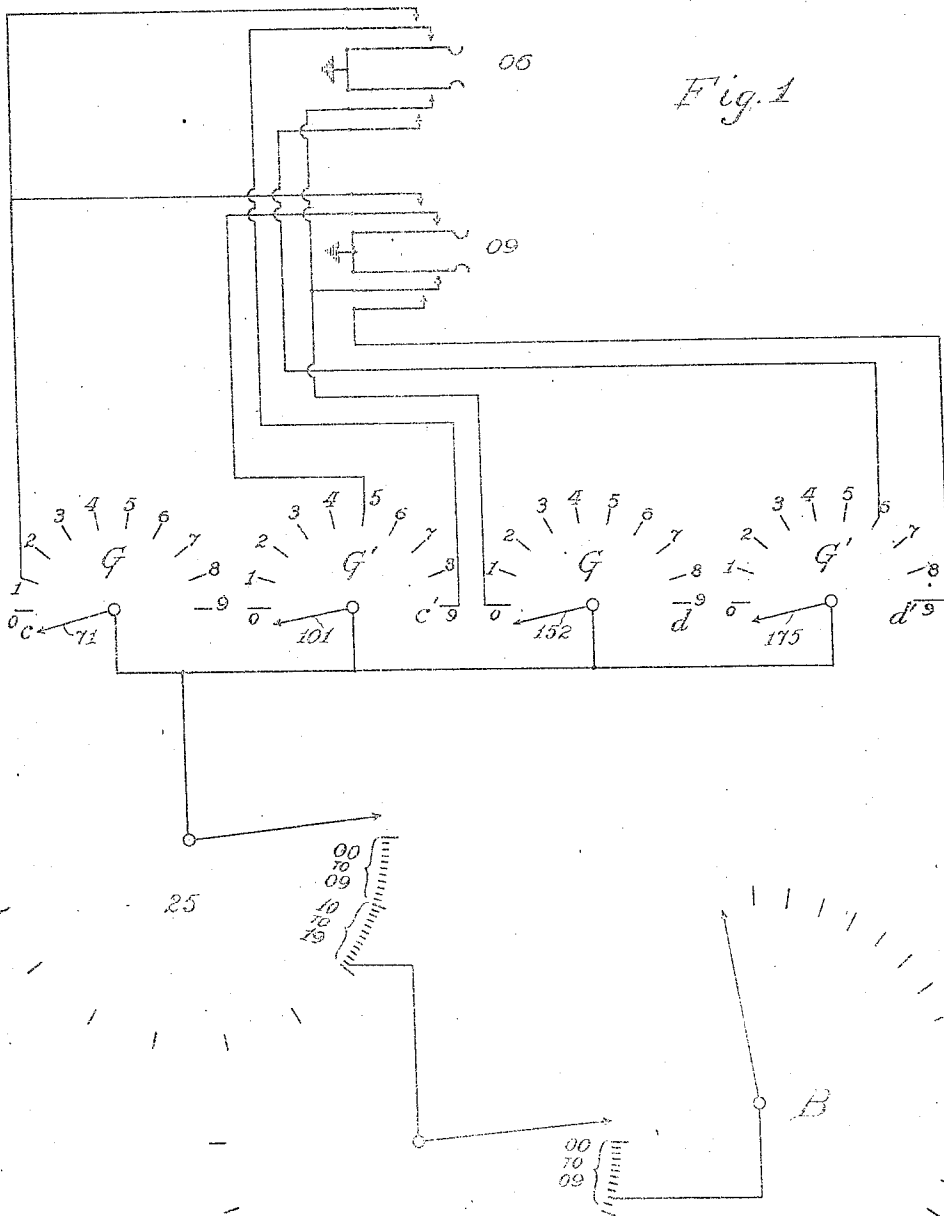


1,126,701.

Patented Feb. 2, 1915.
 5 SHEETS—SHEET 1.



Witnesses:

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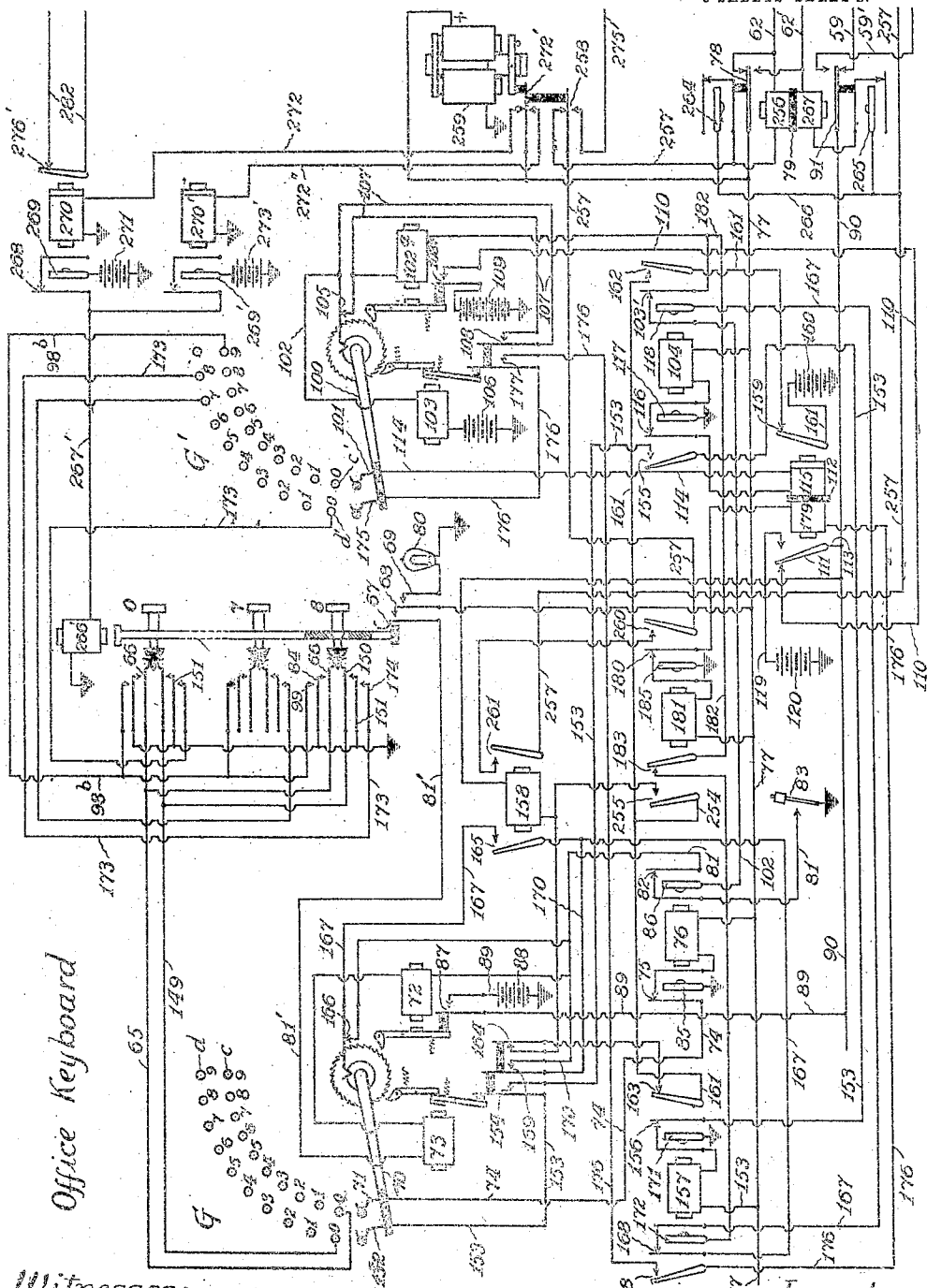
SEMI-MECHANICAL TELEPHONE SYSTEM.

APPLICATION FILED APR. 3, 1907. RENEWED SEPT. 3, 1913.

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6 SHEETS-SHEET 2.



Office Keyboard

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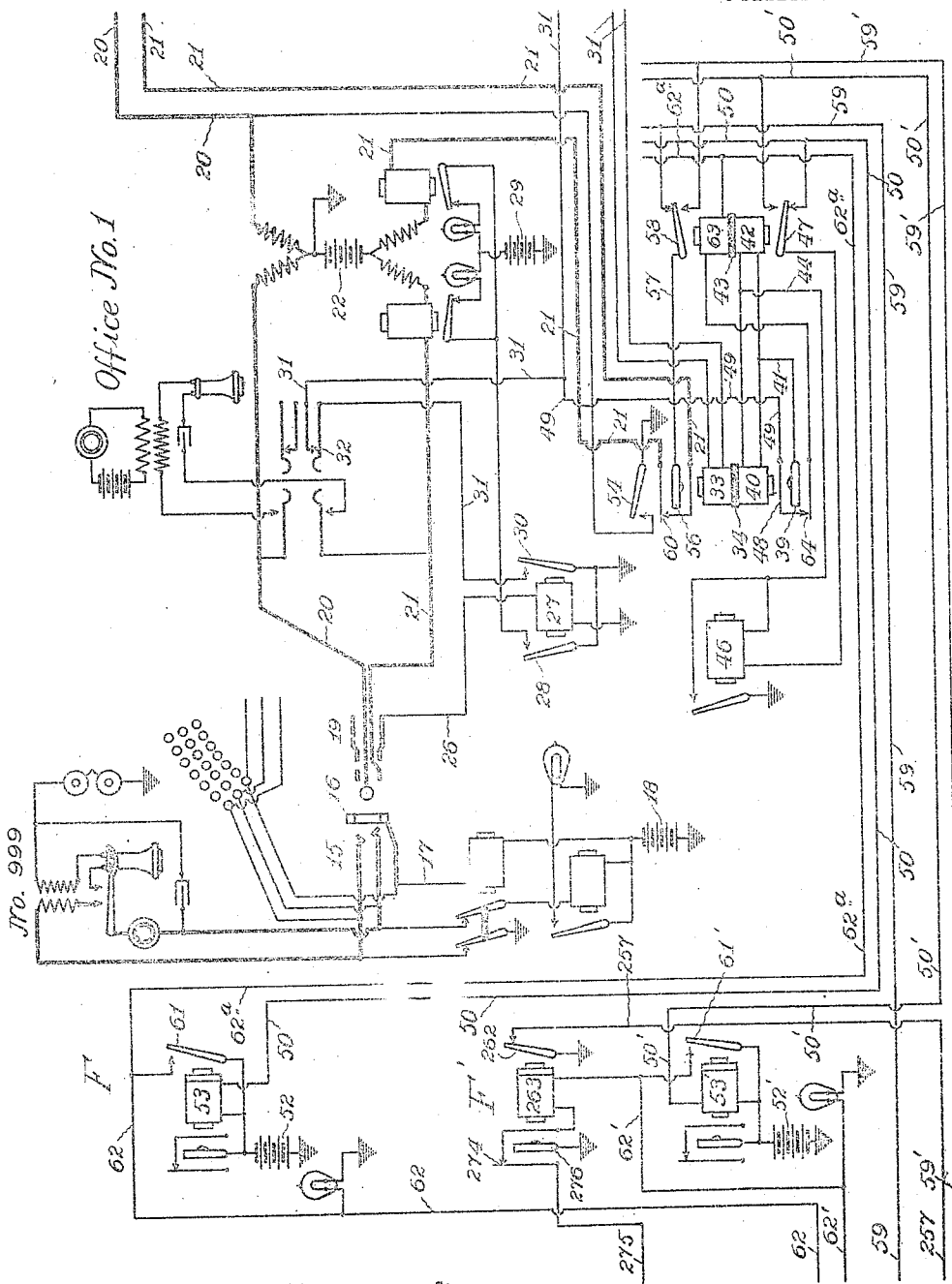
Fig. 2

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1,126,701.

