A. B. SMITH.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED MAR. 25, 1914.

1,258,956.

Patented Mar. 12, 1918.

2 SHEETS—SHEET 1.

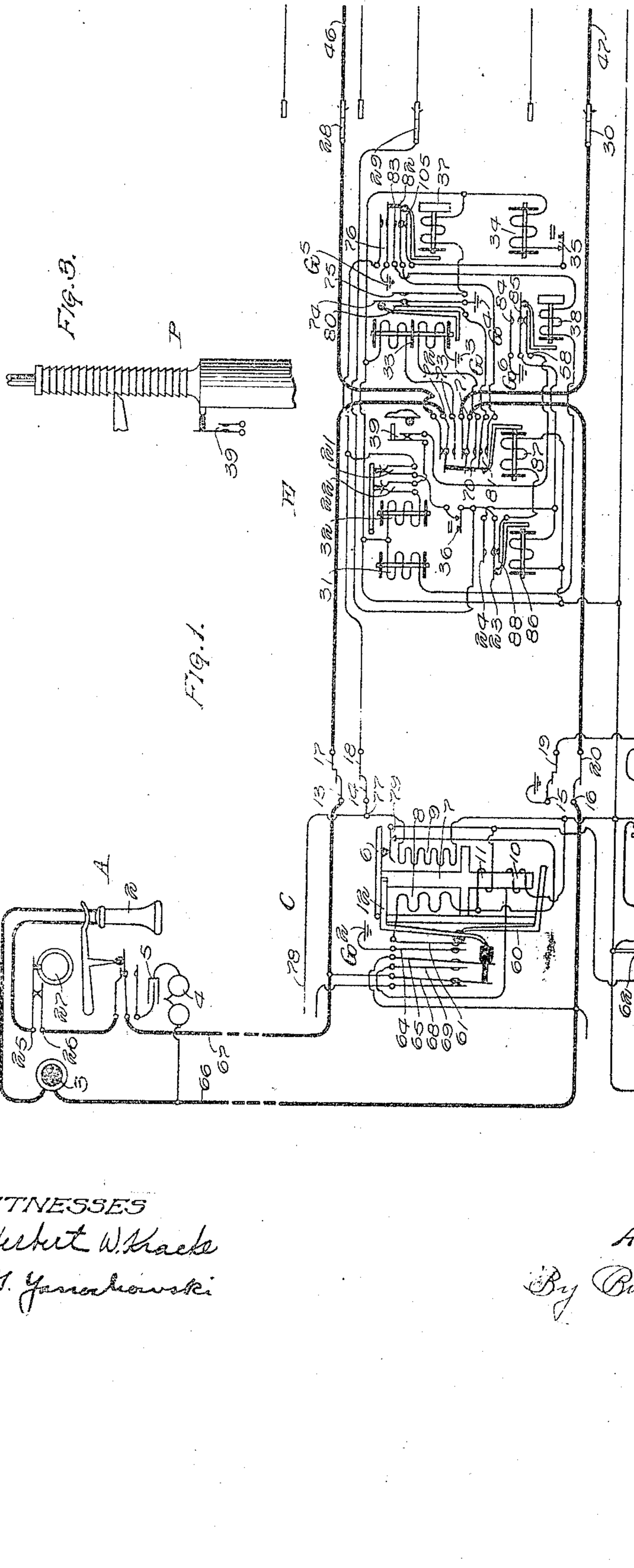

FIG. 1.

FIG. 2.

