A. E. KEITH

TELEPHONE EXCHANGE SYSTEM.

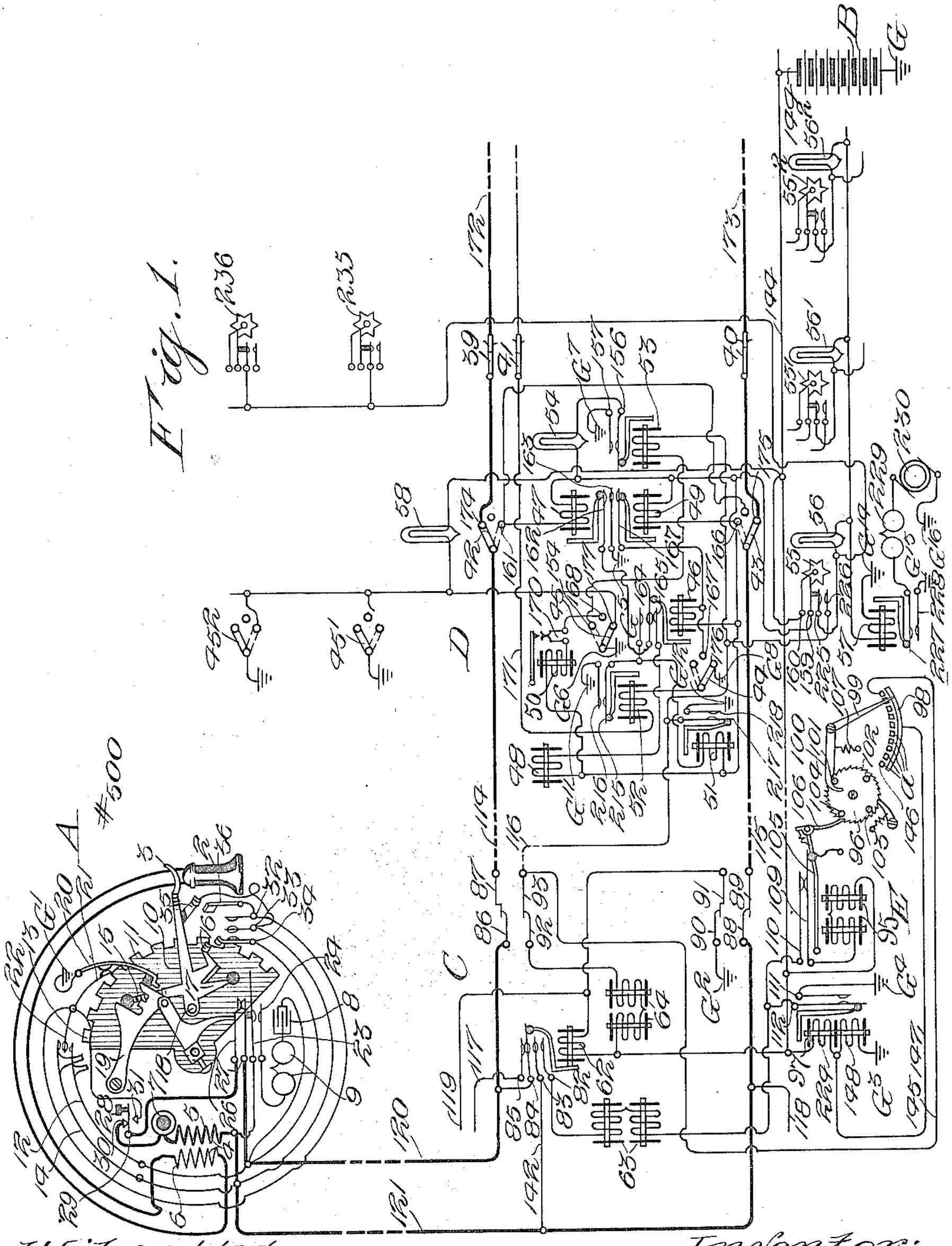
APPLICATION FILED JAN. 22, 1907. RENEWED MAR. 20, 1918.

1,283,413.

Patented Oct. 29, 1918.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses.

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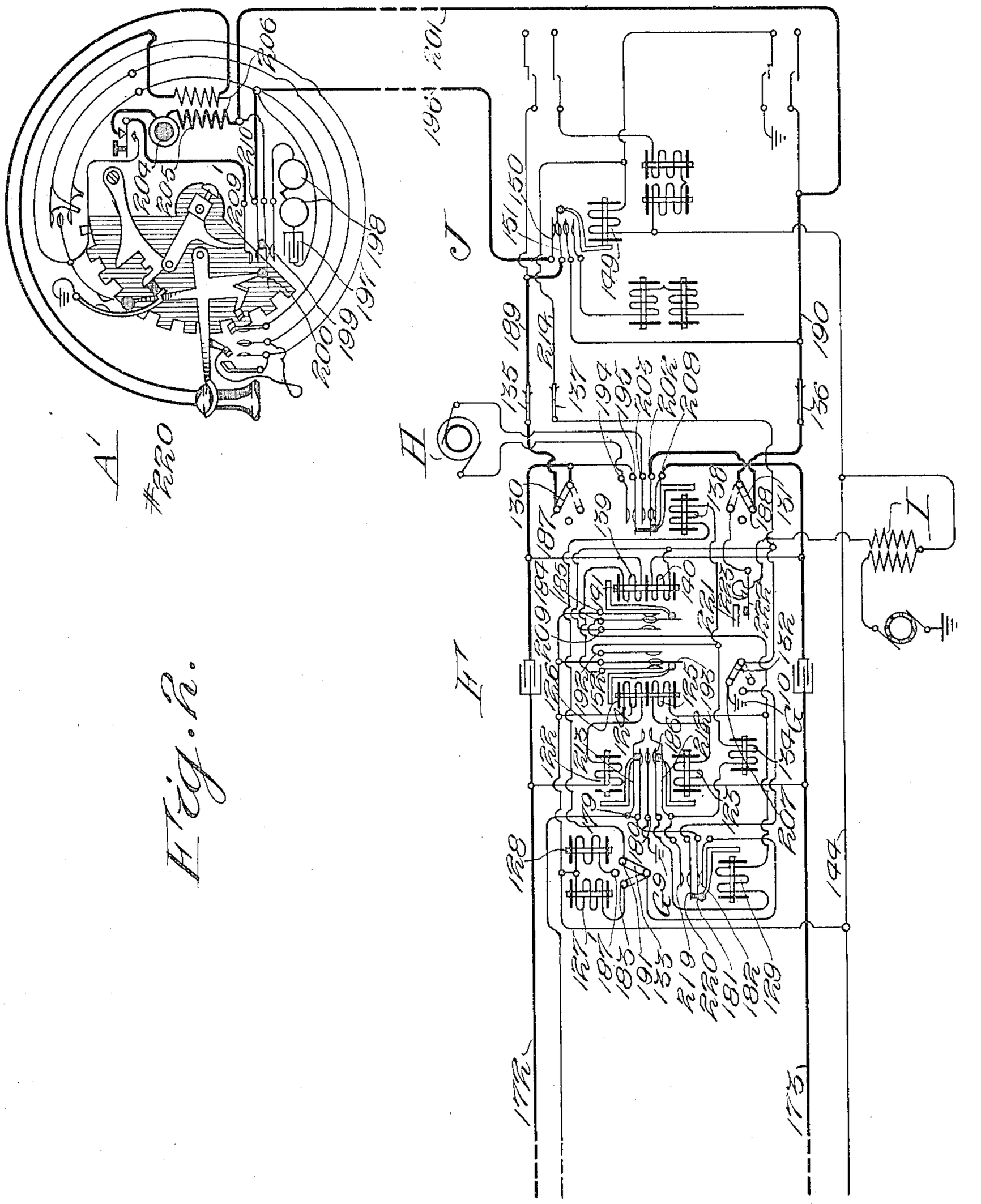

Fig. 2.

Witnesses.
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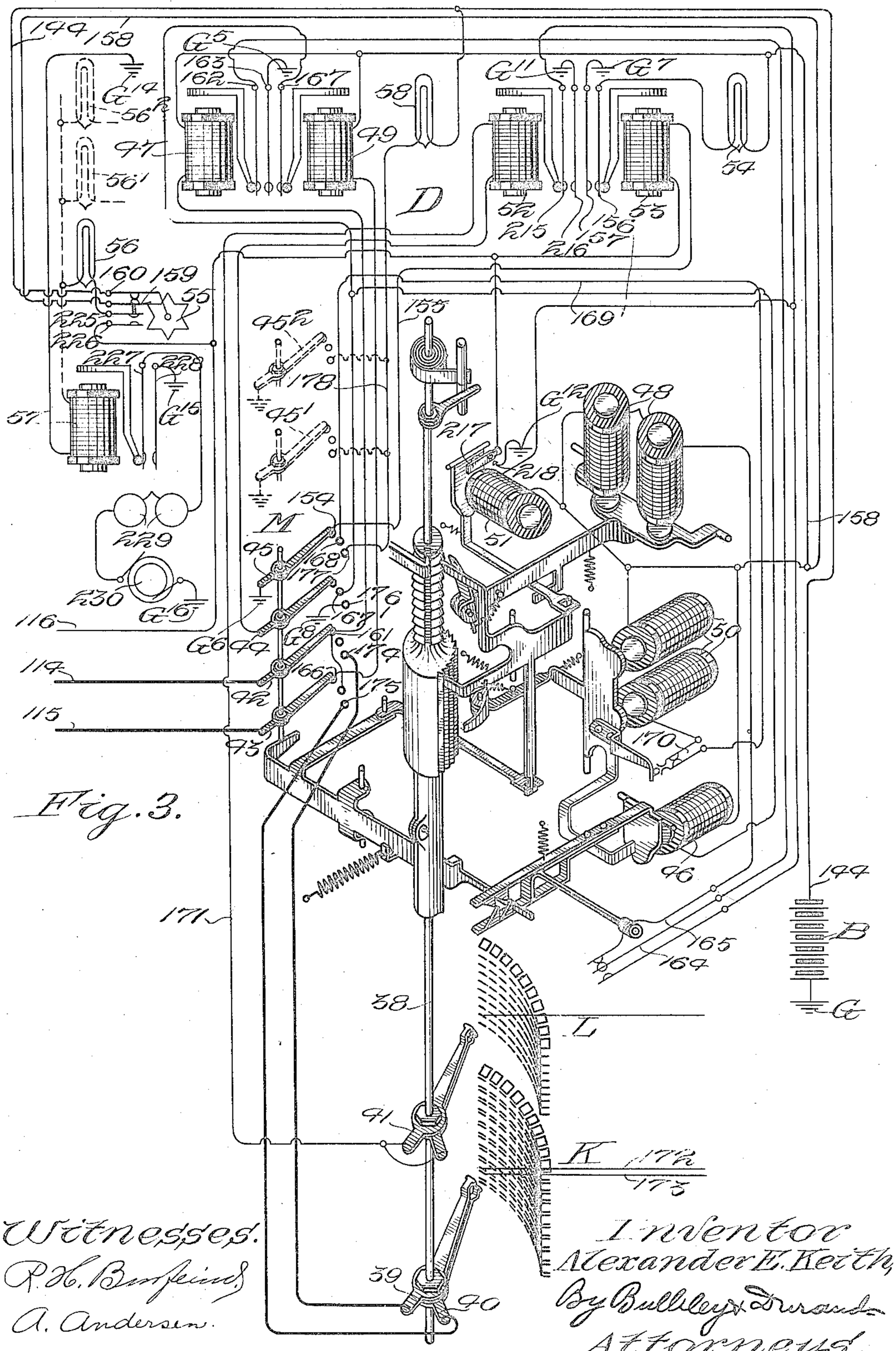

Fig. 3.

