circuit through the cord C is as shown by the heavy lines in Fig. 4. Sometimes, however, as when connecting a common battery line to a local battery line, it is desirable to divide the cord circuit into two sections which are inductively connected through the medium of a repeating coil. This may be done by throwing the key K^3 to the left. When this is done the talking circuit of the left-hand end of the cord extends from the tip of the plug p' over the tip strand of the cord, through the winding 229 of the repeating coil O, springs 230 and 231 of the key K^3 , condenser 19, springs 232 and 233, winding 234 of the coil O and thence over the ring strand to the ring conductor of the plug p' . The circuit of the other section of the cord extends from the tip of the plug p^2 through the winding 235, springs 236 and 237, condenser 20, springs 238 and 239 and winding 240 to the ring of the plug p^2 .

When a common battery line, such as the line A, is called the calling plug p^2 is inserted into one of the multiple jacks j of the desired line. In that case the operation of the relays 14, 13, 21 and 22 is the same as explained for the relays 15, 16, 24 and 25 when substation A was the calling substation. As far as the relays and associated circuits are concerned, both ends of the cord C are alike, so that the supervision of a call from any line is obtained in the same manner whether the line is a calling or a called line. As herein represented, the common battery line is not provided with visual busy signals. In this case the operator may ascertain whether or not the line called is busy by touching the tip of a calling plug to the sleeve of the jack of the line, in the manner commonly used in manual switch-board practice.

It having been explained how the cord C may be used in connection with common battery manual lines, local battery manual lines and how automatic lines may be called by the manual lines, it now remains to be explained how an automatic line may call a manual line. It will now be explained how the automatic substation A^1 may obtain connection with one of the manual sub-

stations. When the receiver 74^a is removed from the switch-hook the circuit of the ringer 79 is opened and a bridge consisting of the transmitter 76, receiver 74^a and impulse springs 71 is closed across the line. The closure of this bridge completes an energizing circuit for the line winding of the line switch H. This circuit extends from ground G²⁰ through springs 241 and 242, line 168, hook switch springs 185 and 186, impulse springs 77, receiver 74^a, transmitter 76, line 167, and springs 187 and 243, through winding 84, spring 277, armature 270, and to the battery lead 118, thence through the battery B to ground G. The winding 84, upon energizing, attracts its armature 89, which forces the spring 244 into engagement with spring 241. The engagement of springs 244 and 241 closes an energizing circuit through the pull-in winding 85. This circuit extends from ground G²⁰ through springs 241 and 244, windings 85 and 87 to battery lead 118, thence through the battery B to ground G. The winding 85, upon energizing, attracts the plunger arm 82^a and the cut-off armature 88. The armature 88, upon being attracted, forces springs 242 and 187 out of engagement with springs 241 and 243, respectively, thus opening the circuit of the winding 84. The armature 89 does not fall back immediately upon the deenergization of winding 84, but remains held up by the current flowing through the winding 87. When the plunger arm 82^a is attracted it forces the plunger into the bank to press springs 90, 92, 94 and 96 into contact with the springs 91, 93, 95 and 97, respectively. In its operated position the plunger arm 82^a also forces spring 245 into engagement with spring 246, thereby short-circuiting the winding 87, which causes the armature 89 to fall back slowly so as to open the circuit of the pull-in winding 85. Before the armature 89 has time to fall back, however, the cut-off winding 86 is energized in the following manner: When the bank springs 90 and 92 are forced into contact with springs 91 and 93 the line conductors are connected with the trunk conductors 247 and 248, which are assumed to lead to the first selector switch D', Fig. 7. When this occurs the line relay 250 is energized by a flow of current from ground G²¹ through the lower winding of said relay, over trunk conductor 248, line conductor 168, through substation A', back over line conductor 167, trunk conductor 247 and through the upper winding of relay 250 to battery lead 118. The relay 250, upon energizing, operates to close the circuit of the release relay 251 in the same manner in which the relay 55 of the selector D was energized. The relay 251 connects the vertical magnet with the impulse spring, as explained in connection with the relay 55 of the selector

D, and also closes a circuit extending from ground G²² through springs 252 and 253, conductor 249 and through the cut-off winding 86 of the line switch H to battery lead 118. This energization of winding 86 serves to hold the plunger arm 82^a and armature 88 in their operated positions after winding 85 is deenergized.

