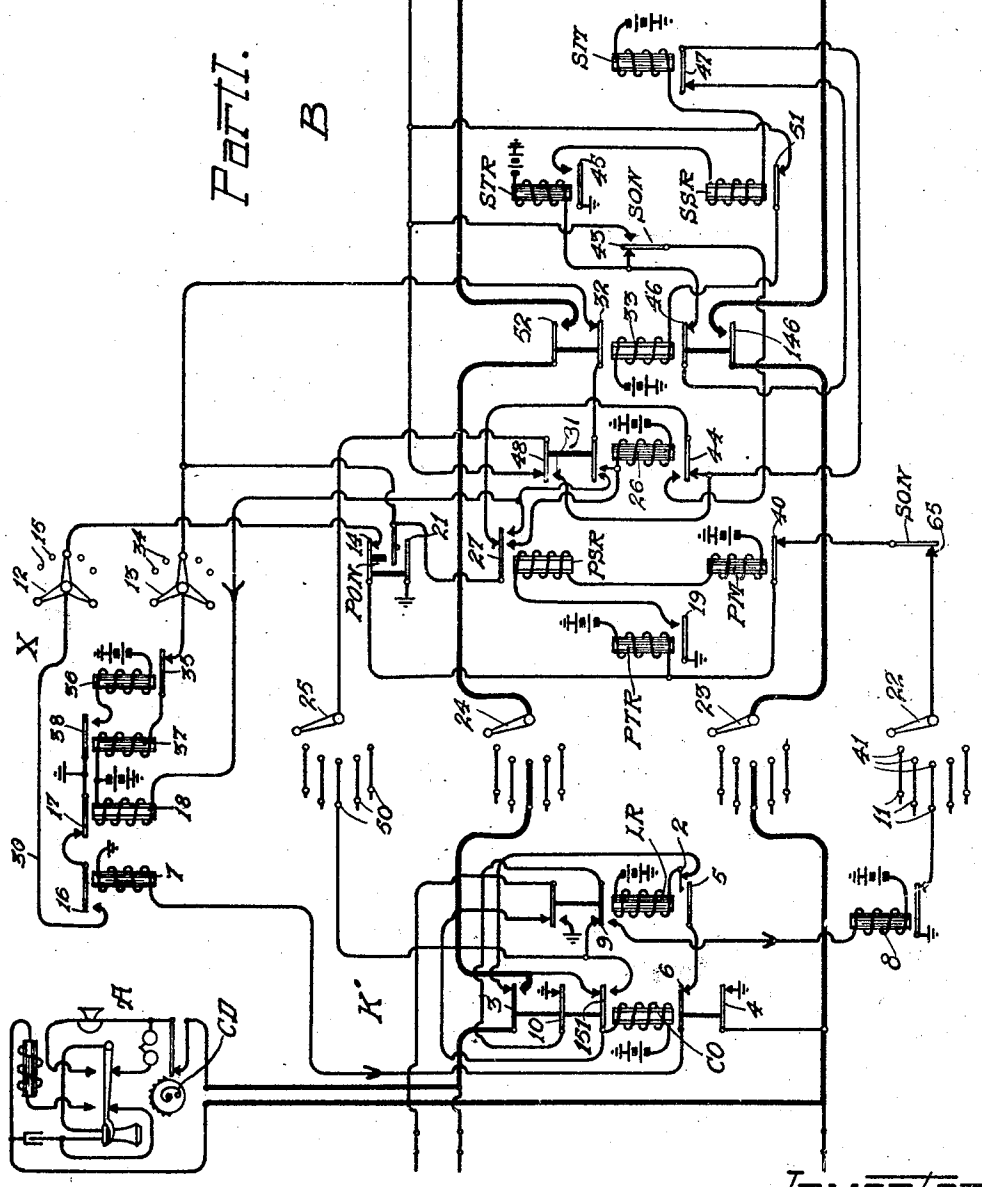
March 17, 1925. 1,529,655

L. D. KELLOGG

TELEPHONE SYSTEM

Filed June 12. 1919 3 Sheets-Sheet 1



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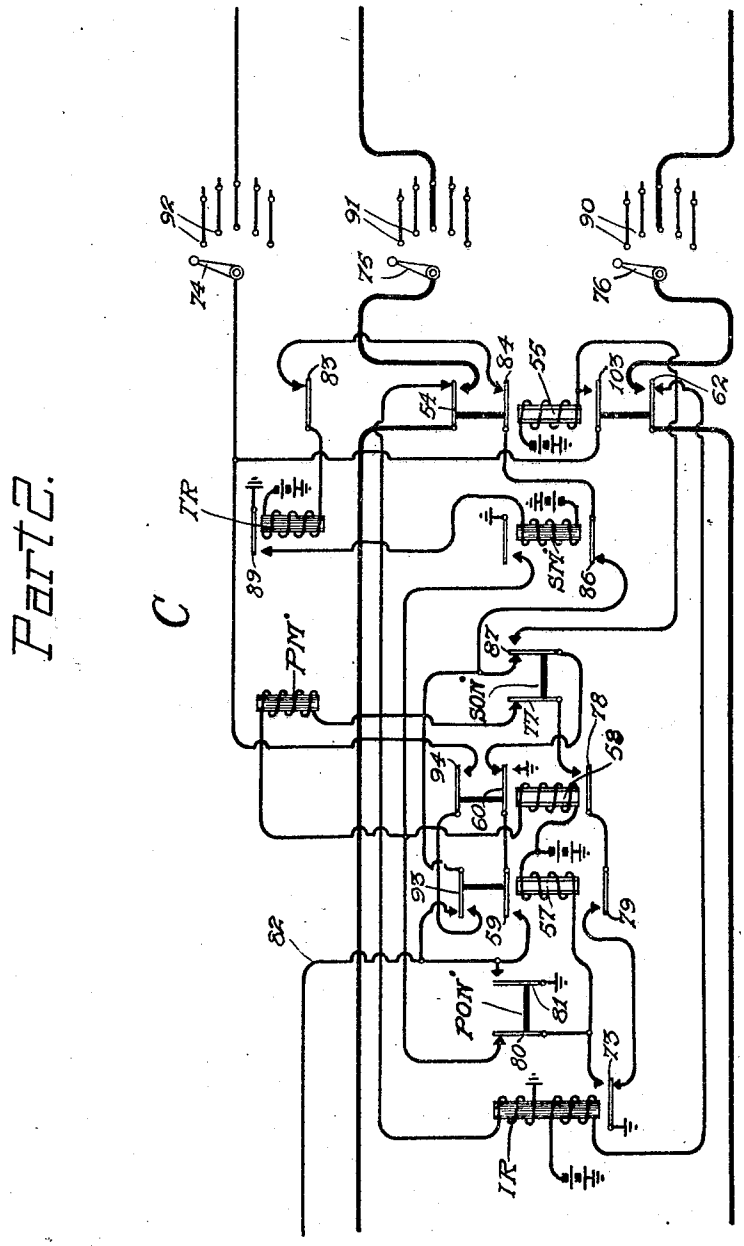
TELEPHONE SYSTEM

