W. L. CAMPBELL.

TELEPHONE SYSTEM.

APPLICATION FILED OCT. 7, 1907.

1,267,743.

Patented May 28, 1918.

4 SHEETS—SHEET 1.

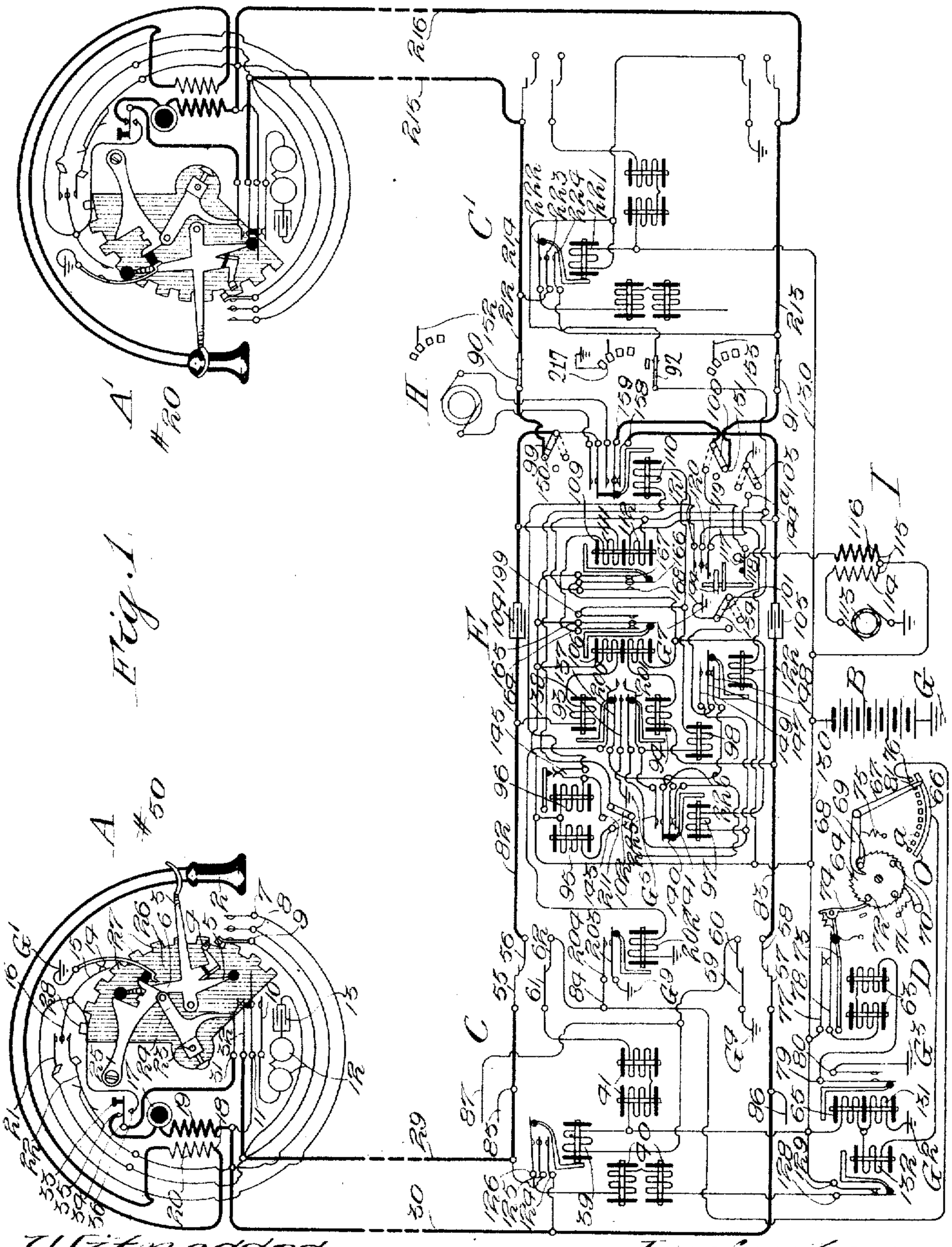

Fig. 1.

Witnesses.

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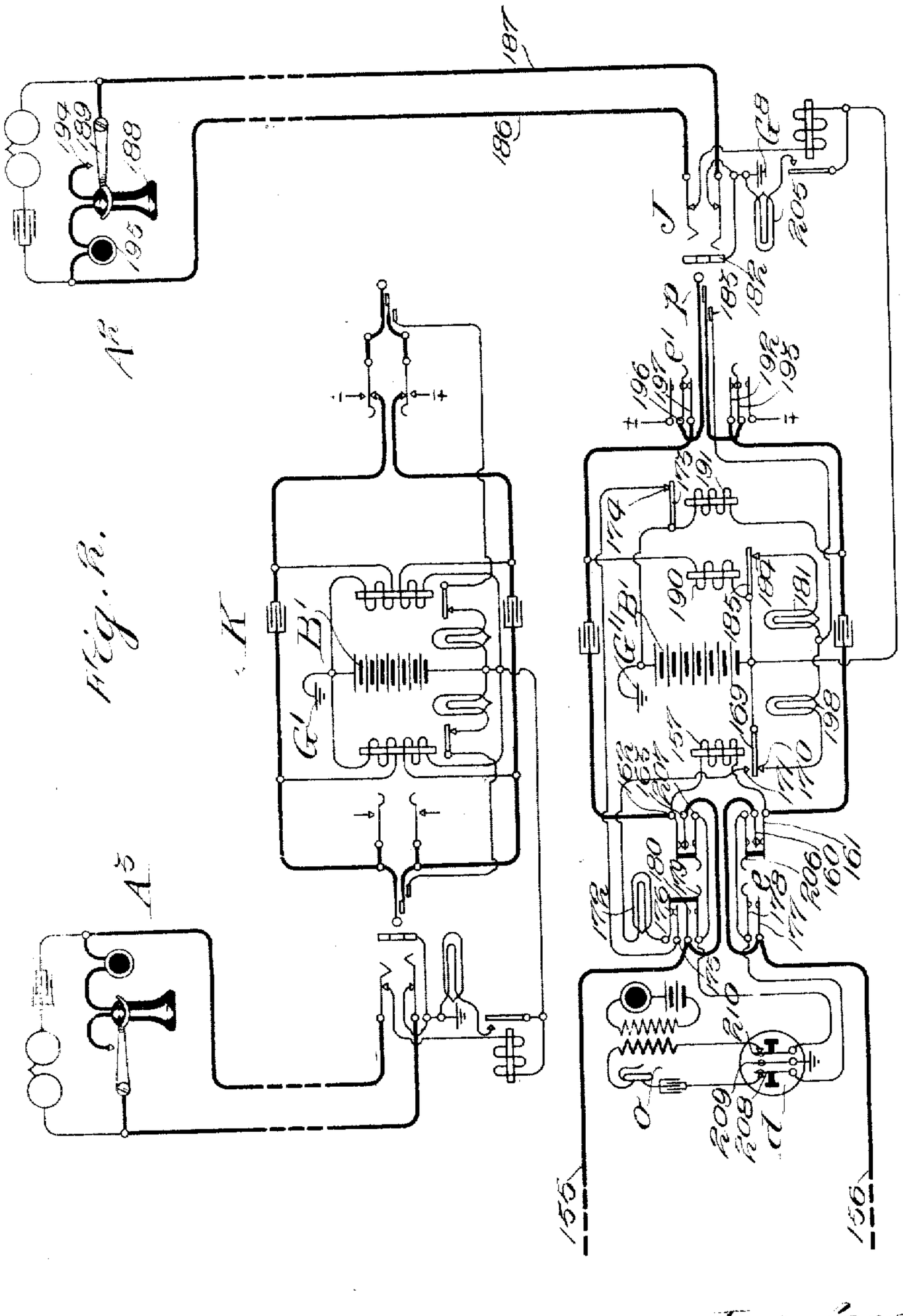

Fig. 2.

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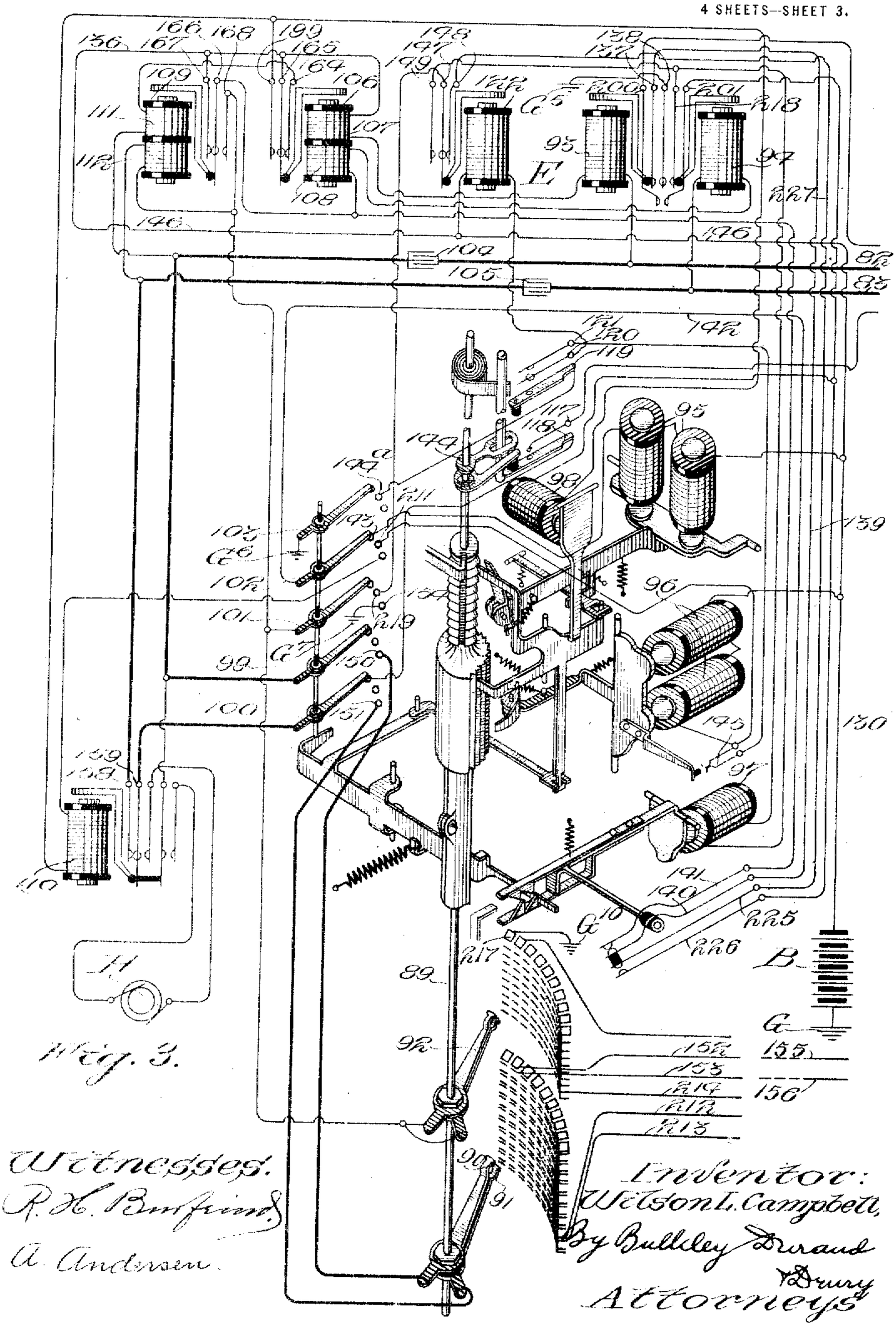

Fig. 3.