Witnesses.
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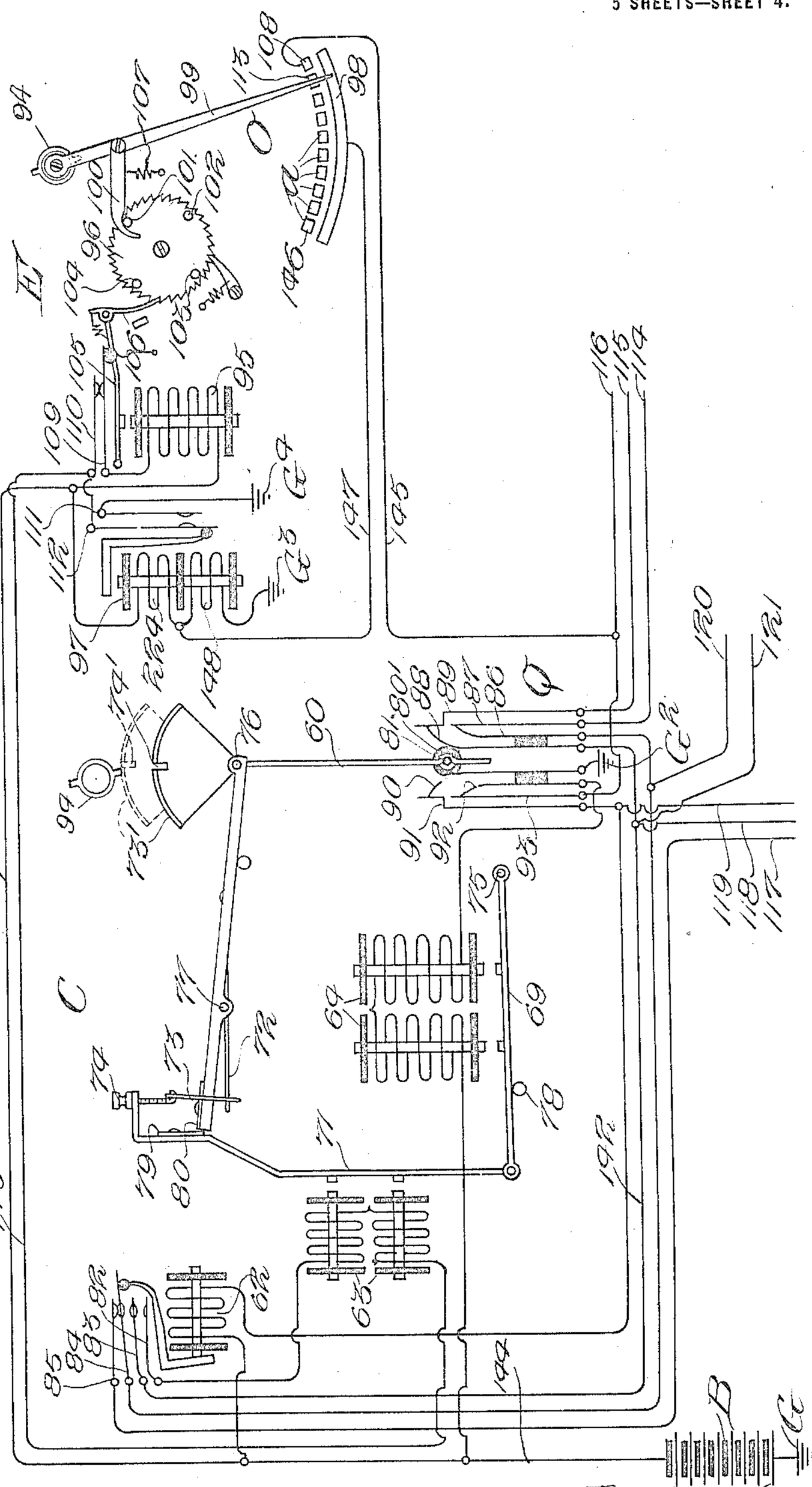
5 SHEETS—SHEET 4.

Fig. 4.



Witnesses.

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5 SHEETS—SHEET 5.

Fig. 5.

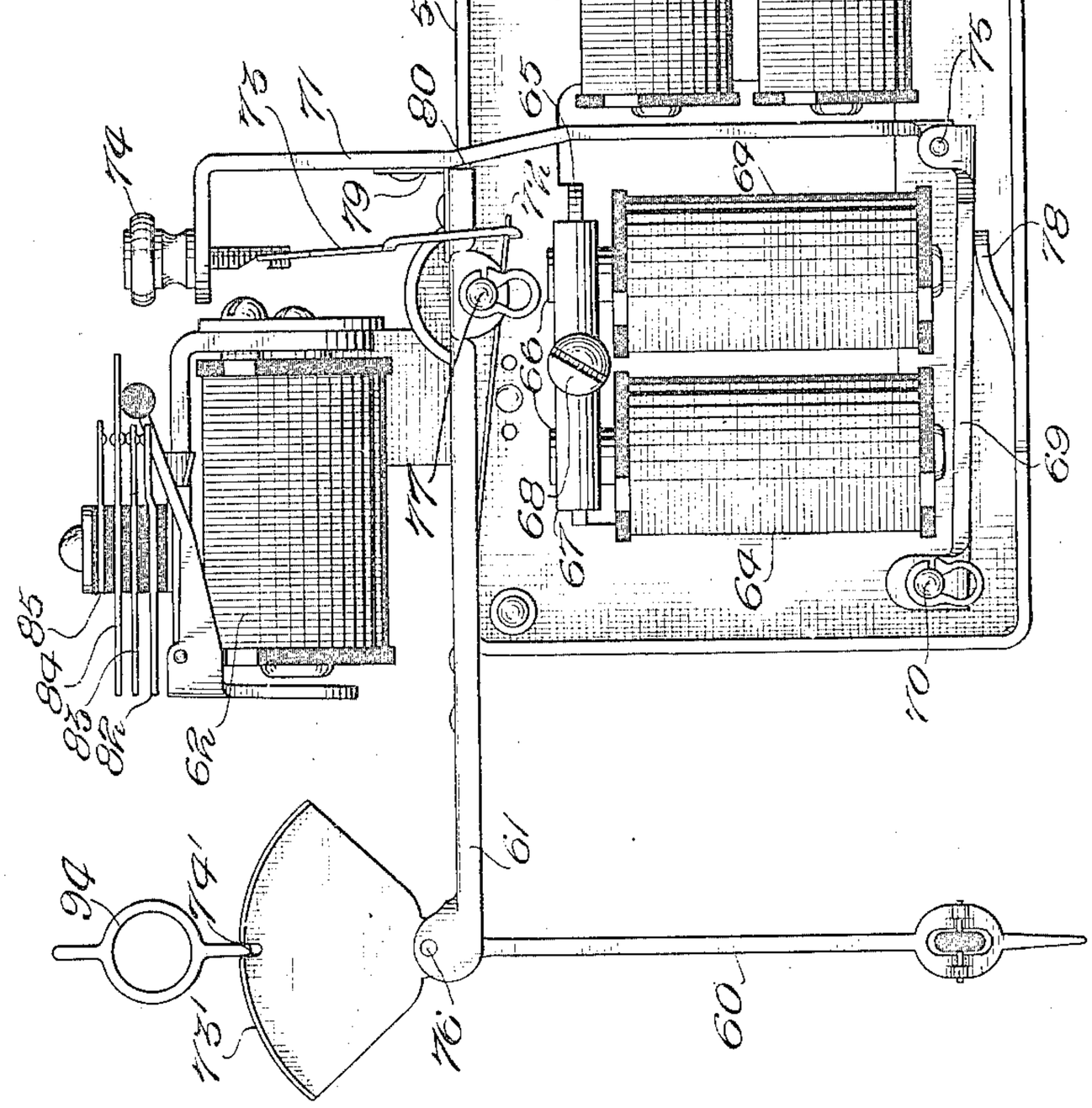


Fig. 6.

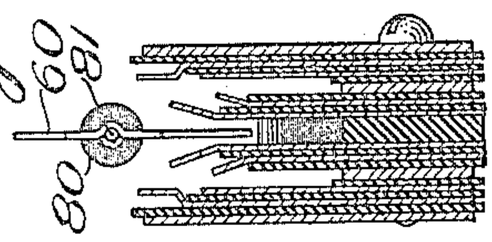


Fig. 7.

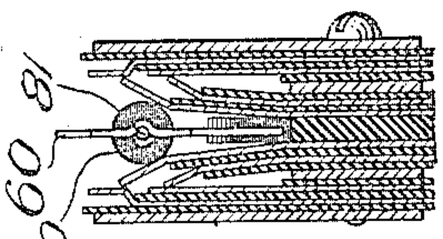
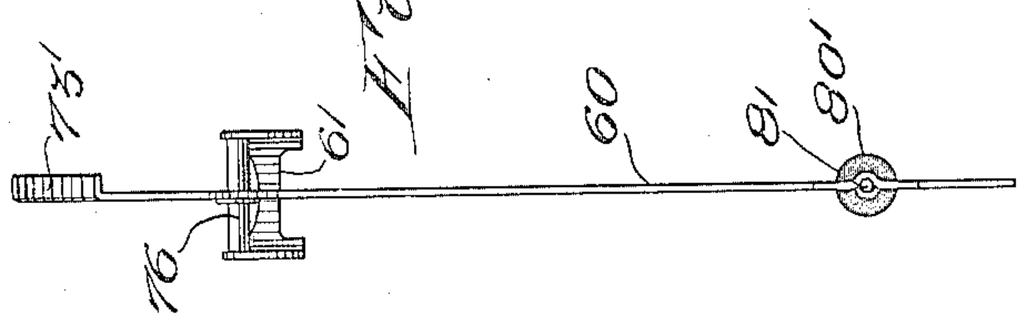


Fig. 8.



Witnesses.

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UNITED STATES PATENT OFFICE.

ALEXANDER E. KEITH, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

1,283,413. Specification of Letters Patent. Patented Oct. 29, 1918.

Application filed January 22, 1907, Serial No. 353,488. Renewed March 20, 1918. Serial No. 223,675.

To all whom it may concern:

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

My invention relates to automatic telephone exchange systems in general, but more particularly to automatic systems which are operated on the district system principle—such as systems involving a main central station and several outlying sub-central stations, with subscribers' stations connected with the sub-central stations—, and especially to systems of this character employing a common battery or centralized source of current for both talking and switching purposes.

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

Special objects of my invention are the provision of means by which an attendant at the main or central station can release the subscribers' individual switches at the sub-central stations; the provision of an improved arrangement involving third or release trunk conductors between the main or central station and the sub-central stations; the provision of means for indicating to the attendant at the central station the condition of the first-selectors—that is to say, for giving a visual signal or indication whenever a first-selector is operated; the provision of means for indicating when a line is grounded and for automatically releasing the first-selectors by the fusing or blowing of the heat-coils; the provision of an arrangement by which the automatic releasing of the first-selectors in this manner will not operate to release the subscribers' individual switches when the heat-coils are fused or blown by the grounding of the lines; the provision of an arrangement by which the restoration of the heat-coils by the attendant will automatically release the subscribers' individual switches, providing the abnormal connection to ground has disappeared or been removed; the provision of improved individual switches for the subscribers' telephone lines; and the provision of certain details and features of construction and combinations tending to increase the general efficiency and serviceability of a telephone exchange system.

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

In the accompanying drawings, Figures 1 and 2 taken together show diagrammatically an established connection between calling and called substations in a system embodying the principles of my invention. The system shown in said figures represents a district system the subscribers in which are arranged in groups, and the lines of each group terminating in a sub-central, while the main central office may be provided with trunking apparatus only.

Fig. 3 is a diagrammatic perspective view of one of the central office switches.

Fig. 4 is a diagram representing one of the switches individual to each subscriber's line, together with the master switch for controlling all the line switches of the same group. In said figure the necessary connections between a line switch and a master switch are also shown.

Fig. 5 is a plan view of one of the line switches.

