Feb. 9, 1926. 1,572,222

W. T. POWELL

TELEPHONE SWITCHING SYSTEM

Filed March 31, 1919 4 Sheets-Sheet 1

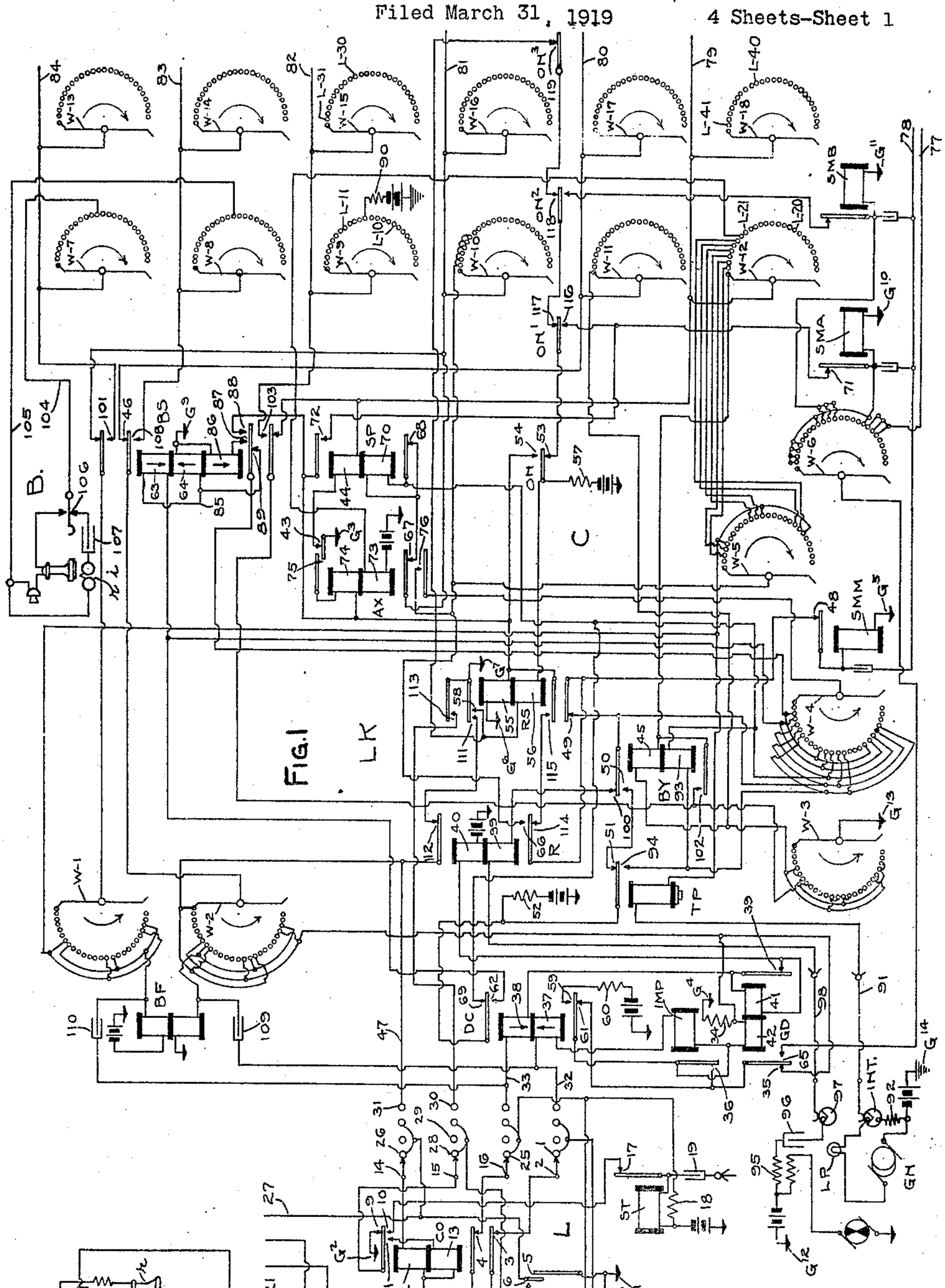

FIG. 1

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TELEPHONE SWITCHING SYSTEM

Filed March 31, 1919 4 Sheets-Sheet 2

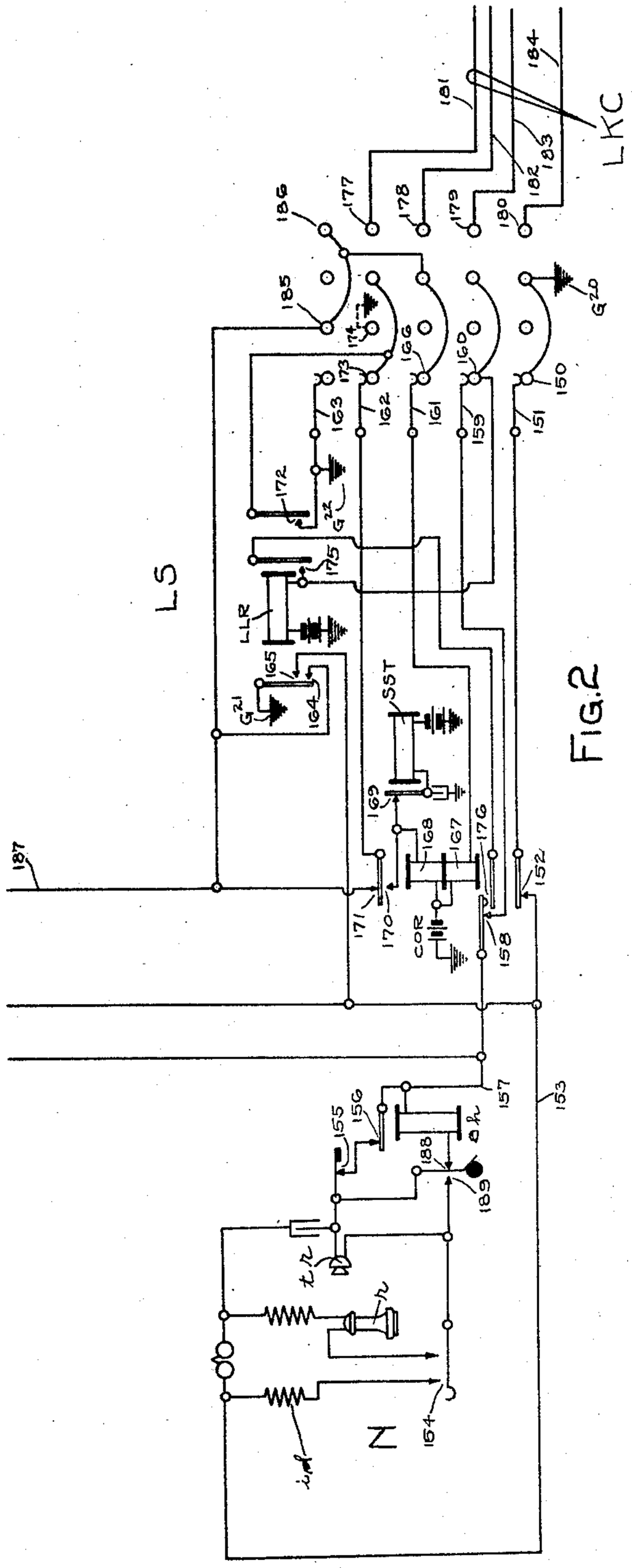

FIG.2

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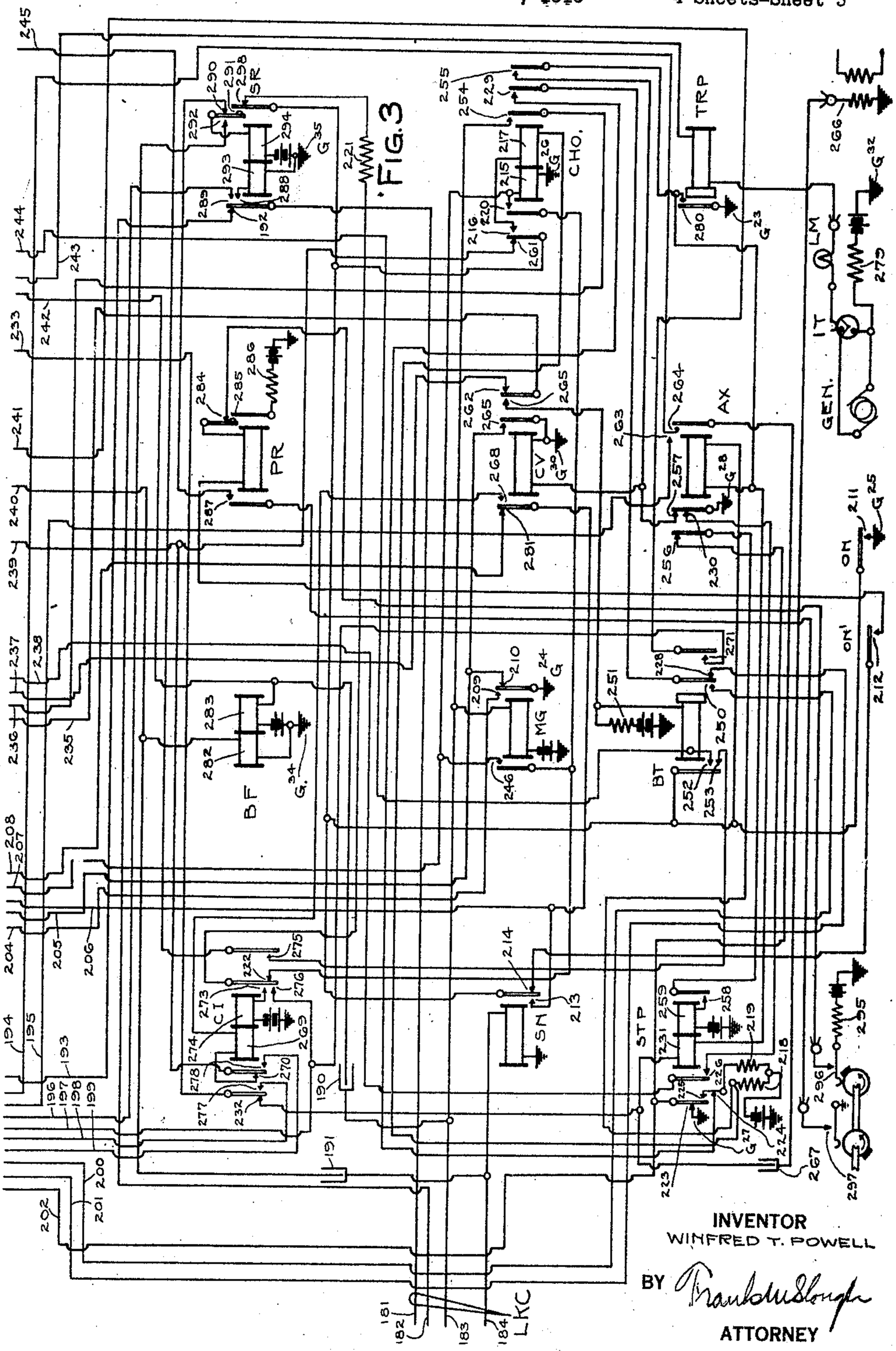
TELEPHONE SWITCHING SYSTEM

Filed March 31, 1919

4 Sheets-Sheet 3



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TELEPHONE SWITCHING SYSTEM

Filed March 31, 1919

4 Sheets-Sheet 4

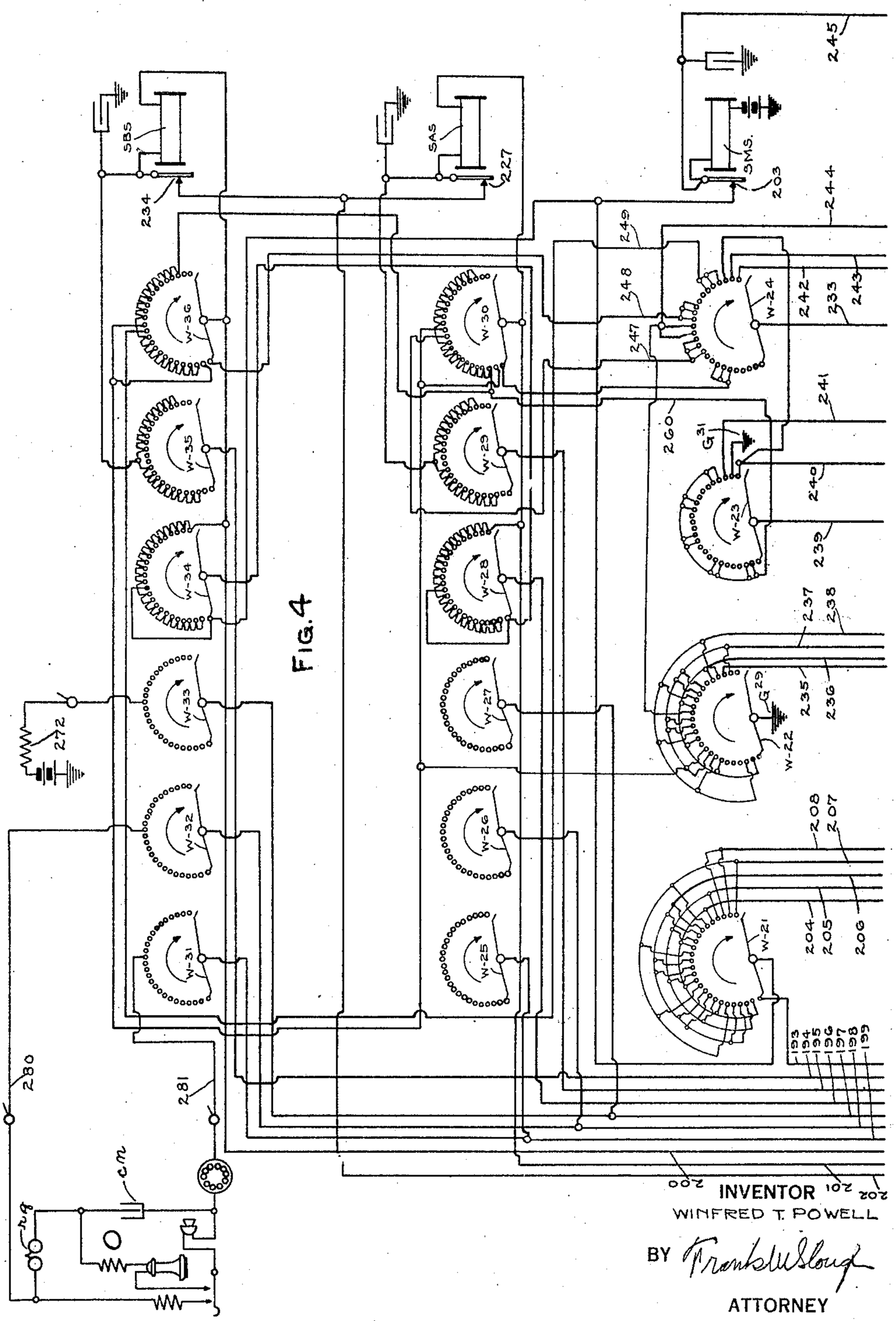

FIG. 4

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UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

TELEPHONE SWITCHING SYSTEM.

Application filed March 31, 1919. Serial No. 286,359.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing in Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Telephone Switching Systems, of which the following is a full, clear, concise, and exact description.

While my invention is capable of many and varied uses its principal value I believe will be in connection with that type of automatic telephone switching systems wherein a relatively small number of switching mechanism units is arranged. For the common use of a relatively larger number of subscribers' lines, switching means are provided to switch a calling line into connection with one of the said switching mechanisms and to isolate the said line and switching mechanisms from intrusion by other switching mechanisms, or other lines until the end of the conversational period when the said switching mechanisms may be released from the control of the said calling line, whereupon it will revert to common use and may be seized by another line.

In the systems of the art with which I am aware, it has been the general practice to follow one of several courses in constructing these systems and switching mechanisms, one course being to make the switches relatively large so as to provide an incoming line with possible connections to a large number of outgoing lines. Another method consists in making the system up of a series of switching mechanisms, each being of relatively smaller size and arranging these switching mechanisms so that a first one, commonly called a first selector, may be operated under a calling substation control to seize a second, and so on until 2, 3, 4, or more switching mechanisms are serially connected to extend a talking circuit between a calling and a called line, it being common practice to arrange these switching mechanisms according to the decimal system for convenience in assigning subscribers' line numbers, etc.

