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SEMI-AUTOMATIC TELEPHONE TRUNKING SYSTEM.

APPLICATION FILED SEPT. 13, 1907. RENEWED MAY 28, 1917.

1,253,703. Patented Jan. 15, 1918.

2 SHEETS—SHEET 1.

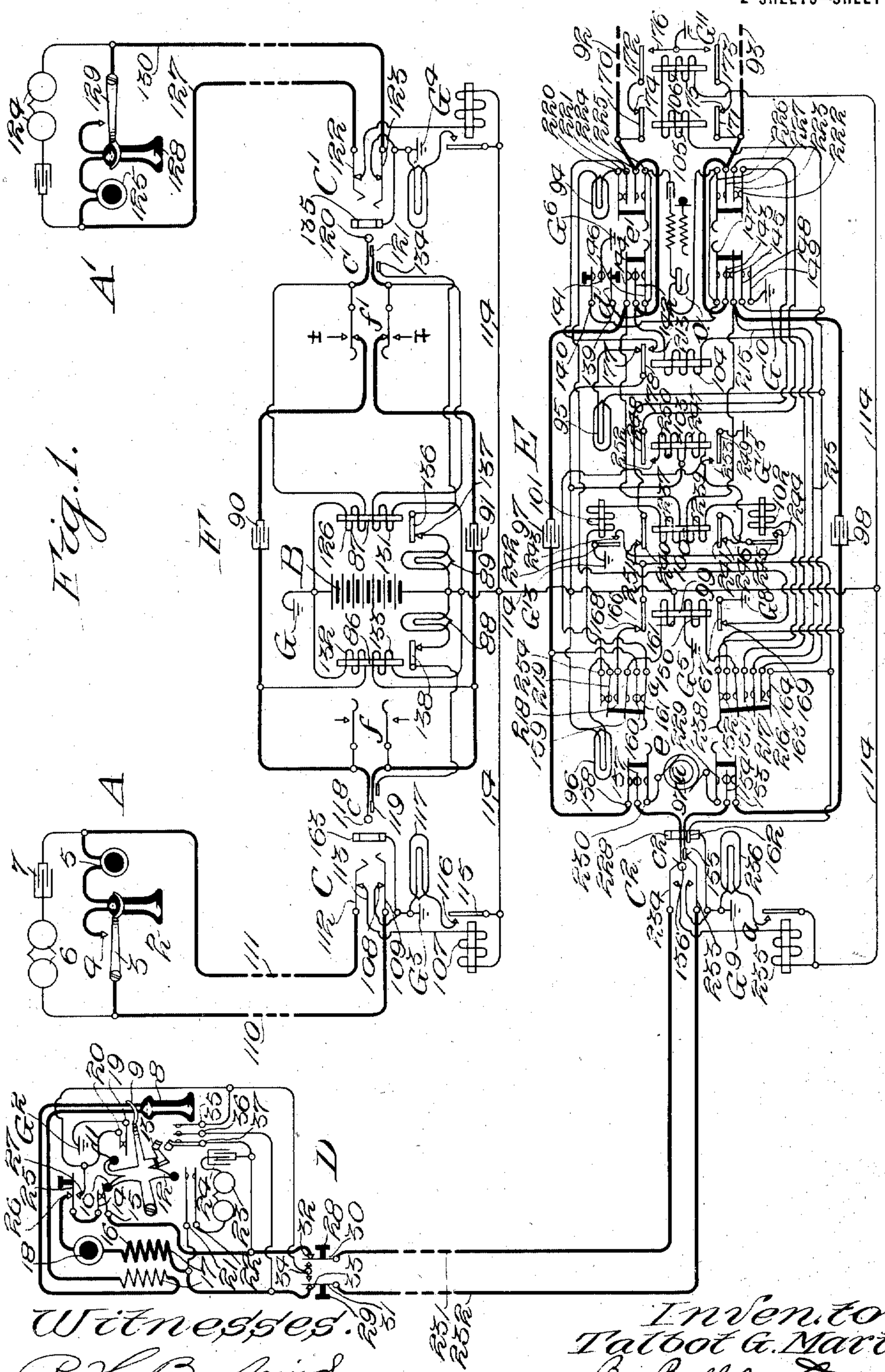

Fig. 1.

Witnesses.
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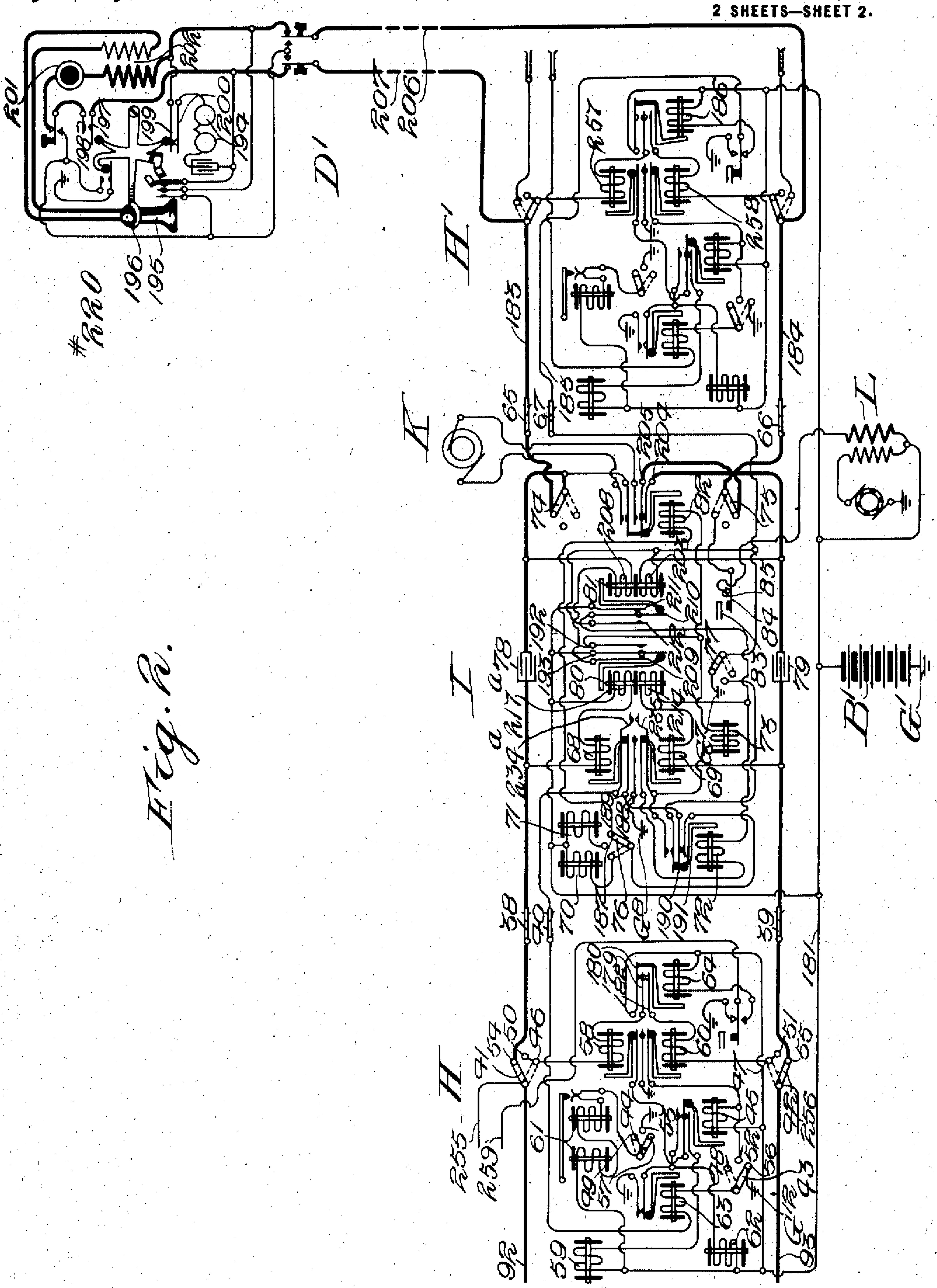

Fig. 2.

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UNITED STATES PATENT OFFICE.

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SEMI-AUTOMATIC TELEPHONE TRUNKING SYSTEM.