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5 SHEETS—SHEET 3.



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Fig. 3

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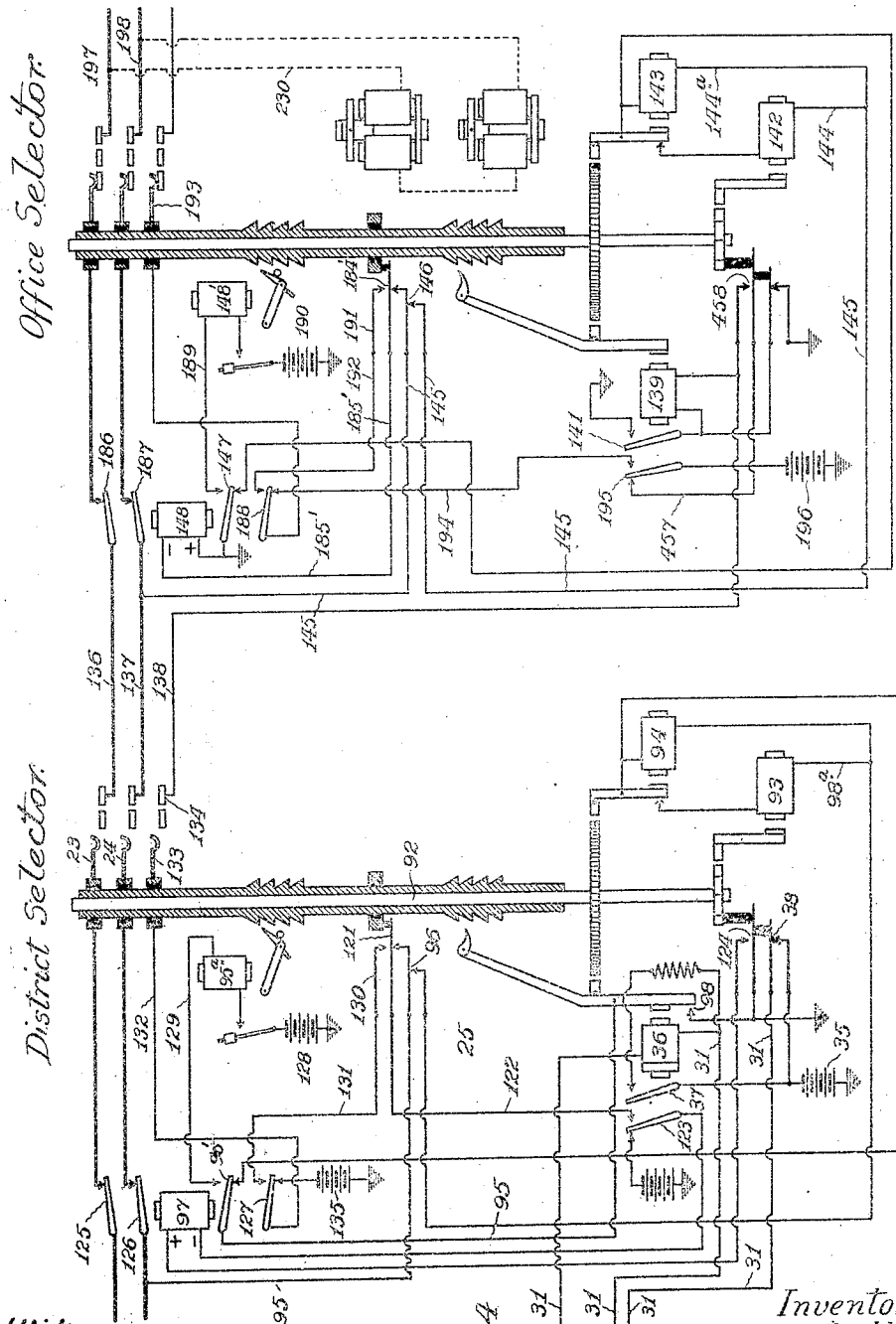
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6 SHEETS-SHEET 4.



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Fig. 4

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5 SHEETS—SHEET 5.

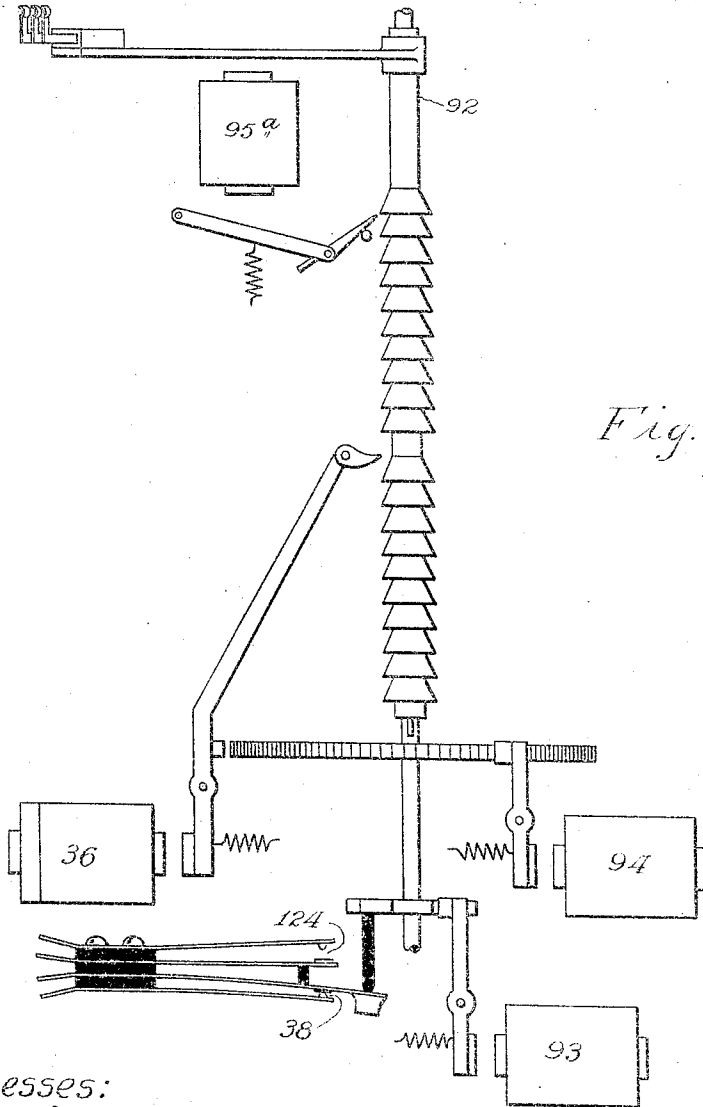
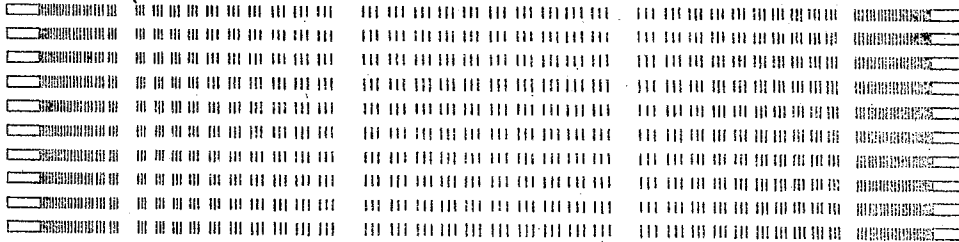


Fig. 5

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UNITED STATES PATENT OFFICE.

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SEMI-MECHANICAL TELEPHONE SYSTEM.

1,126,701.

Specification of Letters Patent.

Patented Feb. 2, 1915.

Application filed April 3, 1907, Serial No. 366,193. Renewed September 3, 1913. Serial No. 788,002.

To all whom it may concern:

Be it known that I, ALBERT M. BULLARD, citizen of the United States, residing at New York, in the county of New York and State of New York, have invented a certain new and useful Improvement in Semi-Mechanical Telephone Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to a telephone exchange system comprising a number of central offices, at each of which a number of lines terminate, the offices being grouped in districts.

My object is, generally speaking, to provide automatic line switching mechanism adapted to be associated with a calling telephone line to select a particular district and a desired office in such district, wherein the line of a called party terminates.

My invention contemplates the provision of a district selector adapted to serve a calling telephone line by picking out the district wherein is located the office to which the called party's line extends, and to unite the calling line with an office selector in the selected district, which selects the office desired, and unites said calling line with a trunk line leading to such office.

A feature of my invention consists in the provision of a number of keys representing the offices of the exchange, each key controlling mechanism adapted to operate the district selector to cause the same to pick out an office selector in the district wherein the office represented by such key falls, and also to actuate the said office selector to choose a trunk line leading to the desired office.

Another feature of my invention consists in the provision of a controller adapted to selectively actuate said switching device. Said controller is adapted when set to supply proper current to the said stepping magnets in proper succession to advance the contact member to the desired terminals.

Another feature of my invention consists in the provision of a polarized relay, which is automatically supplied with current of proper polarity after the long and short step magnets have operated, said relay thereupon completing a pulsating current circuit for the lifting magnet of the contact member to advance said member along a selected row, said relay being maintained energized by current at the busy trunk lines tested by the

contact member until an idle trunk line terminating in such row is reached, whereupon the relay is deprived of current and opens the circuit of the lifting magnet.