The engagement of springs 96 and 97 of the line switch H completes a circuit extending from ground G²⁴ through said springs 96 and 97, master switch bank contact point 273, which corresponds to the trunk seized by switch H, wiper 274, segment 265 and relay 266 to battery lead 118. The relay 266, upon energizing, operates to close a circuit through the relay 267, which in turn attracts its armature 270, which unlocks the plunger shaft by withdrawing the pin 269 from the cam 268 and closes a circuit through the motor magnet 263 and interrupter springs 275. Since the motor magnet circuit includes the interrupter springs 275, the said magnet operates in a manner similar to that of a buzzer as long as the armature 270 engages the contact point 276. The continued operation of the magnet 263 serves to rotate the ratchet wheel 264 step by step to move the plungers that are locked with the plunger shaft away from the trunk occupied by the switch H. After the plunger shaft has moved a short distance the wiper 274 leaves the contact 273, allowing the relays 266 and 267 to be deenergized. The armature of relay 267 can not fall back immediately, because the opening in the cam 268 which was engaged by pin 269 has been moved out of register therewith. The motor magnet 263 will continue to operate to advance the idle plungers until the next opening in the cam 268 passes under the pin 269, whereupon the armature 270 falls back, locking the shaft against further rotation and breaking the operating circuit of the motor magnet 263. If the next trunk after the one just seized had been busy, the wiper 274 would have found the corresponding contact grounded; consequently, the relays 266 and 267 would have remained energized while the next opening was passing under the pin 269, causing the plungers to be carried past the busy trunk. It is evident that as long as the master switch is operating, the armature 270 is disengaged from contact point 277, thus disconnecting the battery from the trip winding 85 of all the switches H which are controlled by the master switch R. This prevents any line switch from being operated while its plunger is being moved from one trunk to another.

The subscriber at substation A' now operates his calling device for the digit corresponding to the bank level of the first selectors to which are connected trunk lines

leading to the manual board. The selector D' operates in response to the operation of the calling device in the same manner as explained for the selector D to extend the connection over the trunk conductors 253 and 254 to an idle jack j^4 . The relay 38 is thereupon energized by a flow of current from battery B through said relay, over conductors 253 and 247, line conductor 167, through substation A' and back over line 168, trunk conductors 248 and 254 and through armature 258 and contact point 259 to ground G²³. The relay 38, upon energizing, closes the circuit of lamp 257, and also grounds the conductor 255 through the armature 260 and contact point 261. This grounding of the conductor 255 is for the purpose of maintaining the energizing circuit of the relay 251 of the selector D' in the same manner that the relay 55 of the selector D (Fig. 4) was maintained energized over the conductor 133. When the operator inserts the plug p' into the jack j^4 to answer the call, the relay 39 is energized in the same manner that the relay 11 of the common battery manual line A was energized. The relay 39, upon energizing, disconnects the relay 38 from the line and provides a new ground for the conductor 255 through the armature 262 and its contact. The operation of the relays 25, 24, 16 and 15 of the cord when the plug p' is inserted in the jack j^4 is exactly the same as when the plug p' is inserted in the jack j' of the line A, and supervision is obtained in the same manner as explained in connection with that line.

