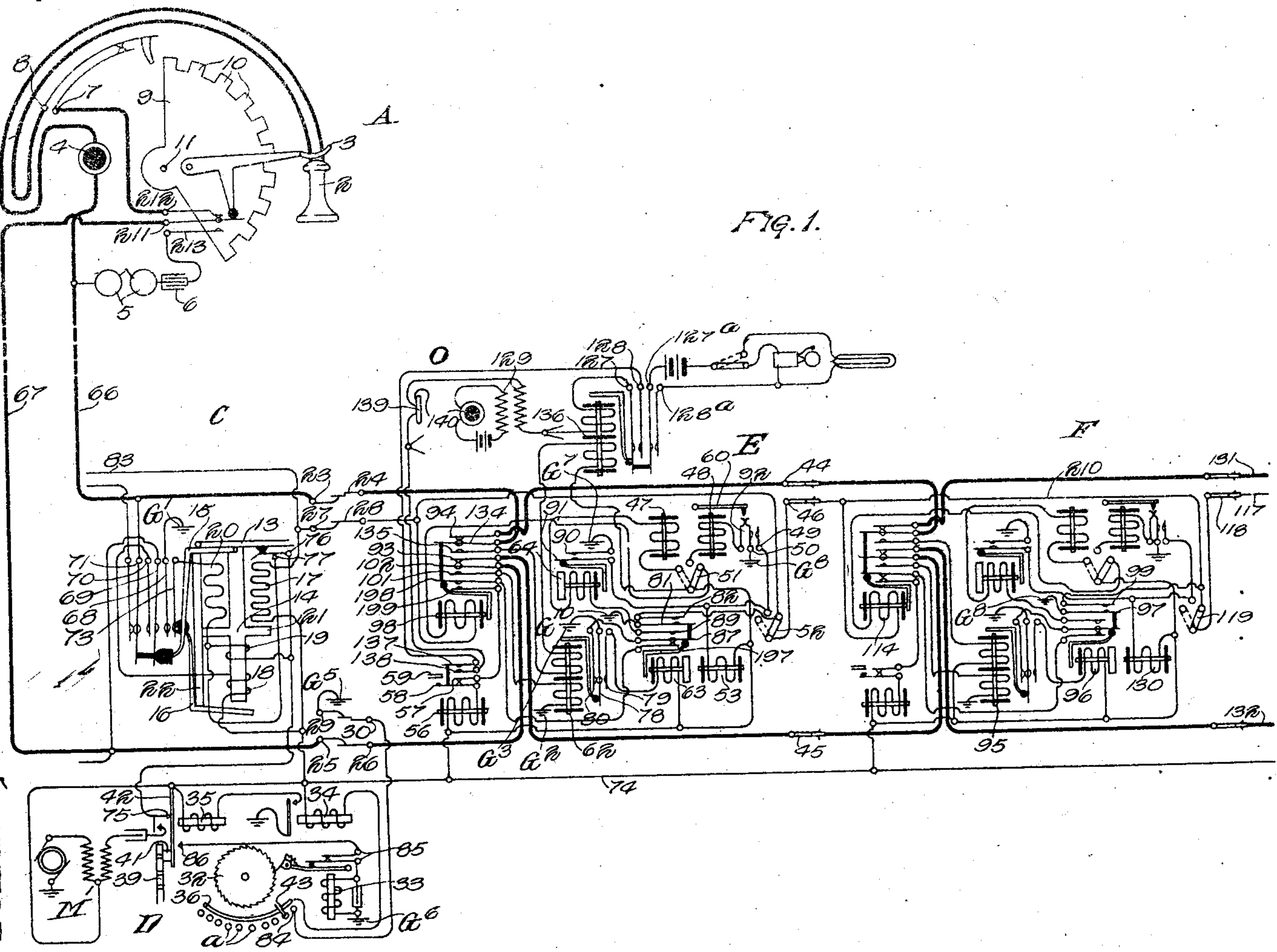


1,051,894.

A. E. KEITH.
SPECIAL CALL TELEPHONE SYSTEM.
APPLICATION FILED MAY 2, 1911.

Patented Feb. 4, 1913.
3 SHEETS-SHEET 1.

FIG. 1.



WITNESSES
A. J. Ray,
A. Anderson.

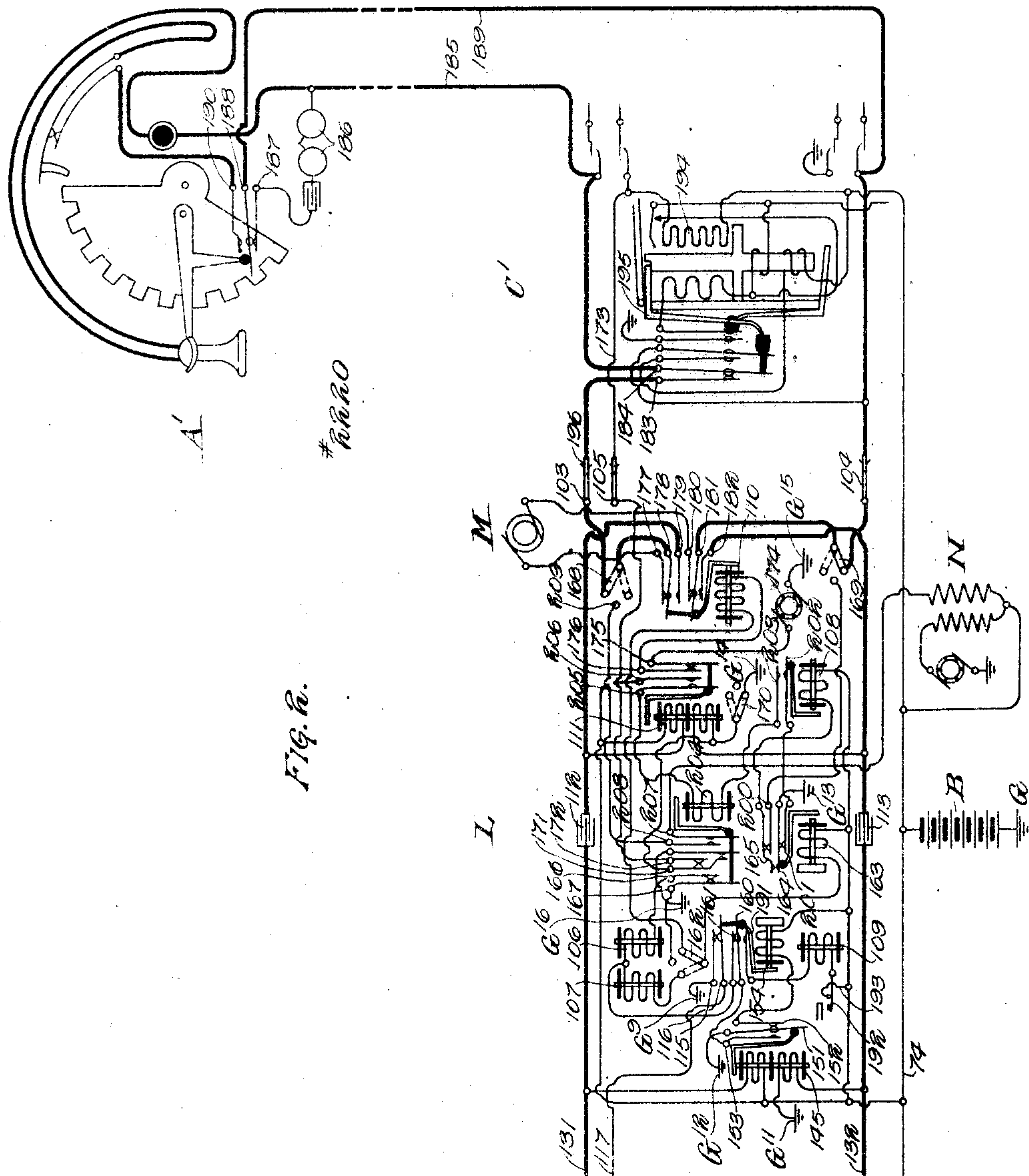
INVENTOR:
Alexander E. Keith
By Buckley & Durand
ATTORNEYS.