Another feature of my invention consists in placing a pair of stepping magnets, in the present case the long and short step magnets, in the same circuit, and supplying said circuit with current of different character, one of said magnets being responsive only to current of one character, and when operated rendering the other stepping magnet inoperative. In the form shown, I provide two magnets in multiple branches of a circuit, said magnets being responsive to currents of different strength, for example, twenty-four and forty-eight volts respectively. The magnet which responds only to the higher voltage current, in operating, breaks the branch containing the other magnet (which of course would respond to such current) and prevents the operation thereof.

Another feature of the invention consists in the arrangement whereby the operating magnets of the controlling mechanism control the application of the operating currents to the said stepping magnets.

A further feature of the invention relates to the method of preventing access to the switching device before the contact member thereof, after being released at the termination of a conversation, has returned to normal position. To this end, I provide means for maintaining the busy condition of the test wire, preferably by placing a test potential upon the multiple terminal or test wire of the switching device during the return of the contact member to normal position.

The present invention is particularly applicable to a telephone exchange system of the type wherein the central office operator answers the call of a subscriber in the usual way, by uniting her connecting circuit with the line of such subscriber, and mechanical switching mechanism completes the connection by uniting the operator's connecting circuit with the called line, the operation of the switching mechanism being controlled by sending apparatus adapted to be actuated by the operator to selectively operate said switching mechanism. In associating my invention with said system, the connecting circuit is led to a district selector, which is adapted to unite said connecting circuit with an office selector in any district. The

5 sending apparatus, which is adapted to be associated with the connecting circuit, has connected therewith an office keyboard, comprising keys representing the digits of the offices in the system, each key when depressed by the operator actuating said district selector to cause the same to unite said connecting circuit with an office selector in the district in which the office represented by said key falls, and also to actuate the said office selector to select a trunk line leading to said office. The key so depressed is locked in such position until the keyboard has completed its work, whereupon said key is automatically restored to normal condition, a signal being displayed while the keyboard is in use and the key depressed, to indicate to the operator the condition of the keyboard.

10 A number of sending apparatuses may be provided at the central office to serve the different connecting circuits, and I provide means actuated when the keyboard has completed its work in connection with a sending apparatus, to automatically transfer the keyboard into association with an idle sending apparatus. In case such second or idle sending apparatus is taken for use by a connecting circuit before the first sending apparatus has completed its work, the keyboard is locked in association with said second sending apparatus independent of the first sending apparatus; but if the second sending apparatus is not so taken for use, it is automatically returned to its association with the first sending apparatus when the same is through its work. I preferably provide a pair of controllers adapted to be successively operated by a depressed office key to selectively actuate both the district selector and the office selector secured thereby.

I will describe my invention more particularly by reference to the accompanying drawings, wherein—

15 Figure 1 is a skeleton diagram to illustrate the method of selecting a given office; Figs. 2, 3 and 4 are diagrams of a portion of a telephone exchange system embodying my invention; and Fig. 5 is a diagrammatic view of a line switching device such as I employ as a district and an office selector.

The same letters of reference indicate the same parts wherever they are shown.

20 Referring first to Fig. 1, I will outline the system shown as embodying my said invention. A district selector 25 is provided having terminals representing the districts of the system, said selector preferably having a number of banks of contacts, as shown in Fig. 5, said banks each containing one hundred terminals arranged in rows, each row being provided with ten terminals representing office selectors in a given district. The contact member of the district selector is adapted to advance in long steps from

group to group of terminals, and in short steps from row to row of a selected bank. Each office-key is adapted to selectively actuate said district selector to pick out an office selector in the district in which lies the office represented by said keys. A pair of controllers G G^1 are provided for the office keys, each controller having two rows of terminals. The row c of controller G represents the tens digits of the districts, while the row c^1 of controller G^1 represents the units digits of the districts. Each office key, when depressed, changes the electrical conditions of the terminals in the rows c c^1 representing the digits of the district in which the office represented by such key lies. For example, if key of office "06" is depressed, the terminals "1," "9" of rows c c^1 are, for example, grounded. The controller G operates first, and advances its brush 71 over the row c to the grounded terminal "1," when it is stopped, the district selector arm in such movement advancing two long steps into operative relation to the bank of terminals representing districts Nos. 10-19. Controller G^1 is now automatically brought into service, and in advancing its brush 101 to terminal "9" causes the district selector arm to advance in short steps to the row of terminals representing selectors in district No. 19, in which office No. 06 is located. Said selector member may now be advanced along the selected row to the terminal of an idle office selector. The office selectors are constructed in a manner similar to the district selectors (Fig. 5) being preferably provided with banks of terminals, each bank preferably containing ten rows of terminals, and each row containing terminals of trunk lines leading to a given office, each bank representing ten offices. The contact member of the selector is preferably arranged to be advanced from bank to bank in long steps, and in short steps from row to row of a selected bank. The controllers G G^1 are provided with rows of terminals d d^1 respectively, representing the tens and units digits of the offices, said controllers being adapted to operate after an office selector has been selected, to operate said selector and pick out a trunk line leading to the desired office. Each office key, when depressed, changes the electrical condition of the terminals of said rows representing its digits. Thus key of office "06" may ground the terminals "0" and "6" of said rows. Then when an idle selector has been secured, the brush 152 will be caused to advance to the grounded terminal "0" of row d , thereby causing the contact member of the selector to advance into operative relation to the bank of terminals representing offices Nos. 00-09. Then the brush 175 is caused to sweep over the row d^1 until it reaches terminal "6," such movement causing the advance of the se-

lector member to the row of terminals representing primary selectors B at office No. 06 in district No. 19, when said selector member is moved along said row to select an idle primary selector.

With this general outline of the system, I will now proceed to describe in detail by reference to Figs. 2-5 the detail operation of an embodiment of my invention. Referring generally to the system shown, as embodying my invention, the operator may be provided with the usual plug for connecting her connecting circuit with the calling line; and said connecting circuit may lead to a district selector adapted to pick out the district wherein is located the office where the called line terminates, and to connect said connecting circuit with a trunk line leading to an office selector in such district, which picks out a trunk line leading to a primary selector at the particular office where the called line terminates. We will assume that subscriber No. 999, whose line is shown in Fig. 3 as terminating in office No. 1, desires connection with the line of subscriber No. 1465 whose line terminates at exchange No. 8 in district No. 9. The line of subscriber No. 999, Fig. 3, extends in two limbs from the substation to the central office No. 1, where the line extends through the usual line signal apparatus to the poles of a central battery. At the central office the usual answering jack 15 is provided for the line, the tumbler 16 of said jack being connected with a conductor 17 which leads through the usual cut-off relay to the free pole of a grounded battery 18. The operator is provided with an answering plug 19 with which to unite her connecting circuit with a calling line, the plug 19 and jack 15 constituting a manual connection switch. The link conductors 20, 21, of the operator's connecting circuit lead from the tip and ring respectively of the answering plug, through the windings of the usual repeating coil, between which is bridged the battery 22 in the usual manner, to the line brushes 23, 24, of a district selector 25, supervisory relays being included in the link conductor 21 on opposite sides of the battery for controlling the usual supervisory signals. The sleeve of the answering plug is connected with a conductor 26 which leads to earth through the winding of a relay 27; said relay 27, whose circuit 26-17 is completed upon the closure of the connection switch, is provided with an armature 28 controlling the application of current from a battery 29 through the supervisory lamps and contacts of the supervisory relays, which control the display of said lamps, to earth.

Association of sending apparatus with connecting circuit.—A sending apparatus, for selectively actuating the line switching mechanism provided for the connecting circuit,

is automatically connected with said connecting circuit when the operator closes her connection switch to unite the connecting circuit with a calling line, and said sending apparatus is automatically disconnected from said connecting circuit when it has completed its work and the switching mechanism has united the connecting circuit with a called line. The armature 30 of relay 27 in the system shown controls the association of a sending apparatus with the operator's connecting circuit. Said armature is connected with earth, while a front contact thereof is connected with a conductor 31 which leads through contacts of a key 32 to the district selector, thence through the retaining magnet 36 of the district selector, winding 33 of relay 34, contacts 38 of the selector arm, to the free pole of a grounded battery 35. The retaining magnet 36 is operated by current in this circuit, and at its armature 37 and front contact connects the battery 35 with conductor 31 independently of the springs 38, closed only while the selector is in normal condition. Current now flows from the battery 35 through the contacts 37 of the retaining magnet, winding of said magnet, conductor 31 to earth. It should be noted that springs 38 when opened at the initial movement of the selector arm, open the portion of conductor 31 including the winding 33 of relay 34.

The relay 34, when initially energized, as previously described, attracted its armature 39 and completed a locking circuit for itself, independent of the circuit of the retaining magnet, by means of its winding 40. The armature 39 is connected with a conductor 41 which leads in multiple through the winding 40 of the relay 34, and the winding 42 of the switching relay 43, to a wire 44, passing through relay 46 to the armature 47 of the switching relay 43; said armature 39 when attracted is adapted to engage a contact spring 48 which is connected by a wire 49 with the conductor 31 leading through the armature 30 and front contact of relay 27 to earth. The armature 47 of switching relay 43 controls the connection of the grounded conductors including the said windings of the relays 34, 43 and 46, with common wires 50, 50', leading respectively to a pair of sending apparatuses F F', a portion only of each being shown, said armature 47 while resting against its back contact connecting said conductor 44 with common wire 50; and when attracted connecting said conductor 44 with common wire 50'.

Assuming that the sending apparatus F is free, and relay 34 has received its initial energization, as above described, armature 39 of said relay, in attracting, causes current to flow from the free pole of grounded

battery 52 associated with sending apparatus F (Fig. 3) through the winding of the controlling relay 53 of said sending apparatus, over the common wire 50 to the connecting circuit and thence through the armature 47 and back contact of relay 43, conductor 44, relay 46 (without operating the same) thence by way of conductor 41 through the windings 40, 42, of relays 34, 43, respectively in multiple (without operating relay 43) through the armature 39 and contact 48 of relay 34, wire 49 to the conductor 31 which is grounded at the armature 30 and front contact of relay 27. Relay 34 is now locked in circuit with the controlling relay at sending apparatus F.

The armature 56 of relay 34 is connected with a conductor 57 leading to the armature 58 of switching relay 43, the back contact of said armature being connected with the common wire 59 leading to sending apparatus F. The armature 56 in its attractive movement is adapted to separate a pair of normally closed springs 60 serially included in the ring strand 21 of the connecting circuit, said armature engaging the member of said springs connected with the portion of the ring strand leading directly to the district stepper. The leads to sending apparatus F are now placed in operative connection with the connecting circuit.

