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Patented May 7, 1918.
 3 SHEETS—SHEET 1.

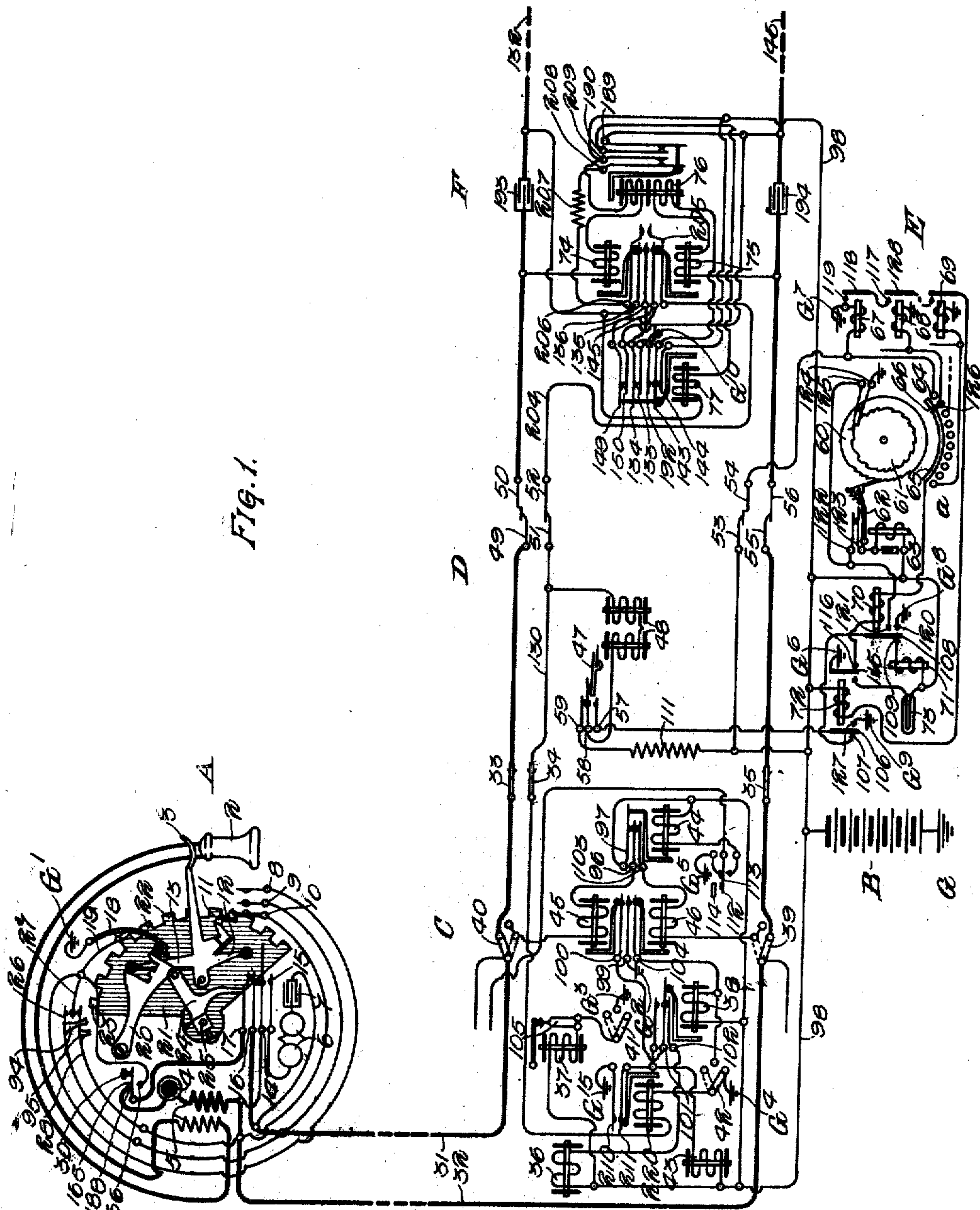


Fig. 1.

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APPLICATION FILED OCT. 11, 1910. RENEWED MAY 18, 1917.

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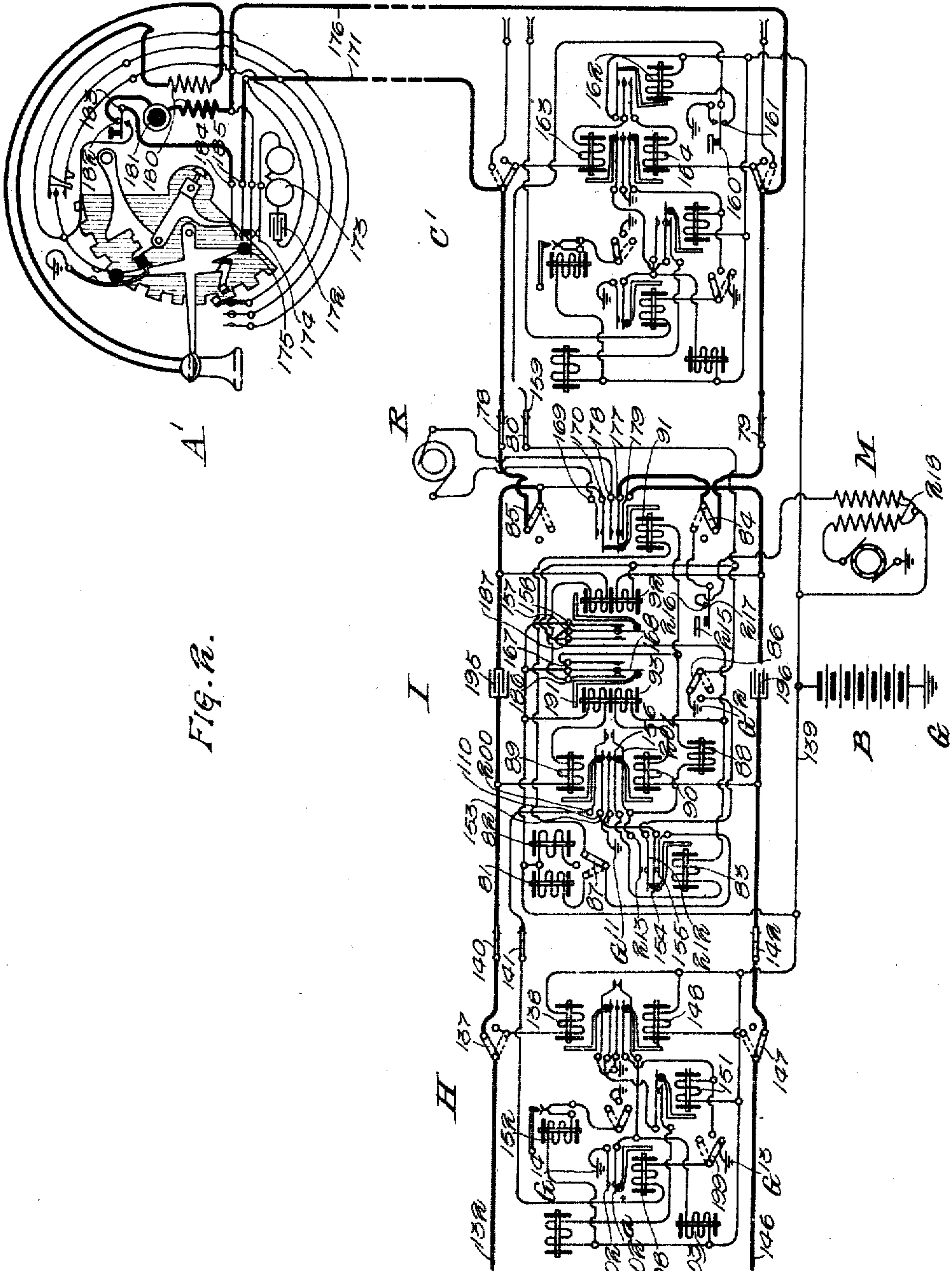


Fig. 2.

