Aug. 3, 1926.

1,594,898

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TELEPHONE SYSTEM

Filed Dec. 18, 1922

3 Sheets-Sheet 1

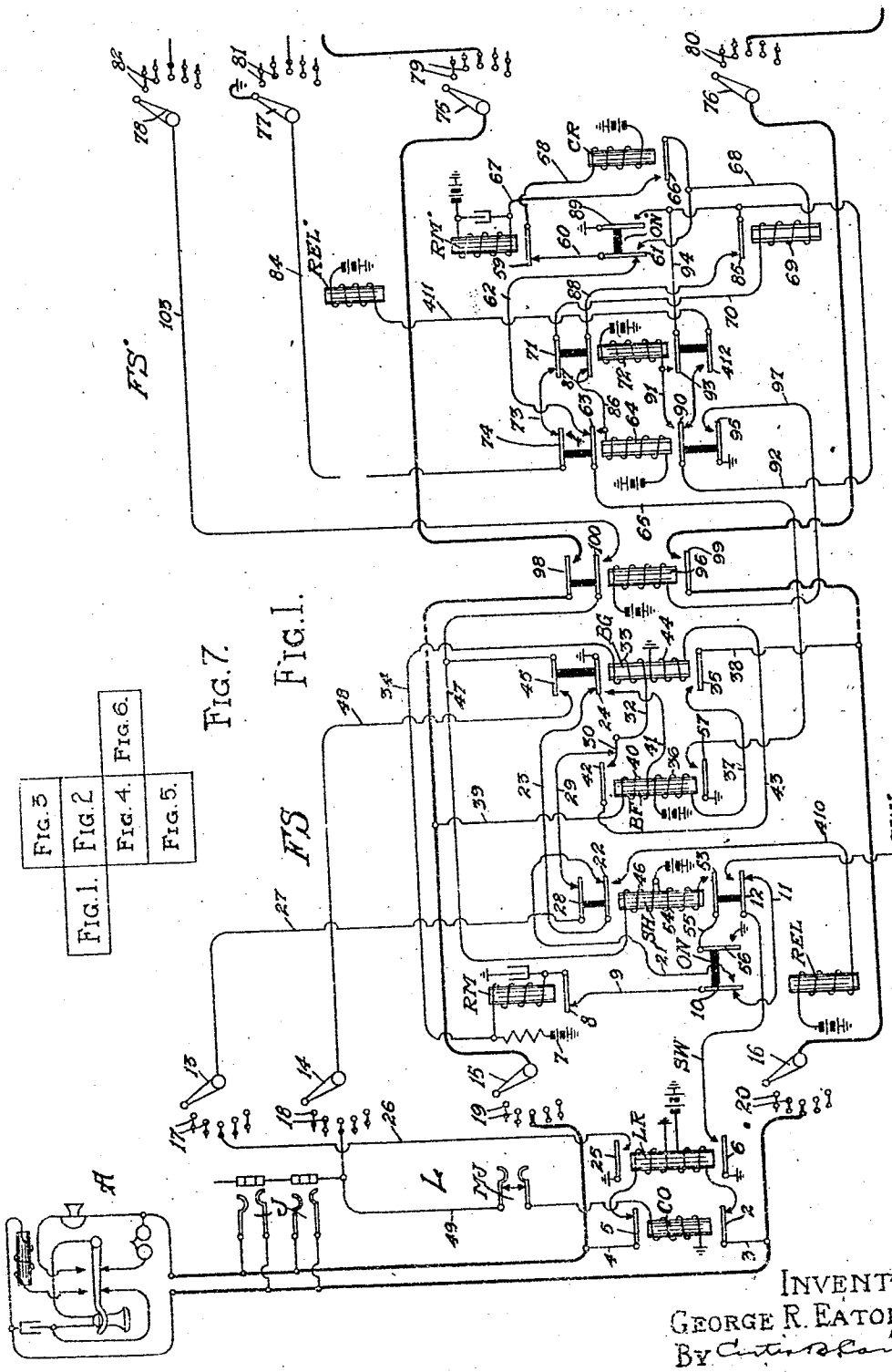

FIG. 7.

FIG. 1.

FIG. 3	FIG. 6.
FIG. 2	FIG. 4.
FIG. 1.	FIG. 5.

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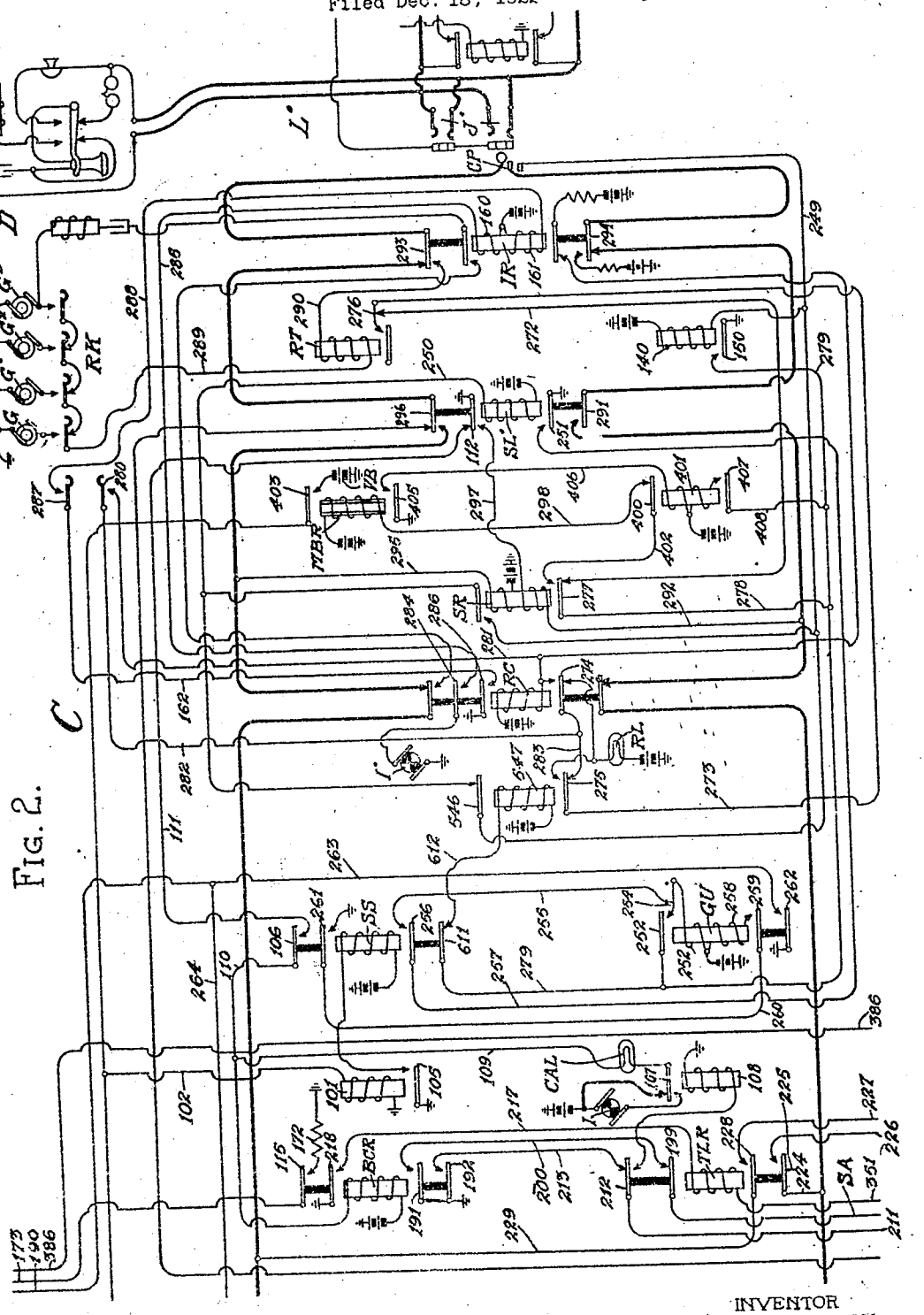

FIG. 2.

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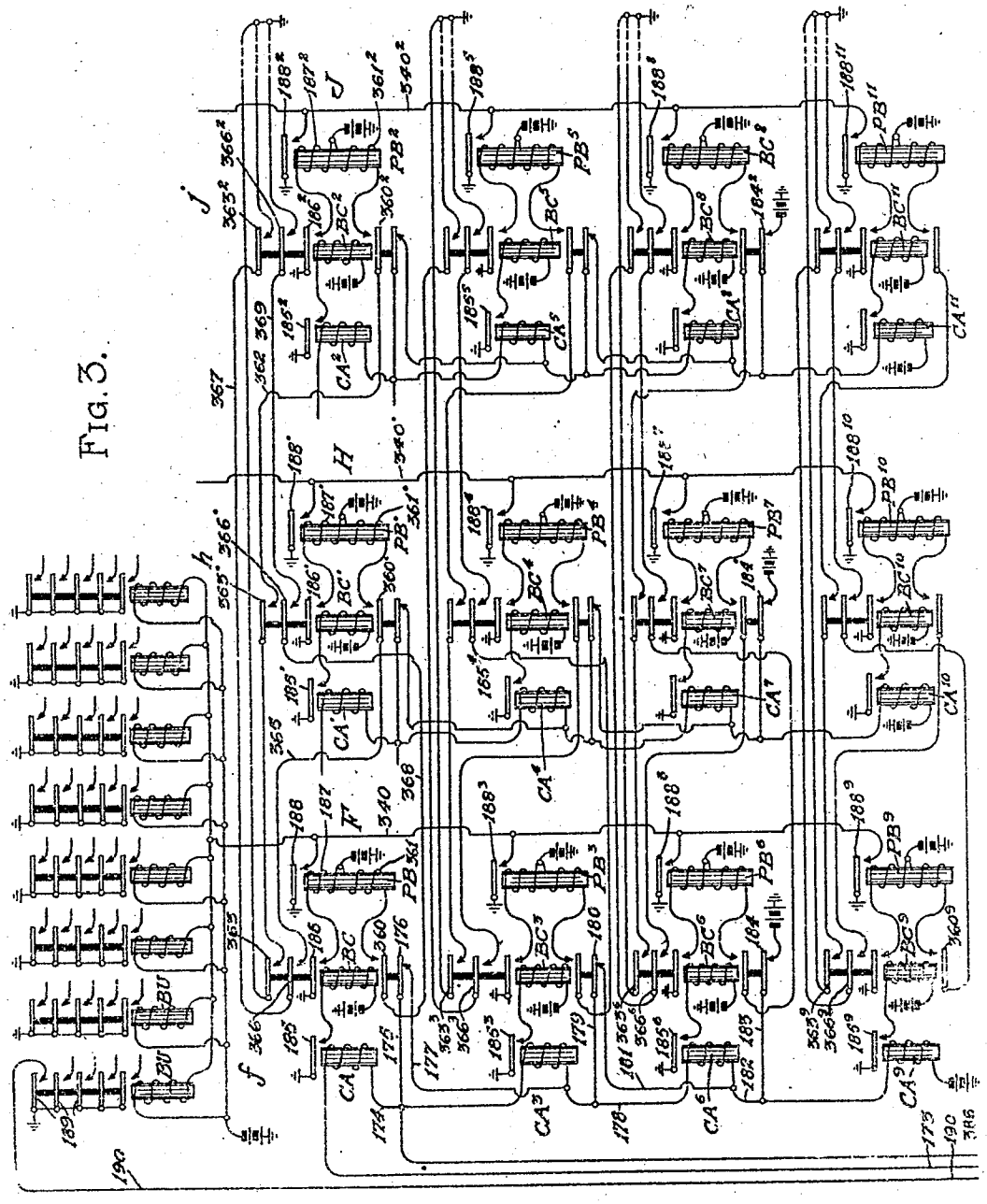
FIG. 3.



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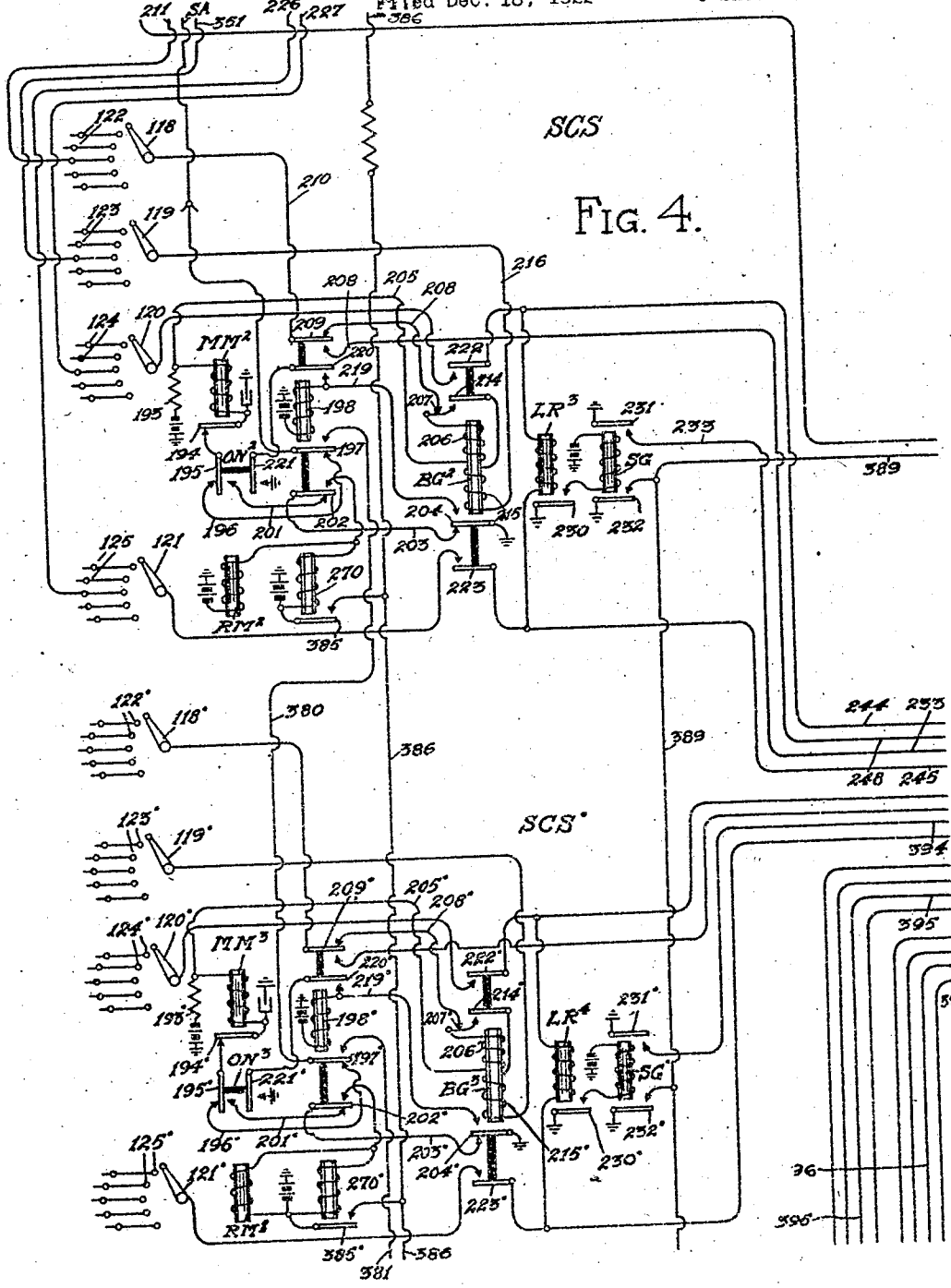

FIG. 4.