While my invention has many objects and secures many advantages, some of which may be employed separately of the others, it is a main object of my invention to provide a system in which relatively simple switches having movement in one direction only, may be used and in which switches a large number of lines may be reached without the necessity of causing the switch to make an excessive number of steps.

Another object of my invention is to provide a system in which the stepping of the switches is always in the same direction, whereby the release mechanisms for the switches are eliminated together with the consequent trouble such release mechanisms introduce, such as getting out of adjustment, wear on the releasing pawls, excessive wear on the switch bank contacts due to the relatively high speed of the wipers when releasing, etc.

Other objects of my invention and the invention itself will be apparent from a description of two embodiments of the same which I have illustrated in the accompanying drawings in which—

Fig. 1, shows one embodiment wherein the switching system of my invention is illustrated in connection with what I term a "grounded dial" impulse system, and in which the switching mechanisms are returned to normal under the control of a novel switch restoring controlling means, and in which system other features of construction and operation as will later appear in the description of the same, are contained.

Figs. 2, 3 and 4 when placed together to make one drawing illustrate a second embodiment of my invention wherein the impulse system is controlled over the two sides of a calling line in series, and in which the release of the switching mechanisms is accomplished under the control of a pair of interrupters, common to a plurality of such switching mechanisms in which other novel features as will hereinafter be particularly set forth in detail, are disclosed.

Referring to Fig. 1, at A I show a calling substation and at B a called substation, line conductors for the calling and called stations being illustrated connecting the same to a main station at C. At L, I illustrate a line switch for the calling line which under the control of the calling substation A is adapted to interconnect circuit conductors of the calling line to circuit conductors of a link circuit LK.

