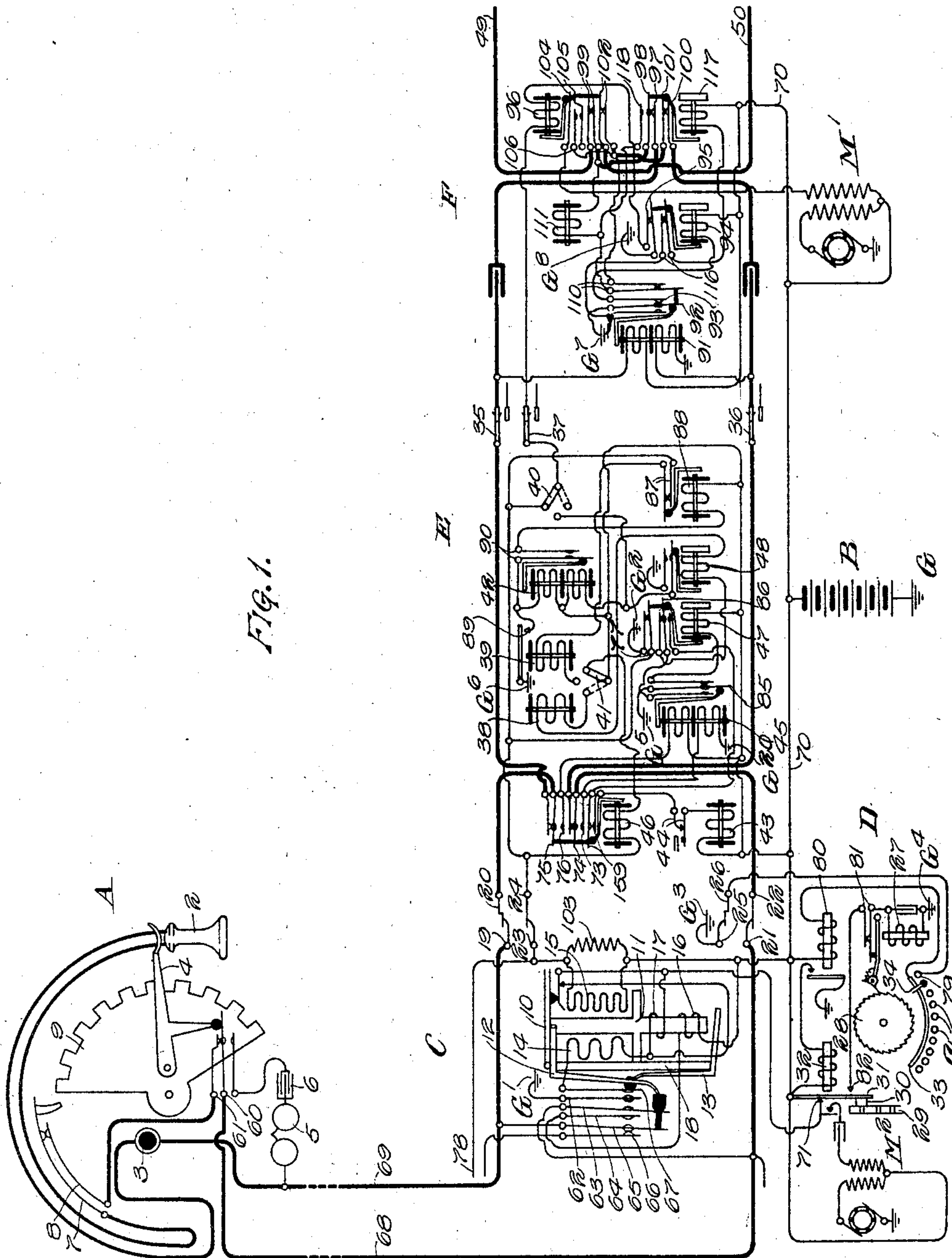


T. G. MARTIN.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED OCT. 21, 1911.

1,236,859.

Patented Aug. 14, 1917.

3 SHEETS—SHEET 1.



WITNESSES

A. J. Ray.

A. Andersen.

INVENTOR:

T. G. Martin
By Bulley & Durand
ATTORNEYS

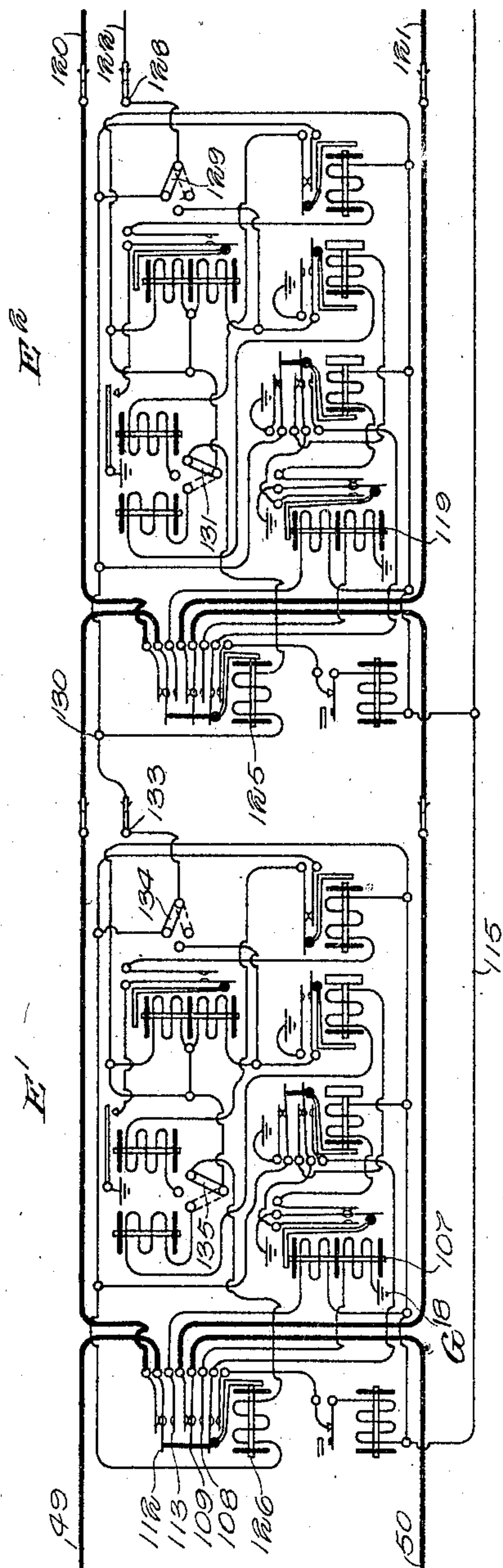
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3 SHEETS—SHEET 2.

FIG. 2.