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3 SHEETS-SHEET 2.



WITNESSES
A. J. Ray.
A. Andersen.

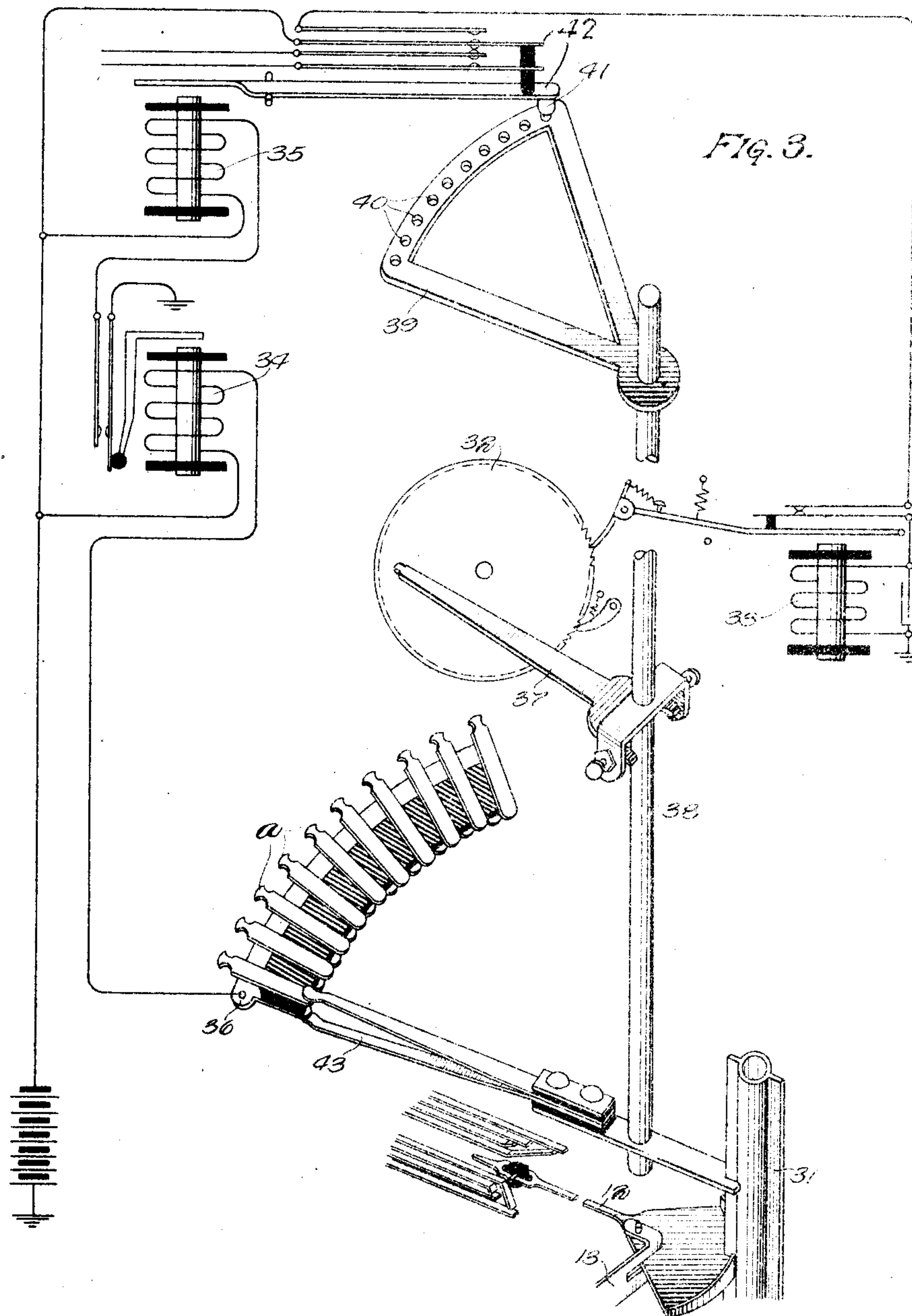
INVENTOR:
Alexander E. Keith
By Bulkeley & Durand
ATTORNEYS.

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2 SHEETS-SHEET 3.



WITNESSES
A. J. Ray.
A. Anderson.

INVENTOR:
Alexander E. Keith
By Bulkeley & Durand
ATTORNEYS

UNITED STATES PATENT OFFICE.