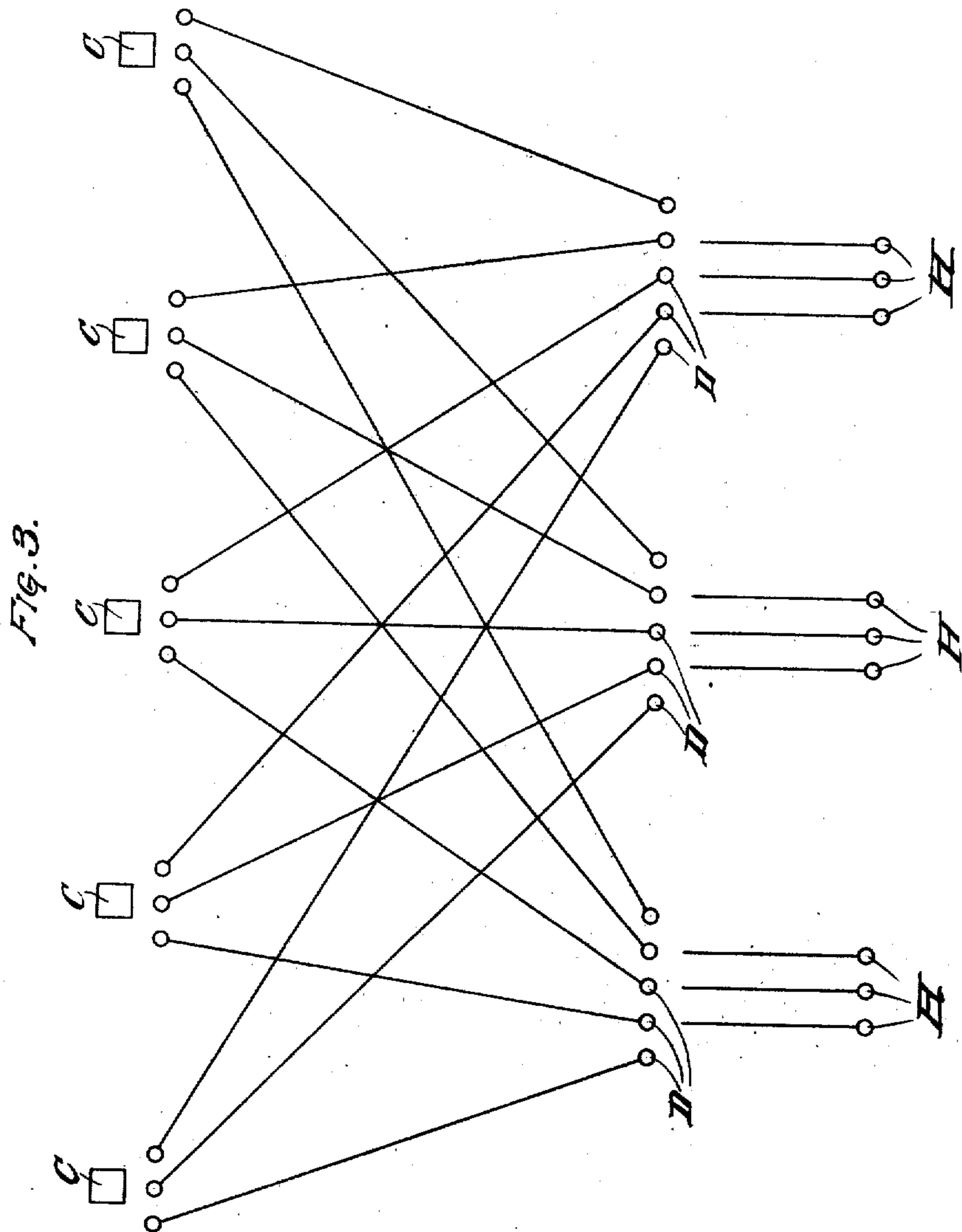
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 3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE TRUNKING SYSTEM.

1,265,228.

Specification of Letters Patent.

Patented May 7, 1918.

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To all whom it may concern:

Be it known that I, EDWARD A. MELLINGER, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Trunking Systems, of which the following is a specification.

My invention relates to telephone exchange systems of that kind in which automatic switches are employed for selecting trunks or other lines. It relates more particularly to systems in which non-numerical trunking switches, sometimes called line switches, are employed between first and second selectors, whereby the said switches are greater in number than the trunks leading therefrom. In such case it frequently happens that the trunks are all busy, and that a number of the switches, although idle, are for this reason not available for use. Suppose, for example, that all of the trunks leading from a certain switchboard become busy, there will then be a certain number of switches thereon that are idle, but which are not available for use, because they cannot find any trunks which are idle. It becomes desirable, therefore, that some provision be made for preventing selection of an idle switch that is temporarily precluded from finding an idle trunk or other line.

The object of my invention is, therefore, to provide an improved arrangement whereby, in a system in which certain switches are greater in number than the trunks leading therefrom, the idle switches cannot be selected, and in which no connection therewith can be made after and while the trunks leading therefrom are all in use.

It is also an object to provide an improved construction and arrangement whereby the simultaneous use of all the trunks leading from a certain switchboard, leaving a certain number of switches that are idle but incapable of use, will serve automatically to prevent connection with any of said idle switches, and to divert the call to some other switchboard.

Another object is to provide a system in which a plurality of trunking switches are controlled by a master switch, and in which means are provided for automatically preventing further actuation of said master switch after and while the trunks leading

from said switches are already in use, the said master switch thereby being incapable of operation except when one or more of the trunks are idle.

A further object is to provide a novel arrangement whereby a guarding potential will be established for one or more idle switches to prevent connection therewith whenever it shall occur that all of the trunks or lines leading from said switches are in use, as in such case a switch, although itself not in use, is incapable of finding a trunk or line which is idle, and its actuation will accomplish no useful purpose.

Another object is to provide a system in which non-numerical trunking switches are employed between the first and second selectors, so that the second selectors are common to all of the subscribers, and in which the simultaneous use of all the trunks leading from a certain group of non-numerical trunking switches will serve automatically to temporarily prevent all further connection with that group, and to divert the prevented connection to some other group, as will hereinafter more fully appear.

It is also an object to provide certain details and features of improvement and combinations tending to increase the general efficiency and serviceability of a telephone exchange system of this particular character.

In the accompanying drawings Figs. 1 and 2 taken together show diagrammatically a complete circuit connection established between two substations A and A' of different exchanges in a system involving the principles of my invention.