WITNESSES

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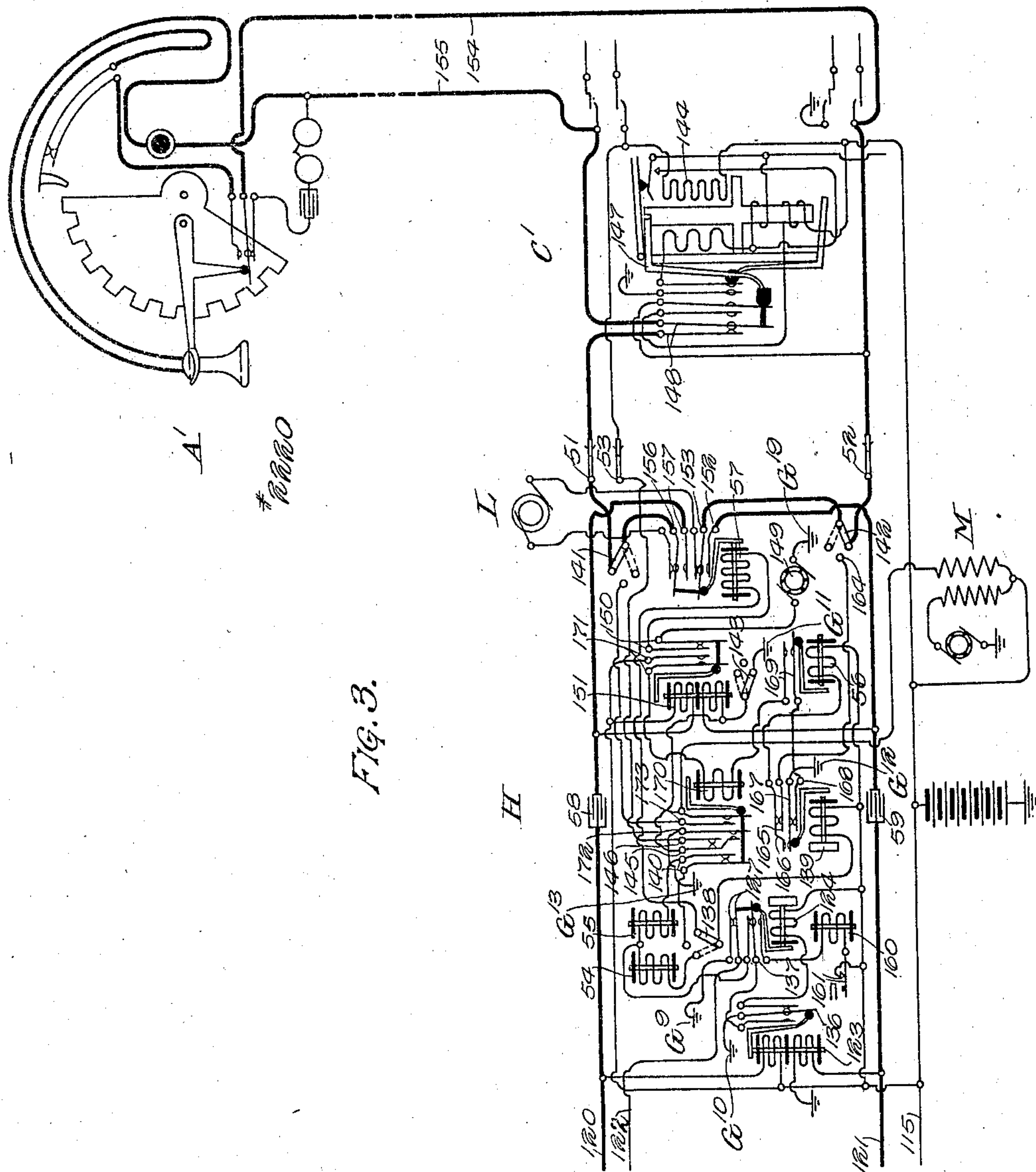
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3 SHEETS—SHEET 3.



WITNESSES
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AUTOMATIC TELEPHONE SYSTEM.

1,236,859.

Specification of Letters Patent.

Patented Aug. 14, 1917.

Application filed October 21, 1911. Serial No. 655,986.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, and is particularly adapted for use in an automatic system in which a series of switches are employed in establishing a connection between a calling and a called subscriber. These switches are preferably of the ordinary vertical and rotary type, and are so arranged that the first selectors are common to a plurality of subscribers' lines. Each subscriber's line is provided with an individual or line switch by means of which they may obtain access to one of these first selectors. Certain of these line switches and first selectors I have shown as being located at a private branch exchange. In such private branch exchange systems it is often desirable to provide a discriminating service—that is, to provide a system in which certain of the subscribers at the private branch exchange can extend a connection to the main exchange, while other of the subscribers are prevented from establishing such a connection, but can merely communicate with other subscribers of their own private branch exchange.

A further novel feature consists in transmitting a signal to a calling subscriber when he attempts to make a connection from which he is barred.

Further new features consist in the specific construction of the selector switch by means of which a more perfect and reliable operation is obtained. The selector switches employed are of the type in which a rotary magnet is employed for automatically rotating the contact arms over the trunks of any level until an idle trunk is found. A relay is employed for automatically interrupting the circuit of the rotary magnet, and a side switch of the usual construction is employed. The circuit of the controlling relay is closed by the armature of the rotary magnet when the latter is energized. The armature of the rotary magnet also closes the circuit of the private magnet, which controls the side-switch in the well-known manner. Heretofore, the rotary magnet closed

the circuit of this interrupter relay as soon as the rotary magnet energized. It was found, however, that sometimes this interrupter relay operated quicker than the private magnet and broke the energizing circuit of the rotary magnet and allowed it to fall back and break the circuit of the private magnet before the private magnet had become completely energized, and therefore the side switch was not tripped to third position. The rotary magnet would, therefore, again be energized so as to rotate the contact arms past the first trunk even though this trunk were idle. By my improved arrangement this is rendered impossible by the addition of springs on the private magnet, which springs are included in the circuit of the interrupter relay. It will therefore be seen that this relay cannot be energized to break the circuit of the rotary magnet until after the private magnet has become completely energized so as to close these springs. This insures that the contact arms of the selector will always stop on the first trunk provided this trunk is idle.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figures 1, 2 and 3 show a complete connection between a calling substation A (Fig. 1) and a called substation A' (Fig. 3) in a system embodying the principles of my invention. The substation A and the apparatus shown in Fig. 1 are assumed to be located in a small private branch exchange, while the apparatus shown in Figs. 2 and 3 is assumed to belong to the main exchange. The connection shown is extended through the subscriber's individual switch C and the selector switch E at the branch exchange and through the repeater F, which is included in a trunk line leading to the main exchange, from whence the connection extends through the first and second selectors E' and E² and the connector H in the main exchange to the called substation. The selector E in the branch exchange, besides having access to trunk lines leading to the main exchange, is assumed to also have access to connectors in its own exchange for the purpose of completing connection with the branch exchange subscribers.