ALEXANDER E. KEITH, OF HINSDALE, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

SPECIAL-CALL TELEPHONE SYSTEM.

1,051,894.

Specification of Letters Patent.

Patented Feb. 4, 1913.

Application filed May 2, 1911. Serial No. 624,556.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and resident of Hinsdale, Dupage county, Illinois, have invented certain new and useful Improvements in Special-Call Telephone Systems, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to automatic or semi-automatic telephone exchange systems in which either all or a part of the calling connection is established by means controlled by the calling subscriber, and more especially to a system of this kind in which the automatic switches are controlled by rotary or other similar calling devices at the substations. In such a system it is necessary, of course, in order to extend the call from any calling line, for the calling subscriber to first take down the receiver, and to then operate the rotary or other suitable calling device, whereby either all or a part of the calling connection is then extended from the calling line. Ordinarily, in a system of this character, a calling subscriber cannot obtain connection with the substation of any other subscriber, or even with the telephone of an exchange operator, except by first operating the said rotary or other calling device at the calling substation. In some cases this is extremely objectionable, as it often occurs that a calling subscriber should have a response as quickly as possible, and without being under the necessity of first operating the rotary calling device.

The object of my invention is, therefore, to provide a system of this general character in which provision is made for enabling a calling subscriber to converse with an operator without the necessity of first operating the rotary calling device at the calling substation. In this way, for example, an alarm of fire can be turned in very quickly and simply by the removal of the receiver at the calling substation. Also, this expedient can be employed for enabling any calling subscriber to converse with a trouble operator, or with an operator for some other special purpose, by simply taking down the receiver at the calling substation, and without the necessity of first operating the rotary calling device. Regular calls can be made in the usual way by operating the rotary calling device in the well-known manner.

But calls for certain special purposes, such as those indicated, or of any other desired character, can be made by simply removing the receiver at the calling substation.

To these and other useful ends my invention contemplates a telephone with which each calling subscriber automatically connects and disconnects, through the medium of switching mechanism controlled from the calling substation, before the call reaches the called line.

It further contemplates a telephone which is common to a plurality of first selectors, being connected therewith, and which is automatically disconnected from the calling line by the initial operation of any first selector, whereby the said telephone is connected with each and every calling line, and then automatically disconnected therefrom by the initial operation of the selector before the call reaches the called line.

It further contemplates a system in which means are provided for enabling an operator to listen in on every calling line as soon as the receiver is removed at the calling substation, and in which means are provided for preventing the operator from listening in on any calling lines over which the calls have progressed to the point where the rotary calling device has been operated to control the automatic switches.

In the accompanying drawings, Figures 1 and 2 taken together show a complete connection between a calling substation A and a called substation A' in a system in connection with which I have chosen to illustrate my invention. Fig. 3 is a diagrammatic representation of a portion of the central office apparatus.

In Fig. 1 the lines of the substation A terminate at the central office in an individual or line switch C. The line switch C, together with a number of similar switches, is controlled by a so-called master switch D and has common access to a plurality of trunk lines leading to first selector switches E. A group of first selectors E has common access to a number of second selectors F, which in turn have access to connector switches L. The connectors have direct access to the subscribers' lines. The connector L is represented as having been brought into connection with the line of substation A', to which there is allotted at the central office the line switch C'.

At O (Fig. 1) there is represented an operator's talking set.

The automatic substation with which I have chosen to illustrate my invention comprises the usual receiver 2, switch hook 3, transmitter 4, ringer 5 and condenser 6. Since it is an automatic substation, it is provided with a pair of impulse springs 7 and 8 and an impulse wheel 9. The impulse wheel 9 carries on its periphery a number of impulse teeth 10 and is secured to a shaft 11, to which there is also secured a dial (not shown) provided with finger holes. By means of the dial the impulse wheel may be rotated forward, after which it may be returned to normal position by a spring (not shown). During this backward movement of the impulse wheel, each of the teeth 10 which passes the end of the spring 8 momentarily separates said spring from the spring 7. The number of teeth which are thus carried past the end of the spring 8 depends upon the digit called.

The line switch C, which is individual to the line of the substation A, and the master switch D are of the general type disclosed in British Patent No. 26,801 of 1906, and in the *American Telephone Journal* of New York, N. Y., of June 6, 1908, but having a somewhat modified construction. As illustrated herein, the line switch C comprises the usual plunger 12 (Fig. 3) attached to the end of the plunger arm 13, which is controlled by the magnet 14. Besides the plunger arm 13, the magnet 14 also controls the relay armatures 15 and 16, and comprises four windings, namely, a pull-in winding 20, a holding and cut-off winding 17, a line winding 18 and an auxiliary winding 19. The core of the magnet 14 is provided with a lateral projection 21 near the center of its length, by means of which the magnet is attached to the bracket 22 upon which the armatures 15, 16 and 18 are mounted. With this arrangement the magnetic circuit of the windings 17 and 20 is made separate from that of the windings 18 and 19, and therefore the armatures on one end of the magnet are not affected by the windings upon the other end. Of the two windings upon the upper end of the magnet, the winding 20 is the stronger, and, when energized, operates both the plunger arm 13 and armature 15. The winding 17 is strong enough to operate only the armature 16 and hold the plunger arm 13 in operated position. It cannot attract the plunger arm from its normal position. When the plunger arm 13 is attracted, the plunger on the end thereof is forced into a group of springs, forcing the springs 23, 25, 27 and 29 into engagement with the springs 24, 26, 28 and 30, respectively. Although only one group of springs (23-30) is shown, each switch C is provided with a number of such groups

of springs, each group forming the terminal of a trunk line leading to a selector E. Each of these trunk lines is common to a number of line switches C. The plungers of idle line switches normally engage a so-called plunger shaft 31 (Fig. 3), through the medium of which they are held opposite idle trunk lines by the master switch D, which is common to a group of line switches. As herein represented, the master switch D comprises, among other details, a ratchet wheel 32, motor magnet 33, relays 34 and 35 and a bank of contacts comprising a common segment 36 and an individual segment *a* for each of the trunk lines to which the switch C has access. The ratchet wheel 32 is connected with the plunger shaft 31 (Fig. 8) by the link 37 and shaft 38 in such a manner that the rotary motion of said wheel imparts to the plunger shaft 31 an oscillatory motion about the shaft 38, to move the idle plungers back and forth in front of the trunk terminals. Attached to the shaft 38 there is a locking plate 39, provided near its outer edge with a number of openings 40 which are adapted to be engaged by a pin 41 on the end of the armature 42 of relay 35. The openings 40 are so spaced that the pin 41 can engage one of them only when the plungers which are in engagement with the plunger shaft are directly opposite the terminals of a trunk line. Attached to the shaft 38 there is a wiper 43 which always keeps the common segment 36 in electrical connection with the individual segment *a* which corresponds to the trunk line in front of which the idle plungers are being held by the plunger shaft 31.