It will be understood that other lines and

other link circuits will be provided for the system, but for simplicity the same have been omitted it being well understood in the art as at this time developed, how such other lines and link circuits would be arranged in connection with the lines and link circuit specifically illustrated.

In connection with the link circuit LK, I illustrate three switches, each having six contact levels and six wipers simultaneously traversing the contacts of their respective levels. The wipers W—1, W—2, W—3, W—4, W—5 and W—6 and the contact banks associated therewith comprise a master controlling or steering switch. Other switches, two of which are illustrated but more of which may be provided in a manner which will be made clear in the description, are shown comprising wipers W—7 to W—12 inclusive, designated, a combined register and connector switch, and W—13 to 18 inclusive, it being understood that the wipers of each switch are adapted all to traverse their respective bank contacts simultaneously and it is furthermore understood that all of the wipers illustrated in the system of Fig. 1 are preferably of the type known as non-bridging wipers, that is, they preferably do not make contact with more than one set of contacts at a time.

Stepping magnets for the master controlling switch and the auxiliary connecting switches are shown at SMM, SMA and SMB respectively. A plurality of relays for controlling the operation of these switches by their control upon the stepping magnets are illustrated and will be more specifically referred to in the description of the operation of the system which follows:—

The subscriber at substation A, upon removing the receiver to initiate a call, completes an energizing circuit for the line relay LR of the individual rotary line switch L over the following path:—ground G′, winding of line relay LR, terminal 1 and wiper 2 of line switch L, contact 3 of cut off relay CO, line conductor 20, impulse contact 22 of substation A, transmitter *t*, switch hook contact 24, induction coil *i*, line conductor 21, contact 4 of relay CO, wiper 16 and terminal 25 of line switch L and resistance coil 18 to the source of current. The line relay LR energizes and by closing contacts 7 and 8 places a shunt around contacts 3 and 4 of relay CO and wipers 2 and 16 of the line switch so that the circuit of the line relay L will not be opened when the cut off relay CO energizes and the wipers leave the "home" terminals. The line relay L also closes the following circuit: ground G′, contact 5 of relay LR, terminal 26, wiper 14 and winding 12 of relay CO to the source of current. This ground is also extended to wire 27 which leads to the incoming test terminal of this line, thereby immediately making this line busy to incoming calls.

Relay CO now energizes and closes a circuit from ground G′, contact 6 of line relay LR, terminal 28, wiper 15, contact 10 of relay CO, contact 17 of line switch stepping magnet ST, and winding of magnet ST to the source of current. This causes the magnet ST to energize, break its own circuit at contact 17 and retract its armature which moves the wipers 2, 14, 15 and 16 from the first to the second row of terminals, which second row represents a trunk which will be assumed to be busy and therefore there will be a ground on terminal 29. This ground will find a path over wiper 15, contact 11 of relay CO, and winding 13 of relay CO to the source of current which will hold relay CO in its energized position, while another path may be traced through contact 10 of relay CO, contact 17 of magnet ST and the winding of ST to the source of current. Magnet ST will again operate and advance the wipers to the third row of terminals where the same circuit as traced for moving the wipers away from the first row of terminals will now be established to move them to the fourth row. It is to be understood that the first, third, etc. rows are "home" or normal points and the second, fourth, etc., rows are trunk points.

There being no guarding potential on terminals 30 or 31 of the fourth row, this being an idle trunk, magnet ST will not be again energized and relay CO will deenergize. It will be seen that there is a path for winding 12 of relay CO to the ground G^3 but this path includes two relay windings and relay CO can be adjusted so as not to hold up through this resistance. Even if relay CO should hold up it would be for only an instant because, as will be later described, relay BY will operate and cause magnet SMM to step the wiper W—2 away from the first terminal which opens this circuit to relay CO. Relay CO, upon denergizing, immediately places a guarding potential on this trunk by closing a circuit from ground G^2, contact 9 of relay CO and wiper 15 to terminal 30. Relay CO also, by closing contacts 3 and 4, connects the line conductors 20 and 21 to the trunk conductors 32 and 33, and now the closed circuit of substation A on the line establishes the following circuit:—ground G^4, resistance coil 34, contact 35 of guarding relay GD, contact 36 of impulse relay IMP, winding of relay IMP, winding 37 of differential "change-over" relay DC, trunk conductor 32, previously traced closed circuit of substation A, trunk conductor 33, winding 38 of relay DC, contact 39 of relay GD, and winding 40 of release relay R to the source of current. Relays IMP and R

energize but DC does not because it is differentially wound. At the same time that the above circuit was closed another one was closed as follows:—ground G^3, contact 43 of auxiliary relay AX, winding 44 of stop relay SP, wiper W—12 and first terminal thereof, winding 45 of busy relay BY, wiper W—11 and first position thereof, contact 46 of brush selecting relay BS, wiper W—2 and first position thereof, trunk conductor 47, line switch wiper 14 and terminal 31 thereof and the winding 12 of cut off relay CO to the source of current. Winding 44 of relay SP is low resistance and will not operate over this circuit but relay BY does energize and closes the following circuit:—ground G^5, winding of master stepping magnet SMM and contact 48 thereof, contact 49 of "reset" relay RS, contact 50 of relay BY, contact 51 of trip relay TP and low resistance coil 52 to the source of current. The magnet SMM will now operate and advance the wipers W—1, W—2, W—3, W—4, W—5 and W—6 from the first to the second set of terminals. Wiper W—2 has now opened the circuit of relay BY which deenergizes and off normal contact 53 is opened and 54 closed which energizes relay RS over the following circuit:—ground G^6, winding 55 of relay RS, contact 54 of off normal springs ON and resistance coil 57 to the source of current. Relay RS locks over the following circuit: ground G^7, contact 58 of relay RS, winding 56 of relay RS and resistance coil 57 to the source of current.

The foregoing operations have all occurred in response to the removal of the receiver from the hook. The subscriber at substation A may now operate the dial in accordance with the first digit of the number of the required station. When the dial is pulled forward the contact 23 at the substation is closed and remains closed until the dial returns to normal and the contact 22 is opened and closed a number of times corresponding to the digit selected. Contact 23 places a ground G^8 on both of the line conductors 20 and 21, this ground on conductor 20 short circuiting relay LR at line switch L, causing it to deenergize and at the same time short circuiting winding 37 of relay DC causing it to become unbalanced and to energize. Relay IMP, being in series with winding 37 of relay DC, is also short circuited and deenergized but because relay DC operates, the following circuit is now closed to again operate relay IMP:—ground G^8, contacts 22 and 23 at substation A, line conductor 20, contact 3 of line switch cut off relay CO, wiper 2, trunk conductor 32, winding 37 of relay DC, winding of relay IMP, contact 59 of relay DC, and resistance coil 60 to the source of current. Relays DC and IMP now being energized and their contacts 61 and 36 respectively being open, a short circuit is removed from the winding 42 of relay GD which energizes from ground G^4, resistance coil 34, winding 42 of relay GD, contact 59 of relay DC and resistance coil 60 to the source of current. Relay GD, energizing removes the short circuit from its winding 41 by opening contact 39, so that this relay will remain in its operated position while the circuit including winding 42 is being interrupted by impulse contact 22 at substation A. The circuit for holding relay GD is as follows:—ground G^8, contact 23 of substation A, transmitter *t*, switch hook contact 24, induction coil *i*, line conductor 21, contact 4 of line switch relay CO, wiper 16, trunk conductor 33, winding 38 of relay DC, winding 41 of relay GD, and winding 40 of relay R to the source of current. It will be seen that relay DC, upon energizing, closed a circuit from ground G^9, windings 64 and 63 of relay BS in series, contact 62 of relay DC and resistance coil 52 to the source of current, but as the two windings of relay BS are wound differentially it will not energize.

The foregoing has all happened as a result of the dial at substation A being turned forward and now as it runs back the continuity of the loop is interrupted a number of times at impulse contact 22. As a result of these interruptions the line conductor 20, which is connected through relay IMP to the source of current, is opened, thereby causing relay IMP to be deenergized a number of times corresponding to the digit pulled on the dial. The ground G^8 is not interrupted and therefore relays DC, GD and R will remain energized while these impulses are coming in. At each deenergization of relay IMP an impulse is delivered to magnet SMA over the following circuit:—ground G^{10}, winding of magnet SMA, wiper W—6 and second position thereof, contact 65 of relay GD, contact 36 of relay IMP, contact 59 of relay DC and resistance coil 60 to the source of current. Magnet SMA will operate at each impulse and step its wipers W—7, W—8, W—9, W—10, W—11 and W—12 to a point on their bank corresponding to the first digit of the number desired.

