W. L. CAMPBELL.

AUTOMATIC TELEPHONE TRUNKING SWITCH AND SYSTEM THEREFOR.

APPLICATION FILED JULY 9, 1907.

1,221,287.

Patented Apr. 3, 1917.

3 SHEETS—SHEET 1.

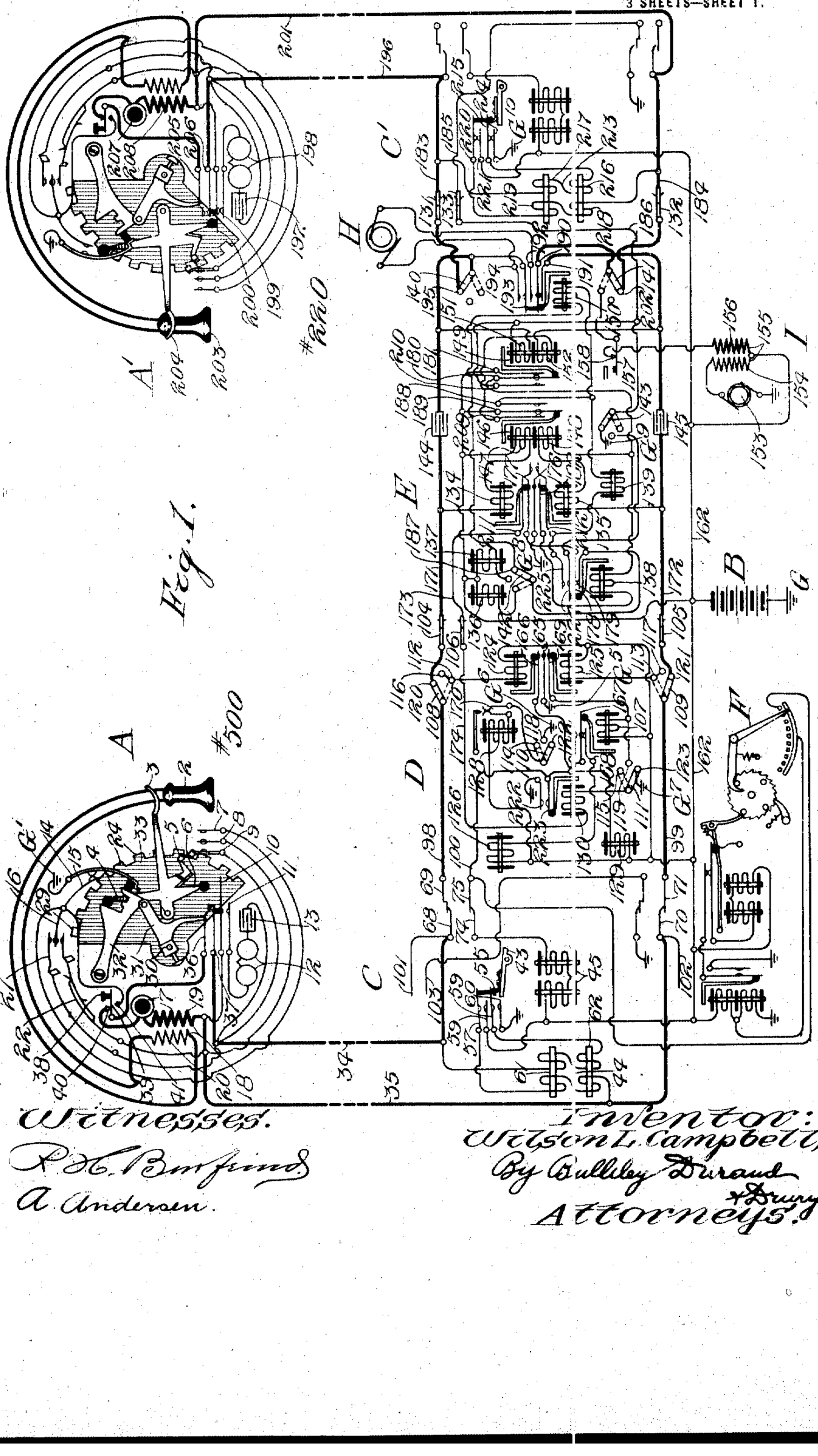

Fig. 1.

Witnesses.

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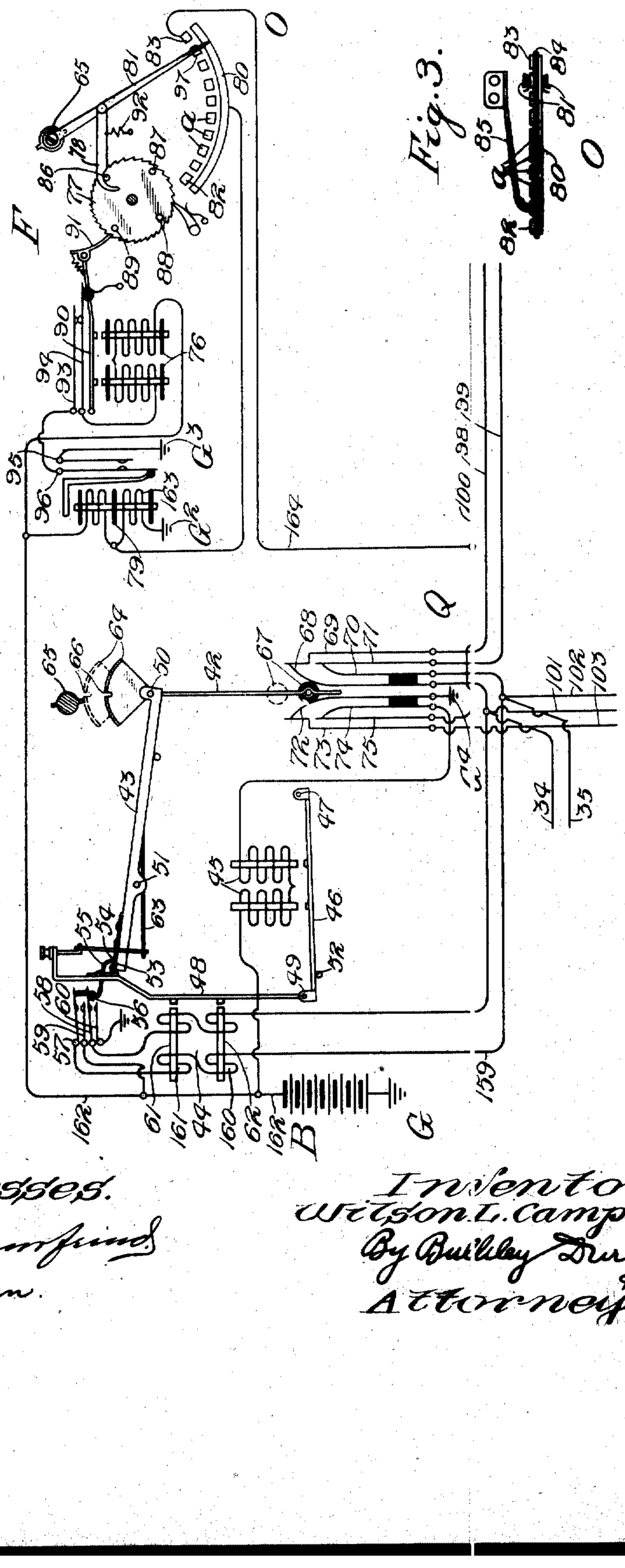

Fig. 2.

Fig. 3.

Witnesses.
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3 SHEETS—SHEET 3.

Fig. 4.

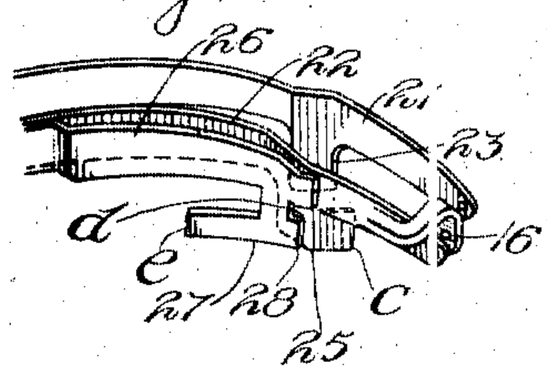


Fig. 5.