Filed June 12, 1919 3 Sheets-Sheet 2



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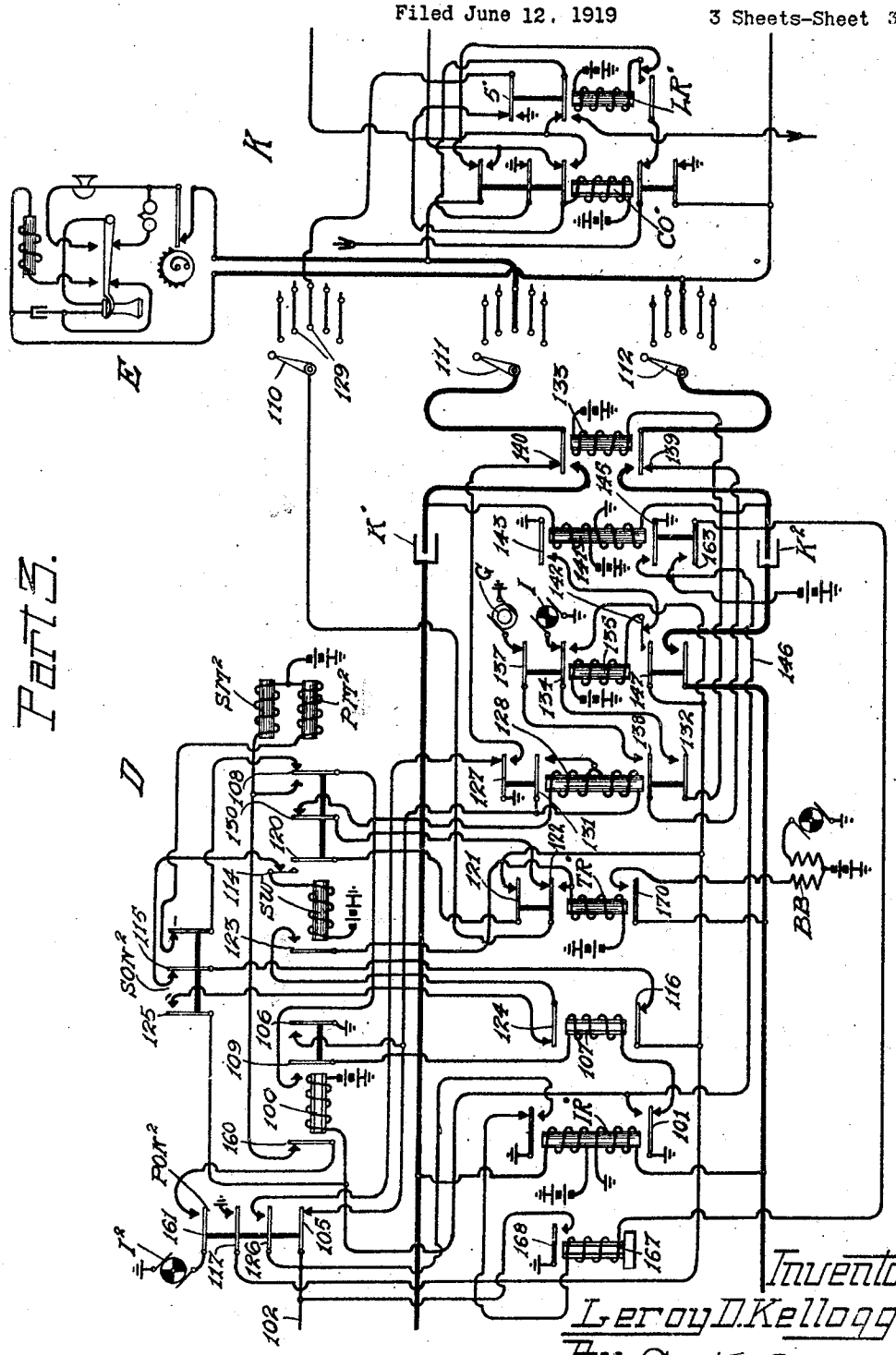
Filed June 12, 1919 3 Sheets-Sheet 3



Patented Mar. 17, 1925. 1,529,655

UNITED STATES PATENT OFFICE.

LEROY D. KELLOGG, OF DEERFIELD, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed June 12, 1919. Serial No. 303,542.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, residing at Deerfield, county of Lake, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems of the two-wire or metallic line type in which the directively controlled switches at the exchange are operated responsive to a series of rapid interruptions of the subscribers' line circuits, and an object of my invention is to provide a system as outlined having simplified and improved circuit arrangements.

My system includes a line finder switch for use in a system of the character outlined above, and a feature of my invention resides in the provision of a so-called "positive drive circuit" for the finder switch in both its primary and secondary movements.

A further feature of my invention resides in the provision of a so-called "positive drive circuit" for the master switch associated with the line finder switches in my system.

A still further feature of my invention resides in the circuit arrangement of my finder switch, which has a vertical, downward primary selecting movement, and a rotary, secondary selecting movement, and is advanced in a rotary direction beyond the last contact in the bank level to permit restoration of the finder switch.

A still further feature of my invention is the provision of quick and slow-acting relays for use in my line finder, first selector and connector switch circuits, the switch structures of which have switch shafts and wipers that are advanced downwardly in a vertical plane when performing a primary selecting movement, rotated in a horizontal plane when performing a secondary movement and subsequently are rotated beyond the last contact of the bank level to permit the switch shafts and wipers to be restored by spring tension to normal.

In the positive drive circuit, a motor magnet is controlled by a test relay which in turn is controlled by the motor magnet.

The novel features of my invention, through the provision of which the above-mentioned and other advantageous results are obtained, will be explained by reference to the accompanying drawings, in which Figure 1, comprising parts 1, 2 and 3, illustrates diagrammatically an automatic telephone system embodied in my invention.