Witnesses:

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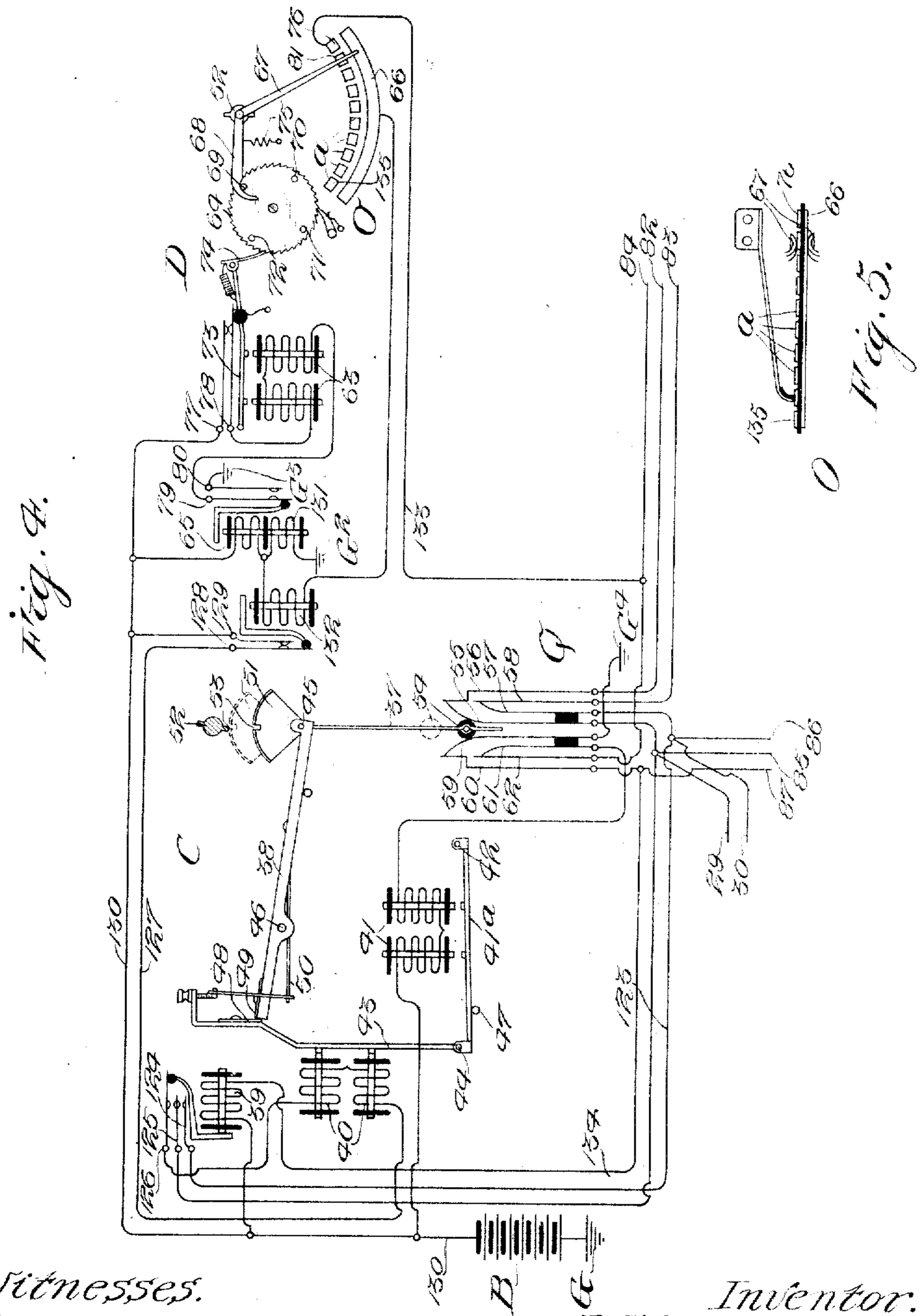

Fig. 4.

Fig. 5.

Witnesses.

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UNITED STATES PATENT OFFICE.

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

TELEPHONE SYSTEM.

1,267,743. Specification of Letters Patent. Patented May 28, 1918.

Application filed October 7, 1907. Serial No. 396,230.

To all whom it may concern:

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

My invention relates to telephone systems in general, but more particularly to systems in which automatic service is provided between the subscribers of the system, either in whole or in part, and more especially to systems in which main and sub-central stations or exchanges are employed, with provisions for giving service between subscribers of the main station and the subscribers of a branch or sub-central station.

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

Special objects are the provision of an improved arrangement by which the subscribers of a branch exchange may be given service between themselves without the necessity of calling through the main or central station, and whereby efficient service may also be insured between the subscribers of the main exchange and the subscribers of the branch or sub-central station; the provision of automatic switches, such, for example, as connectors, which are adapted for use in automatically establishing connection between subscribers' lines of the branch exchange, as well as for automatically establishing trunk connection to the main or central station, said connectors each having provisions for automatically rotating in one or more of the bank levels thereof, whereby each connector is adapted for both selecting idle trunk-lines and making the final connections with the lines of the called subscribers; the provision of means whereby the subscribers of a branch exchange or sub-central station may intercommunicate through the medium of individual trunking switches and connectors, without the necessity of employing any selectors or other automatic switches between said line switches and connectors, whereby each of said connectors is adapted to give service of this kind only in certain bank levels thereof, the remaining level or levels being appropriated exclusively for use in giving automatic trunking service to the main or central station; the provision of automatic connectors which are adapted to make connection directly with the lines of called subscribers, and which are also adapted to automatically select idle trunks terminating at a manual switchboard; the provision of improved means whereby any trunking connections established through these connectors may be efficiently supervised by the operators at the manual switchboards; the provision of means for preventing connectors which are connected directly with non-numerical or individual trunking switches from releasing the latter when the called subscribers' lines are busy; the provision of means for supplying talking current through these connectors, which are rotary or automatic trunk-selecting in one level only, to calling and called automatic subscribers, and separate means for supplying talking current to called manual subscribers; and the provision of certain details and features of improvement and combinations tending to increase the general efficiency and serviceability of a telephone exchange system of this particular character.

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

In the accompanying drawings Figure 1 represents diagrammatically two substations A and A′ of a sub-exchange connected together through the medium of my improved switching apparatus, in a system embodying the principles of my invention. At C is shown diagrammatically an individual switch allotted to the line of substation A, and at D is represented the master switch allotted to the group of which C is a member. At E is shown my improved connector switch, and at C′ is represented the line switch allotted to the line of the substation A′. The common battery B is shown having its positive terminal preferably grounded.

In Fig. 2 is represented the main or manual telephone exchange equipment of the said system.

Fig. 3 is a diagrammatic perspective view of my improved connector switch.

In Fig. 4 is shown diagrammatically the line switch C and its master switch D

Fig. 5 is a detailed view of the master switch bank O.

Figs. 1 and 2 taken together show a telephone system embodying the principles of my invention and comprising an automatic department and a manual department, a connector E of the automatic department or sub-exchange being provided with means whereby connections can be made automatically and directly from one subscriber A in the automatic exchange to another subscriber A′ in this same automatic exchange; this connector being provided with a plurality of trunk-lines leading to the main or manual exchange, all of which trunk-lines may terminate at the same trunk level of the connector switch E, which arrangement is the one adhered to in the specification—that is, through the medium of the first nine levels of the connector switch E connection may be made with automatic subscribers; but the tenth level of said connector is made up of the terminals of the trunk-lines all of which extend to the manual exchange, and to which level the connector wipers must be raised in order that an automatic subscriber may obtain connection with a manual subscriber. In this tenth level the connector E, it will be explained, acts as a selector-switch—that is, it is adapted to automatically pick out the first idle trunk-line leading to the said manual exchange. In the other levels, however, the connector-switch acts as usual—that is, purely and simply as a connector-switch.

The substation A may be of any suitable or approved type. The one in connection with which I have elected to illustrate my invention comprises a receiver 2, switch-hook 3 for controlling the substation circuits, which controlling operations are accomplished through the medium of any suitable means, such as the cam-arms 4, 5 and 6. As the switch-hook is lowered the cam-arm 4 momentarily presses the release springs 7, 8 and 9 into engagement, whereby the substation line conductors may be grounded simultaneously. When the switch-hook is down the cam-arm 5 maintains a contact between the springs 10 and 11, thereby bridging the ringer 12 in series with the condenser 13 across the line. The substation ground circuit is normally broken between the ground springs 14 and 15 by the cam-arm 6, but when said springs are together, then ground potential is provided from the battery to the ground post 16 and to the release spring 7, as is usually the case in telephones of this type. The said substation comprises the usual transmitter 17, induction-coil 18 having the primary winding 19 and secondary winding 20. Being an automatic substation it is provided with the usual vertical and rotary impulse springs 21 and 22. Said substation is, of course, provided with a dial (not shown) which is secured to the shaft 23, together with the locking dog 24. Furthermore, there is a locking cam 25 that locks the dog 24 while the receiver is on the switch-hook to prevent a rotation of the dial. For operating the impulse springs 21 and 22 the substation is provided with an impulse wheel 26 that is secured to the shaft 23, which impulse wheel carries on its periphery the so-called vertical impulse teeth 27, and one rotary impulse tooth 28. The said impulse teeth are so arranged that when the dial is drawn down the impulse spring 22 is carried into contact with the ground post 16; and as the dial returns, first the vertical teeth engage the vertical impulse spring 21, and after they have completed their work the rotary impulse tooth operates the rotary impulse spring 22. In this operation the subscriber's vertical line conductor 29 is first given a number of ground impulses, and then the rotary line conductor 30 is given one ground impulse. It will be seen that as long as the dial is out of normal position the dog 24 permits the primary circuit springs 31 and 32 to separate, thus preventing the impulses that are delivered to either line conductor from passing to the other. Means whereby a subscriber may signal a called subscriber comprises a push-button 33 which, when pressed, carries the spring 34 out of engagement with the contact point 35 and into engagement with the contact point 36, whereby the vertical line conductor 29 is grounded. Furthermore, the rotary impulse spring 22 is of such construction that when the dial is turned forward for the first digit the rotary impulse tooth 28 momentarily presses the said impulse spring onto the ground post 16, whereby the rotary line conductor 30 is given a preliminary impulse for operating the line switch C.