At A (Fig. 1) there is shown a subscriber's three-wire automatic substation. By "three-wire" type is meant that type in which a ground connection is used at the substation for operating purposes. The said substation is connected by means of two line conductors to the first selector C. The first selector C has access to terminals of trunks leading to the non-numerical trunking switches one of which is the switch D. This trunking switch D is one of a group which has access to trunks leading to repeaters, which are for the purpose of repeating the impulses delivered by substations in one exchange to selector switches in another exchange, such as the selector shown at H in

Fig. 2. The trunk lines leading from each level of the selector bank contacts are distributed among a number of groups of these non-numerical switches, and these groups of non-numerical switches are common to a number of different groups of selector switches.

Fig. 3 is a diagram showing how the trunk lines leading from one level of a number of different groups of first selectors may be distributed among a number of groups of secondary line switches, and showing how there may be a larger number of secondary switches in each group than trunk lines leading therefrom.

The plungers of the non-numerical trunking switches such as the one shown at D (Fig. 1) are all normally in locking engagement with a plunger shaft (not shown) which is controlled by the mechanism shown at E, usually called a master switch. This master switch E controls the plungers of the trunking switches of the group of which the switch D is a member in such a manner that they are normally held directly opposite an idle trunk line leading to a repeater such as the repeater F.

The selector switch shown at H (Fig. 2) is similar to the selector C (Fig. 1). The selector H has access to trunks leading to connectors, one of which is the connector shown at I. At A' and C' there are shown a substation and first selector similar to those shown at A and C, respectively. As herein represented, there are but two batteries, with their positive terminals preferably grounded; but it will be understood, of course, that there may be any number, depending upon the conditions to be met.

The substations may be of any suitable or approved type. As shown, the substation A comprises the usual receiver 2, switch hook 3, transmitter 4, induction coil 5, ringer 6, condenser 7 and release springs 8, 9 and 10, which springs are momentarily forced into contact by the cam arm 11 on the downward movement of the switch hook 3. Like the cam 11, there are also secured to the hook 3 the cam arms 12 and 13. When the hook is in its lowest position the cam 12 serves to press the spring 14 into engagement with the spring 15 and to allow the spring 16 to disengage the spring 17. When the hook is in its lowest position the cam 13 holds the ground spring 18 away from the spring 19. The locking cam 20 serves to prevent the dial (not shown) from being rotated as long as the receiver is on the hook, and also prevents the spring 18 from engaging spring 19, after the receiver is removed from the hook, until the dial is turned. The impulse wheel 21, carrying the so-called vertical teeth 22 and rotary tooth 23, and the cam 24 are securely fastened to the shaft 25, to which is also secured a dial (not shown) provided

with finger holes. As soon as the dial is rotated, the cam 24 permits spring 17 to disengage spring 16.

On the backward movement of the impulse wheel the vertical teeth 22 force the spring 26 into engagement with the spring 27. Following the last engagement of springs 26 and 27, the rotary tooth 23 forces the spring 28 into engagement with spring 27. The substation is also supplied with a push button 30.

The substation A is connected to the selector C by means of the line conductors 31 and 32. The selector C is of the general type disclosed in United States Letters Patent #815,321, granted March 13, 1906, to Keith, Erickson & Erickson. In general, it comprises the usual shaft (not shown) carrying the wipers 33, 34 and 35. This shaft has a vertical motion controlled by the vertical magnet 36 and a rotary motion controlled by the rotary magnet 37. The private magnet 38 controls the side switch carrying the wipers 39, 40, 41 and 42 in the usual and well known manner. The release of the switch mechanism is provided for in the release magnet 43. The cut-off relay 44 is for the purpose of cutting off the two line relays 45 and 46 from battery.

The non-numerical trunking switch shown at D is of the general type disclosed in British Patent No. 26,301 of 1906, and in the *American Telephone Journal* of New York, N. Y., of June 6, 1908, but is slightly modified to operate in a system embodying the principles of my invention. It comprises the usual plunger (not shown) attached to the plunger arm 47. This plunger arm is attracted upon the energization of the magnet 48 to force the said plunger into a bank of trunk terminals consisting of a plurality of sets of springs. The said plunger forces the springs 49, 51, 53 and 55 into engagement with the springs 50, 52, 54 and 56, respectively. As the plunger is attracted the spring 58 is shifted out of engagement with the spring 57 and into engagement with the spring 59.

The master switch D is of the general type disclosed in the aforesaid British patent and *Telephone Journal*. The master switch D comprises the ratchet wheel 60 to the shaft of which there is also secured the notched wheel 61. This notched wheel is usually constructed of fiber or some good insulating material. The ratchet wheel 60 is capable of being rotated upon the attraction of the armature 62 by the motor magnet 63. The switch also comprises the bank a consisting of the individual segments 64, 126, etc., and the common segment 65. There is also a wiper 66 secured to the plunger shaft which is used to always keep some one of the individual contacts in electrical connection with the common segment 65. There

are a number of relays 67, 68 and 69, one of which is connected to each of the individual segments of the master switch bank. There are also the operating relays 70, 71 and 72 and lamp 73 used in connection with the master switch.

The repeater shown at F, as before stated, is for the purpose of receiving impulses from a calling substation and repeating them over a trunk line to switches of another exchange. It consists essentially of the two line relays 74 and 75 and the differentially-wound double-wound relay 76. There is also a relay 77, the function of which will be explained later.

The selector shown at H, Fig. 2, is quite similar to that shown at C, Fig. 1, but unlike selector C it has no cut-off relay.

The connector shown at I is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson. It, like the selectors C and H, comprises a shaft and shaft wipers 78, 79 and 80, the vertical motion of the shaft being controlled by the vertical magnet 81 and the rotary motion by the rotary magnet 82. The private magnet 83 controls the side switch carrying the wipers 84, 85, 86 and 87. The release of the connector is provided for in the release magnet 88. The operation of the switch is controlled by the calling subscriber through the medium of the two line relays 89 and 90. The connector is also provided with a ringer relay 91 and two double-wound relays 92 and 93.

As before stated, the substation A' and first selector C' are like substation A and selector C in Fig. 1.

Having given a general description of the apparatus involved in the system, I will now describe the operations of the apparatus when a subscriber at substation A, for instance, calls a subscriber in another exchange, subscriber at substation A', for example, whose number we will assume to be 2220. In making the call the subscriber at substation A removes the receiver from the hook, which permits the springs 14 and 15 to disengage and springs 16 and 17 to engage. The disengagement of springs 14 and 15 opens the circuit of the bells 6. The engagement of springs 16 and 17 has no particular function at this time. The subscriber, after having removed the receiver, rotates the dial, and consequently the impulse wheel 21 and cam arm 24, forward in the usual manner. As the cam arm is rotated upon the forward movement of the dial, it strikes the cam 20, which then allows the spring 18 to engage spring 19. The cam 24 also breaks the engagement of springs 16 and 17. As the subscriber wishes to call the digit 2, he rotates the dial until two of the vertical teeth 22 and the rotary tooth 23 are carried