Assuming that number "1" was turned on the dial, the magnet SMA will advance its wipers from the first to the second set of terminals and then the ground G^8 at substation A will be disconnected from the line conductors just before the dial reaches normal. Relay DC will now again become differential and release but relays IMP, GD and R will be held operated over the line. Relay DC, upon deenergizing, closes the following circuit:—ground G^5, winding and contact 48 of magnet SMM, contact 66 of relay R, wiper W—10 and second terminal thereof, contact 67 of relay AX, contact 68 of relay SP, contact 69 of relay DC and

resistance coil 52 to the source of current. This circuit causes the first switch, by means of its magnet SMM, to operate and advance its wipers W—1, W—2, W—3, W—4, W—5, and W—6 to the row of terminals corresponding to the number which was recorded on the second switch, as previously described, and as this number was "1" and this second switch was left on the second row of terminals, the first switch will be stopped at the first point of the first group which is the third set of terminals. The circuit for stopping this first switch is as follows:—ground G^3, contact 43 of relay AX, low winding 44 of relay SP, wiper W—12 and second terminal thereof, wiper W—5 and third terminal thereof, wiper W—10 and second terminal thereof, contact 67 of relay AX, contact 68 of relay SP, contact 69 of relay DC and the resistance coil 52 to the source of current. This circuit to ground G^3 does two things, first it shunts the magnet SMM so that it will not aga n energize to move the wipers of the first switch and second it will energize relay SP and lock it over the following circuit:—ground G^5, magnet SMM and contact 48 thereof, contact 66 of relay R, wiper W—10, and second terminal thereof, contact 67 of relay AX, winding 70 of relay SP, contact 69 of relay DC and resistance coil 52 to the source of current.

A circuit is now closed from ground G^{10}, winding and contact 71 of magnet SMA, contact 72 of relay SP, off normal contact 54 and resistance coil 57 to the source of current, which circuit causes the second switch to advance to the eighth set of terminals when wiper W—10 will open winding 70 of relay SP, it will deenergize and the second switch will remain on the eighth set of terminals. A circu't is now closed from ground G^3, contact 43 of relay AX, low winding 44 of relay SP, wiper W—12 and eighth terminal thereof and winding 73 of relay AX to the source of current. The winding 44 of relay SP, being of very low resistance, this relay will not be affected but the winding 73 of relay AX, which is of high resistance, will energize relay AX and lock it from ground G^3, make before break contact 75, winding 74, off normal contact 54 and resistance coil 57 to the source of current. Relay AX, upon energizing, opens contact 67 which clears wiper W—10 so that it may be used for another purpose later, and it closes contact 76, the purpose of which will be described later. The subscriber at substation A may now operate the dial for the second digit but before the results of this operation are described some things will be pointed out in connection with the operation of the dial for the first digit.

In the foregoing description it has been shown that if number "1" is the first digit, the second switch will step to the second set of terminals, establish a circuit by means of its wiper W—12 to cause the first switch to stop on the third set of terminals after which the second switch will be stepped to the eighth set of terminals. It will presently be shown that as the dial is again pulled forward, relay BS will operate and connect in wipers W—7, W—8 and W—9 which are the line and test wipers for the lines beginning with digit "1." Now if number "2" was the first digit, the second switch would step to the third set of terminals, the first switch would advance to the fourth set of terminals and the second switch would be stepped to the eighth set as before, but this time when the dial was pulled forward for the second digit, relay BS would remain normal which would connect in wipers W—10, W—11, and W—12 which are the line and test wipers for the lines beginning with digit "2." If number "3" was the first digit, the second switch would step to the fourth set of terminals, the first switch would be stopped on its eleventh set of terminals (by wiper W—12 being on the fourth terminal) and then the second switch would be advanced to its eighth set of terminals, as before, and in this case, when the dial is turned the second time, relay BS will operate and connect in wipers W—13, W—14 and W—15 which are the line and test wipers for the lines beginning with digit "3." When the second digit is sent in from the dial in this case, the third switch will be operated because wiper W—6 is on the eleventh terminal which terminal is connected to the stepping magnet SMB of the third switch. Similarly, if "4" was the first digit the wipers W—16, W—17 and W—18 of the third switch would be used. By adding other switches connected to wires 77, 78, 79, 80, 81, 82, 83 and 84 and connecting in the off normal contacts like ON′ and ON^2, other groups of lines may be served. It will also be noted that corresponding wipers of each switch second, third, etc., are connected together, but that only one of these switches will be away from normal, or the first set of terminals, at one time, therefore only one set of wipers will be effective. The numbers of the lines reached on these switches are represented by L—11, L—21, etc.

Returning now to the point where the subscriber operates the dial for the second digit, relay DC operates, as before and, by means of its contact 59, prepares the impulse circuit for relay IMP. It will be remembered that the first switch was on its third set of terminals and now relay DC, energizing, closes the following circuit:—ground G^5, winding of magnet SMM, and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and third terminal thereof, winding 63 of relay BS, contact 62

of relay DC and resistance coil 52 to the source of current. This circuit will energize relay BS over its winding 63, its winding 64 being sufficiently shunted by magnet SMM to unbalance it. If, however, the first switch was on the fourth set of terminals, because the first digit was "2," the wire 85 connected between the two windings of relay BS would have been open and any current received by one winding would also be received by the other and the relay would not be energized because its windings 63 and 64 are equal and opposite.

Relay BS will lock, when energized, over the following circuit:—ground G^9, winding 86 of relay BS, contacts 87 and 88 of relay BS (contacts 87 and 88 to make before break contact 89 breaks), contact 54 of off normal ON and resistance coil 57 to the source of current. Relay BS, upon energizing, closes the following circuit: ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and third terminal thereof, contact 88 of relay BS, contact 54 of off normal ON and resistance coil 57 to the source of current. This causes the first switch to operate and advance its wipers W—1, W—2, W—3, W—4, W—5 and W—6 to the fourth set of terminals from which point they are again advanced by means of the following circuit: ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and fourth terminal thereof, contact 62 of relay DC and winding of resistance coil 52 to the source of current. If the first switch was on the fourth set of terminals when relay DC operated, this last traced circuit would of course move it to the fifth set but relay BS would not have been operated. It will be seen that the terminals of W—4 are divided into three groups with the corresponding points multipled, therefore the same operations will take place when the third or fourth switches are used instead of the first.

Again returning to the point where the subscriber operates the dial for the second digit, (assuming the number dialed to be 15) the impulse relay IMP will deliver five impulses to the stepping magnet for the second switch over the following circuit:—ground G^{10}, winding of magnet SMA, wiper W—6 and fifth terminal thereof, contact 65 of relay GD, contact 36 of relay IMP, contact 59 of relay DC, and resistance coil 60 to the source of current. As the wipers of the second switch were on the eighth set of terminals when this last series of impulses started, they will now be advanced to the thirteenth set, to which point on the upper set of wipers, is shown a connection to the called line, #15, resistance coil 90 representing the called line cut off relay. When the first switch advanced to the fifth set of terminals the following circuit was closed:—ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, wiper W—5 and fifth terminal thereof, winding of relay TP, common wire 91, interrupter INT and resistance coil 92 to the source of current or, when the interrupter is connected to the generator wire, the circuit will be through lamp LP and generator GN to the source of current. This energizes relay TP, but because of the resistance of TP, magnet SMM will not be energized. Relay TP closes the following circuit to energize relay BY:—ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and fifth terminal thereof, winding 93 of relay BY, contact 94 of relay TP and resistance coil 52 to the source of current. Magnet SMM does not get sufficient current to operate in this case. Now when the dial stops and relay DC deenergizes as before, a circuit is closed from ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and fifth terminal thereof, contact 69 of relay DC and resistance coil 52 to the source of current, which circuit causes the first switch to advance its wipers to the sixth set of terminals. This opens the circuit of relay TP at wiper W—5, TP will deenergize and, after a short interval, retract its armature, but before its armature restores, the called line is tested for its busy or idle condition as follows:—if the line is busy there will either be a ground or an open circuit on the test terminal on which wiper W—9 is resting, (the former if the line had been called and the latter if the line had originated a call, its test wire 27 being open at line switch wiper 14) and if the line is idle a path to the source of current will be found on the test wire. Therefore if the line is busy when relay TP deenergizes there will be no circuit to hold relay BY, it will deenergize and give the calling party the busy signal over the following circuit:—ground G^{12}, common battery, secondary induction coil 95 into which a tone is induced, condenser 96, busy interrupter 97, common busy wire 98, winding 99 of relay R, contact 100 of relay BY, wiper W—4 and sixth terminal thereof, contact 76 of relay AX, contact 66 of relay R, contact 48 and winding of magnet SMM and ground G^5. This current will have no effect on the armature of relay R. A tone will now be induced in the following circuit which the calling party will hear:—ground G^4, resistance coil 34, winding 42 of relay GD, winding of relay IMP, winding 37 of relay DC, through the previously traced circuit of the line switch L and substation A to winding 38 of relay DC, winding 41 of relay GD and winding

40 of relay R to the source of current. If the called line is idle when the first switch steps its wipers to the sixth set of terminals, relay BY will remain energized over the following circuit: ground G^{13}, wiper W—3 and sixth terminal thereof, winding 45 of relay BY, contact 102 of relay BY, contact 103 of relay BS, wiper W—9, test terminal of called line and called line cut off relay (represented by the numeral 90) to the source of current. Now when relay TP deenergizes a circuit is closed from ground G^5, winding of magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and sixth terminal thereof, contact 50 of relay BY, contact 51 of relay TP, and resistance coil 52 to the source of current. This energizes magnet SMM which advances the wipers of the first switch to the seventh set of terminals when the following circuit is closed from ground G^{13}, wiper W—3 and seventh terminal thereof contact 103 of relay BS, and wiper W—9 to the test terminal of the called line, for the purpose of operating the called line cut off relay and preventing this line being called until this connection is released. The circuit of both windings of relay BY is now open and it deenergizes.