The automatic substations represented herein may be of any suitable or approved

type. As shown in Fig. 1, the substation A comprises the usual receiver 2, transmitter 3, switch hook 4, ringer 5 and condenser 6. Since it is an automatic substation it is also provided with the well-known automatic calling device comprising a pair of impulse springs 7 and 8 and a toothed impulse wheel 9, which latter is controlled by the subscriber through the medium of a dial (not shown) provided with finger holes. The mechanism is so arranged that as the dial and impulse wheel are rotated forward by the subscriber, the impulse springs are not operated, but as the dial returns to normal position said springs are separated momentarily a number of times, corresponding to the digit called.

The line switch C and master switch D are of the general type of line and master switches disclosed in British patent to R. W. James, No. 26,301 of 1906, but of the particular form shown in British patent to T. G. Martin, No. 1419 of 1910. As herein represented, the line switch C comprises, among other details, a plunger (not shown) which is attached to the end of the so-called plunger arm 10 that is controlled by the plural wound magnet 11. Besides controlling the plunger arm 10, the magnet 11 also controls the relay armatures 12 and 13 and comprises four windings, namely, a pull-in winding 14, a holding and cut-off winding 15, a line winding 16 and an auxiliary winding 17. The lateral projection near the center of the core of the magnet, by means of which projection said magnet is mounted upon the bracket 18 upon which the armatures are pivoted, provides the magnet with two separate magnetic circuits, so that the windings upon one end of the core do not affect the armatures on the other end. Of the two windings upon the upper end of the magnet, only the winding 14 is strong enough to attract the plunger arm 10 from its normal position. Although the winding 15 is not strong enough to operate the arm 10, it is strong enough to hold it in its operated position after it has once been operated. When the plunger arm 10 is attracted by the magnet 11, the plunger of the switch is forced into a group of contact springs 19, 20, 21, 22, 23, 24, 25 and 26, forcing them into contact in pairs. Although only one set of springs 19—26 is shown, each switch is provided with a plurality of such sets of springs, each set forming a terminal of a separate trunk line leading to a selector E. Each trunk line is multiplied through the corresponding contacts of all of the switches of a group which is controlled by the master switch D, while the line conductors of the substation A are connected in multiple to the springs 19 and 21 of all of the different sets of its switch C. The plungers of all the line switches of the group which is controlled by the master

switch D engage a so-called plunger shaft (not shown), and through the medium of said master switch said plungers are normally maintained opposite the terminal of an idle trunk line. The master switch consists essentially of a motor magnet 27 for rotating the ratchet wheel 28. The ratchet wheel 28 is connected with the plunger shaft in such a manner that a rotary motion of the ratchet wheel gives to the plunger shaft an oscillatory motion to carry the idle plungers back and forth in front of their trunk terminals. To the plunger shaft there is secured a locking plate 29 provided at its outer edge with a number of openings which are adapted to be engaged by a pin 30 on the end of the armature 31 of the relay 32. The openings in the plate 29 are so spaced that the pin 30 can engage one of them and allow the armature 31 to assume its normal position only when the plungers that are in engagement with the plunger shaft are directly opposite the terminals of a trunk line. The master switch is also provided with a bank of contacts comprising a common segment 33 and one individual contact *a* for each trunk line to which the line switches have access. The wiper 34 is adapted to maintain the common segment 33 in electrical connection with the individual contact of the trunk line before which the idle plungers are being held by the master switch.

The selector E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being somewhat modified, however, in order to operate in a two-wire system—that is, a system in which the central office apparatus is controlled by the calling subscriber over the two sides of the line in series. As herein represented, the selector E comprises a bank of contacts arranged in rows or levels and which are adapted to be engaged by a set of wipers 35, 36 and 37 carried upon a vertically and rotatably movable shaft which is controlled by the so-called vertical and rotary magnets 38 and 39. The usual side switch, comprising the wipers 40 and 41, is controlled by the private magnet 42 in a manner well known in the art. In this instance the private magnet comprises two windings. The usual means for restoring the switch to normal position is provided in the release magnet 43. In this instance the release magnet is adapted to restore the switch to normal position immediately upon energizing, as shown in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, for connector switches, rather than by deenergizing as shown in the selector patent hereinabove referred to. The springs 44 are separated by the switch shaft whenever it is in its lowest position. The double-wound line relay 45 is normally connected

with a line through the springs of a switching relay 46. The relays 47 and 48 are slow acting—that is, slow to deenergize after their energizing circuits have been broken.

The desired action may be accomplished by providing a ring of copper around one end of the core of the magnet. In the selector shown herein the rotary magnet 39 controls the private magnet 42 electrically through the medium of the contact 89, rather than mechanically as shown in the said selector patent. The interruption of the rotary magnet circuit to cause the automatic selection of a trunk line is obtained through the medium of an individual interrupter relay 88.

The repeater F comprises a combination of relays which are for the purpose of receiving impulses from the calling substation and repeating them over the trunk conductors 49 and 50 to the selector E' in the main exchange.

The selectors E' and E² are essentially the same as the selector E (Fig. 1).

The connector H is of the general type of connector switch disclosed in said United States Letters Patent No. 815,176 above referred to, being modified slightly, however, so as to operate in a two-wire system in the manner shown in British patent to T. G. Martin No. 1419 of 1910. Like the selectors, the connector is provided with a shaft (not shown) carrying the wipers 51, 52 and 53 and is controlled by the vertical and rotary magnets 54 and 55. The usual side switch is controlled by the private magnet 56 in the usual manner. At 57 there is shown a ringing relay which is provided for the purpose of connecting the ringing current generator with the called line so as to signal the called subscriber. The talking circuit through the connector is divided into two sections inductively connected by the condensers 58 and 59.

The substation A' and the line switch C' are similar to the substation A and line switch C respectively. At L there is shown a ringing current generator. For operating the central office apparatus and for furnishing talking current, there are shown in the drawings a plurality of batteries B having one terminal grounded. If desired, only one battery need be used, but preferably one battery in each exchange. At M and M' there are shown two busy signaling machines comprising an interrupter and an induction coil.