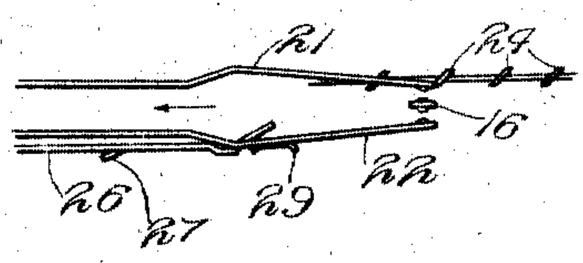


Fig. 6.

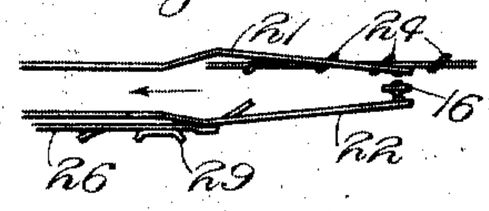


Fig. 7.

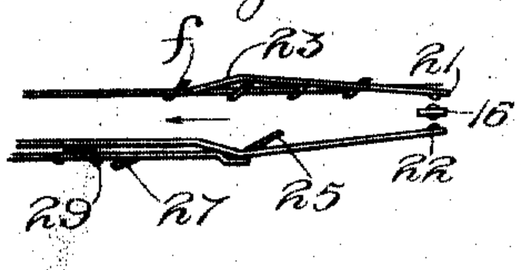


Fig. 8.

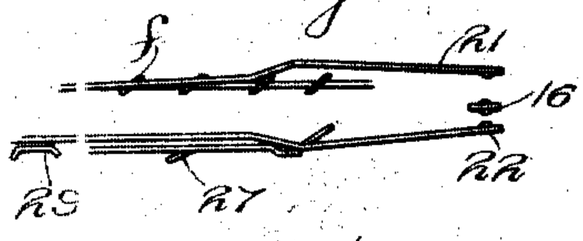


Fig. 9.

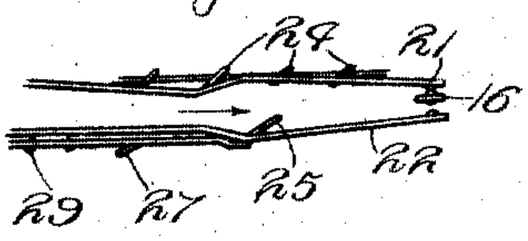
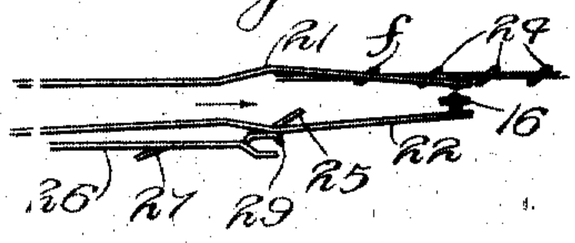


Fig. 10.



Witnesses.
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UNITED STATES PATENT OFFICE.

WILSON L. CAMPBELL, OF LA GRANGE, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC COMPANY, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE TRUNKING-SWITCH AND SYSTEM THEREFOR.

1,221,287. Specification of Letters Patent. Patented Apr. 3, 1917.

Application filed July 9, 1907. Serial No. 382,901.

To all whom it may concern:

Be it known that I, WILSON L. CAMPBELL, a citizen of the United States of America, and resident of La Grange, Cook county, Illinois, have invented a certain new and useful Improvement in Automatic Telephone Trunking-Switches and Systems Therefor, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to automatic or semi-automatic telephone exchange systems, and especially to systems in which one or more of the subscribers' lines have an individual switch for automatically extending a trunk connection when the subscriber calls.

Generally stated the object of my invention is the provision of an improved telephone exchange system.

Special objects of my invention are the provision of a subscriber's individual trunking switch having a swinging plunger-arm which is capable of opening the bridge normally across the calling subscriber's line; the provision of a bridge-cut-off device of this character which will operate when the subscriber calls, but not when the subscriber answers a call; the provision of an arrangement by which battery current for talking purposes is fed to the subscriber's line through the coils or connections by which the battery is normally bridged across the said line; the provision of a subscriber's individual trunking switch having a trip magnet that is responsive when the subscriber calls, but which is not responsive when the subscriber answers a call; and the provision of 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.

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

In the accompanying drawings Figure 1 shows diagrammatically a calling substation A and a called substation A′ connected through the medium of automatic switches C, D and E. To the line #500 of the substation A there is allotted the switch C of an improved type known as a line switch; and to the line #220 of the substation A′ there is allotted a similar line switch C′. At D is represented a first-selector switch, and at E is shown a connector, in connection with which I have elected to explain my invention, the selector being of the general type described in Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, and the connector being an improved form of the type of connector shown in Patent No. 815,176, also granted March 13, 1906, to Keith, Erickson and Erickson. The master switch F is provided for controlling a group of line switches, of which C is a member. For operating and talking purposes a central battery B having its positive terminal preferably grounded at G is used.

Fig. 2 is an enlarged diagram of the line switch C and its master switch F.

Fig. 3 is a detail view of the master switch bank.

Figs. 4, 5, 6, 7, 8, 9 and 10 are detail views showing the construction and operation of the impulse-transmitting springs of the subscriber's telephone.

It will be understood that the first-selectors and connectors may be employed upon a percentage basis—that is, in an automatic exchange of one-thousand capacity a somewhat common arrangement is to divide the subscribers and their allotted line switches into groups of one-hundred each. Then to each group of line switches there is allotted a group of first-selectors, usually ten in number, making, in a one-thousand system, one-hundred first-selectors. To each bank level of these first-selectors there is allotted a group of connector switches, usually ten in number, which in turn are adapted to make connection with the subscribers' lines of that group. For example, the group corresponding to the first level is the one-hundred group; the group of the second level is the two-hundred group, etc.; thus to each hundred group of subscribers of the thousand there is allotted a group of connector switches, so that in a one-thousand system there would be one-hundred connectors when arranged on a ten per cent. basis.

The substations may be of any suitable or approved type. Those in connection with which I have elected to explain my invention comprise, as shown at station A, a receiver 2, a switch-hook 3 for controlling the substation circuits, which controlling operations are accomplished through the medium of any suitable means, such as the cam arms 4.

5 and 6. As the switch-hook is lowered the cam-arm 5 momentarily presses the release springs 7, 8 and 9 into engagement, whereby the substation line conductors may be grounded simultaneously. When the switch-hook is down the cam-arm 6 maintains a contact between the springs 10 and 11, thereby bridging the ringer 12 in series with the condenser 13 across the line. The substation ground circuit is normally broken between the ground springs 14 and 15 by the cam-arm 4; but when said springs are together ground is provided to the ground post 16, and to the release spring 7, as is usually the case in telephones of this type. The said substation comprises the usual transmitter 17, induction-coil 18 having the primary winding 19 and secondary winding 20. Being an automatic substation it is provided with the usual vertical and rotary impulse springs 21 and 22. The vertical impulse spring is provided with an oblique projection or lug 23 (Fig. 4) on the inner side of which the vertical impulse teeth 24 are adapted to engage for driving the spring 21 intermittently onto the ground post 16. The rotary impulse spring 22 is provided with a somewhat similar mechanism, whereby the rotary impulse spring may be driven onto the ground post once when the dial is rotated in one direction and once when rotated in the opposite direction. The said rotary impulse spring 22 has on its inner side a V-shaped member 25 having two sides *c* and *d*, and there is in addition an auxiliary spring 26 which works in conjunction with the V-shaped member. As shown more clearly in Fig. 4, the auxiliary spring 26 is provided with a lower curved part 27 having the rear section *e* curving outwardly, as shown in Figs. 4, 5 and 6. The front section 28 of the said member 27 is designed to fall just below the apex of the V-shaped member 25, so that the rotary impulse tooth 29, when moved in the direction indicated by the arrow in Fig. 5, will pass onto the curved member 27, thus pressing the rotary impulse spring 22 onto the ground post 16 for a comparatively long time, as shown in Fig. 6, thus sending a comparatively long impulse to the line. As the impulse wheel advances, the vertical impulse teeth 24 approach the lug 23 of the vertical impulse spring 21 (Fig. 6), and eventually the first tooth that meets the lug 23 clears the said lug, as shown in Fig. 7, but not until after the rotary impulse tooth 29 clears or disengages the curved member 27. As the impulse wheel continues to advance in the direction indicated by the arrow in Fig. 7, the succeeding impulse tooth will clear the projection 23, as shown in Fig. 8. Then when the impulse wheel is released, first the vertical impulse spring 21 is carried into engagement with the ground post 16 twice, by the teeth previously cleared, as indicated in Fig. 9; but as the impulse wheel nears its normal position the rotary impulse tooth 29 passes under the curved member 27 of the auxiliary spring 26 (Fig. 10), engaging the V-shaped member 25 directly and for a short time only, sending the ordinary impulse through the medium of the rotary impulse spring 22 to the line; after which the said member 27 is cleared (as shown in Fig. 5) as the impulse wheel reaches its normal position. The operations, as thus described, are repeated each time that the dial is turned, and the number of impulses produced through the medium of the vertical impulse spring is accurately and definitely determined at each operation of the dial. Said substation is, of course, provided with a dial (not shown) which is secured to the shaft 30, together with the locking dog 31. Furthermore, there is a locking cam 32 that locks the dog 31 while the receiver is on the switch-hook to prevent a rotation of the dial. For operating the impulse springs 21 and 22 the substation is provided with an impulse wheel 33 that is secured to the shaft 30, which impulse wheel carries on its periphery the so-called vertical impulse teeth 24 and one rotary impulse tooth 29. The said impulse teeth are so arranged that when the dial is drawn down the rotary impulse spring 22 is pressed into contact with the ground post, and the impulse spring 21 is not carried into contact with the ground post 16; but as the dial returns, first the vertical teeth engage the vertical impulse spring 21, and after they have completed their work the rotary impulse tooth 29 operates the rotary impulse spring 22. In this operation the subscriber's rotary line conductor 35 is given a so-called preliminary impulse; then the vertical line conductor 34 is given a number of ground impulses, and then the rotary line conductor 35 is given another ground impulse. It will be seen that as long as the dial is out of normal position the dog 31 permits the primary circuit springs 36 and 37 to separate, thus preventing the impulses that are delivered to either line conductor from passing to the other. Means whereby a subscriber may signal a called subscriber comprises the push-button 38 which, when pressed, carries the spring 39 out of engagement with the contact point 40 and into engagement with the contact point 41, whereby the vertical line conductor 34 is grounded.