The first selector E is of the general type disclosed in United States Letters Patent #815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being somewhat modified, however, in order to operate in a system in which the central office apparatus is controlled from the calling substation over the two sides of the line in series. This selector comprises the usual wipers 44, 45 and 46, carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 47 and a rotary motion controlled by the rotary magnet 48. The usual side switch, comprising the wipers 51 and 52, is controlled by the private magnet 53 in a well-known manner. Means for releasing the switch are provided in the usual release magnet 56. The springs 57 and 58 which are included in the circuit of the release magnet are separated by the arm 59, which is attached to the switch shaft, as long as said shaft is in its lowest position. The springs 137 and 138 are held in contact by the arm 59 as long as the switch shaft is in its lowest position, but become separated as soon as the shaft is raised one or more steps.

The mechanism of the selector E is released immediately upon the energization of the release magnet, rather than by its deenergization as shown in the said selector patent.

5 The armature 60 of the rotary magnet 48 has no finger for pressing down the armature of the private magnet 53, as shown in the selector patent, but controls the said private magnet electrically through the medium of the springs 49 and 50. The calling subscriber controls the operations of the switch through the medium of the double wound line relay 62. The relays 63 and 64 are relays that deenergize slowly after their energizing circuits have been broken. This slow action is usually obtained by securing a heavy copper ring around one end of the core of the magnet. The wipers of the selector E are adapted to engage a bank of contacts forming the terminals of trunk lines leading to selectors F. Each trunk line is common to a number of selectors E.

The selector F is like the selector E, with the omission of the off normal springs 137 and 138.

The operator's talking set O (Fig. 1) comprises a receiver 139, transmitter 140 and induction coil 129. This operator's set is common to a number of first selectors E. Allotted to each selector there is a relay 136 for establishing a talking connection between the operator's set and the selector. The connection between the operator's set and the selector is also controlled by the springs 137 and 138 which are controlled by the arm 59 in the manner already explained.

The connector L (Fig. 3) is of the general type disclosed in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors, is modified somewhat to operate in a two-wire system. Like the selectors, the connector comprises a set of wipers 103, 104 and 105 carried upon a shaft (not shown) which is controlled by the vertical magnet 107 and rotary magnet 106. The usual side switch is controlled by the private magnet 108 in the usual manner. The release magnet 109 is similar to the release magnet of the selector switch. The ringer relay 110 is provided for the purpose of connecting the ringer generator M with the called line after connection has been completed therewith. The talking battery current is fed to the called substation through the winding of the so-called back bridge relay 111. The talking circuit through the connector includes two condensers 112 and 113.

65 Having given a general description of the apparatus, I will now describe its operations in detail. It will first be explained how a calling subscriber A obtains connection with another subscriber A', after which it will be described how a subscriber may communi-

cate with the operator at O. In order to call another subscriber the calling subscriber must first remove his receiver and then operate his calling dial for each of the digits of the number of the line desired. In order to communicate with the operator, all that the calling subscriber need do is simply remove his receiver from the switch hook.

In the following description it will be assumed that the number of the substation A' is 2220. When the receiver is removed from the switch hook preparatory to making a call, the said hook rises, permitting spring 211 to disengage spring 213 and engage spring 212, whereby the circuit of the ringer 5 and condenser 6 is broken, and a bridge consisting of the transmitter 4, receiver 2 and impulse springs 7 and 8 is closed across the line conductors 66 and 67. This completes an energizing circuit for the line winding 18 of the line switch C. This circuit extends from ground G' through springs 68 and 69, line 67, hook switch springs 211 and 212, impulse springs 7 and 8, receiver 2, transmitter 4, line 66, springs 71 and 70 and winding 18 to battery lead 74, thence through the battery B to ground G. The winding 18, upon energizing, attracts the armature 16, which forces the spring 73 into engagement with spring 68, thereby completing a circuit through the pull-in winding 20. This circuit extends from ground G' through springs 68 and 73, windings 20 and 19, contact point 75 and armature 42 to battery lead 74. The winding 20, upon energizing, attracts the armature 15 and plunger arm 13. The armature 15 operates to disconnect the line winding 18 and ground G' from the line conductors 66 and 67, while the plunger arm 13 forces the plunger into the bank of contact springs, as previously explained. When the plunger arm 13 reaches its operated position it short circuits the winding 19 through the springs 76 and 77, thereby causing said winding to deenergize slowly to prevent the armature 16 from breaking the circuit of the winding 20 before the circuit of the holding winding 17 is closed. This circuit is closed in the following manner: The forcing of springs 23 and 25 into engagement with springs 24 and 26, respectively, by the plunger of the switch C extends the line connection to the selector E, whereby the relay 62 becomes energized over a circuit extending from ground G' through the lower winding of said relay, springs 101 and 102, springs 26 and 25, thence to and through substation A and back over the other side of the line, through the line switch springs 23 and 24, springs 134 and 135, upper winding of relay 62 and lower winding of relay 136 to the battery lead 74. The relay 62, upon energizing, completes a circuit from ground

G³ through springs 78 and 79 and relay 63 to the battery lead 74. The relay 63, upon energizing, completes the circuit of the holding winding 17 of the line switch C, said circuit extending from ground G¹⁰ through springs 81 and 82, 28 and 27, and winding 17 to battery lead 74. The current in winding 17 serves to hold the plunger arm 13 and armature 15 in an operated position after the circuit of winding 20 is broken by the falling back of the armature 16. The energization of the relay 63 at the selector E also extends a guarding ground over the conductor 83 to the private bank contacts of the calling line, in the banks of all connector switches which have access to that line.