The called subscriber's bell will now be rung over the following circuit:—ground G^{14}, battery generator GN, lamp LP, interrupter INT, common generator wire 91, winding of trip relay TP, wiper W—1 and seventh terminal thereof, contact 101 of relay BS, wiper W—7, called line conductor 104, switch hook contact 106 of substation B, condenser 107, ringer *r i*, conductor 105, wiper W—8, contact 108 and relay BS, wiper W—2 and seventh terminal thereof and resistance coil 34 to ground G^4. The effect of the resistance coil 34 will be to force a small amount of the ringing current back through the circuit to substation A, thus giving the calling party an indication that the called bell is being rung. When the called party removes the receiver a direct current path is closed for the above traced circuit which causes relay TP to operate and, by means of its contact 94, close a circuit from ground G^5, winding a magnet SMM and contact 48 thereof, contact 66 of relay R, contact 76 of relay AX, wiper W—4 and seventh terminal thereof, contact 94 of relay TP and resistance coil 52 to the source of current. This operates magnet SMM and moves the wipers of the first switch to the eighth or talking position. The talking battery is fed to the called party over the above traced ringing circuit except that the battery feed coil BF is substituted for the ringing circuit by means of wipers W—1 and W—2 being on the eighth set of terminals. The talking battery for the calling line is fed through relays R, GD, IMP and DC and the two are connected together for voice currents by means of condensers 109 and 110.

The calling party releases the connection by hanging up the receiver which opens the line and allows relays R, GD and IMP to deenergize. Relay R closes the following circuit to energize the cut off relay CO of the line switch L:—ground G^7, contact 111 of relay RS, contact 112 of relay R, trunk wire 47, terminal 31 and wiper 14 of line switch L, and winding 12 of relay CO to the source of current. The magnet ST of the line switch is now operated to advance its wipers to the "home" point from ground G^7, contact 113 of relay RS, terminal 30 and wiper 15 of line switch L, contact 10 of relay CO, contact 17 of magnet ST and the winding of magnet ST to the source of current. It will be noted that this ground G^7 will also keep this trunk busy until relay RS deenergizes. Another circuit may now be traced from ground G^5, winding of magnet SMM and contact 48 thereof, contact 114 of relay R, contact 115 of relay RS, contact 54 of off normal ON and resistance coil 57 to the source of current. This circuit causes magnet SMM to operate and advance the wipers of the first switch to the ninth set of terminals, which is a normal point, when contact 54 will be opened and contact 53 closed. (If the wipers had been in some other section except the first, they would be advanced to some other normal point, the ninth, seventeenth, twenty-fifth and first sets being normal points, and contacts 53 and 54 being switched at each.) A circuit is now closed from ground G^{10}, winding of magnet SMA and contact 71 thereof, contact 116 of off normal ON′, contact 53 of off normal ON and resistance coil 57 to the source of current, which will cause the second switch to advance its wipers to the normal point. If the third or fourth switches had been used it can be seen that a corresponding operation would take place by means of off normal ON^2 for the third switch or ON^3 for the fourth. With all switches at normal the following circuit is closed:—ground G^7, contact 58 of relay RS, contact 119 of off normal ON^3, contact 118 of off normal ON^2, contact 117 of off normal ON′, contact 53 of off normal ON and the resistance coil 57 to the source of current, which short circuits winding 55 of relay RS causing it to release. Relays AX and BS are released when contact 54 of off normal ON is opened, all circuits now being in their normal condition ready for use again.

Referring now to the system of Figs. 2, 3 and 4, at N I show a calling substation instrument extending by interconnecting line conductors to a main station where there is located a line switch for the line LS, adapted to interconnect conductors of the

line circuit of the calling line having the substation N, to an idle one of a plurality of link circuits of which the link circuit conductors LKC are associated with one of the said link circuits, other link circuits being provided which are accessible to the traveling wipers of the line switch LS, but which are not specifically illustrated. The circuit conductors LKC of the selected link circuit are shown extended in Fig. 3, where they terminate in circuits and apparatus of relays which control the various operations of a plurality of traveling switch mechanisms illustrated in Fig. 4, the relay controlling means for various switch mechanisms of Fig. 4 being illustrated in Fig. 3. A plurality of circuit conductors are shown extending from the relay controlling means of Fig. 3 to the continuation of these circuit conductors leading into the switch mechanisms of Fig. 4. A called line substation is illustrated at O in Fig. 4, and the line conductors leading therefrom to connector switch bank contacts of one of the switch mechanisms of Fig. 4 being correspondingly illustrated.

Referring particularly to Fig. 4, a plurality of switches each having one direction of movement is illustrated, the first master controlling switch having wipers W—21, W—22, W—23 and W—24 respectively. A pair of auxiliary switches operating under the control of the master controlling switch is illustrated having wipers W—25, W—26, W—27, W—28, W—29, W—30 and W—31, W—32, W—33, W—34, W—35 and W—36 respectively. Each of the three switches is of the type having a plurality of wipers adapted to be simultaneously moved to simultaneously traverse their associated contacts under the propelling actuation of a single stepping magnet, the same stepping magnet being used to restore the switch to normal by stepping the switch in the same direction as in the stepping which accompanies the selective function. The stepping magnet for the master controlling switch is illustrated as SMS, and for the auxiliary switches SAS and SBS.

It will be understood that in order to increase the number of lines which may be reached by the switching mechanisms of Fig. 4, it would be only necessary to add the required number of auxiliary switches in addition to the pair of auxiliary switches illustrated.

In order to convey a better understanding of the system of my invention and the invention itself, a description will now be had of the operation of the same.

Upon the removal of the receiver *r* at substation N, Fig. 2, preparatory to making a call, an energizing circuit is closed for the line relay LLR of line switch LS as follows:—ground G^{20}, terminal 150, wiper 151, contact 152 of cut off relay COR, line conductor 153, induction coil *id*, switch hook contact 154, transmitter *tr*, impulse contact 155, contact 156 of relay *ch*, line conductor 157, contact 158 of relay COR, wiper 159, terminal 160 and winding of relay LLR to the source of current. The line relay LLR when energizing, closes a circuit to cause the line switch wipers 151, 159, 161, 162 and 163 to be advanced from the "home" point to the next adjacent row of terminals, which is a trunk point, said circuit being as follows: ground G^{21}, contact 164 of relay LLR, terminal 166, wiper 161 and winding 167 of relay COR to the source of current which energizes relay COR and then ground G^{22}, extends through contact 172 of relay LLR, terminal 173, wiper 162, contact 170 of relay COR, contact 169 of line switch stepping magnet SST and the winding of magnet SST to the source of current, causing the switch to advance its wipers to the second row of terminals. If this trunk is busy there will be a ground on terminal 174 which will keep relay COR energized and will cause the magnet SST to again operate, bringing the wipers to the third row of terminals which is another "home" point from which the wipers will be stepped as from the other "home" point on to the fourth row which represents the idle trunk shown on Fig. 3 and Fig. 4. When relays LLR and COR operated they closed a holding circuit for the line relay LLR by means of their contacts 165, 175 and 176 so that the line relay LLR would not deenergize when the wipers 151 and 159 opened the original circuit. When the idle trunk is reached there will be no ground potential on terminals 177 and 178, therefore the wipers will come to rest and relays COR and LLR will deenergize. This line was immediately made busy to incoming calls by the line relay LLR closing contact 164 and as long as wiper 163 is standing on a trunk point, ground G^{22}, wiper 163, terminal 185, 186, etc., will be on the incoming test wire 187. Relay LLR upon deenergizing, opens the battery bridge of the line switch at contacts 165 and 175, and relay COR, upon deenergizing, extends the line conductors 153 and 157 to trunk conductors 184 and 183 respectively. Relay COR also closes the following circuit to make this seized trunk busy:—ground G^{22}, wiper 163, terminal 186, contact 171 of relay COR, wiper 162, terminal 177 and trunk conductor 181. It is of course understood that trunk wires LKC are multiply connected to corresponding points on other line switches like LS.

The above traced closed circuit of substation N, through line switch LS on trunk conductors 184 and 183 may be traced on Fig. 3 to ground G^{23} at sensitive relay SN and the source of current at marginal relay

MG. causing them both to energize. It will here be mentioned that relays SN and MG feed talking battery to the calling party over the above traced circuit and that condensers 190 and 191 are used for the voice current path between the calling and called parties. A circuit is also closed from ground G^{22}, wiper 163, terminal 186, contact 171 of relay COR, wiper 162, terminal 177, trunk conductor 181, contact 192 of "secondary release" relay SR, wire 193, wiper W—21 and first terminal thereof, contact 203 of the stepping magnet SMS of the first switch and the winding of said magnet to the source of current. This circuit causes magnet SMS to operate and advance the wipers W—21, W—22, W—23 and W—24 of the first switch to the second set of terminals.

Relay MG. being energized, now closes a circuit to move the wipers of the first switch to the third set of terminals as follows:—ground G^{24}, contact 209 of relay MG, wire 204, wiper W—21 and second position thereof, contact 203 and winding of magnet SMS to the source of current.