The line switch C (Fig. 2) comprises a plunger 42, plunger-arm 43, trip magnet 44 and switch-release magnet 45, all of which are built about a suitable base or frame (not shown). The said switch-release magnet is provided with an armature 46 that is pivoted on a pin 47 which rises from the base of the switch. The said armature carries pivotally secured on its end a

second armature 48 that is controlled by the trip magnet 44. The pin 49 about which the armature 48 moves is carried on the end of the armature 46. The plunger 42 is pivotally secured by the pin 50 to the plunger-arm 43, which latter is in turn pivoted to a pin 51 that rises from the switch frame (not shown). The lug 52 is stamped out of the side of the frame and serves as a stop or rest for the armature 46. Upon the armature 48 is secured the catch spring 53 which is adapted to engage the end 54 of the plunger-arm 43. Furthermore, upon the end of the plunger-arm 43 there is the arm 55 bearing upon its end the insulating bushing 56. This arm 55 is so arranged that when the plunger-arm operates and thrusts the plunger into the bank the springs 57 and 58 are carried out of engagement with the springs 59 and 60, respectively, whereby the trip magnet coils are disconnected from the battery terminals. The trip magnet 44 comprises two double-wound coils 61 and 62 having the windings differentially arranged, so that when one set of windings of the two coils carry current the trip magnet 44 operatively energizes; but when both sets of windings are included in an energizing circuit the said magnet does not operatively energize. The general operation of the switch is as follows: The trip magnet 44 is energized by a preliminary impulse and the armature 48 is attracted against the magnet cores. When the armature 48 is attracted to the left (Fig. 2), the catch 53 slides out of contact with the end 54 of the plunger-arm 43, and the said plunger-arm 43, owing to the tension of the spring 63, moves about the pin 51 and thrusts the plunger 42 into the bank terminal Q. When the plunger-arm 43 thus operates, the arm 55 operates the springs 57 and 58 to disconnect the trip magnet from the battery, as explained; and when the trip magnet deënergizes, the trip armature 48 falls against the end of the plunger-arm 43. The switch is restored when the release magnet 45 becomes energized, whereby the armature 46 is attracted, and accordingly the trip armature 48 is moved upward until the catch 53 slides over the end 54; then when the release magnet 45 becomes deënergized the armature 46 returns to normal position and remains at rest against the stop 52. Furthermore, since the plunger-arm 43 is now in engagement with the armature 48, the said plunger-arm is also moved about the pin 51, whereby the plunger 42 is removed from the bank terminal Q. Also, since the plunger shaft has advanced one step, the hub 64 of the plunger 42 comes to rest in the position shown by the dotted lines in Fig. 2, against the plunger shaft 65; and as the said plunger shaft advances each time an idle trunk is seized the plunger 42 is not advanced, but remains in a position opposite the trunk terminal from which it has just disengaged, since the slot 66 is not in engagement with the plunger shaft 65. After all of the trunk lines, usually ten in number but only one of which is shown at Q, have been successively seized, and the plunger shaft again passes to the position it occupied when the plunger 42 seized the terminal Q, the plunger 42 then returns to normal locking engagement with the said plunger shaft. In the meantime, if the line switch C is again operated, the plunger 42 again engages the same terminal. The said terminal is shown removed from its true position with respect to the swing of the plunger 42, and the bushing 67 is correspondingly illustrated, all for the purpose of making the illustration clearer. The terminal Q comprises the springs 68 and 69, 70 and 71, 72 and 73, and 74 and 75. The said springs are normally disconnected from each other, but are driven into contact in the above mentioned order when the plunger 42 engages the terminal Q. Normally the plunger 42 is, however, retained out of engagement with the line switch bank and in either locking or sliding engagement with the plunger-controlling shaft 65, which latter is operated by the master switch F. By sliding engagement I mean that the slot 66 of the plunger 42 does not engage the plunger shaft 65, and as the plunger shaft is turned the hub 64 slides upon the shaft; but when in locked normal position the slot 66 is in engagement with the shaft 65, and each time the shaft is advanced the plunger 42 is also advanced. The master switch F, which may be of any suitable or approved type, is provided for operating the plunger shaft 65, and for controlling certain circuits that will be disclosed hereinafter. It comprises the following details: A motor magnet 76 for operating the ratchet wheel 77, which latter is designed for operating the plunger shaft 65 through the medium of the cam 78; also a differential relay 79 for controlling the energizing circuit of the motor magnet 76. The said master switch also has a bank O comprising a plurality of individual contact segments *a* and a common metallic segment 80, as shown in Fig. 3. The wiper 81 is adapted to remain in constant engagement with the bank O, and to maintain at all times, except when the wiper is passing from the extreme left contact 82 to the extreme right contact 83, some one of the segments *a* in electrical connection with the common segment 80. As shown in Fig. 3 the individual segments *a* are separated from the common segment by the insulating strip 84. The spring 85 is provided in order that when the wiper 81 passes to the last contact point 82 then on the next step the wiper is carried to the contact 83 on the extreme right, and the upper part of the wiper