Fig. 6 is a sectional view of one of the line switch banks with the plunger or circuit controlling arm in normal position.

Fig. 7 is a similar view showing the plunger or circuit-controlling arm in operative position.

Fig. 8 is an elevation of the plunger or circuit-controlling arm of the line switch.

In Figs. 1 and 2 the calling substation is shown at A and the called substation at A′. For the purposes of my invention the said substations may be considered as being allotted to either the same or different sub-exchanges; but in this case it will be assumed that they are allotted to different sub-exchanges. The substation #500, for example, it is assumed is allotted to the five hundred sub-central, and the substation A′ to the two hundred sub-central. For operating purposes a central source of current B is provided having its positive terminal preferably grounded; but sometimes it may be desirable to provide a separate source for each sub-central and for the main central or trunking office. The switching apparatus which is shown, and through which the subscribers A and A′ are connected, possesses many characteristic features which are well

known. Comprised in said switching apparatus is a subscriber's line switch C which is of an improved and highly efficient type. The said switch C is a modified form of the switch disclosed in my prior application Serial No. 311,327, filed April 12, 1906, for telephone systems and apparatus. It is designed to operate automatically (when the subscriber at the allotted substation sends in an impulse) to seize an idle trunk line leading to the next switch, preferably to a first-selector. The switch D with which the switch C is shown connected is a selector switch of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, and comprises certain new features especially adapting it for supervisory work. The switch E is a master switch for controlling the line switch C and all other line switches of the same group. The connector switch F is a modified form of the connector disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, and is adapted for common battery work. The said line and selector and connector switches are adapted to be operated from the calling substation by ground impulses derived from the grounded terminal G of the battery B. The central exchange is further provided with a central source of ringing current H and a source of busy-signaling current I. The switch J is allotted to the called substation A′ and is, of course, similar to the switch C. The substations A and A′ may be of any suitable type. The substation A comprises a receiver 2, switch-hook 3, induction-coil 4 which consists of the primary winding 5 and secondary winding 6, transmitter 7, condenser 8, and the ringer 9. In addition to the above-mentioned parts there is provided an impulse wheel 10 which has the usual vertical impulse teeth 11 that are adapted to operate the vertical impulse spring 12. The impulse wheel carries the rotary impulse tooth 13 which operates the rotary impulse spring 14. The switch-hook has radiating from its body a number of cam arms 15, 16 and 17, and is pivotally secured to the keyboard (not shown) by the screw 18 about which it moves when the receiver is removed. The movement is produced by a spring (not shown), and the switch-hook is pushed up for the purpose of changing certain circuit connections to be disclosed. The cam arm 15 controls the so-called locking arm 19 that normally rests in the position shown at substation A′. After the switchhook has reached its uppermost position the locking arm 19 occupies the position shown at substation A. The coöperating ground springs 20 and 21 engage, thus placing the ground post 22 in contact with the substation ground G′, whereby, when the subscriber releases the dial after rotating it as described, the vertical impulse teeth 11 will cause the vertical impulse spring 12 to come into contact with the ground post 22, and immediately following, the rotary impulse tooth 13 causes the rotary impulse spring 14 to come into contact with the same ground post 22. When the switch-hook is down the cam arm 17 maintains a contact between the springs 23 and 24, thereby bridging the ringer 9 across the line. The springs 26 and 27 are then disengaged, and the primary circuit, including the winding 5 in series with the transmitter 7, is interrupted by the separation of the springs 26 and 27. The signaling device whereby a subscriber may signal another after a connection has been established comprises a push-button 28 and a spring 29, which latter normally engages the contact point 30; but when the push-button 28 is pressed the spring 29 leaves the contact point 30 and engages the contact point 31 which is connected with the substation ground G′. Means whereby the subscriber may release the central station apparatus brought into service comprises three springs 32, 33 and 34, known as the release springs, so controlled by the cam arm 16 that when the switch-hook descends the three release springs are momentarily brought into contact, thereby grounding both the subscribers' line conductors simultaneously. In addition, the substation A is provided with a fourth cam 35 which is suitably insulated from the switch-hook 3. Said cam is adapted to momentarily engage the spring 36 when the receiver 2 is removed and the switch-hook rises. This momentary engagement when the receiver is removed produces a preliminary impulse, whereby the line switch C is operated. The switch D (shown in Figs. 1 and 3) embodies, among other details, the following well-known devices and circuits: a switch-shaft 38 which carries the vertical and rotary wipers 39 and 40, respectively, and the private wiper 41. The said wipers are adapted to engage the banks K and L. The side switch M is well known and comprises the side switch wipers 42, 43, 44 and 45 which may be designated as vertical, rotary and private side switch wipers and the rotary magnet side switch wiper, respectively. The side switch is under the control of the private magnet 46. Through the medium of the vertical line relay 47, and while the side switch is in first position, the subscriber controls the vertical magnet 48, which latter operates to raise the switch-shaft and shaft wipers 39, 40 and 41 vertically. By means of the rotary line relay 49, and while the side switch is in first position, the subscriber controls the private magnet 46 and, therefore, the side switch. While the side switch is in second position the rotary magnet 50, which carries the shaft and shaft

wipers in a rotary or circular direction, is energized. The vertical and rotary line relays 47 and 49, acting conjointly, provide means whereby the subscriber controls the release magnet 51 while the side switch is in first or second position. After the side switch passes to third position, then, since the first-selector is of the trunk-release type, the said switch is controlled from the next switch with which a connection has been established through the private wiper 41 and by means of the back-release relay 52. In addition, the lamp-relay 53 is provided for closing a circuit through the signal lamp 54 when the first-selector is seized by a line or subscriber's individual switch. Through the heat-coil 55 the operating relays and magnets receive battery current. Also, the signal lamp 56 is provided for indicating to the central office attendant that a heat-coil of the selector group including selector D has blown. The lamps 56′ and 56² are corresponding group lamps of other first-selector groups similar to the group including the switch D. The relay 57 is common to the group of lamps 56, 56′, 56², etc.; hence when any lamp of the said group glows, the energizing current passes through the relay 57, which in turn operates to give an audible signal. Furthermore, the lamp 58 is, like the lamp 56, allotted to a group of switches. One terminal of the said lamp 58 is connected with the third contact point of the wiper 45 of the selector D. The corresponding wipers 45′ and 45² are of other first-selectors of the same group as the selector D. The functions of these signal lamps will be more fully explained hereinafter in connection with the calling operation. The line or individual switch shown in Fig. 5 is an improvement upon the line or subscriber's individual switch shown in my said previous application, and is built about a metallic base or frame 59 and comprises a plunger 60 and plunger arm 61. It is also equipped with a bridge-cut-off relay 62, a trip magnet 63 and switch-release magnet 64. A section of the metal from the central portion of the frame is removed to make the structure as light as possible, while another section of the portion is turned up at a right angle to the base of the frame to form a lug or flange 65 upon which the said switch-release magnet is mounted. Said flange has stamped through it a couple of circular holes through which the ends of the cores 66 are passed to maintain the coils of the said release magnet parallel with the base of the frame. They are retained in this position by a U-shaped locking collar 67 between the faces of which the magnet-supporting flange extends. Said collar has four openings (two on each of the parallel faces) arranged to form two tandem sets through which the cores of the switch-release magnets also pass, as shown. After the magnets are inserted in position they are then tightened in place by a shearing action produced upon the said cores of the switch-release magnets, between the flange and the capping collar, by means of a screw 68 that passes through a threaded portion on the said collar, the end of which screw is forced onto the upper edge of the magnet-supporting flange 65. The said switch-release magnet is provided with an armature 69 that is pivoted on a pin 70 which rises from the base of the switch. The said armature carries pivotally secured on its end a second armature 71 that is controlled by the trip magnet 63. The pin 75 about which the armature 71 oscillates is carried on the end of the armature 69. The plunger 60 is pivotally secured by the pin 76 to the plunger arm 61, which latter is in turn pivoted to a pin 77 that rises from the switch-frame 59. The lug 78 is stamped out of the side of the frame 59 and serves as a stop or rest for the armature 69. The trip magnet 63 is mounted upon the frame 59 in the same manner as the release magnet 64. Upon the armature 71 is secured the catch spring 79 which is adapted to engage the end 80 of the plunger arm 61. The general operation of the switch is as follows: First the trip magnet 63 is energized by a preliminary impulse, and the armature 71 is attracted against the magnet cores. When the armature 71 is attracted to the right (Fig. 5), the catch 79 slides from the end 80 of the plunger arm 61, and the said plunger arm 61, owing to the tension of the spring 72, moves about the pin 77 and thrusts the plunger 60 into the bank Q (shown in Fig. 4); and when the trip magnet again deënergizes, the trip armature 71 falls against the end of the plunger arm 61. The switch is restored when the release magnet 64 becomes energized, whereby the armature 69 is attracted, and accordingly the trip armature 71 is moved upwardly until the catch 79 again slides over the end 80; then when the release magnet 64 becomes deënergized the armature 69 returns to normal position and remains at rest against the stop 78. Furthermore, since the plunger arm 61 is now in engagement with the armature 71, the said plunger arm is also moved about the pin 77, whereby the plunger 60 is removed from the bank Q to the position shown in Fig. 6. Also, since the plunger shaft has advanced one step, the hub 73′ of the plunger 60 comes to rest in the position shown by the dotted lines in Fig. 4, against the plunger shaft 94; and as the said plunger shaft advances each time an idle trunk is seized, the plunger 60 is not advanced but remains in this position opposite the trunk terminal from which it has just disengaged, since the slot 74′ is not in engagement with the plunger shaft 94. After all of the trunk lines have been successively