1,253,703. Specification of Letters Patent. Patented Jan. 15, 1918.

Application filed September 13, 1907, Serial No. 392,686. Renewed May 28, 1917. Serial No. 171,570.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Semi-Automatic Telephone Trunking Systems, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to systems in which both automatic and manual switchboard apparatus is employed for connecting calling subscribers with called subscribers, such systems being ordinarily known as semi-automatic systems.

The principal object of my invention is the provision of an arrangement for enabling the subscribers of a private exchange to communicate with the subscribers of a main exchange, in a system of that character in which the subscribers at the private exchange are both manual and automatic, and in which the main exchange is provided with automatic apparatus for the automatic subscribers, as hereinafter set forth; the provision of an improved two-way trunk line, and a manual switchboard operator's cord circuit, having suitable supervisory apparatus for enabling the operator to fully supervise any and all connections made through the medium of said trunk line and cord circuit, whether between automatic subscribers, or between automatic and manual subscribers, according to the character of the call; and the provision of certain details and features of improvement and combinations tending to increase the general efficiency and serviceability of a semi-automatic trunking system of this particular character.

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

Figure 1 is a diagram of a combined manual and automatic private branch exchange telephone system embodying the principles of my invention, a couple of manual substations being shown at A and A′ and an automatic substation at D. The manual substations A and A′ are each connected with lines which terminate in the jacks C and C′, respectively, of the private branch, and the automatic substation is shown connected with a line which terminates in the jack C^2. The trunk circuit E, which is adapted to connect with the jacks C, C′ and C^2, is used by the operator to connect any substation of the private branch exchange with an outgoing trunk line to the main central exchange, and is also used by incalling subscribers. Therefore, the cord E is a two-way cord; and the cord F is used to connect any two local substations—that is, any two substations having their lines terminating in the private branch board, such as A and D for instance. The central battery B is shown having its positive terminal preferably grounded at G.

Fig. 2 shows diagrammatically the switching apparatus of an automatic central office in connection with which I have elected to explain my invention. At H is shown a first-selector switch allotted to the trunk line leading to the private branch board shown in Fig. 1, said trunk line terminating in the cord E. At I a connector switch is shown, and the selector switch H′ is allotted to the line #220 that leads to the substation D′, which station belongs to this main automatic exchange. At K and L are represented a ringing generator and busy-signaling machine, respectively. The battery of the automatic central office is shown at B′ and has its positive terminal preferably grounded at G′.

Figs. 1 and 2 taken together show the switching mechanism involved when the substation D, which is a substation of the private branch board, calls the station D′, which is a substation of the central exchange. It will be evident, of course, that in the automatic exchange there are a plurality of substations D′ each having a switch H′. There are also a number of connectors I common to the different subscribers for use in completing a connection.

The substations A and A′ may be of any suitable common battery and manual type. Substation A, for instance, comprises the usual receiver 2 and switch-hook 3 which, when the receiver is removed, is adapted to engage the contact point 4, whereby the transmitter 5 in series with the receiver 2 becomes bridged across the line. When the receiver 2 is restored to the switch-hook the primary circuit through the transmitter and receiver is broken, leaving the ringer 6 in series with the condenser 7 bridged across the allotted line. The substation D, like the substation D′, comprises the usual receiver 8, and the switch-hook 9, which latter has a

number of cam arms 10, 11, 12 and 13. When the switch-hook is up the cam arm 10 closes the springs 14 and 15 in contact, whereby the primary winding 16 of the induction-coil 17 in series with the transmitter 18 becomes bridged across the substation line. Also, when the switch-hook is up the cam arm 11 permits the springs 19 and 20 to engage, whereby the substation becomes connected with the substation ground G^2. When the switch-hook is down the cam arm 12 presses the springs 21 and 22 into engagement, bridging across the line the ringer 23 in series with the condenser 24. The signaling device comprises a push-button spring 25 which normally rests in contact with the spring 26, but which when pressed engages the contact point 27. The calling device comprises the push-buttons 28 and 29, and the springs 30 and 31 which normally rest in engagement with the contact points 32 and 33; but when the buttons 28 and 29 are pressed, the said springs then engage the ground contact 34. The means whereby the subscriber may release the central office switches comprises the springs 35, 36 and 37, known as the release springs. When the receiver is restored to the switch-hook said release springs are pressed into engagement momentarily by the cam arm 13.

The first-selector switch shown at H may be of any suitable or approved type, for example of the type described in United States Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson. In this switch the switch shaft (not shown) carries the vertical and rotary wipers 38 and 39, respectively, and the private wiper 40. The side switch is well known and comprises the side switch wipers 41, 42, 43 and 44. The side switch is under the control of the private magnet 45, and in their normal or first position the wipers 41, 42, 43 and 44 occupy the contact points 46, 47, 48 and 49, respectively. In the second position they rest on the contact points 50, 51, 52 and 53, respectively, and in the third position the contact points 54, 55, 56 and 57 are engaged by their respective wipers. Through the medium of the vertical line relay 58, and while the side switch is in first position, the subscriber controls the vertical magnet 59, which latter operates to raise the switch shaft and wipers 38, 39 and 40 vertically. By means of the rotary line relay 60, and while the side switch is in first position, the subscriber controls the private magnet 45 and, therefore, the side switch. While the side switch is in second position the rotary magnet 61, which operates to carry the switch shaft and wipers 38, 39 and 40 in a rotary direction, is energized. The vertical and rotary line relays 58 and 60, acting conjointly, provide means whereby the subscriber controls the release magnet 62 while the side switch is in first or second position. If the side switch passes to the third position then (since the selector H is of the trunk-release type) the selector H is controlled through the next switch, with which latter a connection is then established, and through the private wiper 40 and by means of the back-release relay 63. The bridge-cut-off relay 64 is provided to open the connection between the line relays 58 and 60 and between said relays and battery B′. This is desirable, because if the relays are not disconnected from each other and battery the ringing current for signaling the subscriber may operate either or both of the relays 58 and 60 and cause some interference with the switch. It is also desirable to remove the bridge formed through said relays from across the line to give the voice-currents as clear a path as possible.

The connector switch I is a modified form of the connector switch disclosed in United States Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson. The mechanical devices of the connector and selector, as is well known, are very much the same, although the circuits are different. For example, the connector switch shaft (not shown) carries, like the selector, the line wipers 65 and 66 and the private wiper 67. The connector switch is also controlled by the calling subscriber through the medium of the vertical and rotary line relays 68 and 69. The vertical line relay 68 directly controls the vertical magnet 70 and also the rotary magnet 71. The function of the vertical magnet 70 is to give the shaft and shaft wipers a vertical motion, and the rotary magnet 71 imparts to the shaft and shaft wipers a rotary or circular motion. The rotary line relay 69 controls the private magnet 72, which latter, under certain conditions, controls in turn the vertical and rotary magnets 70 and 71, release magnet 73 and also the side switch wipers 74, 75, 76 and 77. The side switch, like the side switch of the selector, has a normal or first position, a second position and a third position. The release magnet 73 is also controlled by the vertical and rotary line relays 68 and 69 conjointly. By the use of the condensers 78 and 79 the connector divides the talking circuit into two sections. The differential relay 80 controls the energizing circuit of the release magnet 73, and also of the back-bridge relay 81, which latter provides the called substation with battery current for talking purposes, and which upon energizing closes a circuit that provides the calling substation with battery current for talking purposes. When the side switch is in third position the vertical line relay 68 controls the ringer relay 82 by means of which the ringer generator K is bridged across the terminals of the called line to

signal the called subscriber. When the shaft is raised the normal arm 83 permits the springs 84 and 85 to engage, whereby the calling subscriber receives the busy-signal when the side switch is in first position.