WITNESSES
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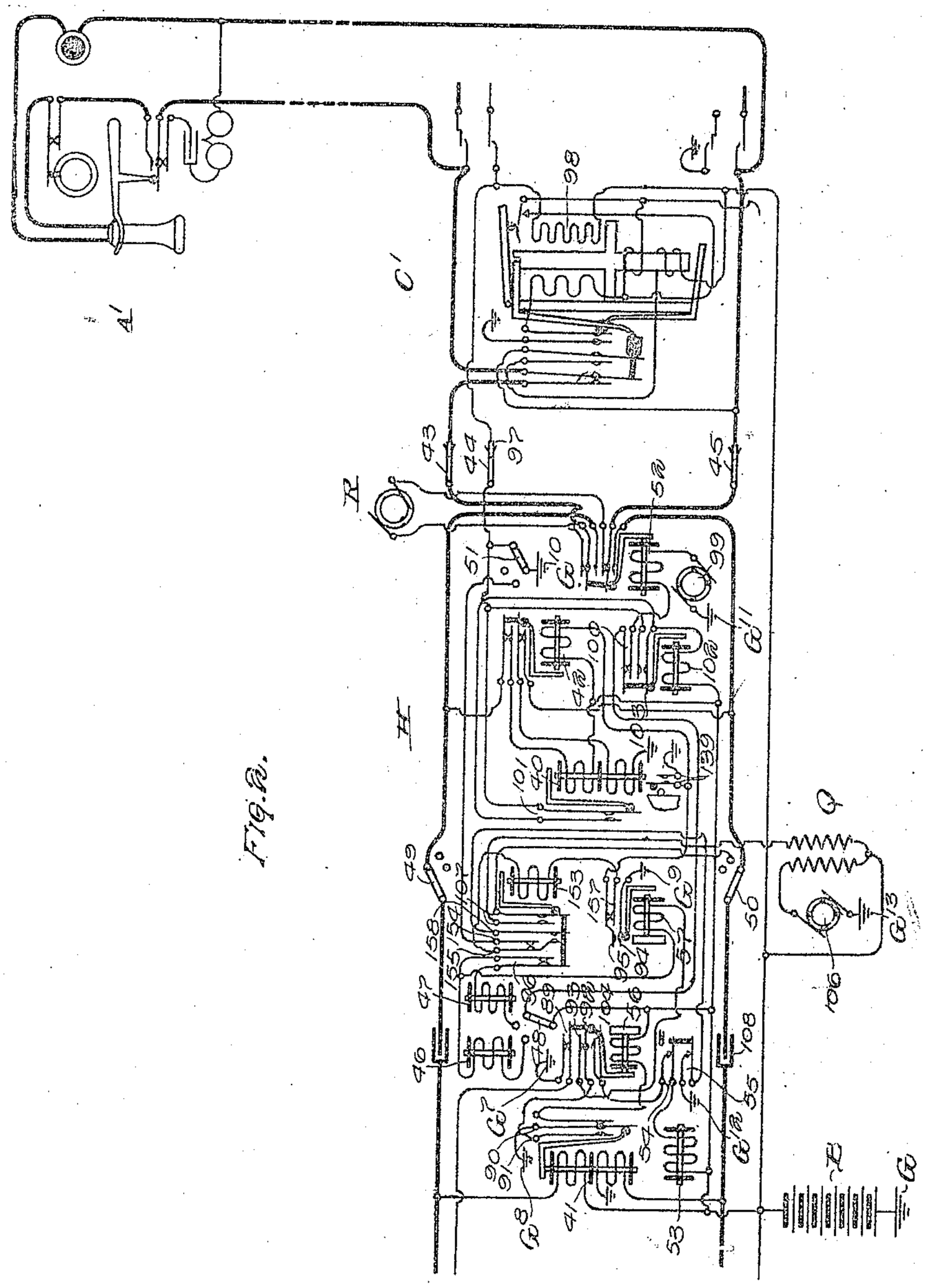

Fig. 2.

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UNITED STATES PATENT OFFICE.

ARTHUR BESSEY SMITH, OF EVANSTON, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,258,956. Specification of Letters Patent. Patented Mar. 12, 1918.

Application filed March 25, 1914. Serial No. 827,064.

To all whom it may concern:

Be it known that I, ARTHUR BESSEY SMITH, a citizen of the United States of America, and resident of Evanston, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems and more particularly to improvements in the automatic switches employed in such systems.

Heretofore, automatic selector and connector switches have been employed, which switches have one motion to select a group and a second motion to find a line in this selected group. In connection with the selector switches, this first movement has been a numerical movement—that is, a definitely controlled movement—while the second movement to select an idle trunk has been non-numerical—that is, one which is automatically controlled by the switch itself, which movement is non-predetermined. In the connector switches both of these movements have been numerical operations.

In systems in which a ten point calling dial is employed—that is, a calling mechanism which is adapted to send at the most ten impulses at any one operation—the groups of contacts in the selector or connector switches have necessarily been limited to ten. By my invention, however, it is possible to increase the number of these groups and to have the selector or connector switch respond to two successive series of impulses to select a given group, and to then automatically select an idle trunk in the selected group, as in the case of a selector, or to respond to the next series of impulses, as in the case of the connector, to find a line in the selected group. Thus it is possible to increase the capacity of an exchange without increasing the number of switches which it is necessary to employ in establishing a connection between any two lines.

These and other objects of my invention will be more clearly understood by reference to the accompanying drawings, in which—

Figures 1 and 2 show a complete circuit connection in an automatic telephone system embodying the principles of my invention.

Fig. 3 is a detail view showing a portion of the switch shaft.

The automatic substation A (Fig. 1) comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. It is also provided with a suitable call-sending mechanism for controlling the automatic switches, which mechanism is represented diagrammatically by a pair of impulse springs 25 and 26 and an impulse wheel 27, which latter may be controlled by a dial (not shown) provided with finger holes in such a way that the impulse springs may be momentarily separated a number of times corresponding to the respective digits of the number of the called subscriber.

The subscriber's individual switch C (Fig. 1) is of the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, being, however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910.

The master switch D (Fig. 1) is of the same general type as that disclosed in British patent to R. W. James No. 26,301, referred to above, being, however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910, also referred to above. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position to engage the terminals of an idle trunk line.