seized, and the plunger shaft again passes to the position it occupied when the plunger 60 seized the terminal Q, the plunger 60 returns into engagement with the said plunger shaft. In the meantime, if the line switch C is again operated, the plunger 60 again engages the same terminal Q. In Fig. 8 is shown a side elevation of the plunger 60, to which is secured the roller bushing 80′ by means of the pin 81. The bridge-cut-off relay 62 is provided with the springs 82, 83, 84 and 85, the former two (82 and 83) for controlling the energizing circuit of the trip magnet 63, and the latter (84 and 85), when in engagement, connecting the subscriber's vertical line conductor with the vertical normal conductor. When the cut-off relay 62 is deënergized the springs 82, 83 and 84 engage, and the springs 84 and 85 disengage. The engagement of the former set (82, 83 and 84) connects both the subscribers' line conductors with the battery through the trip magnet 63. This provision is made in order to keep both sides of the line balanced. The said line switch is provided with a bank of terminals (Fig. 4), usually ten in number, only one of which is shown at Q. As shown in Fig. 4, the said terminal Q is rotated ninety degrees from its true position with respect to the swing of the plunger 60, and the bushing 80′ is correspondingly turned, all for the purpose of making the illustration clearer. The true relative positions of the plunger and banks is shown in Figs. 6 and 7. The terminal Q comprises the springs 86 and 87, 88 and 89, 90 and 91, and 92 and 93. The said springs are normally disconnected from each other, but are driven into contact in the above-mentioned order when the plunger 60 operates. Normally, the plunger 60 is, however, retained out of engagement with the line switch bank and in engagement with the plunger-controlling shaft 94, which latter is operated by the master switch E. The master switch E may be of any suitable or approved type, and is provided for operating the plunger shaft 94 and for controlling certain circuits that will be disclosed hereinafter. It comprises the following details: a motor magnet 95 for operating the ratchet wheel 96, which latter is designed for operating the plunger shaft 94; also a differential relay 97 for controlling the energizing circuit of the motor magnet 95. The said master switch also has a bank O comprising a plurality of individual contact segments *a* and a metallic segment 98, as shown in Fig. 4. The wiper 99 is adapted to remain in constant engagement with the bank O, and to at all times maintain some one of the segments *a* in electric connection with the common segment 98. The wiper 99 is operated in a step-by-step manner by the ratchet wheel 96, through the medium of a cam member 100 rigidly secured to the said wiper 99 and adapted to successively engage the pins 101, 102, 103 and 104 upon the said ratchet wheel 96. The motor magnet 95 is provided with an armature 105 upon the end of which there is suitably secured a pawl 106. Each time that the said magnet is energized the pawl 106 engages the ratchet wheel 96, advancing the latter one step. It will be noticed, therefore, that as the ratchet wheel 96 advances in a counter-clockwise direction the wiper 99 advances step-by-step from right to left; and when the pin 101, for instance, clears the cam 100 the retracting spring 107 restores the wiper 99 to its first position at the right of the bank O and in engagement with the first segment 108. The said motor magnet 95 is provided with a couple of interrupter springs 109 and 110 that are included in the energizing circuit of the said motor magnet, which energizing circuit also comprises the springs 111 and 112 controlled by the differential relay 97. Therefore, whenever the differential relay 97 is energized the springs 111 and 112 are pressed into contact, and the motor magnet 95 operates step-by-step as long as the differential relay 97 remains energized. Further, it is assumed that the terminal Q of the line switch C is the first terminal of the line switch bank. The plunger 60, while in normal engagement with the shaft 94, is retained in front of said terminal by the plunger shaft 94 whenever the master switch wiper 99 is in engagement with the bank segment 108; but as the motor magnet 95 advances the wiper 99 onto the second segment 113, the said plunger and all idle plungers similarly engaging the shaft 94 are carried opposite the next terminal of the line switch bank. It should be noted that in each switch all of the springs 90 are permanently connected and may be made of one common piece. The springs 93, however, are individual—that is, there is one separate and distinct spring for every bank set O, there being ten in the bank. The springs 88, 86, 92 and 91, like the springs 90, are also common, and the springs 87 and 89, like the springs 93, are individual. For every bank terminal Q there is a trunk line of three conductors 114, 115 and 116 leading to a selector; and there is also a normal trunk line comprising the conductors 117, 118 and 119 leading to the connector banks. The subscribers' line conductors 120 and 121 terminate in the springs 86 and 88 which, as has been stated, are common springs. When the subscriber operates the line switch C and the plunger 60 engages the terminal Q, the subscribers' line conductors 120 and 121 are extended to the vertical and rotary trunk conductors 114 and 115 and thence to the switch D. The connector switch F may be of any suitable or approved type. The mechanical

details of the first-selector and connector, as is well known, are very much the same, although there is some material difference in the circuits. The connector switch F is an improvement upon the connector disclosed in said connector patent and in application Serial No. 294,663, filed January 4, 1906, by T. G. Martin for improvement in common battery automatic telephone systems. The vertical and rotary line relays 122 and 123, respectively, receive battery current through the windings 124 and 125 of the differential relay 126. The vertical and rotary magnets 127 and 128 are directly under the control of the vertical line relay 122. The private magnet 129 is controlled by the rotary line relay 123, and said private magnet 129 in turn operates to release the side switch wipers 130, 131, 132 and 133 from first to second position, and from second to third position. The release magnet 134, when energized, operates to restore the side switch and switch-shaft wipers 135, 136 and 137. The ringer relay 138 performs the usual function of bridging the ringer generator across the line of the called subscriber, while through the windings 139 and 140 of the relay 141 the called substation receives battery current for talking purposes. When the relay 141 energizes, the calling substation is then provided with battery current for talking purposes.

A clearer understanding of the operation of my improved system may be obtained by considering its operation when one subscriber calls another. Assume, for example, that the subscriber at substation A desires to call the subscriber at substation A′ to which is allotted the line #220. To call the number 220 the subscriber at substation A operates the calling device once for each digit, in the well-known manner. The preliminary impulse for operating the line or individual switch C occurs when the calling subscriber removes the receiver 2 from the switch-hook 3, whereby the hook in rising permits the cam 35 to engage the ground spring 36. As a result the trip magnet 63 of the line switch C is energized by a flow of current from ground G′ to the spring 36, thence to the switch-hook cam 35 and to the rotary line conductor 121, conductor 142, cut-off relay springs 83 and 82 to the trip magnet 63, thence through said trip magnet to the conductor 143, motor magnet springs 110 and 109, winding of the motor magnet 95 to the battery lead 144, thence through battery B to ground G. As soon as the trip magnet 63 energizes, the armature 71 is then attracted and the plunger 60 is liberated and thrust into the bank terminal Q by the spring 72. The motor magnet 95, upon energizing, attracts its armature 105, whereby the pawl 106 engages the ratchet wheel 96 and rotates the said wheel one step. When the armature 105 is attracted against the magnet cores, the springs 109 and 110 disengage, thereby breaking the energizing circuit through the motor magnet. The cam arm 100 being in engagement with the pin 101 is operated to advance the plunger shaft 94, and consequently all idle plungers that may be in normal position are advanced one step to another trunk corresponding to the terminal Q. Also, the wiper 99 is carried from the contact point 108 (which corresponds to the terminal Q) to the contact point 113, which latter corresponds to the terminal before which the idle plungers are now resting. At the instant that the said plunger 60 enters the said bank position Q the following springs are pressed into contact: 88 and 89, 90 and 91, 92 and 93, and 86 and 87. The engagement of the springs 90 and 91 establishes a circuit from ground G^2 by way of the normal conductor 119 to the connector private bank contacts corresponding to the line that terminates in the line switch C, whereby a guarding potential is set up to prevent any subscriber from calling the said line after the calling subscriber at substation A removes his receiver preparatory to making a call, as explained. The circuit over which the said guarding potential is established extends from ground G^2 through the bank springs 90 and 91 to the private normal conductor 119, thence to the connector private banks. The closure of connection between the springs 92 and 93 also establishes a guarding potential at the master switch bank contact 108 over the following circuit: from battery B to the battery lead 144, thence to the release magnet 64, and through the said magnet and springs 92 and 93 over the conductor 145 to the said contact point 108. It will be understood that the bank terminal Q, being the first bank terminal of the line switch, corresponds to the first segment 108 of the master switch bank O. The said guarding potential protects the seized trunk lines 114, 115 and 116 from being seized by other plungers. Suppose that the master switch has operated and carried the wiper 99 to the last contact point 146. Now, when the motor magnet 95 operates for the next step, the wiper 99 engages the contact point 108, upon which there is a guarding potential. An energizing circuit is established through the differential relay 97, which in turn operates to close an energizing circuit through the motor magnet 95. The current through the said relay 97 flows from the said contact 108 through the wiper 99 to the common segment 98, thence over the conductor 147, through the winding 148 of the differential relay 97 to ground G^3. When the differential relay 97 attracts its armature the differential relay springs 111 and 112 are

pressed into contact, thereby closing an energizing circuit for the motor magnet 95 from ground G^4 through the said springs 111 and 112 to the motor magnet springs 110 and 109, thence through the said magnet 95 to the battery lead 144, and through battery B to ground G. The motor magnet then operates to rotate the ratchet wheel 96 one step for advancing the plunger shaft 94 one step, and also the master switch bank wiper 99 one step, into engagement with the second segment. 113. The plunger shaft 94 when thus advanced one step carries all idle plungers that are in engagement with the said shaft opposite the next bank terminal, as previously explained. If there should be a guarding potential at the bank segment 113 of the master switch the differential relay 97 will remain energized after the motor magnet armature 105 returns to normal position and again closes connection between the springs 109 and 110. As a result the motor magnet 95 is again operated, whereby the plunger-shaft 94 and the master switch wiper 99 are advanced another step. This process continues as long as the wiper 99 continues to find segments with guarding potentials. As soon as an idle segment is found, however, the energizing circuit through the differential relay 97 is broken, at which time the said relay in turn breaks the energizing circuit for the motor magnet 95 until the next subscriber makes a call. Furthermore, the closing in contact of the springs 92 and 93 completes an energizing circuit through the lamp relay 53 of the first-selector D, said circuit extending from ground G^6 to the side switch wiper 45, contact point 154, conductor 155, through the lamp relay 53, private trunk conductor 116, bank springs 93 and 92, through the release magnet 64 to the battery lead 144, thence through battery B to ground G. Although the trip magnet 64 is included in this circuit, the said magnet does not energize, since the relay 53 is wound to a high resistance. The lamp relay 53, upon energizing, closes the springs 156 and 157 in contact, whereby a circuit is closed through the signal lamp 54 extending from ground G^7 through the springs 157 and 156, through the lamp 54 to the conductor 158, heat-coil springs 159 and 160 to the battery lead 144, thence through battery B and to ground G. The glowing of this lamp indicates to the exchange attendant that its allotted first-selector D has been seized by a line switch. When the side switch wiper passes to second position the lamp relay 53 deënergizes and the signal disappears. The closure of connection between the springs 86 and 87 extends the calling subscriber's vertical line conductor 120 to the vertical trunk conductor 114 and to the side switch wiper 42 of the first-selector D. The closure of connection between the springs 88 and 89 in a similar manner extends the subscriber's rotary line conductor 121 to the rotary trunk conductor 115 and to the side switch wiper 43 of the selector D. The subscriber has thus established connection with the selector D and is ready to begin operating his calling device for the first digit. The first digit being 2, the subscriber operates his dial accordingly, grounding the vertical line conductor 120 each time that the spring 12 is pressed onto the ground post 22. As a result the vertical line relay 47 of the first-selector D is energized by a flow of current from the substation ground G′ through the springs 20 and 21 to the ground post 22, thence through the spring 12 to the vertical line conductor 120, line switch bank springs 86 and 87, vertical trunk conductor 114, side switch wiper 42 of the selector D, contact point 161, vertical line relay 47, conductor 158, through the heat-coil springs 159 and 160 to the battery lead 144, thence through battery B and to ground G. Each time that the vertical line relay 47 energizes, the line relay spring 162 is pressed onto the ground post 163. The vertical magnet 48 is thereby energized and the wipers 39, 40 and 41 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 48 extends from ground G^5 through the springs 163 and 162, private springs 164 and 165 to the vertical magnet 48, conductor 158, through the heat-coil springs 159 and 160, thence to the battery lead 144, and through battery B to ground G. The spring 14 is then pressed onto the ground post 22, grounding the rotary line conductor 121 and energizing, therefore, the rotary line relay 49 of the selector D. The energizing current passes from ground G′ to the rotary line conductor 121, through the line switch bank springs 88 and 89, rotary trunk conductor 115, side switch wiper 43 of the selector D, contact point 166 to the rotary line relay 49, conductor 158, thence through the heat-coil springs 159 and 160 to the battery lead 144, and through battery B to ground G. The rotary line relay, upon energizing, presses the line relay spring 167 onto the ground spring 163, thereby establishing a circuit through the private magnet 46 from ground G^5 through the springs 163 and 167 to the private magnet 46, through the said magnet to the conductor 158, to the heat-coil springs 159 and 160, and to battery lead 144 thence through battery B and 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 44 and 45 to engage the contact points 167′ and 168, respectively. The clo-