The line and master switches C and D (Fig. 4) comprise a plunger 37, plunger arm 38, bridge-cut-off relay 39, trip magnet 40 and switch-release magnet 41, all of which is built about a suitable base or frame (not shown). The said switch-release magnet is provided with an armature 41ª that is pivoted on a pin 42 which rises from the base of the switch. The said armature carries pivotally secured on its end a second armature 43 that is controlled by the trip magnet 40. The pin 44 about which the armature 43 oscillates is carried on the end of the armature 41ª. The plunger 37 is pivotally secured by the pin 45 to the plunger arm 38, which latter is in turn pivoted to a pin 46 that rises from the switch frame (not shown). The lug 47 is stamped out of the side of the frame and is provided as a stop or rest for the armature 41ª. Upon the armature 43 is secured the catch spring 48 which is adapted to engage the end 49 of the plunger arm 38. The general operation of the switch is as follows: The trip mag-

net 40 is energized by a preliminary impulse as the subscriber starts to call, and the armature 43 is attracted against the magnet cores. When the armature 43 is attracted to the left (Fig. 4) the catch 48 slides out of contact with the end 49 of the plunger arm 38, and the said plunger arm, owing to the tension of the spring 50, moves about the pin 46 and thrusts the plunger 37 into the bank terminal Q; and when the trip magnet again deënergizes, the trip armature 43 falls against the end of the plunger arm 38. The switch is restored to normal when the release magnet 41 becomes energized, whereby the armature 41ª is attracted, and accordingly the trip armature 43 is moved upwardly, compressing the spring 50 until the catch 48 slides over the end 49; then when the release magnet 41 becomes deënergized the armature 41ª returns to normal position against the stop 47 by the action of the spring 50, since the trip armature 43 is now locked at the catch 48 with the plunger arm 38 at the end 49. Thus, when the plunger arm 38 is unlocked the spring 50 forces the plunger 37 into the bank, but when the three arms 38, 41ª and 43 are locked the spring 50 tends to force the combined parts down against the stop 47, withdrawing the plunger 37; and since the plunger arm 38 is now in engagement with the armature 43, the said plunger arm is moved about the pin 46, whereby the plunger 37 is removed from the bank Q. Also, since the plunger shaft has advanced one step, the hub 51 of the plunger 37 comes to rest in the position shown by the dotted lines in Fig. 4, against the plunger shaft 52; and as the said plunger shaft advances each time an idle trunk is seized, the plunger 37 is not advanced, but remains opposite the trunk terminal from which it has just disengaged, since the slot 53 is not in engagement with the plunger shaft 52. After all of the trunk-lines have been successively seized, and the plunger shaft again passes to the position it occupied when the plunger 37 seized the terminal Q, the plunger 37 then returns to normal engagement with the said plunger shaft. In the meantime, if the line switch C is again operated, the plunger 37 again engages the same terminal Q. The said line switch is provided with a bank of terminals, usually ten in number, only one of which is shown at Q (Fig. 4). As shown in Fig. 4 the said terminal is turned from its true position with respect to the swing of the plunger 37, and the bushing 54 is also shown turned correspondingly, all for the purpose of making the illustration clearer. The terminal comprises the springs 55 and 56, 57 and 58, 59 and 60, and 61 and 62. The said springs are normally disconnected from each other, but are driven into contact in the above-mentioned order when the plunger 37 operates. However, the plunger 37 is normally retained in engagement with the plunger-controlling shaft 52, which latter is operated by the master switch D. The master switch D, which may be of any suitable or approved type, is provided for operating the plunger shaft 52, and for controlling certain circuits that will be disclosed hereinafter. Said switch comprises the following details: A motor magnet 63 for operating the ratchet wheel 64, which latter is designed for operating the plunger shaft 52, and a differential relay 65 for controlling the energizing circuit of the motor magnet 63. The said master switch also has a bank comprising a plurality of individual contact segments *a* and a common segment 66, as shown in Fig. 4. The wiper 67 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 66, except during its backward movement. The wiper 67 is operated in a step-by-step manner by the ratchet wheel 64, through the medium of a cam member 68 rigidly secured to the said wiper 67 and adapted to successively engage the pins 69, 70, 71 and 72 upon the said ratchet wheel 64. The motor magnet 63 is provided with an armature 73 upon the end of which there is suitably secured a pawl 74. Each time that the said magnet is energized the pawl 74 engages the ratchet wheel 64, advancing the latter one step. It will be seen, therefore, that as the ratchet wheel 64 advances, the wiper 67 advances step by step from right to left, and when the pin 69, for instance, clears the cam 68 the retracting spring 75 restores the wiper 67 to its first position at the right of the bank and in engagement with the first segment 76. The said motor magnet 63 is provided with a couple of interrupter springs 77 and 78 that are included in the energizing circuit of the said motor magnet, which energizing circuit also comprises the springs 79 and 80 controlled by the differential relay 65. Therefore, whenever the differential relay 65 is energized, the springs 79 and 80 are pressed into contact, and the motor magnet 63 operates step by step as long as the differential relay 65 remains energized. Furthermore, it is assumed that the terminal Q of the line switch C is the first terminal of the line switch bank. The plunger 37, while in normal engagement with the shaft 52, is retained in front of said terminal by the plunger shaft 52 whenever the master switch wiper 67 is in engagement with the bank segment 76; but as the motor magnet 63 advances the wiper 67 onto the segment 81, the said plunger and all idle plungers similarly engaging the shaft 52 are carried opposite the next terminal of the line switch bank. Furthermore, an auxil-

iary relay 132 is provided for opening the circuit through the trip magnet 40, so that the line switch C cannot be operated while the motor magnet 63 is energized. The auxiliary relay 132 being connected in series with the motor magnet relay 65, and the motor magnet 63 being operated by the relay 65, it is evident that all three will be energized at the same time, the relay 132 thus shifting the spring 128 out of engagement with the spring 129. It should be noted that in each line switch bank all of the springs 55 are permanently connected and may be made of one common piece. The springs 56, however, are individual—that is, there is one separate and distinct spring for every bank set Q, there being ten in the bank. The springs 57, 59, 60 and 61, like the springs 55, are also common, and the springs 58 and 62, like the springs 56, are individual. For every bank terminal Q there is a trunk-line of three conductors 82, 83 and 84 leading to a selector; and there is also a normal trunk-line comprising the conductors 85, 86 and 87 leading to the connector banks. The subscriber's line conductors 29 and 30 terminate in the springs 55 and 57 which, as has been stated, are common springs. When the subscriber operates the line switch C, and the plunger 37 engages the terminal Q, the subscriber's line conductors 29 and 30 are extended to the vertical and rotary trunk conductors 82 and 83, thence to the switch E.

The connector switch E is an improved form of the connector switch described in United States Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson. For instance, the connector switch shaft 89 carries the line wipers 90 and 91 and the private wiper 92. The connector switch is also controlled by the calling subscriber through the medium of the vertical and rotary line relays 93 and 94. The vertical line relay 93 directly controls the vertical magnet 95 and also the rotary magnet 96. The purpose of the vertical magnet 95 is to give the shaft and shaft wipers a vertical motion, and the rotary magnet 96 imparts to the shaft and shaft wipers a rotary or circular motion. The rotary line relay 94 controls the private magnet 97, which latter under certain conditions controls in turn the vertical and rotary magnets 95 and 96, the release magnet 98, and also the side switch wipers 99, 100, 101, 102 and 103, which comprise the well-known side switch. The said side switch has a normal or first position, a second position and a third position. The release magnet 98 is also controlled by the vertical and rotary line relays 93 and 94 conjointly. By the use of the condensers 104 and 105 the connector divides the circuit through it into two sections. The connector is provided with a differentially-wound relay 106 which is composed of the windings 107 and 108. The purpose of this relay is to provide the calling subscriber with talking battery current when the back-bridge relay 109 energizes, and also, by means of the vertical line relay 93, to control the ringer relay 110 by which the ringer generator H is bridged across the terminals of the called line to signal the called subscriber. The back-bridge relay 109, comprising the windings 111 and 112, provides the called subscriber with talking battery current when the primary circuit of the called substation is bridged across the line. The central station is equipped with the busy-signaling apparatus I of any suitable design, as, for example, the one comprising an interrupter 113 (Fig. 1) in series with the primary winding 114 of the induction-coil 115, whereby a busy-signaling current is induced in the secondary winding 116 of the said induction-coil. The secondary winding 116 is connected with the side switch wiper 100, through the normal springs 117 and 118, when the side switch is in first position. In addition, the connector switch E is provided with the shaft springs 119, 120 and 121 so arranged that when the switch shaft 89 rises and reaches the tenth level the springs 119, 120 and 121 are pressed into contact, whereby the relay 122 and the rotary magnet 96 are connected to the side switch contact point 144^a, and, therefore, to ground, while the side switch is in second position. This arrangement gives the connector switch E the rotary feature of the selector switch described in United States Patent No. 815,321, granted March 13, 1906, to Keith, Erickson & Erickson. It will be observed that although the master switch has only one motor element, namely, the magnet 63, the connector switch E has at least two motor elements, namely, the vertical magnet 95 and the rotary magnet 96. As has already been explained the motor magnet 95 is for raising the shaft, whereas the magnet 96 is for rotating the shaft.