The selector switch E (Fig. 1) is of the general type of selector switch as disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, except that the co-called side switch is omitted, and the circuits are modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series, as shown in British patent to T. G. Martin No. 10,376 of 1912, and are further modified to operate in accordance with the principles of my invention. Among other details, the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 28, 29 and 30 carried by the switch shaft P shown in Fig. 3. This shaft, instead of being adapted to be stepped up ten steps so as to contact with any one of ten levels of bank contacts, is provided with twenty vertical teeth so that this shaft is adapted to be stepped up through twenty steps. The bank of contacts, however, instead of being divided into twenty groups, consists of but

nineteen groups, the group corresponding to the tenth step of the switch shaft being omitted for reasons to be hereinafter more clearly set forth. The operation of this switch shaft is controlled in the usual manner through the vertical magnet 31 and the rotary magnet 32. These magnets in turn are controlled by the double-wound line relay 33, while the release of the switch is controlled by the release magnet 34, which, upon energizing, withdraws the retaining pawls from the shaft. This selector is likewise provided with a pair of slow acting relays 37 and 38—that is, relays which are slow to release their armatures upon deënergizing—a locking relay 86 and a switching relay 87, the controlling circuits and operations of which magnets will be more clearly set forth when the operation of the switch is described. Located in the circuit of the rotary magnet there is a pair of normally closed contact springs 39, which are adapted to be separated when the switch shaft is raised to the tenth step, in the manner shown in Fig. 3.

The connector switch H (Fig. 3) is of the same general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series, as shown in British patent to T. G. Martin No. 1419 of 1910, hereinabove referred to. Among other details, the connector H comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 43, 44 and 45 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 46 and a rotary movement controlled by the rotary magnet 47. The shaft of the connector switch is likewise provided with twenty vertical teeth, whereby this shaft can be raised through twenty steps, in a manner similar to the selector shaft shown in Fig. 3. The operations of the switch are controlled through the medium of the double-wound line relay 41, which is bridged across the trunk. The connector is likewise provided with the usual back-bridge relay 40, through the windings of which the called line is provided with talking current, together with the slow acting relays 56 and 57 and the release magnet 53, the busy relay 153 and the private magnet 42. This private magnet controls the usual side switch comprising the wipers 48, 49, 50 and 51. The circuits and operations of these relays and magnets will be more clearly pointed out in the description of the operation of this switch. A pair of normally open contacts 139 is likewise provided, which contacts are adapted to be closed when the switch shaft is raised to the tenth level. The springs 54 and 55 are normally open and are adapted to be closed when the switch has been raised one or more steps from its lowest position. Ringing current is adapted to be supplied to the called line from the generator R, the application of this ringing current being controlled by the ringing relay 52 and the ringing cut-off relay 102. Busy signaling current is furnished in the usual well-known manner from the busy signaling machine Q.

The line switch C′ and the subscriber's substation A′ are similar to the line switch C and the subscriber's substation A.

A general description of the apparatus having been given, it will now be explained how a connection can be established between the line of substation A and the line of a called substation A′.

Since the apparatus disclosed herein is in general well known in the art, and is described in the publications herein referred to, its operation will be explained in a more or less general way.

When the subscriber at substation A removes his receiver 2 preliminary to making a call, an energizing circuit is closed through the line winding 10 of the line switch C, whereupon this line switch operates in the well-known manner to connect with a idle trunk, which we will assume to be the one extending to the selector E. This operation is fully described in the patents referred to, and as it forms no part of my present invention it is not thought necessary to further describe the same. When the connection is thus extended to the selector E, the line relay 33 is energized over a circuit extending from ground G^3 through the lower winding of the relay 33, springs 70 and 71, springs 20 and 16, conductor 66, substation A, conductor 67, springs 13 and 17, springs 72 and 73 and the upper winding of the relay 33 to battery B. The relay 33, upon energizing, closes a circuit from ground G^4 through the springs 74 and 75 and the relay 37 to battery B. The relay 37, upon energizing, closes a circuit from ground G^5 through the springs 76 and springs 18 and 14 to the point 77, thence one branch extends over conductor 78 to the connector private bank contact associated with the calling line and multiples of the same. This guarding potential prevents any subscriber from connecting with the substation A when said substation is calling. Another branch extends from the point 77 through the holding winding 9 of the line switch C to battery B. This circuit through the holding winding 9 is closed before the armature 60 falls back after the circuit through the line winding 10 is broken by the attraction of the armature 12. The armature 60 does not

fall back immediately upon the pulling up of the armature 12, due to the fact that simultaneous with the attraction of the armature 12 is the pulling up of the plunger arm 6, which short-circuits the auxiliary winding 11 by closing the springs 79. This short-circuiting of the winding 11 tends to retard the deënergization of the core and thus the armature 60 is held in an operated position until enough time has elapsed for the circuit through the winding 9 to be closed, whereby the plunger arm 6 is held in an operated position.