The relay 53 of the sending apparatus F in attracting its armature 61 applies current from the free pole of grounded battery 52 to the feed wire 62, a branch from said feed wire leading through a signal lamp to earth in order that the operator may be kept informed as to the condition of the sending apparatus. Said feed wire supplies current for the operation of the mechanism of the sending apparatus. In case the sending apparatus F had been serving another cord circuit, the particular connecting circuit now in use would have been shifted to the sending apparatus F'. It will be noted that the feed wire of sending apparatus F has a branch 62^a which leads through the winding 63 of the switching relay 43 to a contact spring 64 against which the spring 48 of relay 34 normally rests. Now, if under these conditions the operator had plugged in to answer a call, thereby effecting the energization of relay 27, current would have passed from the branch 62^a of the feed wire (which would have been connected with battery 52 of the busy sending apparatus) through winding 63 of relay 43 contacts 64, 48, of relay 34, to the wire 31 which is grounded at the armature 30 of relay 27. The armatures 47, 58, of the switching relay would have thereupon been attracted and would have switched the wires 57, 44, respectively, to the common wires 59^a, 50^a, respectively, leading to the sending apparatus F'. Furthermore, when the ar-

mature 39 of relay 34 had been attracted and the winding 40 of said relay had found a circuit by way of the battery at sending apparatus F', the holding winding 42 of the switching relay would have received current and maintained the switching relay energized.

Operation of office keys and district selector.—In the present system, which is designed for use in a large city, there would be a number of districts in each of which would be located a number of central offices. I have accordingly employed a district selector arranged to pick out the districts in which is located the office desired, and an office selector belonging to such district capable of picking out a trunk line leading to the particular office desired. I have arranged the office keys so that when a given key is operated it will cause the district selector to locate the proper district, and also actuate an office selector in such selected district to select the proper office.

Referring now to the sending apparatus, and to the controlling mechanism associated therewith and known as the office keyboard, Fig. 2, we will describe the process of picking out a trunk line leading to a primary selector or distributor in office No. 08, in which office we have assumed the line of the called party to terminate. In this connection it should be stated that the office keyboard is normally in operative relation to the sending apparatus F in order to serve a connecting circuit with which said sending apparatus may be associated; and, when the office keyboard has completed its work in conjunction with the sending apparatus F it automatically transfers itself into operative relation to the sending apparatus F', and if the sending apparatus F' is taken for use before the first mentioned sending apparatus has completed its work, said office keyboard will be locked in its operative relation to the apparatus F'. However, assuming that the second sending apparatus is not taken for use, the office keyboard will, after the sending apparatus F has completed its work, be re-associated with sending apparatus F.

The office keys are provided with a pair of controllers G G', which govern the operation of the district selector and the office selector which it selects. The office keys are each adapted when depressed to effect the successive operation of the controllers G and G' to cause the same to effect the operation of the district selector and pick out a district determined by the particular office key depressed; and thereupon the controllers are again successively operated to actuate the selected office selector in said district. Referring first to controller G, there is provided a row of contacts c numbered from 0 to 9, these contacts representing the

"tens" digits of the numbers of the districts. From each one of said terminals a conductor 65 leads to the springs 66 of the particular office keys representing offices lying in the district whose tens digit corresponds to the number of said terminal. In the present case I have shown springs 66 of office keys Nos. 0 and 8 as connected with the 0 terminal of the row *c* of contacts. The controller G is provided with a rotary arm 70 carrying a brush 71 adapted to sweep over the row *c* of contacts, said arm being provided with a ratchet adapted to be operated by stepping and retaining magnets 72, 73, respectively. The brush 71 is connected with a conductor 74 which leads through springs 75 associated with a cut-off relay 76, winding of said relay to the feed wire 77 of the office keyboard, which is normally connected through the armature 78 and back contact of a switching relay 79 with the feed wire 62 of the sending apparatus F.

Each office key, when operated, is arranged to bring into electrical engagement springs 67, 68, 69, which control the starting of the office controller or keyboard after the sending apparatus with which it is associated has been connected with a particular connecting circuit. The spring 68 is connected with the feed wire 77 and so with the battery of the sending apparatus, and in engaging spring 69 supplies current to a signal lamp 80, which indicates to the operator the condition of the office keyboard. The spring 67, supplied with current from the feed wire by spring 68, is connected with a conductor 81, which supplies current to the operating magnets of the controller G, said conductor leading through the retaining and stepping magnets 73, 72, respectively, of arm 70, through contact springs 82 associated with the cut-off relay 76 to a grounded vibrating arm or pulsator 83. The stepping magnet 72 responds to this current and advances the contact arm 70, the retaining magnet being sluggish, so that its armature when once attracted is unresponsive to the pulsations. When the controller arm has taken one step and the brush 71 has engaged the first terminal of the row *c*, the cut-off relay 76 is operated to open the circuit of the magnets 72, 73, of the controller, current to operate relay 76 passing from the feed wire 77, conductor 74, winding of relay 76, contact springs 75 associated with said relay, brush 71 and terminal "0", to conductor 65, which leads to earth through the contact springs 66, 84, of the office key No. 8, which is the key we have assumed to be operated. The relay 76 is provided with a pair of armatures 85, 86, the armature 86, when attracted, separating springs 82 to open the circuit through the magnets of the controller, said armature

engaging the member of said spring connected directly with the pulsator 83. The other armature 85 is grounded, and in its attractive movement separates springs, 75, engaging the member thereof connected directly with the winding of relay 76, thereby locking relay 76 to earth from the feed wire.

The stepping magnet 72, in operating, is adapted to make and break a pair of contacts 87, which control the application of current from the free pole of a grounded positive battery 88 to a conductor 89 leading to a common wire 90, which is normally connected at the armature 91 and back contact of a switching relay 79 with the common wire 59 of the sending apparatus F. In the present case, since this contact arm advanced but one step, but one impulse of current would be supplied by contacts 87 from battery 88 to the common wires 90, 59, the common wire 59 being, as before described, connected by the armature 56 and front contact of relay 34, Fig. 3, with the portion of the ring strand of the connecting circuit leading to the district selector. Turning now to the district selector, a number of groups of terminals are provided, each group representing the terminals of office selectors capable of reaching offices in a given number of districts. Thus the selector may have its terminals divided into groups of one hundred terminals subdivided into ten rows, each row representing a number of selectors representing a particular office, and the total number of rows in the group representing the office selectors in ten districts. A brush carrying arm 92, mounted to rotate and to move longitudinally, is provided for the district selector, Fig. 5, having a long step magnet 93 adapted to rotate the arm in long steps, for example, over ten rows of terminals at a step, in correspondence with the tens digits of the district numbers; the stepping magnet 94 is arranged to advance the arm from row to row of a selected group, while the stepping magnet 95^a is adapted to move the arm upwardly to bring the brushes carried thereby into connection with a set of terminals in the selected row connected with an idle office selector. From the strand 21 of the connecting circuit, the conductor 95 leads through a pair of contacts 96 closed by the arm while in its normal and rotary positions, through the winding of the short step magnet 94, armature 96' and back contact of polarized relay 97, through the contacts 98 of the retaining magnet 36, to earth. A conductor 98^a extends in shunt of the stepping magnet 94, said conductor including the long step magnet 93 and the armature and back contact of the stepping magnet 94.

The stepping magnets 93, 94, are so arranged that the magnet 93 requires for its operation a smaller amount of current than

magnet 94, so that magnet 93 may be operated in the same circuit with the magnet 94, without, however, affecting the latter. When current suitable to operate magnet 94 is impressed upon the circuit, magnet 94 is attracted and opens the branch 93, including the stepping magnet 93, so preventing the operation of said magnet. In the present case I employ a battery of 24 volts to operate the magnet 93, such current being without effect upon the magnet 94; and in order to operate magnet 94 I use a battery of 48 volts, whereupon magnet 94 operates and opens the branch containing its mate.

When the impulse from the 24 volt battery 88 was applied to common wires 90, 59, and ring strand 21, as previously described, the stepping magnet 93 received sufficient current for its operation and rotated the arm 92 of the selector through one long step, to the first bank of ten rows of terminals of the district selector, said bank representing the first ten districts. Returning now to the office keyboard, the second controller G¹ is at this point brought into play to complete the selection of a district by causing the district selector arm to advance to the row of terminals in the first bank determined by the units digit of the district in which the particular office desired is located. The controller G² is provided with a row c¹ of ten terminals representing the units digits of the districts. From each of said terminals a conductor 98^a leads to the springs 99 of the office keys representing units digits of offices which lie in the districts whose units digits correspond to the numbers of the terminals in the row c¹; that is to say, taking the case of office No. 08, the spring 99 of such office key is connected with the terminal "9" of the row c¹, which indicates that the units digit of the district in which is located office No. 08 is 9. It should be stated, however, that this arrangement is purely arbitrary, since spring 99 of office key No. 8 could exactly as well have been connected with another terminal of the row c¹, depending of course on how the offices are distributed.

The spring 99 of office key No. 8 rests in engagement with spring 84, due to the operation of key No. 8, and by means of said spring applies a ground to terminal "9" of row c¹ of controller G². The controller G² is provided with a rotary arm 100 carrying a brush 101 adapted to sweep over said row of terminals, said arm being provided with a stepping magnet 102^a and a retaining magnet 103. Now, when the cut-off relay 76 was operated to stop the operation of controller G, as before described, it started the operation of the controller G². The armature 86 of relay 76 is connected with a conductor 102, which leads through the contact springs 100^a of the cut-off relay 104 of

controller G¹, through the stepping magnet 102^a of controller G², contacts 105 closed by the controller arm while in normal position, through the retaining magnet 103 to the free pole of a grounded battery 106. Since the front contact of the armature 86 of cut-off relay 76 is connected with conductor 81 and grounded pulsator 83, a circuit 102, 81, will be completed for the magnets 103, 102^a of the controller G², and pulsations of current from battery 106 will pass through said circuit, causing the stepping magnet 102^a to advance the arm 100. It should be stated at this point that the contacts 105 are for the purpose of preventing access to the controller arm 100 unless the same is in normal position. The contacts are opened as soon as the arm has taken one step, but a branch 107 about said contacts is closed by the armature of the retaining magnet 103, which is sluggish and maintains its armature attracted regardless of the pulsating character of the current in its circuit, said armature when attracted closing a pair of contacts 108 which control the said branch 107.

The armature of the stepping magnet 102^a in its vibration makes and breaks a pair of contacts 108^a, which intermittently applies current from a grounded battery 109 to a conductor 110 which leads to the back contact of the armature 111 of a relay 112, said armature being connected by a conductor 113 with the common wire 90, and so with the ring strand 21 of the connecting circuit. Impulses from battery 109 therefore pass to the conductor 95 at the district selector, and thence through the stepping magnet 94 of the arm 92 to earth. This current is of proper strength to operate magnet 94, preferably 48 volts. Said magnet 94 in operating advances the arm in short steps from row to row of the first group of terminals, and in addition, opens the branch 98^a containing the long step magnet in order to prevent its operation. This current is of improper polarity to operate polarized relay 97 at the selector.