The cord circuit F is provided with the plugs *c* and *c'* which are adapted to engage the jacks C, C' and C². The relays 86 and 87 provide means for supplying the substations with battery current for talking purposes. By the use of the signal lamps 88 and 89 the operator obtains supervision over the lines corresponding to the jacks in which the plugs *c* and *c'* are inserted. The condensers 90 and 91 divide the talking circuit into two sections. By means of the key *f* the operator may bridge her talking set across the calling end of the cord circuit, and by means of the key *f'* a signal may be sent out to the called line. The cord circuit E, as aforesaid, is adapted for making calls both ways over the trunk conductors 92 and 93, which connect the main and sub exchanges. The signaling lamp 94 indicates to the operator when the trunk line conductors 92 and 93 have been seized by a calling subscriber at the main automatic exchange, and acts as a line signal from the trunk side. The lamps 95 and 96 are supervisory lamps, each acting as front and back supervisory lamps, depending upon the direction of the call. If the call is from the branch exchange to the main office the lamp 96 acts as a front and the lamp 95 as a back supervisory signal. Vice versa, if the call comes from the main exchange, then the lamp 95 acts as a front and the lamp 96 as a back supervisory signal. By means of the key *e* the operator may bridge the generator 97ª across the plug c^2, and by throwing the key in the opposite direction the plug c^2, as shown in Fig. 1, may be extended to the trunk conductors 92 and 93. In this way the subscribers A, A', D, etc., may be called or put in connection with the trunk conductors 92 and 93 for calling purposes. By means of the condensers 97 and 98 the trunk circuit E is divided into two sections, as is ordinarily the custom. When the key *e* is in normal position, the relay 99 provides means for supplying the plug-end of the line with battery current for talking purposes, and when the key *e* is operated, as shown, (with the springs 164, 216, 151, 238, 219, etc., all shifted) the plug-end of the line receives talking current through the windings of the relays 100, 101 and 102. The relay 104, under certain conditions, controls the supervisory lamp 95 and the trunk signal lamp 94. By means of the key *e'* the operator may bridge her calling device *d* across the trunk line conductors 92 and 93, and by operating the key in the opposite direction an operator's set is bridged across the same trunk line. By means of the release relays 105 and 106 the trunk line conductors 92 and 93 may be grounded simultaneously to bring about the release of the central office switching apparatus.

The operation of the cord circuit F may be better understood by considering its use for connecting one substation with another substation. Suppose, for example, that the subscriber at substation A desires to communicate with the subscriber at substation A'. When the calling subscriber removes the receiver 2 the switch-hook 3 engages the contact point 4, whereby an energizing circuit is established through the line relay 107. Said circuit extends from ground G³ through the springs 108 and 109, conductor 110, through the switch-hook 3, contact point 4, receiver 2, transmitter 5, conductor 111, springs 112 and 113, through the relay 107 to the battery lead 114, thence through battery B and to ground G. The relay 107, upon energizing, draws its armature 115 onto the contact point 116, thus closing the circuit through the line lamp 117. The circuit through the said lamp extends from ground G³ through the lamp 117, contact point 116, armature 115 to the battery lead 114, thence through battery B and to ground G. The operator, in response to the signal, inserts the plug *c* into the jack C, whereby the tip 118 and sleeve 119 of the plug *c* engage the tip and sleeve springs 112 and 109 and carry them out of engagement with the springs 113 and 108, respectively. The circuit through the line relay 107 being thus broken, said relay deënergizes, and the armature 115 returns to normal position, whereby the circuit through the line lamp 117 becomes broken. The operator, upon bridging her set across the line by means of her key *f*, learns that substation A' is desired. She then inserts the plug *c'* into the jack C', whereby the tip 120 and sleeve 121 of the plug *c'* engage the tip and sleeve springs 122 and 123, respectively. She now throws the key *f'*, whereby the signaling current passes through the ringer 124 at substation A'. The subscriber at substation A', upon removing the receiver 128 from the switch-hook, closes a circuit which provides the transmitter 125 with battery current for talking purposes. This circuit extends from ground G through the winding 126 of the relay 87 to the springs 120 and 122, conductor 127, through the transmitter 125, receiver 128, switch-hook 129, conductor 130, springs 123 and 121, through the winding 131, thence to the battery lead 114 and through battery B to ground G. Over a similar circuit including the windings 132 and 133 of the relay 86 the substation A is provided with battery current for talking purposes, when the plug *c* is inserted into the jack C after the receiver 2 is removed from the switch-hook. Furthermore, when the plug *c'* enters the jack C' the ring 134 engages a

ground ring 135, whereby a circuit is closed through the supervisory lamp 89. Said circuit extends from ground G^4 through the rings 135 and 134, armature 136, contact point 137, through the lamp 89 to the battery lead 114, thence through battery B and to ground G. Now when the subscriber answers, as explained, the relay 87 energizes and attracts the armature 136, whereby the circuit through the said lamp is broken, and the operator knows that the called subscriber has answered. Similarly, the relay 86 attracts its armature 138 and breaks the circuit through the supervisory lamp 88. Now, when both subscribers restore their receivers to their switch-hooks, the energizing circuits through the relays 86 and 87 are destroyed. The armatures 138 and 136 again resume their normal positions, whereby the circuit through the supervisory lamps 88 and 89 is again established, thus giving the operator the disconnect signal. Suppose that the subscriber at substation A had desired connection with substation D. In that case the plug c' would have been inserted in the jack C^2, and the subscriber at substation D called in the same manner. In a similar manner, when the receiver 8 is removed from the hook 9, a circuit is closed through the relay 87, and the two substations A and D are connected in a manner similar to that explained. Of course, should the subscriber at substation D desire connection with substation A he removes his receiver, closes springs 14 and 15 and sets up an energizing circuit through the signal relay 235^a. In that case, the plugs c and c' would be reversed—that is, the plug c would be inserted in the jack C^2 and the plug c' would be inserted in the jack C. Suppose that the subscriber at A desired connection with the subscriber at D′, which is a substation of the central exchange. The operator then answers as before, and, upon learning that substation D′ on the line #220 is wanted, removes the plug c from the jack C and substitutes the plug c^2 of the trunk circuit, whereby the substation A becomes connected directly through the trunk line conductors 92 and 93. The substation A being a manual substation, the desired number may be called by the operator by means of the calling device d which is represented by two push-button springs 139 and 140 and a ground post 141. The key e' is operated to separate the springs 142 and 143 from engagement with the springs 144 and 145, and to carry the former into engagement with the springs 146 and 147. The springs 148 and 149 also engage, but at this time without effect. By the separation of the said springs the operator disconnects the trunk conductors from the substation A, and by the engagement of the above-mentioned springs the calling device d is bridged across the trunk conductors 92 and 93. It will be seen that at the instant that the plug c^2 is inserted in the jack C the substation A is provided with battery current for talking purposes over the following circuit: from ground G^5 at the cord circuit E through the winding 150 of the relay 99 to the springs 151 and 152, springs 153 and 154 to the sleeve 155 of the plug c^2, sleeve spring 109 of the jack C to the conductor 110, switch-hook 3, contact point 4, receiver 2, transmitter 5, conductor 111, tip spring 112 of the jack C, tip 156 of the plug c^2, through the springs 157 and 158, springs 160 and 159, thence through the winding 161 of the relay 99 to the battery lead 114, thence through battery B and to ground G. The said relay 99 energizes, thereby moving the armatures 166 and 167 from engagement with the contact points 168 and 169, respectively. Also, when the ring 162 of the plug c^2 engages the ring 163 of the jack C, a circuit is closed through the release relay 105 in series with the release relay 106, and through the supervisory lamp 95. The circuit through the said relay extends from ground G^3 through the ring 163 and ring 162, through the springs 164 and 165, through the relay 105, thence through the relay 106 to the battery 114, thence through battery B and to ground G. Said relays, upon energizing, attract their armatures 170 and 171 and 172 and 173. The relay 105 is a quick-acting relay, while the relay 106 is a slow-acting relay, and hence the armatures 170 and 171 disengage from the contact points 174 and 175 before the armatures 172 and 173 of the relay 106 engage the ground post 176. The circuit through the supervisory lamp 95 extends from ground G^3 through the ring 163 of the jack C to the ring 162 of the plug c^2, through the springs 164 and 165, through the lamp 95 to the contact point 177, armature 178 to the battery lead 114, thence through battery B to ground G. This lamp continues to burn until the called subscriber answers, at which time the relay 104 becomes energized and operates to break the circuit through the said lamp, as will be explained. To call the number 220 the operator presses the spring 139 onto the ground post 141 twice and the spring 140 onto the ground post 141 once for the first digit. Likewise, for the second digit and for the third digit the spring 139 is pressed a corresponding number of times and the spring 140 is pressed once each time. By pressing the springs 139 and 140 onto the ground post 141 a corresponding number of impulses are delivered to the vertical and rotary trunk conductors 92 and 93. Grounding the vertical line conductor twice energizes the vertical line relay 58 of the selector H (Fig. 2) over a circuit extending from ground G^6 to the ground post 141, spring 139, key springs 146 and 142 to the