Referring to the system illustrated in the accompanying drawings, the system there illustrated may be considered as a thousand line system. Assuming such to be the case, each subscriber's line such as those of substations A and E extends to the exchange and is there provided with its individual passive contacts appearing with those of ninety-nine other lines in the contact banks of ten line selectors such as B. Each line selector has permanent connection with a particular first selector, such as C, which is automatically brought under the control of currents transmitted over the calling line by the operations of the line selector B. Responsive to currents transmitted over the calling line, the first selector is operated to select the group of connectors desired, and then an idle connector in the group, thereby placing it under the control of the calling substation. The connector by its wipers has access to contacts forming multiple terminals of subscribers' lines forming a one hundred line group, said contacts being multipled ten times to appear in the contact banks of ten connectors.

As above indicated, line selector B by means of its wipers has access to one hundred sets of multiple contacts forming terminals of a group of one hundred subscribers' lines. The contacts of these lines are preferably arranged in ten groups of ten contact sets each, the motion of the wipers of the finder switch B being first in a primary direction in one plane to select a group of contacts and then in a secondary direction in another plane to select the calling line of the group. Each group of ten lines, therefore, has a common or group contact 41, controllable by a relay 8. Wiper 22 engages the group contact 41. Wiper 22 controls the primary group of the switch B. When the wiper 22 reaches a group contact belonging to a group of lines among which a calling line is included, the primary movement of the wiper is arrested and wipers 23, 24 and 25 then initiate the secondary move-

ment to select the contacts of a calling line, wiper 22 remaining quiescent at this time and not partaking of the secondary movement. As before stated, each group of one hundred calling lines has associated with it ten line selectors B, so that the contacts of each line and the group contact 41 of each group is mutipled ten times, once to each such line selector bank.

When the calling subscriber removes his receiver he causes a line selector to start in operation to seek out his line, and thereby connect a first selector with his line. This is effected through the agency of the master switch X. To energize relay 7, each calling line is enabled to transmit current via the switch contacts 5 of its line relay LR. The said master switch, when operated at the initiation of the call, causes an idle line selector to start its operation. The line selector then reacts upon the master switch in such manner that its wipers 12 and 13 move away from switch contacts of the line selector which they start, and then keep up an independent progressive movement via terminals of busy line selectors until they reach terminals of an idle one, when the said wipers come to rest. The detailed operation of the different parts one with another will be best understood through the narrative of operation.

The substation A comprises the usual switch hook and substation equipment and includes a calling device CD. The substation is connected by means of the two line limbs shown to relay mechanism K′ at the exchange. The relay mechanism includes the line relay LR and cut-off relay CO.

The master switch X includes a starting relay 7, a slow relay 18, a test relay 37 and a motor magnet 36. Motor magnet 36 is adapted through the medium of ratchet and pawl mechanism to rotate the switch shaft and wipers 12 and 13 over the bank contacts 15 and 34. The wipers of the master switch are so arranged that when one arm of the wipers moves from the last bank contacts, another arm thereof engages the first bank contacts of the bank of contacts.

The circuits shown for the finder switch B, first selector C and connector D are adapted to work with a switch structure similar to that shown in copending application, Serial Number 175,364, filed June 18, 1917, issued as patent to Ide, 1,402,936, Jan. 10, 1922. It is to be understood, however, that the circuits may be used in connection with various switch structures in the art.

The line finder B comprises a primary test relay PTR and a primary magnet PM for moving the switch shaft of the line finder in a primary direction, and a secondary test relay STR, a secondary magnet SM for moving the switch shaft and wipers in a secondary direction to the bank contacts of the calling subscriber's line. A switching relay 33 is also provided, which when energized extends the connection of the calling substation A to the idle first selector C. Primary and secondary off-normal contacts PON and SON, respectively, are provided. The said primary off-normal contacts PON assume their alternate position upon the first step of the wipers in a primary direction, and the secondary off-normal contacts SON assume their alternate position upon the first step of the wipers in a secondary direction. A pair of slow relays PSR and SSR are also provided.

The first selector C comprises an impulse relay IR, which relay is energized and de-energized by impulses from the calling device CD at the calling substation A. The de-energizations of the relay IR bring about the actuation of the primary magnet PM′ to step the first selector switch wipers 74, 75 and 76 in a primary direction to a certain group of contacts. A secondary magnet SM′ is provided for said selector which automatically steps the said wipers in a secondary direction over the contacts 90, 91 and 92 in the selected group to seek out an idle set of contacts leading to the connector D. A switching relay 55 is also provided, which when energized, extends connection of the calling substation A to the idle connector D. Primary and secondary off-normal contacts PON′ and SON′, respectively, are provided and are controlled in substantially the same manner as are the contact springs PON and SON of the finder switch B. A pair of slow relays 57 and 58 are also provided.

The connector switch D is provided with an impulse relay IR′, responsive to the impulses of the calling device CD at the calling substation A, which relay IR′ brings about the actuation of the primary magnet PM^2 to step the connector switch wipers 110, 111 and 112 in a primary direction to an elected group of contacts containing contacts of the called line E. A switching relay SW is provided which energizes upon the termination of the first set of impulses and connects the secondary magnet SM^2 in circuit with the impulse relay IR′ to be actuated by the energization and de-energization thereof to step the connector switch wipers over the bank contacts in the selected group to seek the contacts of the called line. A slow-acting relay 100 is provided and a slow-acting switch relay 107. A test relay TR′ is also provided, which is actuated to test the busy or idle condition of the called subscriber's line, the said test relay TR′ operating to connect busy back apparatus BB to the calling subscriber's line to notify the calling subscriber of the busy condition of the called line. A ringing control relay 133 is provided for intermittently

applying ringing current to the called subscriber's line from the ringing generator G. A back bridge or supervisory relay 141 is also provided, which operates upon the response of the called subscriber and controls disconnection or prevents further applications of ringing current to the called subscriber's line. Primary and secondary off-normal contacts PON^2 and SON^2 are provided and assume their alternate positions upon the primary and secondary movements of the switch shaft and wipers.

To the right of Fig. 1, Part 3, I show a called substation E similar to substation A, substation E being connected to line relay mechanism K at the exchange, similar to line mechanism K'.

Having described in general the structure of the switches and apparatus, I will now explain more in detail the operations.