The calling subscriber now operates his calling device for the first digit of the called number. Assuming that this digit is any number from 1 to 9, such as two, the operation of the calling device causes the substation impulse springs 25 and 26 to be separated twice momentarily, each time breaking the circuit of the line relay 33 of the selector E. The relay 37 of the selector being slow acting does not deënergize during the momentary interruptions of its circuit by the relay 33, and consequently each time the latter relay deënergizes, an impulse is transmitted over the circuit extending from ground G^4 through the springs 74 and 80, springs 81, springs 82 and 83, relay 38 and the vertical magnet 31 to battery B. The vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled contacts 35 and 36 are closed. The slow acting relay 38 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit extending from ground G^6 through the springs 84 and 85 and the relay 86 to battery B. The relay 86, upon energizing, forms a locking circuit for itself extending from ground G^5 through the springs 76, springs 21, off-normal springs 36, springs 23 and 24 and the relay 86 to battery B. Thus upon the deënergization of the relay 38 after the last impulse is delivered to the vertical magnet, the relay 86 remains energized and the circuit of the rotary magnet 32 is closed, which circuit extends from ground G^5 through the springs 76, springs 21, off-normal springs 36, springs 23 and 24, springs 85 and 58, springs 39, springs 22 and the rotary magnet 32 to battery B. The rotary magnet 22, upon energizing, rotates the shaft wipers one step and, by opening the springs 21 and 22, disconnects ground G^5 from itself and from the relay 86. If the first trunk line of the second level is idle, the relay 86 deenergizes as soon as the springs 21 are opened. If this trunk line is busy, however, the private wiper 29 find the contact which it engages provided with a guarding ground potential which is transmitted to the relay 86 through the springs 23 and 24, thereby preventing it from deënergizing. The rotary magnet 32, however, deënergizes when the springs 22 are opened, regardless of whether the relay 86 remains energized or not. If the relay 86 remains energized, the circuit of the rotary magnet will be again closed as soon as its armature drops back far enough to close the springs 21 and 22. The rotary magnet will, therefore, operate in a manner similar to that of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper 29, whereupon the relay 86 deënergizes. The relay 86, upon deënergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of said rotary magnet and closes the circuit of the switching relay 87, which circuit extends from ground G^5 through the springs 76, springs 21, off-normal springs 36, springs 23 and 88 and the relay 87 to battery B. The relay 87, upon energizing, disconnects the line relay 33 from the line and extends the line connection over the heavy conductors shown through the wipers 28 and 30 to the connector H.

If, however, in extending a connection it was necessary that the selector switch be raised to a level above the tenth level, the twelfth level for instance, in order to extend the connection to the called line, the calling subscriber would first operate the calling device for the digit 0, which operation sends ten impulses over the line, and which ten impulses would operate to raise the selector E to the tenth level in a manner similar to that just described, and, as has been previously stated, in this position of the shaft the normally closed contact springs 39 in the circuit of the rotary magnet are opened. As a result, when the relay 38 deënergizes after the last vertical impulse has been delivered to the vertical magnet through it, the circuit of the rotary magnet will not be closed, due to the opening of the springs 39. Consequently, when the calling subscriber operates his calling device for the second digit 2, the vertical magnet of the selector E again operates to raise the switch shaft and wipers two steps to a position opposite the twelfth row or level of bank contacts. Since the springs 39 are opened only while the switch shaft is standing at the tenth vertical step, the deënergization of the relay 38 will now close the circuit of the rotary magnet 32, which will operate in a manner hereinbefore explained to advance the shaft wipers over the bank contacts until an idle trunk line leading to an idle connector switch is found.

The line relay 41 of the connector H thereupon becomes energized and closes the circuit of the relay 56, which in turn, upon

energizing, completes a circuit extending from ground G^7 through the springs 89, private wiper 29, springs 23 and 88 and the relay 87 to battery B. A branch of the above circuit may be traced from the private wiper 2 through the off-normal springs 36, springs 21 to the holding winding of the line switch C over the circuit previously traced. This circuit maintains the relay 87 and the winding 9 energized after their original energizing circuits are broken by the relay 37, which deënergizes shortly after the line relay 33 is disconnected from the line.

The calling subscriber now operates the calling device for the next digit of the called number, which we will assume to be 2, whereupon the substation impulse springs 25 and 26 are separated twice momentarily, each time breaking the circuit of the line relay 41 of the connector H. The relay 56 of the connector being slow acting does not deënergize during the momentary interruptions of its circuit by the relay 41, and consequently each time the latter relay deënergizes, an impulse is transmitted over the circuit extending from ground G^8 through the springs 90 and 91, springs 92 and 93, relay 57, vertical magnet 46 and the side switch wiper 48 (in first position) to battery B. The vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts and at the same time the shaft-controlled contacts 54 and 55 are closed. The slow acting relay 57 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit from ground G^9 through the springs 94 and 95 and the private magnet 42 to battery B. This circuit is broken when the relay 57 deënergizes after the last impulse has been delivered to the vertical magnet. The breaking of this circuit causes the private magnet 42 to deenergize, thus permitting the side switch to pass to second position. In passing from first to second position the side switch wiper 48 transfers the battery connection from the vertical magnet 46 to the rotary magnet 47.