sure of connection between the side switch wiper 45 and the contact point 168 sets up an energizing circuit for the rotary magnet 50 from ground G^6 through the side switch wiper 45, to the contact point 168, conductor 169, interrupter springs 170, rotary magnet 50, conductor 158, through the heat-coil springs 159 and 160 to the battery lead 144, thence through battery B to ground G. The said rotary magnet 50 then operates to rotate the wipers 39, 40 and 41 of the selector D into engagement with a trunk line leading to some idle connector switch, and in the particular case under consideration to the connector switch F. If the wipers have to pass over busy trunk lines, as soon as the private wiper 41 engages a grounded contact point the private magnet 46 again energizes, locking the side switch in second position. The energizing circuit for said private magnet extends from the grounded terminal G of battery B through an occupying switch (not shown) to the private wiper 41, thence over the conductor 171 and through the back-release relay 52 to the side switch wiper 44, contact point 167', private magnet 46, thence through said magnet to the conductor 158, through the heat-coil springs 159 and 160 to the battery lead 144, and through battery B to ground G. The private magnet 46, upon thus becoming energized, locks the grounded side switch wiper 45 in engagement with the contact point 168, whereby the rotary magnet 50 is energized step-by-step 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 46 is destroyed, and as a result the selector side switch passes to third position. If however, there are no busy trunk lines, the rotary magnet 50 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 120 and 121 are extended to the conductors 172 and 173, which in this case, it is assumed, lead to the connector switch F. The extension of the line occurs, of course, as soon as the side switch wipers 42 and 43 engage the contact points 174 and 175, respectively. Not only is the subscriber's line thus extended, but a guarding potential is also established at the private wiper 41 when the side switch wiper 44 passes onto the grounded contact point 176 for protecting the seized trunk line from interference by other calling subscribers. This guarding potential is established from ground G^8 to the contact point 176, thence through the side switch wiper 44, through the back-release relay 52, conductor 171 to the private wiper 41. It will be necessary, of course, that the energizing circuit for the rotary magnet 50 (to which reference has already been made) be destroyed when the idle trunk line is seized. This occurs when the grounded side switch wiper 45 leaves the contact point 168. Also, when the grounded side switch wiper 45 passes to third position in contact with the point 177, an energizing circuit is established through the group lamp 58 extending from ground G^6 through the side switch wiper 45, contact point 177, conductor 178, through the lamp 58 to the battery lead 144, thence through battery B and to ground G. The glowing of the said lamp indicates to the exchange attendant that some selector of the group to which selector D belongs has operated and seized a trunk line leading to the connector switches. The lamp 58 continues to glow as long as any of its group selector side switch wipers 45, 45', 45^2, etc., (which latter two it is assumed belong to other switches) remain in third position. The second digit of the number called being 2, the calling subscriber operates his dial again accordingly, as a result grounding the vertical line conductor 120, when the spring 12 meets the ground post 22. The vertical line relay 122 of the connector switch F is, therefore, energized twice by a flow of current from the substation ground G' to the vertical line conductor 120, thence through the line switch bank springs 86 and 87 to the vertical trunk conductor 114, thence to the side switch wiper 42 of the selector D, contact point 174, vertical line wiper 39, vertical trunk conductor 172, vertical line relay 122, winding 124 of the differential relay 126 to the battery lead 144, thence through battery B to ground G. This circuit, then, comprises the winding 124 of the differential relay 126, so that the said differential relay energizes simultaneously with the vertical line relay 122; but the said energization produces no effect at this stage. The vertical line relay 122, upon energizing, presses the line relay spring 179 into engagement with the ground spring 180, as a result operating the vertical magnet 127 twice by the establishment of a circuit from ground G^9, through the springs 180 and 179, through the private magnet springs 181 and 182 to the side switch wiper 133, thence through the contact point 183 and vertical magnet 127 to the battery lead 144, thence through battery B and to ground G. As is well known, the vertical magnet 127 then operates to raise the switch-shaft wipers 135, 136 and 137 of the connector F to the second bank level. The connector having been thus operated, then when the rotary impulse spring 14 engages the ground post 22 the rotary line conductor 121 is grounded once, energizing the connector rotary line relay 123 over the following circuit: from ground G' at the substation A to the rotary line conductor 121, through the line switch

bank springs 88 and 89 to the rotary trunk conductor 115, thence to the side switch wiper 43 of the selector D, contact point 175, rotary line wiper 40, rotary trunk conductor 173 to the rotary line relay 123, thence through the differential relay winding 125, back-bridge relay springs 184 and 185 to the battery lead 144, thence through battery B and to ground G. The differential relay 126 again energizes, but still to no effect. The rotary line relay 123, however, presses the line relay spring 186 onto the ground spring 180, as a result energizing the private magnet 129. The circuit established extends from ground G^9 to the springs 180 and 186, to the private magnet 129, back-bridge relay springs 184 and 185 to the battery lead 144, and through battery B to ground G. The private magnet, upon energizing and deënergizing permits the connector side switch to pass to second position, and, among other results, shifts the side switch wiper 133 into engagement with the contact point 187′. The rotary magnet 128 is thus substituted for the vertical magnet 127, as far as the control thereof by the vertical line relay 122 is concerned. The third digit of the desired number being naught, the calling subscriber operates his dial to ground the vertical line conductor 120 ten times. As a result the vertical line relay 122 of the connector F is energized ten times, and the line relay springs 179 and 180 operated accordingly. The rotary magnet 128 is energized each time over a circuit extending from ground G^9 through the line relay springs 180 and 179, and through the private springs 181 and 182 to the side switch wiper 133, thence through the contact point 187′ and the rotary magnet 128 to the battery lead 144, thence through battery B and to ground G. The said rotary magnet then operates to rotate the shaft wipers 135, 136 and 137 step-by-step onto the tenth contact of the second level of the connector bank from which terminal leads a trunk line that extends to the called subscriber's line #220. The rotary line conductor 121 is again grounded once, energizing the rotary line relay 123 of the connector F over a circuit that has been pointed out. The said rotary line relay then presses the springs 180 and 186 into contact, as previously explained, with the result that the private magnet 129 is again energized. Energizing the rotary line relay 123 at this time produces one of two results, namely the release of the connector side switch from second to third position and establishing the desired connection, or the busy-release of the connector switch if the desired line is busy. The former result will first be considered, namely the release of the connector side switch from second to third position. The release of the side switch occurs when the private magnet 139 energizes and deënergizes as heretofore explained. At the instant that the said side switch passes to third position, the connector side switch wipers 130 and 131 having engaged the contact points 187 and 188 extend the calling subscriber's line conductors into connection with the normal conductors 189 and 190 which lead to the called line. 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^{10} to the contact point 207, side switch wiper 132 to the shaft wiper 137, which latter engages the private contact of the called line. The said guarding potential also closes an energizing circuit through the cut-off relay 149 of the line switch J, thereby removing the short-circuit from across the vertical and rotary line conductors of the called substation at the line switch J, and connecting the vertical normal conductor 189 with the vertical line conductor 196 when the springs 150 and 151 engage. In order to signal the called subscriber the calling subscriber presses the signaling button 28, carrying the spring 29 into engagement with the grounded contact point 31. As a result the vertical line conductor 120 receives a current impulse from the substation ground G′, ground springs 20 and 21 to the contact point 31, spring 29, thence through the springs 26 and 27 to the vertical line conductor 120. Grounding said conductor operates the connector vertical line relay 122 and also the differential relay 126, over circuits that have been pointed out. The operation of said relays 122 and 126 causes the energization of the connector ringer relay 138 over the following circuit: from ground G^9 at the connector through the line relay springs 180 and 179, private springs 181 and 182 and side switch wiper 133 to the contact point 191, to the ringer relay 138, thence through the differential relay springs 192 and 193 to the battery lead 144, and through battery B to ground G. Of course, since the differential relay 126 is energized, and said springs 192 and 193 are in contact, the energization of said ringer relay 138 bridges the ringer generator H across the normal conductors 189 and 190, whereby ringing current is projected over the normal line conductors 189 and 190 to the substation #220 for operating the ringer at the said substation. The path of the ringing current is as follows: from the ringer generator H through the ringer relay springs 194 and 195, and through the side switch wiper 130, contact point 187, wiper 135 to the vertical normal conductor 189, thence to the vertical line conductor 196, condenser 197, through the ringer 198 at substation #220, springs 199 and 200 to the rotary line conductor

201, thence over the rotary normal conductor 190, wiper 136, contact point 188, side switch wiper 131, ringer relay springs 202 and 203 to the ringer generator H again. The subscriber at substation #220, upon responding, bridges his transmitter 204 and primary winding 205 of the induction-coil 206 across his line conductors 196 and 201. When the connector side switch passes to third position, as explained in the foregoing, the battery B is bridged across the line for furnishing talking current thereto, and when the called subscriber's hook rises the back-bridge windings 139 and 140 of the relay 141 become energized over the following circuit: from ground G^{10} to the connector side switch contact point 207 (which latter has been engaged by the side switch wiper 132), through the side switch wiper 132, rotary back-bridge winding 140, thence through the ringer relay springs 208 and 202 to the side switch wiper 131, contact point 188, rotary line wiper 136, rotary normal conductor 190, rotary line conductor 201, primary winding 205, transmitter 204, and through the springs 209′ and 210 to the vertical line conductor 196, springs 150 and 151, thence over the vertical normal conductor 189, vertical line wiper 135, contact point 187, side switch wiper 130, vertical back-bridge winding 139, through the springs 152 and 193 to the battery lead 144, and through battery B to ground G. The back-bridge relay 141, upon energization, presses the springs 184 and 209 into engagement, thus connecting battery B across the line of the calling subscriber as follows: from ground G^{10}, side switch wiper 132, through the back-bridge relay springs 209 and 184, winding 125 of the differential relay 126, rotary line relay 123 to the rotary trunk conductor 173, and through the selector D and line switch C to the rotary line conductor 121, primary winding 5, transmitter 7, springs 26 and 27 to the vertical line conductor 120, thence through the vertical line relay 122 of the connector F, and through the winding 124 of the differential relay 126 to the battery lead 144, thence through battery B to ground G. The two substations A and A′ being thus supplied with battery current, communication may be carried on over the conductors shown by the heavy lines in Figs. 1 and 2. The release of the central office switching apparatus occurs when the calling subscriber hangs up his receiver and grounds his vertical and rotary line conductors 120 and 121 simultaneously, thereby producing a release of the switches through the medium of which the connection has been established. As the switch-hook 3 descends the release springs 32, 33 and 34 are pressed into contact, whereby the vertical and rotary line relays 122 and 123 of the connector F are energized, together with the differential relay 126, in the following manner: The primary result of grounding the rotary line conductor 121 is to unbalance the differential relay 126 by shunting or short-circuiting the winding 125 between the ground G′ at the substation A and ground G^{10} at the connector F. The shunting or short-circuiting branch may be traced from the substation ground G′ to the ground springs 20 and 21, thence to the release springs 32 and 33, to the rotary line conductor 121, line switch bank springs 88 and 89, first-selector side switch wiper 43, rotary wiper 40, trunk conductor 173, rotary line relay 123, winding 125 of the differential relay 126, back-bridge relay springs 184 and 209 to the side switch wiper 132 and to ground G^{10}. The differential relay immediately energizes by the flow of current through the winding 124 by reason of the ground connection to the vertical line conductor 120. The magnetizing current flows from substation ground G′ to the ground release spring 32, thence through the release springs 33 and 34 to the vertical line conductor 120, line switch bank springs 86 and 87, connector vertical line relay 122, winding 124 of the differential relay 126 to the battery lead 144, thence through battery B to ground G. The differential relay 126, upon energizing, separates the spring 152 from the spring 193, and carries the springs 193 and 192 into engagement. The former of said springs, namely the springs 152 and 193, as already explained, are comprised in the energizing circuit of the back-bridge relay 141, so that as soon as the said springs separate, the said relay 141 deënergizes, whereby the spring 184 leaves the ground spring 209 and returns into engagement with the non-grounded battery spring 185. The effect of this last operation is to remove the shunt from the differential relay winding 125 in series with the rotary line relay 123, as already described, establishing a circuit through said relay and winding, whereby a current-flow is set up in a reverse direction, further strengthening the differential relay 126 and reënergizing the rotary line relay 123. Under these conditions the line relays 122 and 123 are energized, whereby the trunk-release springs 212 and 213 are pressed into contact while the differential relay springs 193 and 192 are in engagement, with the result that an energizing circuit is established through the release magnet 134 of the connector F in series with the back-release relay 52 of the selector D. The release magnet 134 of the connector, upon energizing, restores the side switch and the switch-shaft to normal position in the well-known manner, at which time the line and private wipers 135, 136 and 137 are, of course, disconnected from the normal conductors 189, 190 and 214. The energizing of the back-release relay 52 carries the back-