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FIG. 5.

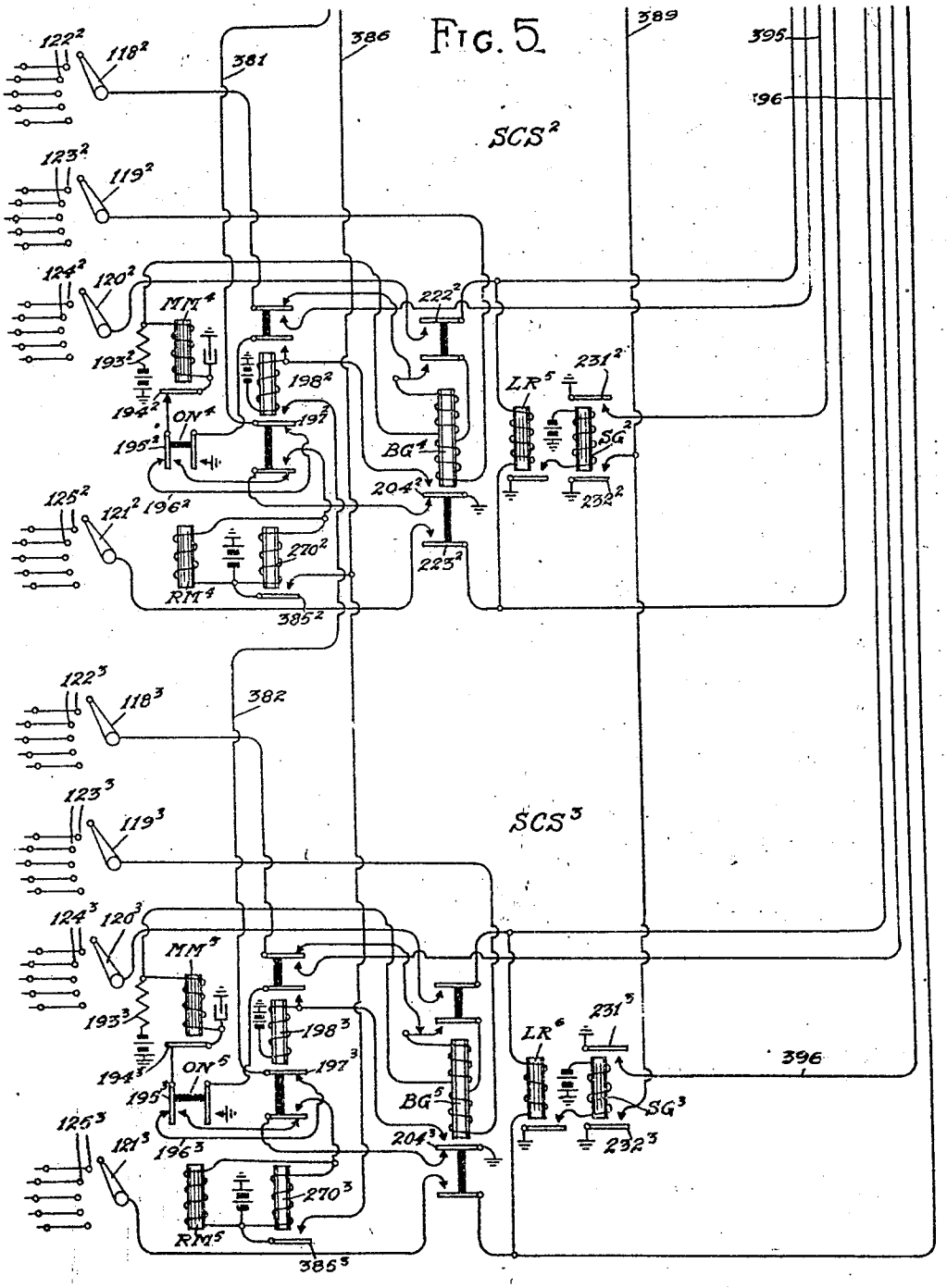

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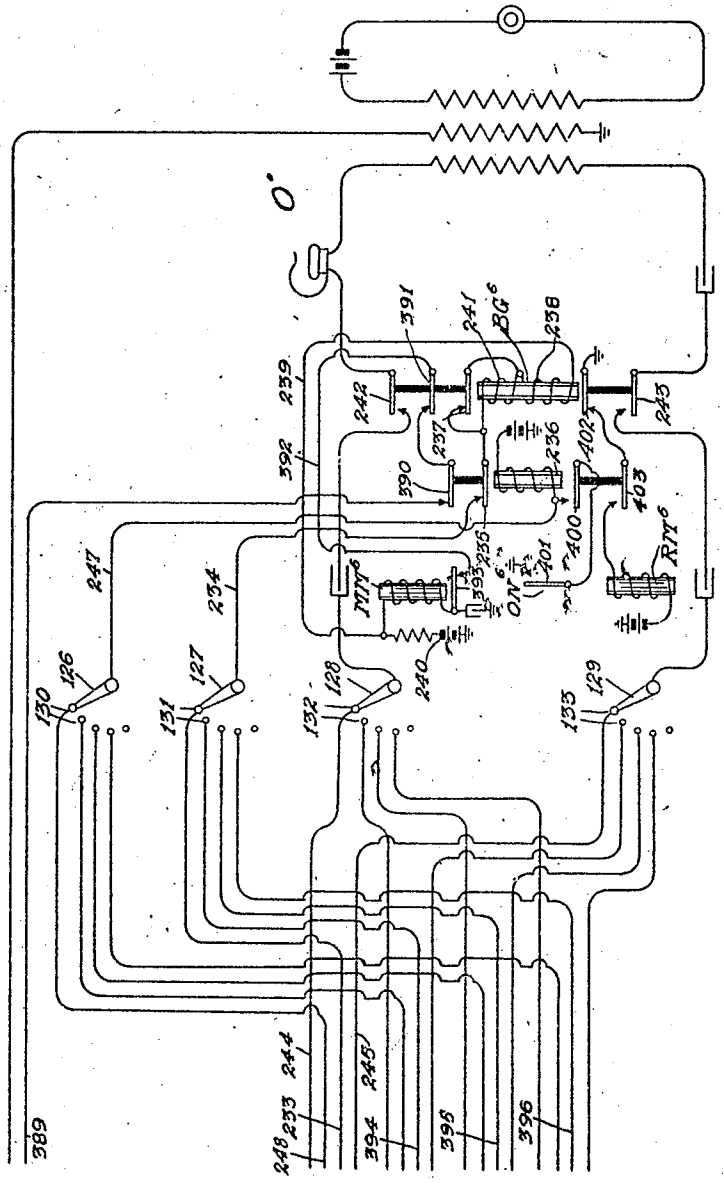
FIG. 6.



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Patented Aug. 3, 1926. 1,594,898

UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed December 18, 1922. Serial No. 607,513.

My invention relates to telephone systems and has to do more particularly with common battery type systems in which the cord circuit used for interconnecting subscribers' lines are of the feature type comprising instantaneous disconnect, secret service and automatic ringing, and an object of my invention is the provision of an improved circuit arrangement for a system of the above type.

One of the features of my invention is the provision of a telephone system in which the subscribers of an exchange system are divided into groups and terminate at the exchange in a group of finder switches as calling lines and multiple jacks as called lines common to the group of lines, and to which said lines are multipled so that when a call is initiated, one of the finder switches of the group is caused to operate to seize the contacts of the calling line.

Another feature of my invention is the provision of call distributing means in which a group of finder switches have multiply connected thereto cords terminating at the different operators' positions at the exchange switchboard, so that a group of subscribers' lines may, through the agency of this group of finder switches have access to a plurality of operators' positions so that the instant a subscriber initiates a call, he will be connected to any one of the plurality of operators at the exchange board.

Another feature of my invention is the elimination of the answering jacks of the subscribers' lines terminating at the exchange board, the said lines being only equipped with multiple jacks, thus permitting the lines per section to be materially increased.

Another feature of my invention is the means for controlling the busy indication at the operator's position. Each position remains busy as long as its particular operator has a greater number of calls before her than any other adjacent operators. Means are also provided for removing the busy indication whenever an operator has a smaller load, or a load equal to the smallest load on any operator's position.

A feature of this busy controlling means is the distribution of the calls to the operators according to their respective abilities to handle calls.

Still another feature of my invention is a provision whereby as many as four calls may be stored at an operator's position in such a way that a distributing means is provided for calls in such a manner as to give each operator the same number of stored calls, in case the operators are not keeping up with the load. This storing feature provides a definite means for checking up the speed at which the calls are being handled at any particular position.

For a more complete understanding of my invention, reference may be had to the accompanying drawings, in which I illustrate apparatus for interconnecting two subscribers, and which comprises Figs. 1, 2, 3, 4, 5 and 6, which, when joined as shown in Fig. 7, illustrate a complete connection.

Referring now more in general to my invention as illustrated, in Fig. 1 I show a calling substation A terminating at the exchange in a line circuit L comprising a line relay LR, cut-off relay CO and multiple jacks J. The line finder switch FS of my invention comprises a rotary magnet RM which automatically operates when a call is initiated by the subscriber at the substation A to step the wipers 13, 14, 15 and 16 over the bank contacts 17, 18, 19 and 20 to select the contacts of the calling line. A common starting wire SW is provided and is common to a group of subscribers' lines which lead to a group of switches FS. A bridging relay BG is provided which energizes when the calling line is seized by the switch FS to shunt the rotary magnet RM to prevent further advancement of the wipers 13, 14, 15 and 16. The switching relay SH energizes upon the actuation of the relay BG to extend the starting conductor SW through to the next finder switch FS of the group (not shown). The switch FS is also provided with a battery feed relay BF and a release magnet REL, which when energized brings about the restoration of the switch wipers 13, 14, 15 and 16. A set of off-normal contacts ON are provided which assume their alternate position on the first step of the switch off normal and remain so until the switch FS is again restored to normal.

A group of finder switches FS' are also associated with the group of calling lines and are similar to the switch FS and are provided with a spring-restored shaft which carries wipers 75, 76, 77 and 78 and contact sets 79, 80, 81 and 82, of which there are

fifty sets, which may be engaged by the wipers 75, 76, 77 and 78, and to which contacts the cord circuit C of the exchange are multipled. A rotary magnet RM′ is provided which steps the wipers 75, 76, 77 and 78 from one set of contacts 79, 80, 81 and 82 to the next to seek an idle cord circuit. A release magnet REL′ is provided which, when energized, permits the release of the switch FS′ to permit the wipers to restore. A set of off-normal contacts ON′ is provided which assume their alternate position upon the first step of the wipers off normal and again restore to their normal position when the wipers assume their normal position when the switch is released.

The cord circuit C as illustrated in Fig. 2 is adapted to be seized by the finder switch FS′, and terminates in the exchange board in a calling plug CP. The cord C is provided with a relay 101 which is energized when the cord is seized by a finder switch FS′ and a relay SS is provided which is actuated upon the energization of the relay 101. An energizing circuit is also established for a busy control relay BCR to prepare circuits in the operator's busy control and storing circuits and in the operator's sequence selecting switch circuit, as will be more fully hereinafter described. An operator's listening relay TLR is provided to control the connection of the operator's set to the cord conductor of the cord C and a calling lamp CAL is also provided which when lighted to glow steadily indicates to the operator associated with the cord C, of which there are a plurality, that calls are stored at her position and when caused to flash will indicate to her that her set has been extended to this particular cord and a call has been extended to her position, as will be described in detail when describing the detail operation of the circuits. A sleeve relay SL′ is provided which is energized when the calling plug CP is inserted into a jack of a called line, and a busy guard relay GU is also provided, which relay GU is energized upon the energization of relay SL′. A party-line ringing key RK is provided and associated therewith are a plurality of ringing generators G, G′, G^2 and G^3 for the usual signaling purposes. A ringing control relay RC, a ringing interrupter relay IR and a ringing trip relay RT are provided for controlling the application of ringing current to the called line, as will be more fully hereinafter described. A calling supervisory relay SR is also provided which is energized when the called subscriber answers. A combined ringing and disconnect lamp RL is provided for the usual purposes.

In the system of my invention I divide the subscribers' lines of the exchange in groups of fifty each, and I associate therewith from six to eight finder switches FS, depending upon the traffic of the group of lines and to which the fifty lines are multipled. I also associate from six to eight finder switches FS′ with the finder switches FS, and which switches FS′ are adapted to seek idle cord circuits C in the operators' positions at the exchange switchboard. Assuming a ten-position switchboard and the switches FS′ being of the fifty-point type, five cords as C of each of the ten operators' positions will be multipled to the eight switches FS′. These values as given above are only for the purposes of illustrating the distribution of the system in an exchange switchboard, and it is to be understood that these values change according to the traffic and size of the exchange switchboard.

