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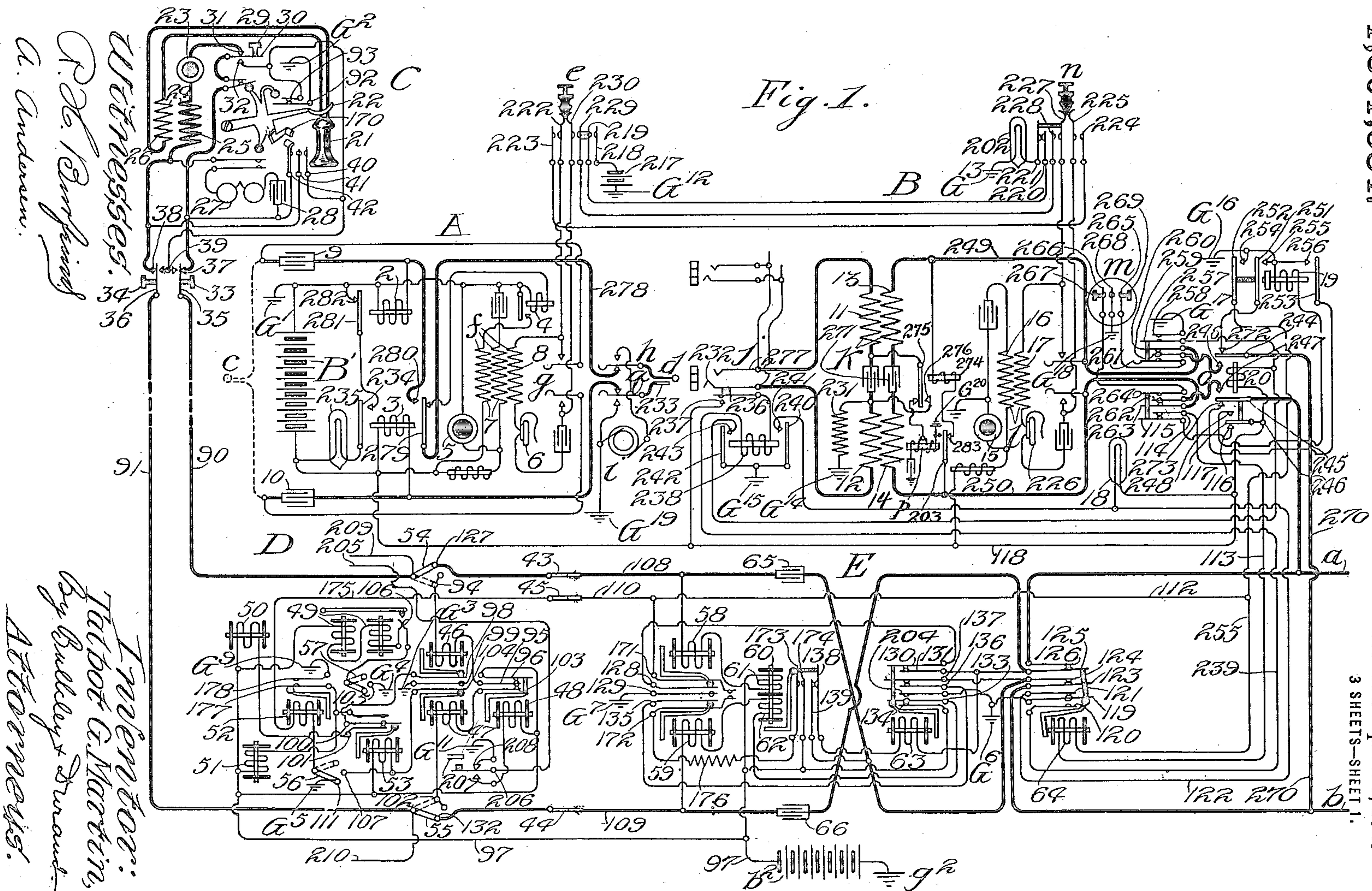
COMBINED AUTOMATIC AND MANUAL TELEPHONE SYSTEM.
APPLICATION FILED NOV. 14, 1906. RENEWED AUG. 1, 1918.

Patented Apr. 22, 1919.

3 SHEETS—SHEET 1.

T. G. MARTIN.

Fig. 1.



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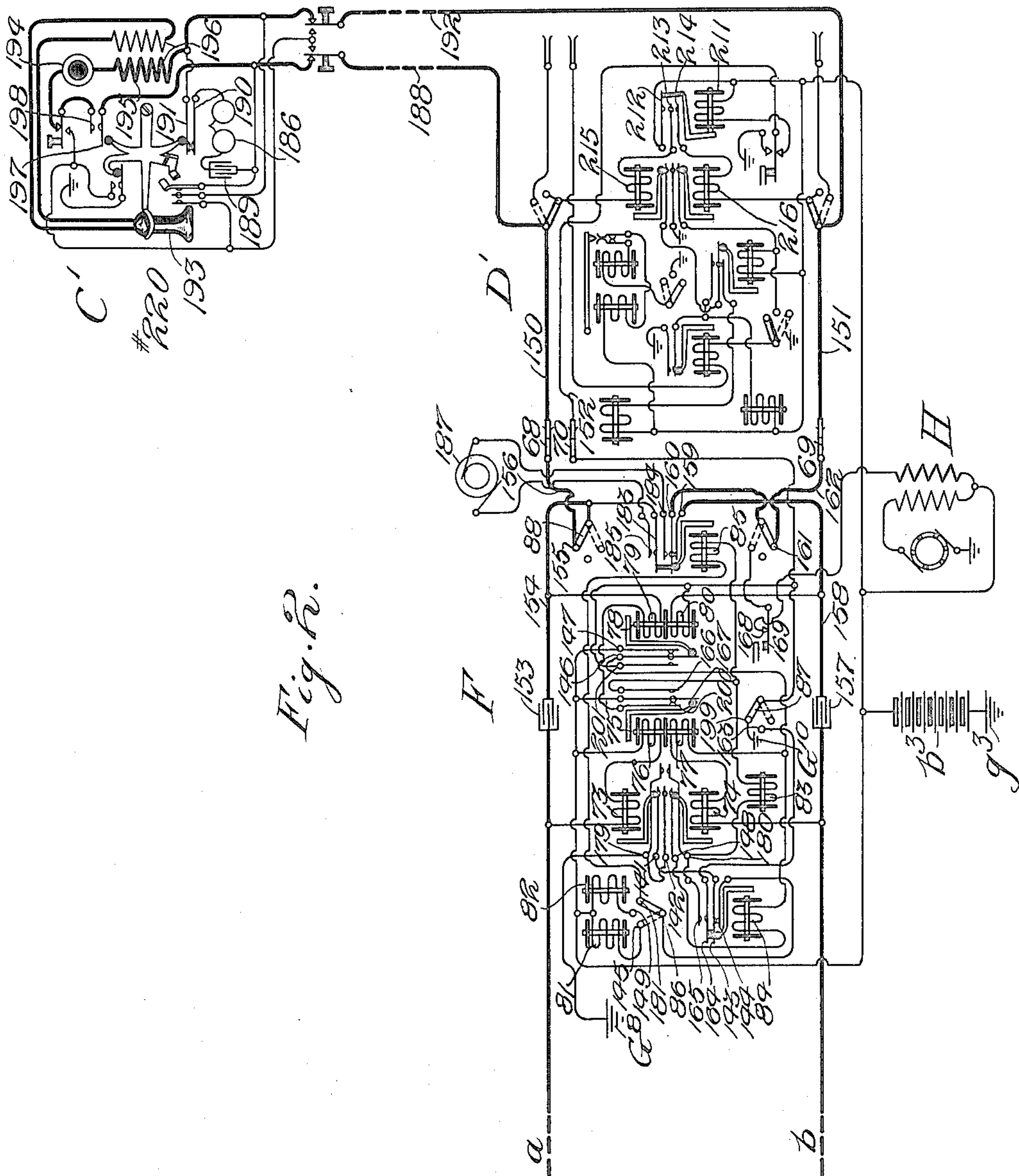


Fig. 2.