release relay springs 215 and 216 into engagement, as a result energizing the release magnet 51 from ground G^{11} through the said springs 216 and 215, through the release magnet 51, heat-coil springs 159 and 160 to the battery lead 144, thence through battery B to ground G. The selector release magnet, upon energizing, draws its armature into position to release the switch when the release springs at the substation disengage, as described in connection with the said selector patent. In the same manner that the connector controls the energization of the release magnet 51 of the selector D, the said release magnet 51 in turn controls the energizing circuit of the release magnet 64 of the switch C. This is done through the medium of the springs 217 and 218 which are under the control of the armature of the release magnet 51 of the selector D. Therefore, when the armature of the release magnet 51 is attracted, an energizing circuit is set up through the release magnet 64 of the switch C when the springs 217 and 218 are brought into contact, which energizing circuit extends from ground G^{12} through the springs 218 and 217, conductor 116, bank springs 93 and 92, through the release magnet 64 to the battery lead 144, and through battery B to ground G. When the release magnet 64 energizes, the armature 69 is attracted, whereby the armature 71 of the trip magnet 63 is raised and the catch 79 engages the terminal 80 of the plunger arm 61, remaining thus in readiness to restore the line switch when the release magnet 64 deënergizes sufficiently. As soon as the substation release springs 32, 33 and 34 separate, the energizing circuits of the rotary and vertical line relays 122 and 123 of the connector F are destroyed. As a result, the energizing circuit through the release magnet 134 and the back-release relay 52 is broken. The deenergization of the back-release relay 52 in turn causes the deënergization of the selector release magnet, with the result already stated, causing the deënergization of the release magnet 64 of the line switch C. When the release magnet 64 of the said line switch deënergizes, the retracting spring 72, through the medium of the armatures 69 and 71, withdraws the plunger 60 from its operated condition into normal engagement with the plunger shaft 94, as a result destroying, of course, the energizing circuit of the cut-off relay 62, removing the guarding potential from the master switch bank O and from the connector bank, and disconnecting the calling subscriber's line switch from the first-selector. The calling subscriber thus restores all of the switching apparatus which he originally brought into use. It will be noticed that the spring 72 of the line switch C supplies the force by which the plunger 60 is tripped, and also the force by which the same plunger is restored. A description of how this occurs is as follows: When the plunger 60 is in normal position the armature 69 of the release magnet 64 is resting against the stop 78 and cannot, therefore, be further lowered. Furthermore, the spring 72 is maintained under tension, and when the armature 71 is withdrawn from the plunger arm 61, since the spring 72 extends behind the pivot 77 of the arm 61, the said arm is necessarily rotated about the pivot 77 in a counter-clockwise direction (Fig. 5) by the spring 72, at which time the plunger 60 is carried into engagement with the bank springs. Now, after the plunger has been operated, if the release magnet 64 energizes, the armature 69 is attracted, and since the plunger 60 is prevented from further entering into the bank, the tension is restored in the spring 72 by the raising of the armature 71, and consequently by the raising of the link 73. It will be evident that since the link 73 is attached to the screw 74, and to the left of the pivot 75 of the armature 71, the tension in the spring 72 rotates the armature 71 so that the catch 79 falls into locking position with the arm 61. It will also be evident that when the magnet 64 deënergizes, the armature 71 will be pressed downwardly by the spring 72 until the armature 69 reaches the stop 78. The busy-release of the connector F follows as a result of the energization of the rotary line relay 123, if the called line is busy, as follows: The said relay 123, upon energizing, energizes the private magnet 129, as previously described, which latter in turn presses the springs 219 and 220 into contact. As soon as the said springs 219 and 220 engage, the release magnet 134 is placed in connection with the private wiper 137 (since the side switch wiper 132 is now in second position), which wiper 137 has been previously rotated onto a grounded contact. As a result a flow of current is sent through the release magnet 134 from the grounded private wiper 137 to the side switch wiper 132, to the private magnet springs 220 and 219, to the release magnet 134, differential relay springs 192 and 193, thence to the battery lead 144, and through battery B and to ground G. The release magnet 134, upon energizing, releases the connector switch-shaft and restores the connector side switch to its first position, returning the vertical magnet 127 to the control of the vertical relay 122. Therefore, if the calling subscriber (Fig. 1) presses the signaling button 28 and grounds the vertical line conductor 120 he operates the vertical line relay 122, which latter in turn operates the vertical magnet 127. The vertical magnet armature raises the switch-shaft, so that the normal post arm 221 permits the switch-shaft spring 222 to come into contact with the spring

223, and the busy-signaling current is sent to the calling subscriber's station. The calling subscriber, upon hearing the busy-signal, will understand that the desired line is in service, and will release the switching apparatus by hanging up his receiver. The vertical and rotary line conductors 120 and 121 are again grounded simultaneously over circuits that have been explained, whereby the vertical and rotary line relays 122 and 123 of the connecter, together with the differential relay 126, are energized at the same time. The circuits for energizing said relays have already been pointed out. It will be evident then that the line relays 122 and 123 will carry the release springs 213 and 212 into engagement at the same time that the differential relay 126 carries the differential relay springs 193 and 192 into engagement, setting up, therefore, the energizing circuit for the release magnet 134 in series with the back-release relay 52 of the selector D, as already explained. As a result the connector is released and the release magnet 51 of the selector D is energized, which in turn energizes the release magnet 64 of the switch C. The energized relays and magnets, of course, remain so until the ground connections to the line conductors 120 and 121 are broken, at which time the switches become fully restored, as has already been explained. In the master switch E special provision is made in the differential relay 97 whereby the said relay may become energized by either a positive or a negative guarding potential at the contact points *a*. Suppose that the release magnet 51 remains energized for any reason at any time after the line switch C becomes trunked to the selector D; then since the springs 217 and 218 are in engagement a grounded positive potential appears at the contact point 108—instead of a negative potential, as previously explained—by way of the conductors 116 and 145. Now, when the wiper 99 engages the said contact point and the common plate 98, the differential relay 97 becomes energized over a circuit extending from ground G^{12} through the springs 218 and 217, private conductor 116, conductor 145, contact point 108, wiper arm 99 to the plate 98, conductor 147, through the winding 224 of the differential relay 97 to the battery lead 144, thence through battery B and to ground G. If it were not for this provision the master switch would become stuck when the wiper 99 finds a positive or grounded potential; and for a satisfactory operation of the system it is desirable that the master switch operate with either a negative or positive guarding potential, so that under no conditions will it be possible for a calling telephone line to plunge in onto a line that has been seized. At the central office I provide another feature that comprises a heat-coil 55. The said heat-coil is included in a series circuit between the main battery and the lead that supplies current to all of the circuits of the switch D. If for any reason the line becomes grounded and a circuit is established through the heat-coil 55 which is maintained for a considerable length of time, said heat-coil blows, and the star-wheel part of the heat-coil, becoming unsoldered, revolves and permits the springs 225 and 226 to come into contact, and the springs 160 and 159 to separate, the latter two breaking the battery lead circuit at the switch D. It is found that ordinarily if, for example, both sides of the line of the subscriber #500 become grounded permanently, owing to some trouble, the line switch C will trip in onto a trunk, for example, the trunk that leads to the switch D. As soon as the switch C trips-in, the line relays 47 and 49 of the selector D will then pull up simultaneously and remain so. When the line relays pull-up, the release magnet 51 becomes energized as a result, which in turn energizes the release magnet 64 of the switch C. The said relays and magnets all remain energized until the heat-coil 55 blows. When the said coil blows, the relays 47 and 49 will, of course, deënergize, since the connection to battery for the said relays is then broken between the heat-coil springs 160 and 159. When the said relays deënergize, the release magnet 51 deënergizes also, and the release magnet 64 of the switch C deënergizes as a result, thus restoring the switch. As soon as the cut-off relay 62 regains its normal position and closes the circuit through the trip magnet 63, the switch C will again trip-in and move onto the next trunk line to some other switch similar to the switch D, the heat-coil of which will in time be blown. This operation will occur with each trunk line until all the selector switches of the group are put out of service. With the arrangement shown, however, the deënergizing of the release magnet 51 is not permitted to produce the deënergization of the release magnet 64 of the switch C if the heat-coil 55 is blown, because a permanent auxiliary energizing circuit is established through the release magnet 64 of the switch C as soon as the heat-coil springs 225 and 226 come into contact. Of course, when the heat-coil is restored to normal position the individual switch C is restored at the same time. The said auxiliary circuit for the release magnet 64 may be traced from ground G^{14} at the selector D through the signal relay 57, lamp 56, springs 225 and 226 to the third or trunk-release conductor 116, thence through the line switch bank springs 93 and 92, and through the release magnet 64 to the battery lead 144, thence through battery B and to ground G. The said relay 57 may be allotted to the whole exchange or to a section of the

exchange—that is, it may be made common to all the selector switches of the exchange, or to a part of the selectors, and is adapted to become energized in series with any release magnet 64 of any line switch C of the exchange or section to which it is allotted. Upon energizing, the said relay closes a local circuit by pressing the springs 227 and 228 into contact, in which circuit is included the signal bell 229. The said circuit may be traced from ground G^{15} to the springs 228 and 227, bell 229 to the ringer generator 230 and back to ground G^{16}. The bell 229 is, of course, designed to call the switchboard attendant's attention to the fact that some switch is in trouble in the exchange. Not only does the said relay energize to give an audible signal, but the lamp 56 (which is a group lamp) provides a visual signal—that is, the said lamp is adapted to light whenever any one of the switches allotted to the group of individual switches to which the individual switch C belongs is put out of service. The relay 57 may be allotted to only a part of the exchange if desired. As indicated in Fig. 3, the lamp 56 may be considered as belonging to one group of selectors, the lamp 56′ to another group of selectors, and the lamp 56^2 to another group of selectors, while the relay 57 is adapted to energize whenever a circuit is established through either of said lamps. It is therefore evident that when the relay 57 energizes and delivers an audible signal, the attendants will see which light is burning and will at once know in which sub-group the trouble may be found. Of course, trouble may be found in one of the groups or in all of the groups, which fact will be indicated by the lamps. The attendant is, therefore, enabled to locate trouble quickly and remedy the cause. Hence it will be seen that when the heat-coil 55 blows and removes the battery connection from the switch D, if the release magnet 51 has energized, although the selector releases, the line switch C does not release, but remains on the trunk line to prevent the said line switch from causing trouble on the other trunk lines, and at the same time a signal is given to indicate the trouble. Referring to Fig. 1, it will be understood that the lamp 56′ is common to any sub-group of selectors, and that the lamp 56^2 is common to any sub-group of selectors; but the heat-coils 55′ and 55^2 are, of course, individual to some one of the switches of their respective groups, said heat-coils being shown to simply indicate the circuits. The lamp 58, as shown, is adapted to light when any of the side switch wipers 45, 45′ and 45^2, which belong to the selector switches of the same group, pass to third position, thus indicating at a glance if any of the selector switches have trunked through to the next set of switches. One terminal of said lamp is permanently connected to battery B, while the said side switch wipers are all connected to ground. As shown in Fig. 1, the heat-coils 235 and 236 are allotted to first-selectors of the group to which selector D belongs, and any one of the said heat-coils blowing closes a circuit through the signal lamp 56 which is allotted to this particular group of first-selector switches. As previously explained, the lamps 56′ and 56^2 are individual to their respective groups in the same manner in which the lamp 56 is individual to its group. It will be understood that locking a grounded individual switch onto a trunk line will maintain a guarding potential at the master switch bank contact corresponding to the seized trunk line, thus preventing any subscriber from plunging in onto the established connection. This method of automatically supervising is especially adapted to an automatic district system, in which case the individual switches and the connectors will be located at sub-centrals, while the selector D will be located at the main exchange; and from the main exchange it will be possible to detect at once which switches at the sub-centrals are in trouble. Said sub-centrals may comprise a group of one hundred line switches and a percentage number of connectors, and at the main exchange there will be provided a set of selector switches for each sub-central station. In that case, if only first-selectors are used at the main exchange for trunking purposes, the system would be limited to a comparatively small number of sub-central offices; but in case that a larger system is desired additional selectors may be added, as is well known.