The brush 101 of the arm 100 of controller G² is connected with a conductor 114 which leads through a winding 115 of a sluggish relay 112, through contact springs 116 of a cut-off relay 104, winding of said relay, to the feed wire 77. Now when the arm 100 has been given ten steps, and the arm of the district selector has been given a like number of steps, so that its brushes lie below the row of terminals representing office selectors adapted to reach offices in district No. 9, the brush 101 will be in engagement with the grounded terminal "9" of the row c¹, and current will flow from the feed wire 77 through the winding of a cut-off relay 104, winding 115 of sluggish relay 112, brush 101, terminal "9," to earth by way of springs 99, 84, of office key No. 8.

The cut-off relay 104 is provided with a pair of armatures 117, 118; the armature 118, when attracted, separates the springs 103¹ to open the circuit of the operating magnets of the controller G¹, while the armature 117, which is grounded, in its attractive movement separates springs 116, engaging the member thereof connected directly with the winding of the cut-off relay 104, and so completing a locking circuit for said relay from the feed wire. The separation of said contacts 116 also breaks the circuit of the brush 101, including the winding 113 of the sluggish relay 112, which, however, has had time to attract its armature.

Automatic selection by district selector of idle office selector.—The front contact of armature 111 of the sluggish relay 112 is connected with a conductor 119 which leads to the free pole of a battery 120 of opposite polarity to battery 109, in the present case a grounded negative battery. Current from this battery is of a proper polarity to operate the polarized relay 97 at the district selector, which controls the hunt of the arm 92 for an idle office selector capable of reaching the offices in district No. 9. Current from said negative battery passes over the common wires 90, 59, and ring strand 21 to the district selector, where said current traverses conductor 95 to one of the members of contacts 96, which is normally connected with a spring 121, and thence over a conductor 122, through the armature 123 and front contact of the retaining magnet 36, winding of relay 97 and contacts 124, closed by the arm 92 while away from normal position, to earth. The stepping magnets 93, 94, do not respond to this current, on account of the rapid attractive movement of the armature 96' of relay 97, which controls the circuit of said magnets. Relay 97, when thus operated, attracts its armatures 125, 126, 96' and 127. The armatures 125, 126, simply maintain the line brushes of the district selector dead during the hunt for an idle office selector; the armature 96' in its attractive movement completes a circuit for the lifting magnet 95^a and the source of pulsating current 123 by way of conductors 129 and 95, whereupon the arm is lifted to bring its brushes into engagement with the first trunk line terminals in the selected row. When the arm has taken its first step upward, it separates spring 121 from the contacts 96 and moves said spring into engagement with a contact 130, which is connected with a conductor 131, leading to the front contact of the armature 127 of relay 97, which armature in turn is connected by a conductor 132 with the local brush 133 carried by the selector arm. The relay 97 is now connected directly to earth from the local brush 133 by way of conductors 132, 131, 122, and in case the said first trunk

line is in use, battery will be present at the local terminal 134 thereof, of a proper polarity to maintain relay 97 energized, whereupon the circuit of the stepping magnet 95^a will be maintained intact, and the arm 92 lifted another step to bring its brushes into engagement with the terminals of a second trunk line leading to a selector serving offices in district 9. This operation will be continued until the contact brushes of the arm 92 reach the terminals of an idle trunk line, at which time battery will not be present upon the local terminal 134 of such trunk line, and the relay 97 will be deprived of current and will release its armatures; armature 96' opening the circuit of the lifting magnet 95^a, and armature 127 applying at its back contact current from a battery 135 to conductor 132 and the local brush 133, in order to lock out other district selectors attempting to make connection with the trunk line in question.

Operation of office selector under the control of the depressed office key.—The trunk line selected by the district selector leads in three limbs 136, 137 and 138 to an office selector (Fig. 4) adapted to make connection with a trunk line leading to a primary selector at any desired office in district No. 09. Said office selector is provided with rows of terminals representing trunk lines leading to the offices in district No. 09, each office having a row of terminals in said office selector. The said office selector is constructed similar to the district selector (Fig. 5), its rows of terminals being arranged in groups, for example, ten rows to a group, and the arm of the selector being adapted to be moved in long steps from group to group, in short steps to select a particular row of the said group, and longitudinally along the selected row to an idle terminal therein. When current was applied at the district selector from battery 135 to the local brush 133 and terminal 134 of the trunk line selected, the retaining magnet 139 of the office selector arm 140 was operated by said current passing over conductor 138 and through said magnet to earth by way of springs closed while the selector is in normal condition; said magnet, when energized, attracting its armature 141, and locking itself to earth from conductor 138, independent of the said springs. The office selector arm is arranged to have a rotary movement by long and short steps, and an upward movement, and said arm is provided with a long step magnet 142 and a short step magnet 143 included in parallel branches 144, 144^a, of a conductor 145, which leads from the line conductor 137, through contacts 146 closed by the arm until it starts its upward movement, to earth through the armature 147 and back contact of a polarized relay 148, which is unresponsive to the

positive current employed to operate the stepping magnets 142, 143. As in the case of the district selector, the long step magnet is responsive to current of low voltage, for example 24 volts, while the short step magnet is unresponsive to such current but requires for its operation current of higher voltage, for example, 48 volts, and in attracting its armature opens the branch 144 containing the long step magnet to prevent its operation. The upward movement of the selector arm is controlled by a lifting magnet 148'.

After an office selector of district No. 09 has been selected, the controllers G, G', successively cooperate with the depressed office key No. 8 to actuate the office selector and select a trunk line leading to the office desired. The controller G is provided with a row *d* of ten terminals corresponding to the "tens" digits of the office numbers, and said terminals are connected with conductors 149, which lead to the springs 150 of the keys representing offices whose tens digits correspond with the number of such terminals in row *d*. Each of said springs 150 is adapted when operated to engage a grounded spring 151; thus in the present case, since office key No. 8 is depressed, its tens digit being "0", a ground is applied by the springs 150, 151, to the first or "0" terminal of the row *d*. The arm 70 of the controller G carries a second brush 152 adapted to sweep over the row of terminals *d*, said brush being connected with a conductor 153 which leads through contacts 154 closed by the retaining magnet 73 of controller G when energized, through contacts 155 closed by the cut-off relay 104 of controller G', (which relay is now locked to the feed wire) through contact springs 156 of relay 157, winding of said relay to the feed wire 77.

The operation of controller G to advance the office selector arm is controlled by relays 112, 158. The relay 112 when deenergized after controller G operated, placed relay 158 in condition to have a circuit therefor completed at the selected office selector, said relay 158, when operated, starting controller G. The relay 112 was operated momentarily to start the automatic selection by the district selector of a trunk line leading to an idle office selector, and when said relay retracted its armature 159, it applied current from a positive battery 160 (for example) to a conductor 161, which leads through said armature 159 and back contact of relay 112, through the armature 162 and front contact of relay 104, through the normally closed contacts 163 of cut-off relay 157 associated with the controller G, through normally closed contacts 164 opened by the retaining magnet 73 of controller G when energized, through the relay 158 to the common wire 90. Now when the district selec-

tor has picked out a trunk line leading to an office selector, and relay 97 has become deenergized, and has retracted its armatures 125, 126, current from said battery 160 at the office keyboard finds a path over conductor 161 through the winding of relay 158 (relay 112 having now retracted its armature 159) to common wires 90, 59, ring strand 21, through the line contacts of the district selector, to the line or trunk conductor 137, and thence to the office selector and through conductor 145 and stepping magnets of the office selector, to earth. The long step magnet of the selector is operated by this current and advances the selector arm a step, which is merely incidental to the operation.

The relay 158 of the controller G in attracting its armature 165 completes a circuit for the operating magnets of the controller G, said circuit extending from the feed wire 77 through springs 67, 68, closed by the office key when operated, conductor 81', retaining magnet 73 and stepping magnet 72 of the arm 70, through contacts 166, which are closed while the arm 70 is in normal position, conductor 167, armature 166 and front contact of the relay 158, contact springs 168 of the cut-off relay 157 of controller G, to the armature 118 of the cut-off relay 104 of controller G' (which is now energized in a locking circuit from the feed wire), thence by way of the front contact of said armature 118 to conductor 102, armature 86 and front contact of the cut-off relay 76 of controller G (which is also energized in a locking circuit from the feed wire) to conductor 81 and the vibrating grounded arm. The stepping magnet 72 is now operated to advance the arm 70 and the retaining magnet 73 attracts its armature, which remains attracted regardless of the pulsatory character of the current in its circuit, said armature opening at contacts 164 the circuit of relay 158, and closing at contacts 169 a branch conductor 170 about the armature 165 and front contact of relay 158 and the contact 166 of the controller arm, both of which sets of contacts are now open. The contacts 166, which are initially in the circuit of the stepping magnet 72 are for the purpose of preventing the operation of the controller arm unless it is in normal position.

The stepping magnet 72 in vibrating its armature operates the contacts 87 to apply current from the 24 volt battery 88 of positive polarity to conductor 89 and common wires 90, 59, cord strand 21, through the district selector line contacts, trunk conductor 137, to the office selector, and thence by way of conductor 145, through the stepping magnets 142, 143, in parallel, to earth. This current operates simply the long step magnet, which is adapted to advance the selec-

tor arm in long steps from bank to bank of the terminals.

When the controller arm 70 has taken one step, and the office selector arm has been rotated through one long step into operative relation to the first bank of terminals, the brush 152 of controller G engages the first terminal "0" in the row *d*, and a circuit is completed from the feed wire 77 through the cut-off relay 157, conductor 153, contacts 155 closed by the cut-off relay 104 of controller G¹, contacts 154 closed by the retaining magnet 73 of the controller G, brush 152, "0" terminal, conductor 149 to ground through the contacts 150, 151, of office key No. 8. The relay 157 is now energized, and attracts its armatures 171, 172; armature 171 separating springs 156 and engaging the member thereof connected directly with relay 157, said armature being grounded and completing a locking circuit for the relay from the feed wire. The armature 172 in its attractive movement separates springs 168, opening the circuit through the operating magnets of controller G, said armature also serving to bring into play the controller G¹, which causes the office selector to advance to the row of terminals of the selected bank representing trunk selectors adapted to pick out an idle primary selector at the desired office.