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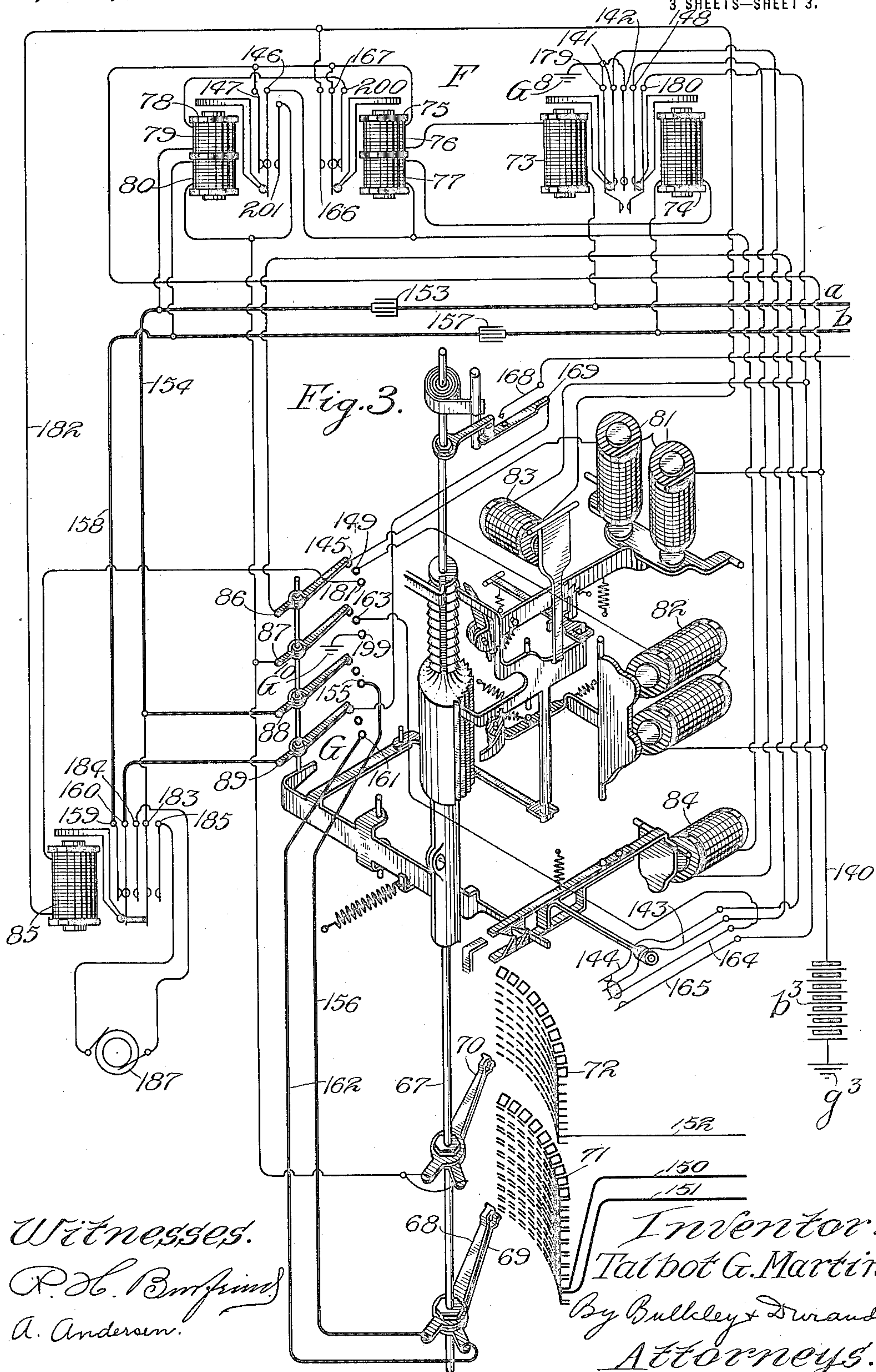
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3 SHEETS—SHEET 3.



UNITED STATES PATENT OFFICE.

TALBOT G. MARTIN, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
AUTOMATIC ELECTRIC COMPANY, A CORPORATION OF ILLINOIS.

COMBINED AUTOMATIC AND MANUAL TELEPHONE SYSTEM.

1,301,584.

Specification of Letters Patent.

Patented Apr. 22, 1919.

Application filed November 14, 1906, Serial No. 343,409. Renewed August 1, 1918. Serial No. 247,869.

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 Combined Automatic and Manual Telephone Systems, of which the following is a specification.

My invention contemplates a telephone system in which one and the same trunk line can be employed by either automatic or manual subscribers of one exchange for calling automatic subscribers of another exchange. It also contemplates certain novel features and details of construction and combinations by which said trunk line can be made busy when used by either automatic or manual calling subscribers for connecting with an automatic subscriber, so as to protect the same against seizure by other subscribers; by which the originating operator, when a manual subscriber calls an automatic subscriber of the other exchange, over said trunk line, has full supervision of the trunk connection thus established between her calling subscriber and the called subscriber of the other exchange; and by which the efficiency and service of a system of this particular character will be improved generally.

In the accompanying drawings, Figure 1 shows in diagram a section of one exchange comprising both manual and automatic apparatus. An ordinary line operator's two-strand cord circuit is shown at A and at B is shown a trunking operator's cord circuit embodying certain novel features. An automatic subscriber's station is shown at C, an automatic selector switch at D, and a repeater at E which also embodies certain novel features to be described.

Fig. 2 is a diagram representing a section of a second exchange comprising a common battery connector F, a called subscriber's selector at D', and a called automatic substation at C'. Between the exchanges #1 and #2, indicated in Figs. 1 and 2, respectively, there are provided trunk lines (only one of which is shown) comprising the conductors *a* and *b*, known as the vertical and rotary trunk connectors.

Fig. 3 is a perspective diagram of the connector.

The cord circuit at A is an ordinary and well-known line operator's cord circuit pro-

vided with an answering plug *c* and a calling plug *d*. A section of the said cord circuit, on the side of the answering plug, is omitted, as it is well understood by those skilled in the art. The section on the side of the calling plug *d* is shown in order that the details may be more readily understood. The said cord circuit A is provided with an order key *e* of a suitable or well-known design, whereby the operator at the cord circuit A may communicate with the trunking operator at the cord circuit B. Among the details shown in connection with the cord circuit A there are the tip and sleeve supervisory relays 2 and 3, the busy test relay 4, the operator's talking set comprising the transmitter 5, receiver 6 and induction-coil *f*, the latter having the primary winding 7 and the secondary winding 8. The operator's key is shown at *g* and the ringing key at *h*, used in connection with the ringer generator *i*. The tip and sleeve condensers 9 and 10 are also shown, which divide the cord circuit into two inductively united sections. The battery B' is shown for providing current to the manual subscribers and operators, and as having its positive terminal preferably grounded at G'.

The cord circuit B of the trunking operator has many of the well-known features of such a circuit, among which are the terminal jack *j* and the repeating coil *k* comprising the windings 11 and 12, and 13 and 14. It will be understood that the said jack is connected with the cord B by a trunk line running from the cord to the board or position of the originating operator. The trunking operator's talking set comprises the transmitter 15, the primary winding 16 and secondary winding 17 of the induction-coil *l*. There is also a supervisory lamp 18 for indicating not only when the cord B is in use, but also when the trunk line *a-b*, to which the said cord is allotted is being used by an automatic subscriber. There is, furthermore, an automatic calling set *m* for operating the automatic switches at exchange #2 (Fig. 2), a couple of auxiliary relays 19 and 20 which are used in supervision and in initiating a release of the automatic switches, and an alternating current relay *p* whereby, after the trunking operator B passes supervision to operator A, the latter may, by throwing ringing current out on the plug *d*, operate to ground.

the vertical trunk leading to the connector F and energize the ringer relay of the connector to signal the called subscriber. The said operator B is, of course, provided with a key *n* to correspond with the order wire key *e* of the operator A, whereby the operator at the cord circuit B may connect with the operator at A when a signal is sent over the order wire by the latter.

The automatic substation C may be of any known or approved type, and as shown comprises a receiver 21 and switch-hook 22, for controlling certain substation circuits, a transmitter 23, an induction-coil 24 having the primary and secondary windings 25 and 26, respectively, ringer 27 connected with a condenser 28, a signaling button 29 for controlling the spring 30 with respect to the contact points 31 and 32, a calling device comprising push-buttons 33 and 34, their respective allotted springs 35 and 36, and the contact points 37 and 38 and the ground post 39. For releasing the automatic apparatus after it has been put in use there are provided three release springs 40, 41 and 42. The calling device, although indicated in the apparatus above described, may be of any approved type, but for the purpose of disclosing the principles of my invention it will be sufficiently clear to represent the apparatus as described.

The selector switch D may also be of any known or approved type. In Fig. 1 a selector of the general type disclosed in Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson is shown. The switch-shaft is not indicated, but the switch-shaft wipers 43, 44 and 45 are shown, together with the vertical and rotary line relays 46 and 47, the bridge-cut-off relay 48, the rotary magnet 49, the vertical magnet 50, the release magnet 51, back-release relay 52, the private magnet 53, and the side switch comprising the side switch wipers 54, 55, 56 and 57.

The repeater E is a switching device allotted to the trunk line which is accessible from both a selector D and the trunking operator's circuit B, and as shown is inserted between the selector bank terminals which the switch-shaft wipers 43, 44 and 45 engage and the interexchange trunk line conductors *a* and *b*. It comprises a couple of line relays 58 and 59, a differential relay 60 with a couple of windings 61 and 62, and two additional auxiliary relays 63 and 64 for controlling certain circuits to be described. The main circuit that passes through the repeater E is divided into two sections, very much like the operator's cord circuit A, by a couple of condensers 65 and 66.

The connector F, shown in Figs. 2 and 3, is an improvement on the connector disclosed in United States Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and

Erickson, being an adaptation of the connector shown in said patent to common battery work, and comprises the well-known switch-shaft 67, switch-shaft wipers 68, 69 and 70, the line and private banks 71 and 72, the vertical and rotary line relays 73 and 74, differential relay 75 having windings 76 and 77, and back-bridge relay 78, the latter being double-wound and comprising the windings 79 and 80. The vertical magnet 81 and rotary magnet 82, which are controlled by the vertical and rotary line relays 73 and 74, are used respectively for operating the switch-shaft 67 in a vertical direction and in a rotary direction. The release magnet 83 constitutes part of the means by which the switch is restored. There are in addition the private magnet 84 and the ringer relay 85, both of which are well known. The private magnet operates to control the side switch G while the switch is being used for calling. Said side switch comprises the usual side switch wipers 86, 87, 88 and 89.

Since the selector D' and the substation C' are duplicates of the selector D and the substation C, respectively, no further explanation is required with respect to the construction thereof. By following up the operations of this system when one subscriber calls another, the circuits will be more clearly understood. These operations are as follows:

The operation whereby one automatic subscriber calls another automatic subscriber does not require the assistance of a manual operator; but when a manual subscriber wishes to call an automatic subscriber it is otherwise. For example, if the automatic subscriber at substation C wishes to call the automatic subscriber at substation C', which will be designated as substation #220, he does so of his own accord by operating his calling device in such a manner that the vertical and rotary line conductors 90 and 91 are grounded in accordance with the digits of the called number. For example, for the digit 2 the vertical button 33 is pressed twice, whereby the vertical line conductor 90 is grounded twice and the rotary button 34 is, after that, pressed once for grounding the rotary line conductor 91. The same operation is repeated with respect to the second digit 2, and also with respect to the digit 0, with the exception that the vertical button 33 is pressed ten times in the last case.