The relays and magnets may be wound to any suitable resistance, but with a central battery of fifty volts good results have been obtained when the lamp relay 53 is wound to a resistance of fifty-five hundred ohms, the differential windings 224 and 148 of the relay 97 to fifteen hundred ohms each, and the trip magnet 63 to a resistance of six hundred ohms.

Thus it will be seen that the blowing of the heat-coil when a subscriber's line is grounded automatically releases the seized first-selector without releasing the individual switch allotted to the grounded line. When the attendant restores or resets the heat-coil, the individual switch will then be released, providing the abnormal ground at the subscriber's station has in the meantime disappeared or been removed. Consequently, I provide means for supervising the outlying individual switches from the central station, making it possible to remedy various kinds of outlying trouble without the necessity of sending a trouble-man out of the exchange. With the arrangement shown, the attendant at the central exchange can release the sub-

scriber's individual switch by simply pressing the armatures of the line relays 47 and 49 of the seized first-selector.

With further respect to the subscriber's individual switch C, it will be seen that each plunger is adapted to occupy a trunk line without closing electrical connections between the same and the subscriber's telephone line. In other words, a subscriber may be occupying a certain trunk line without having his line connected therewith, and without using his telephone. In such case the occupied or selected trunk line remains occupied until the last trunk line in the bank has been seized by some other subscriber; then the plunger which has been temporarily held in an intermediate or half-way position is caught by the flange on the shaft 94 as the latter returns to normal position or starting point, thus allowing the plunger to completely withdraw from the terminal of the trunk line which it was occupying, and to swing into line with all other plungers which are at that time in engagement with the shaft. Consequently, should a subscriber call and use a trunk line, he may then call again and use the same trunk line, providing the shaft 94 has not in the meantime rotated to a position where it allowed the plunger to completely withdraw from the terminal of the trunk line. If a subscriber uses a trunk line for some length of time, and while he is thus occupying it the shaft 94 travels to the end of its forward rotation, and then travels back to normal position and starts over again, before the subscriber is through talking, it will then be upon the forward rotation of the shaft that it picks up the subscriber's plunger, providing he hangs up his telephone before the flange on the shaft reaches his plunger. In fact, a subscriber's plunger may be picked up and brought into locking engagement with the shaft by the movement of the latter in either direction, and for this reason the shaft may be rotated step-by-step in a forward direction, and then rotated to normal position, several times while a subscriber is using the trunk line, and the plunger occupying the trunk line is liable to be picked up by the motion of the shaft in either direction. In any event, and as explained, each subscriber is always given an opportunity to repeat his call and thereby make connection with the same trunk line, thus increasing the speed and efficiency of the service. In this way two kinds of idle plungers are possible, to-wit, plungers which are lined up on the shaft, and plungers which are scattered through the trunk terminals and only partially withdrawn therefrom.

As to the district sustem, it will be seen that third trunk conductors are employed between the central station and the sub-central stations, these third trunks being used by the subscribers for effecting an automatic trunk release back from the connectors and through the selectors to the individual switches. These third trunks are also, as explained, adapted for use by the central station attendants for releasing or supervising the subscribers' individual switches. Furthermore, with the lamp arrangement provided at the exchange and employed in combination with the third trunks, it is possible for the central station attendants to supervise or test the subscribers' lines to ascertain their condition.

What I claim as my invention is:—

1. In a telephone exchange system wherein there is a release conductor separate from the talking circuit, an automatic selector provided with an off-normal lamp, a local circuit for said lamp, an off-normal or supervisory relay for said selector, said relay controlling the circuit of said lamp, and a circuit including said release conductor for energizing said relay.

2. In a telephone exchange system, the combination of an automatic switch, a telephone line leading thereto, a suitable heat-coil, means for causing the heat-coil to operate when brought into connection with the switch by an abnormal grounding of the telephone line, and means for automatically releasing the said switch when the heat-coil is reset or restored to normal condition.

3. In a telephone exchange system, the combination of trunk lines, a non-numerical switch, means for operating said switch to select idle trunk lines, means for releasing said switch from the trunk lines, and for causing said switch to occupy the trunk line after releasing therefrom, whereby a subscriber after releasing may call again and get the same trunk line.

4. In a telephone exchange system, the combination of trunks, a subscriber's individual switch for selecting idle trunks, means for fully releasing said switch from a selected trunk, and means for temporarily preventing a full release from a selected trunk, and for thereby retaining the selection of the trunk by a partial release of said switch.

5. In a telephone exchange system, the combination of trunk lines, an automatic trunk-selecting switch mechanism having provisions for first effecting a partial release from a selected trunk line, for thereby temporarily occupying the trunk and permitting the subscriber to call again and get the same trunk line, and means by which a partial release from a selected trunk is afterward made complete.

6. In a telephone exchange system, the combination of trunk lines, automatic means by which each calling subscriber is given a preselected trunk line and by which another idle trunk is selected for the next calling

subscriber, having provisions for effecting only a partial release from a trunk when the subscriber is through using the same for completing the release if the trunk line thus temporarily operated is necessary for use by another calling subscriber, whereby each calling subscriber after releasing may call again and get the same trunk line, providing the latter has not in the meantime been called into service by some other subscriber.

7. In a telephone exchange system, the combination of trunk lines, automatic means by which each calling subscriber automatically selects an idle trunk line for the next calling subscriber, means by which each calling subscriber effects a partial release from the trunk line which he was using, and means by which some other subscriber may cause a completion of such partial release.

8. In a telephone exchange system, the combination of trunks, subscriber-controlled automatic means for selecting idle trunks, means by which a subscriber may disconnect from the trunk which he was using without discontinuing the occupancy or seizure thereof, means by which a second subscriber may discontinue the occupancy or seizure of the said trunk, and means by which a third subscriber may bring the said completely released trunk into service for talking purposes.

9. In a telephone exchange system, the combination of a plurality of trunks, automatic means by which a subscriber after using a trunk may temporarily occupy the same after disconnecting therefrom, automatic means whereby another subscriber may call and seize the idle trunk thus temporarily occupied by the first subscriber, and automatic means by which the second subscriber also selects another idle trunk for the first subscriber.

10. In a telephone exchange system, the combination of a plurality of trunks or common talking connections, a plurality of telephone lines, said trunks being less in number than the telephone lines, means for connecting the telephone lines with preselected idle trunks, means by which the disconnection of a calling telephone line from a seized trunk temporarily retains the said line in selective relation to said trunk, and automatic means by which another calling telephone line may destroy the said selective relation between the said telephone line and its preselected idle trunk.

11. In a telephone exchange system, the combination of telephone lines, a bank of trunk line terminals for each telephone line, a swinging and endwise-movable plunger for each telephone line, each plunger adapted to enter its allotted bank of terminals to close connection with an idle trunk line, a shaft provided with means for engaging and selectively operating all of said plungers, means individual to the different telephone lines for causing the plungers to enter selected terminals in the banks, and common means by which said shaft is actuated each time an idle trunk line terminal is seized by a calling telephone line, each plunger provided with a broad portion having a notch at the center thereof, and said shaft provided with a flange adapted to engage the notches in the plungers, each plunger provided with a finger adapted to remain in the selected trunk line terminal to prevent movement of the plunger before the shaft rotates sufficiently to bring its flange into engagement with the notch on the other end of such plunger.

12. In a telephone exchange system, a plurality of trunk lines, a plurality of trunking switches each provided with a swinging and endwise-movable plunger, a bank of trunk line terminals for each plunger, means including a master switch for causing said plungers to select idle trunk lines, means by which the plungers are retained in engagement with the banks when disconnections are made from trunk lines, and means for causing full withdrawal of the plungers by a subsequent operation of the master switch.

13. In a telephone system, a line, a swinging and endwise-movable plunger individual to said line, a bank of contacts to which the plunger is allotted, said plunger provided with an enlarged portion having a notch therein, a movable member provided with a flange for engaging said notch to swing the plunger relatively to said bank of contacts, means for causing the plunger to enter the said bank of contacts, controllable over the line, means for retaining said plunger in a partially restored or withdrawn position until subsequent actuation of said movable member brings said flange into position to engage the said notch, and lines leading from said bank.

14. In a telephone exchange system, the combination of a plurality of trunk lines, a plurality of telephone lines, automatic means for closing connection between a calling telephone line and a preselected idle trunk line, means for disconnecting the calling telephone line from the seized trunk line, and for retaining the disconnected telephone line in selective relation to the trunk line with which it was connected to permit the line to call again and get the same trunk line, and means by which another telephone line may connect with the said preselected idle trunk line.

15. In a telephone exchange system, the combination of a plurality of trunk lines, means by which a calling subscriber connects with an idle trunk line, and means by which a calling subscriber in releasing continues to occupy the disconnected trunk line to the exclusion of all other idle subscribers.

16. In a telephone exchange system, an automatic selector provided with an off-normal lamp, a local circuit for said lamp, an off-normal or supervisory relay for said selector, said relay controlling the circuit of said lamp, an energizing circuit for said relay including a trunk connection, and common battery connector switches, together with electrically controlled means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

17. In a telephone exchange system, an automatic selector switch provided with first and second supervisory or off-normal lamps, a circuit for lighting the first lamp during the initial operation of the selector switch, a circuit for lighting the second lamp after the selector switch is through operating, and common battery connector switches, together with electrically controlled means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

18. In a telephone exchange system, the combination of an automatic switch, a telephone line leading thereto, a suitable heat-coil, means for causing the heat-coil to operate when brought into connection with the switch by an abnormal grounding of the telephone line, means for automatically releasing the said switch when the heat-coil is reset or restored to normal condition, and means including common battery connector switches for extending connection from said first-mentioned switches to the called subscriber's line, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers' lines.

19. In a telephone exchange system, the combination of a first-selector, means for causing said selector to perform a trunking operation in accordance with the first digit of the called number, a visual signal for announcing the initial operation of said first-selector, a separate visual signal associated with said selector for announcing that the selector has completed its operation and is temporarily in an off-normal condition, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

20. In a telephone exchange system, the combination of trunk lines, an automatic trunk-selecting switch, means for indicating the initial operation of said switch, means associated with said switch for announcing the completion of the operation of the switch and the temporary seizure thereby of one of said trunk lines, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

21. In a telephone exchange system, an electrically-propelled and step-by-step actuated switch provided with a plurality of visual signals for indicating its initial and final operations, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

22. In a telephone exchange system, the combination of trunk lines, means for selecting idle trunk lines, means for releasing from the trunk lines, means for occupying the trunk line after releasing therefrom, whereby a subscriber after releasing may call again and get the same trunk line, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

23. In a telephone exchange system, the combination of trunks, a subscriber's individual switch for selecting idle trunks, means for fully releasing from a selected trunk, means for temporarily preventing a full release from a selected trunk, together with provisions for retaining the selection of the trunk by a partial release therefrom, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

24. In a telephone exchange system, the combination of trunk lines, an automatic trunk-selecting switch mechanism having provisions for first effecting a partial release from a selected trunk line, for thereby temporarily occupying the trunk and permitting the subscriber to call again and get the same trunk line, means by which a partial release from a selected trunk is afterward made complete, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

25. In a telephone exchange system, the combination of trunk lines, automatic means by which each calling subscriber is given a preselected trunk line and by which another idle trunk is selected for the next calling subscriber, having provisions for effecting only a partial release from a trunk when the subscriber is through using the same, for completing the release if the trunk line thus temporarily operated is necessary for use by another calling subscriber, where-

by each calling subscriber after releasing may call again and get the same trunk line, providing the latter has not in the meantime been called into service by some other subscriber, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

26. In a telephone exchange system, the combination of trunk lines, automatic means by which each calling subscriber automatically selects an idle trunk line for the next calling subscriber, means by which each calling subscriber effects a partial release from the trunk line which he was using, means by which some other subscriber may cause a completion of such partial release, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

27. In a telephone exchange system, the combination of trunks, subscriber-controlled automatic means for selecting idle trunks, means by which a subscriber may disconnect from the trunk which he was using without discontinuing the occupancy or seizure thereof, means by which a second subscriber may discontinue the occupancy or seizure of the said trunk, means by which a third subscriber may bring the said completely released trunk into service for talking purposes, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the sub-stations of calling and called subscribers.