A clearer understanding of the operation of my improved system may be obtained by considering its action when one subscriber calls another. Assume, for example, that the subscriber at substation A desires to call some subscriber at substation A^3, which is allotted to the manual exchange represented in Fig. 2. As previously explained, the trunk-lines from the automatic central office to the manual central office lead from the tenth level of the connector bank. Hence, when a manual exchange connection is desired by an automatic exchange subscriber the automatic subscriber first calls naught on his dial. To call naught the subscriber at substation A operates the calling device in the well-known manner, corresponding to the digit naught. The preliminary impulse for operating the line switch C occurs when

the calling subscriber rotates the dial forward, whereby the rotary impulse spring 22 is momentarily pressed against the ground post 16. As a result, the trip magnet 39 of the line switch C is energized by a flow of current from ground G' to the springs 14 and 15, ground post 16, rotary impulse spring 22 to the rotary line conductor 30, conductor 123 (Fig. 4), bridge-cut-off relay springs 124, 125 and 126 to the trip magnet 40, thence through the said magnet to the conductor 127, springs 128 and 129 to the battery lead 130, and thence through battery B to ground G. As soon as the trip magnet 40 energizes, then the armature 43 is attracted and the plunger 37 is liberated and thrust into the terminal Q by a spring 50. When the plunger 37 engages the bank terminal Q an energizing circuit is closed through the motor magnet relay 65, which in turn operates to close a circuit through the motor magnet 63. The motor magnet operates to place the idle plungers opposite the first idle bank terminal similar to the terminal Q. The circuit through the relay 65 extends from ground G^2 through the winding 131 of the relay 65, thence through the auxiliary relay 132, segment 66, wiper arm 67, segment 76, conductor 133, bank springs 62 and 61, through the release magnet 41 to the battery lead 130, thence through battery B to ground G. Although this circuit includes the release magnet 41, the said magnet does not operatively energize, since the relay 65 is wound to a high resistance, while the winding of the release magnet is of a comparatively low resistance. The relay 65, upon energizing, operates to close the springs 79 and 80 in contact, whereby a circuit is completed through the motor magnet 63 extending from ground G^3 through the springs 80 and 79, motor magnet 63, springs 78 and 77 to the battery lead 130, thence through battery B to ground G. The motor magnet 63, upon energizing, attracts its armature 73, whereby the pawl 74 engages the ratchet wheel 64 and rotates the said wheel one step. When the armature 73 is attracted against the magnet cores, the springs 77 and 78 disengage, thereby breaking the energizing circuit through the motor magnet. The cam-arm 68, being in engagement with the pin 69, is operated to advance the plunger shaft 52 (and, consequently, all idle plungers that may be in normal position) one step to another bank terminal. Also, the wiper 67 is carried from the contact point 76, which corresponds to the terminal Q, to the contact point 81, which latter corresponds to the terminal before which the advanced idle plungers are now resting. At the instant that the plunger 37 enters the bank terminal Q the following springs are pressed into contact: 55 and 56, 57 and 58, 59 and 60, and 61 and 62. The engagement of the springs 55 and 60 establishes a circuit from ground G^4, by way of the normal conductor 87, to the connector private bank contacts corresponding to the line that terminates in the line switch C, whereby a guarding potential is established to prevent any subscriber from calling the said line after the calling subscriber at substation A operates his dial preparatory to making a call, as explained. The circuit over which the said guarding potential is established extends from ground G^4 through the bank springs 59 and 60 to the private normal conductor 87, thence to the connector private bank. The engagement of the springs 59 and 60 also closes a circuit through the bridge-cut-off relay 39, said circuit extending from ground G^4 through the springs 59 and 60, conductor 134, through the relay 39 to the battery lead 130, thence through battery B to ground G. The said relay, upon energizing, breaks the contact between the springs 124, 125 and 126, whereby the vertical and rotary line conductors 29 and 30 are disconnected from the trip magnet 40. The closure of connection between the springs 61 and 62 establishes a guarding potential at the master switch bank contact 76 over the following circuit: from battery B to the battery lead 130, thence through the release magnet 41 and springs 61 and 62, conductor 133 to the said contact point 76. It will be understood that the bank terminal Q, being the first bank terminal of the line switch bank, corresponds to the first segment 76 of the master switch bank O. This guarding potential protects the seized trunk conductors 82, 83 and 84 from being seized by other plungers. Suppose that the master switch has operated and carried the wiper 67 to the last contact point 135. Now, when the motor magnet 63 operates for the first step, the wiper 67 engages the contact point 76, at which there is a guarding potential, and an energizing circuit is established through the differential relay 65, which in turn operates to close an energizing circuit through the motor magnet 63. The current through the said relay flows from the said contact 76 through the wiper 67 to the common segment 66, relay 132, through the winding 131 of the differential relay 65 to ground G^2. When the differential relay 65 attracts its armature the differential relay springs 79 and 80 are pressed into contact, thereby closing an energizing circuit for the motor magnet 63 from ground G^3 through the said springs 80 and 79, through the motor magnet 63, springs 78 and 77, thence to the battery lead 130, and through battery B to ground G. The motor magnet then operates, as previously explained, to rotate the ratchet wheel 64 one step for advancing the plunger shaft 52 one step, and the master switch wiper 67 one step also and into en-

gagement with the second segment 81. When thus advanced one step the plunger shaft 52 carries all idle plungers that are in engagement with the said plunger shaft to a point opposite the next bank terminal, as explained. If there should be a guarding potential at the bank segment 81 of the master switch bank the differential relay 65 will remain energized, whereby the energizing circuit through the motor magnet 63 is again completed when the motor magnet springs 77 and 78 again engage; and as a result, the motor magnet 63 is again operated, whereby the plunger shaft 52 and master switch wiper 67 are advanced another step. This operation continues as long as the wiper 67 continues to find segments with guarding potential. As soon as an idle segment is found, however, the energizing circuit through the differential relay 65 is broken, at which time the said relay in turn breaks the energizing circuit for the motor magnet 63 until the next subscriber makes a call. The closure of connection between the springs 55 and 56 extends the calling subscriber's vertical conductor 29 to the vertical trunk conductor 82, which latter leads to the connector vertical line relay 93. The closure of contact between the springs 57 and 58 extends the subscriber's rotary line conductor 30 to the rotary trunk conductor 83, which latter leads to the connector rotary line relay 94. The subscriber at substation A has thus established connection with the connector E, and now when the dial returns toward normal position, thus grounding the vertical line conductor 29 each time that the impulse spring 21 is pressed onto the ground post 16, the vertical line relay 93 of the connector E is energized by a flow of current from the substation ground G'; and immediately before the dial stops, the impulse to the rotary line conductor 30 energizes the connector rotary line relay 94 also. The circuit through the vertical line relay 93 extends from the ground G' through the springs 14 and 15 to the ground post 16, thence through the impulse spring 21 to the vertical line conductor 29, line switch bank springs 55 and 56, vertical trunk line conductor 82, vertical line relay 93 winding 108 of the differential relay 106, conductor 136 to the battery lead 130, thence through battery B to ground G. Each time that the vertical line relay 93 energizes the relay spring 137 is pressed onto the ground spring 138. The vertical magnet is thereby energized and the wipers 90, 91 and 92 of the connector are raised one step at a time to the tenth bank level and brought opposite the first contact of the said level. The energizing circuit of the said magnet extends from ground G^5 through the springs 138 and 137 to the conductor 139, private magnet springs 140 and 141, conductor 142, side switch wiper 102, contact point 143, through the vertical magnet 95, to the battery lead 130, thence through battery B to ground G. On the tenth step the arm 144 presses the springs 119, 120 and 121 into engagement. As previously explained, when the connector switch reaches the tenth level it acts as a selector switch—that is, it rotates automatically to find an idle trunk line in said tenth level. Of course, this automatic rotation is initiated when the rotary impulse is transmitted by the backward rotation of the calling dial. It is to be noted that in this tenth level the first set of contacts is not used for a trunk-line. As shown in Fig. 3, the first private bank contact 217 is grounded permanently, the object being to provide means by which the side switch may be tripped to third position after the switch has been rotated to the desired point. It will be seen that the switch will never stop on the first set of contacts because of the ground on the private contact 217; but if the second set of contacts is idle the shaft will be rotated until the wipers arrive on these contacts. If the second set of contacts is busy—that is, if the first trunk-line to the manual exchange is busy—the connector will automatically rotate until the wipers are carried onto the third set of contacts, or the second trunk that leads to the manual exchange, and so on. The automatic rotation is brought about as follows: When the springs 119, 120 and 121 are brought into contact, as the shaft 89 reaches the tenth level, as previously explained, the rotary magnet 96 as well as the auxiliary relay 122 are simultaneously connected with the side switch contact point 144^a. If the vertical line relay 93 operates to raise the switch shaft 89 to the tenth level through the medium of the vertical magnet 95, as already explained, then when the rotary impulse energizes the rotary line relay 94 the private magnet 97 is in turn energized and the side switch tripped to second position. The energizing circuit for the rotary line relay 94 extends from the substation ground G' to the rotary line conductor 30, thence through the line switch bank springs 57 and 58 to the rotary trunk conductor 83, thence through the rotary line relay 94, and through the winding 108 of the differential relay 106, through the springs 166 and 167 of the back-bridge relay 109 to the battery lead 130, thence through battery B to ground G. The rotary line relay, upon energizing, presses the springs 218 and 138 into contact, whereby an energizing circuit is closed through the private magnet 97. The energizing circuit for said private magnet 97 extends from ground G^5 through the springs 138 and 218 to the private magnet 97, thence through the springs 166 and 167 of the relay 109 to the battery lead 130, and through battery B to ground G. The private magnet 97, upon energizing, attracts

its armature and releases the side switch from first to second position, at which instant the side switch wiper 103 engages the contact point 144ª to connect the aforesaid magnets 122 and 96 to ground. Grounding these magnets causes each of them to energize. The magnet 122 energizes by a flow of current from ground G⁶ to the side switch wiper 103, contact point 144ª, off-normal springs 119 and 120 to the magnet 122, thence to the battery lead 130, and through battery B to ground G. This magnet or relay 122, upon energizing, presses the springs 147 and 149 into contact, whereby the private magnet 97 is put in connection with the side switch contact point 219, which contact 219 is engaged by the side switch wiper 101, while the side switch is in second position, for extending the said private magnet connection from said contact 219 to the private wiper 92. The energizing circuit for the rotary magnet 96, of course, extends from ground G⁶ to the side switch wiper 103, side switch contact point 144ª, through the springs 119, 120 and 121, and through the interrupter springs 145 to the rotary magnet 96, thence to the battery lead 130, and through battery B to ground G. The rotary magnet, upon attracting its armature, rotates the shaft 89 one step, carrying the private wiper 92 onto the grounded contact point 217. As soon as the said wiper 92 engages the said contact point 217 the private magnet 97 is again energized since, as already explained, the relay 122 is still energized. The energizing circuit for the said private magnet in this case extends from ground G¹⁰ to the contact point 217, private wiper 92, side switch wiper 101, contact point 219, springs 147 and 149 to the private magnet 97, thence to the back-bridge relay springs 166 and 167 to the battery lead 130, and through battery B to ground G. The private magnet, upon energizing, attracts its armature and locks the side switch in second position and maintains the side switch thus locked as long as the private wiper 92 is maintained on grounded bank contacts. The side switch being maintained in second position, after the shaft has been rotated one step the rotary magnet 96 is again energized, and as a result the shaft is rotated one more step. If the second private bank contact is not grounded—that is, if it is not busy—the energizing circuit through the private magnet 97 is broken, and, of course, the side switch is tripped to third position, at which time the wiper 103 leaves the contact point 144ª and prevents the rotary magnet 96 from becoming energized any more. At the instant that the said side switch passes to third position, the connector side switch wipers 99 and 100 having engaged the contact points 150 and 151, the calling subscriber's line conductors are extended into connection with the normal conductors 152 and 153 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 guarding potential extends from ground G⁷ to the contact point 154, side switch wiper 101, shaft wiper 92 which engages the private contact of the called trunk-line. The normal conductors 152 and 153, shown in Fig. 3, lead to the trunk conductors 155 and 156, shown in Fig. 2; and when the side switch passes to third position an energizing circuit is closed through the line relay 157 at the manual exchange. This circuit extends from ground G⁷ to the side switch wiper 101, winding 112 of the back-bridge relay 109, springs 158 and 159 to the side switch wiper 100, contact point 151, shaft wiper 91, normal conductor 153, trunk conductor 156, through the springs 160 and 161, relay 157, springs 162 and 163, vertical trunk-line conductor 155, normal conductor 152, shaft wiper 90, contact point 150, side switch wiper 99, through the winding 111 of the relay 109, springs 164 and 165, through the conductor 146 to the battery lead 130, thence through battery B to ground G. The back-bridge relay 109, upon energizing, presses the spring 166 out of engagement with the spring 167 and into engagement with the spring 168, thus connecting battery B across the line of the calling subscriber, as follows: From ground G⁷, contact point 154, side switch wiper 101, springs 168 and 166, through the winding 108 of the relay 106, rotary line relay 94, trunk conductor 83, line switch springs 58 and 57, rotary line conductor 30, primary winding 19, transmitter 17, springs 31 and 32 to the vertical line conductor 29, line switch springs 55 and 56, conductor 82, vertical line relay 93, winding 107 of the relay 106, conductor 146 to the battery lead 130, thence through battery B to ground G. The relay 157, upon receiving current, as explained, energizes and draws its armature 169 out of engagement with the contact point 170 and into engagement with the point 171, whereby a circuit is completed through the line lamp 172. This circuit extends from ground G¹ to the armature 173, contact point 174, springs 175 and 176, line lamp 172, contact point 171, armature 169 to the battery B', thence to ground G¹¹. The glowing of the lamp 172 indicated to the operator that the trunk-line has been seized. Accordingly, the key *e* is operated to press the springs 178 and 177, 179 and 180 into engagement, and to disengage the springs 175 and 176. By this operation the operator's set *o* is bridged across the trunk-line conductors 155 and 156 when the said springs engage, and when the springs 175 and 176 disengage the