The calling subscriber now operates the calling device, whereby the substation impulse springs 155 are interrupted a number of times corresponding to the first digit of the called number. Assuming this number to be "1," these springs 155 will send one impulse which will, on the opening, de-energize relays SN and MG, whereupon MG will close the following circuit:—ground G^{24}, contact 210 of relay MG. wire 205, wiper W—21 and third terminal thereof, contact 203 and winding of magnet SMS to the source of current, which advances the wipers of the first switch to the fourth set of terminals. Just after this opening of contact 155, contact 188 closes which inserts relay *ch* in line conductor 157, this relay will immediately energize and by opening its contact 156, will open the circuit to the impulse contact 155. With this high resistance relay (2000 ohms for instance) in the line, marginal relay MG will not energize but sensitive relay SN will energize and cause the first switch to advance its wipers to the sixth set of terminals over the following circuit:—ground G^{25}, contact 211 of off normal ON, (off normal contacts ON and ON′ are associated with the first switch and are closed when the wipers are on any but the first set of terminals) contact 213 of relay SN, wiper W—21 and its fourth and fifth terminals in turn, contact 203 and winding of magnet SMS to the source of current. A circuit is now closed from ground G^{26}, winding 215 of "change-over" relay CHO, wire 207. wiper W—21 and sixth terminal thereof, contact 203 and winding of magnet SMS to the source of current. Magnet SMS will not energize in series with relay CHO but CHO energizes and locks over the following circuit:—ground G^{25}, contact 211 of off normal ON, contact 216 of relay CHO, winding 217 of relay CHO, and resistance coil 218 to the source of current. A circuit is also closed from ground G^{25}, contact 211 of off normal ON, low resistance coil 221, contact 222 of "cut-in" relay CI, contact 220 of relay CHO, wire 207, wiper W—21 and sixth terminal thereof, contact 203 and winding of magnet SMS to the source of current. which circuit causes the first switch to advance its wipers to the seventh set of terminals. Relay CHO closes another circuit from ground G^{27}, contact 223 of "stop" relay STP, wire 202, contact 227 and winding of magnet SAS, wire 201, contact 228 of "busy test" relay BT, contact 229 of relay CHO, contact 224 of relay STP and resistance coil 219 to the source of current, which circuit will cause the second switch to advance its wipers to the first set of terminals, assuming that the second switch was left on the second normal point on the previous call, (second and third switches have a first normal point, first set of terminals, and a second normal point, thirteenth set of terminals) when the following circuit is closed:—ground G^{28}, contact 230 of auxiliary relay AX, low winding 231 of relay STP, contact 232 of relay CI, wire 233, wiper W—24 and seventh terminal thereof, wiper W—30 and first terminal thereof to a point between magnet SAS and the resistance coil 219 to the source of current. This effectively shunts out the magnet SAS, causing it to come to rest and at the same time energizing relay STP. It will be noted that if the second switch was resting on the first set of terminals (first normal point) when relay CHO operated, the above traced shunt circuit would have been immediately established which would have caused relay STP to operate as before but magnet SAS would not be stepped. Relay STP will lock over the following circuit:—ground G^{28}, contact 257 of relay AX, contact 255 of relay CHO, contact 258 and winding 259 of relay STP to the source of current. Before proceeding with the operation after relay STP energizes, it will now be pointed out what happens when other numbers such as "2," "3" or "4" are turned on the dial for the first digit.

Assuming the calling subscriber to operate the dial for number "2," the impulse springs 155 at substation M will be opened and closed twice, the first opening, as before described, will cause the first switch to advance its wipers to the fourth set of terminals. Impulse springs 155 are now closed causing relays SN and MG to energize and SN will again cause the first switch to advance its wipers to the sixth set of terminals. Relay MG in this case being energized, winding 215 or relay CHO is

shunted by ground G^{25}, contact 211 of off normal ON, low resistance coil 221, contact 222 of relay CI, contact 246 of relay MG to the winding 215 of relay CHO, so that CHO will not energize. This circuit from ground G^{25} is also traced from contact 246 of relay MG, wire 207, wiper W—21 and sixth terminal thereof, contact 203 and winding of magnet SMS to the source of current, which circuit causes the first switch to advance its wipers to the seventh set of terminals. A circuit is now closed from ground G^{24}, contact 209 of relay MG, wire 204, wiper W—21 and seventh terminal thereof, contact 203 and winding of magnet SMS to the source of current, which circuit causes the wipers of the first switch to be advanced to the eighth set of terminals. Now when impulse contact 155 is opened for the second impulse, relays SN and MG will deenergize, and relay MG, by means of contact 210 will step the first switch to the ninth set of terminals. Relay *ch* at substation N will now be energized as before, prevent relay MG from energizing but allowing relay SN to operate and, by means of the previously traced circuit through its contact 213, this time cause the first switch to step to the eleventh set of terminals. A circuit is now closed, as before, for energizing the locking relay CHO which relay now causes the first switch to take another step and go to the twelfth set of terminals where the circuit is again closed to cause the second switch to advance to the second normal point (the thirteenth set of terminals) in this case because the stopping circuit through winding 231 of relay STP is now by way of the twelfth terminal of wiper W—24, wire 247 and the second normal point of wiper W—30.

If "3" was the first digit the first switch would have stepped around as before but would have come to rest on the seventeenth set of terminals and the stopping circuit would have been by way of wiper W—24, as before, this time through wire 248 to stop the third switch on its first set of terminals. If "4" was the first digit the first switch would have stepped to the twenty-second set of terminals and the stopping circuit would have been by way of wiper W—24, as before, this time through wire 249 to stop the third switch on its thirteenth set of terminals which is the second normal point. The starting circuit for the magnet SAS of the second switch is by way of contact 228 of relay BT as before traced but if either "3" or "4" is the first digit, relay BT will be operated and switch the starting circuit to contact 250 which leads by way of wire 200 to the magnet SBS of the third switch. Relay BT is energized as wiper W—24 passes the fourteenth and fifteenth terminals over the following circuit:—ground G^{28}, contact 230 of relay AX, low winding 231 of relay STP, (not affecting the armature of relay STP) contact 232 of relay CI, wire 233, wiper W—24 and fourteenth and fifteenth terminals thereof, wire 244, winding of relay BT and resistance coil 251 to the source of current. Relay BT locks from ground G^{25}, contact 211 of off normal ON, contact 252 of relay BT, winding of relay BT and resistance coil 251 to the source of current.

Returning now to the point where relay STP was energized after number "1" was turned on the dial at substation N, it will be remembered that the first switch was left on the seventh set of terminals and the second switch on the first set. Relay CHO, being energized, closes the following circuit:—ground G^{29}, wiper W—22 and seventh terminal thereof, wire 236, contact 254 of relay CHO and winding of relay MG to the scurse of current, this ground also going back on truck conductor 183, through the line switch LS, line conductor 157 which short circuits relay *ch* at the substation N. Relay *ch* deenergizes, short circuits itself, relay MG energizes and closes a circuit from ground G^{24}, contact 209 of relay MG, wire 204, wiper W—21 and seventh terminal thereof, contact 203 and winding of magnet SMS to the source of current, which circuit causes the wipers of the first switch to be advanced to the eighth set of terminals. Relay STP, upon energizing, closes the following circuit to cause the second switch to advance its wipers to the second set of terminals: ground G^{28}, contact 230 of relay AX, low winding 231 of relay STP, contact 232 of relay CI, wire 233, wiper W—24 and sixth, seventh or eighth terminal thereof, wiper W—30 and first terminal thereof, winding of magnet SAS and contact 227 thereof, wire 202, contact 225 of relay STP and resistance coil 219 to the source of current. It will be seen that if the first digit was "2" this above traced circuit would be by way of wire 247, causing the second switch to be stepped to its fourteenth set of terminals, and similar circuits may be traced for the third switch when the first digit is "3" or "4."

When the first switch is advanced to the eighth set of terminals, as above described, a circuit is closed from ground G^{29}, wiper W—22 and eighth terminal thereof, wire 238, contact 226 of relay STP, contact 256 of relay AX, and resistance coil 218 to the source of current, which ground short circuits winding 217 of relay CHO, causing it to deenergize. Contact 255 of relay CHO now opens and disconnects the original locking circuit of relay STP but relay STP will remain energized and relay AX will now energize over the following circuit: ground G^{25}, contact 211 of off normal

ON, winding of relay AX, contact 258 and winding 259 or relay STP to the source of current, which circuit also holds relay STP.