past the cams 94 and 95 on the springs 26 and 28. As soon as the dial is released, the impulse wheel rotates backward. The teeth 22 strike the cam 94 and force the spring 26 into contact with the spring 27. The engagement of these two springs closes an energizing circuit through the vertical line relay 45 of the selector C. This circuit extends from ground G' through springs 18 and 19, springs 27 and 26, conductor 31, side switch wiper 40, line relay 45 and springs 96 and 97 to battery lead 98, thence through battery B to ground G. The relay 45 energizes over this circuit to close a circuit through the vertical magnet 36. This circuit extends from ground G² through springs 99 and 100, 101 and 102 and magnet 36 to battery lead 98. As the springs 27 and 26 engage twice momentarily, the vertical magnet energizes twice to raise the shaft and shaft wipers two steps opposite the second level of bank contacts. After the shaft has been raised one or more steps, the arm 114 is lifted from spring 112, permitting it to engage spring 113, which puts a guarding ground onto the connector private bank contact of the calling line in the banks of all of the connectors that have access to said line. This is to prevent the substation A from being called while it is making a call. A moment after the vertical impulses are sent in, the rotary tooth 23 strikes the cam 95 on spring 28 and forces said spring against the ground spring 27. This closes a circuit extending from ground G' through springs 18 and 19, springs 27 and 28, line conductor 32, side switch wiper 39, line relay 46 and springs 103 and 97 to battery lead 98. The rotary line relay 46 energizes once over this circuit and closes a circuit through the private magnet 38. This circuit extends from ground G² through springs 99 and 104 and private magnet 38 to battery lead 98, thence through battery B to ground G. The private magnet thereupon energizes and deenergizes, permitting the side switch to pass to second position. As soon as wiper 41 reaches second position a circuit is closed through the rotary magnet 37. This circuit extends from ground G² through wiper 41, interrupter springs 105 and rotary magnet 37 to battery lead 98. The rotary magnet energizes once to rotate the shaft and shaft wipers one step onto the terminals of a trunk leading to the switch D. The rotary magnet also presses down the private magnet armature and breaks its own circuit. If the first contact upon which the wipers are rotated is idle, the private magnet armature will be released when the rotary magnet armature falls back, and the side switch will thereby be allowed to pass to third position. If, however, the first trunk is busy, the private bank contact upon which the private wiper 34 is rotated will have upon it a guarding

ground potential, as will be hereinafter more fully explained. As soon as the wiper 34 strikes this guarded contact, a circuit is closed through the private magnet over a circuit extending from the said grounded contact through wiper 34, relay 220, wiper 42 (in second position) and private magnet 38 to the battery lead 98. The relay 220 does not energize over this circuit, but the private magnet does energize, thereby locking the side switch in the second position, and as soon as the rotary magnet deenergizes, it is energized again and thus acts in the manner of a buzzer to rotate the shaft, carrying wipers 33, 34 and 35 to a contact that is not busy, at which time the side switch is permitted to pass to the third position. As soon as the side switch wipers 39 and 40 reach the third position, the line conductors are extended to the switch D. The passing of wiper 42 to the third position puts a guarding ground on the private bank contact of the trunk leading to the switch D in the banks of all of the first selectors that have access to the switch D. This circuit extends from ground G¹ through side switch wiper 42, relay 220 to wiper 34, thence to all of said private bank contacts. A circuit also extends over the circuit just traced to the wiper 34, thence through magnet 48, springs 58 and 57, armature 106, contact point 107, armature 108, contact 109 and coil 71 to battery. The magnet 48 is energized over this circuit and attracts the plunger arm 47. As the spring 58 is shifted from spring 57 to spring 59 upon the attraction of the plunger arm, the holding circuit for magnet 48 is shifted through resistance 111 to battery. As before stated, the plunger being thrust into the bank of springs 49-56 forces springs 49, 51, 53 and 55 into engagement with springs 50, 52, 54 and 56, respectively. The engagement of the springs 49, 51 and 53 with springs 50, 52 and 56 completes the trunk conductors to the repeater H. The engagement of springs 53 and 54 closes a circuit through the relays 67 and 70 in multiple. The circuit through relay 70 extends from ground G² through armature 115, contact point 116, relay 70, common segment 65 of master switch bank α , wiper 66, individual segment 64 and springs 54 and 53 to battery lead 98. The other circuit extends from ground G² through relay 67 and springs 54 and 53 to battery lead 98. The energization of relay 67 places ground potential upon the point 117 by means of armature 118 engaging point 119. The function of this ground potential will be explained more fully later. The relay 70 energizes over the circuit before traced to close the circuit of the motor magnet 63. This circuit extends from ground G² through contact 120, armature 108, contact 121, springs 122 and 123 and motor magnet 63 to battery lead 98. The

motor magnet attracts its armature, which rotates the ratchet wheel one step. As soon as the ratchet wheel is rotated one step the spring 124 which normally rests in a notch in the wheel 61 is forced against the spring 125 and held in this engaged position until the spring 124 again engages a notch in the wheel 61. The attraction of the motor armature also breaks its own circuit at springs 122 and 123 and the armature falls back, but as the circuit is now closed at springs 124 and 125, it is immediately attracted again. Thus it operates in the manner of a buzzer to rotate the ratchet wheel until the spring 124 engages the next notch. By means of a suitable mechanical arrangement the rotary motion of the ratchet wheel is imparted to the plunger shaft, giving said plunger shaft an oscillatory motion to move the plungers which are in locking engagement therewith back and forth in front of the banks of trunk terminals. The notched wheel 61 is so constructed that every time the spring 121 engages a notch the plungers stand directly opposite the terminals of a trunk conductor leading to a repeater F. Had the next trunk after the one last put in use been busy, the contact 126 would have guarding potential upon it, which, when the wiper 66 engaged said contact, would complete a circuit through the relay 70, which would energize the motor magnet again and thus would move the plungers to the next trunk.

In case all of the trunks leading from the group of switches of which the switch D is a member are busy, the relays 67, 68, 69, etc., will all be energized in the manner before described, at which time a circuit will be closed through the relay 72. This circuit extends from ground G² through contact point 119, armature 118, contact 117, armature 128, etc., through the armatures of all relays 67, 68, 69, etc., consecutively, through the armature of the relay individual to the last trunk, thence through relay 72 to battery. The relay 72 remains energized as long as the trunks are all busy. The energization of the relay 72 opens the circuit of the relay 70 at armature 115 and contact 116, which in turn deenergizes and opens the motor magnet circuit, thereby stopping the operation of the master switch. The energization of the relay 72 also closes a circuit through the lamp 73, and puts a guarding potential on the selector private bank contacts of all of the trunk lines leading to the switches that are controlled by the master switch E that are not in use. This circuit extends from ground G² through contact point 127, armature 106, thence through springs 57 and 58 of all of the idle switches D, through magnet 48 and back over conductor 130 to said private bank contacts. Thus when all the trunk lines leading from a group of non-numerical switches D become

busy, its master switch E is prevented from uselessly rotating, even though all its bank contacts are provided with a guarding potential, and at the same time a guarding potential is provided for all trunk lines leading into this group of non-numerical switches, even though some of said trunks are not actually in use. Thus a calling line is prevented from being extended into connection with a non-numerical switch D from which no idle trunks are available to extend the connection farther. When the selector wipers encounter a trunk line which is thus guarded, they are rotated past it into connection with a trunk leading to a different group of non-numerical switches.