The first digit being 2 the subscriber, after removing his receiver 21 from the switch-hook 22 and thus closing connection between the substation ground G² and the ground post 39, by causing the ground springs 92 and 93 to engage in contact, presses the vertical button 33 twice, grounding the vertical line conductor 90 twice

through the substation ground G^2 , as previously stated. As a result the vertical line relay 46 of the selector D is energized, which latter in turn causes the energization of the vertical magnet 50 for operating the selector switch-shaft, whereby the switch-shaft wipers 43, 44 and 45 are carried opposite the first contact of the second level of the selector line and private banks (not shown), which level comprises the contacts with which the said wipers are shown engaged in Fig. 1. The energizing circuit for the vertical line relay 46 extends from the substation ground G^2 through the ground springs 92 and 93 to the ground post 39, thence to the vertical line conductor 90, through the side switch wiper 54, contact point 94 to the vertical line relay 46, thence through the bridge-cut-off relay springs 95 and 96 to the battery lead 97, and through battery b^2 to ground g^2 . The energizing circuit which is established through the vertical magnet 50 when the vertical line relay 46 energizes and presses the line relay springs 98 and 99 into contact is as follows: From ground G^3 through the springs 99 and 98, through the private springs 100 and 101 to the vertical magnet 50, thence to the battery lead 97 and through battery b^2 to ground g^2 . After the selector D has thus been operated, when the subscriber presses the rotary button 34 once and grounds the rotary line conductor 91 he in turn energizes the rotary line relay 47 of the selector D by a flow of current from the substation ground G^2 to the ground post 39, rotary line conductor 91, side switch wiper 55, contact point 102, rotary line relay 47, bridge-cut-off relay springs 103, 95 and 96 to the battery lead 97, thence through battery b^2 to ground g^2 . The rotary line relay 47 upon energizing carries the line relay spring 104 onto the spring 99, thereby energizing the private magnet 53 once by a flow of current from ground G^3 through the springs 99 and 104 to the private magnet 53, thence through said magnet to battery lead 97, and through battery b^2 to ground g^2 . The private magnet upon energizing and de-energizing permits the side switch to pass to second position, thus causing the side switch wiper 57 to engage the grounded contact point 105. As a result a flow of current is sent through the rotary magnet 49 from ground G^4 to the contact point 105, thence through the side switch wiper 57, rotary magnet interrupter springs 106, rotary magnet 49 to the battery lead 97, and through battery b^2 to ground g^2 . The rotary magnet 49 is energized to carry the shaft wipers 43, 44 and 45 into engagement with the first contact of the second level of their respective banks. If the trunk line leading from the said first set of contacts is not busy the rotary magnet, when it reaches the limit of its stroke, trips the side switch

so that it may pass to third position, thus permanently breaking the energizing circuit for the rotary magnet 49 when the side switch wiper 57 leaves the grounded contact point 105. But if the first trunk line is busy the private wiper 45 meets a grounded contact point and an energizing circuit is set up through the private magnet 53 for re-energizing said magnet while the side switch is in second position, for the purpose of locking the side switch in said second position until the wipers are carried beyond the busy contact or contacts, as the case may be. This energizing circuit for the private magnet extends from the grounded private bank contact to the private wiper 45, thence through the back-release relay 52 of the selector D to the side switch wiper 56, contact point 107, private magnet 53 to the battery lead 97, and through battery b^2 to ground g^2 . Therefore the interrupter comprising the interrupter springs 106 at the rotary armature 49 produces a series of impulses for operating the rotary magnet 49 in a step-by-step manner to advance the wipers 43, 44 and 45 as the private wiper 45 continues to meet grounded or busy private contact points; but when the last one is passed, the private magnet 53 re-energizes and the side switch is permitted to pass to third position, thus destroying the established energizing circuit for the rotary magnet 49. Assuming that the selector D operates to carry the line wipers 43 and 44 into engagement with the vertical and rotary trunk conductors 108 and 109, and the private wiper 45 into engagement with the trunk-release conductor 110, when the selector comes to a standstill the subscriber's line conductors 90 and 91 will have been placed in connection with the repeater E and a guarding potential established at all points from which the repeater E may be seized, to prevent any interferences. The establishment of said guarding potential occurs when the side switch wiper 56 of the selector D engages the grounded contact point 111, thus placing the private wiper 45 in direct connection with the side switch ground G^5 . A guarding potential thus established is communicated to all selector private bank contacts that are connected in multiple with the trunk-release conductor 110, and a flow of current is also sent through the auxiliary relay 64 at the repeater E, whereby the lamp 18 at the cord circuit B is lighted. The circuit for energizing the supervisory relay 64 may be traced from the private wiper 45 to the trunk-release conductor 110, thence through the conductor 112 to the supervisory relay 64, conductor 113, springs 114 and 115 at the trunk operator's key ϕ , contact point 116, armature 117 of the relay 20 to the battery lead 118, thence through battery B' to ground G' . The said

relay 64 upon energizing accomplishes the following results: It shifts the spring 119 from the spring 120 and into engagement with the spring 121, whereby the circuit
 5 through the lamp 18 is established from ground G^6 through the springs 119 and 121, conductor 122, through the lamp 18 to the battery lead 118, and through battery B' to ground G' . Any operator at the cord circuit B will understand that as soon as the
 10 lamp 18 is lighted that trunk is not to be assigned to anyone. When the auxiliary relay 64 at the repeater E energized, in addition to performing the operation that has already
 15 been explained, the vertical and rotary trunk conductors 108 and 109 are connected to the rotary and vertical outgoing trunk conductors b and a by the closure of contact between the springs 123 and 124 on one side,
 20 and the springs 125 and 126 on the other side.

The second digit being 2 also, the subscriber proceeds, as before, to operate the vertical and rotary buttons 33 and 34, again
 25 grounding the vertical and rotary line conductors 90 and 91. Grounding the former twice energizes the vertical line relay 58 and the differential relay 60 at the repeater E, the said relay 58 and the winding 61 of the
 30 said differential relay 60 being in series. The current flows from substation ground G^2 to the vertical line conductor 90, thence to the side switch wiper 54 of the selector D, contact point 127, vertical line wiper 43,
 35 vertical trunk conductor 108, vertical line relay 58, winding 61 of the differential relay 60 to the battery lead 97, thence through battery b^2 to ground g^2 . Each time that the vertical line relay 58 energizes, the springs
 40 128 and 129 are brought into engagement, whereby a ground impulse is delivered to the outgoing vertical trunk conductor a from ground G^7 at the repeater E, through the springs 129 and 128 and through the springs
 45 130 and 131 of the auxiliary relay 63 to the springs 125 and 126 of the auxiliary relay 64, thence to the outgoing vertical trunk conductor a . The impulses delivered to said conductor a are received at the connector F and the effect will be considered
 50 hereinafter. The grounding of the rotary line conductor 91 by the subscriber energizes in turn the rotary line relay 59 at the repeater E and also the differential relay 60. The energizing current flows from the sub-
 55 station ground G^2 to the rotary line conductor 91, thence to the side switch wiper 55 of the selector D to the contact point 132, to the rotary line wiper 44, thence through the rotary line relay 59 and winding 62 of the
 60 differential relay 60 to the springs 133 and 134 of the auxiliary relay 63, and to the battery lead 97, thence through battery b^2 to ground g^2 . The rotary line relay upon energizing forces the line relay spring 135 onto

the ground spring 129, thereby sending a ground impulse to the rotary trunk conductor b from ground G^7 at the repeater E through the springs 129 and 135, through the
 70 springs 136 and 137 of the auxiliary relay 70 63, and through the springs 124 and 123 of the relay 64 to the said trunk conductor b . The said rotary impulse is also directed to the connector F and will be considered. During the operation of the vertical and
 75 rotary line relays 58 and 59 of the repeater E, the differential relay 60 has been energized each time and the differential relay springs 138 and 139 have been separated each time in order to prevent the impulses delivered to either of the outgoing trunk con-
 80 ductors a or b from passing to the other through the auxiliary relay 63, since there is a normal circuit between the said trunk conductors a and b by way of the relay 63 85 and the differential relay springs 138 and 139, as shown. It is, therefore, necessary, if it is desired to ground only one of the trunk conductors a or b at a time, that
 90 whenever the repeater E is used for such purpose the differential relay 60 be energized to prevent the impulses from crossing from one side to the other. Considering now the effect of the impulses to the trunk
 95 conductors a and b individually, it will be explained that first the connector switch-
 100 shaft is raised and next the side switch is tripped to second position by the impulses that have been delivered, corresponding to the second digit 2. The vertical line relay 100
 of the repeater E was operated twice and two impulses were delivered to the vertical trunk conductor a from the repeater ground G^7 . These impulses continue over the vertical
 105 trunk conductor a to the vertical line relay 73 (Fig. 3) of the connector F, thence through the winding 76 of the differential relay 75 to the battery lead 140, and through battery b^3 to ground g^3 . In this case not
 110 only the vertical line relay 73 but the differential relay 75 also energizes, the latter to no effect as yet. When the vertical line relay 73 energizes, the springs 141 and 142 then engage, establishing a circuit through
 115 the vertical magnet 81 from ground G^8 115 through the springs 142 and 141, through the private springs 143 and 144 to the side switch wiper 86, thence to the contact point 145 and through the vertical magnet 81 to
 120 the battery lead 140, thence through battery b^3 to ground g^3 . The vertical magnet 81 attracts its armature and raises the shaft 67 two steps, lifting the wipers 68, 69 and 70 opposite the first contact of the second level
 125 of the line and private banks 71 and 72. By grounding the rotary line conductor 91 the rotary line relay 59 of the repeater E was energized, as described, the said relay in turn delivering a ground impulse to the rotary
 130 trunk conductor b from the repeater ground

G⁷ to the said conductor. The said impulse continues to the connector rotary line relay 74, thence through said relay and through the winding 77 of the differential relay 75 to the back-bridge relay springs 146 and 147, thence to the battery lead 140, and through battery *b*³ to ground *g*³. The differential and rotary line relays 75 and 74 energize, but the former to no effect, while the latter in pressing the springs 148 and 142 into contact energizes the private magnet 84, which latter then permits the side switch G to pass to second position. The circuit through the private magnet extends from the connector ground G⁸ through the said springs 142 and 148, thence through the private magnet 84 and through the springs 146 and 147 of the back-bridge relay 78 to the battery lead 140, and through battery *b*³ to ground *g*³.