Having given a general description of the apparatus, it will now be explained in detail how the branch exchange substation A may obtain connection with the substation A' of the main exchange, the number of which substation in the main exchange will be assumed to be 2220. When the calling subscriber removes his receiver preparatory to making a call, the switch hook rises, permitting the spring 60 to engage the spring

61, whereby a circuit is completed through the line winding 16 of the line switch C. This circuit extends from ground G' through the springs 62 and 63, line conductor 68, springs 60 and 61, impulse springs 8 and 7, receiver 2, transmitter 3, line conductor 69, springs 65 and 64 and winding 16 to the battery lead 70, thence to the battery B and to ground G. The winding 16, upon energizing, attracts the armature 13, which operates to complete a circuit from ground G' through the springs 62 and 67, pull-in winding 14, auxiliary winding 17, contact point 71 and the armature 31 to the battery lead 70. The winding 14, upon energizing, attracts the plunger arm 10 and the armature 12. The armature 12 operates to disconnect the line winding and ground G' from the line, while the plunger arm 10 causes the plunger to force the springs 19—26 into contact as shown. The engagement of the springs 19 and 21 with the springs 20 and 22, respectively, extends the line conductors 69 and 68 to the selector E, whereupon its line relay 45 becomes energized over a circuit extending from ground G²⁰ through the lower winding of the relay 45, springs 73 and 74, springs 22 and 21, line 68, thence through the substation A and back over the line 69, springs 19 and 20, springs 75 and 76 and the upper winding of the relay 45 to the battery lead 70. The relay 45, upon energizing, closes a circuit through the relay 47. The relay 47, upon energizing, extends a circuit from ground G² through the springs 77, line switch bank springs 24 and 23 and the winding 15 of the switch C to the battery lead. This energization of the winding 15 is for the purpose of maintaining the armature 12 and plunger arm 10 in their operated positions after the circuit of the winding 14 is broken by the falling back of the armature 13 when the line winding 16 is disconnected from the line. The auxiliary winding 17, which is energized in series with the pull-in winding 14, is short-circuited when the plunger arm reaches its operated position and is therefore energized only momentarily. This momentary energization, however, insures that the armature 13 does not break the circuit of the winding 14 before the winding 15 has had time to be energized. The energization of the relay 47 of the selector also extends a guarding potential from ground G² through the springs 77, 24 and 23 and the conductor 78 to the connector private bank contacts of the calling line.

The closure of the springs 25 and 26 upon the operation of the line switch completes a circuit from ground G³ through said springs, contact point 79 (which it is assumed corresponds to the trunk line leading to the selector E), wiper 34 (which is at that time resting on the contact 79) and the relay 80 to the battery lead 70. The relay

80, upon energizing, closes the circuit of the relay 32. The relay 32, upon energizing, completes a circuit from ground G^4 through the motor magnet 27, interrupter springs 81, contact point 82 and the armature 31 to the battery lead 70. Since this circuit includes the interrupter springs 81, the magnet 27 will operate in a manner similar to that of a buzzer to advance the idle plungers as long as the armature 31 engages the contact point 82. If the next trunk after the one seized by the switch C is idle, the relays 80 and 32 will deenergize as soon as the plunger shaft has been rotated far enough to carry the wiper 34 off the contact 79, but the armature 31 will still remain held up by the plate 29 until the next opening therein comes directly under the pin 30, whereupon the armature 31 will drop back, breaking the circuit of the motor magnet and allowing the plungers to come to rest in front of this next trunk line, with the wiper 34 resting upon the corresponding contact in the master switch bank, as shown in the drawings. If this next trunk had been busy, the wiper 34 would have found the corresponding contact grounded and, consequently, the relays 80 and 32 would have remained energized while the next opening was passing under the pin 30, and the plungers would have been carried past the busy trunk to an idle one. It will be seen that while the armature 31 is in its operated position, and consequently while the master switch is operating, the armature 31 is separated from the contact point 71, thereby disconnecting the battery from the pull-in winding 14 of all the line switches operated by said master switch, thus making it impossible to operate a line switch while the plunger is being moved.

The foregoing operations take place immediately upon the removal of the receiver at the calling substation and before the calling device is operated for any of the digits of the called number. As has been previously explained, the selector E has access to connector switches in its own exchange and also to trunk lines leading to selector switches in the main exchange. For the purpose of explanation, it will be assumed that the second level of contacts of the selectors E in the branch exchange are connected with trunk lines leading to first selectors E' in the main exchange, while one or more of the remaining levels of contacts of the selectors E are connected with connector switches which have access directly to the substation lines of the branch exchange. Thus it will be seen that any branch exchange subscriber may call any subscriber in his own exchange by calling three digits. In order to call any subscriber of the main exchange, the branch exchange subscribers must first call the digit 2 to obtain connection with the trunk line lead-

ing to a first selector in the main exchange, after which any subscriber in the main exchange may be called in the usual manner. Thus, in order for the subscriber at the branch exchange substation A to call the substation A', #2220, it will be necessary for the calling device at the substation A to be operated for the number 2—2220. When the calling device is operated for the first digit 2, the springs 7 and 8 are momentarily separated twice, each time breaking the circuit of the selector line relay 45. The relay 47, being slow acting, does not have time to deenergize during the interruption of its circuit by the momentary deenergization of the relay 45. Therefore, each time the relay 45 deenergizes, a circuit is closed from ground G^5 through the spring 85 and its back contact, spring 86 and its front contact, relay 48, vertical magnet 38 and the side switch wiper 41 to the battery lead 70. The digit called being 2, the vertical magnet receives two impulses over this circuit and operates to raise the switch wipers two steps to a position opposite the second level of bank contacts. The relay 48, which is energized in series with the vertical magnet, operates to close the circuit of the lower winding of the private magnet 42 as soon as the first impulse is delivered to the vertical magnet, but, being a slow acting relay, said relay 48 does not deenergize to break the circuit of the private magnet until after the last impulse is delivered. When its circuit is broken the private magnet deenergizes and permits the side switch to pass from first to second position. In second position, the side switch wiper 41 closes the circuit of the rotary magnet 49, said circuit extending from ground G^2 through the springs 77 of the relay 47, springs 87 of the interrupter relay 88, rotary magnet 39 and the side switch wiper 41 to the battery lead. The rotary magnet, upon energizing, rotates the wipers one step onto the contacts of the first trunk of the second level and closes the circuit of the upper winding of the private magnet 42. The private magnet 42, upon energizing, operates in conjunction with the rotary magnet to complete a circuit extending from ground G^6 through the contact 89, private magnet springs 90 and the interrupter relay 88 to the battery lead. The interrupter relay, upon energizing separates the springs 87, thereby interrupting the circuit of the rotary magnet, which in turn deenergizes and breaks the circuit of the upper winding of the private magnet 42. If the first trunk line is idle, the private magnet deenergizes when the circuit of its upper winding is broken and permits the side switch to pass to third position. If this first trunk line is busy, however, the private wiper 37 finds its private bank contact grounded and a holding circuit is closed through said wiper, 130

private wiper 40 and the lower winding of the private magnet 42 to battery. This being the case, the side switch remains locked in second position and the deenergization of the rotary magnet simply breaks the circuit of the interrupter relay 88. The interrupter relay 88, upon deenergizing, again closes the circuit of the rotary magnet, which then operates to advance the wipers a second step.