The foregoing is the operation of the central office mechanism upon the operation of the dial for the first digit 2. The subscriber at substation A now rotates the dial forward for the second digit 2. Two vertical teeth 22 and the rotary tooth 23 are again carried past the impulse springs 26 and 28. The dial is now released and permitted to rotate backward, forcing spring 26 twice against the ground spring 27. The closing of these two springs sends two ground impulses through the vertical line relay 74 of the repeater F. This circuit extends from ground G' through springs 18 and 19, springs 27 and 26, conductor 31, wiper 40, shaft wiper 33, springs 49 and 50 of switch D, line relay 74 of repeater F and upper winding of relay 76 to battery lead 98, thence through battery B to ground G. The relays 74 and 76 both energize twice over this circuit, thereby sending two ground impulses over trunk conductor 132 to the second selector H. This circuit extends from ground G¹⁰ through springs 133 and 134, springs 135 and 136, conductor 132, side switch wiper 137 and line relay 138 of selector H to battery lead 139, thence through battery B to ground G. The selector H operates in the same manner as the selector C to raise the shaft and shaft wipers 140, 141 and 142 opposite the second level of bank contacts. As the rotary tooth 23 of the impulse wheel 21 passes the cam 95 on spring 28 it forces said spring into engagement with spring 27, which closes a circuit through the rotary line relay 75 of the repeater. This circuit extends from ground G' through springs 18 and 19, springs 27 and 28, rotary line conductor 32, wipers 39 and 35, bank springs 55 and 56, relay 75, lower winding of relay 76 and springs 143 and 144 to battery lead 98, thence to battery B.

The relay 75 energizes to close a circuit extending from ground G¹⁰ through springs 133 and 134, springs 135 and 145, springs 149 and 150, conductor 146, wiper 147 and relay 148 to battery lead 139. The relay 148 energizes to close a circuit through the private

magnet 151, thereby stepping the side switch to second position, which closes the circuit of the rotary magnet 152 to rotate the shaft and shaft wipers to the first idle trunk assumed to be the trunk leading to the connector I. The side switch wipers pass to the third position and thus connect the trunk lines 132 and 146 directly from the repeater F to the connector I. The energization of relay 76 of the repeater F, as the lines are grounded at the substation A, serves to open the circuit of the relay 77 to prevent the ground impulse from going to the connector over both sides of the line.

The operation of the repeater F for the last two digits is the same as it was for the second digit 2. The connector I, upon receiving the ground impulses over the vertical line as the third digit is called, operates by means of magnet 81 to raise the shaft and shaft wipers 78, 79 and 80 two steps to a point opposite the second level of bank contacts, the same as in the selectors C and H. The rotary impulse likewise operates to step the side switch to second position. The side switch wiper 87, in passing to the second position, shifts the connection of the impulse spring 110 from the vertical magnet 81 to the rotary magnet 82. The switch is now in position for the fourth and last digit O. The subscriber at substation A turns the dial until ten vertical teeth on the impulse wheel have passed the impulse springs 26. The dial, upon being released, rotates backward, as before described, grounding the vertical line ten times and the rotary line once. The repeater repeats the impulses the same as before to close the circuit of the connector line relay 89. The relay 89 now operates to close the circuit extending from ground G¹¹ through springs 153 and 110, springs 154 and 155, wiper 87 and rotary magnet 82 to battery lead 139. The rotary magnet energizes ten times, thereby rotating the shaft wipers 78, 79 and 80 ten steps onto the line of the called subscriber.

Now comes the one rotary impulse, as heretofore explained, which energizes the rotary relay 90. The energization of this relay again closes the circuit of the private magnet 83. This circuit extends from ground G¹¹ through springs 153 and 156, magnet 83 and springs 157 and 158 to battery lead 139. The private magnet energizes and deenergizes, permitting the side switch to pass to third position. The wipers 84 and 85, in the third position, connect the calling subscriber with the called subscriber. The wiper 86, in third position, closes a circuit from ground G¹² through wiper 86, shaft wiper 80, private bank contact 159, off-normal springs 160 and 161 and cut-off relay 162 to battery. The cut-off relay is energized, thereby disconnecting battery from the line relays 163 and 164, 130

which prevents substation A' from calling while another substation has connection with its line.

A circuit also extends from the contact 5 159 to the corresponding contacts in the banks of all of the connectors that have access to the called line, thus putting a guarding potential on the private bank contacts, which prevents a third party from calling 10 substation A' while said substation is being called.

The subscriber at substation A is now in position to ring the called subscriber. As soon as the dial stops rotating, the subscriber 15 at substation A presses the button 30, which forces spring 165 into engagement with spring 166. The engagement of these two springs closes a circuit extending from ground G' through springs 18 and 19, 20 springs 166 and 165, springs 17 and 16, conductor 31, wipers 40 and 33, springs 49 and 50 and relays 74 and 76 of repeater F to battery lead 98. The relays 74 and 76 energize as before and close a circuit through the 25 relay 89 of the connector. This circuit extends from ground G¹⁰ through springs 133 and 134, springs 135 and 136, conductor 132, wipers 137 and 140, relay 89 and upper winding of relay 93 to battery. The energiza- 30 tion of relays 89 and 93 at this time closes a circuit through the ringer relay 91. This circuit extends from ground G¹¹ through springs 153 and 110, springs 154 and 155, wiper 87, ringer relay 91 and springs 167 35 and 168 to battery lead 139. The ringer relay energizes and by so doing disconnects the calling from the called line and connects the ringing current generator with the line of the called subscriber. A circuit is now 40 closed through the bells of the called substation extending from one side of the generator R through springs 169 and 170, wiper 85, shaft wiper 78, conductor 171, condenser 172, bells 173, springs 174 and 175, conduc- 45 tor 176, wipers 79 and 84 and springs 177 and 178 to the other side of the generator R. The subscriber at substation A', upon hearing the signal, removes the receiver from the hook. Upon the removal of the receiver 50 from the hook at substation A', the called subscriber receives talking battery current through the back-bridge relay 92 of the connector. This circuit extends from ground G¹² through the wiper 86, lower winding of 55 the relay 92, springs 179 and 177, wiper 84, shaft wiper 79, conductor 176, primary winding of the induction coil 180, transmitter 181, springs 182 and 183 of the push button, hook springs 184 and 185, conductor 60 171, shaft wiper 78, side switch wiper 85, upper winding of the relay 92 and springs 186 and 168 to battery lead 139. The relay 92 energizes over this circuit and shifts the spring 157 out of engagement with the 65 spring 158 and into engagement with the

spring 187. This shifting of the springs provides an energizing circuit for the relay 77 of the repeater F, said circuit extending from ground G¹² through the side switch wiper 86, springs 187 and 157, lower wind- 70 ing of the relay 93, relay 90, thence over the heavy conductor to the repeater F, through the springs 189 and 190, relay 77, back over the heavy conductor to the connector relay 89 and the upper winding of the relay 93 to 75 battery lead 139. The current in the two windings of the relay 93 have opposite effects, thus permitting the armature to remain in its normal position. The relay 77 of the repeater is energized over the circuit 80 just traced, thereby disconnecting the rotary impulse spring 145 from the trunk 146, and also disconnecting ground G¹⁰ from the spring 135 and supplying talking battery 85 current to the calling subscriber over a circuit extending from ground G¹⁰ through the springs 192 and 143, lower winding of the relay 76, relay 75, thence over the heavy conductor to substation A, through primary winding of induction coil 5, transmitter 4, 90 push button springs 188 and 165, switch hook springs 17 and 16, back over the heavy conductor to repeater F, through relay 74 and upper winding of relay 76 to battery. The 95 relay 76, like the relay 93 of the connector, is differentially wound and therefore does not energize over the circuit just traced. Thus both subscribers may now converse, it being evident, of course, that the voice-cur- 100 rents flow through the condensers 193 and 194 of the repeater and condensers 195 and 196 of the connector.