The third digit being 0, after the connector side switch passes to second position the subscriber at the substation C operates his calling device in accordance with the said third digit of the desired number. The vertical line conductor 90 is grounded ten times, the vertical line relay 58 of the repeater is energized ten times, and as a result the vertical trunk conductor *a* is grounded ten times and, therefore, the vertical line relay 73 of the connector F ten times. Since the connector side switch G is now in second position and the side switch wiper 86 is in engagement with the contact point 149, the operation of the said vertical line relay 73 affects the rotary magnet 82, instead of the vertical magnet 81 as in the previous instance. The said rotary magnet is energized by a current-flow from the connector ground G⁸ through the springs 142 and 141, private springs 143 and 144 to the side switch wiper 86, thence to the contact point 149 and through the rotary magnet 82 to the battery lead 140, thence through battery *b*³ to ground *g*³. The rotary magnet then operates to rotate the switch-shaft 67 ten steps, carrying the wipers 68, 69 and 70 into engagement with the tenth terminal of the second bank level and, therefore, into engagement with the normal line conductors 150 and 151, and with the private normal conductor 152, the line wipers with the former set, and the private wipers with the latter. The said normal line conductors 150 and 151 extend through the selector D' to the called subscriber's station #220, but the private normal conductor 152 terminates in the said selector D'. When the subscriber grounds the rotary line conductor 91 for the last time the rotary line relay of the repeater E is energized, delivering a ground impulse to the rotary trunk conductor *b* as before. The effect of this impulse may produce either one of two results, namely the busy release of the connector switch if the

desired line is busy, or the release of the connector side switch to third position and, therefore, the final connection between the calling and called subscribers' lines if said called line is not busy. It will first be considered how the connection is established. If the line is not busy the ground impulse delivered to the rotary trunk conductor *b* is sent through the rotary line relay 74 of the connector over circuits that have already been described, which relay in turn energizes the private magnet 84 again, tripping the side switch G into third position at the instant that the private magnet 84 deenergizes. The subscriber's extended line conductors *a* and *b* are thus placed in connection with the normal or called subscriber's extended conductors 150 and 151 over the following path: From the conductor *a* through the condenser 153, conductor 154, side switch wiper 88, contact point 155, conductor 156, vertical line wiper 68 to the vertical normal conductor 150. The rotary trunk conductor *b* is connected through the condenser 157, conductor 158, ringer relay springs 159 and 160 to the side switch wiper 89, contact point 161, conductor 162, rotary line wiper 69 to the rotary normal conductor 151. Furthermore, when the side switch passes to third position the side switch wiper 87 engages the grounded contact point 199, establishing a guarding potential at all contacts connected to the private normal conductor 152. Furthermore, the said guarding potential sets up a flow of current through the bridge-cut-off relay 211 of the called selector D', through the said relay to the non-grounded terminal of battery *b*³, whereby the line relays 215 and 216 are disconnected from across the conductors 150 and 151. Assuming now that the desired line is busy, there will, of course, be found a guarding potential at the private normal conductor 152, for the same reasons described in the matter immediately preceding, which guarding potential appears at all private bank contacts connected to the said conductor 152. The private wiper 70 has already been carried into engagement with the said grounded conductor 152 by the rotation of the shaft 67, as already explained, and since the side switch is in second position and the side switch wiper 87, therefore, in engagement with the contact point 163, the private magnet spring 164, which is connected with the private wiper 70, is also provided with the guarding potential with which the private normal conductor 152 is charged. It will be noticed, furthermore, that the adjacent private magnet spring 165 is connected with the release magnet 83, which latter is in turn connected with the differential relay spring 166 and adapted to be connected with the non-grounded terminal of battery *b*³ when the differential

relay 75 is energized. Therefore, when the last rotary impulse comes in and the rotary line relay 74 energizes the private magnet 84, as described, the said private springs 164 and 165 are brought into engagement and the differential relay springs 166 and 167 also come into engagement, since the said differential relay is energized in series with the rotary line relay 74, and as a result a flow of current is sent through the release magnet 83. The current flows from the said grounded private contact to the private wiper 70, thence through the side switch wiper 87, contact point 163, private springs 164 and 165 to the release magnet 83, thence through the differential relay springs 166 and 167 to the battery lead 140, and through battery b^3 to ground g^3 . The release magnet upon energizing restores the switch-shaft 67 and also the side switch G. Therefore, when the subscriber presses his signaling button 31 and grounds the vertical line conductor 91 by carrying the spring 30 onto the grounded contact point 32, the vertical line relay 73 at the connector F is energized and the vertical magnet 81 operated to raise the switch-shaft. As soon as this occurs the switch-shaft springs 168 and 169 close and a busy signaling circuit is established through the calling subscriber's station, for notifying the said subscriber that the desired line is busy. This busy current flows from any suitable busy machine H to the springs 168 and 169, thence through the side switch wiper 89, ringer relay springs 160 and 159, condenser 157, trunk conductor b , relay springs 123 and 124 at the repeater E, condenser 65 to the subscriber's vertical line conductor 90, thence through the transmitter 23 and primary winding 25 to the rotary line conductor 91 and to the condenser 66 at the repeater E, thence through the relay springs 125 and 126 to the vertical trunk conductor a , through the vertical line relay 73 and winding 76 of the differential relay 75 to the battery lead 140 and back to the busy machine H. The busy current in passing through the primary winding 25 of the induction-coil 24 induces a similar current in the secondary winding 26, which current in passing through the receiver 21 is heard by the subscriber. The subscriber understanding that the line is busy hangs up his receiver 21, which causes the switch-hook 22 to descend, and the cam arm 170 of the latter engages the release spring 42 and presses it onto the springs 41 and 40, whereby simultaneous ground impulses are delivered to the vertical and rotary line conductors 90 and 91 for releasing the switching apparatus. The ground circuit to the said line conductors extends from the substation ground G^2 to the ground release spring 40, thence to the release springs 41 and 42 to the vertical and rotary line conductors 90 and 91. As a result of grounding the said line conductors the vertical and rotary line relays 58 and 59 and the differential relay 60 of the repeater E become energized simultaneously, with the following results: The outgoing vertical and rotary trunk conductors a and b are grounded simultaneously over circuits already described; the trunk-release springs 171 and 172 of the repeater E are brought into contact, and the differential relay springs 173 and 174 are brought into contact at the same time. The effect of grounding the outgoing trunk conductors a and b simultaneously will presently be considered. The effect of the closure of contact between the trunk-release springs 171 and 172 at the same time that the differential relay springs 173 and 174 close contact is to establish an energizing circuit with the back-release relay 52 of the selector D. The path of the current can be followed from ground G^5 at the side switch of the selector D to the side switch wiper 56, back-release relay 52, conductor 175, private wiper 45, trunk-release springs 171 and 172, resistance-coil 176, differential relay springs 173 and 174 to the battery lead 97, and through battery b^2 to ground g^2 . The back-release relay 52 of the selector D upon attracting its armature presses the back-release relay springs 177 and 178 together, energizing the release magnet 51 from ground G^6 through the springs 178 and 177 to the release magnet 51, thence to the battery lead 97 and through battery b^2 to ground g^2 . The release magnet 51 then attracts its armature and remains energized until the substation release springs 40, 41 and 42 separate, in readiness to release the switch at such a time. The simultaneous grounding of the trunk conductors a and b , when the repeater line relays 58 and 59 are simultaneously energized, produces in turn the energization of the vertical and rotary line relays 73 and 74 of the connector F and of the differential relay 75 over circuits that have already been pointed out. As a result the trunk-release springs 179 and 180 controlled by the line relays 73 and 74 are brought into contact at the same time that the differential relay springs 166 and 167 are in engagement. Therefore, the release magnet 83 of the connector F is energized by a flow of current from ground G^8 through the trunk-release springs 179 and 180 to the release magnet 83, thence through the differential relay springs 166 and 167 to the battery lead 140, and through battery b^3 to ground g^3 . The release magnet upon attracting its armature releases the connector switch-shaft and side switch, and the magnets remain energized until the release springs at the substation separate. As soon as the said springs separate, the line relays

58 and 59 and the differential relay 60 at the repeater E deenergize, destroying the trunk-release circuit through the back-release relay 52 of the selector D and removing the ground connections from the vertical and rotary trunk conductors *a* and *b*. The latter result produces a deenergization of all of the energized magnets in the connector switch F, whereby all the magnets of said switch are restored. The removal of the energized circuit through the back-release relay 52 of the selector D produces a deenergization of said relay, which in turn produces the deenergization of the release magnet 51 and a restoration of the selector switch.