vertical trunk line conductor 92, to the side switch wiper 41, contact point 46, vertical line relay 58, bridge-cut-off springs 179 and 180 to the battery lead 181, thence through battery B′ to ground G′. When the spring 140 engages the ground post 141, an energizing circuit is established through the rotary line relay 60 of the selector H, said circuit extending from ground G^8 to the ground post 141, spring 140, key springs 147 and 143 to the rotary trunk line conductor 93, side switch wiper 42, contact point 47, rotary line relay 60, bridge-cut-off springs, 182, 179 and 180 to the battery lead 181, thence through battery B′ to ground G′. After the selector H has operated for the first digit the selector shaft wipers 38, 39 and 40 rest in engagement with the trunk line conductors leading to the connector switch I. The second digit is called the same as the first; but this time the ground impulses are directed toward the vertical and rotary line relays 68 and 69 of the connector switch I. The connector line relay 68, being energized twice, closes an energizing circuit through the vertical magnet 70 twice, which magnet in turn operates to carry the shaft wipers 65, 66 and 67 one step at a time until the said wipers are carried up two steps and raised to a bank level in which are located the terminals of the normal conductors 183, 184 and 185, the former two of which lead to the desired line. When the rotary line conductor 93 is grounded the connector rotary line relay 69 becomes energized, which in turn energizes the private magnet 72, which latter operates to release the side switch from first to second position. The last digit being naught the operator grounds the vertical trunk conductor 92, as previously described, whereby the vertical line relay 68 receives ten impulses and the rotary line relay 69 one. When the vertical line relay energizes, it operates to close an energizing circuit through the rotary magnet 71 instead of through the vertical magnet 70. Each time that the rotary magnet is energized it operates to rotate the shaft wipers 65, 66 and 67 one step at a time until the said wipers are carried into engagement with the normal conductors 183, 184 and 185 that lead to the selector switch H′ in which are the terminals of the desired line. The operation of the rotary line relay for the last digit completes an energizing circuit through the private magnet 72, which latter now operates with one of two results, namely the release of the side switch from first to second position, or the so-called busy-release of the connector. Suppose the former result to occur and the side switch to pass to third position, thus extending the trunk conductors 92 and 93 to the normal conductors 183 and 184, respectively. Furthermore, when the side switch passes to third position a guarding potential is established for protecting the called line. This potential extends from ground G^7 through the side switch wiper 77, switch shaft wiper 67, which latter engages the private contact of the called line. Also, when the side switch wiper 77 engages the third position contact point an energizing circuit is closed through the bridge-cut-off relay 186 of the selector H′, thereby removing the bridge formed by the vertical and rotary line relays 257 and 258 of the said selector.

To signal the called subscriber the operator presses the push-button spring 139 onto the ground post 141, thereby establishing an energizing circuit through the connector vertical line relay 68. It will be assumed that the connector side switch has passed from second to third position, and that the side switch wiper 76 is in engagement with the contact point 187, thereby placing the vertical line relay 68 in control of the ringer relay 82 in the same manner in which the rotary magnet 71 came under the control of the vertical line relay when the side switch passed from first to second position. Therefore, when the vertical line relay 68 operates, an energizing current flows through the ringer relay 82 from ground G^8 through the springs 188 and 189, private magnet springs 190 and 191, side switch wiper 76, contact point 187, ringer relay 82, springs 192 and 193 (bearing in mind that the differential relay 80 is energized) to the battery lead 181, thence through battery B′ to ground G′. Each time that the vertical and rotary line relays 68 and 69 have been energized, as explained, the differential relay 80 is energized also, but this has played no part until now. The ringer relay upon energizing operates to bridge across the line of the called subscriber the ringer generator K. A signaling current, is, therefore, sent from the ringer generator to the substation ringer 194. As soon as the operator ceases to press the spring 139 the ringer relay 82 becomes deënergized and the relay assumes its normal position. The operator, after having completed the call and signaled the desired line, restores the key e' to normal position, whereby the lamp relay 104 becomes bridged across the trunk conductors 92 and 93. As soon as the called subscriber removes his receiver 195 from the switch-hook 196 he closes the springs 197 and 198 and opens the springs 199 and 200, thus removing the ringer 194 from across the line and closing the line circuit through the transmitter 201 and through the primary winding of the induction-coil 202. As a result the back-bridge relay 81 of the connector I energizes from ground G^7 through the winding 203, through the ringer relay springs 204 and 205, rotary line conductor 206, through the substation and back to the

vertical line conductor 207, thence through the other winding 208 of the back-bridge relay 81, through the springs 209 and 193 to the battery lead 181, thence through battery B′ to ground G′. The said relay 81 then attracts its armature and shifts the spring 210 from the spring 211 onto the spring 212, which latter is grounded, thus sending current out over the trunk conductors 92 and 93, which current passes through the lamp relay 104 aforesaid, whereby the said relay becomes energized and moves its armature 178 from the contact point 177 to the contact point 213. This circuit through the relay 104 may be traced from ground G⁷ through the side switch wiper 77, relay springs 212 and 210, winding 214 of the differential relay 80, winding of the rotary relay 69, shaft wiper 39, side switch wiper 42, trunk conductor 93, through the springs 143 and 145, conductor 215, springs 216 and 217 to the relay 104, to the vertical trunk line conductor 92, side switch wiper 41, shaft wiper 38, connector vertical line relay 68, winding 217ª of the relay 80 to the battery lead 181, thence through battery B′ to ground G′. The relay 104 being included in this circuit energizes, as previously stated and attracts its armature 178, whereby the circuit through the supervisory lamp 95 is broken and the lamp goes out, indicating to the operator that the called subscriber has answered. The two substations A and D′ are now connected and communication may be carried on over the circuit shown by the heavy lines in Figs. 1 and 2. When the subscribers are through talking and restore the receivers to their respective switch-hooks the operator is given the disconnect signal as follows: When the receiver 2 is restored to the switch-hook 3 the energizing circuit through the relay 99 becomes broken at the switch-hook 3 and contact point 4. The said relay deënergizes and the armatures 166 and 167 return to engagement with the contact points 168 and 169, respectively. The engagement of the armature 166 and contact point 168 closes a circuit through the supervisory lamp 96, said circuit extending from ground G⁸ through the ring 163 of the jack C and ring 162 of the plug c^2 to the armature 166, contact point 168, springs 218 and 219, through the lamp 96 to the battery lead 114, and through battery B to ground G. The display of this lamp indicates to the operator that the subscriber at substation A has restored his receiver to the switch-hook 3. When the called subscriber at substation D′ restores the receiver 195 to the switch-hook 196 the energizing circuit through the relay 81 is destroyed, which latter in turn, upon deënergizing, destroys the circuit through the supervisory relay 104 at the cord circuit E, at which instant the armature 178 returns to engagement with the contact point 177, whereby the circuit, as previously traced, is again established through the supervisory lamp 95. The two lamps 95 and 96, thus displayed simultaneously, indicate to the operator that both subscribers have restored their receivers to their respective switch-hooks. Suppose that the subscriber at substation A alone restores his receiver, and that the subscriber at substation D′ does not restore his receiver, but wishes a connection with some substation of the private branch exchange. In that event the relay 104 does not deënergize, but maintains a circuit through the signal lamp 94 after the relay 99 deënergizes. This circuit extends from ground G⁸ through the armature 167, contact point 169 to the lamp 94, thence through the springs 220 and 221 to the contact point 213, armature 178 to the battery lead 114, and from battery B to ground G. The glowing of the lamp 94 indicates to the operator that the trunk line conductors 92 and 93 are in the possession of a subscriber who desires some connection at the private branch exchange. Accordingly the operator operates the key e' so that the springs 220 and 221, and 222 and 223 disengage, and the springs 224 and 225, and 226 and 227 engage. This operation of the said key destroys the circuit through the signal lamp 94 when the springs 220 and 221 disengage. This disengagement of the springs 222 and 223 at this time is without effect, but the engagement of the springs 224 and 225 and the springs 226 and 227 bridges across the trunk line conductors the operator's set o. The operator, upon learning that substation D, for example, is desired, throws the key e' in the opposite direction, whereby, when the springs 148 and 149 engage, an energizing circuit is maintained through the release relays 105 and 106, said circuit extending from ground G¹⁰ through the springs 149 and 148, through the release relays 105 and 106 to the battery lead 114, thence through battery B to ground G. She then removes the plug c^2 from the jack C and inserts the former in the jack C², as shown in Fig. 1. When the ring 162 engages the ring 228 a circuit is established through the signal lamp 96, extending from ground G⁹ through the ring 228 and ring 162, armature 166, contact point 168, through the springs 218 and 219, lamp 96 to the battery lead 114, thence through battery B to ground G. The operator then restores the key e' to normal position, whereby the springs 220 and 221 again engage and establish the circuit through the signal lamp 94. The key e is then operated to disengage the springs 157 and 154 from the springs 158 and 153, and to press the said springs into contact with the springs 230 and 229, respectively, whereby upon the engagement of the springs 154, 229 and springs 157, 230