Referring now to Fig. 3, illustrating three operator's busy control and storing circuits *f*, *h* and *j*, assumed to be associated with three operators' positions F, H and J: Each circuit is similar to the others and a description of the circuit *f* is sufficient. The operator's busy control and storing circuit *f* associated with the operator's position F is provided with four call storing relays CA, CA^3, CA^6 and CA^9, which are of the marginal type, in that the relay CA will operate through a 3000-ohm resistance to ground, which is placed in circuit with the relay CA upon the energization of the relay BCR of a cord C which is seized to extend a connection to the trunk operator's position F. The relay CA^3 will operate through a 1500-ohm resistance to ground, but not through 3000 ohms, relay CA^6 through a 1000-ohm resistance to ground, but not through 1500 ohms, and relay CA^9 through a 750-ohm resistance to ground, but not through 1000 ohms, for the purpose of storing calls before this trunk operator's position F, as will be more fully hereinafter described. "Busy clearing" relays BC, BC^3, BC^6 and BC^9 are also provided, which relays upon energization establish energizing circuits for the position busying relays PB, PB^3, PB^6 and PB^9, respectively, to establish energizing circuits for the group busy relays BU, which relays upon energization busy all the cords of the operator's position F when a cord has been seized in this operator's position.

Referring now to Figs. 4 and 5, I illustrate the operator's sequence call selecting switches SCS, SCS′, SCS^2 and SCS^3, which are provided four per operator. These switches, when calls are extended to an operator's position F, are operated to select the selected cord circuit to operatively connect therewith. When calls are stored at an operator's position as F, the switches SCS, etc., are operated and restored in a regular rotation. The switch SCS, which is typical of all four switches with which each opera-

tor's position is equipped, will be described. It is provided with wipers 118, 119, 120 and 121, which, through the agency of a motor magnet MM^2, are stepped into engagement with the contact sets 122, 123, 124 and 125 to select the contacts to which the seized cord circuit is multipled. A bridging relay BG^2 is provided, which when energized connects the operator's talking wires to the cord conductors. A release magnet RM^2 is also provided, which when energized withdraws its retaining pawl to permit the wipers to restore to normal under spring tension. Off-normal contacts ON^2 are also provided, which assume their alternate position upon the first step of the wipers off normal and are restored to their normal position upon the restoration of the wipers to normal.

In Fig. 6 I illustrate an operator's selecting switch OS, which comprises wipers 126, 127, 128 and 129, which are stepped from one contact set 130, 131, 132 and 133 to the next through the agency of a motor magnet MM^6 to pick up the calls extended to an operator's position in the order in which they are received or stored at an operator's position. A bridging relay BG^6 is provided which, when energized, connects the operator's set O' through to the cord conductors. The switch is a five-point switch, and when the wipers engage the fifth set of contacts, a release magnet RM^6 is energized to release the wipers so that they may again be stepped from one contact set to the next to connect the operator's set O' to the cord conductors. A set of off-normal contacts ON^6 are provided, which are moved to their alternate position upon the first step of the wipers off normal and moved back to their normal position when the wipers are restored to normal.

The operator's busy control and storing circuits *f*, *h* and *j* provide means for controlling the "busy" when the operator's set and cord are automatically selected in one of these positions. A position remains busy as long as a particular operator has a greater load than any adjacent operator (one in the same group), and the "busy" is removed whenever the operator has a smaller load, or one equal to the smallest load on any operator's position in the same group.

A storing feature is also provided whereby as many as four calls may be stored in front of each operator. In the cord circuit C as described in connection with Fig. 2, a storing lamp CAL is lighted when a call is extended to the operator's position, and indicates to the operator at all times the number of calls stored at her position. The switches SCS, SCS', etc., of which there are four for each operator's position, also operate when calls are connected to an operator's position, and when calls are stored the switches SCS, SCS', etc., also operate to store the calls on the four switches SCS, SCS', etc., in their regular rotation. The operator's switch OS, of which there is one for each position, picks up these calls in the sequence in which they are received and stored.

Assuming now that the subscriber at the substation A initiates a call, the removal of the receiver at the substation establishes an energizing circuit for the line relay LR, traced from battery through the lower winding of the line relay LR, normal contact 2 of the cut-off relay CO, conductor 3, through the closed contact of the substation switchhook, conductor 4, normal contact 5 of the cut-off relay CO to ground through the upper winding of the line relay LR. The closing of alternate contact 6 of the line relay LR establishes an energizing circuit for the rotary magnet RM of the finder switch FS, traced from battery 7 through the winding of the rotary magnet RM, normal contact 8 of the magnet RM, conductor 9, normal contact 10 of the off-normal contact ON, conductor 11, normal contact 12 of the switching relay SH, the starter conductor SW to ground at alternate contact 6 of the line relay LR. The rotary magnet RM energizing steps the wipers 13, 14, 15 and 16 into engagement with the first set of contacts 17, 18, 19 and 20. Upon the first step of the wipers 13, 14, 15 and 16 from their normal position, the off-normal contacts ON assume their alternate position, and the opening of normal contact 10 opens the initial energizing circuit of the rotary magnet RM, but a substitute energizing circuit is again established for the rotary magnet RM upon the closure of its normal contact 8, this substitute circuit being traced from battery through the winding of the rotary magnet RM, its normal contact 8, conductor 9, alternate contact 10, of the off-normal contacts ON, conductor 21, normal contact 22 of the relay SH, conductor 23, to ground at normal contact 24 of the bridging relay BG. The rotary magnet RM energizing steps the wipers 13, 14, 15 and 16 into engagement with the next set of contacts 17, 18, 19 and 20, and the opening of its normal contact 8 again allows the magnet RM to restore. Upon the closure of contact 8 magnet RM is again energized and the interruption of its contact 8 causes the said magnet RM to energize and de-energize, thus stepping the wipers 13, 14, 15 and 16 over the contact sets 17, 18, 19 and 20 in search of the calling line of the subscriber A, and when the wiper 16 of the finder switch FS engages the grounded contact 20 associated with the calling line A, an energizing circuit is established for the bridging relay BG, traced from ground at alternate contact 25 of the line relay LR, conductor 26, contact

20, wiper 16, conductor 27, normal contact 28 of the relay SH, conductor 29, normal contact 30, of the relay BF, conductor 32, the winding 33 of the relay BG, conductor 34 to battery 7. The low resistance path through the winding 33 of the relay BG shunts the rotary magnet RM preventing further actuation of the said magnet, and the wipers 13, 14, 15 and 16 of the finder switch FS are now in engagement with contacts 17, 18, 19 and 20 which lead to the line of the calling subscriber A. The closing of alternate contacts 24 and 35 of the bridging relay BG establishes an energizing circuit for the battery feed relay BF, traced from battery through the winding 36 of the relay BF, conductor 37, alternate contact 35 of the relay BG, conductor 38, wiper 14, contact 18, to the closed contacts of the substation switchhook at the calling substation A, and back through contact 17 and wiper 13, conductor 29 through the winding 40 of the relay BF, conductor 41, to ground at alternate contact 24 of the relay BG. The initial energizing circuit of the relay BG is opened upon the energization of the relay BF, but due to its slow-to-release construction, a substitute energizing circuit is established for the relay BG, traced from battery 7, conductor 34, through the winding 33 of relay BG, make-before-break contact 42 of relay BF, conductor 43 to ground through the winding 44 of the relay BG.

The closure of alternate contact 45 of the relay BG establishes an energizing circuit for the switching relay SH, traced from battery through the winding 46 of relay SW, conductor 47, through alternate contact 45 of the relay BG, conductor 48, of the wiper 15, contact 18, conductor 49 to ground through the winding of the cut-off relay CO. The switching relay SH, upon energizing, closes its alternate contact 53, establishing a locking circuit for the relay SH, traced from battery through the winding 54 of relay SH, its alternate contact 53, conductor 55 to ground at alternate contact 56 of the off-normal contacts ON. The closing of alternate contact 12 of the relay SH now extends the common starting conductor SW through the said alternate contact 12, to the starting conductor wire SW', which wire SW' leads to the next switch of the group so that in the event that another subscriber initiates a call in the group with which the finder switch FS is associated, the next finder switch FS of the group will be used to select its calling line. The closing of alternate contact 57 of the relay BF establishes an energizing circuit for the control relay CR of the finder switch FS', traced from battery through the winding of the relay CR, conductor 58, normal contact 59 of the rotary magnet RM', of the finder switch FS', conductor 60, normal contact 61 of the off-normal contacts ON', conductor 62, normal contact 63 of the relay 64, conductor 65 to ground at alternate contact 57 of relay BF. The relay CR upon energizing closes its alternate contact 66, establishing an energizing circuit for the rotary magnet RM', traced from battery through the winding of the rotary magnet RM', conductor 67, alternate contact 66 of the relay CR, conductor 68, through the winding of the slow-acting relay 69, conductor 70, normal contact 71 of the relay 72, conductor 73, normal contact 74 of the relay 64 to ground at wiper 77 of the finder switch FS'. The rotary magnet RM', upon energization, steps the wipers 75, 76, 77 and 78 into engagement with the first set of contacts 79, 80, 81 and 82, which lead to a cord circuit in an operator's position. The rotary magnet RM' upon energization opens its normal contact 59 to open the energizing circuit of the control relay CR, and the relay CR now de-energizes and the opening of its alternate contact 66 opens the circuit of the rotary magnet RM'. Should the first set of contacts engaged by the wipers 75, 76, 77 and 78 lead to a cord circuit that is already in use, private contact 81 will be grounded and another energizing circuit is established for the control relay CR, traced from battery through the winding of the relay CR, conductor 58, normal contact 59 of the rotary magnet RM', conductor 60, alternate contact 61 of the off-normal contacts ON (said off-normal contacts ON' having moved to their alternate position upon the first step of the wipers 75, 76, 77 and 78 from their normal position), conductor 68, through the winding of the relay 68, conductor 70, normal contact 71 of the relay 72, conductor 73, normal contact 74 of the relay 64, conductor 84 to the grounded wiper 77 which is engaging a busy grounded contact 81. The relay CR energizing closes its alternate contact 66, establishing an energizing circuit for the rotary magnet RM' to ground at busy grounded contact 81 over the previously described path, and the rotary magnet RM' steps the wipers 75, 76, 77 and 78 into engagement with the next set of contacts 79, 80, 81 and 82. The rotary magnet RM' upon energization opens its normal contact 59, allowing the relay CR to restore, and the relay CR restoring opens the energizing circuit of the rotary magnet RM' and its alternate contact 66.

It will thus be seen that due to the see-saw action of the relay CR and the rotary magnet RM', the wipers 75, 76, 77 and 78 are stepped from one contact set to the next, until an idle set is encountered. When the wiper 77 engages an ungrounded contact 81, no energizing circuit is established for the relay CR, and the relay CR remains at normal and thus prevents further actuation

of the rotary magnet RM′ and the wipers now remain in engagement with the idle contact sets 79, 80, 81 and 82. The slow-acting relay 69 remains energized during the rapid energizations and de-energizations of the relay CR, and its normal contact 85 is opened to prevent the energization of the relay 64, and when an idle contact set is encountered the relay 69 restores and the closing of its normal contact 85 establishes an energizing circuit for the relay 64 of the finder switch FS′, traced from battery through the winding of the relay 64, the conductor 86, normal contact 87 of the relay 72, conductor 88, normal contact 85 of relay 69 to ground at alternate contact 89 of the off-normal contacts ON′.

The closing of alternate contact 90 of the relay 64 establishes an energizing circuit for the relay 72, traced from battery through the winding of the relay 72, conductor 91, alternate contact 90 of the relay 64, conductor 92 to ground at alternate contact 89 of the off-normal contacts ON′. The closing of alternate contact 93 of the relay 72 establishes a locking circuit for itself, traced from battery through its windings and its alternate contact 93, over conductor 94 to ground at alternate contact 89 of the off-normal contacts ON′. The initial energizing circuit of the relay 64 is opened at normal contact 87 upon the energization of the relay 72, but a substitute energizing circuit is established for the relay 64, traced from battery through the winding of the relay 64, its alternate contact 63, conductor 65, to ground at alternate contact 57 of the battery feed relay BF of the finder switch FS. The closing of alternate contact 95 of relay 64 establishes an energizing circuit for the relay 96, traced from battery through the winding of the relay 96, conductor 97, to ground at alternate contact 95 of the relay 64. The closing of alternate contact 74 of the relay 64 places ground upon the private wiper 77, which busies the engaged private contact 81 to prevent any other switch FS′ from engaging the selected contact set. The relay 96 energizing, closes its alternate contacts 98 and 99, and the closing of the said alternate contacts 98 and 99 now extends the calling subscriber at the substation A to the selected idle cord circuit C at an idle operator's position at the exchange.

The closure of alternate contact 100 of relay 96 establishes an energizing circuit for the relay 101, traced from ground through the relay 101, conductor 102, contact 82, wiper 78, conductor 103, alternate contact 100 of relay 96, conductor 47 to battery and ground through the winding 46 of the relay SH. The relay 101 upon energization closes its alternate contact 105, establishing an energizing circuit for the secondary relay SS, traced from battery through the winding of the relay SS to ground at alternate contact 105. The closure of alternate contact 106 of the secondary relay SS establishes a circuit for the call line lamp CAL of the cord circuit C, traced from battery through normal contact 107 of relay 108, through the lamp CAL, conductors 109 and 110, alternate contact 106 of relay SS, conductor 111 to ground at normal contact 112 of the sleeve relay SL. The lamp CAL is lighted and burns steadily and indicates to the operator that a call is stored at her position, as will be more fully hereinafter described. The closure of alternate contact 106 of the relay SS also establishes an energizing circuit for the busy control relay BCR of the seized cord circuit C, traced from battery through the winding of the relay BCR, conductor 110, alternate contact 106 of relay SS, conductor 111 to ground at normal contact 112 of the relay SL. The busy control relay BCR energizing closes its alternate contact 115, establishing an energizing circuit for the called storing relay CA of the operator's busy control and storing circuit *f*, which circuit *f* is common to its operator's position F with which the cord circuit C is seized by the switch FS′. The energizing circuit of the relay CA may be traced from ground through the 3000-ohm resistance 172, alternate contact 115 of the relay BCR, conductor 173, which is common to all relays BCR of the cord circuits at position F, through the winding of the relay CA, conductors 174 and 175, normal contact 176 of the busy clearing relay BC, conductors 177, 178, 179, normal contact 180 of the busy clearing relay BC^3, conductors 181, 182 and 183 to battery through normal contact 184 of the busy clearing relay BC^6. The relay CA, upon energization, closes its alternate contact 185, establishing an energizing circuit for the busy clearing relay BC, traced from battery, through the winding of the relay BC, to ground at alternate contact 185 of the relay CA.