Assuming that subscriber A is to be connected with subscriber E, whose telephone number will be assumed to be 456, subscriber A first removes his receiver, thereby completing a conductive bridge of his line conductors by the usual elevation of the switch lever. Line relay LR is energized by current from battery therethrough, its break-before-make contact 2, normal contact 3 of relay CO, over one side of the line through the substation and back over the other side of the line and through normal contact 4 of relay CO. Relay LR upon energizing, places ground through its alternate contact 5 on the private bank contacts of the connector switches that have access to substation A. Another result of the energization of relay LR is that it closes a locking circuit for itself traced from battery through its winding, its alternate contact 5, contact 6 of relay CO, and the winding of relay 7 of the master switch X to ground, independent of its initial energizing circuit. A further result due to the energization of the relay LR is that a circuit is closed for sub-group relay 8 extending from battery through the winding of said relay, alternate contact 9 of relay LR, normal contact 10 of relay CO to ground. Relay 8 attracts its armature to remove ground from the multiple group contacts 11 of the line selectors that have access to the calling subscriber's line.

Returning to the operation of relay 7 of the master switch X, this relay upon energizing closes a circuit through the primary test relay of an idle finder switch (in this instance finder switch B), with which the wipers 12 and 13 of the master switch X are in engagement. This circuit may be traced from battery through the winding of relay PTR, normal contact 14 of contacts PON, master switch bank contact 15, wiper 12 of the master switch X, alternate contact 16 of relay 7, and normal contact 17 of relay 18 to ground. The relay PTR upon energizing closes a circuit through the primary magnet PM and the primary switching relay PSR in series extending from battery through the winding of magnet PM and the winding of relay PSR to ground at alternate contact 19 of relay PTR. Relay PSR energizing prepares a circuit for the slow-acting relay 18 of the master switch X which is closed as soon as the wipers of the finder switch B are moved from normal and the off normal contact 21 closed. The magnet PM energizing causes the switch wiper 22 to take one step in a primary direction, moving said wiper into engagement with the first group contact 41. The shifting of the off normal contact 14 to its alternate position opens the original energizing circuit for relay PTR and the shifting of off normal contact 21 to its alternate position closes an energizing circuit for relay 26 of the finder switch B and for relay 18 of the master switch X. The circuit for relay 26 extends from battery through the winding of said relay 26, alternate contact 27 of relay PSR and alternate contact 21 to ground, and the circuit for relay 18 extends from battery through the winding of said relay 18, alternate contact 27 of relay PSR and alternate contact 21 to ground. The energization of relay 18 of the master switch X opens the starting circuit 30 at contact 17. A further result, due to the shifting of the off normal contact 21, is the closing of a circuit for relay 37 of the master switch X, which circuit extends from battery through the winding of said relay, normal contact 35 of relay 36, wiper 13 and its engaged bank contact 34 to ground at alternate contact 21. Relay 37 of the master switch upon energizing closes a circuit through the stepping magnet 36 of the master switch X extending from battery, through the winding of said magnet 36, alternate contact 38 of relay 37 to ground. The magnet 36 upon energizing moves the wipers 12 and 13 into connection with the next set of bank contacts. If these contacts lead to a busy finder switch B, the engaged bank contact 34 will be found to have a busy potential upon it. The energization of the magnet 36 of the master switch X opens the circuit of test relay 38 at contact 36. Now when the magnet 36 de-energizes, if the wiper 13 is in engagement with a busy contact, a circuit will be immediately closed from ground at off normal contact 21 of a busy finder switch through the bank contact 34 and wiper 13, normal contact 35 of relay 36 and the winding of relay 37 to battery. Relay 37 energizing again causes a circuit to be closed for the stepping magnet 36 of the master switch X. The magnet 36 and the relay 37 are thus included in a vibratory circuit arrangement and they operate alternately to cause the

wipers 12 and 13 of the master switch X to be moved into engagement with a set of contacts leading to an idle finder switch. The relay 18 has remained energized during this time to prevent the wiper 12 from applying ground to the bank contact 15 with which wiper 12 has moved over.

Returning now to the operation of the finder switch B, the first step thereof opens the circuit of relay PTR at contact 14 of the PON springs. The de-energization of PTR causes the de-energization of the primary magnet PM. The de-energization of magnet PM again closes a circuit for the primary test relay PTR extending from battery through the winding of said relay, normal contact 40 of magnet PM, contact 65 of contacts SON, wiper 22 and the engaged group bank contact 41 to ground. Relay PTR energizing over this circuit again closes a circuit for relay PSR and magnet PM. The magnet PM again energizing steps the wiper 22 into engagement with the next group contact 41 and opens the energizing circuit of relay PTR. The relay PTR and magnet PM will thus operate in a see-saw manner to move the wiper 22 into engagement with the group contact 41 associated with the group or level of contacts in which the calling subscriber's line A appears. The finder switch wiper 22 having been moved into engagement with the group contact from which the relay 8 has removed ground, the relay PTR is permitted to remain in its de-energized position, thereby causing the slow-acting relay PSR to de-energize. Relay PSR has remained energized during the entire time that the relay PTR and magnet PM have been co-operating to move the wiper 22 into engagement with the group contact of the group of contacts that contain the calling subscriber's line. Relay PSR de-energizing removes ground from relay 18 of master switch X, and from relay 26 of the finder switch B, but these relays do not de-energize at this time as a substitute ground has been supplied for these relays through contact 32 of relay 33. Relay PSR deenergizing again closes its normal contact thereby closing a circuit for secondary test relay STR extending from battery through the winding of said relay, normal contact 43 of secondary off normal contacts SON, alternate contact 44 of relay 26 and normal contact 27 of relay PSR to ground at contact 21. The relay STR energizing closes a circuit for secondary magnet SM and secondary switching relay SSR extending from battery through the windings of said magnet and relay in series to alternate contact 45 of relay STR. Magnet SM upon energizing, moves the switch shaft wipers 23, 24 and 25 one step in a secondary direction into engagement with the first set of bank contacts in the selected group of contacts and also moves secondary off normal contacts 43 and 65 to their alternate positions. The opening of contact 43 opens the original energizing circuit for relay STR. The magnet SM upon de-energizing closes a test circuit for relay STR extending from battery through the winding of said relay STR, normal contact 46 of relay 33, normal contact 47 of relay SM, alternate contact 48 of relay 26 to the wiper 25.