10 The rotary magnet continues to advance the wipers step by step in this manner until an idle trunk is reached, whereupon the private magnet deenergizes and permits the side switch to pass to third position. It will be

15 seen that the circuit of the interrupter relay 88 includes the springs 90 on the private magnet, and it is, therefore, impossible for the interrupter relay to interrupt the rotary magnet circuit and permit it to fall back

20 before the private magnet has had time to become completely energized. This is to make sure that the side switch shall be stepped to third position when the wipers are rotated the first step in case the first

25 trunk line is idle. When the side switch passes to third position, whether after one or more rotary steps of the switch shaft, the wiper 41 breaks the circuit of the rotary magnet and closes the circuit of the switching relay 46. This circuit extends from

30 ground G^2 through the springs 77, relay 46 and side switch wiper 41 to battery. The relay 46, upon energizing, disconnects the line relay 45 from the line and extends the

35 line connection over the heavy conductors through the wipers 35 and 36 to the line relay 91 of the repeater F. The relay 91 thereupon energizes and closes a circuit from ground G^7 through the springs 92 and 93

40 and the relay 94 to the battery lead 70. The relay 94, upon energizing, completes a circuit from ground G^8 through the springs 95, relay 96, selector private wiper 37, side

45 switch wiper 40, whence the circuit divides into two branches, one branch passing through the relay 46 and the side switch wiper 41 to the battery lead, while the other branch passes through the holding winding

50 15 of the line switch C to battery. The closure of this circuit serves to maintain the relay 46 and winding 15 energized after the deenergization of the relay 47, which occurs soon after the line relay 45 of the selector

55 is disconnected from the line and allowed to break the circuit of the relay 47. The relay 96 of the repeater which was included in the above circuit, upon energizing, operates to close the normally open contacts in the trunk

60 circuit so as to complete the connection between the calling line and the selector E' (Fig. 2). From the wiper 35 of the selector E the upper side of the line connection extends through the springs 97 and 98 and the

65 springs 99 to the trunk conductor 49. The other side of the line extends from the se-

lector wiper 36 through the springs 100, 101 and 102 to the trunk conductor 50. It will thus be seen that the connection of the calling substation with the first selector of the main exchange is dependent upon the energization of the relay 96 of the repeater. It has also been pointed out that this relay is energized in series with the cut-off winding 15 of the line switch of the calling line. As shown in the drawings, the winding 15 of the line switch C is shunted by a resistance 103. This is for the purpose of reducing the resistance in series with the relay 96 sufficiently to permit it to be completely operated. The relay 96 is a marginal relay and is so adjusted that when it is included in a circuit with the winding 15 which is not shunted by the resistance 103, said relay 96 is energized only strong enough to carry the spring 104 into contact with the spring 105, but not strong enough to separate the springs 105 and 106 and close the springs 99 and 102. Thus it will be seen that any subscriber whose line switch is not provided with the resistance 103 will not be able to call through to the main exchange, because he will be unable to close the contacts 99 and 102 in the trunk line at the repeater. If such a subscriber attempts to call the main exchange, he will not only fail to obtain a complete connection, but will be given the busy signal in the following manner: The partial energization of the relay 96 completes a connection from the busy signaling machine M' through the springs 104, 105 and 106, springs 101 and 100, selector wiper 36, thence to and through the substation and back over the other side of the line through the upper winding of the line relay 91 of the repeater to the battery lead 70, and thence to the other terminal of the busy signaling machine. This busy signaling current signifies to the calling subscriber that he has attempted to make a connection which is impossible. It will thus be seen that the relay 96 in the repeater F serves as a means by which the service between the branch exchange subscribers and the main exchange may be discriminating. All the substations which are to be permitted to call the main exchange are provided with a shunt around the holding winding 15 of their line switches, while the line switches of the substations which are not to be permitted to call the main exchange are not provided with such a shunt.

When the connection is extended through to the selector E' by the relay 96 of the repeater F, the line relay 107 of the selector E' is energized over a circuit extending from ground G^{18} through the lower winding of the relay 107, springs 108 and 109, trunk conductor 50, springs 102, springs 110 of the repeater line relay, impedance coil 111, springs 99, conductor 49 and springs 112, 130.

and 113 and the upper winding of the relay 107 to the battery lead 115. When the substation calling device is operated for the second digit 2, the line relay 91 of the repeater F is deenergized twice momentarily. Each time the relay 91 deenergizes, it separates the springs 110, thereby breaking the circuit of the line relay 107 of the selector E'. The selector E' is in all respects the same as the selector E, and operates in response to the impulses repeated to its line relay 107 by the repeater F in the same manner as has been explained for the selector E. The operations of the selector E' are effective to extend the connection to a second selector E². At the repeater F it will be seen that each time the relay 91 deenergizes in response to impulses from the substation, it closes a circuit from ground G⁷ through the spring 92 and its back contact, springs 116 of the slow acting relay 94 and through the slow acting relay 117 to the battery lead 70. The relay 117 is energized by the first impulse and, being a slow acting relay, does not deenergize until after the last impulse is delivered. Therefore, while the repeater is operating to repeat the impulses over the trunk line 49—50, the end of the trunk toward the calling line is disconnected at the contacts 100 and 101 and 97 and 98, and the impedance coil 111 is short-circuited through the springs 98 and 118 so that it will not interfere with the operation of the line relays of the switches in the main exchange. When the substation calling device is operated for the third digit 2, the repeater F operates to repeat the two impulses to the line relay 119 of the second selector E² in the main exchange. The second selector E² operates in the same manner as explained for the selector E to extend the connection over the trunk conductors 120 and 121 to an idle connector H which is one of a group of connectors having access to the desired line #2220. When the connection is extended to the connector H, its line relay 123 is energized as a consequence of a closed bridge across the line at the repeater F, in the same manner as explained for the line relay 107 of the selector E'. The relay 123, upon energizing, closes the circuit of the slow acting relay 124, which relay corresponds to the relay 47 of the selector E. The relay 124, upon energizing, completes a holding circuit for the switching relays 125 and 126 of the selectors E² and E'. This circuit extends from ground G⁹ through the springs 127, conductor 122, private wiper 128, side switch wiper 129 to the point 130, thence one branch of the circuit passes through the relay 125 and the side switch wiper 131 to the battery lead 115, while another branch passes through the wiper 133 of the selector E', side switch wiper 134, relay 126

and the side switch wiper 135 to the battery lead 115. It will be seen that in the circuit just traced a connection is extended from ground G⁹ to the selector private bank contacts of the trunks engaged by the selectors E' and E², which connection provides a guarding potential to prevent any other selectors from obtaining connection with the trunk lines while they are in use.