The relay BC energizing closes its alternate contact 186 to establish an energizing circuit for the position busying relay PB, traced from battery through the upper winding 187 of the relay PB to ground at alternate contact 186 of the relay BC. The relay PB energizes over this circuit and closes its alternate contact 188 connecting ground to the conductor 340, which ground operates the group of busying relays BU associated with the position F, and the busying relays BU upon energization close their alternate contacts 189, temporarily busying the balance of the cords in this position by grounding the contacts 81 at the selecting switches, each cord having a wire, as 190, leading to a relay BU. The busy potential

thus placed on all the private contacts 81 and their multiples of cords at this operator's position remains until the call which has been extended over this particular cord to her position is extended to the called line, as will be more fully hereinafter described. The relay BCR upon energizing also closes its alternate contacts 191, 192. The closing of alternate contact 191 connects ground to the starting conductor SA common to all relays BCR of the position, to close an energizing circuit for the motor magnet MM^2 of the operator's sequence call selecting switch SCS, of which there are four for each operator's position, for purposes as will be hereinafter more fully described.

The circuit of the motor magnet MM^2 of the switch SCS may be traced from battery through the resistance 193, the winding of magnet MM^2, its normal contact 194, normal contacts 195 of the off-normal contacts ON^2, conductor 196, normal contact 197 of the relay 198, starting conductor SA, normal contact 199 of the cord listening relay TLR, conductor 200, to ground at alternate contact 191 of the relay BCR. The magnet MM^2 upon energization steps the wipers 118, 119, 120 and 121 into engagement with the first set of contacts 122, 123, 124 and 125, and upon the first step of the wipers off normal, the off-normal contacts ON^2 assume their alternate position, and the motor magnet MM^2 upon energization opens its normal contact 194 to interrupt its circuit, and the magnet MM^2 now restores. The off-normal contacts ON^2 having moved to their alternate position, the initial energizing circuit of magnet MM^2 is opened at normal contact 195 of off-normal contacts ON^2, but the closing of alternate contact 195 of off-normal contacts ON^2 establishes a substitute energizing circuit for the motor magnet MM^2, traced from battery through resistance 193, through the winding of the motor magnet MM^2, its normal contact 194, alternate contact 195 of off-normal contact ON^2, conductor 201, normal contact 202 of relay 198, conductor 203 to ground at normal contact 204 of the bridging relay BG^2. The motor magnet MM^2 is again energized over this circuit, and, due to the opening and closing of its contact 194, it is thus alternately energized an deenergized to step the wipers 118, 119, 120 and 121 from one set of contacts 122, 123, 124 and 125 to the next, and when the wiper 118 engages the contact 122, which was grounded upon the energization of the relay BCR of the cord circuit C, an energizing circuit is established for the bridging relay BG^2 of the switch SCS, which may be traced from battery through the resistance 193, conductor 205, through the upper winding 206 of the relay BG^2, normal contact 207 of relay BG^2, conductor 208, normal contact 209 of the relay 198, conductor 210, wiper 118, contact 122, conductor 211, normal contact 212 of the relay TLR, conductor 213, to ground at alternate contact 192 of relay BCR. The relay BG^2 upon energization closes its alternate contact 214, closing a locking circuit for itself traced from battery through the resistance 193, conductor 205, through the upper winding 206 of the relay BG^2, its alternate contact 214, lower winding 215 of the relay BG^2, conductor 216, wiper 119, contact 123, conductor 351, through the winding of the relay TLR, conductor 217, to ground at alternate contact 218 of the relay BCR. The circuit through relay TLR also brings about its energization for the purposes as will presently be described.

The circuit just described, which causes the energization of relay BG^2 shunts the motor magnet MM^2 and prevents further actuations of the said magnet, and the wipers 118, 119, 120 and 121 remain in engagement with the selected set of contacts 122, 123, 124 and 125. The relay BG^2 upon energization closes its alternate contact 204, establishing an energizing circuit for the relay 198, traced from battery through the winding of the relay 198, conductor 219 to ground at alternate contact 204 of the relay BG^2, and the relay 198 energizing closes its alternate contact 220, establishing a locking circuit for itself from battery through its winding, its alternate contact 220 to ground at alternate contact 221 of the off-normal contacts ON^2. The closing of alternate contacts 222 and 223 of the relay BG^2 establishes an energizing circuit for the line relay LR^3 associated with the finder switch SCS, traced from battery through the winding 36 of the battery feed relay BF, associated with the finder switch FS of the calling line, conductor 37, alternate contact 35 of the relay BG, alternate contact 99 of relay 36, wiper 76, contact 80, conductor 115, conductor 224, alternate contact 225 of the relay TLR, conductor 226, contact 125, wiper 121, alternate contact 223 of the relay BG^2, through the winding of the line relay LR^3, alternate contact 222 of the relay BG^2, wiper 120, contact 124, conductor 227, alternate contact 228 of the relay TLR, conductor 229, contact 79, wiper 75, alternate contact 98 of relay 96, conductor 39, winding 31 of relay BF, conductor 41 to ground at alternate contact 24 of relay BG. The relay LR^3 energizing closes its alternate contact 230, establishing an energizing circuit for the starting relay SG, traced from battery through the winding of the relay SG, to ground at alternate contact 230 of the relay LR^3. The relay SG upon energization closes its alternate contacts 231 and 232, and the closing of alternate contact 231 establishes an energizing circuit

for the switching relay BG^6 of the operator's selecting switch OS, traced from ground at alternate contact 231 of the relay SG, conductor 233, contact 131, wiper 127, conductor 234, normal contact 235 of relay 236, normal contact 237 of the relay BG^6, through the low resistance winding 238 of the relay BG^6, conductor 239, through the resistance 240 to battery.

The circuit just traced through the relay BG^6 shunts the magnet MM^6 of the switch OS, due to the low resistance path through winding 238 of the relay BG^6, and prevents the magnet MM^6 from stepping the wipers 126, 127, 128, 129 of the switch. The relay BG^6 upon energization opens its normal contact 237 and a substitute circuit is established for the said relay BG^6, traced from battery through the resistance 240, conductor 239, through the windings 238 and 241 of the relay BG^6, normal contact 235 of the relay 236 to ground at alternate contact 231 of the relay SG over the previously described path.

The closing of alternate contacts 242 and 243 of the relay BG^6 connects the operator's set O' to the cord conductors of the cord circuit C, from alternate contact 242 of the relay BG^6, the wiper 128, contact 132, conductor 244, alternate contact 222 of relay BG^2, wiper 120, contact 124 of switch SCS, conductor 227, contact 228 of the relay TLR, conductor 229 to the tip strand of the cord C, and the other lead from the operator's set O' extends through alternate contact 243 of the relay BG^6, the wiper 129, contact 133, conductor 245, through alternate contact 223 of the relay BG^2, wiper 121, contact 125 of switch SCS, conductor 226, alternate contact 225 of the relay TLR, conductor 224, to the sleeve strand of the cord circuit C.

Referring again to the switch SCS, the energization of relay 198 causes its alternate contact 209 to close, to establish an energizing circuit for the relay 108 of the cord circuit C of the position F, traced from battery through the winding of the relay 236 of the switch OS, conductor 247, wiper 126, contact 130, conductor 248, alternate contact 209 of the relay 198, conductor 210, wiper 118, contact 122, conductor 211, alternate contact 212, of the relay TLR, to ground through the winding of the relay 108, which relay energizes over this circuit, but relay 236 of the switch OS does not, due to its construction and adjustment.

The opening of normal contact 107 of relay 108 opens the initial circuit of the call lamp CAL, but a substitute circuit is established for the lamp CAL, traced from battery through the rotating interrupter I, through alternate contact 107, through the lamp CAL, conductors 109 and 110, alternate contact 106 of relay SS, conductor 111, to ground at normal contact 112 of relay SL'. The lamp CAL is caused to flash over this circuit and notifies the operator of the position F that her operator's set has been extended to the cord C in which the lamp CAL had been burning steadily and that a call is awaiting her attention. The lamps CAL at an operator's position are lighted and burn steadily when calls are being stored at an operator's position, but flash when the operator of a position at which calls are stored is available as will be more fully hereinafter described. The operator's head set O' having been connected to the cord conductors as just described, through alternate contacts 225 and 228 of the relay TLR of the seized cord C, the operator noting the flashing signal CAL inquires the number of the substation that is wanted by the calling subscriber at substation A and now tests the multiple jack J' of the wanted substation in the usual manner as to its idle or busy condition.

Assuming that the line is idle, the operator at the position F associated with the cord circuit C inserts the calling plug CP into the multiple jack J' of the wanted substation D, thus establishing a series energizing circuit for the sleeve relay SL' of the cord circuit C and the cut-off relay CO of the line circuit L' associated with the called line, traced from battery, through the winding of the relay SL', conductor 250, normal contact 546 of relay 547, conductor 249, sleeve contacts of the connected plug TP and jack J' to ground through the winding of the cut-off relay CO. The relay SL' upon energization opens its normal contact 112, interrupting the flashing circuit of the call lamp CAL, which lamp is now effaced. The insertion of the calling plug CP of the seized cord circuit C into the multiple jack J' of the wanted line also establishes an energizing circuit for relay 140 traced from battery through the winding of relay 140, conductor 249, to ground through the cut-off relay CO, and the purpose of the relay 140 will be more fully hereinafter described. The sleeve relay SL' energizing closes its alternate contact 251, establishing an energizing circuit for the busy guard relay GU, traced from battery, through its upper winding 252, its normal contact 254, conductor 255, alternate contact 256 of relay SS, conductor 257 to ground at alternate contact 251 of the relay SL'. A locking circuit is closed through the lower winding 258 of the relay GU, traced from battery through its lower winding 258, its alternate contact 259, conductor 260, to ground at alternate contact 261 of relay SS. A locking circuit is also established through the upper winding 252 of the relay GU, from battery through the winding 253 of the relay GU, its alternate contact 252, conductor 279 to ground at alternate contact 150 of the

relay 140. These two locking circuits for the relay GU are for purposes as will be presently described.

The sleeve relay SL' upon energization opens its normal contact 112 to open the energizing circuit through the relay BCR and the relay BCR upon de-energization opens its alternate contact 115 and the opening of alternate contact 115 of relay BCR opens the energizing circuit of the relay CA of the cord operator's control and storing circuit associated with this operator's position F, of which the cord circuit C is one. The relay CA now restores and the opening of its alternate contact 185 opens the energizing circuit of the relay BC. The relay BC upon restoration opens its alternate contact 186, opening the energizing circuit of the relay PB and the relay PB upon de-energization opens its alternate contact 188, removing the ground from the group of busying relays BU, which relays now restore, and the opening of their alternate contacts 189 removes the busying grounds from the multiple contacts 81 of the switches FS' in which the cords C of this operator's position F terminate, making them again selectable so that other calls may be extended to this operator's position F.

The closing of alternate contact 262 of the relay GU, however, places a busy potential upon the private contact 81 of the selected cord circuit C which may be traced from ground at alternate contact 262 of the relay GU, conductors 263 and 264 to the contact 81, thus preventing any other switch, as FS', from selecting this particular cord that is now in use. The relay BCR upon restoration opens its alternate contact 218 to open the energizing circuit of the relay TLR of the cord C, and the relay BG^2 of the switch SCS. The relay TLR upon restoration opens its alternate contact 212, allowing relay 108 to de-energize, and the relay TLR upon restoration also opens its alternate contacts 225 and 228 to disconnect the operator's set O' from the cord conductors. The relay BG^2 upon restoration closes its normal contact 204, closing an energizing circuit for the release magnet RM^2, traced from battery through the winding of release magnet RM^2, alternate contact 202 of relay 198, conductor 203 to ground at normal contact 204 of the now de-energized relay BG^2, and the release magnet RM^2 now withdraws the retaining pawl from the ratchet and allows the wipers 118, 119, 120 and 121 to restore to their normal position.

The relay 270 is also energized upon the restoration of the relay BG^2, due to the closing of its normal contact 204, but the energization of this relay has no effect on the circuit at this time. When the wipers reach their normal position, the off-normal contacts ON^2 assume their normal position, and the opening of alternate contact 221 of the said off-normal contacts ON^2 opens the locking circuit of relay 198, and the opening of alternate contact 221 allows relay 198 to restore, and the opening of alternate contact 202 of relay 198 opens the circuit of the release magnet RM^2 and the relay 270, which relay and magnet now restore to normal. When relay BG^2 de-energizes, its alternate contacts 222 and 223 are opened, allowing relay LR^3 to restore and the relay LR^3 in turn opens the energizing circuit of the relay SG at its contact 230. The relay SG upon de-energization opens its alternate contact 231 opening the energizing circuit of relay BG^6 of the switch OS, and the relay now restores. The apparatus of the sequence selecting switch SCS and the operator's selecting switches are now at normal and the switches are again ready to select another call that may be extended to the operator's position F.