From the foregoing it will be seen that I provide a cord circuit of universal utility, inasmuch as it can be used indiscriminately between different kinds of telephone lines, giving efficient supervision of the connection in each case. Furthermore, this indiscriminate or haphazard use of lines of different kinds is possible without manually changing the character of the cord circuit—that is to say, without employing key switches to adapt the cord circuit to the varying conditions of different lines. The cord circuit, as explained, is provided with relays which automatically adapt the cord circuit for use in connection with different kinds of lines. When a connection is desired between certain lines the relays, or one or more of them, serve to automatically put the circuits in condition for giving efficient supervision of the calling connection. When the same cord circuit is employed between certain other lines, or between one of said lines and some other line, the said relays, or one or more of them, then serve to automatically insure the circuit conditions necessary for giving supervision of the calling connection, which, in this case, is

different from the other calling connection, at least to the extent of requiring a different kind of supervisory control. Thus the cord circuit is provided, as explained, with means serving to automatically adapt it for use under varying conditions, as between telephone lines of different kinds. The automatic switching of the cord circuits may, however, be used for other purposes.

What as I claim as my invention is:—

1. In a telephone system, a plurality of different kinds of telephone lines, a cord circuit for use in variously connecting said lines together, a supervisory relay, and automatic means for either connecting said relay directly in bridge of said cord circuit or connecting one side of said cord to one pole of battery and the other to the other pole of battery through said supervisory relay.

2. In a telephone system, a plurality of different kinds of telephone lines, a cord circuit for use in variously connecting said lines together, a supervisory relay, automatic means for either connecting said relay in bridge of said cord circuit, or connecting one side of said cord to one pole of battery and the other to the other pole of battery through said supervisory relay, and means for locking said relay in energized position when it is operated while in bridge of the cord.

3. In a telephone system, a cord circuit, a plug for said cord, a plurality of jacks with which said plug is adapted to cooperate, cut-off relays of varying resistance associated with said jacks, a supervisory signal for said cord, and means whereby the operation of said signal is dependent upon the resistance of said cut-off relays.

4. In a telephone system, a cord circuit, a plug for said cord, a plurality of jacks with which said plug is adapted to cooperate, cut-off relays of varying resistance associated with said jacks, a supervisory signal for said cord, a plurality of relays controlling the operation of said signal, and means whereby the operation of said relays is dependent upon the resistance of said cut-off relays.

5. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for said cord adapted to be connected in circuit with said cut-off relay, and means whereby the operation of said supervisory relays is variable, dependent upon the resistance of said cut-off relay.

6. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of relays for said cord adapted to be connected in cir-

cuit with said cut-off relay, a supervisory relay, and means whereby the connection of said supervisory relay to said cord is controlled by said pair of relays.

5 7. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for said cord adapted to be
10 connected in circuit with said cut-off relay, means whereby the operation of said supervisory relays is variable, dependent upon the resistance of said cut-off relay, an auxiliary relay, and means whereby the connection of
15 said auxiliary relay to said cord is controlled by said supervisory relays.

8. In a telephone system, common battery lines, local battery lines and automatic lines, a cord circuit for use in variously connect-
20 ing said lines together, a supervisory relay, automatic means for either connecting said relay directly in bridge of said cord circuit or connecting one side of said cord to one pole of battery and the other to the other
25 pole of battery through said supervisory relay, an automatic switch, and means in said cord for transmitting impulses to control said switch.

9. In a telephone system, common battery
30 lines, local battery lines and automatic lines, a cord circuit for use in variously connecting said lines together, a supervisory electromagnetic equipment, automatic means for either connecting said equipment in bridge
35 of said cord circuit or connecting one side of said cord to one pole of battery and the other to the other pole of battery through said supervisory equipment, means for locking said equipment in energized position
40 when it is operated while in bridge of the cord, an automatic switch, and means in said cord for transmitting impulses to control said switch.

10. In a telephone system, common bat-
45 tery lines, local battery lines and automatic lines, a cord circuit, a plug for said cord, a plurality of line jacks with which said plug is adapted to cooperate, cut-off relays of varying resistance associated with said jacks,
50 a supervisory signal for said cord, means whereby the operation of said signal is dependent upon the resistance of said cut-off relays, an automatic switch, and means in said cord for transmitting impulses to con-
55 trol said switch.