When the substation calling device is operated for the fourth digit 2, the repeater F repeats two impulses through the line relay 123 of the connector H. Each time the relay 123 deenergizes in response to these impulses, a circuit is closed from ground G¹⁰ through the spring 136 and its back contact, spring 137 and its front contact, vertical magnet 54, side switch wiper 138 and the relay 139 to the battery lead 115. The vertical magnet operates in response to these impulses to raise the switch wipers 51, 52 and 53 two steps, while the slow acting relay 139 operates to close the circuit of the private magnet 56 and maintain it closed as long as the vertical magnet is operating. After the last impulse is delivered to the vertical magnet, the relay 139 deenergizes and breaks the circuit of the private magnet 56, which thereupon permits the side switch to pass to second position. When the substation calling device is operated for the last digit 0, the connector line relay is deenergized ten times, each time completing a circuit from ground G¹⁰ through the spring 136 and its back contact, spring 137 and its front contact, rotary magnet 55, springs 140, side switch wiper 138 and relay 139 to the battery lead. The rotary magnet operates to rotate the shaft wipers ten steps onto the contact of the desired line, while the relay 139 operates in the same manner as for the previous digit to cause the private magnet to release the side switch one more step after the last impulse is delivered. The movement of the side switch wipers 141 and 142 from second to third position finally completes the connection between the calling and the called lines. The side switch wiper 143, upon reaching third position, extends a guarding potential to the connector private bank contacts of the called line and closes an energizing circuit for the cut-off winding 144 of the switch C'. This guarding potential and circuit extend from ground G¹¹ through the side switch wiper 143, springs 145 and 146, private wiper 53, connector private bank contacts and through the winding 144 to the battery lead 115. The winding 144 attracts the cut-off armature 147, which disconnects the switch C' from the called line and closes the normally open contact 148 in the talking circuit. The side switch wiper 138 of the connector, upon reaching third position, completes the circuit of the ringing relay 57,

said circuit extending from ground G^{19} through the interrupter 149, springs 150, relay 57, side switch wiper 138 and relay 139 to battery. The relay 57, upon energizing, disconnects the calling line from the called line and connects the ringing current generator L with the called line to signal the called subscriber. Since the circuit of the ringing relay 57 includes the interrupter 149, said relay is energized only intermittently so as not to ring the called subscriber continuously. When the subscriber at the called substation removes his receiver, or as soon thereafter as the ringing relay deenergizes, if it happens to be energized at the time, the called substation is provided with talking current over a circuit extending from ground G^{11} at the connector, through the side switch wiper 143, lower winding of the connector back-bridge relay 151, ringing relay springs 152 and 153, side switch wiper 142, shaft wiper 52, line 154, thence through the talking circuit of the substation and back over the line 155, through the contact 148, wiper 51, side switch wiper 141, springs 156 and 157 and the upper winding of the relay 151 to battery. The relay 151, upon energizing, breaks the circuit of the ringing relay 57 at the springs 150, and the calling and called subscribers may now carry on an uninterrupted conversation over the talking circuit outlined by heavy conductors in the drawings.

After the conversation is completed, all the automatic apparatus employed in the connection is released by the hanging up of the receiver at the calling substation. The hanging up of the receiver at the substation A destroys the energizing circuit of the line relay 91 of the repeater F. The relay 91, upon deenergizing, opens the bridge across the trunk conductors 49 and 50 at the springs 110, and also opens the circuit of the relay 94. The relay 94, upon deenergizing, destroys the holding circuit of the relay 46 of the selector E and of the holding winding 15 of the line switch C. The winding 15, upon deenergizing, permits the plunger of the line switch to be restored to normal position, while the relay 46, upon deenergizing, completes the circuit of the release magnet 43. This circuit extends from ground G^5 through the spring 85 and its back contact, spring 86 and its back contact, springs 159, off normal springs 44 and magnet 43 to the battery lead 70. The magnet 43, upon energizing, immediately restores the selector to normal position, and as soon as the shaft reaches its lowest position, the circuit of the magnet 43 is broken at the springs 44.

When the bridge across the trunk 49—50 is broken at the repeater E, the connector line relay 123 denenergizes. The relay 123, upon deenergizing, breaks the circuit of the

relay 124. The relay 124, upon deenergizing, closes the circuit of the release magnet 160 and breaks the holding circuit of the relays 125 and 126 of the selectors E^2 and E' , respectively. The circuit of the release magnet 160 extends from ground G^{10} through the spring 136 and its back contact, spring 137 and its back contact, magnet 160 and off normal springs 161 to the battery lead 115. The magnet 160, upon energizing, releases the connector and the release circuit is broken at the springs 161 as soon as the switch shaft reaches its lowest position. The selectors E^2 and E' are released by the deenergization of the relays 125 and 126 in the same manner in which the selector E is released when its relay 46 deenergizes.

In the foregoing it has been assumed that the called line was idle at the time it was called by the subscriber at substation A. If said line had been busy there would have been a guarding potential at its connector private bank contacts, and the connector H would have been prevented from completing connection therewith in the following manner: When the private wiper 53 engages a grounded contact of a busy line, a connection is extended from said grounded contact through said wiper, springs 146 and 145, lower winding of the relay 151, springs 152 and 153, side switch wiper 142 (which is then in second position), contact 164 to the spring 165 of the private magnet relay 139. When the private magnet relay 139 deenergizes after the last digit is called, the spring 166, since it engages the spring 165 before it is disengaged from the spring 167, completes a circuit from the grounded private bank contact of the busy line through the private magnet 56 in series with the lower winding of the relay 151 without allowing the private magnet to deenergize. The relay 139 being deenergized and the relays 56 and 151 being energized, a circuit is closed from ground G^{12} through the springs 167 and 168, springs 169, relay 170 and springs 171 to the battery lead. The relay 170, upon energizing, shifts the holding current of the private magnet and the relay 151 from the guarded private bank contact to ground G^{13} through the springs 145 and 172, thereby forming a locking circuit for the private magnet independent of the private bank contacts. Since the private magnet does not have a chance to deenergize after the last digit is called, the side switch remains locked in second position, thereby preventing completion of connection with the called line through the wipers 141 and 142, and at the same time the busy signaling machine M is connected with the calling line through the springs 173, side switch wiper 141, springs 156 and 157 and condenser 58. The switches are released in this

position upon the hanging up of the receiver at the calling substation in essentially the same manner as when an idle line is called.

5 While I have illustrated my invention in connection with a complete automatic private branch exchange system, it is to be understood that I do not wish to limit myself to such a system, as the various features of
10 my invention may be employed in any system in which automatic switches are employed.

What I claim as my invention is:—

1. In a telephone system, a plurality of
15 subscribers' lines, a trunk line, means including an automatic switch for extending a connection from any one of said subscribers' lines to seize said trunk line, means on certain of said subscribers' lines for ex-
20 tending a connection over said trunk line, and means for preventing other of said subscribers from extending such a connection.