The engagement of the line switch bank springs 29 and 30 completes an energizing circuit for the relay 34 of the master switch D. This circuit extends from ground G⁵ through springs 29 and 30, contact 84, wiper 43, segment 36 and relay 34 to battery lead 74. The relay 34, upon energizing, operates to close the circuit of relay 35, which in turn attracts its armature 42, withdrawing the pin 41 from the plate 39 and completing the circuit of the motor magnet 33. This circuit extends from ground G⁶ through magnet 33, interrupter springs 85, contact point 86 and armature 42 to battery lead 74. As long as the armature 42 engages contact point 86, the magnet 33 operates in a manner similar to that of a buzzer, to rotate the ratchet wheel 32 to advance the plungers that are in locking engagement with the plunger shaft. After the plungers have been advanced a short distance, the wiper 43 passes off the contact 84, thus allowing the relays 34 and 35 to deenergize. The armature 42 does not fall back immediately upon the deenergization of relay 35, because the opening in the plate 39, which was engaged by pin 41, has passed out of register therewith. After the relay 35 is deenergized, the master switch still continues to advance the plungers, until the next opening in the plate 39 passes under the pin 41, whereupon, if the corresponding trunk line is idle, the pin 41 drops into said opening, locking the plunger shaft against further rotation and allowing the armature 42 to disengage contact point 86 to break the circuit of magnet 33. If the next trunk after the one seized by the switch C had been busy, the wiper 43 would have found the corresponding contact of the master switch bank grounded, which would have kept the relays 34 and 35 energized while the next opening was passing under the pin 41, thereby causing the idle plungers to be advanced past the busy trunk to an idle one. During the time the master switch D is operating, the pull-in windings 20 of all the line switches controlled by said master switch are disconnected

from the battery and connected to the busy signaling machine M'. Thus any subscriber who attempts to make a call while the plunger of his line switch is being moved from one trunk to another will not be able to operate the line switch, but will receive a busy signal, due to the inductive relation of the line winding 18 to the winding 19, which is connected to the busy signaling machine.

The foregoing are the operations which take place immediately upon the removal of the receiver at the calling substation. The calling subscriber now operates his calling dial in the usual manner for the first digit 2 of the number desired. As the impulse wheel 10 returns to normal position after being rotated with the dial for the digit 2, the impulse springs 7 and 8 are momentarily separated twice. The separation of the impulse springs 7 and 8 breaks the energizing circuit of the selector-line relay 62, allowing it to be momentarily deenergized. Since the relay 63 is slow acting, it does not have time to deenergize during the momentary interruption of its circuit by the deenergization of the relay 62. Consequently, the deenergization of the line relay completes an energizing circuit for the vertical magnet 47. This circuit extends from ground G³ through the springs 78 and 80, springs 87 and 89, relay 64, vertical magnet 47 and side switch wiper 51 to the battery lead 74. Since the digit called is 2, the vertical magnet receives two impulses over this circuit, operating to raise the shaft and wipers two steps to a position opposite the second row or level of bank contacts. The relay 64, which is included in the energizing circuit of the vertical magnet, is energized by the first impulse through it, but, being a slow acting relay, its circuit is not opened long enough to permit it to deenergize until after the last impulse for the digit is transmitted. In its energized position the relay 64 closes a circuit extending from ground G⁷ through the springs 90 and 91 and private magnet 53 to the battery lead 74. After the last impulse for the first digit is transmitted, the relay 64 deenergizes and opens the circuit of the private magnet, which in turn deenergizes and permits the side switch to pass to second position. In passing from first to second position the side switch wiper 51 disconnects the battery from the vertical magnet 47 and closes a circuit through the rotary magnet 48. This circuit extends from ground G⁶ through interrupter springs 50 and 92, rotary magnet 48 and side switch wiper 51 to battery lead 74. The magnet 48, upon energizing, attracts its armature 60, which rotates the switch shaft and wipers one step, opens the circuit of its own magnet at the interrupter springs 92, and closes the circuit of the private magnet 53 by forcing spring 50 into engagement with

spring 49. When the circuit of magnet 48 is broken at the springs 50 and 92 the armature falls back, disconnecting the ground G^8 from the private magnet. If the first trunk upon the contacts of which the selector wipers have just been rotated is idle, the private magnet deenergizes when the ground G^8 is disconnected and allows the side switch to pass to third position. If, however, the first trunk is already in use, the private wiper 46 finds the first contact which it engages grounded, and maintains the private magnet energized over a circuit extending from said grounded bank contact through the wiper 52 and magnet 53 to battery lead 74. The private magnet thus locks the side switch in second position, and the rotary magnet continues to operate in a manner similar to that of a buzzer to advance the wipers step by step until the private wiper 46 engages a non-grounded contact of an idle trunk, whereupon the private magnet deenergizes and permits the side switch to pass to third position. At the instant the side switch passes to third position a guarding potential is established at the selector private bank contacts of the trunk seized by the selector E. This guarding potential extends from ground G^{10} through the springs 81 and 82, side switch wiper 52 and private wiper 46 to the selector private bank contacts. The passage of the side switch wiper to third position also completes an energizing circuit for the relay 98. This circuit extends from ground G^{10} through the springs 81 and 82, relay 98 and side switch wiper 51 to the battery lead 74. The relay 98 thereupon energizes and, by shifting the springs 102 and 134 out of engagement with the springs 101 and 135 and into contact with the springs 93 and 94, respectively, disconnects the line relay 62 from the line and extends connection through the shaft wipers 44 and 45 to the second selector F. The relay 62 thereupon deenergizes and disconnects the ground from the slow acting relay 63, which deenergizes and disconnects the ground G^{10} from the relay 98. Before this happens, however, a new holding circuit is provided for this relay by the selector F in the following manner: As soon as connection is extended to said selector, its line relay 95 becomes energized in the same manner in which the relay 62 of the selector E was energized when the connection was first extended thereto. The relay 95, upon energizing, completes a circuit through the slow acting relay 96, which corresponds to the relay 63 of selector E. The relay 96, upon energizing, completes the circuit from ground G^8 through the springs 97 and 99, conductor 210, private wiper 46, side switch wiper 52, relay 98 and side switch wiper 51 to the battery lead 74. The energization of the relay 96 of

the selector F also provides a holding circuit for the winding 17 of the line switch C after the relay 63 of the selector E has deenergized.