28. In a telephone exchange system, the combination of a plurality of trunks, automatic means by which a subscriber after using a trunk may temporarily occupy the same after disconnecting therefrom, automatic means whereby another subscriber may call and seize the idle trunk thus temporarily occupied by the first subscriber, automatic means by which the second subscriber also selects another idle trunk for the first subscriber, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

29. In a telephone exchange system, the combination of a plurality of trunks or common talking connections, a plurality of telephone lines, said trunks being less in number than the telephone lines, means for connecting the telephone lines with idle trunks, means by which the disconnection of a calling telephone line from a seized trunk temporarily retains the said line in selective relation to said trunk, automatic means by which another calling telephone line may destroy the said selective relation between the said telephone line and the said temporarily occupied idle trunk, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

30. In a telephone exchange system, the combination of a plurality of trunk lines, a plurality of telephone lines, automatic means for closing connection between a calling telephone line and an idle trunk line, means for disconnecting the calling telephone line from the seized trunk line, means for retaining the disconnected telephone line in selective relation to the trunk line with which it was connected to permit the line to call again and get the same trunk line, means by which another telephone line may connect with the said occupied idle trunk line, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

31. In a telephone exchange system, the combination of a plurality of trunk lines, means by which a calling subscriber connects with an idle trunk line, means by which a calling subscriber in releasing continues to occupy the disconnected trunk line to the exclusion of all other idle subscribers, means including common battery connector switches for extending connection from said trunk lines to the called subscriber's line, and means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

32. In a telephone system, a subscriber's line, a non-numerical switch individual to said line, an operating plunger for said switch, and a single spring adapted to trip said plunger and to restore the same.

33. In a telephone system, a plurality of trunk lines, a switch for selecting an idle trunk line, an operating plunger for said switch, and a spring adapted to trip said plunger when said switch is operated and also adapted to restore said plunger to inoperative position.

34. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunking connection between the individual switch and the first selector, a telephone line leading to the individual switch, means whereby the grounding of the telephone line will operate both the individual switch and the first selector, release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for each individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, and circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch upon such release of the first selector.

35. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, means whereby the grounding of the telephone line will operate both the individual switch and the first selector, release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, and circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch upon such automatic release of the first selector, a main central station at which the first selector is located and an outlying subcentral station at which the said individual switch is located.

36. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means for automatically releasing the first selector upon the operation of the heat-coil and breaking the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch when the first selector is thus automatically released, and means for automatically releasing the individual switch when the heat-coil is restored to normal condition providing the ground has been removed from the telephone line.

37. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means for automatically releasing the first selector upon the operation of the heat-coil and breaking the release circuit for said individual switch, and circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch when the first selector is thus automatically released, means for automatically releasing the individual switch when the heat-coil is restored to normal condition, providing the ground has been removed from the telephone line, a main central station at which the first selector is located, and an outlying subcentral station at which the individual switch is located.

38. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, means whereby the grounding of the telephone line will operate both the individual switch and the first selector, release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch upon such automatic release of the first selector, and common battery connector switches, together with means for supplying talking current through said connector switches to the substations of calling and called subscribers.

39. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, means whereby the grounding of the telephone line will operate both the individual switch and the first selector, release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, circuit means controlled by said heat coil for closing said auxiliary circuit to prevent a release of the individual switch upon such automatic release of the first selector, a main central station at which the first selector is located and an outlying subcentral station at which the said individual switch is located, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

40. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means for automatically releasing the first selector upon the operation of the heat-coil and breaking the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch when the first selector is thus automatically released, means for automatically releasing the individual switch when the heat-coil is restored to normal condition providing ground has been removed from the telephone line, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of the calling and called subscribers.

41. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means for automatically releasing the first selector upon the operation of the heat-coil and breaking the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent a release of the individual switch when the first selector is thus automatically released, means for automatically releasing the individual switch when the heat-coil is restored to normal condition providing the ground has been removed from the telephone line, a main central station at which the first selector is located, an outlying subcentral station at which the individual switch is located, and common battery connector switches, together with means for supplying talking current through the said connector switches to the substations of calling and called subscribers.

42. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, means for operating both the individual switch and the first selector, release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, and circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent a release of the individual switch upon such automatic release of the first selector.

43. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line allotted to the individual switch, means for operating both the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, circuit means controlled by said heat-

coil for closing said auxiliary circuit to prevent a release of the individual switch upon such automatic release of the first selector, a main central station at which the first selector is located and an outlying subcentral station at which the said individual switch is located.

44. In a telephone system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, circuits for grounding the telephone line, and automatic means responsive thereto for operating both the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line remains grounded for a prolonged period of time, an auxiliary holding circuit for said individual switch release means, automatic means by which the operation of the heat-coil releases the first selector and breaks the normal release circuit for said individual switch, and circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent the release of the individual switch upon such automatic release of the first selector.

45. In a telephone exchange system, the combination of a subscriber's individual switch, a first selector, trunk connection between the individual switch and the first selector, a telephone line leading to the individual switch, automatic means responsive to the grounding of the telephone line to operate both the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, automatic means by which the operation of the heat-coil releases the first selector and breaks the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent a release of the individual switch upon such automatic release of the first selector, a main central station at which the first selector is located and an outlying sub-central station at which the said individual switch is located.

46. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, electrically controlled means for automatically releasing the first selector upon the operation of the seat-coil and breaking the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent a release of the individual switch when the first selector is thus automatically released, and electrically controlled means for automatically releasing the individual switch when the heat-coil is restored to normal condition, providing the ground has been removed from the telephone line.

47. In a telephone exchange system, the combination of a subscriber's individual switch, a telephone line leading to said switch, a first selector, trunk connection between the individual switch and the first selector, automatic release means for said individual switch and for said first selector, release circuits for controlling said release means, a heat-coil allotted to the first selector and adapted to operate when the telephone line becomes abnormally grounded, an auxiliary holding circuit for said individual switch release means, electrically controlled means for automatically releasing the first selector upon the operation of the heat-coil and breaking the release circuit for said individual switch, circuit means controlled by said heat-coil for closing said auxiliary circuit to prevent a release of the individual switch when the first selector is thus automatically released, electrically controlled means for automatically releasing the individual switch when the heat-coil is restored to normal condition providing the ground has been removed from the telephone line, a main central station at which the first selector is located and an outlying subcentral station at which the individual switch is located.

48. In a telephone exchange system, the combination of an automatic switch, a telephone line associated with said switch, a heat-coil. electrically controlled means for operating the switch to connect the line and the heat-coil, a battery associated with said apparatus in the exchange, said heat-coil having one terminal connected to one side of said battery, the other terminal of said heat-coil being connected with the line after said switch is operated, means whereby when the other side of said battery is connected with said line for an abnormal length of time a flow of current is set up through said heat-coil for operating the same, an electrically

operated release means for said switch under the control of said heat-coil for releasing said switch when the heat-coil is restored.

49. In a telephone exchange system, a subscriber's line, trunk lines, electrically controlled means for selecting an idle trunk line for said line, electrically controlled means for releasing from the selected trunk line and for holding the trunk line assigned exclusively to said subscriber's line notwithstanding the release therefrom, whereby the subscriber may release, call again and get the same trunk.

50. In a telephone exchange system, the combination of trunks, a subscriber's individual switch for selecting idle trunks, electrically controlled means for fully releasing said switch from a selected trunk, and electrically controlled means for temporarily preventing a full release from a selected trunk, and thereby retaining the selection of the trunk by a partial release of said switch.

51. In a telephone exchange system, the combination of trunk lines, automatic means by which each calling subscriber automatically selects an idle trunk line for the next calling subscriber, electrically controlled means by which each calling subscriber effects a partial release from the trunk line which he was using, and electrically controlled means by which some other subscriber may cause a completion of such partial release.

52. In a telephone exchange system, the combination of trunks, subscriber-controlled automatic means for selecting idle trunks, electrically controlled means by which a subscriber may disconnect from the trunk which he was using and still retain selection thereof, electrically controlled means by which a second subscriber may discontinue the occupancy or seizure of the said trunk, and electrically controlled means by which a third subscriber may bring the said completely released trunk into service for talking purposes.

53. In a telephone exchange system, the combination of a plurality of trunks or common talking connections, a plurality of telephone lines, said trunks being less in number than the telephone lines, electrically controlled means for connecting the telephone lines with preselected idle trunks, electrically controlled means by which the disconnection of a calling telephone line from a seized trunk temporarily retains the said line in selective relation to said trunk, and automatic means by which another calling telephone line may destroy the said selective relation between the said telephone line and its preselected idle trunk.

54. In a telephone exchange system, the combination of telephone lines, a bank of trunk line terminals for each telephone line, a swinging and endwise-movable plunger for each telephone line, each plunger adapted to enter its allotted bank of terminals to close connection with an idle trunk line, a shaft provided with automatic means for engaging and selectively operating all of said plungers, automatic means individual to the different telephone lines for causing the plungers to enter selected terminals in the banks, and common electrically controlled means by which said shaft is actuated each time an idle trunk line terminal is seized by a calling telephone line each plunger provided with a broad portion having a notch at the center thereof, and said shaft provided with a flange adapted to engage the notches in the plungers, each plunger provided with a finger adapted to remain in the selected trunk line terminal to prevent movement of the plunger before the shaft rotates sufficiently to bring its flange into engagement with the notch on the other end of such plunger.

55. In a telephone exchange system, a plurality of trunk lines, a plurality of trunking switches each provided with a swinging and endwise-movable plunger, a bank of trunk line terminals for each plunger, electrically controlled means including a master switch for causing said plungers to select idle trunk lines, automatic means by which the plungers are retained in engagement with the banks when disconnections are made from trunk lines, and electrically controlled means for causing full withdrawal of the plungers by a subsequent operation of the master switch.

56. In a telephone system, a line, a swinging and endwise-movable plunger individual to said line, a bank of contacts to which the plunger is allotted, said plunger provided with an enlarged portion having a notch therein, a movable member provided with a flange for engaging said notch to swing the plunger relatively to said bank of contacts, automatic means for causing the plunger to enter the said bank of contacts, controllable over the line, automatic means for retaining said plunger in a partially restored or withdrawn position until subsequent actuation of said movable member brings said flange into position to engage the said notch, and lines leading from said bank.

57. In a telephone exchange system, the combination of a plurality of trunk lines, a plurality of telephone lines, automatic means for closing connection between a calling telephone line and a preselected idle trunk line, automatic means for disconnecting the calling telephone line from the seized trunk line, and for retaining the disconnected telephone line in selective relation to the trunk line

with which it was connected to permit the line to call again and get the same trunk line, and electrically controlled means by which another telephone line may connect with the said preselected idle trunk line.

58. In a telephone exchange system, the combination of a plurality of trunk lines, electrically controlled means by which a calling subscriber connects with an idle trunk line, and electrically controlled means for disconnecting from the said trunk line and for retaining said trunk line busy to the exclusion of all the idle subscribers, notwithstanding the release therefrom.

Signed by me at Chicago, Cook county, Illinois, this 16th day of January, 1907.

ALEXANDER E. KEITH.

Witnesses:

EDWARD D. FALES,

ARTHUR B. SPERRY.