The subscriber at substation N may now operate the dial for the second digit when relays SN and MG will function the same as before: Relay MG, upon deenergizing, closes a circuit from ground G^{24}, contact 210 of relay MG, wiper W—21 and eighth terminal thereof, contact 203 and winding of magnet SMS to the source of current, which circuit causes the wipers of the first switch to be advanced to the ninth set of terminals. A circuit is now closed from ground G^{29}, wiper W—22 and ninth terminal thereof, wiper W—30 and second terminal thereof, (this terminal is multiplied to the other terminal of this second switch which follows the second normal point, and to corresponding terminals of the third switch, and is for the purpose of causing the proper switch to be stepped no matter which normal point it had been set on,) winding of magnet SAS and contact 227 thereof, wire 202, contact 225 of relay STP, and resistance coil 219 to the source of current, which circuit causes magnet SAS to operate and advance the wipers of the second switch to the third set of terminals. Relay SN, now being energized, will cause the first switch to advance its wipers past the ninth and tenth sets of terminals over the previously traced circuit. The switch will be stepped past the eleventh set if relay MG is energized. Thus it will be seen that the first switch follows the impulses of the dial until the "change-over" point is reached when relay MG remains deenergized as before described. It will also be seen that for each impulse, wiper W—23 of the first switch travels over a multiple of wire 260 (this wire is multiplied to two terminals and a bridging brush used so as to deliver a long impulse to the magnet SAS or SBS,) and in so doing closes a circuit from ground G^{25}, contact 211 of off normal ON, contact 261 of relay CHO, wire 239, wiper W—23 and terminal thereof, wire 260, multiple terminals and wiper W—30, winding of magnet SAS, multiple terminals and wiper W—29, wire 195, contacts 263 and 264 of relay AX, contact 225 of relay STP and resistance coil 219 to the source of current. This circuit causes the second switch to step its wipers in accordance with the number of impulses sent in for the second digit.

It will be seen that the wire 260 is connected to multiple terminals of wiper W—36 and that magnet SBS is connected to multiple terminals of wiper W—35, and if the third switch, instead of the second, was stepped away from its normal point, these ground impulses through wiper W—23 would be delivered to the magnet SBS.

When the last impulse is sent in from the dial, relay CHO energizes as before and closes the following circuit: ground G^{30}, winding of second "change-over" relay CV, contact 255 of relay CHO, contact 258 of relay STP and winding 259 of relay STP to the source of current, which circuit energizes relay CV. No matter where the wipers of the first switch are resting when this happens (they may have made more than a complet revolution or they may have made less than a complete revolution depending on the number of impulses sent in for the second digit,) they will now be advanced to the twenty-fourth set of terminals, the following circuits to ground being found on the different terminals of wiper W—21: 1—ground G^{22} from line switch LS; 2, 7, 12, 17 and 22—ground G^{24} through contact 209 of relay MG; 3, 8, 13, 18 and 23—ground G^{30} and contact 265 of relay CV; 4, 5, 9, 10, 14, 15, 19 and 20—ground G^{25} through contact 213 of relay SN, and 6, 11, 16, 21 and 26—ground G^{25} through low resistance coil and contact 246 of relay MG. It will be seen that if number "1" or number "2" is the first digit, relay AX energizes before the wipers of the first switch reach the fourteenth set of terminals, therefore the ground for operating relay BT will be open at contact 230 of relay AX. Relay BT will however be operated from ground G^{29} as wiper W—22 passes the sixteenth terminal.

When the wipers of the first switch get to the twenty-fourth set of terminals a test is made of the called line as follows:—If said line is busy there will be ground on the terminal on which wiper W—27 (or W—33) is resting, placed there either by a terminating call, as will be presently shown, or because the called line had originated a call when this ground would have been placed on the test terminal as previously described in connection with wire 187 of Fig. 2. With wiper W—22 on its twenty-fourth terminal a circuit is closed from ground G^{29}, wiper W—22 and twenty-fourth terminal thereof, wire 235, contact 265 of relay CV, and resistance coil 251 to the source of current, said circuit short circuiting relay BT which relay being slow acting, after a short interval retracts its armature. The calling party now hears the busy signal which is on common wire 266 (placed on wire 266 in the same or a similar manner as described for the operation of Fig. 1), by way of condenser 267, contact 232 of relay CI, wire 233, wiper W—24 and twenty-fourth terminal thereof, wire 240, condenser 191, trunk conductor 184, through the line switch LS and substation N; trunk conductor 183, winding of relay MG and through the battery to the other side of the busy induction coil. Disconnection takes place when the calling

party hangs up as will be presently described.

Assuming the number dialed to be "41" and this number represented by the substation O, the circuit operation after the first switch reaches the twenty-fourth set of terminals will now be described. Relay BT will be short circuited as above described but before it releases, a circuit will be closed from ground G^{25}, contact 211 of off normal ON, contact 213 of relay SN, contact 268 of relay CV, winding 269 and contact 270 of relay CI, wire 239, wiper W—23 and twenty-fourth terminal thereof, wire 241, contact 271 of relay BT, wire 197, wiper W—33 (or W—27 if the first switch was used) terminal and resistance coil 272 to the source of current. This circuit energizes relay CI and, by means of contact 273 which makes before contact 270 breakes, it locks from ground G^{25}, contact 211 of off normal ON, resistance coil 221, contact 273 and winding 274 of relay CI to the source of current. The first switch now advances its wipers to the twenty-fifth set of terminals over the following circuit, before the armature of relay BT is retracted:—ground G^{25}, contact 211 of off normal ON, contact 253 of relay BT, contact 275 of relay CI, wire 245, and winding of magnet SMS to the source of current, which circuit energizes magnet SMS and, when relay BT releases and opens contact 253, magnet SMS deenergizes.

A circuit is now closed for making the called line busy to other calls and for operating the cut off relay of the called line switch (represented by coil 272) from ground G^{25}, contact 211 of off normal ON, resistance coil 221, contact 276 of relay CI, wire 197, wiper W—33 and terminal thereof and cut off relay 272 to the source of current.

The called party's bell is now rung over the following path: ground G^{32}, battery, resistance coil 279, generator GEN, interrupter IT, lamp LM, ringing trip relay TRP, wire 243, wiper W—24 and twenty-fifth terminal thereof, wire 233, contact 277 of relay CI, wire 198, wiper W—32, called line conductor 280, ringer *rg* at substation O, condenser *cn*, line conductor 281, wiper W—31, wire 199, contact 278 of relay CI, wire 239, wiper W—23 and twenty-fifth terminal thereof to ground G^{31}. When the called party answers a direct current path is closed which energizes relay TRP, closing the following circuit: ground G^{33}, contact 280 of relay TRP, to the winding of relay AX short circuiting AX which deenergizes. This ground G^{33} also goes through contact 255 of relay CHO to the winding of relay CV, short circuiting it, causing it to deenergize and the short circuit is now maintained for relays AX and CV by ground G^{28} and contact 257 of relay AX, so that when relay TRP deenergizes neither of these relays AX and CV, will again energize. Relay CV, upon deenergizing, closes a circuit from ground G^{25}, contact 211 of off normal ON, contact 213 of relay SN, contact 281 of relay CV, wire 208, wiper W—21 and twenty-fifth terminal thereof, contact 203 and winding of magnet SMS to the source of current, which circuit causes the first switch to operate and advance its wipers to the twenty-sixth set of terminals. The talking battery is now fed to the called party from ground G^{34}, winding 282 of battery feed coil BF, wire 240, wiper W—23 and twenty-sixth terminal thereof, wire 239, contact 278 of relay CI, wire 199, wiper W—31 and terminal thereof, called line conductor 281, through the usual substation apparatus O, line conductor 280, wiper W—32 and terminal thereof, wire 198, contact 277 of relay CI, wire 233, wiper W—24 and twenty-sixth terminal thereof, wire 242, and winding 283 of coil BF to the source of current. The wires leading into coil BF are connected to condensers 190 and 191 which condensers are also connected to the calling line as previously described. The talking circuit is now established between the calling and called parties.

The release of the connection will now be described. The calling party, hanging up the receiver, causes relays SN and MG to be deenergized and the following circuit closed by relay SN: ground G^{25}, contact 211 of off normal ON, contact 214 of relay SN, contact 212 of off normal ON', winding of primary release relay PR, contact 284 of relay PR, common interrupter contact 296, and resistance coil 295 to the source of current, which circuit energizes relay PR and locks it with battery through resistance coil 286 and contact 285. Relay PR could be energized over the above circuit during the time that relay SN was deenergized as the impulses were being sent, but the circuit would be again opened, allowing relay PR to deenergize, when relay SN was energized. In this case however, relay SN will remain deenergized for a sufficient time to allow the common interrupter contact 297 to extend ground by way of contact 287 of relay PR, contact 290 and winding 294 of secondary release relay SR to the source of current. Relay SR will energize and lock from ground G^{25}, contact 211 or off normal ON, contact 291 and winding 294 to the source of current, this locking circuit holding relay SR in its operated position until the first switch restores to normal when, by the opening of off normal contact 211, the current will be disconnected from winding 294. A circuit is now closed from this off normal ground G^{25} and contact 292 of relay SR by way of wire 196, wiper W—28 and all off normal terminals thereof, winding and contact 227 of magnet SAS,

wire 202, contact 225 of relay STP, and resistance coil 219 to the source of current, which circuit causes the wipers of the second switch to be advanced to the nearest normal point. If the third switch was the one used instead of the second, this ground would go through wiper W—28 and normal (first or thirteenth) terminal thereof, wiper W—34 and all off normal terminals thereof, winding and contact 234 of magnet SBS, wire 202, contact 225 of relay STP, and resistance coil 219 to the source of current, which circuit would cause the wipers of the third switch to be stepped to their normal point. A circuit is now closed over this above traced path from ground by way of the normal terminal of wiper W—34, contact 203 and winding of magnet SMS to the source of current, which circuit causes the wipers of the first switch to be advanced to its first set of terminals when off normal contacts 211 and 212 open and break the stepping circuit for the first magnet and the locking circuit for all relays. Relay SR, by opening contact 298, releases relay CI which deenergizes and keeps the line wipers W—25 and W—26 or W—31 and W—32 clear while they are stepped over terminals of lines which may be in use.