Returning to that point where the automatic subscriber established connection with the desired subscriber, as explained, it will now be described how the called subscriber is signaled by the calling subscriber.

To signal, the calling subscriber presses his signaling button 29 and grounds the vertical line conductor 90, as already explained. As a result the vertical line relay 73 of the connector F and the differential relay 75 energize simultaneously, the former pressing the springs 141 and 142 into contact, and the latter pressing the springs 166 and 167 into contact. As a result the ringer relay 85 becomes energized by a flow of current from round G^8 through the springs 142 and 141, and through the private springs 143 and 144 to the side switch wiper 86, thence through the contact point 181, ringer relay 85, conductor 182, differential relay springs 166 and 167 to the battery lead 140, and through battery b^3 to ground g^3 . The ringer relay 85 then attracts its armature and carries the springs 160 and 183 onto the ringer springs 184 and 185. A signaling current is then sent through the ringer 186 at the substation #220 from the ringer generator 187 to the ringer relay spring 185, thence to the spring 183, side switch wiper 88, contact point 155, vertical line wiper 68, vertical normal conductor 150, vertical line conductor 188, through the condenser 189 and ringer 186 to the springs 190 and 191, thence to the rotary line conductor 192, rotary normal conductor 151, rotary line wiper 69, contact point 161, side switch wiper 89, ringer relay springs 160 and 184 to the ringer generator 187. The subscriber, upon hearing his bell 186 ring, removes his receiver 193, thereby breaking the circuit through the ringer 186 and bridging across the line, instead, the transmitter 194 and the primary winding 195 of the induction-coil 196 when the springs 197 and 198 close in contact. As soon as the said circuit is closed the back-bridge relay 78 at the connector F is energized by a flow of current from the connector side switch ground G^{10} to the contact point 199, side switch wiper 87, through the

winding 80 of the said relay 78, and through the ringer relay springs 159 and 160 to the side switch wiper 89, contact point 161, rotary line wiper 69, rotary normal conductor 151, rotary line conductor 192, primary winding 195, transmitter 194, primary circuit springs 198 and 197 to the vertical line conductor 188, vertical normal conductor 150, vertical line wiper 68, contact point 155, side switch wiper 88, winding 79 of the relay 78, and through the differential relay springs 200 and 167 that are normally in contact to the battery lead 140, thence through battery b^3 to ground g^3 . The called subscriber is thus provided with talking battery current upon answering, and at the same time energizes the back-bridge relay 78 to provide the calling subscriber with talking battery current. The latter circuit is established as soon as the back-bridge relay 78 presses the springs 146 and 201 into engagement and energizes the pole-changing relay 63 at the repeater E. The current flows from the connector side switch ground G^{10} to the contact point 199 and side switch wiper 87, thence through the said back-bridge relay springs 201 and 146 and through the winding 77 of the differential relay 75 and the rotary line relay 74 to the rotary trunk conductor *b*, thence through the springs 123 and 124 of the relay 64 at the repeater E, thence through the springs 139 and 138 of the differential relay 60 to the pole-changing relay 63, springs 125 and 126 of the auxiliary relay 64 to the vertical trunk conductor *a*, thence through the vertical line relay 73 at the connector F, and through the winding 76 of the differential relay 75 to the battery lead 140, thence through battery b^3 to ground g^3 . Not only does the pole-changing relay 63 energize in this circuit, but the line relays 73 and 74 of the connector F energize also, and the trunk-release springs 179 and 180 are brought into engagement; but the release of the connector does not occur, because the differential relay 75 does not energize, since the current through the windings 76 and 77 of the said relay is passing in such a manner as to render the magnetic force of no effect. When the pole-changing relay 63 at the repeater E energizes, the connection between the line relay springs 128 and 135 and the respective vertical and rotary trunk conductors *a* and *b* is broken, when the springs 130 and 131 and the springs 137 and 136 separate. Furthermore, when the spring 133 shifts away from the spring 134 and into engagement with the spring 204, a circuit is established through the transmitter 33 of the calling subscriber for providing the said subscriber with talking battery current. The circuit extends from ground G^8 through the springs 204 and 133, winding 62 of the differential relay 60, rotary line relay 59 to the rotary

line conductor 91, thence through the primary winding 25 and transmitter 23 at the substation C to the vertical line conductor 90, thence to the vertical line relay 58 of the repeater E, and through the winding 61 of the differential relay 60 to the battery lead 97, thence through battery b^2 to ground g^2 . The subscribers after being thus provided with talking battery current may communicate with each other over the heavily marked conductors between the substations C and C' (shown in Figs. 1 and 2), namely the conductors 90 and 91, and through the condensers 65 and 66 at the repeater E, vertical and rotary trunk conductors a and b , condensers 153 and 157 at the connector F to the vertical and rotary line conductors 188 and 192 of the called subscriber's line. It will be understood, of course, that the calling subscriber's line is protected against interference by other subscribers who might attempt to connect with his line while he is busy, by a guarding potential that is established by way of the private normal conductor 205 of the selector D to the connector banks, which conductor 205 is directly connected to the switch-shaft spring 206. When the switch-shaft rises the normal post arm 207 on said shaft, upon rising, permits the spring 206 to engage the grounded contact point 208, thus establishing a guarding potential from ground G^{11} . When the switch is in normal position, however, the subscriber at the substation C may be called by any other automatic subscriber over the normal line conductors 209 and 210, just as the subscriber #220 is called over the normal conductors 150 and 151. The called subscriber is, of course, protected by a guarding potential that appears at the private wiper 70 when the side switch wiper 87 passes to third position and engages the grounded contact point 199. This guarding potential appears at the private normal conductor 152 and at all private bank contacts connected in multiple therewith. Said guarding potential not only prevents interference from other subscribers, but also causes the energization of the bridge-cut-off relay 211 at the called selector D', whereby the bridge-cut-off relay springs 212, 213 and 214 are separated for disconnecting the line relays 215 and 216 from across the line and for disconnecting them also from the battery b^3 . After the subscribers are through talking the connection may be destroyed by the calling subscriber when he hangs up his receiver and grounds the vertical and rotary line conductors 90 and 91 simultaneously. The circuits involved in the release after the called subscriber has answered are a trifle different from those involved before the subscriber has answered, or at any time when the switch-hook of said called subscriber is in normal position. Since the calling sub-

scriber's transmitter is provided with talking battery current through the line relays 58 and 59 of the repeater E, as described, the said relays, like the relays 73 and 74 of the connector F, are energized during talking; but the differential relay 60 does not energize for obvious reasons. Therefore, since the extended end of the rotary line conductor 91 is grounded at ground G^6 while the subscribers are talking, when the release comes in and the said rotary line conductor 91, together with the vertical line conductor 90, is grounded, the rotary line relay 59 at the repeater E and the winding 62 of the differential relay 60 are short-circuited through ground between the ground terminals G^6 at the repeater E and G^2 at the substation C. Therefore, the flow of current through said windings is cut off and the differential relay 60 energizes. When the said relay energizes, the differential relay springs 138 and 139 are separated, so that the circuit of the pole-changing relay 63 is broken and the said relay returns to normal condition. As a result the springs 130 and 131 will engage, and also the springs 136 and 137, and furthermore the spring 133 leaves the ground spring 204 and returns into engagement with the spring 134. The rotary line conductor 91 being still grounded, the rotary line relay 59 is now reenergized, and a flow of current is set up through the winding 62 of the differential relay 60 in a reverse direction from the original current flowing therein, so that the already energized differential relay is further strengthened. As the rotary line relay 59 energizes, the trunk-release springs 171 and 172 come into contact while the differential relay springs 173 and 174 are in engagement. Therefore, the trunk-release circuit through the back-release relay 52 of the selector D is established, as already explained, with the results already pointed out. The energizing circuit for the pole-changing relay 63 at the repeater E being destroyed when the differential relay 60 is energized, as explained, the vertical and rotary line relays 73 and 74 of the connector F also deenergize for a moment, since said relays 63, 73 and 74 are in a series circuit, as explained; but as soon as the connection is reestablished between the line relay springs 128 and 135 of the repeater E and the trunk conductors a and b , respectively, when the relay 63 deenergizes and the rotary line relay 59 of the repeater reenergizes, as explained, the trunk conductors a and b are grounded simultaneously, as in the previous instance and, therefore, the line relays 73 and 74 of the connector F reenergize, carrying the trunk-release springs 179 and 180 into contact, and the differential relay 75 is also energized. The result is that the connector release magnet 83 is operated, as before, and the con-

nector switch-shaft and side switch are re-
 stored. The connection is therefore broken
 between the switch-shaft wipers and the
 normal conductors 150, 151 and 152, where-
 5 by a disconnection is obtained from the
 called line and the energizing circuit
 through the bridge-cut-off relay 211 of
 the selector D' is also destroyed, whereby
 the said relay deenergizes, permitting the
 10 bridge-cut-off relay springs 212, 213 and 214
 to reengage. As soon as the substation re-
 lease springs 40, 41 and 42 separate, the full
 restoration of the switching apparatus then
 follows, as already explained. Of course,
 15 in every instance of a release, when the con-
 nection is broken between the selector D and
 the repeater E, the auxiliary relay 64 de-
 energizes and the supervisory lamp 18 at
 the cord circuit B goes out as a signal to
 20 the manual operator that the trunk is no
 longer busy.