81 slides on the guide spring 85, thus preventing the wiper from placing any of the individual segments *a* in contact with the common segment 80, whereby some interference might be caused with the master switch. The wiper 81 is operated in a step-by-step manner by the ratchet wheel 77 through the medium of the cam member 78 rigidly secured to the said wiper 81 and adapted to successively engage the pins 86, 87, 88 and 89 upon the said ratchet wheel 77. The motor magnet 76 is provided with an armature 99 upon the end of which there is suitably secured a pawl 91. Each time that the said magnet is energized the pawl 91 engages the ratchet wheel 77, advancing the latter one step. It will be seen, therefore, that as the ratchet wheel 77 advances the wiper 81 also advances step-by-step from right to left, and when the pin 86, for instance, clears the cam 78 the retracting spring 92 restores the wiper 81 to its first position at the right of the bank in engagement with the first segment 83. The said motor magnet 76 is provided with a couple of interrupter springs 93 and 94 that are included in the energizing circuit of the said motor magnet, which energizing circuit also comprises the springs 95 and 96 controlled by the differential relay 79. Therefore, whenever the differential relay is energized the springs 95 and 96 are pressed into contact and the motor magnet 76 operates step-by-step as long as the differential relay 79 remains energized. Furthermore, it is assumed that the terminal Q of the line switch C is the first terminal of the line switch bank. While in normal locking engagement with the shaft 65 the plunger 42 is retained in front of said terminal by the plunger shaft 65, whenever the master switch wiper 81 is in engagement with the bank segment 83; but as the motor magnet 76 advances the wiper 81 onto the second segment 97 the said plunger and all idle plungers similarly engaging the shaft 65 are carried opposite the next terminal of the line switch bank. It should be noted that in each switch bank all of the springs 68 are permanently connected and may be made of one common piece; the springs 69 are, however, individual—that is, there is one separate and distinct spring for every bank set Q, there being ten in the bank. The springs 70, 72, 73 and 74, like the springs 68, are also common, and the springs 71 and 75, like the springs 69, are individual. For every bank terminal Q there is a trunk line of three conductors 98, 99 and 100 leading to a selector; and there is also a normal trunk line comprising the conductors 101, 102 and 103 leading to the connector banks. The subscriber's line conductors 34 and 35 terminate in the springs 68 and 70 which, as has been stated, are common springs. When the subscriber operates the line switch C and the plunger 42 engages the terminal Q, the subscriber's line conductors 34 and 35 are extended to the vertical and rotary trunk conductors 98 and 99 and thence to the switch D.

The mechanical details of the first-selector are, in general, well known, involving the switch shaft (not shown) which carries the line wipers 104 and 105 and the private wiper 106. The side switch is controlled by the private magnet 107, and when the switch is in normal or first position the side switch wipers 108, 109, 110 and 111 engage the contact points 112, 113, 114 and 115, respectively. In the second position the side switch wipers engage the contact points 116, 117, 118 and 119, and when the wipers are in third position the contact points 120, 121, 122 and 123 are engaged by their respective wipers. After the line switch C has operated and a trunk leading to a first-selector has been seized, the first-selector is then under the control of the calling subscriber through the medium of the vertical and rotary line relays 124 and 125. While the side switch is in the first position the calling subscriber controls the vertical magnet 126 which operates to give the switch shaft a vertical motion. By means of the rotary line relay 125, and while the side switch is in the first or second position, the subscriber controls the private magnet 107 and, therefore, the side switch. When the side switch is in second position the rotary magnet 128 is energized and the switch shaft that carriers the wipers 104, 105 and 106 is operated in a rotary direction. The vertical and rotary line relays 124 and 125, acting conjointly, provide the means by which the release magnet 129 is operated by the subscriber while the side switch is in first or second position. If the side switch passes to third position, however, since the selector D is of the trunk-release type, the release magnet 129 is then controlled through the connector E by way of the private wiper 106, and by means of the back-release relay 130.

The mechanical details of the selector and connector, as is well known, are very much the same. For instance, the connector switch shaft (not shown), like the selector, carries the line wipers 131 and 132 and the private wiper 133. The connector switch is also controlled by the calling subscriber through the medium of the vertical and rotary line relays 134 and 135. The vertical line relay 134 directly controls the vertical magnet 136 and also the rotary magnet 137. The function of the vertical magnet 136 is to give the shaft and shaft wipers a vertical motion, and the rotary magnet 137 imparts to the shaft and shaft wipers a rotary or circular motion. The rotary line relay 135 controls the private magnet 138, which lat-

ter, under certain conditions, controls in turn the vertical and rotary magnets 136 and 137, the release magnet 139, and also the side switch wipers 140, 141, 142 and 143. The said side switch, like the side switch of the selector, has a normal or first position, a second position and a third position. The release magnet 139 is also controlled by the vertical and rotary line relays 134 and 135 conjointly. By the use of the condensers 144 and 145 the circuit through the connector is divided into two sections. The connector is provided with a differentially wound relay 146 which is composed of the windings 147 and 148. The function of this relay is to provide the calling subscriber with talking battery current when the back-bridge relay 149 energizes, and also in conjunction with the vertical line relay 134 to control the ringer relay 150 by means of which the ringer generator H is bridged across the terminals of the called line to signal the called subscriber. The back-bridge relay 149, comprising the windings 151 and 152, provides the called subscriber with talking battery current when the primary circuit of the called substation is bridged across the line. The central station is equipped with the busy signaling apparatus I, of any suitable design, as, for example, the one comprising an interrupter 153 in series with the primary winding 154 of the induction-coil 155, whereby a busy signaling current is induced in the secondary winding 156 of the said induction-coil. When the connector shaft is raised one or more steps the secondary winding 156 is connected with the side switch wiper 141 through the normal springs 157 and 158 when the side switch is in first position.

The operation of my improved line switch C may be more clearly understood from a description of a call, as follows: To call the number 220 (substation A′) the subscriber at substation A removes his receiver from the switch-hook and operates the calling device once, in the well-known manner, for each digit. When the dial is rotated for the first digit a preliminary impulse is transmitted over the rotary line conductor. This preliminary impulse energizes the trip magnet 44, whereby the line switch C is operated to seize an idle trunk line leading to a first-selector. In returning to normal position for the first digit the dial operates the first-selector switch to establish connection with an idle trunk line leading to a connector. Of course, it will be understood that when the dial is turned for each digit a preliminary rotary impulse is transmitted to the rotary line, which impulse, if the selector D or a connector E is on the line, is received by the rotary line relay of the switch while the side switch is in first position. This rotary line relay, of course, energizes; but since the side switch is in first position this is without effect, and the switch is not operated until the dial delivers the vertical impulses. This preliminary operation of the rotary line relay causes the private magnet to be energized and deënergized once, but in the switches disclosed in the said selector and connector patents the side switch can under no circumstances leave the first position until after the vertical magnet has been operated one or more times. Said preliminary impulse is effective only in operating the line switches. The impulses for the last two digits are directed toward the connector E which operates to place its shaft wipers in connection with the contacts corresponding to the desired line. The preliminary impulse for operating the line switch C that occurs when the calling subscriber rotates the dial forward for the first digit is caused by the rotary impulse spring 22 being pressed against the ground post 16. As a result of the impulse the trip magnet 44 of the line switch C is energized by a flow of current from ground G′ to the springs 14 and 15, ground post 16, impulse spring 22 to the rotary line conductor 35, conductor 159 (Fig. 2), through the windings 160 and 161 of the trip magnet coils 62 and 61, cut-off springs 57 and 59 to the battery lead 162, thence through battery B to ground G. As soon as the trip magnet 44 energizes, the armature 48 is attracted, and the plunger 42 is liberated and thrust into the bank terminal Q (assuming that the plunger 42 is opposite this particular terminal at the time) by the spring 63. The plunger, upon thus operating, moves the plunger-arm 43 about the pin 51, whereby the arm 55 upon the end of the plunger-arm carries the springs 57 and 58 out of engagement with the springs 59 and 60. The disengagement of the springs 57 and 59 breaks the energizing circuit through the trip magnet 44; the said trip magnet then deënergizes and permits its armature 48 to fall back—that is, the spring catch 53 falls against the terminal piece 54, as shown. When the plunger 42 engages the bank terminal Q an energizing circuit is closed through the motor magnet relay 79, which in turn operates to close an energizing circuit through the motor magnet 76. The motor magnet then operates to advance all idle plungers in locking engagement with the shaft 65 to a point opposite the next idle bank terminal, similar to the terminal Q. The circuit through the relay 79 extends from ground G^2 through the winding 163 of the relay 79, segment 80, wiper arm 81, segment 83, conductor 164, bank terminal springs 75 and 74, release magnet 45 to the battery lead 162, thence through battery B to ground G. Although this circuit includes the release magnet 45, the magnet 45 does not operatively energize since the windings of the