11. In a telephone system, common bat-
tery lines, local batter lines and automatic lines, a cord circuit, a plug for said cord, a plurality of line jacks with which said plug
30 is adapted to cooperate, cut-off relays of varying resistance associated with said jacks, a supervisory signal for said cord, a plurality of relays controlling the operation of said signal, means whereby the operation of

said relays is dependent upon the resistance 65 of said cut-off relays, an automatic switch, and means in said cord for transmitting impulses to control said switch.

12. In a telephone system, common bat-
tery lines, local battery lines and automatic 70 lines, a cord circuit, a plug therefor and a line jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for said cord adapted to be connected in circuit 75 with said cut-off relay, means whereby the operation of said supervisory relays is variable, dependent upon the resistance of said cut-off relay, an automatic switch, and means in said cord for transmitting impulses to 80 control said switch.

13. In a telephone system, common bat-
tery lines, local battery lines and automatic lines, a cord circuit, a plug therefor and a line jack with which said plug is adapted to 85 cooperate, a cut-off relay associated with said jack, a pair of relays for said cord adapted to be connected in circuit with said cut-off relay, a supervisory relay, means whereby the connection of said supervisory 90 relay to said cord is controlled by said pair of relays, an automatic switch, and means in said cord for transmitting impulses to control said switch.

14. In a telephone system, common bat- 95 tery lines, local battery lines and automatic lines, a cord circuit, a plug therefor and a line jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for 100 said cord adapted to be connected in circuit with said cut-off relay, means whereby the operation of said supervisory relays is variable, dependent upon the resistance of said cut-off relay, an auxiliary relay, means 105 whereby the connection of said auxiliary relay to said cord is controlled by said supervisory relays, an automatic switch, and means in said cord for transmitting im-
110 pulses to control said switch.

15. In a telephone system, a plurality of different kinds of telephone lines, a cord circuit for use in variously connecting said lines together, a supervisory electromagnetic equipment, automatic means for either con- 115 necting said equipment directly in bridge of said cord circuit or connecting one side of said cord to one pole of battery and the other to the other pole of battery through said supervisory equipment, an automatic 120 switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

16. In a telephone system, a plurality of 125 different kinds of telephone lines, a cord circuit for use in variously connecting said lines together, a supervisory electromagnetic

equipment, automatic means for either connecting said equipment in bridge of said cord circuit or connecting one side of said cord to one pole of battery and the other to the other pole of battery through said supervisory equipment, means for locking said equipment in energized position when it is operated while in bridge of the cord, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

17. In a telephone system, a cord circuit, a plug for said cord, a plurality of jacks with which said plug is adapted to cooperate, cut-off relays of varying resistance associated with said jacks, a supervisory signal for said cord, means whereby the operation of said signal is dependent upon the resistance of said cut-off relays, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

18. In a telephone system, a cord circuit, a plug for said cord, a plurality of jacks with which said plug is adapted to cooperate, cut-off relays of varying resistance associated with said jacks, a supervisory signal for said cord, a plurality of relays controlling the operation of said signal, means whereby the operation of said relays is dependent upon the resistance of said cut-off relays, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

19. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for said cord adapted to be connected in circuit with said cut-off relay, means whereby the operation of said supervisory relays is variable, dependent upon the resistance of said cut-off relay, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

20. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of relays for said cord adapted to be connected in circuit with said cut-off relay, a supervisory relay, means whereby the connection of said supervisory relay to said cord is controlled by said pair of relays, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

21. In a telephone system, a cord circuit, a plug therefor and a jack with which said plug is adapted to cooperate, a cut-off relay associated with said jack, a pair of supervisory relays for said cord adapted to be connected in circuit with said cut-off relay, means whereby the operation of said supervisory relay is variable, dependent upon the resistance of said cut-off relay, an auxiliary relay, means whereby the connection of said auxiliary relay to said cord is controlled by said supervisory relays, an automatic switch controllable over two sides of a line circuit in series, and means in said cord for transmitting impulses over said line circuit in series to control said switch.