If the manual subscriber allotted to the
 cord circuit A (Fig. 1) wishes to call the
 automatic subscriber #220, for example, he
 25 removes his receiver and a signal is thus
 given to his manual operator A who takes
 his order from him. She then operates the
 order key *e*, causing the lamp 202 to flash
 up, when the springs 218 and 219 close and
 30 signal the trunking operator B. The circuit
 through said lamp 202 extends from ground
 G¹² through the battery 217, and through
 the springs 218 and 219 of the order key *e*
 to the springs 220 and 221 of the key *n* at
 35 the operator's cord B, thence through the
 lamp 202 to ground G¹³. The operator at
 the cord circuit A presses her key *e* in order
 to converse with the operator at B when the
 latter presses the key *n*. It will be under-
 40 stood that when the key *e* is pressed the
 springs 222 and 223, and 230 and 229 close in
 contact, respectively, and at the key *n* the
 springs 224 and 225, and 227 and 228, re-
 spectively, engage, and the springs 221 and
 45 220 disengage when said key *n* is pressed.
 The talking circuit for said operators ex-
 tends from the receiver 6 at the cord circuit
 A through the secondary winding 8 of the
 50 induction-coil *f*, through the springs 222 and
 223 to the springs 224 and 225 at the key *n*,
 thence through the receiver 226 at the cord
 circuit B, through the secondary winding 17
 to the springs 227 and 228, thence to the
 55 springs 229 and 230 back to the receiver 6.
 The transmitters 5 and 15 of the respective
 operators are, of course, included in local
 circuits comprising the primary windings,
 in the usual manner. The operator B, when
 she comes on the line, instructs the operator
 60 A to come in on a certain trunk—for exam-
 ple, the trunk leading from the jack *j*. As
 soon as the plug *d* is inserted into the jack *j*
 the back supervisory relay 3 of the cord cir-
 65 cuit A is energized by a flow of current
 from ground G¹⁴ at the cord circuit B,

through the resistance coil 231, through the
 repeating coil winding 12 to the sleeve
 spring 232 of the jack *j*, thence to the sleeve
 233 of the plug *d*, to the supervisory relay
 3 and through battery B'. The said relay 70
 upon energizing attracts the armature 234,
 lighting the lamp 235. Furthermore, the
 insertion of the said plug *d* in the jack *j*
 presses the springs 236 and 237 into contact,
 whereby the relay 238 is energized by a flow 75
 of current from ground G⁶ at the repeater E
 through the auxiliary relay springs 119 and
 120, conductor 239, relay 238, springs 236
 and 237 to the battery lead 118, thence
 through battery B' to ground G'. Said 80
 relay 238 upon attracting the armature 240
 onto the contact point 241 lights the super-
 visory lamp 18. The circuit for lighting
 said lamp extends from ground G¹⁵ at the
 cord circuit B through the armature 240, 85
 contact 241 and lamp 18 to the battery lead
 118, and through battery B' to ground G'.
 The operator at the cord circuit B is, there-
 fore, informed as soon as the operator at the
 cord circuit A seizes the trunk. Another 90
 circuit is, furthermore, established when the
 said relay 238 carries the other armature 242
 into engagement with the contact point 243,
 whereby the auxiliary relay 20 of the cord
 circuit B is energized from ground G¹⁵ 95
 through the armature 242 and contact point
 243 to the relay 20, thence through said re-
 lay to the battery lead 118, and through bat-
 tery B' to ground G'. Said relay 20 then at-
 100 tracts its armatures 244, 245 and 117 onto
 the respective contact points 246, 247 and
 248. The engagement of the armatures 244
 and 245 with the contact points 246 and 247
 connects the tip and sleeve conductors 249
 and 250 of the cord circuit B with the out- 105
 going trunk conductors *a* and *b*; and the
 engagement of the armature 117 with the
 contact point 248 energizes the auxiliary
 relay 19 at the cord circuit B, by a flow of
 current from ground G¹⁶ through the said 110
 relay 19 to the contact point 248, thence
 through the armature 117 to the battery lead
 118, and through battery B' to ground G'.
 The said relay 19 then attracts its armatures
 251, 252 and 253, carrying them into engage- 115
 ment with the contact points 254, 255 and
 256, respectively. The closure of connection
 between the armature 252 and contact point
 254 establishes a guarding potential at the
 private trunk conductor 110 between the re- 120
 peater E and the selector banks. Therefore,
 all the private bank contacts connected with
 said private trunk conductor are provided
 with a guarding potential to prevent any
 automatic subscriber from coming in on the 125
 line. The circuit over which said potential
 is established is as follows: From ground
 G¹⁶ at the cord circuit B to the contact point
 254, thence to the armature 252, conductor
 112 and to the trunk conductor 110 and to 130

all private bank contacts connected therewith. Meanwhile the operator at the cord circuit B proceeds to call the desired subscriber by shifting her key *o*, whereby the spring 257 is carried into engagement with the spring 258, and the spring 259 disengaged from the spring 260 and pushed against the spring 261. Furthermore, the spring 262 is disconnected from the spring 263 and placed in engagement with the spring 264, and the springs 114 and 115 are separated. Should the operator at the cord circuit A delay in plugging in the jack *j*, the operator at the cord circuit B secures the outgoing trunk comprising the conductors *a* and *b* as soon as the said springs 257 and 258 are carried into contact by the operator at the cord circuit B when the key *o* is operated, as described. In that case the auxiliary relay 20 is energized from the ground G^{17} at the key *o*, through the said springs 258 and 257 and through the coil 20 to the battery lead 118. The said relay 20, of course, attracts its armatures, as already explained, establishing a guarding potential at the selector private bank contacts, as already pointed out. After the trunk line is thus once seized the operator at the cord circuit B does not release her key *o* until she sees the lamp 18 flash up, indicating to her that the operator at the cord circuit A has plugged in. The operator at the cord circuit B in the meantime proceeds to call the desired number which, has been given to said operator over the order wire. The separation of the springs 259 and 262 from the springs 260 and 263, respectively, disconnects the tip and sleeve conductors 249 and 250 from the trunk conductors *a* and *b*, and the engagement of said springs 259 and 262 with the springs 261 and 264 places the trunk line conductors *b* and *a* in connection with the automatic calling device *m* and with the springs 265 and 266 thereof. Since the operator at the cord circuit B is thus connected direct with the trunk line conductors *a* and *b*, it is only necessary for her to operate her calling device *m* in accordance with the last digits 2 and 0, since the trunking operation corresponding to the preceding case, to reach the trunk conductors *a* and *b*, is performed by the manual operators A and B. The operator B, therefore, presses her vertical button 267 twice, pushing the spring 266 against the ground spring 268 and sending two ground impulses to the vertical trunk conductor *a*, operating the connector vertical line relay 73, as already understood, by a flow of current from ground G^{18} through the springs 268 and 266 and springs 264 and 262, contact 247 and armature 245 to the vertical trunk conductor *a*, thence through the vertical line relay 73 at the connector F, winding 76 of the differential relay 75 to the battery lead 140, thence through battery b^3 to ground g^3 . The connector switch-shaft 67 is, therefore, raised two steps. Then when the operator presses her rotary button 269 she forces the rotary spring 265 onto the ground spring 268, grounding the rotary trunk conductor *b* from ground G^{18} through the springs 268 and 265 and springs 261 and 259, contact point 246 and armature 244 to the rotary trunk conductor *b*. Therefore, the rotary line relay 74 at the connector F is energized, which in turn energizes the private magnet 84, tripping the side switch G to second position. The operator then proceeds to press the vertical spring 266 ten times in accordance with the digit 0, thereby grounding the vertical trunk conductor *a* ten times and operating the vertical line relay 73 at the connector F ten times, whereby the rotary magnet 82 is energized ten times to so rotate the switch-shaft 67 as to carry the wipers 68, 69 and 70 into engagement with the normal conductors 150, 151 and 152, respectively. When the rotary button 265 is pressed for the last time, if the line is busy the connector is released, as already explained; and then when the vertical button 267 is pressed, in order to ground the vertical trunk conductor *a* for signaling, the busy signaling circuit is established, as already stated, when the switch-shaft 67 is raised and the switch-shaft springs 168 and 169 close in contact. Assuming that the operator at the cord circuit A has plugged in and extended the calling subscriber's telephone line with the cord circuit B, the operator at the said cord circuit B, after performing the required operations, releases the key *o*, thus connecting the calling subscriber with the trunk conductors *a* and *b* over circuits marked by the heavy conductors shown in Fig. 1. The busy signaling current then reaches the rotary trunk conductor *b* over circuits already known and passes to the conductor 270, to the armature 244, of the relay 20 at the cord circuit B, thence to the contact point 246, springs 259 and 260 to the sleeve conductor 249, thence through the winding 13 of the repeating coil *k*, condenser 271, repeating coil winding 14, sleeve conductor 250, springs 263 and 262, contact point 247, armature 245 and back to the vertical trunk conductor *a*. The current is, of course, induced in the windings 11 and 12 of the repeating coil *k*, from whence it extends to the cord circuit A and through the condensers 9 and 10 to the calling subscriber's station. Upon hearing the signal the calling subscriber hangs up his receiver, causing the front supervisory lamp (not shown) at the cord circuit A to flash up, giving the operator the disconnect signal. The operator then withdraws the plug *d* from the jack *j*, thereby breaking the ener-