the ringer generator 97ª becomes bridged across the line conductors 231 and 232 which lead to the substation D. When the key *e* returns to normal position the springs 157, 158 and 153, 154 again engage. When the called subscriber at substation D answers, an energizing circuit is then established through the relay 99, which supplies the called substation D with battery current for talking purposes. This circuit extends from ground G^5 through the winding 150 of the relay 99, springs 151 and 152, through the springs 153 and 154, sleeve 155 to the sleeve spring 233, conductor 232 to the substation primary winding 16, transmitter 18, through the springs 14 and 15 to the conductor 231, tip spring 234, tip of the plug 156, thence through the springs 157 and 158, key springs 160 and 159 to the winding 161 of the coil 99, thence to the battery lead 114, and through battery B to ground G. The relay 99 energizes and operates, as explained, when the armature 166 disengages from the contact point 168. The circuit through the lamp 96 becomes broken, thus indicating that the subscriber at substation D has answered. Furthermore, when the armature 167 disengages from the contact point 169 the circuit through the signal lamp 94 is broken, and when the signal disappears from both lamps the operator knows that both subscribers are in possession of the line. After the conversation is finished and the receivers at the substations D and D′ are restored to their switch-hooks, a disconnect signal is given the operator when the lamps 95 and 96 are caused to glow simultaneously. When the subscriber at substation D′ restores his receiver the energizing circuit through the relay 104 becomes broken, and the armature 178 engages the contact point 177, whereby the circuit through the lamp 95 is again established. Similarly, when the receiver at substation D is restored to the switch-hook the energizing circuit through the relay 99 is also broken, and the armature 166 engages the contact point 168, thus again establishing the circuit through the lamp 96. Both of the subscribers having left the line, the operator then removes the plug c^2 from the jack C^2, whereby, when the ring 228 of the jack C^2 and the ring 162 of the plug c^2 disengage, the energizing circuits through the release relays 105 and 106 become broken. The said relays deënergize, but the relay 105 being a quick-acting relay and the relay 106 a slow-acting relay, the armatures 170 and 171 of the relay 105 engage the contact points 174 and 175 before the armatures 172 and 173 disengage from the ground post 176, and thus both trunk line conductors 92 and 93 are grounded simultaneously. The grounding of conductors 92 and 93 at this time closes energizing circuits through the relays 68, 69 and 80. The circuit through the relay 68 extends from ground G^{11} through the contact point 176, armature 172, contact point 174, armature 170, vertical trunk conductor 92, side switch wiper 41, contact point 54, shaft wiper 38, relay 68, winding 217 of the relay 80 to the battery lead 181. The energizing circuit through the relay 69 extends from ground G^{11}, armature 173, switch wiper 42, contact point 55, shaft wiper 39, relay 69, winding 214 of the differential relay 80, springs 210 and 211 to the battery lead. The differential relay 80 now operates to close springs 192 and 193, connecting main battery to the release magnet. The relays 68 and 69 also operate and the trunk-release springs 234ª and 235 come into contact, whereby an energizing circuit is established through the release relay 63 of the selector switch H in series with the release magnet 73 of the connector I. The current now in passing, as before stated, through the winding 214 aids the winding 217ª in maintaining the springs 193 and 192 in contact. The energizing circuit through the release relay 63 and the release magnet 73 extends from ground G^{12} at the selector H through the side switch wiper 43, release relay 63, shaft wiper 40, through the trunk-release springs 234ª and 235, release magnet 73, springs 192 and 193 to the battery lead 181, thence through battery B′ to ground G′. When the connector release magnet 73 is thus supplied with current it is energized, and as a result the switch shaft and side switch are restored to normal position, thus breaking the connection between the connector switch shaft wipers 65, 66 and 67 and the normal conductors 183, 184 and 185. The back-release relay 63, being in the same circuit with the release magnet 73, energizes simultaneously with the release magnet 73, and operates to close a circuit through the selector release magnet 62. When the ground to the line conductors 92 and 93 is interrupted all the magnets involved in the release are deënergized and all the switches are fully restored. Suppose that the subscriber at substation D wishes a connection with some subscriber D′ of the central exchange. In that event the subscriber at substation D removes his receiver from the switch-hook, whereby an energizing circuit is established through the line relay 235ª, which in turn operates to close a circuit through the line lamp 236. The operator, seeing the line signal, inserts the plug *c* into the jack C^2, and upon learning that an outside connection is desired removes the said plug and inserts the trunk line plug c^2 instead. She now throws the key *e* to operate the springs, as shown in Fig. 1. The subscriber at substation D may now operate his calling device and establish his own connection independently of the operator. The calling subscriber at sub-

station D suitably operates his calling device for each digit of the number 220. When the button 28 presses the spring 30 onto the ground post 34 an energizing circuit is established through the vertical line relay 58 of the selector switch H over the following path: from substation ground G^2 through the springs 19 and 20 to the ground post 34, spring 30, vertical line conductor 231, tip spring 234, tip 156, through the springs 157 and 158, springs 160 and 161^a, through the relay 101, winding 237, through the springs 144 and 142 to the vertical line conductor 92, thence through the side switch wiper 41, vertical line relay 58, bridge-cut-off springs 179 and 180 to the battery lead 181, thence through battery B′ to ground G′. Then when the rotary button 29 is pressed a rotary impulse passes from the ground post 34 to the spring 31, rotary line conductor 232, sleeve spring 233 and sleeve 155, through the springs 154 and 153, springs 152 and 238, through the relay 102, winding 239 of the relay 100, through the springs 145 and 143 to the rotary trunk line conductor 93, side switch 42, rotary line relay 60, bridge-cut-off springs 182, 179 and 180 to the battery lead 181, thence through battery B′ to ground G′. It will be seen that these two circuits include the windings of the relays 100, 101 and 102. The said relays energize, but their operation at this time is without effect. After the subscriber at substation D has operated the central office switches and established connection with substation #220 the called subscriber is then signaled, and in response to the signal removes the receiver from the switch-hook, which closes an energizing circuit through the relay 81, as previously explained, which relay in turn operates to provide the calling line with battery current for talking purposes, as follows: from ground G^7 at the connector I through the springs 212 and 210 and winding 214, relay 69 to the trunk line conductor 93, as before, through the springs 143 and 145, winding 239 of the differential relay 100, relay 102, springs 238 and 152, springs 153 and 154, through the jack C^2 to the rotary line conductor 232, thence through the substation D to the vertical line conductor 231, and again through the jack C^2 to the springs 157 and 158, through the springs 160 and 161^a, relay 101, winding 237 of the coil 100, springs 144 and 142 to the vertical trunk line conductor 92, thence through the connector vertical line relay 68 and winding 217^a of the differential relay 80 to the battery lead 181, thence through battery B′ to ground G′. The windings of the relays 100, 101 and 102 being included in the circuit, the said relays energize and attract their respective armatures, but at this time without effect. The two substations D and D′ are now connected, and communication may be carried on over the circuit indicated by the heavy lines in Figs. 1 and 2. The release of the central office switches occurs, as before, when the subscriber at substation D grounds both line conductors 231 and 232 simultaneously—that is, the ground impulses delivered to the line conductors 231 and 232 simultaneously pass to the connector I, energizing the line relays 68 and 69 and the differential relay 80 in the manner previously explained, whereby the connector switch I together with the first-selector switch H are restored to normal condition. Also, at the same time, when the conductors 231 and 232 are grounded simultaneously, the windings 237 and 239 of the differential relay 100 both carry current; but now the relay 100 being differential, it does not operatively energize, since both windings 237 and 239 carry current passing in the same direction. The relays 101 and 102 maintain their armatures in an attracted position, and the armatures 240 and 241 of the differential relay 100 return to normal position, whereby a circuit is established through the relay 103. This circuit extends from ground G^{13} through the armature 242, contact point 243, contact point 244, armature 245, armature 241, contact point 246, through the winding 247 of the relay 103, thence to battery lead 114, and through battery B to ground G. The relay 103 becomes energized and attracts its armatures 248 and 249, whereby a locking circuit is closed through the winding 250 of the relay 103 and also through the supervisory lamp 96. The locking circuit extends from ground G^9 through the jack and plug to the contact point 251, armature 240, through the springs 222 and 223 to the armature 248, contact point 252, through the winding 250 of the relay 103, thence to battery lead 114 and through battery B to ground G. The relay 103 is thus maintained energized by this locking circuit when the first circuit traced through the winding 247 becomes broken, at which time the ground is removed from the line conductors 232 and 231. As long as the relay 103 is energized the circuit from ground G^{15} through the armature 249, contact point 253, springs 254 and 219, lamp 96 to the battery lead 114, thence through battery B and to ground G is maintained, thus indicating to the operator that the subscriber at substation D is through with the trunk line. The operator then removes the plug c^2 from the jack C^2 and restores the key e to normal position. When the plug c^2 is removed from the jack C^2 the locking circuit through the winding 250 of the relay 103 becomes broken, and the said relay deënergizes, cutting off the ground connection from the supervisory lamp 96.