The line switch LS is released from ground G^{35}, low winding 293 of relay SR, contact 289 of relay SR, trunk conductor 182, line switch terminal 178, wiper 161 and winding 167 of line switch cut-off relay COR to the source of current, thereby energizing relay COR which in turn closes a circuit from ground G^{35}, low winding 293 of relay SR, contact 288 of relay SR, trunk conductor 181, line switch terminal 177, wiper 162, contact 170 of relay COR, contact 169 and winding of magnet SST to the source of current. The line switch wipers are now given one step which takes them to a "home" point and, by opening the circuits of line switch terminals 177 and 178, relay SR is deenergized. The circuits are now in normal condition ready to again be used.

It will be understood that whereas I have illustrated specific embodiments of my invention, that the same is capable of being embodied in systems varying widely in structural details from that specifically illustrated and described, but what I claim is my invention is defined in the following claims:—

1. In an electromechanical telephone switching system, the combination with a main station trunk circuit, of a telephone line adapted to be connected thereto, of a telephone substation for the said line, a sending device at the said substation, switching mechanism for the said trunk circuit under the control of the said sending device, the said switching mechanism comprising a plurality of switches, one of the said switches being a steering switch and another of the said switches being a combined register and connector switch, means to operate the substation sender to give the said combination switch a predetermined setting in accordance with the first digit of the called line number, means responsive thereto, to cause the said steering switch to take a setting corresponding to the setting of the said combination switch, means operative after the said setting of the steering switch to cause the said combination switch to always take a second setting which is the same for every case being independent of the first position setting of the said combination switch, and means responsive to the second operation of the said substation dial to operate the said combination switch to cause it to make connection with the terminals of the desired called line.

2. In an electromechanical telephone switching system, the combination with a main station trunk circuit, of a telephone line adapted to be connected thereto, of a telephone substation for the said line, a sending device at the said substation, switching mechanism for the said trunk circuit under the control of the said sending device, the said switching mechanism comprising a plurality of switches, one of the said switches being a steering switch and another of the said switches being a combined register and connector switch, means to operate the substation sender to give the said combination switch a predetermined setting in accordance with the first digit of the called line number, means responsive thereto, to cause the said steering switch to take a setting corresponding to the setting of the said combination switch, means operative after the said setting of the steering switch to cause the said combination switch to always take a second setting which is the same for every case being independent of the first position setting of the said combination switch, a plurality of other connector switches, means responsive to the said setting of the said steering switch to select a given one of the said other connector switches or the said combination switch, and means responsive to the second action of the substation sender to cause the said selected switch to operate to make connection with the terminals of the desired called line.

3. In an electromechanical telephone switching system, the combination with a main station trunk circuit, of a telephone line adapted to be connected thereto, of a telephone substation for the said line, a sending device at the said substation, switching mechanism for the said trunk circuit under the control of the said sending device, the said switching mechanism comprising a plurality of switches, one of the said switches being a steering switch and another of the

said switches being a combined register and connector switch, means to operate the substation sender to give the said combination switch a predetermined setting in accordance with the first digit of the called line number, means responsive thereto, to cause the said steering switch to take a setting corresponding to the setting of the said combination switch, means operative after the said setting of the steering switch to cause the said combination switch to always take a second setting which is the same for every case being independent of the first position setting of the said combination switch, a plurality of other connector switches, means responsive to the said setting of the said steering switch to select a given one of the said other connector switches or the said combination switch, means responsive to the second action of the substation sender to cause the said selected switch to operate to make connection with the terminals of the desired called line, a plurality of brush sets on each of the said switches, and a relay responsive to the setting of the said steering switch to determine which brush set of the selected switch shall be used to make connection with the terminals of the desired called line.

4. In an electromechanical telephone switching system, the combination with a main station trunk circuit, of a telephone line adapted to be connected thereto, of a telephone substation for the said line, a sending device at the said substation, switching mechanism for the said trunk circuit under the control of the said sending device, the said switching mechanism comprising a plurality of switches, one of the said switches being a steering switch and another of the said switches being a combined register and connector switch, means to operate the substation sender to give the said combination switch a predetermined setting in accordance with the first digit of the called line number, means responsive thereto, to cause the said steering switch to take a setting corresponding to the setting of the said combination switch, means operative after the said setting of the steering switch to cause the said combination switch to always take a second setting which is the same for every case being independent of the first position setting of the said combination switch, and means responsive to the second operation of the said substation dial to operate the said combination switch to cause it to make connection with the terminals of the desired called line, a plurality of brush sets for the said combination switch, only one of which is used to make the above desired connection with the called line, and relay means responsive to the said steering switch setting to select a particular brush set to make connection with the desired called line.

5. In a telephone system, the combination with a telephone line, a plurality of central office trunk circuits, a line switch for the said line adapted when the said line is a calling line, to interconnect the said line with an idle one of the said link circuits, a line relay for the said line switch, substation apparatus for the said line, means under the control of the said substation apparatus to operate the said line relay, means under the control of the said line relay to operate the said line switch, normal circuit connections from the line conductors of the said line to the said line relay, substitute circuit conductors for connecting the said line relay to the said line conductors when the said switch is operating, the said substitute conductors comprising normally open contacts of the said line relay, substation apparatus to disable the said line relay, whereby the said line relay is operatively dissociated from the telephone line conductors by the rupture of the said normally open contacts.

6. In a telephone system, the combination with a telephone line, substation apparatus for the said line comprising a substation sending device, an idle trunk circuit, a line switch for the said line adapted to make connection with the said idle trunk circuit, switching means in the said trunk circuit under the control of the said sending device, a line relay controlling the said line switch, substation apparatus adapted to operate the said line relay when the said line is a calling line, normal connections for the said line relay to the said line comprising normal contacts of the said line switch, secondary circuit connections to connect the said line relay with the said line conductors when the said switch is operated, the said secondary circuit connections comprising normally open contacts of the said line relay, which contacts are closed when the said relay is operated, and disabling means for the said line relay under the control of the said sending device.

7. In a telephone system, the combination with a telephone line, substation apparatus for the said line comprising a substation sending device, an idle trunk circuit, a line switch for the said line adapted to make connection with the said idle trunk circuit, switching means in the said trunk circuit under the control of the said sending device, a line relay controlling the said line switch, substation apparatus adapted to operate the said line relay when the said line is a calling line, normal connections for the said line relay to the said line comprising normal contacts of the said line switch, secondary circuit connections to connect the said line relay with the said line conductors when the said switch is operated, the said secondary circuit connections comprising

normally open contacts of the said line relay, which contacts are closed when the said relay is operated, disabling means for the said line relay under the control of the said sending device, the said disabling means operating to disable the said line relay to rupture the said secondary connections when the sending device is operated to control the said switching means.

8. In a telephone system, an incoming circuit, a multi-brush automatic switch individual to said incoming circuit, a plurality of outgoing circuits arranged in groups terminating in said automatic switch, a set of brushes on said switch for each group of outgoing circuits terminating thereat, means for moving all of said sets of brushes into successive engagement with the terminals of said outgoing circuits, means including a progressively movable switch associated with said multi-brush switch for controlling the operation of said automatic switch and means including said progressively movable switch for selectively rendering one or another of said sets of brushes effective to connect said incoming circuit to a wanted outgoing circuit.

9. In a telephone system, an incoming circuit, a plurality of automatic switches individual to said incoming circuit, groups of outgoing circuits terminating in each of said automatic switches, each automatic switch being provided with a set of brushes for each group of outgoing circuits terminating thereat, means including a progressively movable switch individual to said incoming circuit for rendering effective one or another of said automatic switches to select a group of trunks, and means including said progressively movable switch for rendering effective a set of brushes of the selected switch for extending said incoming circuit to a wanted outgoing circuit of the selected group.

10. In a telephone system, a subscriber's telephone line, a plurality of trunk lines, a non-numerical switch for extending said subscriber's line to an idle trunk line on the initiation of a call, a plurality of structurally independent switches individual to each trunk, groups of outgoing circuits terminating in each of said automatic switches, means including a progressively movable switch individual to a selected trunk for rendering one or more of said automatic switches effective and means including said progressively movable switch for rendering effective a set of brushes of the selected switch to extend the selected trunk line to a wanted outgoing line.

11. In a telephone system, an incoming circuit, an automatic switch individual to said incoming circuit, groups of outgoing circuits terminating in said automatic switch, said automatic switch being provided with a group of brushes for each set of outgoing circuits terminating thereon, a progressively movable switch associated with said incoming circuit and means including said automatic switch for variably setting said progressively movable switch in accordance with its own adjustment, and means including said progressively movable switch for selectively rendering effective one of said sets of brushes of said automatic switch for connecting said incoming circuit to a wanted outgoing circuit.

In testimony whereof, I hereunto subscribe my name this 29th day of March A. D. 1919.

WINFRED T. POWELL.