2. In a telephone system, a plurality of
25 subscribers' lines, a trunk line accessible in common to said subscribers' lines, an automatic switch individual to each subscriber's line, a relay associated with said trunk, means including said individual switch for
30 extending a connection toward said trunk, means controlled by said relay for completing a connection from a subscriber's line to said trunk, and means whereby said relay may be energized to complete such a connection from certain of said subscribers' lines
35 and cannot be energized from others.

3. In a telephone system, a plurality of subscribers' lines, an automatic switch individual to each of said lines, an operating
40 magnet for each of said switches, a shunt about a winding of certain of said magnets, a trunk line, means including said individual switches for extending the connection from a subscriber's line to said trunks, and means
45 whereby a subscriber whose individual switch includes said shunt may extend a connection over said trunk line, and whereby other of said subscribers are prevented from establishing such a connection.

50 4. In a telephone system, a non-numerical switch, a trunk line, means including said switch for extending a connection to said trunk, a relay for controlling the circuit of said trunk, an operating magnet for
55 said switch, and means for energizing said relay in series with a winding of said operating magnet.

5. In a telephone system, a plurality of subscribers' lines, a switch including an op-
60 erating magnet individual to each of said subscribers' lines, a trunk line, means including one of said switches for extending a connection from a subscriber's line to said trunk, a relay for controlling the circuit of

said trunk, an energizing circuit for said
65 relay including a winding of said operating magnet, and means for varying the resistance of said circuit, depending upon the individual switch with which said trunk is
70 connected.

6. In a telephone system, a plurality of subscribers' stations, a trunk line, a repeater accessible from said subscribers' stations for repeating impulses over said trunk, a relay
75 in said repeater, and means whereby said relay may be energized from certain of said subscribers' stations but cannot be energized from others.

7. In a telephone system, a plurality of subscribers' lines, a trunk line, means includ-
80 ing an automatic switch for extending a connection from said subscribers' lines to said trunk, a repeater included in said trunk for repeating impulses over the same, a relay in said repeater for controlling the cir-
85 cuit of said trunk, and means whereby said relay may be energized to control said circuit from certain of said subscribers' lines but cannot be so energized from others.

8. In a telephone system, a plurality of
90 subscribers' lines, an automatic switch individual to said lines, an operating magnet for each of said switches, a trunk line, means including one of said switches for extending a connection from a subscriber's line to said
95 trunk line, a repeater in said trunk for repeating impulses over the same, a relay in said repeater for controlling the circuit of said trunk, and means for energizing said relay in series with a winding of the oper-
100 ating magnet of the individual switch employed in establishing a connection.

9. In a telephone system, a plurality of subscribers' lines, a non-numerical trunking
105 switch individual to said lines, an operating magnet for each of said switches, a shunt for a winding of certain of said operating magnets, a trunk line, means for extending a connection from said individual switches to
110 said trunk line, a repeater in said trunk for repeating impulses over the same, a relay in said repeater for controlling the circuit of said trunk, and a circuit for said relay including the operating magnet of the non-
115 numerical switch employed in establishing a connection, said relay being adapted to be energized to control said circuit when it is connected in series with an operating mag-
120 net having a shunt, and said relay being adapted not to be so energized when it is connected in series with an operating magnet which does not have a shunt.

10. In a telephone system, a plurality of subscribers' lines, means for establishing a
125 plurality of different kinds of connections from said lines, means whereby certain of said subscribers are prevented from establishing certain of said connections, and

means for giving a signal when a subscriber attempts to make a connection from which he is barred.

11. In a telephone system, a plurality of subscribers' lines, a trunk line accessible in common to said subscribers' lines, means on said subscribers' lines for extending a connection to said trunk line, means whereby certain of said subscribers are prevented from establishing a connection over said trunk, and means for giving a signal when one of said last-mentioned subscribers attempts to establish a connection over said trunk.

12. In a telephone system, a plurality of subscribers' lines, a trunk line accessible in common to said lines, means whereby certain of said subscribers can transmit impulses over said trunk to establish a connection with a second subscriber's line, means for preventing other of said subscribers from establishing such a connection, and means for giving a signal when one of said last-mentioned subscribers attempts to establish a connection over said trunk.

13. In a telephone system, a plurality of subscribers' lines, a trunk line, means including an automatic switch for extending a connection from any one of said subscribers' lines to said trunk line, means on certain of said subscribers' lines for extending a connection over said trunk line, means for preventing other of said subscribers from extending such a connection, and means for giving a signal when one of said last-mentioned subscribers attempts to extend such a connection.

14. In a telephone system, a plurality of subscribers' lines, a trunk line accessible in common to said subscribers' lines, an automatic switch individual to each subscriber's line, a relay associated with said trunk, means including said individual switch for extending a connection toward said trunk, means controlled by said relay for completing a connection from a subscriber's line to said trunk, means whereby said relay may be energized to complete such a connection from certain of said subscribers' lines and cannot be so energized from others, and means for giving a signal when a subscriber attempts to extend a connection over said trunk and said relay is not so energized.

15. In a telephone system, a plurality of subscribers' lines, an automatic switch individual to each of said lines, an operating magnet for each of said switches, a shunt about a winding of certain of said magnets, a trunk line, means including said individual switches for extending the connection from a subscriber's line to said trunks, means whereby a subscriber whose individual switch includes said shunt may extend a connection over said trunk line, and whereby other of said subscribers are pre-

vented from establishing such a connection, and means for giving a signal when one of said last-mentioned subscribers attempts to establish such a connection.

16. In a telephone system, a plurality of subscribers' lines, a trunk line, means including an automatic switch for extending a connection from said subscribers' lines to said trunk, a repeater included in said trunk for repeating impulses over the same, a relay in said repeater for controlling the circuit of said trunk, means whereby said relay may be energized to control said circuit from certain of said subscribers' lines but cannot be so energized from others, and means for giving a signal when a subscriber attempts to transmit impulses over said trunk when said relay is deenergized.

17. In a telephone system, a plurality of subscribers' lines, a non-numerical trunking switch individual to said line, an operating magnet for each of said switches, a shunt for a winding of certain of said operating magnets, a trunk line, means for extending a connection from said individual switches to said trunk line, a repeater in said trunk for repeating impulses over the same, a relay in said repeater for controlling the circuit of said trunk, a circuit for said relay including the operating magnet of the non-numerical switch employed in establishing a connection, means whereby said relay is energized when it is connected in series with an operating magnet having a shunt, and whereby said relay is not energized when it is connected in series with an operating magnet which does not have a shunt, and means for giving a signal when a subscriber attempts to extend a connection over said trunk when said relay is deenergized.

18. In a telephone system, an automatic switch including a rotary magnet, an interrupter relay for controlling the circuit of said rotary magnet, a side switch, a private magnet for controlling said side switch, a circuit for said private magnet controlled by said rotary magnet, and means for preventing said interrupter relay from energizing until after the private magnet has energized.