It has been explained how a call leaves the private branch exchange, and it will now be assumed that a call comes in on the

trunk line conductors 92 and 93. It is to be understood that the trunk line that terminates in the cord circuit E has assigned to it a number (like any subscriber), and that if one of the subscribers of the automatic exchange wishes to call one of the subscribers at the private branch exchange, he calls that particular number. For example, if the number 230 is given to this line the subscriber of the automatic office who wishes a connection with the sub-exchange calls the number 230 and finds the normal conductors 255, 256 and 259. Now, when the normal conductors 255 and 256 are seized by a connector switch, the energizing circuit for the back-bridge relay 81 of the connector, already described, is immediately established through the supervisory relay 104 at the cord circuit E. This circuit extends from the vertical winding of the back-bridge relay to the vertical trunk line conductor 92, through the relay 104, springs 217 and 216 of the key *e*, conductor 215, through the springs 145 and 143 to the rotary trunk line conductor 93, thence through the back-bridge relay of the connector, as previously explained. The relay 104, being included in the circuit of the back-bridge relay of the connector, becomes energized and attracts its armature 178 to engage with the contact point 213, whereby a circuit is closed through the signal lamp 94. The said circuit extends from ground G^8 through the armature 167, contact point 169, through the lamp 94, springs 220 and 221, contact point 213, armature 178 to the battery lead 114, thence through battery B to ground G. The display or glowing of the said lamp indicates to the operator or attendant that the trunk line conductors 92 and 93 leading to the main central exchange have been seized, and that a subscriber desires connection with some substation of the private branch exchange. The operator operates the key *e'* so that the springs 220 and 221, 222 and 223 disengage and the springs 224 and 225, and 226 and 227 engage. By this operation of the key the circuit through the lamp 94 becomes broken and the operator's set *o* becomes bridged across the trunk line conductors 92 and 93. The disengagement of the springs 220 and 221 breaks the circuit through the signal lamp 94. The disengagement of the springs 222 and 223 at this time is without effect. The engagement of the springs 224, 225 and 226, 227 bridges the operator's set *o* across the trunk line conductors 92 and 93. The operator, upon learning that substation D, for example, is desired, inserts the plug c^2 into the jack C^2, which latter is allotted to the line leading to the substation D. Immediately, then, the ring 162 of the plug c^2 engages the ring 228 of the jack C^2, and a circuit is established through the supervisory lamp 96 over conducting paths explained. The operator now operates the key *e* to bridge the ringer generator 97 across the line conductors 231 and 232 to signal the subscriber at substation D. When the subscriber at substation D removes the receiver 8 from the switchhook 9 a circuit is closed through the relay 99, as previously explained. The said relay energizes and attracts its armatures 166 and 167. When the armature 166 disengages from the contact point 168 the circuit through the signal lamp 96 is broken, and the operator then knows that the subscriber at substation D has answered. When the subscriber at substation D restores his receiver to the switch-hook the energizing circuit through the relay 99 is broken, and the armatures 166 and 167 engage the contact points 168 and 169, thereby closing the circuit through the supervisory lamp 96 and the signal lamp 94. When the calling subscriber on the trunk conductors 92 and 93 releases the central office switches the circuit through the relay 104 becomes broken, whereby the relay deënergizes and the armature 178 passes from the contact point 213 to the contact point 177, and the circuit through the lamp 94 is broken; and a circuit is established through the signal lamp 95, whereby the operator is given the disconnect signal when both lamps 95 and 96 glow simultaneously. Suppose that after the subscriber at substation D had restored the receiver to the switch-hook the subscriber on the line conductors 92 and 93 desired a subscriber at substation A. In that event the relay 104 does not deënergize, but maintains the circuit through the lamp 94. The operator seeing the lamps 96 and 94 displayed simultaneously, knows that the subscriber at substation D has restored his receiver to the switch-hook, and that the subscriber on the trunk line conductors 92 and 93 desires another connection. Accordingly, the key *e'* is operated as before, to bridge the operator's set *o* across the trunk line conductors 92 and 93, whereby the desired connection may be determined.

It will be apparent that when one of the automatic subscribers calls the cord circuit E the bridge-cut-off relay 64 energizes as soon as the connector places ground on the private normal conductor 259. The object in thus energizing this bridge-cut-off relay 64 is so well known that it needs no further comment.

The relay coils used in the trunk circuit E may be wound to any suitable resistance, but good results have been obtained when the relays 99, 105 and 106 are wound to a resistance of one hundred ohms each; the relays 100, 101 and 102 to twenty-five ohms each; and the relays 103 and 104 to five hundred ohms each.

From the foregoing it will be seen that I

provide an improved semi-automatic telephone trunking system in which the operator at the cord circuit of a two-way trunk is equipped with supervisory apparatus for supervising any and all connections made through the medium of the trunk line and the cord circuit. Such operator is also equipped with means for extending connections in either direction—that is to say, for either receiving or sending calls over the trunk line, as well as for releasing both manual and automatic connections after the subscribers are through talking. An automatic private exchange subscriber, desiring to communicate with a subscriber at the main exchange, first gets the attention of the operator, and is then given a trunk line connection to the main exchange. This having been done, the calling subscriber can then transmit the call and operate the automatic apparatus at the main exchange, for the purpose of finding the line of the called subscriber. When a manual private exchange subscriber desires to communicate with a main exchange subscriber, the trunking operator's attention is first obtained, and after the said operator has established a trunk line connection to the main exchange, and to the line of the called subscriber, the calling manual subscriber is then given a cord circuit connection with the trunk line connection thus established. In either case the operator has complete supervision of the established connection, and is also provided with means for releasing any and all switches or other devices after the subscribers are through talking. Moreover, it will be seen that telephone service is thus provided between common battery manual subscribers and common battery automatic subscribers. With this arrangement one or more of the subscribers of the manual exchange can be accorded special privileges, so to speak—that is to say, can be given special automatic service to a main or automatic exchange. This is sometimes desirable, and with my invention one or more of the telephones at the manual exchange can be equipped for transmitting the electrical impulses necessary for operating the automatic switches of an automatic exchange. Such connections, however, as explained, are subject to the manual supervision of an operator. Furthermore, any subscriber at the automatic exchange can call the trunk line and then, through the medium of the trunking operator, obtain connection with any subscriber of the manual exchange.