Returning for the moment to the original energizing of line relay LR, it will be noted that by the shifting of contact 9 of this relay to its alternate position, it removes ground from private contact 50 of the finder switch bank contacts in the level in which the calling subscriber's line A appears. The engagement of wiper 25 with the first bank contact, which in this instance is ground, closes a circuit for relay STR over the path just traced thereby causing the energization of relay STR. Relay STR upon energizing again closes a circuit for relay SSR and magnet SM. The magnet SM upon energizing causes the switch shaft wipers to be moved into engagement with the second set of bank contacts and opens the energizing circuit of relay STR at its contact 47. The relay STR thus de-energizes and opens the circuit of magnet SM. The relay STR and magnet SM co-operate in this see-saw manner to move the switch shaft wipers 23, 24 and 25 into engagement with the set of bank contacts connected to the calling subscriber's line. The wipers 23, 24 and 25 having been moved into engagement with the calling subscriber's line and the bank contact 50 now being free of ground potential permits the relay STR to remain in its de-energized position, thereby causing the de-energization of slow-acting relay SSR. Relay SSR de-energizing closes a circuit for relay 33 traced from battery through the winding of said relay 33, normal contact 51 of relay SSR, alternate contact 43 of the secondary off normal springs, alternate contact 44 of relay 26 and normal contact 27 of relay PSR to ground at contact 21. Relay 33 upon energizing connects the heavily marked talking conductors through from the finder switch to the impulse relay IR of first selector C, opens the test circuit of relay STR and also opens the locking circuit of relay 26. The connection of the impulse relay IR through to the calling line causes the energization of relay CO of the subscriber's line equipment over a circuit extending from battery through the winding of said relay CO, its normal contact 151, wiper 24, alternate contact 52 of relay 33, normal contact 54 of relay 55, and the upper winding of relay IR to ground. Relays IR and CO energize over this circuit. Relay CO energiz-

ing closes a locking circuit for itself extending from battery through its own winding, its alternate contact 151, private wiper 25, contact 48 of relay 26 (relay 26 now being in de-energized position), alternate contact 59 of relay 57, and alternate contact 60 of relay 58 to ground. (Relays 57 and 58 having been energized when impulse relay IR energized.) Further results, due to the energization of relay CO, are the connecting of the calling line through to the impulse relay IR, the opening of the locking circuit of relay LR, and the removing of ground from the calling subscriber's line. The relay LR de-energizing permits group relay 8 and starting relay 7 to return to their normal positions. Impulse relay IR is now held energized over the two sides of the calling subscriber's line in series over a circuit extending from battery through the lower winding of said relay IR, normal contact 62 of relay 55, alternate contact 146 of relay 33, wiper 23 of the finder switch B, out over the calling line and through the calling substation back through alternate contact 3 of relay CO, wiper 24, alternate contact 52 of relay 33 and normal contact 54 of relay 55 to the upper winding of relay IR and through its winding to ground.

The calling subscriber's line having been connected to a first selector switch C, the subscriber A now actuates the calling device CD to send three impulses of current over the line, which impulses bring about three rapid de-energizations and energizations of the impulse relay IR. The primary magnet PM′ energizes and de-energizes three times due to the closing and opening of contact 73 of relay IR which magnet operates to step the wipers 74, 75 and 76 of the first selector in a primary direction to the third group of contacts, thus selecting the three hundredths group of connectors. The circuit for the primary magnet extends from battery through the winding of slow-acting relay 58, the winding of magnet PM′, normal contact 77 of off-normal contacts SON′, contact 78 of relay 58, contact 79 of relay 57 and contact 73 to ground. The relay 58 was originally energized through contact 80 of springs PON′, but the original circuit for relay 58 is opened at the instant that the switch shaft is moved from normal position and the contacts 80 operated. Contact 81 of the primary off normal springs moving to its alternate position connects ground to the trunk release conductor 82, to maintain the relay 33 of the finder switch B in its energized position after relay 58 is de-energized and opens its alternate contact 60. After the last impulse of the series of three impulses, relay 58 de-energizes and closes a circuit for test relay TR over a path extending from battery through the winding of said relay, contact 83, contact 84 of relay 55, contact 86 of magnet SM′, contact 87 of springs SON′, contact 60 of relay 58, contact 59 of relay 57, and alternate contact 81 of springs PON′ to ground. Test relay TR energizing closes a circuit through secondary magnet SM′ extending from battery through the winding of said magnet and through alternate contact 89 of relay TR to ground. Secondary magnet SM′ energizing steps the switch shaft and wipers one step in a rotary or secondary direction to engage the first set of contacts 90, 91 and 92, and the opening of normal contact 86 of magnet SM′ causes the relay TR to de-energize. The first step of the switch shaft in a rotary direction from normal causes the secondary off normal contacts SON′ to be moved to their alternate position. The relay TR de-energizing opens the circuit of secondary magnet SM′ and permits it to de-energize. The magnet SM′ upon de-energizing connects the test relay TR to the private wiper 74 of the selector switch C, and should the private wiper engage a contact leading to a busy connector, a circuit is established for relay TR extending from battery through the winding of said relay, contact 83, contact 84, of relay 55, contact 86 of magnet SM′, contact 93 of relay 57, contact 94 of relay 58 to the private wiper 74 (the relay 58 again energizing when secondary magnet SM′, is energized). The relay TR energizing over this circuit again closes a circuit for magnet SM′ and magnet SM′ in turn closes and opens the circuit of relay TR. The magnet SM′ and relay TR continue to operate until private wiper 74 engages a contact leading to an idle connector switch at which time the relay TR is permitted to remain in its de-energized position. Relay TR remaining in its de-energized position permits magnet SM′ to remain in its de-energized position, thereby causing the de-energization of slow-acting relay 58. Relay 58 de-energizing closes a circuit for switching relay 55 extending from battery through the winding of said relay, secondary off normal contact 87, normal contact 60 of relay 58, alternate contact 59 of relay 57 and alternate contact 81 of springs PON′. Relay 55 upon energizing disconnects the impulse relay IR from the subscriber's line and connects the subscriber's line through to the impulse relay IR′, of the connector switch D, and at the same time closes a locking circuit for itself to the private wiper 74. The connecting of the subscriber's line through to the impulse relay IR′ of the connector switch causes this relay to be energized over the two sides of the calling subscriber's line in series, and the energization thereof closes a circuit through slow-acting magnet 100, extending from battery through the winding of said

relay and alternate contact 101 of relay IR′ to ground. Relay 100 energizing connects ground to private conductor 102 thereby maintaining relay 55 of selector C in an energized position over a path extending from battery through the winding of said relay 55, its alternate contact 103, wiper 74 and bank contact 92, conductor 102, contact 105 of springs PON², and contact 106 of relay 100 to ground.