relay 79 are of a high resistance, while the winding of the release magnet is comparatively low. The relay 79 upon energizing operates to place the springs 95 and 96 in contact, whereby a circuit is completed through the motor magnet 76 extending from ground G^3 through the springs 95 and 96, motor magnet springs 93 and 94, through the motor magnet 76 to the battery lead 162, thence through battery B to ground G. The motor magnet 76 upon energizing attracts its armature 90, whereby the pawl 91 engages the ratchet wheel 77 and rotates the wheel one step. When the armature 90 is attracted against the magnet cores the springs 93 and 94 disengage, thereby breaking the energizing circuit through the motor magnet. The cam 78 being in engagement with the pin 86 is operated to advance the plunger shaft 65 and all idle plungers that may be in normal locked position with the shaft 65 one step opposite another trunk terminal, similar to the terminal Q, assuming the next succeeding trunk is idle. Consequently, the wiper 81 is carried from the contact point 83, which corresponds to the terminal Q, to the contact point 97, which latter corresponds to the terminal before which the advanced idle plungers are now resting. Suppose that nine subscribers have called and that the master switch has been thus operated nine steps, carrying the wiper 81 to the last contact point 82. Now, when the motor magnet 76 operates for the next step, when the tenth subscriber calls, the wiper 81 passes back and drops into engagement with the contact point 83, as already explained. If the trunk is still busy the wiper 81 finds battery current on contact 83, and an energizing circuit is established through the differential relay 79, which in turn operates to close an energizing circuit through the motor magnet 76. The current through the said relay 79 flows from the said contact 83 through the wiper 81 to the common segment 80, through the winding 163 of the differential relay 79 to ground G^2. When the differential relay 79 attracts its armature the differential relay springs 95 and 96 are pressed into contact, thereby closing an energizing circuit for the motor magnet 76 from ground G^3 through the said springs 95 and 96, through the motor magnet springs 93 and 94, motor magnet 76, thence to the battery lead 162 and through battery B to ground G. The motor magnet then operates, as previously explained, to rotate the ratchet wheel 77 one step for advancing the plunger shaft 65 one step and the master switch bank wiper 81 one step also and into engagement with the second segment 97. The plunger shaft 65, when thus advanced one step, carries all idle plungers that are in locked engagement with the said shaft to a point opposite the next bank terminal, as previously explained. If there should still be a guarding potential at the bank segment 97 of the master switch bank, the differential relay 79 will remain energized, whereby the energizing circuit through the motor magnet 76 is again completed when the motor magnet springs 93 and 94 again engage; and as a result the motor magnet 76 is again operated, whereby the plunger shaft 65 and the master switch wiper 81 are advanced another step. This operation continues as long as the wiper 81 continues to find segments with guarding potentials. As soon as an idle segment is found, however, the energizing circuit through the differential relay 79 is broken, at which time the said relay in turn breaks the energizing circuit for the motor magnet 76 until the next subscriber makes a call. At the instant that the plunger 42 enters the said bank terminal Q the following springs are pressed into contact: 68 and 69, 70 and 71, 72 and 73, and 74 and 75. The engagement of the springs 72 and 73 establishes a guarding potential, by way of the normal conductor 103, at the connector private bank contacts corresponding to the line that terminates in the line switch C, to prevent any subscriber from calling the said line after the calling subscriber at substation A operates his dial preparatory to making a call, as explained. The circuit over which the said guarding potential is established extends from ground G^4 through the bank springs 72 and 73 to the private normal conductor 103. Also, the closure of connection between the springs 74 and 75 establishes a guarding potential at the master switch bank contact 83 over the following circuit: from battery B to the battery lead 162, thence through the release magnet 45 and springs 74 and 75 over the conductor 164 to the said contact point 83. It will be understood that the bank terminal Q, being the first bank terminal of the line switch bank, corresponds to the first segment 83 of the master switch bank O and, therefore, to the trunk line conductors 98, 99 and 100 which terminate in the selector D. This guarding potential protects the seized trunk conductors 98, 99 and 100 from being seized by other plungers, as already explained. The closure of connection between the springs 68 and 69 extends the calling subscriber's vertical line conductor 34 to the vertical trunk conductor 98 and to the side switch wiper 108 of the first-selector D. The closure of contact between the springs 70 and 71 in a similar manner extends the subscriber's rotary line conductor 35 to the rotary trunk conductor 99 and to the side switch swiper 109 of the selector D. The subscriber has thus established connection with the selector D which is now operated by the impulses that are delivered as the dial returns to normal position. The first

digit being 2 the spring 21 is pressed onto the ground post 16 twice. As a result the vertical line relay 124 of the first-selector D is energized each time by a flow of current from the substation ground G′ through the springs 14 and 15 to the ground post 16, thence through the spring 21 to the vertical line conductor 34, line switch bank springs 68 and 69, vertical trunk conductor 98, side switch wiper 108 of the selector D, contact point 112, vertical line relay 124 to the battery lead 162, thence through battery B to ground G. Each time that the vertical line relay 124 energizes, the line relay spring 166 is pressed onto the ground spring 165. The vertical magnet 126 is thereby energized and the wipers 104, 105 and 106 of the selector D are raised to the second bank level opposite the first contact of said level. The energizing circuit for the said vertical magnet 126 extends from ground G⁵ through the springs 165 and 166, private springs 167 and 168 to the vertical magnet 126, thence to the battery lead 162 and through battery B to ground G. Following the vertical impulses the rotary impulse spring 22 is then pressed onto the ground post 16, grounding the rotary line conductor 35 and energizing, therefore, the rotary line relay 125 of the selector D. The energizing current passes from ground G′ to the rotary line conductor 35; thence it flows through the line switch bank springs 70 and 71, rotary trunk conductor 99, side switch wiper 109 of the selector D, contact point 113 to the rotary line relay 125, to the battery lead 162 and through battery B to ground G. The rotary line relay upon operating presses the line relay spring 169 onto the ground spring 165, thereby establishing a circuit through the private magnet 107 from ground G⁵ through the springs 165 and 169 to the private magnet 107, thence through the said magnet to the battery lead 162, and through battery B to ground G. The private magnet, upon energizing and deënergizing, permits the selector side switch to pass from first to second position, permitting the side switch wipers 110 and 111 to engage the contact points 118 and 119, respectively. The closure of connection between the side switch wiper 110 and the contact point 118 sets up an energizing circuit for the rotary magnet 128 from ground G⁶ to the contact point 118, through the side switch wiper 110, interrupter springs 170, rotary magnet 128 to the battery lead 162, and through battery B to ground G. The said rotary magnet 128 then operates to rotate the wipers 104, 105 and 106 of the selector D into engagement with the first contact of the second level of the selector D, from which contact, it is assumed, the trunk line conductors 171, 172 and 173 lead to the connector E. If the first trunk is busy, however, and the wipers pass over busy trunk lines, then as soon as the private wiper 106 engages the first grounded private bank contact point, the private magnet 107 energizes again, locking the side switch in second position. The energizing circuit for said private magnet extends from the grounded terminal G of battery B through the occupying switch (not shown) to the private wiper 106, thence over the conductor 174 and through the back-release relay 130 to the side switch wiper 111, contact point 119, private magnet 107, thence through said magnet to the battery lead 162, and through battery B to ground G. The private magnet 107, upon thus becoming energized, locks the side switch wiper 110 in engagement with the contact point 118, whereby the rotary magnet 128 will be energized intermittently until the wipers are carried beyond the last busy trunk line. At the instant that the private wiper leaves the last busy contact point the energizing circuit through the private magnet 107 is destroyed, and as a result the selector side switch passes to third position. If, however, there are no busy trunk lines, the private magnet 107 releases the side switch to third position as soon as the wipers are carried into engagement with the first trunk line. As soon as the side switch passes to third position, as stated, the subscriber's line conductors 34 and 35 are extended to the conductors 171 and 172 which, in this case, it is assumed lead to the connector switch E. The extension of the line occurs, of course, as soon as the side switch wipers 108 and 109 engage the contact points 120 and 121, respectively. Not only is the subscriber's line thus extended, but a guarding potential is established at the private wiper 106, when the side switch wiper 111 passes onto the ground contact point 123, for protecting the seized trunk line from interference by other calling subscribers. This guarding potential is established from ground G⁷ to the contact point 123, thence through the side switch wiper 111, through the back-release relay 130, conductor 174 to the private wiper 106. It will be evident, of course, that the energizing circuit for the rotary magnet 128, to which reference has already been made, is destroyed when the idle trunk line is seized—that is, when the side switch wiper 110 leaves the contact point 118. The grounding of the line conductors 34 and 35 for the last two digits affects the connector by operating the vertical and rotary line relays 134 and 135. When the said vertical line conductor 34 is grounded the vertical line relay 134 is energized by a flow of current from the substation ground G′, vertical impulse spring 21 to the vertical line conductor 34, bank springs 68 and 69, trunk conductor 98, side switch wiper 108, shaft wiper 104, conduc-