What I claim as my invention is:—

1. In a telephone system, an automatic main exchange, a private branch exchange for manual subscribers, a trunk line connecting the main exchange with the branch exchange and terminating at the main exchange in automatic switching apparatus, and at the branch exchange in a cord circuit, said cord circuit comprising means whereby an automatic subscriber may be placed in connection with the trunk line and then permitted to complete the call automatically, and means whereby if one of the manual subscribers wants a connection to the main exchange the operator completes the connection automatically and then places the calling subscriber in connection with the trunk line signals controlled from all of said subscribers' lines, and a common source of energy for operating all of said signals and for supplying talking current to all of said lines.

2. In a telephone system, a main exchange, a private branch exchange, manual and automatic subscribers' lines allotted to the private branch exchange, a trunk line connecting the main exchange with the private branch exchange, a terminal for said trunk line, automatic subscribers' line signals and manual subscribers' line signals, a cord circuit having an automatic calling device whereby if a manual subscriber wants to make a call to the main exchange the operator completes the call automatically over said trunk line, each automatic subscriber at the branch exchange being also provided with an automatic calling device whereby if he wants to make a call to the main exchange he may be placed in connection with the trunk line and then permitted to make his own call, said cord circuit also adapted, if a subscriber in the main exchange wants to call a subscriber in the branch exchange, to be called automatically by the calling subscriber of the main exchange, whereby the operator may then connect the calling main exchange subscriber with any one of the private branch exchange subscribers, signals controlled from all of said subscribers' lines, and a common source of energy for operating all of said signals and for supplying talking current to all of said lines.

3. In a telephone system, a calling subexchange automatic subscriber's line and a called main exchange automatic subscriber's line, means including a manual cord circuit whereby the calling subscriber may establish connection with the called subscriber, said cord circuit comprising supervisory means including a lamp whereby, when the automatic calling subscriber releases the established connection, the supervisory lamp is displayed, and whereby if the calling subscriber starts to make another call before the cord circuit is taken down the lamp is retired.

4. In a telephone system, a cord circuit one end of which terminates in a trunk line and the other end in a plug, a front supervisory lamp, a back supervisory lamp, a trunk supervisory lamp, means comprising

a key whereby an automatic subscriber may be connected with the trunk line and may then make his own call, means comprising a calling device whereby, if a manual subscriber wants to make a call, the operator may complete the call automatically, other means whereby another subscriber may establish connection with the said trunk line and signal the operator and then be connected with either the manual or automatic subscribers, said front supervisory lamp adapted, when the automatic subscriber calls through to the trunk, to be displayed when said calling subscriber hangs-up, and to be retired if the said automatic subscriber proceeds to make a call, said front supervisory lamp adapted, when the manual subscriber calls, to be displayed when said manual subscriber hangs up his receiver, and to be retired if the said manual subscriber again removes his receiver, said back supervisory lamp being adapted when either the automatic or manual subscribers call to be retired when the called subscriber answers, and to be displayed again when the called subscriber hangs-up, said trunk supervisory lamp adapted to be displayed when the aforesaid automatic calling subscriber finds the trunk line, and to be retired when the called subscriber answers.

5. In a telephone system, a private branch exchange comprising a manual subscriber station A and an automatic subscriber station D and a cord circuit E, a main automatic exchange, a trunk line connecting said cord circuit E with said automatic exchange, subscribers' lines allotted to said automatic exchange, said automatic exchange comprising automatic apparatus by means of which one line may automatically be put in connection with another, means whereby either the automatic or manual subscribers D or A may, through the cord circuit E, be put in connection with any of the automatic subscribers of the main exchange, the automatic subscriber D being provided with means whereby after a connection is once established with one of said main exchange subscribers the connection may then be automatically broken by the calling subscriber, and releasing means allotted to the trunk line whereby the operator at the cord circuit E may release the automatic apparatus, signals controlled from all of said subscribers' lines, and a common source of energy for operating all of said signals and for supplying talking current to all of said lines.

6. In a telephone system, an automatic switch, a calling substation suitably connected with said switch, condensers in the circuit between the substation and the switch, and means for manually closing connections around said condensers to permit the calling subscriber to operate said switch, a signal controlled from said substation, and a common source of energy for operating said signal and for supplying talking current to said substation.

7. In a telephone system, a calling substation including a calling device, an automatic switch, a circuit connecting said switch with said calling device, condensers in said circuit, and means for closing connections around said condensers to permit the calling impulses to pass to the automatic switch, a signal controlled from said substation, and a common source of energy for operating said signal and for supplying talking current to said substation.

8. In a telephone system, a cord circuit, condensers in the talking strands of said circuit, a centralized source of talking current, and means for establishing shunt connections around each of said condensers to permit talking current to pass entirely through said shunt to the calling subscriber.

9. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, a key switch for operatively connecting the cord circuit with the trunk line to permit the calling subscriber to operate said automatic switch, calling and called supervisory signals for indicating to the operator when a disconnection is desired, and a common battery for supplying talking and operating current.

10. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, a signal controlled from said telephone line, and a common source of energy for operating said signal and for supplying talking current to said line.

11. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connected with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

12. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line,

a telephone line, a key switch for operatively connecting the cord circuit with the trunk line to permit the calling subscriber to operate said automatic switch, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

13. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

14. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit for the other end of said trunk line, a key switch controlling the connection between the cord circuit and the trunk line, an operator's calling device for operating said automatic switch, said calling device adapted to be connected with the trunk line by the actuation of said key switch, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

15. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said automatic switch over the trunk line, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

16. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically, a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, and suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber.

17. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connected with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, and front and back supervisory signals for said cord circuit.

18. In a telephone system, a cord circuit, condensers in said circuit, a centralized source of talking current, means for establishing connections around each of said condensers to permit talking current to pass entirely through said shunt to the calling subscriber, and front and back supervisory signals for said cord circuit.

19. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, means including a key switch for operatively connecting the cord circuit with the trunk line and for permitting the calling subscriber to operate said automatic switch, and front and back supervisory signals for said cord circuit.

20. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, and front and back supervisory signals for said cord circuit.

21. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said switch over the trunk line, and front and back supervisory signals for said cord circuit.

22. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically,

a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, and front and back supervisory signals for said cord circuit.

23. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connected with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, and supervisory relay mechanism for said cord circuit, said mechanism comprising front and back supervisory relays, as set forth, and means for supplying talking current over the trunk line to the calling substation.

24. In a telephone system, a cord circuit, condensers in the talking strands of said circuit, a centralized source of talking current, means for establishing shunt connections around each of said condensers to permit talking current to pass entirely through said shunt to the calling subscriber, and supervisory relay mechanism for said cord circuit, said mechanism comprising front and back supervisory relays, as set forth.

25. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, means including a key switch for operatively connecting the cord circuit with the trunk line and for permitting the calling subscriber to operate said automatic switch, supervisory relay mechanism comprising front and back supervisory relays, as set forth, and means for supplying talking current over the trunk line to said line.

26. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said automatic switch over the trunk line, supervisory relay mechanism for said cord circuit, said mechanism comprising front and back supervisory relays, as set forth, and means for supplying talking current over the trunk line to said line.

27. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically, a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, supervisory relay mechanism for said cord circuit, said mechanism comprising front and back supervisory relays, as set forth, and means for supplying talking current over the trunk line to said line.

28. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connecting with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

29. In a telephone system, a cord circuit, condensers in said circuit, a centralized source of talking current, means for establishing connections around said condensers to permit talking current to pass to the calling subscriber, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

30. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, a key switch for operatively connecting the cord circuit with the trunk line to permit the calling subscriber to operate said automatic switch, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with

a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

31. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

32. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit for the other end of said trunk line, a key switch controlling the connection between the cord circuit and the trunk line, an operator's calling device for operating said automatic switch, said calling device adapted to be connected with the trunk line by the actuation of said key switch, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

33. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said automatic switch over the trunk line, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals. and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

34. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically, a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, and supervisory relay mechanism for said cord circuit, said mechanism comprising a relay provided with a winding having end and intermediate terminals, and a battery normally disconnected from the end terminals of said relay, but permanently connected with the intermediate terminal thereof.