If, however, the called subscriber's line terminated in a level of the connector above the tenth level, such as the twelfth level, it would then be necessary for the calling subscriber to first operate his calling dial for the digit 0 to thus raise the switch shaft of the connector to the tenth level and to then operate his dial for the digit 2, which would raise the switch shaft two more steps to the twelfth level. This operation is rendered possible for the reason that when the switch shaft of the connector reaches the tenth level, the contact springs 139 are closed, which closes a ground connection through the private magnet 42, thus preventing this private magnet from deënergizing after the first series of impulses is received and thus the side switch is maintained in first position and the next series of impulses pass through the vertical magnet to raise the switch shaft the two additional steps necessary. As soon as the switch shaft is raised above the tenth level, the springs 139 again separate and thus, after these two impulses have been transmitted, the private magnet deënergizes in the usual manner and the side switch is tripped to second position and the battery connection transferred from the vertical magnet 46 to the rotary magnet 47.

The calling subscriber now operates his calling device for the last digit, which I will assume to be 2, in response to which the connector line relay operates to transmit two impulses through the rotary magnet 47, whereby the shaft wipers are rotated onto the contacts of the desired line. The circuit of the rotary magnet extends from ground G^8 through the springs 90 and 91, springs 92 and 93, relay 57, springs 96, rotary magnet 47 and the side switch wiper 48 (in second position) to battery B. The relay 57 operates in response to the impulses for this digit in the same manner as for the previous digit to cause the private magnet 42 to advance the side switch to third position. By the engagement of the side switch wipers 49 and 50 with their third-position contact points, the line connection is completed with the called line. Upon the engagement of the side switch wiper 51 with its third-position contact point, a circuit is completed through the cut-off winding of the line switch C′. This circuit extends from ground G^{10} through the side switch wiper 51 (in third position) through the private wiper 44, bank contact 97 and the cut-off winding 98 of the line switch C′ to battery B. The cut-off winding of the line switch C′, upon energizing, operates to disconnect the line relay from the called substation. The connection of ground G^{10} with the connector private bank contact associated with the called line prevents the called line from being seized by some other connector switch. By the engagement of the side switch wiper 48 with its third-position contact point, the circuit of the ringing relay 52 is closed. This circuit extends from ground G^{11} through the interrupter 99, ringer relay 52, springs 100 and the side switch wiper 48 (in third position) to battery B. The ringer relay is energized intermittently, due to the interrupter 99, and operates to disconnect the calling line from the called line and to bridge the ringing current generator R across the called line to signal the called subscriber. Upon the removal of the re-

ceiver at the called substation, a circuit will be closed through the back-bridge relay 40. Said relay, upon energizing, will close a circuit from ground G^{10} through the side switch wiper 51 (in third position), springs 101, relay 102 to battery B. The relay 102, upon energizing, opens the circuit of the ringer relay 52 at the springs 100 and closes a locking circuit for itself through the springs 103 independent of the springs 101.

Upon the completion of the conversation, the calling subscriber, by returning his receiver to the switch hook, opens the circuit of the connector line relay 41. The relay 41, upon deënergizing, opens the circuit of the relay 56, which in turn, upon deënergizing, removes the holding ground for the relay 87 and the winding 9, and in addition closes a circuit from ground G^8 through the springs 90 and 91, springs 92 and 104, off-normal springs 54 and the release magnet 53 to battery B. The release magnet, upon energizing, operates to remove the retaining pawls from the shaft and its own circuit is opened at the springs 54 when said shaft reaches its lowest position. The deënergization of the relay 87 of the selector E completes a circuit from ground G^4 through the springs 74 and 80, springs 81, springs 82 and 105, off-normal springs 35 and the release magnet 34 to battery B. The release magnet, upon energizing, operates to remove the retaining pawls from the shaft and its own circuit is opened at the springs 35 when said shaft reaches its lowest position. The deenergization of the winding 9 of the line switch C releases the plunger arm 6 and the cut-off armature 12, thus allowing the line switch C to return to normal.

It will thus be seen that I have devised very efficient automatic switches, which switches have three distinct movements, two of which movements are controlled by one motor magnet, while the third movement is controlled by a separate motor magnet. That is, by my invention I provide a switch having but two motor magnets, and the first of these motor magnets is responsive to two separate and distinct series of impulses to operate the switch to select a group, while the second motor magnet is then responsive to impulses to select a line in the selected group. In this manner I am enabled to increase the capacity of the switch without increasing the number of impulses in any other series for controlling the operation of this switch.