circuit through the line lamp 172 is broken. Upon learning that substation A^2 is desired the operator inserts the plug p into the jack J allotted to the line of substation A^2. When the plug p enters the jack J a circuit is closed through the supervisory lamp 181. This circuit extends from ground G^8 through the ring 182 of the jack J, ring 183 of the plug p to the lamp 181, contact point 184, armature 185 to battery B', thence to ground G^{11}. The key e' is operated to bridge the ringer generator across the line conductors 186 and 187 of the called line. When the called subscriber removes the receiver 188 from the switch-hook 189 a circuit is closed through the relays 190 and 191. This circuit extends from ground G^{11} through the relay 191, springs 192 and 193, through the plug p to the conductor 187, switch-hook 189, contact point 194, receiver 188, transmitter 195, conductor 186, through the plug p, springs 196 and 197, through the relay 190 to battery B', and thence to ground G^{11}. This circuit provides the called substation A^2 with battery current for talking purposes. When the relay 190 energizes, then the armature 185 disengages from the contact point 184, thereby breaking the circuit through the supervisory lamp 181, which indicates to the operator that the called subscriber has answered. Similarly, when the relay 191 attracts its armature 173 from the contact point 174, the circuit through the line lamp 172 is broken, even after the operator restores the key e to normal position. The two substations A and A^2 being thus connected, communication may then be carried on over the conductors shown in heavy lines in Figs. 1 and 2. After the conversation has terminated, and the receivers 2 and 188 have been restored to their respective switch-hooks, the central office apparatus is released, and the energizing circuit through the relays 157, 190 and 191 becomes broken, whereby their respective armatures return to normal position. The armature 169 engages the contact point 170, thus closing a circuit through the lamp 198, which circuit extends from ground G^8 through the ring 182 and plug contact 183, lamp 198, contact point 170, armature 169, and through battery B' to ground G^{11}. The armature 185, upon engaging the contact point 184 closes a circuit through the lamp 181, as previously explained. Also, the armature 173 engages the contact point 174, but the circuit through the lamp 172 is broken at the contact point 171, and the said lamp does not glow. The simultaneous glowing of the lamps 198 and 181 gives the operator the disconnect signal. Suppose that the subscriber at substation A^2 alone restores his receiver, and that the subscriber at substation A remained upon the line, desiring another connection at the manual exchange. In that event the line lamp 172 and supervisory lamp 181 glow, owing to the fact that the relay 157 remains energized while the relays 190 and 191 deënergize. The circuit through the lamp 172 extends from ground G^{11} to the armature 173, contact point 174, springs 175 and 176, lamp 172, contact point 171, armature 169 to the battery B', thence to ground G^{11}. The circuit for the lamp 181 extends from ground G^8 through the ring 182, plug contact 183, lamp 181, contact point 184, armature 185 of the relay 190 to the battery B', and thence to ground G^{11}. The glowing of the lamp 172 and the lamp 181 indicates that the subscriber at substation A^2 has restored his receiver, and that the subscriber at substation A still waits upon the trunk-line, desiring another connection. The key e is operated, as above, to bridge the operator's set o across the trunk conductors 155 and 156, thereby the operator may learn what connection is desired.

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 29 and 30 simultaneously, thereby producing a release of the switches through the medium of which the connection was established. As the switch-hook 3 descends the release springs 7, 8 and 9 are pressed into contact, whereby the vertical and rotary line relays 93 and 94 of the connector E are energized, together with the differential relay 106, in the following manner: The result of grounding the rotary line conductor 30 is to unbalance the differential relay 106 by shunting or short-circuiting the winding 108 between ground G' at the substation A and the ground G^7 at the connector E. The shunting or short-circuiting branch may be traced from the substation ground G' to the ground springs 14 and 15, thence to the release springs 7 and 8 to the rotary line conductor 30, line switch bank springs 57 and 58, trunk conductor 83, rotary line relay 94, winding 108 of the differential relay 106, back-bridge relay springs 166 and 168 to the side switch wiper 101 and to ground G^7. The differential relay immediately energizes by the flow of current through the winding 107, by reason of the ground connection to the vertical line conductor 29. The magnetizing current flows from substation ground G' to the ground release spring 7, thence through the release springs 8 and 9 to the vertical line conductor 29, line switch bank springs 55 and 56, conductor 82, connector vertical line relay 93, winding 107 of the differential relay 106 to the battery lead 130, and through battery B to ground G. The differential relay 106, upon energizing, separates the springs 164 and 165 and carries the springs 165 and 199 into engage-

ment. The former of said springs (namely the springs 164 and 165), as already explained, are comprised in the energizing circuit of the back-bridge relay 109, so that as soon as the said springs separate, the said relay 109 deënergizes, whereby the spring 166 leaves the ground spring 168 and returns into engagement with the non-grounded battery spring 167. The effect of this last operation is to remove the shunt from the differential relay winding 108, in series with the rotary line relay 94, 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 106 and reënergizing the rotary line relay 94. Under these conditions the line relays 93 and 94 are energized, whereby the trunk-release springs 200 and 201 are pressed into contact while the differential relay springs 165 and 199 are in engagement, with the result that an energizing circuit is established through the release magnet 98 of the connector E in series with the back-release relay 202 allotted to the trunk-line. The back-release relay 202 may be considered either a part of the connector E or a part of the trunk-line that terminates in the line switch bank springs 56 and 58. In any event, the purpose of this relay 202 is to prevent the release of the line switch C during the busy-release of the connector—that is, when the connector E attempts to close connection with a busy line it is released; but contrary to the practice heretofore employed, and owing to the provision of the said relay 202, and the fact that the connector release magnet has two circuits, the line switch C is not released by the busy-release of the connector. The release magnet 98 of the connector, upon energizing, restores the side switch and switch shaft to normal position, in a manner well-known and fully described in connection with the connector disclosed in said connector patent, at which time, of course, the line and private wipers 90, 91 and 92 are disconnected from the normal conductors 152 and 153 and the private contact. The energizing of the back-release relay 202 carries the back-release relay springs 203 anad 204 into engagement, energizing the release magnet 41 of the line switch C. When the armature of the release relay 202 is attracted an energizing circuit is set up through the release magnet 41 of the line switch C, when the springs 203 and 204 are brought into contact, which energizing circuit extends from ground G^2 through the springs 203 and 204, conductor 84, bank springs 62 and 61, through the release magnet 41 to the battery lead 130, and through battery B to ground G. When the release magnet 41 energizes, the armature 41^a is attracted, whereby the armature 43 of the trip magnet 40 is raised, compressing the spring 50, and the catch 48 engages the terminal 49 of the plunger arm 38, remaining thus in readiness to restore the line switch. As soon as the substation release springs 7, 8 and 9 separate, the energizing circuits of the rotary and vertical line relays 93 and 94 of the connector E are destroyed. As a result, the energizing circuit through the release magnet 98 and the back-release relay 202 is broken. The deënergization of the back-release relay 202 in turn causes the deënergization of the release magnet 41 of the line switch C. When the release magnet 41 of the said line switch deënergizes, the retracting spring 50, through the medium of the armatures 43 and 41^a, withdraws the plunger 37 from its operated position, bringing it into normal engagement with the plunger shaft 52; as a result, of course, destroying the energizing circuit of the cut-off relay 39, removing the guarding potential from the master switch bank O and also from the connector bank, and disconnecting the calling subscriber's line switch from the connector E. The calling subscriber thus restores all of the switching apparatus which he originally brought into use. It will be seen that the connector switch E may also be used to establish connection between any two automatic subscribers of the same exchange—that is, two subscribers such as the subscribers A and A' (Fig. 1). Such local connections will, of course, be confined to the first nine levels in the connector E, and of all connectors similarly constructed; for, as previously explained, said connector automatically rotates to select any one of a group of trunk-lines on the tenth level. It will be obvious that the automatic rotating feature, in any instance, need not be confined to the tenth level, but may be used in any level in which it may be found desirable. In the case of the connector E, of course, the automatic rotating feature fails to appear in any of the first nine levels. Therefore, the subscriber at substation A (Fig. 1), to call the subscriber at substation A', operates the dial in the manner already described. The line switch C is operated, as previously explained, to seize the trunk conductors 82 and 83. The first digit being 2, the vertical line relay of the connector is energized twice, and the shaft wipers are advanced two steps. When the rotary line is grounded the rotary line relay operates to energize the private magnet, whereby the side switch passes from first to second position. The last digit being naught the vertical line conductor 29 is grounded ten times, thereby operating the vertical line relay, which relay in turn causes the energization of the rotary magnet 96 and the step-by-step rotation of the shaft wipers.