The controller G¹ is provided with a row *d*¹ of ten terminals representing the units digits of the office numbers, and from said terminals conductors 173 lead to contact springs 174 of the office keys representing offices whose units digits correspond to the numbers of such terminals of said row *d*¹. Thus in the present case contact spring 174 of key No. 8 is connected with the "8" terminal in said row *d*¹, said spring, owing to the operation of key 8 engaging spring 151 which is grounded. The controller arm 100 carries a brush 175 which is adapted to sweep over said row *d*¹ of terminals until it engages the terminal which is grounded, at which point the circuit of the operating magnets of the controller is broken. The said brush 175 is connected with a conductor 176 which leads through normally open contacts 177 closed by the armature of the retaining magnet 103 of controller G¹ when attracted, through contacts 178 closed by cut-off relay 157 of controller G, winding 179 of sluggish relay 112, contact springs 180 and a cut-off relay 181, to the feed wire 77.

As before stated, the armature 172 of the cut-off relay 157 of controller G controls the operation of the controller G¹ in its relation to the office selector. When said armature is attracted a circuit is completed from the free pole of battery 106 by way of conductor 102 through the retaining magnet 103 at controller G¹, contacts 105 closed when the

arm 100 is in normal condition, stepping magnet 102^a, conductor 182, normally closed contacts 183 of cut-off relay 181 of controller G¹, through armature 172 and front contact of the operated cut-off relay 157 of controller G, conductor 167, armature 118 and front contact of operated relay 104, back to conductor 102 and thence by way of armature 86 and front contact of cut-off relay 76, conductor 81, to the ground pulsator 83. The retaining magnet 103 in said circuit, when energized, attracts its armature, which closes contacts 177, completing the connection of brush 175 by way of conductor 176, with the feed wire, said conductor including the cut-off relay 181 and winding 179 of sluggish relay 112; the retaining magnet also closes contacts 108, completing the branch 107 about contacts 105, so as to maintain the stepping magnet circuit independent of contacts 105.

The armature of the stepping magnet 102^a, in its vibration, operates the contacts 108^a, applying impulses from the positive 48 volt battery 109 by way of conductors 110, 113, to 90, 59, cord strand 21, trunk conductor 137 to the office selector, and thence to earth through conductors 145 and 144^a, including the short step magnet 143 of the selector, which rotates the selector arm in short steps from row to row of terminals, and maintains open the branch including the long step magnet. When both the controller arm 100 and the office selector arm have taken nine steps and the office selector arm is in operative relation to the row of terminals representing primary selectors at office No. 8 in district No. 9, a circuit is completed for the cut-off relay 181 of controller G¹ and sluggish relay 112, said circuit extending from the feed wire 77 over conductor 176, brush 175 and terminal "8" in row *d*¹, conductor 173 to ground at office key No. 8. The cut-off relay 181, when thus energized, attracts its grounded armature 185 which separates springs 180, breaking the connection of battery with sluggish relay 112, and brush 175, and engaging the member of said springs connected directly with the relay 181, to include said relay in a locking circuit from the feed wire. The armature 183, when attracted, opens the circuit including the operating magnets of the controller G¹.

Automatic selection by office selector.—

The relay 112, which operates after the controller G¹ has completed its work, serves to start the "hunting" of the selector arm for an idle trunk line in the selected row; said relay applying current of proper polarity to the relay 148 at the office selector, said relay 148 controlling the operation of the lifting magnet 148'. The relay 112, which was momentarily operated, as above described, in attracting its armature 111, applied current from the negative battery 120, by way of 180

conductors 119, 113, to common wires 90, 59, cord strand 21, trunk conductor 137, through one member of contacts 146 controlled by the selector arm, to a spring 184¹ connected with a conductor 185¹ leading to earth through the winding of a polarized relay 148, which responds only to negative current. Relay 148 is now energized and attracts its armatures 186, 187, 147 and 188. The armatures 186, 187, interrupt the continuity of the trunk conductors 136, 137, leading to the line brushes upon the selector arm, to maintain the said line brushes dead during the upward hunt of the arm for an idle trunk line. The armature 147, when attracted, completes a circuit 189, including the lifting magnet 148¹ and a source of pulsating current 190, whereupon the arm is lifted to bring the brushes thereof into engagement with the terminals of the first trunk line in row "8" in the first bank of terminals. At this point the contacts 146 are separated and spring 185¹ engages spring 191 which is connected with the conductor 192 leading to the front contact of the armature 188, and through said armature to the local brush 193 of the selector arm. The relay 148 is now connected directly to earth from the local brush 193 of the selector arm through its own armature 188 and front contact, springs 191, 184¹. Assuming that the first trunk line is engaged, negative battery will be present at the local terminal thereof, and relay 148 will be maintained energized, and in turn will continue the continuity of the circuit 189 including the lifting magnet, which will advance the selector arm to the next set of terminals, and so on until an idle trunk line is reached, in which case, no potential will be present upon the local terminal of such trunk line, and relay 148 will become de-energized, retracting its armatures, armature 188, when retracted engaging a back contact connected with conductor 194 leading through the armature 195 and front contact of retaining magnet 139 to the free pole of a grounded battery 196, such current applying a test potential to the multiple local terminals of the selected trunk line to lock out other office selectors.

Disconnection of office keyboard from sending apparatus F.—When the office keyboard completed its work in connection with sending apparatus F, it was automatically transferred into operative relation to sending apparatus F', and the depressed office key and mechanism of the keyboard restored to normal condition. It will be remembered that after the short step magnet of the office selector had operated, the relay 112 was momentarily energized to start the automatic selection by the selector arm. Said relay in retracting its armature 159 supplies current from battery 160 to con-

ductor 161, armature 159 and back contact of relay 112, armature 162 and front contact of cut-off relay 104, to conductor 254, which leads through the armature 255 and front contact of cut-off relay 181 and winding of test relay 158 to the common wire 90. Now when an idle primary selector has been selected at office No. 8 current from said battery 160 flows through the relay 158 over the common wires 90, 59, conductors 21, 137, 198, through the bridge 230 at the selected selector (Fig. 4) and back by way of line conductors 197, 136, 20, to earth at the armature 54 and front contact of relay 34 (Fig. 3). Test relay 158 when energized in the said circuit serves to complete a circuit for the switching relay 79 which transfers the feed wire 77 and common wire 90 to the feed wire 62' and common wire 59' of the sending apparatus F'. The said circuit for relay 79 extends from the feed wire 62' of sending apparatus F, conductor 257, through the winding 256 of switching relay 79, spring 258 and its back contact of a polarized relay 259, responsive, for example, to positive current only, through contacts 260 of the cut-off relay 181 of controller G', through contacts 261 of said test relay 158 to earth through contacts 262 of the relay 263 at the sending apparatus F', which relay may control the starting of the primary controller of such sending apparatus.

The switching relay 79 is adapted to transfer the office keyboard to the sending apparatus F' in such manner that should sending apparatus F' be taken for use before apparatus F completes its work, the keyboard will be locked in association with sending apparatus F'. If, however, the sending apparatus F' is not taken for use before its mate is through serving a given cord circuit, the keyboard will be restored to its normal association with sending apparatus F.

The switching relay 79 when energized by current in its winding 256, attracts its armatures 264, 78, 91 and 265. The armatures 78 and 91 connect the wires 77, 90 of the keyboard with the wires 62' 59' of sending apparatus F'; the armature 264 engages a spring connected directly with the feed wire 62 and completes by way of conductors 266, 257, a locking circuit for the said switching relay controlled by relay 263 of the sending apparatus F'. The armature 265 of said switching relay is also connected with conductors 266, 257, leading through the contacts 262 to earth, and said armature in its attractive movement engages a spring connected with a conductor leading through a winding 267 of the switching relay to the wire 62' of sending apparatus F', so that when current is applied to the said feed wire 62' by the armature 61' of the controlling relay 53' of sending apparatus F', said

switching relay will maintain the association of the office keyboard with the sending apparatus F' independent of the condition of the sending apparatus F.

5 *Restoration of depressed office keys.*—

The office key No. 8 when depressed, was locked in such position preferably by means of a locking bar having openings therein through which all the key plungers project, 10 each key carrying a conical latch member adapted when the key is depressed to engage the under side of the said locking bar. Said bar is adapted to be moved by a release magnet 266' to release the depressed key. 15 Said magnet is included in a conductor 267' which leads to a pair of contacts 268, one member whereof is adapted to be engaged by the armature 269 of a sluggish relay 270, said armature being connected with the 20 free pole of a grounded battery 271. Said armature 269 in its retractive movement is adapted to effect momentary electrical engagement between itself and both members of the contacts 268 to apply current to conductor 267' and operate said release magnet. 25 The said relay 270 is included in a conductor 272 which leads to normal resting contact of a spring 272' adapted to be operated by the armature of the polarized relay 259, said spring being connected with the feed wire 77 of the office keyboard. When current is applied to the feed wire of sending apparatus F, it passes by way of the feed wire 77, of the office keyboard, 35 through the spring 272' and back contact of relay 259 to conductor 272 and relay 270 to earth. Relay 270 attracts its armature 269, separating springs 268. An impulse of current is thereby delivered from battery 271 to conductor 267' and release magnet 266' 40 to earth, so that in case an office key has been accidentally depressed, it will be restored. Now when the office keyboard has performed its work in connection with sending apparatus F, the switching relay 79 is operated as before described, and removes at its armature 78 and back contact current from the office feed wire 77, whereupon the relay 270 is deprived of current, 50 and its armature 269 in retracting applies current to operate the release magnet 266' and restore the depressed key.