While I have illustrated and described my invention in connection with automatic switches of well-known types, which switches have first a vertical motion for selecting groups and then a rotary motion for finding a line in the selected group, it will, of course, be understood that my invention is capable of use in connection with other forms of automatic switches in which different characters of movement are employed for selecting groups and lines.

What I claim as my invention is:—

1. In a telephone system, an automatic switch, a plurality of groups of lines terminating in said switch, a motor magnet, means for transmitting a plurality of series of impulses to said switch to operate said motor magnet to cause said switch to select a group, a second motor magnet, and means for then operating said second motor magnet to connect with a line in the selected group.

2. In a telephone system, an automatic switch, and a plurality of groups of trunk lines terminating in said switch, said switch having a plurality of numerical operations to select a group, followed by a numerical operation for finding a line in the selected group.

3. In a telephone system, an automatic switch having a pair of operating magnets, means for transmitting a plurality of series of impulses to said switch, and means for causing said plurality of series of impulses to at one time control the operation of one of said magnets only, and at another time to control the operation of both of said operating magnets.

4. In a telephone system, an automatic switch, and a plurality of lines divided into groups terminating therein, said switch having three successive numerical operations for first selecting a group of lines and for then finding a line in the selected group.

5. In a telephone system, an automatic switch having vertical and rotary motion, trunk lines divided into a plurality of groups terminating therein, a vertical magnet for controlling the vertical movement of said switch, a rotary magnet for controlling the rotary movement of said switch, means for transmitting a plurality of series of impulses through said vertical magnet to raise said switch to a proper level, and means for then operating said rotary magnet to rotate said switch to connect with the desired line.

6. In a telephone system, an automatic switch having a pair of operating magnets, means for transmitting a series of impulses to said switch, means for causing said impulses to cause the operation of said first magnet, said first means also for transmitting a second series of impulses to said switch, means for causing said second series of impulses to cause the operation of said second magnet, and means controlled by the operation of said first magnet when a certain number of impulses are transmitted to said switch for preventing said second series of impulses from causing the operation of said second magnet.

7. In a telephone system, an automatic switch, having a pair of operating magnets,

means for transmitting a series of impulses to said switch, means for causing said impulses to cause the operation of said first magnet, said first means also for transmitting a second series of impulses to said switch, means for causing said second series of impulses to cause the operation of said second magnet, and means controlled by the operation of said first magnet when a certain number of impulses are transmitted to said switch for preventing said second series of impulses from causing the operation of said second magnet and for causing said second series of impulses to then cause a further operation of said first magnet.

8. In a telephone system, an automatic switch having vertical and rotary movement, a vertical and a rotary magnet for controlling the operation of the same, and normally closed contacts in the circuit of said rotary magnet adapted to be opened when said vertical magnet has been operated a predetermined number of times.

9. In a telephone system, an automatic switch having a plurality of operating magnets, a switch for shifting the connection from one to the other of said magnets, means for transmitting a plurality of series of impulses to said switch to cause the operation of said magnets and for shifting the connection from one to the other of said magnets, and means for preventing said connection being shifted when a predetermined number of impulses are transmitted to said switch.

10. In a telephone system, an automatic switch having a pair of operating magnets, a side switch adapted to shift an operating connection from one to the other of said magnets, means for transmitting a series of impulses through the first of said magnets, means for then operating said side switch to switch the connection to the second of said magnets, and means for preventing the operation of said side switch when said first magnet has been operated a predetermined number of times.

11. In a telephone system, an automatic switch having vertical and rotary motion, a vertical and a rotary magnet for controlling the operation of the same, a side switch, means for first operating said vertical magnet to raise said switch a desired number of steps, means for then operating said side switch to render said vertical magnet inoperative and render said rotary magnet operative, and means for preventing said operation of said side switch when said vertical magnet has operated said switch a predetermined number of steps.

12. In a telephone system, an automatic switch having vertical and rotary motion, a vertical and a rotary magnet for controlling the operation of same, a private magnet, a side switch controlled thereby, means for transmitting a plurality of impulses through said vertical magnet to operate said automatic switch, means for then operating said private magnet to cause the operation of said side switch, and means controlled by a predetermined operation of said vertical magnet for preventing this operation of the private magnet.

13. In a telephone system, an automatic switch, a plurality of groups of lines terminating in said switch, a motor magnet controlled by a plurality of series of impulses transmitted over two sides of a line circuit in series for operating said switch to select a group, and a second motor magnet for then controlling said switch to connect with a line in the selected group.

14. In a telephone system, an automatic switch, a plurality of groups of lines terminating in said switch, a motor magnet, means for transmitting a plurality of series of impulses over two sides of a line circuit in series to said switch to operate said motor magnet to cause said switch to select a group, a second motor magnet, and means for then operating said second motor magnet to connect with a line in the selected group.

15. In a telephone system, an automatic switch, a plurality of groups of trunk lines terminating in said switch, said switch having a motor magnet responsive to a plurality of numerical operations to select a group, and a second motor magnet responsive to a non-numerical operation for finding an idle line in the selected group, and means for controlling the operation of said switch over two sides of a line circuit in series.