Returning now to the extension of a call to the called subscriber at the substantion B, a circuit for the ringing lamp RL is established, traced from battery through the lamp RL, normal contact 274 of relay RC, normal contact 275 of relay 547, conductor 273, normal contact 276 of relay RT, conductor 272, normal contact 277 of relay SR, conductors 278 and 279 to ground at alternate contact 150 of relay 140. The ringing lamp RL is lighted over this circuit, giving the operator associated with this cord C visual indication, notifying her that the called subscriber at the substation D has as yet not been signaled. To signal the called-for subscriber at the substation D, the operator associated with the cord circuit C now depresses the proper ringing key plunger of the ringing key RK to connect the proper ringing generator frequency of the generators G, G', G^2 or G^3, as the case may be, to operate the call signal at the called substation D.

Assuming that the ringing generator G' is the proper frequency for signaling the substation D, the operator depresses the ringing key plunger associated with this frequency and the depression of the said key plunger actuates the end spring contact 280, causing it to momentarily assume its alternate position, and the closure of said alternate contact 280 establishes an energizing circuit for the ringing control relay RC, traced from battery through the winding of the said relay RC, conductor 281, alternate contact 280 of the end spring contacts of the ringing key RK, conductor 282, normal contact 275 of the relay 547, conductor 273, normal contact 276 of relay RT, conductor 272, normal contact 277 of relay SR, conductors 278 and 279, to ground at alternate contact 150 of relay 140. The closing of alternate contact 274 of the relay RC establishes a

locking circuit for itself traced through the winding of the said relay RC, its alternate contact 274, conductor 283, normal contact 275 of the relay 547, to ground at alternate contact 150 of relay 140. The closing of the end spring contact 287 of the ringing key RK establishes an energizing circuit for the interrupter relay IR, traced from battery through the winding 161 of the relay IR, conductor 288, closed end spring contact 287, conductor 162, to ground at alternate contact 286 of relay RC. The relay IR is energized over this circuit, and the closing of its alternate contact 293 connects the selected generator G' to the tip cord conductor of the cord circuit C to operate the call bell at the called substation D to give the subscriber thereat an instantaneous first ring, as is well understood. The opening of normal contact 274 of the relay RC opens the circuit of the ringing lamp RL, and the closure of alternate contact 284 of the relay RC closes an energizing circuit for the interrupter relay IR, traced from battery through the winding 160 of the relay IR, conductor 285, alternate contact 284 of relay RC, through the constantly rotating interrupter I' to ground. The relay IR is thus intermittently energized and de-energized by the interrupter I' and the ringing current from the generator G' is thus connected and disconnected to intermittently operate the called signal at the called-for substation D. The ringing current may be traced from the ungrounded pole of the generator G' through the closed key plunger contact of the ringing key RK, conductor 289, through the winding of the ringing trip relay RT, conductor 290, alternate contact 293 of the interrupter relay IR, tip contacts of the connected plug CP and jack J', through the condenser and call bell to the called substation D, back through the ring contacts of the connected jack J' and plug CP to battery and ground through alternate contact 294 of the ringing interrupter relay IR. The call signal at the substation D is thus intermittently actuated due to the energization and de-energization of interrupter relay IR, and the subscriber at the substation D, in response to his call signal, removes his receiver from the switchhook.

Should the subscriber at the substation D remove his receiver during a ringing period, the combined generator and battery flowing through the winding of the ringing trip relay RT causes the same to actuate, and the opening of its normal contact 276 opens the locking circuit for the ringing control relay RC, which relay RC restores, and the opening of the alternate contact 284 disconnects interrupter I from the winding 160 of interrupter relay IR, and the relay IR now restores to normal and prevents further application of ringing current after the called subscriber at the substation D answers in response to his call signal.

Should the subscriber at the substation D remove his receiver during a silent period, that is, when the ringing interrupter relay IR is in one of its de-energized positions, an energizing circuit for the supervisory relay SR is established, the circuit being traced from battery through the upper winding of the relay SR, conductor 295, alternate contact 296 of relay SL', normal contact 293 of the relay IR, ring contacts of the connected plug CP and jack J', through the now closed contacts of the substation switchhook at the substation D, back through the tip contacts of the connected jack J' and plug CP, normal contact 294 of the relay IR, alternate contact 291 of relay SL', conductor 292, through the lower winding of relay SR, conductor 297, to ground at alternate contact 112 of relay SL, and the opening of its normal contact 277 opens the locking circuit of relay RC to prevent further application of ringing current.

The closing of alternate contact 277 of relay SR establishes an energizing circuit for the meter battery connecting relay MBR, traced from battery through the winding of the meter battery connecting relay MBR, conductor 298, normal contact 400 of relay 401, conductor 402, alternate contact 277 of relay SR, conductor 278, to ground at alternate contact 150 of relay 140. The relay MBR upon energization closes its alternate contact 403 connecting the high voltage battery VB to establish an energizing circuit for meter relay associated with the calling line and which is located at the main exchange, and which may be connected in circuit through the medium of a meter jack MP and a suitable plug associated with the meter mechanism.

The closing of alternate contact 405 of relay MBR establishes an energizing circuit for the relay 401, traced from battery through the upper winding of relay 401, conductor 406 to ground at alternate contact 405. Relay 401 upon energization closes its alternate contact 407, establishing a locking circuit for itself, traced from battery through its lower winding, its alternate contact 407, conductors 408 and 279 to ground at alternate contact 150 of relay 140 for purposes as will presently be described.

The subscriber at the substation A and the subscriber at the substation D are now in conversational circuit, the talking circuit being traced over the heavily marked conductors.

Assuming now that the subscribers at the substations A and D have finished conversation, they replace their receivers upon their respective switchhooks. The replacing of the receiver by the subscriber at the calling

substation A opens the circuit of the battery feed relay BF of the finder switch FS and the relay BF de-energizing, its alternate contact 42 is opened, opening the energizing circuit of the bridging relay BG. Relay BG de-energizing its normal contact 24 is closed, establishing an energizing circuit for the release magnet REL, traced from battery through the winding of release magnet REL, conductor 410, alternate contact 22 of relay SH, conductor 23, to ground at normal contact 24 of relay BG, and the opening of alternate contact 45 of BG opens the circuit of the cut-off relay CO of the line circuit L associated with the calling line A, which relay restores. The release magnet REL withdraws the retaining pawl which held the wipers 13, 14, 15 and 16 in their advanced position and permits them to restore to normal. The off-normal contacts ON also assume their normal position upon the restoration of the wipers and the opening of alternate contact 56 of the off-normal contacts ON opens the energizing circuit of relay SH, which relay restores, and the opening of alternate contact 22 of relay SH upon its restoration opens the circuit of the release magnet REL and the finder switch FS is now at normal.

The relay BF upon restoration as above described also opens its alternate contact 57, opening the locking circuit of the relay 64 of the switch FS', and the relay 64 upon restoration closes its normal contact 90, establishing an energizing circuit for the release magnet REL', traced from battery through the winding of magnet REL', conductor 411, alternate contact 412 of relay 72, normal contact 90 of relay 64, conductor 92 to ground at alternate contact 89 of the off-normal contacts ON'. The release magnet REL' upon energization withdraws the retaining pawl and allows the wipers 78, 79, 80 and 81 to restore. The off-normal contacts ON' also assume their normal position when the wipers of the switch FS' have restored and the opening of alternate contact 89 of off-normal contacts ON' opens the locking circuit of relay 72 which now restores to normal. Relay 64 having restored to normal, its alternate contact 95 is opened, thus opening the energizing circuit of relay 96, which relay now restores, and the switch FS' and its associated parts or mechanism are now at normal. The switch FS' having restored to normal, the circuit of relay 101 of the cord circuit C which was seized by the finder switch FS' to extend the connection to cord circuit C is opened, and the relay 101 restores, and the opening of its alternate contact 105 opens the energizing circuit of the relay SS, which relay SS now restores to normal. The opening of alternate contact 261 of relay SS opens one of the locking circuits of the busy guard relay GU which extends through the winding of relay 258, but the relay GU remains locked up to ground at alternate contact 150 of relay 140 through its upper winding 252 over the circuit as previously traced. Relay SS upon deenergization closes its normal contact 611, establishing an energizing circuit for the relay 547, traced from battery through the winding of relay 547, conductor 612, normal contact 611 of relay SS, conductor 279 to ground at alternate contact 150 of relay 140. The relay 547 upon energization opens its normal contact 546, which opens the energizing circuit of the sleeve relay SL', which relay SL' now restores. The relay 547 upon energization also closes its alternate contact 275, establishing a circuit for the combined supervisory and ringing lamp RL, traced from battery through the lamp RL, alternate contact 275, conductor 273, normal contact 276 of the ringing trip relay TR, conductor 272, normal contact 277 of relay SR, conductors 278 and 279 to ground at alternate contact 150 of relay 140. The lamp RL is lighted over this circuit and notifies the operator of the position F associated with the cord circuit C that the calling subscriber has replaced his receiver and that conversation has terminated between the calling subscriber at the substation A and the called subscriber at the station D. The relay SL' upon de-energization brings about the energization of the relay 547, which in turn allows relay SL to restore, but as relay 140 is connected in multiple with the sleeve strand of the cord C, it remains energized, and due to its high resistance permits the cut-off relay of the called line circuit to de-energize, placing the line circuit of the called line at normal to permit the called subscriber to initiate a call, even though the plug CP remains in the jack, or be called. Relay 140 remains energized to ground through the cut-off relay of the line circuit L' of the called line and its grounded alternate contact 150 maintains the locking circuit of the busy guard relay GU through its upper winding 252 and the contact 262 of relay GU is thus held in its alternate position connecting ground over conductors 263 and 264 to the private contact 81 of the finder switch FS'. The condition will exist as long as the calling plug CP of the cord C remains in the jack J' of the called line and the ground that is extended to contact 81 busies the said contacts and prevents any other finder switch as FS' from seizing the cord C as long as its plug CP is in the jack J' of the called line. The operator noting the lighted signal RL removes the calling plug CP from the jack J', which opens the circuit of the relay 140, and the relay 140 restoring its alternate contact 150 restores and opens the locking circuit of relay GU and the circuit of relay 547.

Relay GU restoring, its alternate contact 262 is opened, removing the busy ground from the private contacts 81 of the finder switches FS' and the apparatus that was used in establishing a connection from the calling subscriber at the substation A to the called subscriber at substation D is now at normal and available for establishing other connections.

In the foregoing description I have assumed that all the apparatus was in its normal unactuated position, but for a clearer understanding of the trunk operator's busy control and storing circuit of Fig. 3 and the operator's sequence selecting circuit of Figs. 4, 5 and 6, I will now describe more in detail the operation of the circuits when calls are being stored before the different operators' positions, and the method of selecting the calls in sequence by means of the operators' sequence selecting circuits, illustrated in Figs. 4, 5 and 6.

Assuming now that the operators at positions F, H and J are idle and that the first call coming in has selected the cord C associated with the operator's position F, as in the previous description, relays T, SS and BCR are energized, and the closure of the alternate contact 115 of relay BCR of the selected cord C connects the 3000-ohm resistance 172 from ground to battery through the relay CA of the operator's position F over a path previously described. The relays BC and PB are also operated as previously described and the relay PB closes its alternate contact 188 to cause the operation of the group busying relays BU, which relays BU operate to place a ground or busy potential upon the balance of the cords in this operator's position F, as previously described in detail. The lamp CAL is also lighted and glows steadily, indicating to the operator that a call is stored at her position.

Assuming that the operator at position F does not answer this call, the second call extended to the exchange will select a cord circuit as C in the operator's position H. Relays T, SS and BCR of the cord C seized in the operator's position H will operate in a like manner, and the closing of alternate contact 115 of the relay BCR will connect ground through the 3000-ohm resistance through the winding of relay CA' of the operator's position H to battery at normal contact 184' of the relay BC' associated with the operator's position H. Relay CA' operates to close an energizing circuit for the relay BC', due to the closure of alternate contact 185' of the relay CA. The relay BC' energizing in turn establishes an energizing circuit for the relay PB' from ground through alternate contact 186' of the relay BC', and through the winding 187' of the relay PB' to ground. Relay PB' energizing, its alternate contact 188' is closed to establish an energizing circuit for the group busying relays BU associated with the operator's position H, which relays BU operating close their alternate contacts, placing a ground or busy potential upon the rest of the cords in this position H. The lamp CAL of this cord C associated with the position H now glows steadily, indicating to the operator that a call is stored at her position.

Assuming that the operators at positions F and H do not answer either call and that a third call is extended to the position J, the only position having cords as C not busy, the relay CA^2 associated with the position J will operate from ground through the 3000-ohm resistance of the selected cord circuit C of the operator's position J, through the winding of the relay CA^2 to battery at normal contact 184^2 of relay BC^2 of the position J. The closing of alternate contact 185^2 of relay CA^2 closes a circuit through relay BC^2, which will be energized to in turn close a circuit for the relay PB^2 from battery through its upper winding 187^2 to ground at alternate contact 186^2 of relay BC^2, and the closure of alternate contact 360^2 of relay BC^2 closes a circuit through the lower winding 361^2 of relay PB^2 from battery through the winding 361^2, alternate contact 360^2, conductor 362, alternate contact 363' of the relay BC' of the position H, alternate contact 363 of the relay BC of the position F to ground. The closing of alternate contact 363^2 of the relay BC^2 at the position J now closes a circuit through the lower winding 361' of the relay PB' of the position H, the circuit being traced from battery through the lower winding 361', alternate contact 360' of the relay BC', conductor 365, the alternate contact 366 of the relay BC of the position F, conductor 367, alternate contact 363^2 of relay BC^2 of position J to ground.