Restoration of office key when keyboard serving sending apparatus F'.—Assume 55 for a moment that the office keyboard is serving the sending apparatus F' and that current from the battery 52' at said sending apparatus has been applied to the feed wire 62'. This current being of opposite polarity from corresponding battery at sending apparatus F will operate the polarized relay 259, said current passing from the feed wire 62' through the armature 78 and front contact of the switching 60 relay 79, to the feed wire 77' of the office

keyboard and thence to earth through a branch including said polarized relay. Said relay in attracting its armature moves spring 272' into engagement with a contact connected with a conductor 272'' leading to earth through a relay 270', said relay being 70 thereupon energized, since the spring 272' is connected with the feed wire 77. Said relay is provided with an armature 269' adapted to operate a pair of contacts, one 75 member whereof is connected with conductor 267', said armature being connected with the free pole of a grounded battery 273' and serving to apply impulses to the conductor 267' to operate the release magnet 266'. 80

Restoration of keyboard to sending apparatus F' after serving sending apparatus F'.—When the office keyboard is through serving the sending apparatus F', the relay 263 is operated to deenergize relays 79 and 85 259, which thereupon restore the association of the office keyboard with the sending apparatus F. Said relay 158 when operated at the completion of the service of the keyboard, completes a circuit from the feed 90 wire 62' of sending apparatus F', through the winding of relay 263, contacts 274 of said relay, to a conductor 275, which leads to the front contact of spring 258 of polarized relay 259, and thence by way of conductor 257, contacts 260 of cut-off relay 181, contacts 261 closed by the relay 158, contacts 262 of said relay 263 to earth. Relay 263 is energized in the said circuit and attracts its armature 276 which is grounded. 100 said armature opening springs 274 and engaging a member thereof connected directly with the winding of relay 263, thereby locking said relay to earth from the feed wire 62'. The armature 262 of said relay 263 105 opens the locking circuit of the switching relay 79 from said feed wire 62', whereupon said switching relay restores at its armatures 78, 91 the connection of wires 77, 90, of the office keyboard with the wires 62, 59 110 of sending apparatus F. The armature 78 of said switching relay in its retractive movement disconnects the feed wire 62' from the circuit of the polarized relay 259, which thereupon releases its armature, moving spring 272' to break the circuit of relay 270', which retracts its armature 269' 115 causing an impulse of current to pass through the release magnet 266' of the office keys. 120

Summary of operation.—Having now described in detail the circuits shown as embodying my said invention, I will endeavor to give an outline of the complete operation of the system as briefly as possible. I will 125 assume that the subscriber No. 999 shown in Fig. 3 desires connection with subscriber No. 2749 whose line terminates in office "07" in district No. 09. The operator upon observing the display of the line signal of line No. 130

999, inserts her answering plug into the jack of such line, and depresses the listening key of her connecting circuit to inquire the number wanted. When the answering plug is inserted in the jack of the calling line, the sending apparatus F is automatically associated with the connecting circuit by means of the relays 27 and 34. The relay 27 is operated in the circuit completed by the operator's connection switch, and in turn completes an initial circuit for the relay 34, which thereupon at its armature 39 completes a locking circuit for itself, said relay 34 at its armature 56 connecting the common wire leading to the sending apparatus with the link conductor 21. The controlling relay 53 of the sending apparatus is included in the locking circuit before referred to, and when operated applies current from the battery 52 to the feed wire 62, whereupon the sending apparatus is placed in operative condition. The operator, upon ascertaining the number of the subscriber desired, which we have assumed to be 1465, in office 08 of district 09, depresses office key No. 8. The office key depressed starts the operation of the office keyboard to actuate the district selector associated with the connecting circuit and pick out an office selector in district 09. The retaining magnet of the district selector is included in a circuit controlled by a relay 27 of the connecting circuit. Office No. 08 being located in district No. 09, the office key No. 8 when depressed, applies a ground to the "0" terminal of the row *c* of controller G, and to the terminal 9 of the row *c'* of terminals of controller G¹, these terminals representing respectively the tens and units digits of the district in which the desired line is located. The office key when depressed, operated contacts 67, 68, 69, to start the operation of controller G, said contacts completing a circuit for the operating magnets 72, 73, of said controller, which advance the controller arm, said stepping magnet 72 applying current from battery 88 out to the district selector to operate the long step magnet 93 thereof, thereby advancing the selector arm in long steps from bank to bank of terminals, each bank representing ten districts. When the controller arm has taken one step and the brush 71 reaches the grounded terminal in row *c*, the district selector arm lies in operative relation to the first bank of terminals representing the first ten districts. At this point the cut-off relay 76 of controller G is operated and stops the movement of the arm 70 of controller G, permitting its return to normal position. Said relay 76, in operating, switches into service the controller G¹, completing an operating circuit for its operating magnet 102^a and retaining magnet 103, whereupon the arm of said controller G¹ is advanced and

its brush 101 sweeps over the row of terminals *c'*. The stepping magnet of the controller serves to apply impulses of current from the battery 109 to the circuit of the short step magnet 94 of the district selector arm, which magnet thereupon advances the selector arm in short steps from row to row of the selected bank. When the brush 101 of the controller G¹ reaches the terminal grounded by the depressed office key, the selector arm will have advanced to the last row of terminals in the first bank representing district 09. Thereupon the cut-off relay 104 of controller G¹ will operate to stop the movement of the controller arm and interrupt the impulses supplied to the district selector.

A relay 112 was operated in conjunction with the cut-off relay referred to and applied a momentary impulse from battery 120 to the conductor leading to the district selector, said current passing through the polarized relay 97 at the district selector and being of proper polarity to operate the same. Said relay thereupon starts the operation of the lifting magnet 95^a, which lifts the district selector along the selected row to pick out an idle trunk line leading to an office selector in district 09; the polarized relay receiving current from the local conductor of the busy selectors to maintain the circuit of the lifting magnet. When, however, an idle selector has been found, the relay 97 is deenergized, breaking the circuit of the lifting magnet and applying a test potential to the row of terminals of the trunk line leading to the office selector. The depressed office key No. 8 applied a ground to the "0" terminal of the row *d* of contacts of controller G, and the "8" terminal of the row *d'* of contacts of controller G¹, said two terminals representing the tens and units digits of the desired office. The said relay 112, when deenergized, connected a test relay 158 in a conductor leading from battery 160, to common wire 90, and said relay 158 found a complete circuit when the district selector had united with the terminals leading to an idle office selector, current from said battery passing to earth through the stepping magnets of the office selector and serving merely to give the selector arm an incidental long step. The relay 158, when thus operated, brings into play the controller G, which causes the selector arm to advance into operative relation to the bank of terminals in which is located the terminals representing the desired office, each branch comprising ten rows of terminals representing ten offices. Said relay 158 serves to complete a circuit for the stepping magnet 72 and retaining magnet 73 of controller G, the retaining magnet in operating completing said circuit independent of the test relay and rendering operative the

brush 152 which sweeps over the row of terminals α under the control of the stepping magnet. The stepping magnet 72 in its operation applies impulses of current from the battery 88 over the trunk conductors to the office selector, where said current passes through the stepping magnet 142 to earth, advancing the arm in long steps. When the arm has taken one long step into operative relation to the first bank of terminals in which is located the desired office terminal, the brush 152 of the controller G will have engaged the terminal grounded by the depressed office key, and the cut-off relay 157 will operate and open the circuit of the operating magnets of the controller, thereby cutting off the supply of current to the office selector. The cut-off relay 157 in operating, starts the controller G', which causes the office selector arm to advance in short steps from row to row of terminals in the selected bank into operative relation to the row of terminals representing office No. 08. Said relay in operating completes a circuit for the stepping magnet 102^a and retaining magnet 103 of the arm of the controller G', said retaining magnet rendering operative the brush 175, which sweeps over the row of terminals representing the units digits of the office numbers. The stepping magnet of the controller G' in operating applied impulses of current from the battery 109 to the trunk conductors to operate the short step magnet 143 of the office selector. When the office selector arm has advanced into operative relation to the row "8" of terminals in the first bank, representing office No. 08, the brush 175 will have advanced to the terminal grounded by the office key depressed, and the cut-off relay 181 will have operated, opening the circuit of the operating magnets of the controller and removing current from the operating magnet of the selector. The starting relay 112 again operates, this time in conjunction with the cut-off relay 104, and applies a momentary impulse from the battery 120 to the trunk conductors to operate the polarized relay 148 at the office selector, which completes a circuit for the lifting magnet 148^a, and thereafter receives current from the local wires of busy trunk lines to continue the upward movement of the selector arm until an idle trunk line is reached, when said relay becomes deenergized, opening the circuit of the lifting magnet and applying a test potential to the local terminals of the selected trunk line. The office selector arm has now brought its brushes into engagement with the terminals of a trunk line leading to a primary selector at office No. "08" adapted to pick out a connector capable of uniting with the called line. The remaining operations of selection may be controlled by a sending apparatus, such as shown in my

application, Serial No. 355,896 filed February 5th, 1907. When an idle inter-office trunk has been secured, the relay 158 is again operated by current from battery 160 passing out over the trunk conductors through the bridge 230 at the primary selector of the selected office, and back over the trunk conductors to earth, said relay 158, in operating, causing the operation of the switching relay 79, which locks itself to the feed wire of sending apparatus F, and transfers the leads of the office keyboard into association with the leads of the sending apparatus F'. Said switching relay in operating also breaks the circuit of the relay 270, which was energized during the operation of the office keyboard, and said relay effects the operation of the release magnet of the office keys to restore the depressed office key to normal position. Said relay 270 may serve to start the operation of the sending apparatus F.

Certain features of the system and apparatus herein disclosed are claimed in other applications to which I desire to refer, as follows: joint application of James L. McQuarrie and myself, Serial No. 355,884, filed February 5th, 1907, for semi-mechanical telephone system; joint application of James L. McQuarrie and myself, Serial No. 336,401, filed September 27th, 1906, for semi-mechanical telephone system; and sole applications of myself, Serial No. 355,896, filed February 5th, 1907, for semi-mechanical telephone system; Serial No. 363,197, and filed April 8rd, 1907, for semi-mechanical telephone system.

I claim:

1. In a semi-mechanical telephone exchange system, the combination with telephone lines leading to different central offices, of trunk lines extending between such offices, a series of mechanical selectors at one of said offices adapted to extend connection from a line in such office through said selectors to a trunk line leading to any distant office, a set of keys designating the different offices, and automatic controller mechanism set in operation by any key and selectively governed thereby, said controller mechanism being adapted to cause the operation of said selectors in sequence to select a trunk line leading to the office designated by such key.

2. In a semi-mechanical telephone exchange system, the combination with a connecting circuit terminating in a district selector, of an office selector to which said district selector is adapted to extend said circuit, a trunk line to which said office selector is adapted to further extend said circuit, said trunk line leading to a distant office, an office key designating such distant office, and automatic controller mechanism arranged to be set in operation by said key

and adapted under control thereof, to cause the sequence of selecting operations by said district selector and office selector required to select the trunk line leading to the office designated by such key.

3. In a telephone exchange system, the combination with telephone lines terminating at central offices, said central offices being divided into districts, of a talking circuit, district and office selecting devices, trunk lines leading from a district selecting device to different office selecting devices, said district selecting device being adapted to unite said talking circuit with a trunk line leading to an office selecting device in a desired district, trunk lines leading from the office selecting devices to the different central offices, said selected office selecting device being adapted to unite said trunk line and said talking circuit with a trunk line leading to a desired office, keys representing the digits of districts and offices, and means controlled by said keys for selectively operating said selecting devices.

4. In a telephone exchange system, the combination with telephone lines extending to central offices, said central offices being arranged in districts, of an operator's connecting circuit at a given central office, a connection switch for uniting said connecting circuit with a calling line, a district selector forming the terminal of said connecting circuit, office selectors and trunk lines leading therefrom to the different offices, such district selector being adapted to select an office selector in the particular district, and a keyboard adapted to be actuated by the operator to selectively operate said district selector and the office selector selected thereby, to unite such connecting circuit with a trunk line leading to the office in which the called line terminates.