16. In a telephone system, an automatic switch, a plurality of groups of trunk lines terminating in said switch, said switch having a plurality of numerical operations to select a group, followed by a numerical operation for finding a line in the selected group, and means for controlling the operation of said switch over two sides of a line circuit in series.

17. In a telephone system, an automatic switch having a pair of operating magnets, means for transmitting a plurality of series of impulses to said switch over two sides of a line circuit in series, and means for causing said plurality of series of impulses to at one time control the operation of one of said magnets only, and at another time to control the operation of both of said operating magnets.

18. In a telephone system, an automatic switch, a plurality of lines divided into groups terminating therein, said switch having three successive numerical operations for first selecting a group of lines and for then finding a line in the selected group, and means for controlling the operation of said switch over two sides of a line circuit in series.

19. In a telephone system, an automatic

switch having vertical and rotary motion, trunk lines divided into a plurality of groups terminating therein, a vertical magnet for controlling the vertical movement of said switch, a rotary magnet for controlling the rotary movement of said switch, means for transmitting a plurality of series of impulses through said vertical magnet to raise said switch to a proper level, means for then operating said rotary magnet to rotate said switch to connect with the desired line, and means for controlling the operation of said switch over two sides of a line circuit in series.

20. In a telephone system, an automatic switch having a pair of operating magnets, means for transmitting a plurality of series of impulses over two sides of a line circuit in series to said switch, means for causing the first series of impulses to cause the operation of said first magnet, means for causing the second series of impulses to cause the operation of said second magnet, and means controlled by the operation of said first magnet when a certain number of impulses are transmitted to said switch for preventing said second series of impulses from causing the operation of said second magnet.

21. In a telephone system, an automatic switch having a pair of operating magnets, means for transmitting a plurality of series of impulses over two sides of a line circuit in series to said switch, means for causing the first series of impulses to cause the operation of said first magnet, means for causing the second series of impulses to cause the operation of said second magnet, and means controlled by the operation of said first magnet when a certain number of impulses are transmitted to said switch for preventing said second series of impulses from causing the operation of said second magnet and for causing said second series of impulses to then cause a further operation of said first magnet.

22. In a telephone system, an automatic switch having vertical and rotary movement, a vertical and a rotary magnet for controlling the operation of the same, normally closed contacts in the circuit of said rotary magnet adapted to be opened when said vertical magnet has been operated a predetermined number of times, and means for controlling the operation of said switch over two sides of a line circuit in series.

23. In a telephone system, an automatic switch having a plurality of operating magnets, a switch for shifting the connection from one to the other of said magnets, means for transmitting a plurality of series of impulses over two sides of a line circuit in series to said switch to cause the operation of said magnets and for shifting the connection from one to the other of said magnets, and means for preventing said connection being shifted when a predetermined number of impulses are transmitted to said switch.

24. In a telephone system, an automatic switch having a pair of operating magnets, a side switch adapted to shift an operating connection from one to the other of said magnets, means for transmitting a series of impulses through the first of said magnets, means for then operating said side switch to switch the connection to the second of said magnets, means for preventing the operation of said side switch when said first magnet has been operated a predetermined number of times, and means for controlling the operation of said automatic switch over two sides of a line circuit in series.

25. In a telephone system, an automatic switch having vertical and rotary motion, a vertical and a rotary magnet for controlling the operation of the same, a side switch, means for first operating said vertical magnet to raise said switch a desired number of steps, means for then operating said side switch to render said vertical magnet inoperative and render said rotary magnet operative, means for preventing said operation of said side switch when said vertical magnet has operated said switch a predetermined number of steps, and means for controlling the operation of said automatic switch over two sides of a line circuit in series.

26. In a telephone system, an automatic switch having vertical and rotary magnet, a vertical and a rotary magnet for controlling the operation of same, a private magnet, a side switch controlled thereby, means for transmitting a plurality of impulses through said vertical magnet to operate said automatic switch, means for then operating said private magnet to cause the operation of said side switch, means controlled by a predetermined operation of said vertical magnet for preventing this operation of the private magnet, and means for controlling the operation of said automatic switch over two sides of a line circuit in series.

27. In a telephone system, an automatic switch having a progressively movable element, a pair of operating magnets for controlling said element, circuits for said magnets, the circuit of one of said magnets controlled at one point by said element at one stage of its operation and again at a different point at a different stage of its operation.

28. In a telephone system, an automatic switch, a vertical and a rotary movable shaft, a vertical operating magnet and a rotary operating magnet for controlling said shaft, a circuit for said rotary magnet, said circuit controlled at one point when said switch is in normal position and again

at another point when said switch is in its off normal position.

29. In a telephone system, a progressively movable element, a pair of coils, means controlled by said coils for moving said element, a circuit including one of said coils, said circuit controlled by said means, and a second means for energizing the other of said coils whereby said first means may be controlled to in turn control the said circuit of the first one of said coils.