The closing of alternate contact 366^2 of the relay BC^2 of position J closes a circuit through the lower winding 361 of the relay PB of the position F traced from battery through the winding 361, alternate contact 360 of the relay BC of the position F, conductor 368, alternate contact 366' of the relay BC' of the position H, conductor 369, alternate contact 366^2 of the relay BC^2 of the position J to ground. The circuits through the lower windings 361, 361', 361^2 of the relays PB, PB' and PB^2 at the positions F, H and J bring about the de-energization of the said relays at the respective positions F, H and J, due to their differential construction, and the opening of their alternate contacts 188, 188' and 188^2 removes the ground from conductors 340, 340' and 340^2 to open the circuits of each of the groups of busy relays BU associated with the positions F, H and J, thus removing the busying ground from all the cords not in

use. The lamp CAL of the cord C seized in the position J is now lighted and burns steadily and indicates to the operator of the position J that a call is stored at her position. Assuming that the operators at positions F, H and J have not answered any one of the three calls and a fourth call comes in, and assuming that position F is selected, the relay BCR of the seized cord circuit C associated with the position F that is extending the call to the operator's position F closes its alternate contact 115, placing an additional 3000-ohm resistance 172 in multiple of the common conductor 173, and the two 3000-ohm resistances 172 placed in multiple of the conductor 173 reduces the resistance to 1500 ohms, and as the relay CA^3 will operate through 1500 ohms the relay CA^3 of the position F operates over a circuit traced from battery at normal contact 184 of the relay BC^6, conductors 183, 182 and 181, normal contact 180 of the relay BC^3, conductors 179 and 178 through the winding of the relay CA^3, conductor 174, through the winding of the relay CA and over conductor 173 to ground at the alternate contacts 115 of the two relays BCR of the cord circuits C that are selected, now that another call has been extended to the operator's position F. The lamp CAL of the second cord C seized in the position F now glows steadily and we now have two lamps CAL glowing at the position F, indicating that there are two calls stored at this position. The relay CA^3 upon energization closes its alternate contact 185^3 to bring about the energization of relay BC^3, and the relay BC^3 in turn closes a circuit for the relay PB^3, and relay PB^3 upon energization closes its alternate contact 188^3 to again establish an energizing circuit for the busy group relays BU associated with the position F, which relays upon energization again close their alternate contacts to busy the remaining cords at the operator's position F.

The fifth incoming call will be extended to position H and cause the energization of the relay CA^4 associated with the position H, the said relay CA^4 energizing in a similar manner to that described in connection with relay CA^3 of position F, whereby two resistances 172 placed in multiple with the conductor 173 permit the relay CA^4 to energize for the same reason as described in connection with relay CA^3 of position F. The relay CA^4 upon energization closes its alternate contact 185^4 and brings about the energization of the relay BC^4, which in turn closes a circuit for relay PB^4, and the relay PB^4 upon energization closes its alternate contact 188^4 to operate the busy group relays BU associated with the position H to cause the remaining trunks at the position H to be busied against selection.

The sixth incoming call extended will be extended to the position J to cause the relay CA^5 to be energized in a manner obvious from the preceding, and relay CA^5 in turn brings about the energization of the relay BC^5 through its alternate contact 185^5. Relay BC^5 upon energization closes its alternate contact to close a circuit through the upper winding of the relay PB^5, but the relay PB^5, due to the differential construction, restores to normal, as a circuit is also closed through its lower winding which brings about the de-energization of this relay PB^5. The differential relays PB^3 and PB^4 of the positions F and H also restore to normal due to circuits being closed through their lower windings over circuits corresponding to those described in connection with the first three calls that were stored at the operators' positions F, H and J. The relays PB^3, PB^4 and PB^5 open their alternate contacts to permit the de-energization of the busy group relays BU associated with the three positions F, H and J, and each group of relays BU associated with said position will cause the remaining cords in the positions F, H and J to again test idle.

Assuming that none of the six calls thus far extended to the positions F, H and J have been answered, a seventh call coming in will again be extended to the position F, and as relays BC and BC^3 of the position F are energized, the normal contacts 176 and 180 of the relays BC and BC^3 are opened and such seventh call will be extended to a cord circuit C at the position F and bring about the energization of the relay BCR at that cord, and the closing of its alternate contact 170 will place another 3000-ohm resistance 172 in multiple with the other two resistances 172 of the two other trunk cords C that have been connected. The resistance between wire 173 and ground being 1000 ohms, relay CA^6 energizes, in turn bringing about the energization of the relays BC^6 and PB^6. The relay PB^6 energizing, its alternate contact 188^6 is closed to energize the group busying relays BU, which relays BU in turn busy the remaining cords at the operator's position F.

An eighth call coming in will operate the relay CA^7 in a like manner as described in connection with relay CA^6, and the relay CA^7 upon energization brings about the energization of the relay PC^7 and PB^7, and the closing of the alternate contact of the relay PB^7 operates the busy relays BU associated with the position H, busying all the remaining cords of this operator's position.

A ninth call coming in will be extended to the operator's position J and cause the energization of the relay CA^8 of position J in the same manner as described in connec-

tion with relay CA^6, and the relay CA^8 in turn closes the circuits for the relay BC^8 and the relay PB^8. The relay PB^8 will not energize, due to a circuit now being closed through its upper and lower windings, which circuit is closed upon the energization of relay BC^8, and due to the differential construction of the relay PB^8, the relay remains at normal. Circuits are also established through the lower windings of the relays PB^6 and PB^7 of the positions F and H upon the energization of relay BC^8 of positions J, and due to their differential construction they restore, and due to the opening of the alternate contacts of the relays PB^6, PB^7 and PB^8 at the positions F, H and J, the circuits of each group of group busying relays BU will be opened and permit the de-energization of their associated group busying relays BU to remove the busy from the remaining cords at the positions F, H and J.

A tenth call coming in will be extended to the operator's position F, and a cord circuit C having been seized in the operator's position F, a fourth 3000-ohm resistance 172 is connected in multiple with the other three resistances 172 of the other cords at the operator's position F, to further reduce the resistance connected to the common conductor 173, thus causing the relay CA^9 to energize and the relay CA^9 energizing brings about the energization of the relays BC^9 and PB^9, and the relay PB^9 upon energization closes its alternate contact to energize the group busying relays BU associated with the position F to busy the remaining cords at the operator's position F.

An eleventh call coming in will be extended to the operator's position H, and the relay CA^{10} is energized in the same manner as relay CA^9, and the relay CA^{10} in turn will bring about the energization of the relays BC^{10} and PB^{10}, and the relay PB^{10} in turn will bring about the energization of the group busying relays BU associated with the position H to busy the remaining cords in this position.

A twelfth call coming in will be extended to the operator's position J and cause the energization of the relay CA^{11} in the same manner as described in connection with relays CA^9 and CA^{10}, and the relay CA^{11} upon energization will bring about the energization of the relay BC^{11}. No energizing circuit is effected for the relay PB^{11} of the position J, as a circuit is also closed through its lower winding, and due to its differential construction relay PB^{11} de-energizes. Relays PB^9 and PB^{10} at the positions F and H are also de-energized, due to the circuits being established through the lower windings upon the energization of relay BC^{11} of position J, and due to their differential construction they restore to normal, and the opening of their alternate contacts will permit the de-energization of the group of group busying relays BU of the respective positions F, H and J, removing the busy from the remaining cords at the operators' positions.

For a simple understanding and description of the circuit operation, I have in the foregoing assumed that the calls came in to the various positions in regular sequence, that is, 1, 2, 3 order, top level, then 1, 2, 3, order, second level, and so on down to the bottom level. It is, however, obvious that in actual practice such regular sequence would rarely, if ever, occur. Now that the regular order operation is disclosed, it is apparent that the organization of the system as a whole assures merely the desired method of operation, which is that each operator of the group F, H, J, has one stored call (it making absolutely no difference in the circuit organization which of F or H or J got the first call or the last call) before a second call can be stored before any operator of the group. Furthermore, it is indifferent to the circuit organization whether the second call stored at one position happens to strike F, H or J. The organization of circuits, however, does guarantee to each operator that she will not have a third call stored against her until the operators each have two awaiting attention. In other words, the calls will in actual practice be stacked up at hazard, as one might say, except that no operator can ever have more than one call more than any other operator.

In the description thus far I have assumed that twelve calls have come in and none of them were answered, so that each of the positions F, H and J have four calls stored in each position.

Four cords C have been seized in each operator's position F, H and J, as just described, and from the previous description it is remembered that relays T, SS and BCR are energized as soon as switch FS' seizes the cords C in the positions F, H and J. The energization of each of the relays SS of the cord circuits C will bring about the lighting of the four lamps CAL at each operator's position F, H and J and shows that four calls are stored at each of the operators' positions. When the first call was stored in the operator's position F, the relay BCR was energized, and the closure of its alternate contact 191 of the relay BCR closes an energizing circuit for the motor magnet MM^2 of the sequence call-selecting switch SCS, of which there are four for each operator's position, and the motor magnet MM^2 steps the wipers 118, 119, 120 and 121 into engagement with the set of contacts 122, 123, 124 and 125 which lead to the seized cord C. The second call stored at the position F causes the relay BCR of the

second seized cord C to close its alternate contact 191 to establish an energizing circuit for the motor magnet MM³ of the switch SCS′ associated with the operator's position F, the circuit being traced from battery through the resistance 193′ through the winding of the magnet MM³ its normal contact 194′, normal contact 195′ of the off-normal contacts ON³, conductor 196′, normal contact 197′ of the relay 198′, over conductor 380, through alternate contact 197 of relay 198 of switch SCS, common starting conductor SA, normal contact 199 of relay TLR, conductor 200 to ground at alternate contact 191 of the relay BCR of the cord C that was seized in extending the second call to the operator's position F.

The motor magnet MM³ of the switch SCS′ is energized over this circuit and steps the wipers 118′, 119′, 120′ and 121′ into engagement with the first set of contacts 122′, 123′, 124′ and 125′. Upon the first step of the switch wipers off normal, normal contact 195′ of the off-normal contacts ON³ is moved to its alternate position and a substitute energizing circuit is established for the motor magnet MM³, traced from battery through the motor magnet MM³, its normal contact 194′, alternate contact 195′ of the off-normal contacts ON³, conductor 201′, normal contact 202′, conductor 203′, to ground at normal contact 204′ of the relay BG³. The motor magnet MM³ steps the wipers 118′, 119′, 120′ and 121′ from one contact set 122′, 123′, 124′ and 125′ to the next, and when the wiper 118′ engages the grounded contact 122′ which is grounded through alternate contact 192 of the relay BCR of the cord C, an energizing circuit is established for the relay BG³ from the said ground at alternate contact 192 of the relay BCR of the cord C that was seized in extending the second connection to the operator at position F, through contact 122′, wiper 118′, normal contact 209′ of the relay 198′, normal contact 207′ of the relay BG³ through the winding 206′ of the relay BG³, conductor 205′ through the resistance 193′ to battery. The circuit through the relay BG³ shunts out the motor magnet MM³ of the switch SCS′ and prevents further stepping of the wipers of the switch.

The closing of alternate contacts 222′ and 223′ of relay BG³ brings about the energization of the line relay LR⁴, and the line relay LR⁴ in turn closes an energizing circuit for the relay SG′. The closing of alternate contacts 204′ of relay BG³ closes a circuit for the relay 198′ from battery through its winding 198′, conductor 219′, to ground at alternate contact 204′ of the relay BG³; the relay 198′ then closes a locking circuit for itself through its alternate contact 220′ to ground at alternate contact 221′ of off-normal contacts ON³. The closure of alternate contact 214′ of relay BG³ closes a locking circuit for itself from battery through its upper winding 206′, its alternate contact 214′, through its lower winding 215′, wiper 119′, contact 123′, through the winding of the relay TCR of the cord C that is seized in extending the second connection to ground at alternate contact 218 of the relay BCR of the second cord seized to extend the connection.

The third call having been extended to the operator's position F causes the relays T, SS, BCR of the said cord C to energize, and the closing of alternate contact 191 of relay BCR of this third cord C establishes a circuit for the motor magnet MM⁴ from the ground that was placed on the starting conductor SA, due to the closing of alternate contact 191 of the relay BCR of the third cord, through alternate contact 197 of the switch SCS, over conductor 380, through alternate contact 197′ of the relay 198′ of the switch SCS′ over conductor 381, through normal contact 197² of the relay 198² of the switch SCS², conductor 196², normal contact 195² of the off-normal contacts ON⁴, normal contact 194² of the motor magnet MM⁴, through the winding of the motor magnet MM⁴, through the resistance 193² to battery. The motor magnet MM⁴ steps the wipers 118², 119², 120² and 121² into engagement with the first set of contacts 122², 123², 124² and 125², and the operation of the switch SCS² is the same as described in connection with the switch SCS′. When the wiper 118² engages the grounded wiper 122² due to the closing of alternate contact 192 of the relay BCR of the third cord seized in extending a connection to this operator's position F, it closes an energizing circuit for the relay BG⁴, and the relay BG⁴ upon energization shunts out the motor magnet MM⁴ and prevents further stepping of the wipers of the switch SCS². Relay 198², relay LR⁵ and relay SG² are also energized.

The fourth call that is extended to the position F selects the fourth cord circuit C associated with the operator's position F, and brings about the energization of the relays T, SS, BCR of the seized cord C, and the closure of alternate contact 191 of the relay BCR of this fourth trunk circuit C that is extending a connection to the operator's position F places a ground upon the common starting conductor SA and brings about the energization of the motor magnet MM⁵ of the switch SCS³, circuit being traced from ground on the starting conductor SA, through alternate contact 197 of the relay 198 of the switch SCS, conductor 380, through alternate contact 197′ of the relay 198′ of the switch SCS′, conductor 381, through alternate contact 197² of the relay 198² of the switch SCS², over conductor 382, through normal contact 197³ of relay 198³,

conductor 196³, normal contact 195³ of the off-normal contacts ON⁵, normal contact 194³ of the motor magnet MM⁵, through the winding of the said motor magnet MM⁵, through the resistance 193³ to battery. The motor magnet MM⁵ steps the wipers 118³, 119³, 120³ and 121³ into engagement with the first set of contacts 122³, 123³, 124³ and 125³. Upon the first step of the wipers off normal, their normal contacts ON⁵ assume their alternate position, and the closure of alternate contact 195³ closes a substitute energizing circuit for the motor magnet MM⁵ to ground at normal contact 204³ of the relay BG⁵. The motor magnet MM⁵ now steps the wipers from one contact set to the next, and when the wiper 118³ engages the grounded contact 122³, which contact is grounded upon the closure of alternate contact 192 of relay BCR of the fourth cord seized, it brings about the energization of the relay BG⁵, and the relay BG⁵ shunts out the motor magnet MM⁵ and prevents further stepping of the wipers of the switch SCS³. The relay BG⁵, line relay LR⁶, relay SG³ and relay 198³ are energized over circuits as previously described.