35. A semi-automatic telephone exchange trunking system provided with selectors, and connectors responsive to a calling subscriber, means by which an operator connects a selector with the line of the calling subscriber before the call can be extended in the direction of the called subscriber, calling and called supervisory signals for indicating to the operator when a disconnection is desired, and a common battery for supplying talking and operating current.

36. In a telephone exchange system, a plurality of subscribers' lines, a number of first selector switches less than the number of subscribers' lines, means manually controlled for bringing said first selector switches into connection with calling lines, together with means whereby the said selector switches may then be controlled by the subscribers to select the lines wanted, and to restore the switches after use, calling and called supervisory devices connected with the manual portion of the apparatus to indicate to the operators the necessity for a disconnection and a common battery for supplying talking and operating current.

37. In a telephone exchange system, a plurality of subscribers' lines, a number of first selector switches less than the number of subscribers' lines, operators' cord-circuits for connecting said first selector switches with the calling lines, together with sending devices, at the substations, and responsive devices at the central station whereby the said selector switches may then be controlled by the subscribers to select the lines wanted, and to restore the switches after use, line-annunciators and calling and called clearing-out annunciators connected with the lines and cords, respectively, to indicate to the operators the desire of the respective subscribers for connection and disconnection, and a common battery for supplying talking and operating current.

38. In a telephone exchange system, a plurality of subscribers' lines terminating upon spring-jacks, a line signal associated with each jack and controlled from the subscrib-

er's station, a plurality of first selector switches less in number than the number of lines, operators' connective circuits with answering plugs and means to connect a calling line therethrough with an idle first selector switch, a clearing-out signal associated with said answering plug, a second supervisory signal associated with the calling end of said connective circuits, auxiliary switches containing line-terminals and coöperating with the first selector switches, sending devices at the subscribers' stations whereby after a connection is manually initiated in response to a call, the calling subscriber may thereafter complete the connection through the automatic switches and at the end of the conversation may restore the same, and a common battery for supplying talking and operating current.

39. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connected with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

40. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, a key switch for operatively connecting the cord circuit with the trunk line to permit the calling subscriber to operate said automatic switch, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

41. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

42. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit for the other end of said trunk line, a key switch controlling the connection between the cord circuit and the trunk line, an operator's calling device for operating said automatic switch, said calling device adapted to be connected with the trunk line by the actuation of said key switch, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

43. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said automatic switch over the trunk line, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

44. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically, a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, suitable instrumentalities for supplying talking current over the trunk line to a calling subscriber, and means for automatically supplying current for ringing purposes.

45. In a telephone system, a trunk line, a trunking operator's cord circuit connected with said trunk line, condensers in said cord circuit, an automatic switch, a calling telephone line connected with said cord circuit, an operator's key switch provided with means for closing connections around said condensers, means at the calling substation for transmitting electrical impulses over the telephone line and said connections and trunk line to operate said automatic switch, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

46. In a telephone system, a cord circuit, condensers in said circuit, a centralized source of talking current, means for establishing connections around each of said condensers to permit talking current to pass entirely through said shunt to the calling sub-

scribers, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

47. In a telephone system, an automatic switch, a trunk line leading thereto, a cord circuit at the other end of said trunk line, a telephone line, means including a key switch for operatively connecting the cord circuit with the trunk line and for permitting the calling subscriber to operate said automatic switch, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

48. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit for the other end of said trunk line, condensers in said cord circuit, a telephone line connected with the cord circuit, means for closing parallel connections around said condensers to permit the calling subscriber to operate said automatic switch, suitable inductive resistance in said parallel connections, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

49. In a telephone system, an automatic switch, a trunk line leading thereto, a trunking operator's cord circuit provided with means for calling over the trunk line to operate said automatic switch, condensers in said cord circuit, a telephone line, means controlled by the operator for connecting the telephone line around the said condensers to permit the subscriber of said line to operate the said switch over the trunk line, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

50. In a telephone system, an exchange comprising manual switchboard apparatus, subscribers' lines terminating at said manual switchboard apparatus, one or more of said lines being provided with means for transmitting impulses suitable for calling automatically, another exchange comprising automatic switches and subscribers' lines provided with means for calling automatically, a trunking operator's cord circuit, a trunk line for connecting the first-mentioned exchange with the last-mentioned exchange, a trunking operator's calling mechanism for calling automatically over the trunk line to operate the switches at the last-mentioned exchange, means by which the trunking operator connects a telephone line with the trunk line to permit the calling subscriber to control the said automatic switches, front and back supervisory signals for said cord circuit, and means for automatically supplying current for ringing purposes.

51. In a telephone system, means including a plurality of serially related automatic switches controllable over a calling line for extending a connection to a called line, an operator's position through which the connection extends, a supervisory signal at said position under the control of the called subscriber, and suitable means for supplying talking current from a central source to the connected lines.

52. In a telephone system, means including a plurality of serially related automatic switches controllable over a calling line for extending a connection to a called line, an operator's position through which the connection extends, supervisory signals at said position under the control, respectively, of the calling and called subscribers, and suitable means for supplying talking current from a central source to the connected lines.

53. In a telephone system, means including a plurality of serially related automatic switches controllable over a calling line for extending a connection to a called line, an operator's position through which the connection extends, supervisory signals at said position under the control, respectively, of the calling and called subscribers, operator controlled means for releasing said switches, and suitable means for supplying talking current from a central source to the connected lines.

54. In a telephone system, a trunk line, manual equipment for extending connections to or from said trunk line at one end, automatic equipment comprising a pair of automatic switches one of which is controllable over the said trunk line for extending connections to or from said trunk line at the other end, whereby calling and called subscribers' lines may be connected via said trunk line, a central source of current, and suitable means for supplying current from said source to connected lines for talking purposes.

55. In a telephone system, a trunk line, an automatic switch at one end of said trunk line for connecting a calling line thereto, a call signal and manual connective apparatus at the other end of said trunk line for receiving the call and for extending the same to a called line, said manual apparatus also adapted to connect a second calling line with said trunk line, a second automatic switch associated with said first switch and controllable over said trunk line to extend the said second calling line to a second called line, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

56. In a telephone system, a trunk line, manual equipment for extending connections to or from said trunk line at one end, and automatic equipment comprising a pair of automatic switches one of which is control-

lable over the said trunk line for extending connections to or from said trunk line at the other end, whereby calling and called lines may be connected, and a circuit closed when one of said switches is operated for rendering the said trunk line busy to the other of said switches, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

57. In a telephone system, a trunk line, an automatic switch at one end of said trunk line for connecting a calling line thereto, a call signal and manual connective apparatus at the other end of said trunk line for receiving the call and for extending the same to a called line, said manual apparatus also adapted to connect a second calling line with said trunk line, a second automatic switch associated with said first switch and controllable over said trunk line to extend the said second calling line to a second called line, and a circuit closed when the said second switch is operated for rendering the said trunk line busy to the said first switch, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

58. In a telephone system, a trunk line, manual equipment for extending connections to or from said trunk line at one end, automatic equipment comprising a pair of automatic switches one of which is controllable over the said trunk line for extending connections to or from said trunk line at the other end, whereby calling and called lines may be connected, means for rendering one of said switches inoperative whenever a connection is extended to the said trunk line by means of the other switch, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

59. In a telephone system, a trunk line, an automatic switch at one end of said trunk line for connecting a calling line thereto, a call signal and manual connective apparatus at the other end of said trunk line for receiving the call and for extending the same to a called line, said manual apparatus also adapted to connect a second calling line with said trunk line, a second automatic switch associated with said first switch and controllable over said trunk line to extend the said second calling line to a second called line, a relay for rendering said second switch inoperative controlled by the said first switch, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

60. In a telephone system, a trunk line, means including an automatic switch for seizing said trunk line at one end and a manual connective terminal and a call signal at the other end for completing a connection over the said trunk line in one direction, means including the said manual connective terminal and a second automatic switch at the other end controllable over said trunk line for completing a connection over said trunk line in the opposite direction, each connection when completed including a calling and a called subscriber's line, a central source of current, and suitable means for supplying connected calling and called lines with talking current from said source.

Signed by me at Chicago, Cook county, Illinois, this 6th day of September, 1907.

TALBOT G. MARTIN.

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