The energizing circuit through the said rotary magnet extends from ground G^5 through the springs 138 and 137, conductor 139, springs 140 and 141, side switch wiper 102, contact point 211, through the rotary magnet 96 to the battery lead 130, thence through battery B to ground G. The rotary magnet 96 being energized ten times, the shaft 89 is rotated ten steps, whereby the wipers 90, 91 and 92 are carried into engagement with the tenth terminal of the second level, from which level lead the normal conductors 212, 213 and 214 which extend to the line switch C' of the called line, and the former two of which conductors continue through to the called substation #20. After the connector has thus operated, the ground impulse to the rotary line conductor 30 energizes the rotary line relay 94 of the connector over circuits that are already known, which relay in turn operates the private magnet 97, whereby the side switch is released from second to third position. The calling subscriber's line conductors 29 and 30 are now extended to the called line conductors 215 and 216, and conversation may be carried on over the circuits shown in heavy lines, Fig. 1. When the calling subscriber at substation A restores his receiver to the switch-hook, the release of the central office switching apparatus is brought about, as previously explained. It will be evident, of course, that when the connector side switch passes to third position to extend the calling subscriber's line to the line conductors 215 and 216, a guarding potential is established at the private wiper 92, as previously explained, for protecting this seized line. This guarding potential, furthermore, forces an energizing current through the bridge-cut-off relay 221, whereby the said relay may energize to separate the bridge-cut-off relay springs 222, 223 and 224, in order to remove the normal short-circuit maintained through said springs from across the called line, to enable the subscribers to communicate. Had the subscriber A' been busy, the connector private bank contact-corresponding to said line would have been grounded, and the private wiper 92 would have been carried into connection with said grounded contact. The connector switch E then, upon attempting to close the connection between the calling and called line, would have been automatically released. The operation of this guarding potential to cause the busy-release of the connector E may be described as follows: After the private wiper 92 has been carried onto the grounded contact, as aforesaid, and while the connector side switch is in second position, then when the rotary line relay 94 is energized at the instant that the last ground impulse is delivered to the rotary line conductor 30 the rotary line relay 94 will operate to close an energizing circuit through the release magnet 98, including the said private wiper 92 and the said grounded contact. Of course, said rotary line relay 94, upon energizing, causes the private magnet 97 to energize, which magnet then presses the springs 225 and 226 into contact, at which instant the energizing circuit for the release magnet 98 is completed. This energizing circuit extends from the grounded private contact point to the private wiper 92, thence to the side switch wiper 101, contact point 219, springs 147 and 148, conductor 227, through the private springs 226 and 225 to the release magnet 98, thence through the back-release relay springs 199 and 165 to the battery lead 130, and through battery B to ground G. It will also be understood that the differential relay 106 is energized at the same time, owing to the ground impulse delivered to the rotary line conductor 30. When the release magnet energizes it attracts its armature and forces the support from under the switch shaft 89, and the side switch to first position. The switch shaft also drops to normal position, as is well known. It will be seen, therefore, that only the connector switch E is released, and that the line switch C remains connected with the connector E. Therefore, when the subscriber presses his signaling button 33 and thereby grounds his vertical line conductor 29, the connector switch shaft is raised, whereby the springs 118 and 117 are permitted to close in contact to close a busy-signaling circuit for notifying the calling subscriber that the desired line is busy. This busy-signaling circuit extends from the secondary winding 116 of the busy-coil I (Fig. 1) through the springs 117 and 118 to the side switch wiper 100, thence to the condenser 105, through the substation and back through the vertical line relay 95 to the battery lead 130, and back to the coil 116. The subscriber, upon hearing the busy-signal, will hang up his receiver and ground his line conductors 29 and 30 simultaneously, causing the release of all of the switches in the manner already explained.

With the arrangement shown it will be evident that the manual subscriber A^2 may, if he desires, obtain connection with one of the automatic subscribers of the automatic exchange—subscriber A' (No. 20), for example. In order to explain the method by which this connection may be established, and in order to make the illustration as simple as possible, it will be assumed that the conductors 155 and 156 of Fig. 2 terminate in the line switch C. Of course, for the time being it will be assumed that the conductors 29 and 30 are disconnected therefrom. In that event, when the receiver 188 is removed from the switch-hook 189 a sig-

nal appears at the line lamp 205. The operator inserts the plug *p* into the jack J and operates the key *e* to bridge the operator's set *o* across the extended line, and after learning that substation A, for instance, which is allotted to the line 50, is desired, the operator throws the key *e* in the opposite direction, whereby the springs 160 and 163 disengage from the springs 161 and 162 and pass into engagement with the springs 206 and 207. By this operation, when the said springs 160 and 161 and the springs 162 and 163 disengage, the calling substation A^2 and part of the cord circuit are disconnected from the trunk-line conductors 155 and 156. Furthermore, when the springs 160 and 206 and the springs 163 and 207 engage, the operator's calling device *d* is bridged across the trunk-line conductors instead. To call the number 50, which it is assumed is the number of substation A, the operator presses the button 208 onto the ground spring 209, whereby a preliminary impulse is sent over the rotary line conductor 156 for operating the line switch allotted to the trunk-line conductors 155 and 156, and the calling device is then operated in the usual manner to call the number 50. After the operator has signaled the called subscriber at A the key *e* is restored to normal position, whereby the springs 160, 161 and 162, 163 engage, thus extending the calling subscriber's line conductors 186 and 187 to the trunk-line conductors 155 and 156 over the circuits indicated by the heavy lines in Fig. 2. The relays 157, 190 and 191, upon becoming energized by the talking battery current, attract their respective armatures, breaking the circuits through the supervisory lamps, as before explained. When the subscribers A^2 and A' restore their respective receivers to the switch-hooks the circuits through the relays 190 and 191 become broken, whereby the armatures return to normal position. The armature 185 engages the contact point 184, whereby the circuit through the supervisory lamp 181 is completed, as before explained. Furthermore, since the talking battery current has been removed from the line conductors 155 and 156, the relay 157 also deënergizes, and the armature 169 engages the contact point 170, whereby the circuit through the lamp 198 is completed. The lamps 181 and 198 glowing simultaneously give the operator the disconnect signal, and accordingly the springs 208 and 210 are pressed simultaneously onto the ground spring 209, whereby both the vertical and rotary line conductors 155 and 156 are grounded simultaneously, thus bringing about the release of the central office switches, in the well-known manner.

As indicated in Fig. 2, not only can the manual subscribers be called by the automatic subscribers, and the manual subscribers call the automatic subscribers, but also one manual subscriber can call another manual subscriber by the use of the cord circuit K, of any suitable or approved design, in the ordinary manner.

From the foregoing it will be seen that I provide a telephone exchange system in which provision is made for automatic service between the subscribers of a branch exchange or sub-central station, as well as for efficient service between the subscribers of the two exchanges. The subscribers at the main exchange can carry on communication between themselves in any suitable manner, as, for example, by means of the manual apparatus shown in Fig. 2, or by automatic apparatus if desired. In any event, however, the connectors at the branch exchange shown in Fig. 1 are adapted for two kinds of service—that is to say, each connector is adapted not only to make the final connections directly with any called subscribers' lines that terminate at the branch exchange, but is also adapted, when raised to a certain level, to operate automatically, and in the manner of a selector, for automatically selecting an idle trunk-line leading to the main exchange or central station. Means are provided, as described, for automatically converting each connector into an automatic trunk-selecting mechanism as soon as it is raised to a certain level, so that the selection of the idle trunk is purely automatic. Although the trunks leading from the non-numerical line or individual switches of the branch exchange are connected directly to the connectors, it is possible for each connector to automatically release and restore itself to normal condition, after having tried to seize a busy subscriber's line, without releasing the line switch of the calling subscriber. In this way a comparatively small number of subscribers can be grouped together to form or compose a branch exchange, with efficient service between all of the subscribers thereof, and the same apparatus which furnishes this service is also adapted to give automatic trunking service to the main exchange. Any trunking connections of this kind are efficiently supervised by the operators of the manual board at the main exchange, through the medium of the supervisory apparatus associated with the trunking operators' cord-circuits, in the manner explained. Furthermore, it will be seen that these connectors which have provisions for operating automatically as trunk-selectors are adapted to control the supply of talking current to the calling subscriber, and also to the called subscriber, if the latter be found in the same exchange; but when the call is over a trunk-line to the main exchange, then the battery current flowing through the connector in the direction of the

called subscriber serves only to energize the supervisory relay 157 of the trunking operator's cord-circuit, the talking current for the called subscriber being furnished from the battery B′, in the manner explained. The trunk-lines between the two exchanges are in the nature of two-way trunks—that is to say, each trunk-line is adapted for trunking in either direction, so that a subscriber in either exchange can call a subscriber in the other exchange. At the main exchange the said trunk-lines terminate in trunking operators' cord-circuits of the kind shown in Fig. 2, and at the branch exchange these trunk-lines terminate in non-numerical trunking switches of the kind shown at C in Fig. 1, as well as in the multiple contacts or terminals of automatic connectors of the kind shown at E in Fig. 1. In this way the automatic subscribers at the branch exchange can use the said trunk-lines for automatically trunking to the main exchange, and the operators at the said main exchange can use the same trunk-lines for trunking to the branch exchange and for then automatically trunking to the lines of the called subscribers. When the connection is between subscribers of the branch exchange, then the current from the battery B is supplied in opposite directions for talking purposes, as well as for releasing purposes. When the connection is between the subscriber of one exchange and the subscriber of another exchange, then the current from the battery B flows over the line of the branch exchange subscriber's line for both talking and releasing purposes, and in the opposite direction over the trunk-line for supervisory purposes only; the current for talking purposes being supplied to the manual subscriber from the battery B′ in the manner explained.

It will also be seen from the foregoing that when the connector switch E is acting altogether under the directive control of the calling subscriber, as for example when the subscriber A is calling the subscriber A′, both of the motors 95 and 96 are subject at one instance to the direct control of the calling subscriber A, whereas when the switch E is acting as a rotary connector only one of the motors is subject to the direct control of the calling subscriber, to wit, the motor 95, or the vertical magnet.

What I claim as my invention is:—

1. In a telephone system, a bank of terminals, subscribers' lines leading from one or more of the levels of said bank of terminals, trunk-lines leading from at least one of the levels of said bank of terminals, switch wipers adapted to engage said terminals, two motors both subject at one instance to the direct control of the calling subscriber for causing said wipers to seize the terminal of any idle subscriber's line, and only one, at another instance, subject to the direct control of the calling subscriber, for causing said wipers to pass terminals of busy trunk-lines and stop on the terminal of the first idle trunk-line when a trunking connection is desired.

2. In a telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, and automatic means comprising two motors for causing said connector to select idle trunk-lines or to connect with any one of said subscribers' lines, only one of said motors under the direct control of the calling subscriber to find an idle trunk line and both of said motors under the control of the calling subscriber to connect with one of the subscribers' lines, and a calling line for controlling the connector.

3. In a telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels, said first provisions comprising two motors under the direct control of the calling line and said last provisions comprising only one motor under the direct control of the calling line, and a calling line for controlling the automatic switch.

4. In a telephone system, a main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, and connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector having also provisions for automatically selecting idle trunk-lines leading to the main exchange, said first provisions comprising two motors under the direct control of the calling line and said last provisions comprising only one motor under the direct control of the calling line, and calling lines for controlling the connectors.

5. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, and subscribers' lines also terminating directly in and adapted to be seized by said connectors.

6. In a telephone system, a main exchange and a branch exchange, trunk-lines

connecting one exchange with the other, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a local trunk for and leading to each connector, an automatic trunking switch for and in which each local trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, and means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange.

7. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange to the other, automatic connectors in the banks of which the trunk-lines terminate in one exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a manual switchboard in which the trunk-lines terminte in the other exchange, subscribers' lines terminating directly at said manual switchboard, means on the manual board for connection with the lines terminating thereat, and other subscribers' lines terminating directly in and adapted to be seized by said connectors.

8. In a telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, automatic means comprising two motors for causing said connector to select idle trunk-lines, or to connect with any one of said subscribers' lines, only one of said motors under the direct control of the calling subscriber to find an idle trunk line, both of said motors under the control of a calling subscriber to connect with one of the subscribers' lines, a calling line for controlling the connector; and a centralized means of current-supply for furnishing talking current through said connector to calling and called subscribers' lines.

9. In a telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels, said first provisions comprising two motors under the direct control of the calling line, said last provisions comprising only one motor under the direct control of the calling line, a calling line for controlling the automatic switch and a centralized means of current-supply for furnishing talking current through said automatic switch to calling and called subscribers' lines.

10. In a telephone system, a main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector having also provisions for automatically selecting idle trunk-lines leading to the main exchange, said first provisions comprising two motors under the direct control of the calling line, said last provisions comprising only one motor under the direct control of the calling line, calling lines for controlling the connectors, and a centralized means of current-supply for furnishing talking current through said connectors to calling and called subscribers' lines.

11. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, subscribers' lines also terminating directly in and adapted to be seized by said connectors, and a centralized means of current-supply for furnishing talking current through said connectors to calling and called subscribers' lines.

12. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange with the other, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a local trunk for and leading to each connector, an automatic trunking switch for and in which each trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, and a centralized means of current-supply for furnishing talking current through said connectors to calling and called subscribers' lines.

13. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange to the other, automatic connectors in the banks of which the

trunk-lines terminate in one exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a manual switchboard in which the trunk-lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, means on said manual board for connection with the lines terminating thereat, other subscribers' lines terminating directly in and adapted to be seized by said connectors, and a centralized means of current-supply for furnishing talking current through said connectors to calling and called subscribers' lines.

14. In an automatic and manual telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, automatic means for causing said connector to select idle trunk-lines, and a centralized means of current-supply for furnishing talking current through said connector to calling automatic subscribers' lines, adapted to supply current in the direction of a called manual subscriber for supervisory purposes.

15. In an automatic and manual telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels, and a centralized means of current-supply for furnishing talking current through said automatic switch to calling automatic subscribers' lines, adapted to supply current in the direction of a called manual subscriber for supervisory purposes.

16. In a telephone system, an automatic and manual main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector being also provided with means for automatically selecting idle trunk-lines leading to the main exchange, and a centralized means of current-supply for furnishing talking current through said connectors to calling automatic subscribers' lines, adapted to supply current in the direction of a called manual subscriber for supervisory purposes.

17. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, means at the main exchange for connection with said trunk-lines, connectors in the banks of which the trunk-lines terminate at the branch exchange, subscribers' lines also terminating directly in and adapted to be seized by said connectors, a centralized means of current-supply for furnishing talking current through said connectors to calling subscribers' lines, and adapted to supply current in the direction of a called subscriber in the main exchange for supervisory purposes.

18. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange with the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, a local trunk for and leading to each connector, an automatic trunking switch for and in which each trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, a centralized means of current-supply for furnishing talking current through said connectors to calling subscribers' lines, and adapted to supply current in the direction of a called subscriber in the main exchange for supervisory purposes.

19. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange to the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate in one exchange, a manual switch-board in which the trunk-lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, and a centralized means of current-supply for furnishing talking current through said connectors to calling subscribers' lines, adapted to supply current in the direction of a called manual subscriber for supervisory purposes.

20. In an automatic and manual telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, automatic means for causing said connector to select idle trunk-lines, a centralized means of current-supply for furnishing talking current through the said connector to calling a tomatic subscribers' lines, and a separate or independent source of electrical current-

supply for furnishing talking current to called manual subscribers' lines.

21. In an automatic and manual telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels, a centralized means of current-supply for furnishing talking current through the said automatic switch to calling automatic subscribers' lines, and a separate or independent source of electrical current-supply for furnishing talking current to called manual subscribers' lines.

22. In a telephone system, an automatic and manual main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector being also provided with means for automatically selecting idle trunk-lines leading to the main exchange, a centralized means of current-supply for furnishing talking current through the said connectors to calling automatic subscribers' lines, and a separate or independent source of electrical current-supply for furnishing talking current to called manual subscribers' lines.

23. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, means at the main exchange for connection with said trunk-lines, connectors in the banks of which the trunk-lines terminate at the branch exchange, subscribers' lines also terminating directly in and adapted to be seized by said connectors, a centralized means of current-supply for furnishing talking current through the said connectors to calling subscribers' lines, and a separate or independent source of electrical current-supply for furnishing talking current to called manual subscribers' lines.

24. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange with the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, a local trunk for and leading to each connector, an automatic trunking switch for and in which each trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, a centralized means of current-supply for furnishing talking current through the said connectors to calling subscribers' lines, and a separate or independent source of electrical current-supply for furnishing talking current to called subscribers' lines in the main exchange.

25. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange to the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate in one exchange, a manual switchboard in which the trunk-lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, a centralized means of current-supply for furnishing talking current through the said connectors to calling subscribers' lines, and a separate or independent source of electrical current-supply for furnishing talking current to called manual subscribers' lines.

26. In a telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, automatic means for causing said connector to select an idle trunk-line by the calling of a single digit, and a trunking operator's supervisory mechanism for supervising any trunking connection established by the connector.

27. In a telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels by the calling of a single digit, and a trunking operator's supervisory mechanism for supervising any trunking connection established by the automatic switch.

28. In a telephone system, a main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector being also provided with means for automatically selecting idle trunk-lines leading to the main exchange by the calling of a

single digit, and a trunking operator's supervisory mechanism for supervising any trunking connection established by a connector.

29. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, means at the main exchange for connection with said trunk-lines, connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, subscribers' lines also terminating directly in and adapted to be seized by said connectors, and a trunking operator's supervisory mechanism for supervising any trunking connection established by a connector.

30. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange with the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a local trunk for and leading to each connector, an automatic trunking switch for and in which each trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, and a trunking operator's supervisory mechanism for supervising any trunking connection established by a connector.

31. In a telephone system, a main exchange and a branch exchange trunk-lines connecting one exchange to the other, means at the main exchange for connection with said trunk-lines, automatic connectors in the banks of which the trunk-lines terminate in one exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a manual switchboard in which the trunk-lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, and a trunking operator's supervisory mechanism for supervising any trunking connection established by a connector.

32. In a telephone system, a connector provided with a bank of terminals arranged in a plurality of levels, subscribers' lines leading from one or more of said levels, trunk-lines leading from at least one of said levels, automatic means for causing said connector to select an idle trunk-line by the calling of a single digit, and a manual switchboard operator's mechanism for controlling said connector when said trunk-lines are used by the operator for calling subscribers' lines terminating in said connector.

33. In a telephone system, an automatic switch provided with a bank of terminals arranged in a plurality of levels, suitable lines leading from said terminals, said switch having provisions for enabling it to seize any particular line desired by the calling subscriber in one or more of the levels thereof, and having provisions for automatically selecting the first idle line in at least one of said levels by the calling of a single digit, and a manual switchboard operator's mechanism for controlling said automatic switch when said lines are used by the operator for calling subscribers' lines terminating in said automatic switch.

34. In a telephone system, a main exchange and a sub-exchange, trunk-lines extending from one exchange to the other, connectors at the sub-exchange, each connector having provisions for seizing any particular one of a number of subscribers' lines terminating thereat, and each connector being also provided with means for automatically selecting idle trunk-lines leading to the main exchange by the calling of a single digit, and a manual switchboard operator's mechanism for controlling said connectors when said trunk-lines are used by the operator for calling subscribers' lines terminating in said connectors.

35. In a telephone system, a main exchange and a branch exchange, trunk-lines leading from one exchange to the other, connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, subscribers' lines also terminating directly in and adapted to be seized by said connectors, and a manual switchboard operator's mechanism for controlling said connectors when said trunk-lines are used by the operator for calling subscribers' lines terminating in said connectors.

36. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange with the other, automatic connectors in the banks of which the trunk-lines terminate at the branch exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a local trunk for and leading to each connector, an automatic

trunking switch for and in which each trunk-line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk-lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, and a manual switchboard operator's mechanism for controlling said connectors when said trunk-lines are used by the operator for calling subscribers' lines terminating in said connectors.

37. In a telephone system, a main exchange and a branch exchange, trunk-lines connecting one exchange to the other, automatic connectors in the banks of which the trunk-lines terminate in one exchange, means individual to each connector for completing the connection of said connector with an idle trunk line by the calling of a single digit, a manual switch-board in which the trunk-lines terminate in the other exchange, means at the manual board for connection with the lines terminating thereat, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, and a manual switchboard operator's mechanism for controlling said connectors when said trunk-lines are used by the operator for calling subscribers' lines terminating in said connectors.

38. In a telephone system, a connector, a subscribers' non-numerical individual trunking switch, means for connecting the said individual switch with the said connector, release means for said individual switch under the control of said connector, means for preventing a release of the said individual switch if the called subscriber's line is busy, and automatic means for releasing the connector without releasing the individual switch if the called subscriber's line is busy.

39. In a telephone system, an automatic connector, a subscriber's non-numerical individual trunking switch, means for connecting the individual switch with the connector, release means for said individual switch under the control of the connector, and means for preventing the individual switch from releasing when the connector attempts to seize a busy subscriber's line.

40. In a telephone system, an automatic switch, a connector, a trunk-release circuit for the automatic switch, a relay individual to the connector and controlling said release circuit, and a release magnet for said connector adapted to be energized in series with said relay.

41. In a telephone system, an automatic switch, a connector, a trunk-release circuit for the automatic switch, a relay individual to the connector for controlling said release circuit, a release magnet for the connector adapted to be energized in series with said relay when the release is effected by a subscriber, and a busy-release circuit for energizing said release magnet without energizing said relay when the connector attempts to seize a busy subscriber's line.

42. In a telephone system, a subscriber's individual non-numerical trunking switch, a connector, a trunk-release circuit for the said individual switch, a relay individual to the connector for controlling said release circuit, a release magnet for the connector adapted to be energized in series with the said relay when the release is effected by a subscriber, a pair of voice-current conductors directly connecting the individual switch with the connector, and a busy-release circuit for energizing said release magnet without energizing the said relay when the connector attempts to seize a busy subscriber's line.