The first call answered by the operator of the position F has already been described in the previous description, which connection was described in tracing a call from the calling subscriber at the substation A to the called subscriber at the substation D. The relay TLR of the seized cord C of position F is energized in series with the relay BG² of the switch SCS and the relay TLR in turn closes an energizing circuit for the relay 108 which relay closes its alternate contact 107 to close the flashing circuit for the lamp CAL, all of which has been previously described. The flashing signal CAL notifies the operator of position F that a call is awaiting her attention and that her operator's set O is connected to the seized cord conductors. As the calls that were stored before the operators' positions F, H and J are seized and the operator's set O connected thereto, the signal CAL will flash indicating to the operator that she is connected to the cord and that a call is awaiting her attention. As soon as the operator's set is connected to the cord C that has extended the first call to the operator's position F, and after receiving the number of the party wanted, the operator has inserted the plug CP into the multiple jack J′ of the called line, the relay BCR is de-energized due to the opening of normal contact 112 of the sleeve relay SL′, and the opening of alternate contact 218 of the relay BCR opens the energizing circuit of the relay BG² of the switch SCS, and relay TLR of the connected cord C and the relay TLR de-energizing opens the circuit of relay 108 and stops the flashing of the signal CAL. The closing of normal contact 204 of relay BG² closes an energizing circuit for the release magnet RM², also for relay 270. The release magnet RM² withdraws its retaining pawl and allows the switch wipers 118, 119, 120 and 121 to restore to normal. The relay BCR of the cord C when de-energized allows its alternate contact 170 to open and disconnect the resistance 172. The disconnection of this resistance again increases the resistance connected to the common conductor 173 from 750 to 1000 ohms, as there are still three resistances connected in multiple with the conductor 173. This increased resistance permits the relay CA⁹ of the position F to restore as it operates through 750 ohms resistance but releases through a 1000-ohm resistance. The closing of alternate contact 385 of the relay 270 places a releasing battery shunt on the common conductor 386 from battery through the alternate contact 385 of the relay 270, over conductor 386, about the windings of relays CA³, CA⁶ and CA⁹ to battery. This shunt does not affect the relay CA, but does restore to normal relay CA⁹, but relays CA³ and CA⁶ are so adjusted that they hold up when the 20-ohm battery shunt is applied. The said shunt exists only momentarily or until the switch SCS restores, at which time relay 270 de-energizes, its circuit being opened at contacts ON², and the shunt is removed. By the de-energization of BCR one of the resistances 172 has been removed from circuit, so that when the shunting effect terminates relay CA⁹ does not re-energize because the resistance on wire 173 is now 1000 ohms. The relay CA⁹ restoring to normal, the opening of its alternate contact 185⁹ permits the de-energization of the relay BC⁹, and the relay BC⁹ upon restoration opens its alternate contacts 363⁹, 366⁹ to open the circuit through the lower windings of the relays PB¹⁰ and PB¹¹ of the positions H and J, and the relays PB¹⁰ and PB¹¹ are again energized through their upper windings, and the closing of alternate contacts 188¹⁰ and 188¹¹ of the relays PB¹⁰ and PB¹¹ again closes circuits of relays BU associated with positions H and J.

The relay BG² at SCS de-energizes, and the opening of alternate contacts 222 and 223 permits the de-energization of the line relay LR³, and the line relay LR³ de-energizing its alternate contact 230 is opened to permit the de-energization of the relay SG, and the opening of alternate contact 231 of the relay SG opens the energizing circuit of the relay BG⁶ of the switch OS and the said relay restores. The first call having been answered, the second call stored at the position F will now be answered by the operator at the position F. The relay SG′ of the switch SCS′ being energized, as before described, ground from alternate contact

232′ of said relay SG′ extends over conductor 389, through normal contact 390 of relay 236 of switch OS, normal contact 391 of the relay BG⁶ of switch OS, conductor 392, normal contact 393 of the motor magnet MM⁶ of switch OS, through the winding of the said motor magnet MM⁶, through the resistance 240 to battery. The motor magnet MM⁶ now steps the wipers 126, 127, 128 and 129 into engagement with the second set of contacts 130, 131, 132 and 133, and when the wiper 127 engages the contact 131 of the second set, an energizing circuit is again established for the relay BG⁶, traced from battery through the resistance 240, conductor 239 through the winding 238 of the relay BG⁶, normal contact 237 of the said relay BG⁶, normal contact 235 of relay 236, conductor 234, conductor 394 to ground at alternate contact 231′ of the relay SG′. The circuit through the relay BG⁶ just described shunts out the motor magnet MM⁶, and the wipers 126, 127, 128 and 129 now remain in engagement with the second set of contacts 130, 131, 132 and 133, and the closure of alternate contacts 242 and 243 of the relay BG⁶ now connects the operator's set O′ to the cord C that was seized in extending the second call to the operator's position F. The lamp CAL of this second cord C at the operator's position F is caused to flash as described in connection with the first call that was extended to her position and notifies her that a call is awaiting her attention. When the operator of position F inserts the plug of this second cord into the jack of the called line, relay BCR of this cord is de-energized, opening the energizing circuit of the relay BG³ of the switch SCS′, and the relay BG³ restoring its normal contact 204′ is again closed, closing an energizing circuit for the release magnet RM³, the release magnet RM³ withdrawing its pawl to permit the wipers 118′, 119′, 120′ and 121′ to assume their normal position. The relay BCR of the second cord de-energizing interrupts the flashing of lamp CAL as previously described, and its alternate contact 115 is opened, disconnecting the resistance 172 from the common conductor 173, and as there are still two cords connected to the position F, two resistances 172 are still connected in multiple with the conductor 173, thus increasing the resistance from 1000 to 1500 ohms. The relay 270′ is also energized and the closing of its alternate contact 385′ places battery upon the common shunting conductor 386, and the effect of the release shunt placed across the relays CA³, CA⁶ causes the relay CA⁶ to de-energize, and the opening of the contact 185⁶ permits the relay BC⁶ to de-energize, and the opening of its alternate contacts 363⁶ and 366⁶ permits the relays PB⁷ and PB⁸ of the positions H and J to again energize, as the circuit through their lower windings is opened at the said contacts, to again busy the remaining trunk at the positions H and J.

In regard to the relay 270′, it energizes and de-energizes again immediately (as soon as switch SCS′ in restoring opens its ON contacts), and the shunting battery placed on 386 is connected momentarily only. During the shunting, relay CA⁵ remains operated due to its adjustment. However, relay CA⁶ will not, for reasons previously explained, pull up under these circumstances. It will now be observed that although position F tests idle to incoming calls, there is a double "busy" protection to position H, because relays PB⁷ and PB¹⁰ are both energized. Similarly, relays PB⁸ and PB¹¹ being both energized, afford a double "busy" to position J.

The operator at the position F now answers a third call. The switch SCS² having selected the third cord C that has been seized in the operator's position F, and the relay SG² of the switch SCS² being energized, its alternate contact 232² is closed, establishing an energizing circuit for the motor magnet MM⁶ of the switch OS, from ground at alternate contact 232² over conductor 389, normal contact 390 of the relay 236, normal contact 391 of the relay BG⁶, conductor 392, normal contact 393 of the magnet MM⁶, through the resistance 240 to battery. The magnet MM⁶ now steps the wipers 126, 127, 128 and 129 of the switch OS to the third set of contacts 130, 131, 132 and 133 of the switch OS, and when the wiper 127 engages the contact 131 of the third set, an energizing circuit is established for the relay BG⁶ of the switch OS, traced from ground at alternate contact 231², over conductor 395, contact 131, wiper 127, conductor 234, normal contact 235 of relay 236, normal contact 237 of relay BG⁶, winding 238 of the said relay, conductor 239, resistance 240 to battery. The circuit through the relay BG⁶ shunts out the motor magnet MM⁶ and prevents further stepping of the wipers 126, 127, 128 and 129. The closing of alternate contacts 242 and 243 of relay BG⁶ connects the operator's set O′ to the cord conductors of the trunk cord C that has been seized when the third call has been extended to the operator's position F. When the operator of position F inserts the plug of the third plug into the multiple jack of the called line, the relay BCR of this trunk cord restores and opens the energizing circuit of the relay BG⁴ of the switch SCS², and the relay BG⁴ closes its normal contact 204², closing an energizing circuit for the release magnet RM⁴, and the release magnet RM⁴ energizing withdraws the retaining pawl and allows the wipers 118², 119², 120² and 121² to restore to normal. The relay BCR of the third cord trunk de-energizes

to open its alternate contact 170 to disconnect the resistance 172 from the common conductor 173, and as there is now only one cord C connected to the position F that is waiting to be extended to a called line, the resistance is increased to 3000 ohms. The relay 270^2 is also energized, and the closing of its alternate contact 385^2 connects battery to the releasing shunt conductor 386 and de-energizes the relay CA^3. The relay CA^3 de-energizing, its alternate contact 185^3 is opened to bring about the restoration of the relay BC^3, and the opening of alternate contacts 363^3 and 366^3 of the relay BC^3 again permits the energization of the relays PB^4 and PB^5 as the circuits through their lower windings are opened at these contacts. Relays PB^4 and PB^5 again energizing cause the trunks of their respective positions H and J to be again busied against selection. The relay BG^4 of switch SCS^2 de-energizing its alternate contacts 222^2 and 223^2 are opened, permitting the de-energization of the line relay LR^5, the line relay LR^5 in turn de-energizing the relay SG^2. The relay SG^2 upon de-energization opens the energizing circuit of the relay BG^6 of the switch OS, and the said relay restores to normal and disconnects the operator's set O' from the third cord C. From what has gone before, it will be understood that relay 270^2 only momentarily places the release shunt; also that positions H and J are now three times "busy."

The third call having been answered, the operator is now connected to the fourth cord that was seized in extending the fourth call to the operator's position F. The closing of alternate contact 232^3 of the relay SG^3 establishes an energizing circuit for the motor magnet MM^6 of the switch OS from ground at alternate contact 232^3 of the relay SG^3 of the switch SCS^3, over conductor 389 to battery through the winding of the motor magnet MM^6 of the switch OS over the previously described path. The motor magnet MM^6 steps the wipers 126, 127, 128 and 129 into engagement with the fourth set of contacts 130, 131, 132 and 133, and the wiper 127 engages the fourth contact 131 of the set, and ground from alternate contact 231^3 of relay SG^3 establishes a circuit for the relay BG^6 of the switch OS from ground at alternate contact 231^3 of the relay SG^3, conductor 396, contact 131, wiper 137, to battery, through the winding 238 of the relay BG^6, over a previously described path. This circuit through the relay BG^6 shunts out the motor magnet MM^6 and prevents further stepping of the wipers 126, 127, 128 and 129. The relay BG^6 upon energization closes its alternate contacts 242 and 243 to connect the operator's set O' to the fourth cord seized, and when the operator connects the plug of this cord into the multiple jack of the called line, the sleeve relay of this cord energizes to open the energizing circuit of the relay BCR of the cord. This opens the energizing circuit of the relay BG^5, and the relay BG^5 de-energizing, its normal contact 204^3 is closed, establishing a circuit for the release magnet RM^5, and the release magnet RM^5 energizing withdraws the retaining pawl to permit the wipers 118^3, 119^3, 120^3 and 121^3 to restore. The relay BCR of the fourth cord trunk de-energizes to open its alternate contact 115 to disconnect the resistance 172 from the common conductor 173, and this permits the relay CA of the position F to de-energize, as its circuit is opened at the alternate contact 172 of the de-energized relay BCR. The relay CA upon de-energization opens its alternate contact 185 to cause the de-energization of relay BC, and the relay BC upon de-energization opens its alternate contacts 363 and 366 and permits the relays PB' and PB^2 at the positions H and J to be energized to hold busy these two positions H and J so that now positions H and J are "busy" four times as compared to position F.

Now, should another call be extended the call will be extended to the position F and cause the operation of the relay CA, as the calls stored at positions H and J have as yet not been answered, and upon the energization of relay CA relay BC will energize, but relay PB will not, due to its differential construction, and due to the energization of relay BC, relays PB' and PB^2 will also de-energize, but positions H and J will still test busy, as the other position busying relays PB at H and J will still be energized and keep these two positions busy. The position F will, of course, be idle, due to the failure of relay PB to operate, and the next call extended will appear in position F, and this will also be true of the third and fourth calls.

The order in which stored calls were above assumed to be answered, namely, all of position F's calls answered before the operators at H and J answered any of theirs, is, of course, not an order that would be at all likely to occur in actual service conditions, and I adopted it for the purpose of giving a straight ahead explanation of the circuit and switch operation.

The connections of the "busying" apparatus of positions H and J to their trunk circuits and to their respective switches SCS, SCS', etc., and to OS being like those of position F, it will be readily seen that if the operator at position H had been the first to answer one of the twelve calls stored at the three positions F, H and J, then her position (H) would have been the idle one, while the de-energization of the relay BC^{10} would unbalance differential relays PB^9 and PB^{11}, and positions F and J would become "busy."

Assume now that the operator at J next answered a call, her relay CA^{11} would de-energize and her position would be "idle" as well as position H, position F continuing busy. Now observe that the circuit of the lower or neutralizing winding of relay PB^9 at F is open both at relay BC^{10} (H) and at relay BC^{11} (J). Thus, position F is twice "idle," as it might for conciseness be expressed. Now, assume that the next operator J answers the second stored call at her position. Then her relays CA^8 and BC^8 will de-energize with obvious results as to relay PB^8. The lower or neutralizing winding of relay PB^7 at H will be open at contact of relay BC^8 at J. Hence, PB^7 energizes to "busy" position H. In this status, it will be noted that position F is twice "busy" towards position J, and once "busy" towards position H, while H is once "busy" towards position J. Further detail is considered superfluous, it being now apparent that the organization governs itself on the principle of relativity and seeks automatically and continuously, as calls come in and are disposed of, to keep an even number before each operator of the group.