The release of the apparatus used in the connection described is initiated by the 105 hanging up of the receiver at the calling substation. As the hook 3 is lowered the cam arm 11 forces springs 8, 9 and 10 momentarily into engagement, thereby grounding both the vertical and rotary lines simul- 110 taneously. Thus the relays 74, 75 and 76 of the repeater momentarily energize. The simultaneous energization of these three relays closes a circuit through the relays 89, 90 and 93 of the connector. The circuits 115 thus closed are the same as when the repeater closed the circuit of each line relay individually. The simultaneous energiza- tion of the relays 89, 90 and 93 closes an energizing circuit through the release mag- 120 net 88 of the connector in series with the release relay 198 of the selector H. This circuit extends from ground G¹³ through side switch wiper 199, relay 198, private wiper 141, springs 200 and 201, magnet 88 and springs 167 and 168 to battery. The 125 energizing of magnet 88 restores the connector to normal position. The relay 198, upon energizing, closes a circuit extending from ground G¹⁴ through springs 202 and 202^a and release magnet 203 to battery lead 130

139. The release magnet attracts its armature, but does not release the switch mechanism until the magnet deenergizes. Returning now to the repeater, the simultaneous energization of the relays 74, 75 and 76 closes an energizing circuit through the release relay 220 of the selector C. This circuit extends from ground G⁴ through wiper 42, relay 220, wiper 34, springs 51 and 52, conductor 204, springs 205 and 206, resistance 207 and springs 208 and 209 to the battery lead 98. The resistance 207 is low enough to permit the relay 220 to be energized to close a circuit through the release magnet 43. This circuit extends from ground G¹⁵ through springs 210 and 211, and magnet 43 to battery. As soon as the release springs 8, 9 and 10 at the substation A break contact the line relays of the repeater deenergize, which in turn permits the release relay of the selector and the line relays of the connector to deenergize. The deenergization of the selector release relays breaks the circuits of their corresponding release magnets, which deenergize and restore the switches to normal position in readiness for another call.

Returning now to that part of the operation where the shaft and shaft wiper of the connector had been rotated to the called line, but the side switch had as yet not passed to the third position, had the called line been busy, the private wiper 80 would have found a ground upon the contact 159. As the rotary line relay 90 energizes for the last time, the private magnet energizes in the usual manner.

The energization of the private magnet this time, however, closes a circuit through the release magnet 88. This circuit extends from the ground at the private bank contact through the private wiper 80, side switch wiper 86 (in second position), springs 212 and 213, magnet 88 and springs 167 and 168 to the battery lead 139. The release magnet 88 energizes and restores the switch mechanism to normal position. Now, as the subscriber at substation A presses the button to ring, as before, the vertical magnet 81 is energized over the same circuit over which it was energized when the third digit was called. As soon as the shaft is raised one or more steps the arm 215 is also raised, which allows the spring 217 to engage the spring 216. A busy signal then extends to the calling subscriber over a circuit extending from the battery lead 139 through the secondary winding of the induction coil 218 of the busy signaling machine M, springs 216 and 217, side switch wiper 84 (in first position), ringer springs 177 and 179, thence over the heavy conductor, including the condensers 196 and 194, to and through the substation A, back over the heavy conductor, including the

condenser 193 of the repeater, through the relays 89 and 93 to battery. Upon hearing the busy signal the subscriber A places the receiver on the hook and thereby releases all of the apparatus used in the connection in the manner hereinbefore described.

From the foregoing it will be seen that means are provided for preventing further selection of switches on a board after and while all of the trunks leading therefrom are in use, and for diverting the incoming calls to some other switchboard. There are as many relays as there are trunks, and if all of these relays are energized the circuit of a certain other relay is energized, whereby a guarding potential is then established for all of the automatic switches which are idle, the number of automatic switches being greater than the number of trunks leading therefrom. In other words, when the trunks are all busy there is then an excess or surplus of switches, and means are provided for preventing connection with the said excess or surplus, and for diverting the connection to some other switchboard. Thus the second selectors are all common to the different subscribers, and at the same time the idle non-numerical switches that are temporarily unable to find an idle trunk are removed from the sphere of use, and are caused to remain in such condition until one or more of the trunks leading therefrom become idle. Furthermore, it will be seen that after the trunks of a certain switchboard, or of a certain group of non-numerical trunking switches, are all in use, the master switch controlling such group is then incapable of further operation, and remains so until one or more of the trunks over which it has control become idle. Two things follow, therefore, from the energizing of all of the relays which are individual to the different trunks, to-wit, a guarding potential is established for the remaining idle switches, and the master switch is prevented from operating to select a trunk—that is to say, it is so controlled that it cannot rotate or operate in any manner whatsoever. As soon as a trunk is released, however, the excess or surplus of switches then become accessible, and the master switch is again operative to select idle trunks. It will be observed that the said master switch is of the type in which idle trunks are selected ahead of the calls. In this way each calling subscriber obtains connection with a pre-selected trunk, and at the same time causes the master switch to select another trunk for the next calling subscriber. Each trunk lead- 125
tains a repeater, and a second selector is located at the end of each trunk. Each repeater is provided with means for controlling the two sides of a trunk in series to control the second selector at the other end thereof. The said repeater also exercises a

similar control over the connectors, which connectors are provided with means for bridging the common battery across the called line. The repeaters, it will be seen, are also provided with means for bridging the talking battery across the trunk to supply talking battery current to the calling sub-station. The selectors and connectors are known as numerical switches, and each one has motion first in one plane to select a group, and then in another plane at an angle thereto—that is to say, at an angle to the first plane—to find a line in the selected group. The selectors, of course, rotate automatically to automatically select an idle trunk in the predetermined group. Each connector rotates under direct control of the subscriber to find the called line in the predetermined group.

20 A numerical switch is, of course, one that operates in accordance with some digit of the called number. A non-numerical switch is one that performs a trunking operation without reference to the called number. As shown, the non-numerical trunking switches are interposed between the first and second selectors. The first selector operates in accordance with the first digit of the called number, and the second selector operates in accordance with the second digit thereof.

30 What I claim as my invention is:—

1. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit of the called number, and means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use.

2. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, and means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches.

3. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted when energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, and means for energizing a relay of said set each time a trunk is seized by a switch.

4. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches,

and electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use.

5. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, and means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said master switch.

6. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

7. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit of the called number, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

8. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

9. In a telephone system, a plurality of trunks, switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for automatically establishing a guarding potential for all idle switches after and while the trunks are all in use, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

10. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted when energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, means for energizing a relay of said set each time a trunk is seized by a switch, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

11. In a telephone system, a plurality of switchboards, trunks leading therefrom, means for automatically selecting idle switches on said boards, means automatically serving when the trunks on any board are all in use to divert the automatic selection to some other board, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

12. In a telephone system, a plurality of switchboards, trunks leading therefrom, switches on each board greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selection of idle switches on any board when all the trunks thereof are busy, there being trunk lines leading to said boards so disposed that any attempted selection of an idle switch on a board when all the trunks leading therefrom are busy will be diverted to another board, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

13. In a telephone system, a plurality of non-numerical trunking switchboards with trunks leading therefrom, means for extending calling connections to said boards, devices rendered operative only by the simultaneous use of all the trunks on any board to divert the calls to other boards, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

14. In a telephone system, a plurality of non-numerical trunking switchboards, the switches on any board being greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selection of idle switches on any board when the other switches and all the trunks are in use, there being trunk lines leading to said boards so arranged that the prevented selection will

be diverted to another board, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

15. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

16. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said master switch, a repeater in each trunk, and a second selector at the end of each trunk, each repeater adapted to control the two sides of its trunk to control the second selector thereof.

17. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

18. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit of the called number, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

19. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches, telephone lines, and means for controlling the two sides of a

calling telephone line to control said switches and extend the call to the called line.

20. In a telephone system, a plurality of trunks, switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for automatically establishing a guarding potential for all idle switches after and while the trunks are all in use, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

21. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted to be energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, means for energizing a relay of said set each time a trunk is seized by a switch, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

22. In a telephone system, a plurality of switchboards, trunks leading therefrom, means for automatically selecting idle switches on said boards, means automatically serving when the trunks on any board are all in use to divert the automatic selection to some other board, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

23. In a telephone system, a plurality of switchboards, trunks leading therefrom, switches on each board greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selection of idle switches on any board when all the trunks thereof are busy, there being trunk lines leading to said boards so disposed that any attempted selection of an idle switch on a board when all the trunks leading therefrom are busy will be diverted to another board, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches and extend the call to the called line.

24. In a telephone system, a plurality of non-numerical trunking switchboards, the switches on any board being greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selection of idle switches on any board when the other switches and all the trunks are in use, there being trunk lines leading to said boards so arranged that the

prevented selection will be diverted to another board, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches to extend the call to the called line.

25. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches to extend the call to the called line.

26. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said master switch, telephone lines, and means for controlling the two sides of a calling telephone line to control said switches to extend the call to the called line.

27. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit of the called number, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, telephone lines, a central source of talking and operating current, and connectors provided with means for bridging said source of current across any called telephone line.

28. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches, telephone lines, a central source of talking and operating current, and connectors provided with means for bridging said source of current across any called telephone line.

29. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted when energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, means for energizing a relay of said set each time a trunk is seized by

a switch, telephone lines, a central source of talking and operating current, and connectors provided with means for bridging said source of current across any called telephone line.

30. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use, telephone lines, a central source of talking and operating current, and connectors provided with means for bridging said source of current across any called telephone line.

31. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks, ahead of the calls for said trunking switches, means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said master switch, telephone lines, a central source of talking and operating current, and connectors provided with means for bridging said source of current across any called telephone line.

32. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

33. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit of the called number, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

34. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, means whereby the energizing of all of said relays

serves to automatically prevent further seizure of idle switches, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

35. In a telephone system, a plurality of trunks, switches for automatically connecting with idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for automatically establishing a guarding potential for all idle switches after and while the trunks are all in use, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

36. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted when energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, means for energizing a relay of said set each time a trunk is seized by a switch, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

37. In a telephone system, a plurality of switchboards, trunks leading therefrom, means for automatically selecting idle switches on said boards, means automatically serving when the trunks on any board are all in use to divert the automatic selection to some other board, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

38. In a telephone system, a plurality of switchboards, trunks leading therefrom, switches on each board greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selections of idle switches on any board when all the trunks thereof are busy, there being trunk lines leading to said boards so disposed that any attempted selection of an idle switch on a board when all the trunks leading therefrom are busy will be diverted to another board, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source

across the trunk thereof to supply talking current to the calling telephone line.

39. In a telephone system, a plurality of non-numerical trunking switchboards with trunks leading therefrom, means for extending calling connections to said boards, devices rendered operative only by the simultaneous use of all the trunks on any board to divert the calls to other boards, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

40. In a telephone system, a plurality of non-numerical trunking switchboards, the switches on any board being greater in number than the trunks leading therefrom, means for automatically selecting idle switches on said boards, means for preventing further selection of idle switches on any board when the other switches and all the trunks are in use, there being trunk lines leading to said boards so arranged that the prevented selection will be diverted to another board, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

41. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

42. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said master switch, telephone lines, a repeater in each trunk, and a central source of talking and operating current, each repeater provided with means for bridging said source across the trunk thereof to supply talking current to the calling telephone line.

43. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting idle switches in accordance with the first digit

of the called number, means serving automatically to prevent further seizure of idle switches after and while the trunks are all in use, a numerical switch for each trunk, and lines leading from each numerical switch, which lines are divided into groups, each numerical switch having motion in one plane to select a group and then in another plane at an angle to the first plane to find a line in the selected group.

44. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, means for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches, a numerical switch for each trunk, and lines leading from each numerical switch, which lines are divided into groups, each numerical switch having motion in one plane to select a group and then in another plane at an angle to the first plane to find a line in the selected group.

45. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk, relay mechanism adapted when energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, means for energizing a relay of said set each time a trunk is seized by a switch, a numerical switch for each trunk, and lines leading from each numerical switch, which lines are divided into groups, each numerical switch having motion in one plane to select a group and then in another plane at an angle to the first plane to find a line in the selected group.

46. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, electrically-controlled means automatically serving to prevent actuation of said master switch after and while all of said trunks are in use, a numerical switch for each trunk, and lines leading from each numerical switch, which lines are divided into groups, each numerical switch having motion in one plane to select a group and then in another plane at an angle to the first plane to find a line in the selected group.

47. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, means electrically controlled only by the simultaneous use of all said trunks to temporarily prevent further actuation of said

master switch, a numerical switch for each trunk, and lines leading from each numerical switch, which lines are divided into groups, each numerical switch having motion in one plane to select a group and then in another plane at an angle to the first plane to find a line in the selected group.

48. In a telephone system, a plurality of trunks, as many relays as there are trunks, a plurality of switches for automatically selecting idle trunks greater in number than said trunks, a master switch for automatically selecting idle switches, means for energizing a relay each time a trunk is selected, and means whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches, and likewise prevents further operation of said master switch.

49. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, a plurality of relays, one for each of said trunks, means for operating one of said relays whenever a trunk is seized, and means controlled by the energization of a plurality of said relays for preventing actuation of said master switch.

50. In a telephone system, a main switch, a non-numerical auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary switch busy to the main switch, said means including the auxiliary switch.

51. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary switch busy to the main switch, said means including a guarding potential circuit and the auxiliary switch.

52. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary switch busy to the main switch, said means including a guarding potential circuit allotted to said line and the auxiliary switch.

53. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary switch busy to the main switch, said means including a controlling magnet in said auxiliary switch.

54. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary

switch busy to the main switch, said means including a guarding potential circuit and a controlling magnet in said auxiliary switch.

55. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, and means for making said line busy to the auxiliary switch and for making said auxiliary switch busy to the main switch, said means including a guarding potential circuit allotted to said line and a controlling magnet in said auxiliary switch.

56. In a telephone system, a main switch, a non-numerical auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said last means including the auxiliary switch.

57. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to the main switch, said first means including a guarding potential circuit, said last means comprising the auxiliary switch.

58. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said first means comprising a guarding potential circuit allotted to said line, said last means including the auxiliary switch.

59. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said second means including a guarding potential circuit and the auxiliary switch.

60. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said first and second means each including a guarding potential circuit, the last means including also the auxiliary switch.

61. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said last means including a controlling magnet in said auxiliary switch.

62. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to the main switch, said first means including a guarding potential circuit, said last means including a controlling magnet in said auxiliary switch.

63. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said first means including a guarding potential circuit allotted to said line, said last means including a controlling magnet in said auxiliary switch.

64. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said second means including a guarding potential circuit and a controlling magnet in said auxiliary switch.

65. In a telephone system, a main switch,
an auxiliary switch accessible thereto, a line
accessible to said auxiliary switch, means for
making said line busy to the auxiliary
switch and means for making said auxiliary
switch busy to said main switch, said second
means including a guarding potential cir-
cuit allotted to said auxiliary switch and a
controlling magnet in said auxiliary switch.

66. In a telephone system, a main switch, an auxiliary switch accessible thereto, a line accessible to said auxiliary switch, means for making said line busy to the auxiliary switch and means for making said auxiliary switch busy to said main switch, said first and second means each including a guarding potential circuit, the last means including also a controlling magnet in said auxiliary switch.

switch.
67. In a telephone system, a main switch,
an auxiliary switch accessible thereto, a line
50 accessible to said auxiliary switch, means for
making said line busy to the auxiliary
switch and means for making said auxiliary
switch busy to said main switch, said first
means including a guarding potential cir-
55 cuit allotted to said line, and said second
means including a guarding potential cir-
cuit allotted to said auxiliary switch and a
controlling magnet in said auxiliary switch.

60 68. In a telephone system, a series of main switches, non-numerical auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy

to the series of main switches, said means 65 including the auxiliary switches.

69. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy to the series of switches, said means including guarding potential circuits and the auxiliary switches.

70. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy to the series of main switches, said means including guarding potential circuits allotted to said lines and the auxiliary switches.

71. In a telephone system, a series of main switches, non-numerical auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy to the series of switches, said means including magnets in said auxiliary switches.

72. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy to the series of main switches, said means including guarding potential circuits and controlling magnets in said auxiliary switches.

73. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, and means for making all of said lines busy to the auxiliary switches and for making said auxiliary switches busy to the series of main switches, said means including guarding potential circuits allotted to said lines and controlling magnets in said auxiliary switches.

74. In a telephone system, a series of main switches, non-numerical auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said last means including the auxiliary switches.

75. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means including guarding potential circuits, said last means including the auxiliary switches.

76. In a telephone system, a series of main

switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means including guarding potential circuits allotted to said lines, said last means including the auxiliary switches.

77. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said second means including guarding potential circuits and the auxiliary switches.

78. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means comprising the guarding potential circuits, and said second means including guarding potential circuits, the last means including also the auxiliary switches.

79. In a telephone system, a series of main switches, non-numerical auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches, and means for making said auxiliary switches busy to said series of main switches, said last means including controlling magnets in said auxiliary switches.

80. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches, and means for making said auxiliary switches busy to said series of main switches, said first means including guarding potential circuits, said last means including controlling magnets in said auxiliary switches.

81. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means including guarding potential circuits allotted to said lines, said last means including controlling magnets in said auxiliary switches.

82. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of

main switches, said second means including guarding potential circuits and controlling magnets in said auxiliary switches.

83. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said second means including guarding potential circuits allotted to said auxiliary switches and controlling magnets in said auxiliary switches.

84. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means including guarding potential circuits and second means including guarding potential circuits, the last means including also controlling magnets in said auxiliary switches.

85. In a telephone system, a series of main switches, auxiliary switches accessible thereto, lines accessible to said auxiliary switches, means for making all of said lines busy to the auxiliary switches and means for making said auxiliary switches busy to said series of main switches, said first means including a guarding potential circuit allotted to each line, and said second means including a guarding potential circuit allotted to each auxiliary switch and including also controlling magnets in said auxiliary switches.

86. In a telephone system, a plurality of trunks, a plurality of non-numerical switches for automatically connecting with idle trunks, greater in number than said trunks, first selectors for automatically selecting an idle one of said switches in accordance with the first digit of the called number, and electromagnets and circuits serving automatically to prevent further seizure of idle switches after and while the trunks are all in use.

87. In a telephone system, a plurality of trunks, a relay individual to each trunk, a plurality of switches for automatically selecting idle trunks, greater in number than said trunks, electrically controlled means for automatically selecting idle switches, circuits for energizing a relay each time a trunk is selected, and electromagnets and circuits whereby the energizing of all of said relays serves to automatically prevent further seizure of idle switches.

88. In a telephone system, a plurality of trunks, a plurality of switches for automatically connecting with idle trunks, greater in number than said trunks, a set of relays for said trunks, one for each trunk and individual thereto, relay mechanism adapted when

energized to establish a guarding potential for all idle switches, a circuit for said mechanism controlled by all relays of the set, and circuits for energizing a relay of said set each time a trunk is seized by a switch.

89. In a telephone system, a plurality of trunks, trunking switches, a master switch for selecting idle trunks for said switches, a relay for each trunk and individual thereto, and electromagnetic means controlled by said relays jointly to prevent actuation of said master switch after and while all of said trunks are in use.

90. In a telephone system, a plurality of trunks, non-numerical trunking switches with which said trunks are multiplied, a master switch for selecting idle trunks ahead of the calls for said trunking switches, electromagnetic means comprising a relay for each trunk and individual thereto controlled only by the simultaneous use of all of said trunks to temporarily prevent further actuation of said master switch.

91. In a telephone system, a plurality of groups of automatic switches, a group of trunk lines accessible to each group of switches, other automatic switches having access to said first switches, and means comprising trunk relays serving automatically when all the trunk lines in a particular group are busy to render the switches having access to such trunk lines busy also.

92. In a telephone system, a plurality of groups of secondary automatic switches, a group of trunk lines accessible to each group of secondary switches, groups of primary switches, the switches in each primary group having access to switches in each of said

secondary groups, and means comprising a relay for each trunk serving automatically when all the trunk lines accessible to a particular group of secondary switches are busy for rendering such group of secondary switches busy to said primary switches.

93. In a telephone system, a plurality of groups of trunk selecting switches, trunk lines leading into said groups, trunk lines leading out of said groups, means for selecting and seizing idle trunk lines leading into said groups, and means for preventing the seizure of an idle trunk leading into any particular group when all the trunk lines leading out of such group are busy, said last means comprising a set of chain relays for each group of outgoing trunks, and each chain comprising a relay for each trunk of the group.

94. In a telephone system, a plurality of groups of secondary switches and a group of trunk lines accessible to each group, groups of primary switches, the switches of each primary group having access to a switch in each secondary group, and means comprising trunk relays and a circuit controlled thereby serving automatically when all the trunk lines of a particular group are busy to render all the associated secondary switches busy also and to divert calls from said primary switch to another secondary switch board.

Signed by me at Chicago, Cook county, Illinois, this 30 day of Sept., 1910.

EDWARD A. MELLINGER.

Witnesses:

EDWARD D. FALES,
ARTHUR J. RAY.