Returning to the first selector switch C, the de-energizing of relay IR permits the slow-acting relay 57 to de-energize and return to its normal position. The selector switch C is now held in its off normal or advanced position by the energization of relay 55. The apparatus is now in condition for the subscriber to send the second series of impulses constituting the second digit of the calling number.

The calling subscriber operates his calling device CD as above mentioned, thereby causing five de-energizations and energizations of relay IR′. Relay IR′ upon its first de-energization closes a circuit through primary magnet PM² and slow-acting relay 107 in series over a circuit extending from battery through the winding of said magnet, contact 108 of relay SW, contact 109 of relay 100, through the winding of relay 107 and normal contact 101 of relay IR′ to ground. Primary magnet PM² operates to step the switch wipers 110, 111 and 112 five steps in a primary direction to the fifth level or group of bank contacts in which is situated the line of the calling subscriber. The first movement of the switch shaft from normal permits the primary off normal springs PON² to move to their alternate position. After the last impulse of the series has been sent the slow-acting relay 107 de-energizes and returns to its normal position thereby closing a circuit for switching relay SW over a circuit extending from battery through the winding of relay SW, its contact 114, contact 115 of secondary off normal springs SON², contact 116 of relay 107 and contact 117 of springs PON² to ground.

The switching relay SW upon energizing switches the impulses circuit from primary magnet PM² of secondary magnet SM² and closes a locking circuit for itself extending from battery through its own winding, locking contact 120, normal contact 121 of relay TR′ and primary off normal contact 117 to ground. The subscriber now operates his calling device to send six impulses for the last digit of the called number. The relay IR′ is caused to de-energize six times and consequently sends six impulses of current through secondary magnet SM² over a circuit extending from battery, through the winding of said magnet SM², alternate contact 108 of switch relay SW, alternate contact 109 of relay 100, through the winding of relay 107 and normal contact 101 of relay IR′ to ground. Magnet SM² operates to step switch wipers 110, 111 and 112 in a secondary direction into engagement with the bank contacts of the called subscriber's line. The switch shaft moving in a secondary direction operates the secondary off normal contacts SON². After the last impulse of the series has been transmitted, relay 107 returns to normal position and closes an energizing circuit for test relay TR′ over a path extending from battery through the winding of relay TR′, alternate contact 123 of relay SW, normal contact 124 of relay 107, contact 125 of springs SON², and to ground at alternate contact 101 of relay IR′. Relay TR′ upon energizing opens the energizing circuit of relay SW at its contact 121, thereby permitting the same to de-energize. A further result, due to the energization of relay TR′, is that it connects itself through its alternate contact 122 to the private wiper 110 and if the contact engaged by the wiper 110 be busy, the private contact 129 of the called line will be grounded, thus closing a locking circuit for the said relay TR′ through the private wiper.

Called line idle.

Assuming that the called line is idle, private contact 129 of the called line will be free of ground and the relay TR′ will not remain energized, but will de-energize. The relay TR′ de-energizing causes the energization of relay 128 by current from battery, through the winding CO′ of the apparatus K individual to the called subscriber's line, contact 5′ of LR′, bank contact 129 and wiper 110, normal contact 122 of relay TR′, normal contact 130 of relay SW, and the two windings of relay 128 in series and contact 106 of relay 100 to ground. The relay 128 energizing closes its alternate contact 131, thereby short circuiting the lower winding of the said relay, and the closing of alternate contact 132 of relay 128 closes a circuit through the interrupter relay 133 over a path extending from battery through the winding of said relay 133 and through contact 132 of relay 128 and normal contact 134 of relay 135 to the interrupter I and to ground. A further result, due to the energization of relay 128, is the connection of generator G through contact 137 of relay 135, and contact 138 of relay 128 to back contact 139 of relay 133 and the connecting of ground from alternate contact 127 of relay 128 to back contact 140 of relay 133. The relay 133 due to the interrupter I is operated intermittently to connect ringing current from generator G through the line wipers 111 and 112 to the called subscriber's line.

Reverting for the moment to the operation of the cut-off relay CO′ of the individ-

ual subscriber's mechanism this relay operating disconnects the line relay LR′ from the called subscriber's line, thereby removing substation control of the line mechanism K from the called subscriber.

The called subscriber at the substation E is thus intermittently rung, and when the called subscriber answers and the relay 133 is in an energized position, the relay 141 is energized over the two sides of the called subscriber's line in series. The circuit for relay 141 may be traced from battery through its upper winding, through alternate contact 140 of relay 133, wiper 111, over the called subscriber's line, and back through wiper 112, alternate contact 139 of relay 133 and through the lower winding of relay 141 to ground. The relay 141 energizing, closes an energizing circuit for relay 135 traced from battery through the winding of said relay, its contact 142, and contact 143 of relay 141 to ground. A further result, due to the energization of relay 141 is the placing of ground through its alternate contact 145 upon conductor 146. The relay 135 energizing closes a locking circuit for itself through its locking contact 147 to ground at contact 117 of springs PON², and disconnects the interrupter I from the relay 133, but locks the relay 133 to ground through its alternate contact 134. This locking circuit for relay 133 may be traced from battery through the winding of said relay 133, alternate contact 132 of relay 128, alternate contact 134 of relay 135 and contact 117 of springs PON² to ground. A further result, due to the energization of relay 135 is the disconnection of the generator G from the called subscriber's line.

The subscribers are now in conversational circuit, and the talking circuit may be traced over the heavily marked conductors, said circuit including the condensers K′ and K².

Release.

Assuming that the subscriber at the calling substation A is the first to replace his receiver, the resulting de-energization of the impulse relay IR′ removes ground from the trunk release conductor 102, thereby opening the holding circuit of relay 55 of the first selector C. Relay 55 of the first selector C de-energizing closes an energizing circuit for test magnet TR over a path extending from battery through the winding of said magnet TR, contact 83, normal contact 84 of relay 55, contact 86, of magnet SM′, normal contact 93 of relay 57 and alternate contact 81 of the springs PON′ to ground. The relay TR energizing, closes a circuit for secondary magnet SM′. The relay PR and secondary magnet SM′ are thus alternately energized and de-energized (as before described), and the secondary magnet SM steps the wipers 74, 75 and 76 past the last contact of the row or level of bank contacts, from which point the wipers are restored to normal by spring tension.