The switch OS which connects the operator's set O′ to the cord conductors is a five-point switch, and from the previous description, it is remembered that the wipers 126, 127, 128 and 129 were left in engagement with the fourth set of contacts. Now, when another call is extended to the position F, ground over conductor 389 will close an energizing circuit for the motor magnet MM^6 over a circuit as previously described, to step the wipers 126, 127, 128 and 129 into engagement with the fifth set of contacts 130, 131, 132 and 133, and when the wipers 126 and 127 engage the contacts 130 and 131, which are permanently grounded, a circuit is established for the relay BG^5, traced from battery, through the resistance 240, conductor 239, winding 238 of relay BG^5, normal contacts 237 and 235 of relays BG^5 and 236 to ground at contact 131 engaged by wiper 127. The ground at contact 130 which is now engaged by wiper 126 closes an energizing circuit for relay 236 from battery through the winding of relay 236 to ground at contact 130 engaged by wiper 126. Relay 236 upon energization closes its alternate contact 400 to close a locking circuit for itself, traced from battery through relay 236, its alternate contact 400 to ground at alternate contact 401 of off-normal contact ON^6, which assumed their alternate position upon the first step of the wipers of the switch OS off normal. The opening of normal contact 235 of relay 236 opens the energizing circuit of relay BG^5, and relay BG^5 upon restoration closes its normal contact 402, establishing an energizing circuit for the release magnet RM^6, traced from battery through the winding of magnet RM^6, alternate contact 403 of relay 236, to ground at normal contact 402 of relay BG^5. The release magnet RM^6 upon energization withdraws the retaining pawl and allows the wipers 126, 127, 128 and 129 to restore to their normal position to again engage the first set of contacts 130, 131, 132 and 133.

The wipers upon restoration bring about the restoration of the off-normal contacts ON^6, and the opening of alternate contact 401 of contacts ON^6 opens the energizing circuits of the relay 236 and release magnet RM^6 so as to again start selecting to connect the operator's set O′ to the cord C to which a call has been extended.

While I have described a preferred embodiment of my invention, it may obviously be adjusted and employed in various ways, and I do not intend in the appended claims to limit myself to the precise structures shown and described.

Having described my invention, what I claim as new and desire to secure by United States Letters Patent, is:

1. In a telephone system comprising calling telephone lines, operators' positions and a group of cord circuits for each position, non-numerical rotary switches associated with said lines for selecting them as calling lines, other non-numerical switches having rotary motion only for extending said lines only to cord circuits at idle operators' positions, call storing means and position busying means for each of said operators' positions, said storing means operable upon the selection of any one of said cords in an operator's position to cause the operation of said busying means to render all the cord circuits in that particular operator's position busy against selection until such time as the call has been extended to a called line, and automatic means for signaling the called subscriber.

2. In a telephone system comprising calling telephone lines, operators' positions and a group of cord circuits for each of said positions, non-numerical switches for selecting said lines as calling lines, other non-numerical switches for extending said lines only to cord circuits at idle operators' positions, said first and said second non-numerical switches being operatively tied together in pairs and adapted to operate as such, call storing means and position busying means for each of said operators' positions, said storing means operable upon the selection of any one of said cords in an operator's position to cause the operation of said position busying means to render all the cord circuits in that particular operator's position temporarily busy against selection as long as the number of cords se-

lected in that position are greater in number than those stored at any other of said operators' positions.

3. In a telephone system comprising telephone lines, operators' positions and cord circuits for each of said operators' positions, non-numerical switches for automatically selecting said lines as calling lines, other non-numerical switches for automatically extending said calling lines only to cord circuits at idle operators' positions, said first and said second non-numerical switches being operatively tied together in pairs and adapted to operate as such, an operator's telephone set for each operator's position, automatic means for connecting the operator's set to the selected cord in said idle operator's position, a calling supervisory signal individual to each cord circuit, and means for flashing said signal to indicate to the operator the circuit to which her set has been connected.

4. In a telephone system comprising telephone lines, operators' positions and groups of cord circuits for each of said operators' positions, non-numerical switches associated with said lines for selecting any of said lines as calling lines, other non-numerical switches for extending said calling lines only to cord circuits at idle operators' positions, call storing means and position busying means for each of said operators' positions, said storing means operable upon the selection of any one of said cords in an operator's position by said second non-numerical switches to cause the operation of said busying means to render the selected position busy against selection, an operator's telephone set for each operator's position, automatic means for connecting the operator's telephone set to the selected cord in said idle operator's position and indicating means individual to each cord circuit operating in one manner to apprise the operator of calls stored at the position, and to also operate in another manner to indicate the cord circuit to which her set has been connected.

5. In a telephone system comprising telephone lines, operators' positions each of which is provided with a group of cord circuits, non-numerical switches for automatically selecting said lines as calling lines, other non-numerical switches for automatically extending said selected calling lines only to cord circuits at an idle operator's position, call storing and position busying means for each of said operators' positions, said storing means operating when a cord in an idle operator's position is selected by one of said second non-numerical switches, means operative in said storing means to cause said busying means to operate to render said position against selection, an operator's set for each set, an operator's switch associated with said operator's position, a group of sequence switches associated with said operator's switch, both operable to connect said operator's set to the selected cord circuits, and means in said cord circuit operated when the cord is connected to a called line to be placed in selectable condition.

6. In a telephone system comprising telephone lines, operators' positions and a plurality of cord circuits associated with each operator's position, means for seizing said lines as calling lines, and means for extending said seized lines only to cord circuits at idle operators' positions, call storing means for each operator's position comprising a plurality of units for storing calls in the same order in which the calls are extended to said operators' circuits, a group of sequence switches cooperating with said storing means and being the same in number as the number of units of said storing means, such a group of switches being associated with each operator's position, an operator's telephone set for each operator's position, an operator's selecting switch for each operator's position and common to the group of sequence switches thereat and operable by one of said sequence switches for connecting the operator's set to the seized cord, and a call signal individual to each cord circuit and adapted to light when connection is made with a cord of an idle operator's position, and adapted to give the operator a distinctive indication that a call is stored at her position.

7. In a telephone system comprising telephone lines, operator's positions at the exchange switchboard including a plurality of cord circuits for each of said operators' positions, groups of switches associated with said line for selecting the said lines as calling lines, other groups of switches for extending said seized lines only to cord circuits at idle operators, storing and busy positioning means for each operator's position, a plurality of storing units for each operator's position for storing calls in the same order in which the calls are extended to said operators' circuits, a group of sequence switches operatively associated with said storing units, the number of sequence switches in a group being the same in number as the number of storing units of an operator's position, an operator's telephone set for each operator's telephone position, an operator's selecting switch for each operator's position and common to each group of sequence switches, and means operable in said sequence switches to cause said operator's switch to operate to connect the operator's set of said idle position to the seized cord, a calling lamp individual to each cord circuit adapted to glow steadily to indicate a stored call at the seized operator's position, and means actuated in the seized cord

when the operator's set is connected thereto to cause said lamp to flash to indicate the cord circuit to which her telephone set is connected.

8. In a telephone system including telephone lines, operators' positions at the exchange switchboard comprising a plurality of cord circuits for each operator's position, finder switches for automatically selecting said lines as calling lines, other finder switches for extending said calling lines only to cord circuits at idle operators' positions, storing means comprising a plurality of units associated with each operator's position, position busying means for each operator's position, a group of sequence switches associated with each operator's position, the number of switches in each group being the same in number as the units of said storing means, means individual in each cord circuit operable when one of said second finder switches selects a cord in an idle operator's position to cause the operation of one of said units in said storing means of the selected operator's position to operate said busying means to make this position busy against selection, an operator's telephone set for each operator's position, an operator's selecting switch for each position and common to said sequence switches and operable by one of said sequence switches to connect the operator's set of the position to the seized cord circuit, a call signal individual to the cord circuits of each position adapted to light to indicate a stored call at an operator's position, and to flash when said operator's set is connected to the seized cord circuit to indicate the cord circuit to which said set is connected.

9. In a telephone system including telephone lines, a plurality of operators' positions, means for extending calls to said operators' positions, cord circuits for extending said calls to called lines, call storing means at each operator's position to store calls in the order in which they are extended to said operators' positions, busying means for each operator's position and operable by its associated storing means to render the position busy, an operator's set for each operator's position, means for connecting the operator's set to the seized cord circuit of a selected position in the order in which the calls are stored in a position, signaling means individual to the cord circuits for indicating stored calls at said operator's position, means operable when the operator's set is connected to the seized cord circuits at which calls are stored in the order in which they were stored to cause said signaling means to flash to indicate the cord circuit to which the said set is connected, and means operable when said call is extended to said called line to efface said flashing signal.

10. A telephone system including telephone lines, operator's cord circuits for connecting to said lines as called lines, automatic non-numerical switches for selecting and connecting to said lines as calling lines, other non-numerical switches associated with said first switches for extending said lines as calling lines to idle cord circuits of said cord circuits, storing means for said cord circuits for storing the calls in the order initiated, an operator's set operatively associated with but normally disconnected from said cord circuits, and automatic switches for connecting said operator's set to the cord circuits in the order in which said cord circuits are selected.

11. A telephone system including calling and called telephone lines, a plurality of operator's positions having said lines multiplied therethrough, a group of cord circuits for each of said operators' positions for connecting to said called lines, automatic non-numerical switches for connecting to said calling lines and for connecting the same to idle cord circuits, automatic means for storing up the calls at said operators' positions so that one operator will not have more than one call more than any of the other operators stored at her position, and automatic switches at each operator's position for permitting the operator to handle the calls at her position in the order in which the same are stored.

12. A telephone system including telephone lines, operator's cord circuits and automatic non-numerical switches for interconnecting said lines as calling and called lines, storing means for storing the calls before the operator's position in the order initiated, and automatic means including automatic switches for permitting the operator to handle the calls only in the order initiated and stored.

13. A telephone system including telephone lines, operator's cord circuits for connecting to said lines as called lines, automatic non-numerical switches for selecting said lines as calling lines and connecting the same to idle ones of said cord circuits, storing means for automatically storing the calls in the order initiated, an operator's telephone set, and automatic switches for connecting and disconnecting said operator's set to said connected-to cord circuits in the order said calls are stored.

14. A telephone system including calling and called lines, a plurality of operators' positions, each of which is provided with a group of cord circuits for connecting to said called lines, automatic switches common to said calling lines and adapted to extend said calling lines to idle cord circuits at said operators' positions, means for preventing the extension of a calling line to the group of cord circuits at an operator's position that has one more calling line extended thereto

than any other of said operators' positions, automatic storing means for storing calls at each operator's position in chronological order, and automatic switches associated with said storing means for permitting the stored calls to be handled in the order stored.

15. A telephone system including telephone lines, a plurality of operators' positions, a group of cord circuits for each of said operators' positions, automatic non-numerical switches common to said lines and adapted to select said lines as calling lines and to automatically extend the same to idle cord circuits at said operators' positions, automatic means for directing the extension of calling lines to an operator's position or to operators' positions having the least or an equal number of calling lines extended thereto, and automatic means including automatic switches at each operator's position for enabling the operator thereat to extend the calling lines to called lines in the same chronological order in which said calling lines are extended to the operator's position.

16. A telephone system including telephone lines, a plurality of operators' positions, a group of cord circuits for each of said operators' positions, automatic switches common to said lines arranged in pairs and adapted to select said lines as calling lines and to connect the same to idle cord circuits at said operators' positions, busying means for each operator's position for rendering the cord circuits thereat busy against selection when the number of calling lines extended to any other operator's position is less, and means including automatic switches at each operator's position for extending the calling lines to called lines in the order in which said calling lines are extended to the operator's position.

17. A telephone system including telephone lines, an operator's position, a group of cord circuits for said operator's position, automatic switches common to said lines and arranged in pairs for selecting said lines as calling lines and for extending the same to idle cord circuits of said group of cord circuits, means for storing the extension of said calling lines at said operator's position in chronological order, an operator's telephone set for said position, and automatic means including non-numerical switches for connecting and disconnecting said operator's telephone set to and from said selected idle cord circuits in the same chronological order in which said cords are selected, whereby the operator is enabled to learn and extend the calling lines to the desired called lines in the order the calls are initiated.

18. A telephone system including telephone lines, an operator's position, a group of cord circuits for said operator's position, automatic switches common to said lines and arranged in pairs for selecting said lines as calling lines and for extending the same to idle cord circuits of said group of cord circuits, means for storing the extension of said calling lines at said operator's position in chronological order, an operator's telephone set for said position, automatic means including non-numerical switches for connecting and disconnecting said operator's telephone set to and from said selected idle cord circuits in the same chronological order in which said cords are selected, whereby the operator is enabled to learn and extend the calling lines to the desired called lines, in the order the calls are initiated, and supervisory means for each cord circuit for indicating to the operator the cord circuit selected and also the particular cord circuit to which her telephone set is connected.

19. A telephone system including telephone lines, an operator's position provided with cord circuits, automatic switches common to said lines and arranged in pairs for selecting said lines as calling lines and for extending the same to idle cord circuits, storing means at the operator's position for automatically storing the extension of said calling lines in the same order extended, an operator's telephone set, and automatic means including switches for connecting the said set to said selected idle cord circuits one at a time and in the same order in which the extensions are stored whereby the operator handles the call chronologically as initiated.

20. A telephone system including telephone lines, an operator's position provided with cord circuits, automatic switches common to said lines and arranged in pairs for selecting said lines as calling lines and for extending the same to idle cord circuits, storing means at the operator's position for automatically storing the extension of said calling lines in the same order extended, an operator's telephone set, automatic means including switches for connecting the said operator's telephone set to said selected idle cord circuits one at a time and in the same order in which the extensions are stored, whereby the operator handles the call chronologically as initiated, and supervisory means for each of said cord circuits for indicating to the operator the cord circuits selected and the particular cord circuit to which said operator's set is connected.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 15th day of December, 1922.

GEORGE R. EATON.