When the calling subscriber operates his calling device for the second digit 2, the circuit of the line relay 95 of the second selector F is broken twice by the substation impulse springs 7 and 8. The selector F operates in response to these impulses in exactly the same manner as explained for the selector E to raise its wipers two steps and then to automatically rotate them onto an idle trunk line 131—132 leading to a connector L. The relay 114 of the selector F is then energized in the same manner as explained for the relay 98 of the selector E and disconnects the line relay 95 from the line. The relays 95 and 96 thereupon deenergize, causing the ground G^8 to be disconnected from the trunk release conductor 210. Since the relay 96 is slow acting, a new holding ground for the switches F, E and C is provided by the connector L before the said relay 96 has time to deenergize. This holding ground is provided in the following manner: When the connection is extended to the connector, its line relay 145 becomes energized in the same manner as the line relays 95 and 62 of the selectors F and E. The relay 145, upon energizing, completes a circuit extending from ground G^{12} through the springs 151 and 152 and slow acting relay 154 to the battery lead 74. The relay 154, upon energizing, completes a circuit from ground G^8 through springs 115 and 116, conductor 117, private wiper 118 of selector F (Fig. 1), side switch wiper 119, conductor 210, from which one branch extends through the relay 114 to battery, while another branch extends to and through the relay 98 of the selector E and also through the holding winding 17 of the line switch C to battery.

When the calling subscriber operates his calling device for the third digit 2, the circuit of the connector line relay is broken twice momentarily. Each time the relay 145 deenergizes, a circuit is closed extending from ground G^{12} through the springs 151 and 153, 160 and 161 (the slow acting relay 154 remaining operated during the entire time the relay 145 is operating), the vertical magnet 107, side switch wiper 162 and private magnet relay 163 to the battery lead. The vertical magnet 107 receives two impulses over this circuit and operates in response thereto to raise the shaft wipers 104, 105 and 103 two steps. The private magnet relay 163 is energized by the first impulse to the vertical magnet and, being a slow acting relay, remains in its energized position until the last impulse is transmitted. In its energized position, the relay 163 completes a circuit from ground G^{12} through springs 130

164 and 165 and private magnet 108 to the battery lead. When the private magnet relay 163 deenergizes after the last impulse is delivered to the vertical magnet, it allows the private magnet 108 to deenergize also, which causes the side switch to be tripped to second position. The side switch wiper 162, in passing from first to second position, transfers the battery connection from the vertical magnet 107 to the rotary magnet 106. Now, each time the line relay 145 deenergizes in response to the operation of the substation calling device for the last digit 0, the rotary magnet 106 is energized over a circuit extending from ground G^{12} through springs 151 and 153, 160 and 161, magnet 106, springs 166 and 167, side switch wiper 162 and relay 163 to battery. Since the last digit is 0, the rotary magnet receives ten impulses, thus causing the wipers to be rotated ten steps onto the contacts of the desired line, No. 2220. The private magnet relay 163 is energized in series with the rotary magnet and remains in its operated position until after the last impulse has been delivered. The private magnet 108 is thus energized as soon as the rotary magnet begins to operate, and deenergizes shortly after the wipers have been rotated onto the called line. This operation of the private magnet causes the side switch to pass from second to third position in the usual manner, thereby completing the connection from the calling to the called substation through the medium of its wipers 168 and 169. The side switch wiper 170, in its third position, provides an energizing circuit for the cut-off winding 194 of the line switch C' , and a guarding potential for the connector private bank contacts of the called line, extending from ground G^{14} through said wiper 170, springs 171 and 172, private wiper 105, thence to the connector private bank contacts and over conductor 173 and through winding 194 to battery. The winding 194, upon energizing, attracts the armature 195, which operates to disconnect the line switch C' from the called line and to complete a connection from the connector bank contact 196 to the line conductor 185.

The side switch wiper 162, in passing to third position, completes a circuit extending from ground G^{15} through the interrupter 174, springs 175 and 176, ringer relay 110, side switch wiper 162 and relay 163 to battery. The relay 110 is intermittently energized over this circuit, each time operating to disconnect the calling from the called line and connect the ringer generator M with the called line. Ringing current then flows from one terminal of said generator through the ringer relay springs 177 and 178, side switch wiper 168, shaft wiper 103, springs 183 and 184, line 185,

ringer 186, springs 187 and 188, line 189, wipers 104 and 169 and springs 181 and 180 back to the generator M. When the called subscriber removes his receiver from the switch hook, or as soon thereafter as the ringer relay 110 deenergizes, a circuit is completed extending from ground G^{14} through the side switch wiper 170, lower winding of the connector back bridge relay 111, ringer relay springs 182 and 181, thence over the heavy conductor to the hook switch spring 188 at the substation, spring 190, thence through the transmitter and receiver, back over the other side of the line to and through the ringer relay springs 178 and 179 and the upper winding of the connector back bridge relay 111 to battery lead 74. This circuit supplies the called substation with talking battery current and also causes connector relay 111 to energize. The relay 111, upon energizing, by separating the springs 175 and 176, opens the circuit of the ringer relay 110 so that the generator will not be again connected with the called line after the receiver has been removed from the switch hook at the substation A' . The two subscribers may now carry on an uninterrupted conversation over the talking circuit which is outlined by heavy lines in Figs. 1 and 2, the calling substation being supplied with talking current through the connector line relay 145, while the called substation receives talking current through the relay 111, as described. The release of all of the central station apparatus is brought about by the hanging up of the receiver at the calling substation when the conversation is completed. The hanging up of the receiver destroys the energizing circuit of the connector line relay 145 by the separation of the hook switch springs 211 and 212. The relay 145, upon deenergizing, breaks the energizing circuit of the connector release relay 154. The relay 154 thereupon deenergizes and, by permitting the spring 160 to engage spring 191, completes a circuit for the release magnet 109. This circuit extends from ground G^{12} through the springs 151 and 153, 160 and 191, magnet 109 and springs 192 and 193 to battery. The magnet 109, upon energizing, immediately restores the mechanism of the connector to normal position. When the connector shaft reaches its lowest position, it separates the springs 192 and 193, thereby allowing the magnet 109 to deenergize. The deenergization of the relay 145 also disconnects the ground G^6 from the trunk release conductor 117, which permits the relays 114 and 98 and the winding 17 of the switches F, E and C, respectively, to deenergize. The deenergization of the winding 17 permits the plunger of the line switch C to be restored to normal position. The deenergization of the relay

98 of the selector E completes a circuit extending from ground G⁸ through the springs 78 and 80, 87 and 197, 198 and 199, 57 and 58 and magnet 56 to battery. The magnet 56, upon deenergizing, immediately releases the selector E. The deenergization of the relay 114 causes the release of the selector F in the same manner as just described for the selector E when its relay 98 deenergized. When the switch shafts of the selectors reach their lowest positions, the circuits of their respective release magnets are broken in the same manner as described for the connector, and all apparatus employed in the connection is left in readiness for another call.