tor 171, through the connector vertical line relay 134, winding 147 of the differential relay 146 to the battery lead 162, thence through battery B to ground G. The winding 147 of the relay 146 being included in this circuit, the said relay energizes, but its operation at this particular time is without effect. Each time that the vertical line relay 134 operates for the second digit, the vertical magnet 136 operatively energizes to carry the shaft wipers 131, 132 and 133 in a vertical direction one step at a time until the said wipers are carried two steps and thus brought opposite a level in which are located the terminals of the line #220. The circuit through the vertical magnet 136 extends from ground G^8 through the springs 176 and 177, private magnet springs 178 and 179, side switch wiper 142, vertical magnet 136 to the battery lead 162, and through battery B to ground G. When the rotary line conductor 35 is grounded, following the grounding of the vertical line conductor, the connector rotary line relay 135 becomes energized through a circuit extending from the substation ground G' through the rotary impulse spring 22, rotary line conductor 35, bank springs 70 and 71, conductor 99, side switch wiper 109, shaft wiper 105, conductor 172, rotary line relay 135, winding 148 of the differential relay 146, through the springs 180 and 181 to the battery lead 162, thence through battery B to ground G. The winding 148 of the differential relay 146 being included in this circuit, as is also the winding 147 in the vertical line relay circuit, the said relay 146 energizes, but with no effect. The rotary line relay 135, upon energizing, operates to close an energizing circuit through the private magnet 138, which latter in turn operates to release the side switch from first to second position. The energizing circuit through the private magnet 138 extends from ground G^8 through the springs 176 and 182, through the private magnet 138, springs 180 and 181 to the battery lead 162, and through battery B to ground G. For the last digit the subscriber operates the dial as previously described, grounding the vertical line conductor 34 ten times and the rotary line conductor 35 once. The connector vertical and rotary line relays 134 and 135 are operated over previously traced circuits. However, when the vertical line relay operates, a circuit is closed through the rotary magnet 137 instead of through the vertical magnet 136, since the side switch wiper 142 is now in second position. Each time that the rotary magnet is energized the shaft wipers 131, 132 and 133 are rotated one step at a time until the said wipers are carried into engagement with the normal conductors 183, 184 and 185, the first two of which conductors lead to the line terminals of the desired substation. The rotary line relay 135, upon energizing completes an energizing circuit through the private magnet 138, as before, which latter now operates with one of two results, viz., the release of the side switch from second to third position, or the so-called busy-release of the connector. It will be assumed that the former result occurs, and that the side switch passes to third position, whereby the side switch wipers 140 and 141 are placed in connection with the shaft wipers 131 and 132, respectively. Furthermore, when the side switch passes to third position a guarding potential is established for protecting the called line. This potential extends from ground G' through the side switch wiper 143, conductor 186 to the private wiper 133, which latter engages the private contact of the called line. In order to signal, the subscriber at substation A presses the signaling-button 38, whereby the vertical line conductor 34 is grounded, and the connector vertical line relay 134 and the differential relay 146 become energized as before. It will be remembered that the side switch has passed from second to third position, and that the side switch wiper 142 is in engagement with the contact point 187, thereby placing the vertical line relay 134 in control of the ringer relay 150 in the same manner in which the rotary magnet 137 came under the control of the vertical line relay when the side switch passed from first to second position. Therefore, when the vertical line relay presses the springs 176 and 177 into contact the ringer relay 150 is energized by a flow of current from ground G^8 through the springs 176 and 177, private magnet springs 178 and 179, side switch wiper 142, contact point 187, ringer relay 150, springs 188 and 189 (bearing in mind that the differential relay 146 is energized) to the battery lead 162, thence through battery B to ground G. The ringer relay, upon energizing, shifts the spring 190 from contact with the spring 191 into engagement with the spring 192, and the spring 193 is shifted into engagement with the spring 194. This results in bridging across the called subscriber's line the terminals of the ringer generator H. A signaling current is therefore sent from the generator H to the ringer relay springs 194 and 193, side switch wiper 140, contact point 195, shaft wiper 131, normal conductor 183, vertical line conductor 196, condenser 197, ringer 198, springs 199 and 200 to the rotary line conductor 201, rotary normal conductor 184, shaft wiper 132, contact point 202, side switch wiper 141, ringer relay springs 190 and 192 back to the generator H. As soon as the calling subscriber ceases to press the signaling button 38 the ringer relay 150 becomes deënergized and the springs 190 and 193 assume their normal position. The sub-

scriber at substation #220, in response to the signal, removes the receiver 203 from the switch-hook 204, whereby the switch-hook rises and permits the springs 205 and 206 to engage, and the springs 199 and 200 to disengage, thereby removing the ringer 198 from across his line. The engagement of the springs 205 and 206 closes a series energizing circuit through both windings of the relay 149 at the connector E, this circuit extending from ground G^9 to the side switch wiper 143, winding 151 of the relay 149, side switch wiper 140, contact point 195, shaft wiper 131, vertical normal conductor 183, vertical line conductor 196, springs 205 and 206, through the signaling device of the called substation, transmitter 207, primary winding 208, vertical line conductor 201, conductor 184, shaft wiper 132, contact point 202, wiper 141, ringer relay springs 190 and 191, through the winding 152 of the relay 149, springs 209 and 189 to the battery lead 162, thence through battery B to ground G. The called substation is also provided with battery current through the trip magnet 213 of the line switch C', as follows: from ground G^{10} through the springs 214 and 215, through the windings 216 and 217 to the vertical line normal conductor 183, thence through the substation transmitter 207 to the rotary normal conductor 184, as previously traced, then through the windings 218 and 219, springs 220 and 221 to the battery lead 162, thence through battery B to ground G. The trip magnet 213, upon being supplied with current in this manner, does not operatively energize, since the windings 216 and 217 are so arranged that they neutralize the energizing effect produced by the windings 218 and 219. The relay 149, upon energization, operates to shift the spring 180 from the spring 181 (which latter is connected to the battery lead 162) to the spring 210, which is in turn connected with ground. The reversal of the polarity of the spring 180 sets up a circuit which provides the calling sub-station with battery current for talking purposes. This circuit may be traced from ground G^9 to the side switch wiper 143, through the springs 210 and 180, winding 148 of the differential relay 146, rotary line relay 135, conductor 172, shaft wiper 105, side switch 109, conductor 99, springs 71 and 70, rotary line conductor 35, primary winding 19, transmitter 17, springs 36 and 37, vertical line conductor 34, bank springs 68 and 69, conductor 98, side switch wiper 108, shaft wiper 104, conductor 171, vertical line relay 134, winding 147 of the differential relay 146 to the battery lead 162, thence through battery B to ground G. Both windings of the relay 146 now carry current, but the windings are so arranged that the said relay does not operatively energize. The vertical and rotary line relays 134 and 135, being included in the above circuit, operatively energize and place the springs 176, 177 and 182 in contact, and the release springs 211 and 212 are also brought into contact; but the simultaneous action of these relays at this particular time is without effect, since there are no energizing circuits established thereby. The two substations A and A' being thus provided with battery current for talking purposes, conversation may be carried on over the circuit shown by the heavy line conductors in Fig. 1.

The release of the switching apparatus is brought about when the calling subscriber restores the receiver 2 to the switch-hook 3, thereby pressing the release springs 7, 8 and 9 into engagement for a moment. The contact of the said release springs grounds the vertical and rotary line conductors 34 and 35 simultaneously from ground G' to the release spring 7, thence through the springs 8 and 9 to the rotary and vertical line conductors. The grounding of the rotary line conductor 35 produces a short-circuit of the rotary line relay 135 in series with the winding 148 of the differential relay 146, said circuit extending from ground G^9 at the connector to the side switch wiper 143, springs 210 and 180, winding 148 of the differential relay 146, rotary line relay 135 to the shaft wiper 105, side switch wiper 109, trunk conductor 99, bank springs 71 and 70 to the rotary line conductor 35, release springs 8 and 7 to the substation ground G'. Therefore, since the winding 147 of the differential relay 146 alone carries current, the said relay becomes energized and attracts its armature, which shifts the spring 189 out of contact with the spring 209 and into contact with the spring 188. The disengagement of the springs 209 and 189 destroys the energizing circuit through the relay 149, and the spring 180 passes out of engagement with the spring 210 and into engagement with the spring 181, which removes the said short-circuit of the rotary line relay 135 and winding 148, and establishes an energizing circuit instead extending from the substation ground G' through the release springs 7 and 8 to the rotary line conductor 35, then to the rotary line relay 135, as previously traced, winding 148 of the differential relay 146, through the springs 180 and 181 to the battery lead 162, thence through battery B to ground G. The rotary relay 135 now operates and the springs 211 and 212 come into contact, whereby an energizing circuit is established through the release magnet 139 of the connector E and the release relay 130 of the selector D. However, the current now in passing, as above stated, through the winding 148 aids the winding 147 in maintaining the springs 189 and 188 in contact. The