19. In a telephone system, an automatic switch including a rotary magnet, an interrupter relay for controlling the circuit of said rotary magnet, a private magnet, a circuit for said magnet controlled by said rotary magnet, a normally open circuit for said interrupter relay including contact springs controlled by said private magnet, whereby said interrupter relay is prevented from operating until after said private magnet has operated.

20. In a telephone system, an automatic switch including a rotary magnet, an interrupter relay for controlling the circuit for said rotary magnet, a second magnet, a cir-

cuit for said second magnet controlled by said rotary magnet, and means for preventing said relay from energizing until after the second magnet has energized.

5 21. In a telephone system, a magnet, a circuit controlling relay and an auxiliary relay, means whereby the circuit controlling relay controls the circuit of said magnet, a circuit for said auxiliary relay controlled by
10 said rotary magnet, and a normally open switch point in the circuit of said circuit controlling relay controlled by said auxiliary relay, whereby said circuit controlling relay cannot open the circuit of said magnet until
15 the auxiliary relay has been energized.

22. In a telephone system, an automatic switch including a rotary magnet, a circuit therefor, a circuit controlling relay and an auxiliary relay, a circuit for said auxiliary relay controlled by said rotary magnet, means controlled by said circuit controlling relay for controlling the circuit of said rotary magnet, and means controlled by said auxiliary relay for controlling the circuit
20 of said circuit controlling relay, whereby said circuit controlling relay cannot be energized until after the auxiliary relay is energized.

23. In a telephone system, a plurality of
30 lines, a trunk line, trunking equipment for connecting any one of said lines with the trunk, said trunk normally inoperative for extending a connection therethrough, means for rendering said trunk operative, said
35 trunking equipment comprising a bridge cut-off relay for rendering the equipment individual to the calling line inoperative when the calling line is called, said means comprising a relay individual to the trunk, and
40 an energizing circuit for said relay comprising the said bridge cut-off relay.

24. In a telephone system, a plurality of lines, a trunk line, trunking equipment for connecting any one of said lines with the
45 trunk, said trunk normally inoperative for extending a connection therethrough, means for rendering said trunk operative, said trunking equipment comprising a bridge cut-off relay for rendering the equipment individual to the calling line inoperative when
50 the calling line is called, said means comprising a relay individual to the trunk, an energizing circuit for said relay comprising the said bridge cut-off relay, and a circuit in multiple with said bridge cut-off
55 relay.

25. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the
60 first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with the said trunk line, said trunk normally inoperative to extend a connection there-

through, means for automatically rendering
65 said trunk operative when connected with the first line, said means inoperative for rendering the trunk operative whenever the trunk is connected with the second line.

26. In a telephone system, a line, a second
70 line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with the said trunk
75 line, said trunk normally inoperative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said means inoperative for rendering the trunk
80 operative whenever the trunk is connected with the second line, and means for signaling the second line that the trunk is inoperative.

27. In a telephone system, a line, a second
85 line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with the said trunk
90 line, said trunk normally inoperative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said means inoperative for rendering the trunk
95 operative whenever the trunk is connected with the second line, and means for signaling the second line that the trunk is inoperative, said last means individual to the trunk line.
100

28. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either
105 the first or second line with the said trunk line, said trunk normally operative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said
110 means inoperative for rendering the trunk operative whenever the trunk is connected with the second line, a signal and means individual to the trunk for signaling the second line that the trunk is inoperative.
115

29. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either
120 the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said
125 means inoperative for rendering the trunk operative whenever the trunk is connected with the second line, and means for signal-

ing the second line that the trunk is inoperative, the signal always inaccessible to the first line.

30. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with the said trunk line, said trunk normally inoperative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said means inoperative for rendering the trunk operative whenever the trunk is connected with the second line, and means for signaling the second line that the trunk is inoperative, said last means individual to the trunk line, the signal always inaccessible to the first line.

31. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with the said trunk line, said trunk normally operative to extend a connection therethrough, means for automatically rendering said trunk operative when connected with the first line, said means inoperative for rendering the trunk operative whenever the trunk is connected with the second line, a signal and means individual to the trunk for signaling the second line that the trunk is inoperative, said signal always inaccessible to the first line.

32. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk operative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, means in the branch individual to the second line for preventing the relay from energizing for the purpose set forth.

33. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk inoperative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, and means in the branch indi-

vidual to the first line for insuring the supply of sufficient current to energize the relay to render the trunk operative.

34. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk operative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, means in the branch individual to the second line for preventing the relay from energizing for the purpose set forth, and means individual to the first line for insuring the supply of sufficient current to energize the relay to render the trunk operative.

35. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk operative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, means in the branch individual to the second line for preventing the relay from energizing for the purpose set forth, said energizing circuit extending from the calling line to the trunk over a conductor separate from the talking conductor.

36. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk operative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, means in the branch individual to the second line for preventing the relay from energizing for the purpose set forth, said energizing circuit extending from the calling line to the trunk over a conductor separate from the talking conductor, and release mechanism for the trunking equipment, said release mechanism controlled over said energizing circuit.

37. In a telephone system, a line, a second line, a group of lines, a trunk line, trunking equipment for connecting either the first or second line with any one of the lines of said

group, or for connecting one at a time either the first or second line with said trunk line, said trunk normally inoperative to extend a connection therethrough, a relay individual to said trunk for rendering the trunk operative, an energizing circuit for said relay having a branch individual to the first line and a branch individual to the second line, means in the branch individual to the second line for preventing the relay from energizing for the purpose set forth, said energizing circuit extending from the calling line to the trunk over a conductor separate from the talking conductor, release mechanism for the trunking equipment, said release mechanism controlled over said energizing circuit, and means for making the trunk busy when a connection is extended to the same, said means comprising said energizing circuit.

38. In a telephone system, subscribers' lines of two kinds, means responsive to a calling line of either kind for performing a preliminary automatic trunking operation, and means actuated only when the calling line is of a particular kind to perform a second automatic trunking operation.

39. In a telephone system, subscribers' lines of two kinds, means including trunk lines for connecting calling and called lines, means responsive to a calling line of either kind for automatically connecting such calling line with an idle trunk line, other trunk lines, and means actuated only when the calling line is of a particular kind for further extending such calling line to an idle one of said other trunk lines.

40. In a telephone system, a plurality of subscribers' lines, means including a plurality of automatic switches for establishing a plurality of different kinds of connections from said lines, means whereby certain of said subscribers are prevented from establishing certain of said connections, and means for giving a signal when a subscriber attempts to make a connection from which he is barred.

Signed by me at Chicago, Cook county, Illinois, this 18th day of October, 1911.

TALBOT G. MARTIN.

Witnesses:

ARTHUR J. RAY,
EDWARD D. FALES.