The secondary off-normal contacts SON′ and the primary off-normal contacts PON′ are restored to normal and the opening of alternate contact 81 of the primary off-normal contacts PON′ opens the energizing circuit of the holding relay 33 of the finder switch B. The relay 33 restoring closes a circuit for secondary test relay STR over a path extending from battery, through the winding of said relay, contact 46 of relay 33, contact 47 of magnet SM, contact 44 of relay 26, contact 27 of relay PSR and primary off-normal contact 21 to ground. Relay STR energizing closes a circuit for secondary magnet SM and the relay STR and the secondary magnet SM alternately energize and de-energize as before described. The secondary magnet SM steps the wipers 22, 23 and 24 beyond the last contact of the row or level of bank contacts from which point the wipers are restored to normal by spring tension.

Secondary off-normal contacts SON and the primary off-normal contacts PON are restored to normal by the return of the switch shaft to normal. The removal of the ground from the trunk release conductor 102′ permits the cut-off relay CO of the calling subscriber's relay mechanism K′ to restore to normal.

The subscriber E restoring his receiver upon the switchhook interrupts the circuit of relay 141 at the switch contacts, causing the said relay to de-energize. Relay 141 de-energizing and opening its contact 145, removes ground from the slow-acting relay 100. Slow-acting relay 100 de-energizing closes a circuit for the secondary magnet SM², traced from battery, through said magnet SM², contact 160 of relay 100, and contact 161 of springs PON² to the interrupter I². The secondary magnet SM² thus steps the wipers 110, 111 and 112 beyond the last set of contacts in the group. The wipers then restore to normal by spring tension. The restoring of the switch shaft operates to restore the primary off-normal contacts PON² and the secondary off-normal contacts SON². These contacts restoring permit the de-energization of the other relays of the connector D, thereby returning the apparatus to normal for use in other connections. The removal of ground from bank contact 129 permits cut-off relay CO′ of the called subscriber's mechanism K to restore to normal.

Assuming now that the subscriber at called substation E was first to replace his receiver upon the switch hook, the opening of the switch hook contacts at the substation E brings about the de-energization of the relay 141. Nothing else happens at this time

as the relay IR′ is still maintained energized over the line of the calling substation A. The calling subscriber at the substation A replacing his receiver interrupts the circuit of impulse relay IR′ at switch hook contacts. The de-energization of relay IR′ opens the circuit of slow-acting relay 100, causing the said relay to deenergize as hereinbefore described. The slow-acting relay 100 de-energizing causes the restoration of the switch D, as hereinbefore described. A further result due to the de-energization of relay IR′ is the removal of ground from trunk release conductor 102, permitting the restoration of switches C and B and the release mechanism K′ of the calling subscriber's line as above mentioned.

Should the subscriber at the called substation fail to replace his receiver, he permits a continued energization of the relay 141, thus holding the contact 145 of this relay in its alternate position thereby maintaining slow-acting relay 100 in its energized position. When the calling subscriber replaces his receiver, the de-energization of relay IR′ removes ground from trunk release conductor 102 to permit the switches B and C to restore. A further result due to the de-energization of relay IR′ is the closing of an energizing circuit for slow-acting relay 167. This relay is slow to energize and permits the switches B and C to restore to normal before it places a ground upon trunk release conductor 102 through its alternate contact 168 to maintain the connector D busy until the called subscriber replaces his receiver and drops back relay 141, which in turn opens its contact 145 to de-energize relay 100, and the opening of contact 163 de-energizes relay 167.

Called line busy.

Assuming now that the called line is busy, the operation of the circuit is the same as above, up to and including the time the relay TR′ momentarily energizes. The line being busy, the private contact 129 has a busy potential connected to it, thereby causing a locking circuit to be closed for the test relay TR′, traced from battery, through the winding of said relay, its alternate contact 122, and the private wiper 110 to ground. Alternate contact 170 remains closed and connects busy signal apparatus BB to the calling line to transmit a busy signal to the calling substation A, thus notifying the calling subscriber of the busy condition of the called line.

The calling subscriber replacing his receiver drops back the line relay IR′ of the connector switch D and releases the connection as hereinbefore described.

While I have shown a system of 1,000 line capacity, it is to be understood that by inserting second selectors, the system may be increased to a 10,000 line system, etc.

While I have described my invention operating in connection with a well-known system, I do not wish to be limited to this exact disclosure as my invention may be applied to other systems without departing from the spirit of the invention, and I, therefore, do not wish to be limited to this exact disclosure but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. A telephone system including a two-motion subscriber-controlled automatic side-switchless switch, a relay and a driving magnet adapted to operate alternately for controlling one of said motions, and a second relay and driving magnet for controlling the other of said motion, a positive drive circuit arrangement for said first relay and driving magnet, said circuit arrangement including a contact of said relay and a contact of said magnet, and a positive drive circuit arrangement for said second relay and driving magnet, said circuit arrangement including a contact of said second relay and a contact of said second driving magnet.

2. A telephone system including a plurality of automatic switches and telephone lines, a rotary non-restoring master switch for controlling said automatic switches, a motor magnet and a relay for said master switch connected in a positive drive circuit arrangement, and a relay associated with said automatic switch for controlling the starting of the said positive drive circuit arrangement of the relay and magnet of said master switch, said last relay also adapted to operate said automatic switch to select a group of said telephone lines.

3. A telephone system including an automatic side-switchless switch provided with a switch shaft and wipers having motion in one plane to select groups of lines and motion in another plane to select a line in the group, a relay and a magnet adapted to energize and de-energize alternately a plurality of times for controlling said first motion, said relay and magnet being connected in a positive drive circuit arrangement, automatic restoring means for said switch, and a second relay and magnet connected in a positive drive circuit arrangement for controlling said second motion, said second relay and magnet operable through a positive drive operation for permitting the operation of said automatic restoring means.

4. A telephone system including a subscriber-controlled automatic side switchless switch provided with a switch shaft and

wipers having motion in one plane to select groups of lines and motion in another plane to select a line in the group, a relay and a magnet controlling said second motion, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, said relay and said magnet adapted to operate alternately a number of times for advancing said switch in one plane of said motions, and restoring means including said relay and magnet for restoring said automatic switch to normal said last relay and magnet being in a positive drive circuit arrangement.