energizing circuit through the release relay 130 and release magnet 139 extends from ground G^7 at the selector D, side switch wiper 111, release relay 130, shaft wiper 106, conductor 173, trunk-release springs 211 and 212, release magnet 139, springs 188 and 189 to the battery lead 162, and through battery B to ground G. When the connector release magnet 139 is thus supplied with current it energizes, and as a result the switch shaft and side switch are restored to normal position, thus breaking the connection between the connector switch shaft wipers 131, 132 and 133 and the normal conductors 183, 184 and 185. The back-release relay 130 being in the same circuit with the release magnet energizes simultaneously with the latter, and operates to close a circuit through the selector release magnet 129 by pressing together the back-release springs 222 and 223. Also, when the springs 222 and 223 engage, an energizing circuit is closed through the release magnet 45 of the line switch C extending from ground through the springs 222 and 223, bank springs 75 and 74, release magnet 45 to the battery lead 162, thence through battery B to ground G. The circuit through the said release magnet 129 extends from ground through the release springs 222 and 223, through the release magnet 129, thence to the battery lead 162, and through battery B to ground G. When the ground to the line conductors 34 and 35 is interrupted all the magnets involved in the release are deënergized and all of the switches are fully restored. If the called line #220 is busy at the time that the calling subscriber #500 attempts to establish connection, the connector E is released by the last impulse to the rotary line conductor 35, as follows: The said impulse energizes the rotary line relay 135 of the connector E, which relay in turn energizes the private magnet 138, pressing the private springs 224 and 225 into contact after the private wiper 133 has been carried onto the grounded private bank contact. Of course, it is understood that whenever the line #220 is busy the connector private bank contacts connected with the private normal 185 are all connected to ground. Therefore, since the connector side switch is in second position when the private magnet springs 224 and 225 are brought into contact, an energizing circuit is established through the release magnet 139 from the said grounded private bank contact to the private wiper 133, thence to the side switch wiper 143 (which is in second position) to the private magnet springs 224 and 225, to the release magnet 139, through the springs 188 and 189 to the battery lead 162, thence through battery B to ground G. The connector switch shaft and side switch are thus released, and connection is not established with the called line. Now, when the calling subscriber presses the signaling button, the vertical line relay 134 becomes energized and operates to close a circuit through the vertical magnet 136. The vertical magnet operates to carry the switch shaft vertically, whereby the off-normal springs 157 and 158 engage to permit the busy-signaling current to pass to the called subscriber in the usual way. Of course, when the subscriber hangs up his receiver after receiving the busy-signal, he grounds the line relays 134 and 135 of the connector E, as already explained, producing the release of the switching apparatus as formerly.

From the foregoing it will be seen that I provide a common battery system in which current for talking purposes is fed to a subscriber's line through the coils by which the battery is normally bridged across such line. For example, as shown in Fig. 1, the called subscriber's line is normally connected with the opposite poles of the battery B through the medium of the windings 216, 217, 218 and 219, and when this line is called this connection is retained for feeding the talking current to the line. In this way, as stated, means are provided for automatically trunking calling lines into connection with called lines, and at the same time provision is made for feeding talking current to a subscriber's line through the medium of the normal connection between that line and the common battery. It will be understood, of course, as previously explained, that the talking current also flows through the coils of the back-bridge relay, and is fed through these coils to the called line, so that the back-bridge relay windings are in multiple with the trip magnet windings of the called subscriber's line. In this way it is not necessary to open the bridge normally existing across the called subscriber's line, because closing the called line does not energize the trip magnet of the individual switch C′, inasmuch as this magnet is differentially wound. The plunger-arm 43 of the calling subscriber's line is, however, equipped with means for opening the bridge across the calling subscriber's line, in the manner explained. In other words, the energizing of this trip magnet causes it to open its own circuit, thus keeping the bridge open as long as the plunger-arm 43 is in position to maintain the connection between the calling subscriber's line and the trunk line. Furthermore, the differential windings of the trip magnets make them unresponsive to ringing current, when ringing currents are sent over the called lines to signal the called subscribers. It will be seen that the called subscriber's trip magnet does not

energize when he hangs up his receiver, for the reason that at such time there is no ground connection with his line at the substation. In other words, the called subscriber has not operated his dial, and consequently the ground connection which is used for releasing purposes is not closed, and the downward movement of the switch-hook does not ground the line. Of course, when the subscriber calls, he then puts the ground connection into condition to be closed by the downward movement of the switch-hook, so that the calling subscriber, upon hanging up his receiver, energizes the release mechanism of the connector and effects the release or disconnection between the lines.

What I claim as my invention is:—

1. In a telephone system, a subscriber's line, an individual non-numerical switch therefor having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch.

2. In a telephone system, a subscriber's line, an individual switch therefor having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch, said magnet having windings connected with the line, adapted to neutralize each other when connected in series, whereby said magnet is unresponsive to battery current flowing in both sides of the line in series, or to ringing current projected over the line.

3. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, and trunks adapted to be selected by said switch, said switch provided with a differentially-wound magnet connected in the line and provided with means for initiating the operation of said switch to seize an idle trunk.

4. In a telephone system, a subscriber's line, an individual trunking switch for said line, trunks adapted to be seized by said switch, means for selecting the trunks ahead of the calls, and a differentially-wound magnet connected in the said line and provided with means for initiating the operation of said switch to seize the preselected trunk.

5. In a telephone system, a subscriber's line, an individual trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, and means operated by said plunger-arm for opening the said bridge across the line.

6. In a telephone system, a subscriber's line, an individual trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, means operated by said plunger-arm for opening the said bridge across the line when the subscriber calls, and means for preventing actuation of said switch when the subscriber answers.

7. In a telephone system, automatic means for trunking a calling line into connection with a called line, a common battery, means normally bridging said battery across the called line and serving to feed talking current thereto after the called subscriber answers, and means for opening the bridge when the line thereof is used as a calling line.

8. In a telephone system, subscriber-operated or controlled automatic means for extending connection from a calling line to a called line, a common battery, means normally bridging said battery across the called line and serving to feed talking current thereto after the called subscriber answers, and means for opening the bridge when the line thereof is used as a calling line.

9. A telephone system comprising subscribers' lines and means for automatically extending calling lines into connection with called lines, a common battery, coils normally bridging the battery across a subscriber's line and feeding talking current thereto, and means for opening the bridge when the line thereof is used as a calling line.

10. A telephone system comprising subscribers' lines, means for automatically extending calling lines into connection with called lines, a common battery, coils normally bridging the battery across a subscriber's line and feeding talking current thereto, and means by which the calling subscriber controls the connection of said bridge across said line.

11. In a telephone system, a subscriber's line, an individual trunking switch for said line, trunks adapted to be seized by said switch, a magnet bridged across the line and adapted to initiate the operation of said switch when the subscriber calls, and provisions for making the said magnet unresponsive without opening the bridge when the subscriber answers.

12. In a telephone system, a subscriber's line, an individual trunking switch therefor, trunks adapted to be seized by said switch, and a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line, responsive only when the line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch.

13. In a telephone system, a subscriber's line, an individual trunking switch therefor, trunks adapted to be seized by said switch, a connector for seizing said line,

said individual switch comprising electromagnet windings bridged across the said line responsive only when said line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch, and a common battery for feeding talking current through all of said windings to the said line.

14. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical switch for said line having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch.

15. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual switch for said line having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch, said magnet having windings connected with the line, adapted to neutralize each other when connected in series, whereby said magnet is unresponsive to battery current flowing in both sides of the line in series, or to ringing current projected over the line.

16. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, and trunks adapted to be selected by said switch, said switch provided with a differentially-wound magnet connected in the line and provided with means for initiating the operation of said switch to seize an idle trunk.

17. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks adapted to be seized by said switch, means for selecting the trunks ahead of the calls, and a differentially-wound magnet connected in the said line and provided with means for initiating the operation of said switch to seize the preselected trunk.

18. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, and means operated by said plunger-arm for opening the said bridge across the line.

19. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, means operated by said plunger-arm for opening the said bridge across the line when the subscriber calls, and means for preventing actuation of said switch when the subscriber answers.

20. In a telephone system, a suitable line, means for seizing the line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks adapted to be seized by said switch, a magnet bridged across the line and adapted to initiate the operation of said switch when the subscriber calls, and provisions for making the said magnet unresponsive without opening the bridge when the subscriber answers.

21. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks adapted to be seized by said switch, and a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line, responsive only when the line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch.

22. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual trunking switch for said line, trunks adapted to be seized by said switch, a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line responsive only when said line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch, and a common battery for feeding talking current through all of said windings to the said line.

23. In a telephone system, a subscriber's line, an individual non-numerical switch therefor having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

24. In a telephone system, a subscriber's line, an individual non-numerical switch therefor having a releasable plunger-arm and a differentially-wound trip magnet, and

trunks adapted to be selected by said switch, said magnet having windings connected with the line, adapted to neutralize each other when connected in series, whereby said magnet is unresponsive to battery current flowing in both sides of the line in series, or to ringing current projected over the line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

25. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, and trunks adapted to be seized by said switch, said switch provided with a differentially-wound magnet connected in the line and provided with means for initiating the operation of said switch to seize an idle trunk, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

26. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, trunks adapted to be seized by said switch, means for selecting the trunks ahead of the calls, and a differentially-wound magnet connected in the said line and provided with means for initiating the operation of said switch to seize the preselected trunk, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

27. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, and means operated by said plunger-arm for opening the said bridge across the line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

28. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, means operated by said plunger-arm for opening the said bridge across the line when the subscriber calls, and means for preventing actuation of said switch when the subscriber answers, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

29. In a telephone system, a subscriber's line, an individual non-numerical trunking switch for said line, trunks adapted to be seized by said switch, a magnet bridged across the line and adapted to initiate the operation of said switch when the subscriber calls, and provisions for making the said magnet unresponsive without opening the bridge when the subscriber answers, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

30. In a telephone system, a subscriber's line, an individual non-numerical trunking switch therefor, trunks adapted to be seized by said switch and a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line, responsive only when the line is calling, and the connector being provided with electromagnet windings connected in multiple with the said windings of the individual switch, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

31. In a telephone system, a subscriber's line, an individual non-numerical trunking switch therefor, trunks adapted to be seized by said switch, a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line responsive only when said line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch, and a common battery for feeding talking current through all of said windings to the said line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

32. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical switch for said line having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

33. In a telephone system, a suitable line, means for preventing seizure of said line

when the same is busy or already in use, an individual non-numerical switch for said line having a releasable plunger-arm and a differentially-wound trip magnet, and trunks adapted to be selected by said switch, said magnet having windings connected with the line, adapted to neutralize each other when connected in series, whereby said magnet is unresponsive to battery current flowing in both sides of the line in series, or to ringing current projected over the line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

34. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, and trunks adapted to be selected by said switch, said switch provided with a differentially-wound magnet connected in the line and provided with means for initiating the operation of said switch to seize an idle trunk, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

35. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks adapted to be seized by said switch, means for selecting the trunks ahead of the calls, and a differentially-wound magnet connected in the said line and provided with means for initiating the operation of said switch to seize the preselected trunk, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

36. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, and means operated by said plunger-arm for opening the said bridge across the line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

37. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks to be selected by said switch, the said switch comprising a releasable plunger-arm, a trip magnet normally bridged across the line, means operated by said plunger-arm for opening the said bridge across the line when the subscriber calls, and means for preventing actuation of said switch when the subscriber answers, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

38. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks to be seized by said switch, a magnet bridged across the line and adapted to initiate the operation of said switch when the subscriber calls, and provisions for making the said magnet unresponsive without opening the bridge when the subscriber answers, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

39. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks adapted to be seized by said switch, and a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line, responsive only when the line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

40. In a telephone system, a suitable line, means for preventing seizure of said line when the same is busy or already in use, an individual non-numerical trunking switch for said line, trunks adapted to be seized by said switch, a connector for seizing said line, said individual switch comprising electromagnet windings bridged across the said line responsive only when said line is calling, and the connector being provided with electromagnet windings adapted to be connected in multiple with the said windings of the individual switch, and a common battery for feeding talking current through

all of said windings to the said line, said system being operative by vertical motion of certain elements thereof to select groups and by rotary motion of the same elements to then connect with the called lines found in the groups selected by the vertical motion.

41. In an automatic telephone system, means including automatic switches having step-by-step selecting movement for establishing a connection between a calling line and a called line, means common to several subscribers for feeding talking current to the called line, and means individual to said called line, connected in multiple with said common means, also serving to feed talking current to the said line.

42. In a telephone system, means including automatic switches having step-by-step selecting movement for establishing a connection between a calling line and a called line, means common to several lines for feeding talking current to a subscriber's line, and means individual to that line, connected in multiple with said common means, also serving to feed talking current to said line.

43. In a telephone system, means common to several subscribers for feeding talking current to the called line, means individual to said called line, connected in multiple with said common means, also serving to feed talking current to the said line, and subscriber-controlled means for controlling the circuit of said individual means at the central station.

44. In a telephone system, means common to several lines for feeding talking current to a subscriber's line, means individual to that line, connected in multiple with said common means, also serving to feed talking current to said line, and subscriber-controlled means for controlling the circuit of said individual means at the central station.

45. In a telephone system, a called line, means common to two or more subscribers for seizing said line, an automatic switch responsive when the said line is used as a calling line, but adapted to remain normal when the line is called, and means for supplying current through elements of said switch to the called line for talking purposes.

46. In a telephone system, a called line, an automatic connector common to two or more subscribers for seizing said line responsive to the call, an automatic switch responsive when the said line is used as a calling line, but adapted to remain normal when the line is called, and means for supplying current through elements of said automatic switch to the called line for talking purposes.

47. In a telephone system, a called line, an individual trunking switch therefor responsive only when the line is used as a calling line, means for seizing said line responsive to a call, and means for supplying current through elements of said individual switch to the called line for talking purposes.

48. In a telephone system, a called line, a non-numerical trunking switch individual to said line, responsive only when the line calls, means for seizing said line responsive to a call, and means for supplying current through elements of said switch to the called line for talking purposes.

49. In a telephone system, a called line, means for seizing said line responsive to the call, means for sending the calling impulses adapted to come to rest after each digit, a non-numerical automatic switch, and means for supplying current through elements of said switch to the called line for talking purposes.

50. In a telephone system, a calling line, a called line, means for sending the calling impulses adapted to come to rest after each digit, means including a switch having both vertical and rotary motion to extend the call to the called line, a non-numerical trunking switch, means for supplying current for talking purposes, connections whereby such current is fed through elements of the first-mentioned switch to the calling line, and other connections whereby such current is fed through elements of said last-mentioned switch to the called line.

51. In a telephone system, a called line, means for sending the calling impulses adapted to come to rest after each digit, means common to two or more subscribers and controlled by said impulses for seizing said line, a central source of talking current, and a normal connection between said source and said line for supplying current thereto for talking purposes.

52. In a telephone system, means including automatic switches for establishing a connection between a calling and a called subscriber's line, a normal connection for supplying current from a central source to the called line for talking purposes, and means for opening said normal connection when the line is used as a calling line.

53. In a telephone system, means including automatic switches for establishing a connection between a calling and a called subscriber's line, a normally closed battery bridge across a line adapted to supply current thereto for talking purposes when the line is called, and means for opening said bridge when the line is used as a calling line.

54. In a telephone system, a normally closed battery bridge across a telephone line adapted to supply current thereto for talk-

ing purposes when the line is called, and means responsive to the subscriber of such line for opening said bridge when the line is used as a calling line.

55. In a telephone system, means for sending the calling impulses adapted to come to rest after each digit, means individual to a line for supplying current thereto for talking purposes when the same is used as a called line, and means common to two or more subscribers for supplying such current to said line when the latter is used as a calling line.

Signed by me at Chicago, Cook county, Illinois, this 26th day of June, 1907.

WILSON L. CAMPBELL.

Witnesses:
EDWARD D. FALES,
ARTHUR B. SPERRY.