43. In a telephone system, trunks and means for selecting them ahead of the calls, a two-way trunk-line, a non-numerical trunking switch individual to and adapted for extending connection from one end of said trunk-line by seizing preselected trunks, an automatic connector for seizing or extending connection to the same end of said trunk-line, and manual apparatus for extending connection to or from the other end of said trunk-line.

44. In a telephone system, trunks and means for selecting them ahead of the calls, a two-way trunk-line, a non-numerical trunking switch individual to and adapted for extending connection from one end of said trunk-line, and a manual switchboard in which the other end of said trunk-line terminates.

45. In a telephone system, trunks and means for selecting them ahead of the calls, a two-way trunk-line, a switch-plug for one end of said trunk-line, and a non-numerical trunking switch for the other end of said trunk-line, adapted to seize preselected trunks.

46. In a telephone system, a connector switch having vertical and rotary motion, a rotary magnet and an interrupter normally inoperative, and means for rendering said interrupter operative in circuit with said rotary magnet when said switch is raised to a given level.

47. In a telephone system, a connector switch having vertical and rotary motion, a rotary magnet and an interrupter normally inoperative, a plurality of off normal springs, and means for rendering said interrupter operative by connecting it in series with said rotary magnet through said springs when said switch is raised to a given level.

48. In a telephone system including sub-

scriber's lines, a connector switch having vertical and rotary motion, a relay controlling the release of said switch when a connection is made with a busy line, and means for rendering said relay inoperative for releasing said switch when said switch is raised to a given level.

49. In a telephone system, a plurality of lines divided into groups, a two-motion connector switch having motion in one direction to select groups and motion in another direction to connect with a line in a selected group, an operating magnet, a normally inoperative interrupter, and means rendered effective at a predetermined point in the first movement of said switch for rendering said interrupter operative in circuit with said operating magnet.

50. In a telephone system, a plurality of lines divided into groups, a connector switch provided with a shaft and wipers having one motion to select groups and a second motion to connect with a line in a selected group, an operating magnet, a normally inoperative interrupter, a plurality of off-normal springs controlled by said shaft, and means for rendering said interrupter operative by connecting it in series with said operating magnet through said springs when said wipers are moved to a given group.

51. In a telephone system, a plurality of lines divided into groups, a connector switch having one motion to select groups and a second motion to select a line in a selected group, separate controlling means for said second movement effective if a particular one of said groups is selected, a relay normally controlling the release of said switch when a connection is made with a busy line, and means for rendering said relay inoperative for releasing said switch during the operation of said controlling means.

52. In a telephone system, a main exchange and a branch exchange, trunk lines leading from one exchange to the other, means at the main exchange for connection with said trunk lines, connectors in the banks of which the trunk lines terminate at the branch exchange, subscribers' lines also terminating directly in and adapted to be seized by said connectors, a centralized means of current supply for furnishing talking current through the connectors to calling subscribers' lines in said branch exchange, and adapted to supply current in the direction of a called subscriber in the main exchange for supervisory purposes.

53. In a telephone system, a main exchange and a branch exchange, trunk lines connecting one exchange with the other, means at the main exchange for connection with said trunk lines, automatic connectors in the banks of which the trunk lines terminate at the branch exchange, a local trunk line leading to each connector, an automatic trunking switch for and in which each trunk line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk lines to cause the trunking switches to select the trunks of idle connectors when subscribers of the main exchange call subscribers of the branch exchange, a centralized means of current supply for furnishing talking current through said connectors to branch exchange calling subscribers' lines, and adapted to supply current in the direction of a called subscriber in the main exchange for supervisory purposes.

54. In a telephone system, a main exchange and a branch exchange, trunk lines connecting one exchange to the other, means at the main exchange for connection with said trunk lines, automatic connectors in the banks of which the trunk lines terminate in one exchange, a manual switch board in which the trunk lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, a centralized means of current supply for furnishing talking current through said connectors to branch exchange calling subscribers' lines, and adapted to supply current in the direction of a called manual subscriber for supervisory purposes.

55. In a telephone system, a main exchange and a branch exchange, trunk lines connecting one exchange with the other, means at the main exchange for connection with said trunk lines, automatic connectors in the banks of which the trunk lines terminate at the branch exchange, a local trunk for and leading to each connector, an automatic trunking switch for and in which each trunk line terminates at the branch exchange, subscribers' lines also terminating in and adapted to be seized by said connectors, means for controlling said trunking switches over the trunk lines to cause the trunking switches to select the trunks of an idle connector when subscribers of the main exchange call subscribers of the branch exchange, a centralized means of current supply for furnishing talking current through the said connectors to branch exchange calling subscribers' lines, and a separate or independent source of electrical current supply for furnishing talking current to called subscribers' lines in the main exchange.

56. In a telephone system, a main exchange and a branch exchange, trunk lines connecting one exchange to the other, means at the main exchange for connection with said trunk lines, automatic connectors in the banks of which the trunk lines terminate in

one exchange, a manual switch board in which the trunk lines terminate in the other exchange, subscribers' lines terminating directly at said manual switchboard, other subscribers' lines terminating directly in and adapted to be seized by said connectors, a centralized means of current supply for furnishing talking current through the said connectors to branch exchange calling subscribers' lines, and a separate or independent source of electrical current supply for furnishing talking current to called manual subscribers' lines.

57. In a telephone system, a line, an automatic switch, a group of lines each having a terminal individual thereto for said switch, a busy test circuit for each line, means for applying a busy potential to any one of said circuits, means for operating said switch to advance the same and for controlling said switch over said first line to terminate its advance when it reaches a position corresponding to one of said lines, to the busy test circuit of which a busy potential has been applied, and release means for said switch responsive to said busy potential to release said switch, a second group of lines, each line of the second group having a terminal individual thereto, a busy test circuit for each line of the second group, means for applying a busy potential to a line of said second group of lines and means for operating said switch to advance the same to a position corresponding to said line of said second group to which said busy potential is applied, and responsive to said potential to cause the switch to advance to a new position corresponding to another line of the second group of lines, and for then bringing together through said switch and the individual terminal of said last line, the said last line and the said first mentioned line, a telephone for said first mentioned line, conductors for said first mentioned line, and means for supplying said telephone with current for talking purposes over the conductors of said first mentioned line.

58. In a telephone exchange system, the combination of a calling line, a plurality of called lines, a plurality of trunk lines, an automatic switch, means to cause said switch to operate and establish connection between said calling line and any one of said called lines of a local group by the calling of two digits only, means to cause said switch to operate and establish connection between said calling line and any one of said trunk lines, and means individual to the switch adapted to complete the connection of said switch with an idle trunk line by the calling of a single digit.

59. In a telephone exchange system, a plurality of subscribers' lines, a plurality of trunk lines, an automatic switch adapted to connect a subscriber's line with any one of said lines and controlled by impulses sent over said subscriber's line, and means operable upon the sending of a single group of impulses, to cause the switch to connect with, and test trunk lines only.

60. In a telephone exchange system, the combination of a plurality of subscribers' lines, a plurality of trunk lines, an automatic switch, a common means to make said trunk lines, and said subscribers' lines, when in use, "busy" to said switch, means to cause said switch to operate and establish a connection between a calling subscriber's line and any other of said subscribers' lines and said trunk lines, and a testing circuit adapted upon connection with a busy subscriber's line to stop the operation of said switch, and upon connection with a busy trunk line to cause said switch to connect with the next succeeding trunk line.

61. In a telephone exchange system, incoming lines and outgoing lines, a selector switch for extending an incoming line to an outgoing line, means for producing series of current impulses in said incoming lines, means for controlling the operation of said switch in accordance with certain single series of impulses, and means operated when certain other series of impulses are produced for controlling the operation of said switch in accordance with a plurality of series of impulses.

62. In a telephone exchange system, incoming lines and outgoing lines, a selector switch for extending an incoming line to an outgoing line, means for producing series of impulses in said incoming lines, an electromagnet for controlling the operation of said switch, means for actuating said electromagnet in accordance with a single series of impulses if a certain one of said series has been produced, and means for operating said electromagnet in accordance with a plurality of series of impulses if a certain other series has been produced.

63. In a telephone system, a plurality of lines, a selector switch having a contact arm adapted to connect with any one of said lines, means for operating said arm, means whereby said arm will not stop upon certain of said lines unless said lines are idle, means whereby said arm will stop upon other of said lines whether they are idle or busy, and means for preventing the establishment of a circuit over said last-mentioned lines if they are busy.

64. In a telephone system, a plurality of subscribers' lines, means including a group of lines for establishing a connection between a calling and a called subscriber's line, an automatic switch for connecting with said lines, means whereby said switch will not stop upon certain of said lines unless

said lines are idle, means whereby said switch will stop upon one of said lines whether it is idle or busy, and means for giving a busy signal in case said switch stops upon a line that is busy.

65. In a telephone system, a plurality of lines, a selector switch adapted to connect with any one of said lines, means whereby said switch will not stop upon certain of said lines unless said lines are idle, and means whereby said switch will stop upon other of said lines whether they are idle or busy.

66. In a telephone system, a plurality of lines, a selector switch having a contact arm adapted to connect with any one of said lines, means for operating said arm, means whereby said arm will not stop upon certain of said lines unless said lines are idle, means whereby said arm will stop upon other of said lines whether they are idle or busy, means for preventing the establishment of a circuit over said last-mentioned lines if they are busy, all of said means controlled by a single battery, other lines, and means for extending a connection from some of said first lines to any one of said other lines.

67. In a telephone system, a plurality of subscribers' lines, means including a group of lines for establishing a connection between a calling and a called subscriber's line, an automatic switch for connecting with said lines, means whereby said switch will not stop upon certain of said lines unless said lines are idle, means whereby said switch will stop upon one of said lines whether it is idle or busy, and means for giving a busy signal in case said switch stops upon a line that is busy, all of said means controlled by a single battery.

68. In a telephone system, a plurality of lines, a selector switch adapted to connect with any one of said lines, means whereby said switch will not stop upon certain of said lines unless said lines are idle, means whereby said switch will stop upon other of said lines whether they are idle or busy, all of said means controlled by a single battery, other lines, and means for extending a connection from some of said first lines to any one of said other lines.

69. In a telephone system, a connector switch having primary and secondary movements, groups of lines accessible to said switch, means for directively controlling the primary movement of said switch to select a desired group, means for directively controlling the secondary movement of said switch to select a desired line in a selected group, automatic controlling means for the secondary movement, and means actuated at a predetermined point in the primary movement of said switch for rendering said automatic controlling means operative.

Signed by me at Chicago, Cook county, Illinois, this 2nd day of October, 1907.

WILSON L. CAMPBELL.

Witnesses:
EDWARD D. FALES,
FRANKLIN J. TRUBY