gizing circuit through the back supervisory relay 3, which permits the lamp 235 to go out, and also the springs 236 and 237 at the cord circuit B to separate on the withdrawal of the plug *d*, and the relay 238 is deenergized as a result. The lamp 18 then goes out, since the armature 240 leaves the contact point 241, and when the armature 242 leaves the contact point 243 the relay 20 deenergizes, said relay causing the deenergization of the relay 19 which it controls. The relay 20, however, is a quick-acting relay, while the relay 19 is a slow-acting relay, and as soon as the armatures 244 and 245 of the quick-acting relay return into engagement with the contact points 272 and 273, the vertical and rotary trunk conductors *a* and *b* are simultaneously grounded from ground G^{16} , which ground connection is controlled by the slow-acting relay 19. The impulses to the said conductors *a* and *b* pass over the following paths: From ground G^{16} to the contact point 255, armature 251 of the slow-acting relay, contact 272 and armature 244 of the quick-acting relay to the conductor 270, and thence to the rotary trunk conductor *b*. The other path for the ground impulses is from ground G^{16} to the contact point 256 and armature 253 of the slow-acting relay to the contact point 273 and armature 245 of the quick-acting relay to the vertical trunk conductor *a*. As a result the connector switch *F* is released, as already described. If, however, instead of the line being busy the connector side switch passes to third position, then when the vertical trunk conductor *a* is grounded, and when the operator presses the spring 266 onto the ground spring 268 to signal the called subscriber, after the connection is completed, the ringer relay 85 is operated as before. The called subscriber is thus notified that he is called; then when he answers he receives talking current through the back-bridge relay 78 of the connector *F*, as previously described, which relay in turn, upon shifting the spring 146 onto the ground spring 201, establishes a circuit through the relay 274 at the cord circuit B for energizing the supervisory relay 2 at the cord circuit A and for extinguishing the lamp 235. The circuit through the said relay 274 begins with the ground terminal G^{10} at the connector side switch, thence to the contact point 199, side switch wiper 87, back-bridge relay springs 201 and 146, thence through the winding 77 of the differential relay 75, rotary line relay 74 to the rotary trunk conductor *b*, thence by way of the conductor 270 to the armature 244 of the quick-acting relay 20 at the cord circuit B, contact point 246 to the relay 274, thence through said relay to the contact point 247 and armature 245 of the quick-acting relay 20, to the vertical trunk conductor *a*, thence

to the vertical line relay 73 of the connector *F* and through the winding 76 of the differential relay 75 to the battery lead 140, and through battery b^3 to ground g^3 . The relay 274 at the cord circuit B upon attracting its armature 275 onto the contact point 276 energizes the supervisory relay 2 at the cord circuit A by establishing a circuit from the non-grounded terminal of battery B' at the cord circuit A through the supervisory relay 3 to the sleeve 233 of the plug *d*, thence to the sleeve spring 232 of the plug *j*, to the winding 12 of the repeating coil *k* at the cord circuit B, to the contact point 276 and armature 275 of the relay 274, thence through the repeater winding 11 to the tip spring 277 of the jack *j*, thence to the tip conductor 278 of the cord circuit A, armature 279, contact 280 of the supervisory relay 3 to the supervisory relay 2, thence through said relay to ground G' . When the said relay attracts its armature 281 said armature leaves the contact point 282, breaking the circuit of the lamp 235, which lamp signal then, of course, disappears, indicating to the operator that the called subscriber has answered. After the subscribers are through talking they may restore their receivers, the calling subscriber thus giving a disconnect signal to the operator A, and the called subscriber sending a disconnect signal to the operator A also, when the relay 2 deenergizes. This, of course, occurs when the subscriber destroys the energizing circuit through the back-bridge relay 78 of the connector *F*, which in turn upon falling back and permitting the springs 146 and 201 to separate causes the deenergization of the relay 274 at the cord circuit B. Said relay in turn causes the deenergization of the supervisory relay 2 at the cord circuit A, at which time the back supervisory lamp 235 flashes up again. Of course, when the operator A withdraws the plug *d*, the release of the switches follows, as before, from the deenergization of the relay 238 of the cord circuit B, and the subsequent deenergization of the quick and slow acting relays 20 and 19, as before. After the operator at the trunking circuit B operates the key *o* to connect the calling and called subscribers, then if the called subscriber does not answer, the operator at the cord circuit A may signal the called subscriber by pressing the signaling key *q*, in which case the ringer generator $\bar{z}$, which is normally grounded at G^{10} , is bridged across the tip and sleeve springs 232 and 277 of the cord circuit B, and the signaling relay *p* at the said cord circuit B is energized. Thus the armature 203 is carried away from the contact point 283 and into engagement with the ground terminal G^{20} . The effect of thus operating the relay *p* is to disconnect the bridge formed through the relay 274 across the tip and sleeve con-

ductors 249 and 250, grounding the latter and, therefore, grounding the vertical trunk conductor *a*, whereby the ringer relay 85 at the connector F is energized, as already known, for signaling the called subscriber. The alternating current signaling relay *p*, of course, may be of any suitable design that will accomplish the purposes set forth.

From the foregoing it will be seen that I provide a highly improved combined manual and automatic system whereby automatic subscribers may call automatic subscribers over a given trunk line to which the manual operators also have access, giving a certain class of said operators a signal when the trunk line is brought into use; a highly improved system in which manual subscribers may not only call each other, but the automatic subscribers as well, through a trunking operator B, the line operator A being given total supervision over the connection after the trunking operator has established the connection.

In the repeater E it is found that the resistance of the coils may be varied, but good results are obtained when the line relays 58 and 59 are wound to one hundred ohms each; the windings 61 and 62 of the differential relay 60 to two hundred and fifty ohms each; the pole-changing relay 63 to five hundred ohms; the auxiliary relay 64 to thirteen hundred ohms. In the cord circuit B the coil 231 may be wound to five hundred ohms; the coil 238 to one thousand ohms; the quick-acting relay 20 to two hundred and fifty ohms; and the slow-acting relay 19 to two hundred and fifty ohms.

As far as the broad idea of both manually and automatically trunking over a trunk line in the same direction to call an automatic subscriber is concerned, the details can be changed or varied without departing from the spirit of my invention.

The connectors can be employed on a percentage basis, and may thus be less in number than the subscribers having access to them. The first-selectors can also be reduced to a percentage basis in any suitable or known manner, and second and third selectors can be employed if necessary. In this way automatic trunking is afforded in a system in which a trunk line can be used by either a manual or an automatic subscriber for getting connection with the line of an automatic subscriber.

As indicated in Fig. 1 the jack *j* will have as many multiples thereof as there are operators' switching positions at the manual board. In this way each manual or originating operator will have access to each of the different trunking operators' cord circuits allotted to the different outgoing trunks extending to the other exchange—that is to say, the different outgoing trunks having re-

peaters E through the medium of which the calling automatic subscribers control the automatic switches at the other exchange. With the arrangement shown, one or more levels in the first-selector D can be reserved for the outgoing trunk lines leading to the said other exchange, and all other levels can then be used for establishing connection between automatic subscribers of the main exchange. In this way, as explained, automatic and manual trunking is afforded in a common battery telephone system having provisions by which either a manual or an automatic subscriber can employ the same trunk line for obtaining connection with the line of an automatic subscriber at another exchange.

What I claim as my invention is:—

1. In a telephone exchange system, the combination of a trunk line, an automatic switch at the end of said line, a subscriber's calling mechanism for controlling said switch over said trunk line, means responsive to the calling subscriber for automatically seizing the trunk line, means for manually connecting with said line, an operator's calling mechanism for controlling said switch over said line, and means for preventing automatic selection of said trunk line when it is in use for connecting a manual subscriber's line with an automatic subscriber's line.
2. In a telephone exchange system, the combination of an automatic switch, a trunk line leading to said switch, an automatic selector switch responsive to the calling subscriber for connecting with the other end of said trunk line, a manual switchboard apparatus for connecting with said trunk line, a subscriber's calling mechanism for controlling both of said switches, an operator's calling mechanism for controlling the first-mentioned switch, and means for preventing automatic selection of said trunk line when it is in use for connecting a manual subscriber's line with an automatic subscriber's line.

3. A trunk line, a spring jack for one end of said trunk line, a selector provided with a bank terminal of said line, an automatic switch individual to and in which the other end of said line terminates, and a trunking operator's cord circuit for connecting said jack with said trunk line.

4. A trunk line, a spring jack for one end of said trunk line, a selector provided with a bank terminal of said line, an automatic switch individual to and in which the other end of said line terminates, a subscriber's calling mechanism for operating said selector and automatic switch, an operator's calling mechanism for operating said automatic switch, a manual switchboard provided with a cord and plug adapted for insertion in said jack, and a trunking operator's cord circuit

for connecting said jack with said trunk line.

5. In a telephone exchange system, the combination of a trunk line, a repeater for one end of said trunk line, an automatic switch for the other end of said trunk line, a spring jack and a trunking operator's cord circuit for the repeater end of the trunk line, a trunking operator's calling mechanism for controlling said automatic switch, an originating operator's cord circuit for connecting a calling manual subscriber's line with said jack, an automatic switch for connecting with the repeater end of the trunk line, a subscriber's calling mechanism for controlling both of said automatic switches, an order line between the two cord circuits, means by which the originating operator supervises any connection established over said cord circuits and trunk line, and means for preventing automatic selection of said trunk line when the same is in use for connecting the manual subscriber's line with the first-mentioned automatic switch.

6. The combination of a trunk line, a repeater for receiving and repeating impulses to said trunk line, an operator's calling mechanism for directly transmitting impulses over said trunk line, but not through said repeater, and an automatic switch responsive to all of said impulses.

7. In a telephone exchange system, a repeater provided with a pole-changing relay, an auxiliary relay, a talking circuit controlled by the latter relay, relay mechanism having springs, trunk conductors in said talking circuit, and connections between the said relay springs and said trunk conductors, controlled by said relays.