30. In a telephone system, a progressively movable element, a pair of coils, means controlled by said coils for moving said element, a circuit including one of said coils, said circuit controlled by said means, and a second means for energizing the other of said coils whereby said first means may be controlled to close the said circuit and also to open said circuit.

31. In a telephone system, a progressively movable element, a pair of coils, means controlled by said coils for moving said element, a circuit including one of said coils, said circuit controlled by said means, and a second means for energizing the other of said coils whereby said first means may be controlled to first close the circuit of the first coil at one point and to thereafter open the said circuit at another point.

32. In a telephone system, an automatic switch having a switch shaft and a pair of magnets for operating said shaft, a plurality of pairs of contacts included in the circuit of one of said magnets, said shaft controlled by the other of said magnets to directly control said pairs of contacts.

33. In a telephone system, an automatic switch having a switch shaft and a pair of magnets for operating said shaft, a plurality of pairs of contacts included in the circuit of one of said magnets, said shaft controlled by the other of said magnets to directly control said pairs of contacts and means for controlling the operation of said switch over the two sides of a line in series.

34. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending an incoming line to an outgoing line, means for controlling said switch to select one group of outgoing lines, automatic means operative thereupon for causing said switch to select an idle one of the selected group of lines, and means for delaying the operation of said automatic means if another group of outgoing lines has been selected.

35. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending an incoming line to an outgoing line, means for producing series of impulses in said incoming lines, a primary and a secondary electromagnet for controlling the operation of said switch, means for operating said primary electromagnet in accordance with one series of impulses, automatic means operative thereupon for actuating said secondary electromagnet, and means for delaying the operation of said automatic means if said primary magnet has been controlled in accordance with another series of impulses.

36. In a selector switch, a directively operable primary magnet and an automatically operable secondary magnet for controlling the operation of said switch, means for actuating said secondary magnet after a completed operation of said primary magnet, and means for operating said primary magnet by a plurality of series of impulses prior to the actuation of said secondary magnet.

37. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending an incoming line to an outgoing line, means controllable over said incoming lines for causing said switch to select an outgoing line in a certain group, and means for causing said switch to select an outgoing line in a predetermined group if it is controlled to select a line in a certain other group.

38. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending an incoming line to an outgoing line, means for controlling said switch to select one group of said outgoing lines, means operative thereupon for controlling said switch to select an idle outgoing line in the selected group, and means for causing said switch to select an idle outgoing line in a predetermined group if the switch is controlled to select another group of said outgoing lines.

39. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending an incoming line to an outgoing line, means controllable over said incoming lines for causing said switch to select a group of said outgoing lines, automatic means for causing said switch to select an idle line in the selected group, and means for causing the selection of an idle outgoing line in another group than the selected one.

40. In a telephone exchange system, incoming lines and groups of outgoing lines, a selector switch for extending a calling incoming line to an outgoing line, an electromagnet controllable over said incoming lines for operating said switch to select a group of outgoing lines, another electromagnet for causing said switch to select an idle outgoing line, and means for causing said switch to select an idle outgoing line in another group than the selected one.

41. In a telephone system, an automatic switch, an operating magnet therefor, two main groups of trunk lines terminating in said switch, each main group being divided into sub-groups, and means for transmitting

a single series of impulses to operate said magnet to cause said switch to select a sub-group in one of said main groups, said means also for transmitting two series of impulses to said magnet to cause said switch to select a sub-group in the other of said main groups.

42. In a telephone system, an automatic switch, an operating magnet therefor, two main groups of trunk lines terminating in said switch, each main group being divided into sub-groups, means for transmitting a single series of impulses to operate said magnet to cause said switch to select a sub-group in one of said main groups, said means also for transmitting two series of impulses to said magnet to cause said switch to select a sub-group in the other of said main groups, a second operating magnet for said switch, and means for operating said second magnet to select an idle trunk line in the selected sub-group of either main group.

43. In a telephone system, a combined first and second selector switch, a directively operable primary magnet for controlling the operation of said switch, and means in one instance for operating said primary magnet by the impulses corresponding to the first digit only of the called number, said means in another instance for operating said primary magnet by the impulses corresponding to the first and second digits of the called number.

44. In a telephone system, a combined first and second selector switch, a directively operable primary magnet and an automatically operable secondary magnet for controlling the operation of said switch, means in one instance for operating said primary magnet by the impulses corresponding to the first digit only of the called number, said means in another instance for operating said primary magnet by the impulses corresponding to the first and second digits of the called number, and means for actuating said secondary magnet after completion of either operation of said primary magnet.

Signed by me at Chicago, Cook county, Illinois, this 12th day of March, 1914.

ARTHUR BESSEY SMITH.

Witnesses:

GEORGE YANOCHOWSKI,

HERBERT W. KRACKE.