In the foregoing description it was assumed that the line of the called substation A' was idle when called by the subscriber at substation A. In case this line had been busy, the connector L would not have completed connection therewith and the calling subscriber would have been given the busy signal in the following manner: It is evident from the previous description that whenever a line is busy there is a guarding ground potential upon its connector private bank contacts. Thus it will be seen that at the instant the wipers of the connector L are rotated onto the contacts of a busy line, a ground connection is extended from the guarded private bank contact of said line through the wiper 105, springs 172 and 171, lower winding of the relay 111, ringer relay springs 182 and 181, side switch wiper 169 (which is then in second position) to the spring 200 of the relay 163. As the relay 163 deenergizes after the last impulse for the last digit has been delivered, the spring 165 engages the spring 200 before it is disengaged from the spring 164, and the private magnet 108 does not deenergize, but remains locked in series with the lower winding of the back-bridge relay 111. The relay 111 also becomes operatively energized through its lower winding, and operates in conjunction with the magnet 108 and the relay 163 to complete a circuit extending from ground G¹³ through the springs 164 and 201, 202 and 203, relay 204 and springs 205 and 206 to battery. The relay 204, upon energizing, disconnects the private wiper from the magnets 111 and 108 and substitutes therefor the ground G¹⁶. This prevents the private magnet from deenergizing and completing the connection with the called line in case the guarding potential should be removed from its private bank contacts before the connector is released. The relay 204, in its energized position, also completes a circuit over which the calling subscriber receives the busy signal. This circuit extends from one terminal of the busy signaling machine N through springs 207 and 208 of relay 204, contact point 209,

side switch wiper 168, thence over the heavy conductors to and through substation A and back over the other side of the line, to and through the connector line relay 145 to ground G¹¹, thence through the battery B to the battery lead 74 and to the other terminal of the busy signaling machine. Since the private magnet is not allowed to deenergize after the last digit is called, it is evident that the side switch remains locked in second position and the connection between the calling and called lines remains open at the wipers 168 and 169 while the calling subscriber is receiving the busy signal. Upon hearing the busy signal, the calling subscriber, by hanging up his receiver, may release all of the switches in the same manner as when a successful connection has been made.

In the foregoing it has been explained how a calling subscriber may obtain connection with any other subscriber in the system by operating his calling device for the successive digits of the number of the line wanted. It will now be explained how, in case of emergency, a subscriber may obtain connection with an operator without operating his calling device at all. It will be remembered that, when the calling subscriber removes his receiver, the line switch C operates to extend the connection to the first selector E, whereupon its line relay 62 becomes energized over a circuit which includes the transmitter of the substation A and the lower winding of the relay 136. This circuit, therefore, furnishes the calling substation with talking battery current and also causes the relay 136 to energize. The energization of this relay completes the secondary circuit of the operator's set 0. This circuit extends from one terminal of the secondary winding of the induction coil 129 to the upper winding of relay 136, springs 127 and 128, 137 and 138 and receiver 139 back to the coil 129. The two windings of the relay 136 also form an inductive connection between the substation talking circuit and the secondary circuit of the operator's set, whereby the calling subscriber may converse with the operator. It will thus be seen that every calling subscriber is put into connection with the operator as soon as he removes the receiver to make a call, but if he does not wish to converse with the operator, but wishes to call some other subscriber, this connection with the operator is broken as soon as the shaft of the selector E is raised the first step. The first upward movement of the switch shaft allows the springs 137 and 138 to be separated and thereby breaks the secondary circuit of the operator's set. The relay 136 may also be provided with a pair of springs 128^a and 127^a for the purpose of controlling a bell, lamp or suitable signal in case it is desired to provide an audible or visual sig-

nal to attract attention if there should be no one listening on the operator's set when a call comes in.

It will be seen, therefore, that by my invention I provide an arrangement for enabling an operator to listen in on all calling lines as soon as the receivers at the substations thereof are removed from their switch hooks, and in which means are provided for preventing the operator from listening in on any calling lines over which the calls have progressed to the point where the rotary calling device has been operated to control the automatic switches. Thus each and every calling line is momentarily connected with the operator's telephone, regardless of the character of the call, and if the calling subscriber wishes at any time to converse with the operator no operation of the rotary calling device at the calling substation is necessary. Each calling line is initially connected with the operator's telephone, but the initial operation of the first selector disconnects the operator's telephone from the calling line, whereby the call may then progress in the usual manner, and without the possibility of the operator listening in on the connection. The operator's telephone can be located at a manual switchboard, or at any other suitable point in the system, and every calling subscriber can, before operating the rotary calling device, attract the attention of the operator by simply speaking into the transmitter at the calling substation. This is useful, for example, in turning in fire alarms, or in conversing with a trouble operator, or for various other purposes. Every call that goes through the exchange must make a passing connection, so to speak, with the operator's telephone. If the calling subscriber desires to converse with the operator, then the call stops at that point. On the other hand, if the call is regular, and from one line to another, then the call immediately passes on and finds the called line. In every case, and when the calling and called lines are finally connected, the operator is cut off and cannot overhear the conversation. Thus, for certain purposes at least, an operator is given supervision of the system without entailing any additional work or effort on the part of the subscribers. A subscriber may at any time obtain the attention and services of an operator, but this does not necessitate any additional devices at the substations.

What I claim as my invention is:—

1. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, a telephone common to all of said lines, means for connecting said telephone with a calling line, and means controlled by the operation of said mechanism

to always disconnect said telephone before the call reaches the called line.

2. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, a signal common to all of said lines, means for connecting said signal with a calling line, and means controlled by the operation of said mechanism to always disconnect said signal before the call reaches the called line.

3. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, an operator's board common to all of said lines, means for connecting said operator's board with a calling line, and means controlled by the operation of said mechanism to always disconnect said operator's board before the call reaches the called line.

4. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, a telephone common to all of said lines, means for connecting said telephone with a calling line, and means controlled by the operation of said mechanism to always disconnect said telephone before the call reaches the called line.

5. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, a signal common to all of said lines, means for connecting said signal with a calling line, and means controlled by the operation of said mechanism to always disconnect said signal before the call reaches the called line.

6. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, an operator's board common to all of said lines, means for connecting said operator's board with a calling line, and means controlled by the operation of said mechanism to always disconnect said operator's board before the call reaches the called line.

7. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, a telephone for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said telephone before the call reaches the called line, said mechanism comprising a first selector in which said means are pro-

vided in the form of contacts which control the circuit of said telephone.

8. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, a signal for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said signal before the call reaches the called line, said mechanism comprising a first selector in which said means are provided in the form of contacts which control the circuit of said signal.

9. In a telephone system, a plurality of telephone lines, mechanism operable under substation control to extend connection from calling lines to called lines, and disconnect therefrom, an operator's board for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said operator's board before the call reaches the called line, said mechanism comprising a first selector in which said means are provided in the form of contacts which control the circuit of said operator's board.

10. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, a telephone for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said telephone before the call reaches the called line, said mechanism comprising a first selector in which said means are provided in the form of contacts which control the circuit of said telephone.

11. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, a signal for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said signal before the call reaches the called line, said mechanism comprising a first selector in which said means are provided in the form of contacts which control the circuit of said signal.

12. In a telephone system, a plurality of telephone lines, an automatic switch mechanism common to said lines, responsive to any calling party to extend connection from the calling line, an operator's board for connection with every calling line, common to all of said lines, and means controlled by the operation of said mechanism to always disconnect said operator's board before the call reaches the called line, said mechanism comprising a first selector in which said means

are provided in the form of contacts which control the circuit of said operator's board.

13. In a telephone system, a plurality of telephone lines, a telephone common to said lines, and means controllable from any calling substation to automatically connect the calling line with said telephone, and disconnect therefrom, before the call reaches the called line.

14. In a telephone system, a plurality of telephone lines, a telephone common to said lines, said telephone being connected with all calling lines over which the calls have not progressed beyond a certain point, and disconnected from all calling lines over which the calls have progressed beyond said point, said system being provided with means by which the said disconnection is controlled by the calling subscribers only.

15. In a telephone system, a plurality of telephone lines, a telephone common to said lines for the purpose of connection with all calling lines, means by which the removal of the receiver at any calling substation connects the calling line with said telephone, a calling mechanism at the substation of each line, switches responsive to said mechanism to extend the call from any calling line, and means controlled by the operation of said switches to disconnect the said telephone from the calling line before the call reaches the called line.

16. In a telephone system, a plurality of telephone lines, a telephone common to said lines, means whereby said telephone is operatively connected with all calling lines over which the calls have not progressed beyond a certain point, and means whereby the said telephone is not in operative relation to any calling lines over which the calls have progressed beyond said point, said means being under the control of the calling subscribers only.

17. In a telephone system, a line, a telephone, a calling mechanism for said line, a hook switch for said line, means whereby the operation of said hook switch connects the said line with said telephone, and means whereby the operation of said mechanism disconnects the telephone from said line.

18. In a telephone system, a plurality of first selectors, a telephone common to said selectors, connected therewith, and means on each selector for opening the circuit of said telephone, said means being operated by the initial actuation of said selectors.

19. In a telephone system, a plurality of telephone lines, automatic switches controllable over said lines to extend calls therefrom, an operator's telephone for listening in on all calling lines, and means controlled by said selectors for preventing listening in after the operation thereof.

20. In a telephone system, a calling line, a calling mechanism therefor, means respon-

sive to said mechanism for extending the call, an operator's telephone for listening in on the calling line, and means controlled by said calling mechanism for preventing listening in after the operation thereof.

21. In a telephone system, a plurality of telephone lines, an automatic switch common to a plurality of said lines, a line relay for said switch, a second relay connected in series with said line relay and adapted to be energized in series therewith, and an operator's telephone set adapted to be connected through said switch to a subscriber's line upon the energization of said second relay.

22. In a telephone system, a plurality of telephone lines, an automatic switch common to a plurality of said lines, a line relay for said switch, a second relay connected in series with said line relay and adapted to be energized in series therewith, an operator's telephone set adapted to be connected through said switch to a subscriber's line upon the energization of said second relay, and normal contacts controlled by the movement of said switch for again disconnecting said operator's telephone set.

23. In a telephone system, a plurality of subscribers' lines, an automatic switch common to a plurality of said lines having vertical and rotary motion, an operator's set normally disconnected from said switch, a line relay for said switch, a second relay adapted to be energized in series with said line relay for connecting said operator's set with said switch, and off-normal contacts in the circuit of said operator's set adapted to be opened by the first vertical movement of said switch for again disconnecting said telephone set from the switch.

24. In a telephone system, a plurality of subscribers lines, an automatic switch com-

mon to a plurality of said lines, an operator's set normally disconnected from said switch, a double-wound relay for said switch, a second double-wound relay having one winding connected in series with one of the windings of said line relay, the second winding of said second relay being connected in series with said operator's telephone, means for energizing said line relay and said second relay when said switch is seized to connect said operator's set with said switch, and contacts connected in series with said operator's telephone controlled by the first movement of said switch to again disconnect said telephone from said switch.

25. In a telephone system, a plurality of telephone lines, a telephone common to said lines, means controllable from any calling substation to automatically connect the calling line with said telephone, and disconnect therefrom, before the call reaches the called line, and means for preventing connection of said telephone with called lines.

26. In a telephone system, a plurality of telephone lines, a telephone common to said lines, said telephone being connected with all calling lines over which the calls have not progressed beyond a certain point, and disconnected from all calling lines over which the calls have progressed beyond said point, said system being provided with means by which the said disconnection is controlled by the calling subscribers only, and means for preventing connection of said telephone with called lines.

Signed by me at Chicago, Cook county, Illinois, this 15th day of April, 1911.

ALEXANDER E. KEITH.

Witnesses:

ARTHUR J. RAY,
E. D. FALES.