8. In a telephone exchange system, the combination of automatic means for trunking between calling and called subscribers, including a trunk line common to both automatic and manual service, a manual trunking apparatus provided with a slow-acting relay, and with a quick-acting relay for controlling the said slow-acting relay, said slow-acting relay controlling a guarding potential circuit to prevent other subscribers coming in said trunk when the same is in use.

9. In a telephone exchange system, the combination of trunk line conductors, an originating operator's cord circuit, a trunking operator's cord circuit, a quick-acting relay and a slow-acting relay allotted to said trunk line conductors, and means by which a disconnection of the originating operator's cord circuit and the trunking operator's cord circuit causes said quick-acting relay to de-energize before said slow-acting relay, to simultaneously ground the said trunk line conductors, a selector provided with a private bank contact, means by which said slow-

acting relay establishes a guarding potential at said bank contact, a connector switch, means by which said slow-acting relay effects a release of the connector switch when the originating operator's cord circuit is disconnected from the trunking operator's cord circuit, an operator's key, means by which the restoration of said key to normal position causes said slow-acting relay to effect a restoration of the connector switch, means by which said quick-acting relay controls the connection between said trunking operator's cord circuit and the said trunk line conductors, connections over which said slow-acting relay transmits the release impulses to the said trunk line conductors, means by which said quick-acting relay controls said connections, and an auxiliary relay, said auxiliary relay controlled by said quick-acting relay, said slow-acting relay being also controlled by the said quick-acting relay, substantially as set forth.

10. In a telephone exchange system, the combination of an operator's key, a quick-acting relay provided with an energizing circuit controlled by said key, a cord circuit, and trunk conductors, a connection between the said cord circuit and the said trunk conductors, controlled by said key, a calling device, a connection between said calling device and said trunk conductors, controlled by said key while said relay is energized, and an auxiliary relay provided with an energizing circuit controlled by said key, substantially as set forth.

11. In a telephone exchange system, the combination of a trunk line, another trunk line, an operator's trunk circuit normally connected with one trunk line and normally disconnected from the other trunk line, a relay for connecting the circuit with the said other trunk line, and a talking circuit including said trunks and circuit in series, said trunk lines being individual to each other.

12. In a telephone exchange system, the combination of a spring jack, a cord circuit, a trunk line permanently connecting the spring jack with the cord circuit, another trunk line to which the said trunk line is individual, and means for connecting the cord circuit with the said other trunk line.

13. In a telephone exchange system, the combination of a trunk line terminating at one end in a progressively movable switch, an operator's trunk circuit at the outgoing end of said trunk individual thereto, and normally disconnected therefrom, connecting means between the trunk circuit and the trunk line, a spring jack connected with the other end of said trunk circuit, and an operator's connecting cord provided with a plug adapted for insertion in said jack.

14. In a telephone exchange system, the combination of an outgoing trunk line, a re-

peater individual to said trunk line, an automatic switch individual to said trunk line, a subscriber's calling mechanism for controlling said switch through the medium of said repeater, and a trunking operator's cord circuit individual to said trunk line.

15. In a telephone exchange system, the combination of multiple jacks, a trunking operator's cord circuit to which said jacks are individual, and an outgoing trunk line to which the said cord circuit is individual, said cord circuit constituting the medium of connection between the said trunk line and jacks.

16. In a telephone exchange system, the combination of a trunk line, an automatic switch, a trunking operator's cord circuit, an originating operator's cord circuit, means by which the trunking operator controls the said automatic switch over the trunk line, and means by which a disconnection of one cord circuit from the other automatically releases the said automatic switch.

17. In a telephone exchange system, the combination of a trunk line, an automatic switch, a trunking operator's cord circuit, an originating operator's cord circuit, means by which the trunking operator controls the said automatic switch over the trunk line, means by which a disconnection of one cord circuit from the other automatically releases the said automatic switch, a repeater, and a subscriber's calling mechanism for controlling said automatic switch through the medium of said repeater.

18. In a telephone system divided into groups, the combination of a trunk line, an automatic switch at the end of said line, a subscriber's calling mechanism for controlling said switch over said trunk line, means for manually connecting with said line, an operator's calling mechanism for controlling said switch over said line, and means for indicating that the trunk line is busy to prevent manual connection therewith, said system being provided with means operative by vertical motion to select groups and by rotary motion to connect with the called line in any selected group.

19. In a telephone system divided into groups, the combination of an automatic switch, a trunk line leading to said switch, an automatic switch for connecting with the other end of said trunk line, a manual switchboard apparatus for connecting with said trunk line, a subscriber's calling mechanism for controlling both of said switches, an operator's calling mechanism for controlling the first-mentioned switch, and means for indicating that the trunk line is busy to prevent manual connection therewith, said system being provided with means operative by vertical motion to select groups and by rotary motion to connect with the called line in any selected group.

20. In a telephone system divided into groups, the combination of a trunk line, a repeater for one end of said trunk line, an automatic switch for the other end of said trunk line, a spring jack and a trunking operator's cord circuit for the repeater end of the trunk line, a trunking operator's calling mechanism for controlling said automatic switch, an originating operator's cord circuit for connecting a calling manual subscriber's line with said jack, an automatic switch for connecting with the repeater end of the trunk line, a subscriber's calling mechanism for controlling both of said automatic switches, an order line between the two cord circuits, means by which the originating operator supervises any connection established over said cord circuits and trunk line, and means for preventing automatic selection of said trunk line when the same is in use for connecting the manual subscriber's line with the first-mentioned automatic switch, said system being provided with means operative by vertical motion to select groups and by rotary motion to connect with the called line in any selected group.

21. In a telephone system including subscribers' lines divided into groups, an automatic switch, a repeater provided with a pole-changing relay, an auxiliary relay, relay springs, trunk conductors adapted to be seized by said switch and connections between the said relay springs and said trunk conductors, controlled by said relays, said automatic switch controlled by said repeater and having motion first to select groups and motion to then find a line in a selected group.

22. In a telephone system including subscribers' lines divided into groups, the combination of an automatic switch, an outgoing trunk line extending from said switch, a repeater individual to said trunk line, an automatic switch individual to said trunk line, a subscriber's calling mechanism for controlling said switch through the medium of said repeater, and a trunking operator's circuit individual to said trunk line, said last-mentioned automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group.

23. In a telephone system including subscribers' lines divided into groups, the combination of an automatic switch, multiple jacks, a trunking operator's circuit to which said jacks are individual, and an outgoing trunk line extending to said switch to which the said circuit is individual, said circuit constituting the medium of connection between the said trunk line and jacks, said automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group.

24. In a telephone system including sub-

scribers' lines divided into groups, the combination of a trunk line, an automatic switch, a trunking operator's circuit, an originating operator's cord circuit, means
 5 by which the trunking operator controls the said automatic switch over the trunk line, and means by which a disconnection of one circuit from the other automatically releases the said automatic switch, said automatic
 10 switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group.

25. In a telephone system, a spring jack,
 15 a trunk line terminating at one end in an automatic switch, a connection between said jack and the opposite end of said trunk line, and means by which an operator controls the connection between the jack and trunk line,
 20 said jack being allotted to said trunk line.

26. In a telephone system, an automatic progressively movable switch, a slow-acting relay, means controlled by said relay for automatically establishing a guarding potential to prevent seizure of said switch when
 25 the same is in use and for initiating an automatic release of said switch.

27. In a telephone system, a cord circuit, a relay and a supervisory signal controlled
 30 thereby associated with said cord, a trunk circuit accessible to said cord, a relay in said trunk for directly controlling the circuit of said first-mentioned relay and said signal, an automatic switch, and means for connect-
 35 ing said switch with said trunk.

28. In a telephone system, an automatic switch, a trunk extending to said switch, said trunk consisting of two parts, one normally connected with said switch and a pair
 40 of condensers in the other part, said condensers being normally disconnected from said switch, and means for establishing a talking circuit through said condensers and over said trunk to said switch.

29. In a telephone system, an automatic switch, a trunk line extending to said switch and normally connected thereto, a second trunk normally disconnected from said
 45 first trunk, a repeater in said second trunk, a pair of condensers in said second trunk, and means for repeating impulses from said

first to said second trunk and for then connecting said trunks together, whereby said condensers are connected to said automatic switch.

30. In a telephone system, an operator's circuit provided with jack springs, a relay having a pair of armatures, means for energizing said relay when connection is made with said circuit, a trunk line normally dis-
 60 connected from said operator's circuit, and a second relay for controlling the connection between said operator's circuit and said trunk, said second relay being controlled by said first relay.

31. In a telephone system, an operator's circuit provided with jack springs, a relay having a pair of armatures, means for energizing said relay when connection is made with said circuit, a trunk line normally dis-
 70 connected from said operator's circuit, a second relay for controlling the connection between said operator's circuit and said trunk, said second relay being controlled by said first relay, and a supervisory signal con-
 75 trolled by said first relay.

32. In a telephone system, an automatic switch, a slow acting relay, means controlled by said relay for establishing a guarding potential to prevent seizure of said
 80 switch by another automatic switch and for initiating an automatic release of said switch, said other switch having access to said first mentioned switch.

33. In a telephone system, an automatic
 85 switch, a trunk line extending to said switch, said trunk line consisting of two parts, one normally connected with said switch, and a pair of condensers in the other part, said condensers being normally disconnected
 90 from said switch, a line relay for controlling said switch, said relay normally connected to said normally connected part of said trunk line, and means for establishing a talking circuit through said condensers and
 95 over said trunk line to said switch.

Signed by me at Chicago, Cook county, Illinois, this 9th day of November, 1906.

TALBOT G. MARTIN.

Witnesses:

EDWARD D. FALES,
 JOHN ERICKSON.