22. In a telephone system, a cord circuit, a supervisory signal in said cord circuit, a plurality of manual lines, a source of current individual to each of said lines, means for connecting said cord with any one of said lines, and for operating said signal from the source of current individual to said line; a plurality of other manual lines, a source of current common to said lines, means for connecting said cord with any one of said lines and for operating said signal from said source; a plurality of automatic lines, said source of current also common to said automatic lines, means for connecting said cord with any one of the lines of said last group, and means in the connected line for controlling the current from said source associated with said cord for operating said signal.

23. In a telephone system, a plurality of different kinds of telephone lines, a cord circuit for use in variously connecting said lines together, supervisory electromagnetic equipment, and automatic means for either connecting said equipment across the talking circuit of said cord without a battery or with a battery in series.

24. In a telephone system, common battery lines, local battery lines and automatic lines, a cord circuit for use in variously connecting said lines together, a supervisory electromagnetic equipment, automatic means for either connecting said equipment across the talking circuit of said cord without a battery or with a battery in series, an automatic switch, and means in said cord for transmitting impulses to control said switch.

25. The combination with a telephone system comprising common and local battery lines, of a universal cord circuit provided with a terminal by which the said cord circuit may be connected with a line of either kind, supervisory circuits of different character associated with said cord circuit, cut-off relays for said lines, the relays associated with different kinds of lines being of different resistances, and a switching relay in said cord circuit adapted to be included in the circuit of the cut-off relay of a connected

line, the operation or non-operation of said switching relay depending on the resistance of the cut-off relay with which it is in circuit, and means whereby said switching relay controls said supervisory circuits.

26. A telephone system comprising common and local battery telephone lines having their talking conductors terminating in jacks at the central office, cut-off relays for said lines, of different character according to the associated line, a link circuit for universal connection with said lines, a pair of supervisory relays for said link circuit, a switching relay for said link circuit for connecting one of said relays in bridge of the talking strands of the cord circuit, said switching relay being adapted to be connected in series with a cut-off relay when connection is made with a calling line, and means whereby said switching relay is or is not operable according to the character of the cut-off relay of the calling line when connection is made therewith, to operatively associate one of the supervisory relays with the talking strands of the cord circuit.

27. A telephone system comprising common battery and local battery or magneto lines, and a universal cord circuit for interconnecting said lines, said cord circuit comprising three relays associated with each end, a supervisory signal for each end of the cord circuit, and circuit connections whereby said signals are controlled by one of said relays when connection is made with a local battery or magneto line and by two of said relays when connection is made with a common battery line.

28. A telephone system comprising common battery and local battery or magneto lines, and a universal cord circuit for interconnecting said lines, said cord circuit comprising a pair of supervisory relays and a switching relay associated with each end, a supervisory signal for each end of the cord circuit, and circuit connections whereby a signal is controlled by one of said super-

visory relays if connection is made with a local battery, or magneto line and by the other of said supervisory relays and said switching relay if connection is made with a common battery line.

29. A telephone system including line circuits having line and cut-off relays, connecting jacks associated with said circuits, magneto and common battery telephones associated with said line circuits respectively, the connections of said line circuits being adapted to be varied according to the associated telephone, and a universal cord circuit for interconnecting said lines including a pair of supervisory relays for each end thereof, each one adapted for serving one type of line, and a switching relay corresponding to each pair of supervisory relays and adapted to be controlled according to the circuit connections of the line connected with whereby the corresponding supervisory relay is connected in operative relation with the line.

30. A telephone system comprising magneto and common battery lines, line circuits for said lines comprising line and cut-off relays, the circuit connection of the cut-off relays being adapted to be varied according to the associated line, and a universal cord circuit for interconnecting said lines having two supervisory relays for each end, one being adapted for use with a magneto line and the other for use with a common battery line, and a third relay for each end of the cord circuit adapted to be connected in circuit with the cut-off relay when connection is made with a line and differently operative according to the connections of the connected cut-off relay for rendering the proper supervisory relay effective.

Signed by me at Chicago, Cook county, Illinois, this 27 day of April, 1910.

MORTON L. JOHNSON.

Witnesses:

EDWARD D. FALES,
ARTHUR J. RAY.