5. A telephone system including subscribers' lines, a subscriber-controlled line finding side switchless switch having motion in one plane to select groups of said lines and motion in another plane to select the calling line in the selected group, a relay and a magnet controlling the first of said motions, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, said relay and magnet adapted to energize and de-energize alternately for each selective step of said switch, means for restoring said switch to normal, and means included in a positive drive circuit arrangement for advancing said switch in said second plane to permit said switch to restore to normal.

6. A telephone system including subscribers' lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select the calling line in the selected group, a relay and a magnet controlling the first of said motions, a circuit for said relay controlled by said magnet, and a circuit for said magnet controlled by said relay, a relay and a magnet controlling the second of said motions, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, and means including said last relay and magnet for automatically restoring said switch to normal.

7. A telephone system including subscribers' lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select the calling line in the selected group, a relay and a magnet controlling the first of said motions, a circuit for said relay controlled by said magnet, and a circuit for said magnet controlled by said relay, a relay and a magnet controlling the second of said motions, a circuit for said relay controlled by said magnet, and a circuit for said magnet controlled by said relay, and a master switch having a starting relay for controlling the initial energization of said first relay.

8. A telephone system including subscribers' lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select a line in the selected group, a test relay, a driving magnet and a slow-acting relay controlling the first of said motions, and a second test relay, driving magnet and slow-acting relay controlling the second of said motions.

9. A telephone system including subscribers' telephone lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select a line in a selected group, a driving magnet for controlling the first of said movements, a slow-acting relay in circuit in series with said driving magnet for rendering inert said driving magnet and for rendering operative a second driving magnet controlling the second of said motions, said second magnet adapted to operate said switch to a point where it automatically restores to normal.

10. A telephone system including subscribers' telephone lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select a line in a selected group, a driving magnet for controlling the first of said movements, a slow-acting relay for rendering inert said driving magnet and for rendering operative a second driving magnet controlling the second of said magnets, and a second slow-acting relay for rendering inoperative the second of said driving magnets and for performing a switching operation.

11. A telephone system including subscribers' telephone lines, a line finding switch having motion in one plane to select groups of said lines and motion in another plane to select a line in a selected group, a driving magnet for controlling the first of said movements, a slow-acting relay for rendering inert said driving magnet and for rendering operative a second driving magnet controlling the second of said magnets, and a second slow-acting relay for rendering inoperative the second of said driving magnets and for performing a switching operation, said second magnet being adapted to advance the switch to permit the same to be restored to normal.

12. A telephone system including an automatic non-numerical selector switch provided with a switch shaft and wipers having movement in one plane to select a group of lines and movement in a second plane to select a calling line in the group, a relay and a magnet controlling the second of said movements connected in a positive drive circuit arrangement including contacts of said relay and magnet, and a slow-acting relay controlling the operation of said relay and magnet and also to close contacts in the talking conductors of said telephone system.

13. A telephone system including an automatic non-numerical selector switch provided with a switch shaft and wipers having movement in one plane to select a group of lines and movement in a second plane to select a calling line in the group, a relay and a magnet controlling the second of said movements connected in a positive drive circuit arrangement, a slow-acting relay controlling the operation of said relay and magnet and also adapted to close contacts in the talking conductors of said telephone system, and means for causing a second operation of said magnet to advance the switch shaft and wipers to a position where they will automatically restore to normal.

14. A telephone system including an automatic non-numerical selector switch having motion in one plane to select groups of lines and a motion in a second plane to select a calling line in the group and to advance the switch to a position where it will automatically restore to normal, a relay and a magnet for controlling the movement of the switch in the said second plane, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, and a slow-acting relay for controlling the operation of said relay and magnet and for closing contacts in the talking conductors of said telephone system.

15. A telephone system including groups of subscribers' telephone lines, automatic switches for connecting said lines, a rotary non-restoring master switch for controlling one of said automatic switches, a relay and a magnet for advancing the wipers of said master switch, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay and a relay associated with said automatic switch for controlling the initial energization of the relay of said master switch and also for operating said switch to connect to one of said groups of lines.

16. A telephone system including subscribers' telephone lines, automatic switches for connecting said lines, a rotary non-restoring master switch for controlling one of said automatic switches, a relay and a magnet for advancing the wipers of said master switch, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, said master switch shaft and wipers adapted to always be rotated in the same direction and a relay associated with said automatic switch for controlling the initial energization of the relay of said master switch and also for operating said switch to pick out the group of lines containing the calling subscriber's line.

17. A telephone system including groups of subscribers' telephone lines, automatic switches for connecting said lines, a master switch for controlling the initial movement of one of said automatic switches, a relay and a magnet for advancing the wipers of said master switch, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, said master switch shaft and wipers adapted to always be rotated in the same direction, a relay associated with said automatic switch for controlling the initial energization of the relay of said master switch, and a slow-acting relay for preventing said master switch from starting said automatic switch while the wipers of the master switch are being moved, said second relay adapted to operate said automatic switch to connect to one of said groups containing the calling line independently of said master switch after the initial movement of said automatic switch.

18. A telephone system including subscribers' telephone lines, automatic switches for connecting said lines, a master switch for controlling the initial movement of one of said automatic switches, a relay and a magnet for advancing the wipers of said master switch, a circuit for said relay controlled by said magnet, a circuit for said magnet controlled by said relay, said master switch shaft and wipers adapted to always be rotated in the same direction, a relay associated with said automatic switch for controlling the initial energization of the relay of said master switch, and a relay common to the subscribers for starting an idle one of said automatic switches, said second relay operable upon the operation of said last relay to cause said automatic switch to operate to connect to a group of said lines independently of said master switch after the initial movement of said automatic switch.

19. A telephone system including subscribers' telephone lines, a master switch common to said telephone lines, a line finder switch having motion in one plane to select a group of said lines and motion in another plane to select a line in the selected group, a driving magnet for controlling the first of said movements, a relay for controlling the circuit of said magnet and a circuit for said relay controlled by said magnet, a relay associated with said master switch for initially energizing the relay of said line finder switch, and a set of off-normal contacts operable upon the operation of said magnet and relay for effecting the operation of said master switch.

Signed by me at Chicago, county of Cook and State of Illinois this 10th day of June, 1919.

LEROY D. KELLOGG.