5. In a telephone exchange system, the combination with telephone lines extending to central offices, said central offices being divided into districts, of a talking circuit, a district selecting device, office selecting devices, trunk lines leading from said selecting devices to the different central offices, said district selecting device being adapted to unite said talking circuit with an office selecting device in a particular district, such office selecting device being adapted to unite with a trunk line leading to a desired office, keys representing the digits of the office numbers, means controlled by a depressed office key for operating said district selecting device to select an office selector in the district wherein said office is located, and means also controlled by said key for operating the selected office selecting device to select a trunk line leading to the desired office.

6. The combination with telephone lines extending to central offices, said offices being

divided into districts, a talking circuit, a district selecting device, office selecting devices, said district selecting device being adapted to select an office selecting device in any desired district and unite said talking circuit therewith, trunk lines leading from the office selecting devices to the different central offices, the selected office selecting device being adapted to unite said talking circuit with a trunk line leading to the desired office, and a pair of controllers adapted when set to successively actuate said district selecting device and the office selecting device selected thereby to unite said talking circuit with a desired office.

7. The combination with telephone lines extending to central offices, said offices being divided into districts, a talking circuit, a district selecting device, office selecting devices, trunk lines leading from the office selecting devices to the different central offices, and a pair of controllers operating successively in association with the district selecting device to unite said talking circuit with a desired office selecting device, said controllers thereupon operating in conjunction with said office selecting device to connect said talking circuit with a trunk line leading to the desired office.

8. The combination with telephone lines extending to central offices, said offices being divided into districts, a talking circuit, a district selecting device, office selecting devices, trunk lines leading from the office selecting devices to the different central offices, and selecting mechanism adapted when set to operate said district selecting device to unite said talking circuit with an office selecting device in a particular district, and thereupon actuate said selected office selecting device to unite said talking circuit with a trunk line leading to the desired office in said district.

9. The combination with telephone lines extending to central offices, said offices being divided into districts, a talking circuit, a district selecting device, office selecting devices, trunk lines leading from the office selecting devices to the different central offices, keys representing the digits of office numbers, and controlling mechanism operating in conjunction with a depressed key to actuate said district selecting device and unite said talking circuit with an office selecting device in the district wherein the office represented by said depressed key lies, said controlling mechanism thereupon operating said office selecting device to unite said talking circuit with a trunk line leading to the office represented by said key.

10. The combination with telephone lines extending to central offices, said offices being divided into districts, a talking circuit, a district selecting device, office selecting devices, trunk lines leading from the office se-

lecting devices to the different central offices, keys representing digits of the office numbers, a pair of controllers selectively operated by a given office key for actuating said district selecting device to unite said talking circuit with an office selecting device in the district to which the office represented by said key belongs, and means for causing said controllers to again operate under the control of said office key to actuate said selected office selecting device and unite said talking circuit with a trunk line leading to the desired office.

11. The combination with telephone lines extending to central offices, said offices being divided into districts, of a talking circuit, a district stepping device, office selecting devices, controlling mechanism comprising rows of terminals representing district digits, keys representing the digits of the offices, means controlled by a depressed office key for changing the electrical conditions of the terminals in said rows representing the digits of a district in which said office lies, means controlled by said key and the altered terminals for operating said district selecting device to unite said talking circuit with an office selecting device in said district, rows of terminals representing digits of office numbers, means controlled by an office key for altering the electrical condition of the terminals in said rows corresponding to the digits of the office represented by said key, and means controlled by the depressed office key and the altered terminals in said rows for operating said selected office switching device to unite said talking circuit with a trunk line leading to the office represented by said key.

12. The combination with telephone lines extending to central offices, said offices being divided into districts, of a talking circuit, a district selecting device, office selecting devices, trunk lines leading from the office selecting devices to the different central offices, a pair of controllers G G^1 , a row c of terminals in controller G representing tens digits of the districts, a row c^1 of terminals in controller G^1 representing the units digits of the districts, office and district keys associated with the controllers G and G^1 , means controlled by a given office key when operated for altering the electrical condition of terminals in said rows representing the district in which the said office lies, means controlled by said altered terminals and said key for operating said district selecting device to unite the talking circuit with an office selecting device in the district in which the office represented by said key lies, a row d of terminals in controller G representing the tens digits of the office numbers, a row d^1 of terminals in controller G^1 representing the units digits of the offices, means controlled by a given office key for altering the

electrical condition of the terminals in said rows representing the digits of the office represented by said key, and means actuated, when the office selecting device has been selected, under the control of said key and said altered terminals, for operating said office selecting device to unite said talking circuit with a trunk line leading to the office corresponding to said key.

13. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, one of said sending apparatuses adapted to operate selected line switching mechanism, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, and means, automatically operated when said office keyboard has completed its work, for transferring the same into association with the other sending apparatus.

14. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, a pair of sending apparatuses adapted to operate the selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, a relay adapted to transfer said office keyboard to the other sending apparatus, and a circuit for said relay completed when said selecting mechanism has united said talking circuit with the line switching mechanism of a desired office.

15. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, a pair of sending apparatuses adapted to operate the selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, means automatically operated when said keyboard has completed its work for transferring the same to the other sending apparatus, and means automatically operated when said first mentioned sending apparatus has operated the selected line switching mechanism for re-associating said office key-

board with said first-mentioned sending apparatus.

16. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate the selected line switching mechanism, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, a relay adapted to transfer said keyboard to the other sending apparatus, a circuit for said relay completed when said keyboard has operated the office selecting mechanism, and means actuated when said sending apparatus has operated the line switching mechanism for opening the circuit of said relay.

17. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate the selected line switching mechanism, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, a relay adapted to transfer said keyboard into association with the other sending apparatus, a relay operated when the office selecting mechanism has selected the desired office, an initial circuit for said relay completed by said relay, a locking circuit for said relay completed by itself when energized, and means operated when said sending apparatus has operated for opening said locking circuit.

18. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate the selected line switching mechanism, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, means automatically operated when said office keyboard has selectively actuated the office selecting mechanism, for transferring said keyboard into operative relation to the said sending apparatus, means actuated in case said second sending

apparatus is not taken for use before the first mentioned sending apparatus has completed its work, for re-associating said office keyboard with the first sending apparatus, and means actuated in case the second sending apparatus is taken for use before the first sending apparatus has completed its work for locking said office keyboard in association with said second sending apparatus independent of the first sending apparatus.

19. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, means automatically operated when said office keyboard has selectively actuate the office selecting mechanism, for transferring said keyboard into operative relation to the second sending apparatus, and means automatically operated when said second sending apparatus has completed its work for restoring said office keyboard to operative relation to the first sending apparatus.

20. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, a relay adapted when operated to transfer the keyboard into operative relation to the second sending apparatus, a circuit for said relay completed when the keyboard has served said talking circuit, means operated when the said first sending apparatus has actuated said line switching mechanism, for opening said circuit, and an independent circuit for said relay completed by the second sending apparatus in case the same is taken for use prior to the complete operation of the first sending apparatus.

21. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line

switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, a relay 79 adapted to transfer the office keyboard into association with the second sending apparatus, a relay 158 operated when the office keyboard has operated said office selecting mechanism, an initial circuit for relay 79 completed by said relay 158, a locking circuit completed by said relay for itself under the control of said first sending apparatus, and an independent locking circuit for said relay completed by said second sending apparatus if taken for use before the first sending apparatus completes its work, said second locking circuit being opened when the second sending apparatus has completely operated.

22. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, and means automatically operated when the office keyboard has completed its work for restoring said keyboard to normal condition.

23. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, said keyboard having keys representing the offices, each key when depressed selectively actuating said keyboard, means for locking said depressed key in such position, and means automatically operated when said keyboard has completed its work for releasing said depressed key.

24. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, a pair of sending apparatuses adapted to operate the selected line

switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism, said office keyboard having keys representing the offices, each key when depressed being adapted to operate said keyboard to selectively operate said office selecting mechanism and to unite said talking circuit with the line switching mechanism at the office represented by said key, each key when operated being locked in such position, means automatically operated when said keyboard has served said talking circuit for transferring the same into association with the other sending apparatus, and means actuated in said transfer for restoring said operated key.

25. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism, said office keyboard having keys representing the offices, each key when depressed being adapted to operate said keyboard to selectively actuate said office selecting mechanism and unite said talking circuit with the line switching mechanism at the office represented by said key, each key when operated being locked in such position, means automatically operated when said keyboard has served said talking circuit, for transferring the same to the other sending apparatus, means actuated in case said second sending apparatus is taken for use, for locking said keyboard in operative relation thereto, and means actuated when said keyboard is through serving either sending apparatus for restoring the depressed key and the mechanism thereof to normal condition.

26. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism, said office keyboard having keys representing the offices, each key when depressed being adapted to operate said keyboard and selecting mechanism to unite said talking circuit with the line switching

mechanism at the office represented by said key, each key when operated being locked in such position, means automatically operated when said keyboard has served said talking circuit, for transferring the same to the second sending apparatus, a release magnet controlling the restoration of a depressed key, and a circuit for said magnet completed upon the transfer of said keyboard to the second sending apparatus.

27. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism, said office keyboard having keys representing offices, each key when depressed being adapted to operate said keyboard and mechanism and unite said talking circuit with the line switching mechanism at the office represented by said key, each key when operated being locked in such position, a relay 79 operated when said keyboard has served said talking circuit, for transferring the same to the second sending apparatus, a release magnet controlling the restoration of a depressed key, a relay 270 adapted when operated to apply a momentary impulse to said release magnet, and means controlled by said relay 79 when operated for actuating said relay 270.

28. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism, said office keyboard having keys representing the offices, each key when depressed being adapted to operate said keyboard and mechanism and unite said talking circuit with the switching mechanism at the office represented by said key, each key when operated being locked in such position, a relay 79 operated when said keyboard has served said talking circuit for transferring the same to the other sending apparatus, a release magnet controlling the restoration of a depressed key, a pair of relays 270, 270', adapted to momentarily operate said release magnet, a circuit for relay 270, controlled by relay 79 in transferring said office keyboard, a circuit for the relay 270', a re-

lay 270 controlling the placing of said circuit under the control of relay 79, said relay 270 being operated when the second sending apparatus is taken for use, and means thereupon controlled by said relay 79 after the second sending apparatus has operated for operating relay 270'; whereby the depressed office key is restored to normal condition after serving either sending apparatus.

29. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus, adapted to operate said office selecting mechanism to unite said talking circuit with line switching mechanism at a desired office, and means automatically operated when said keyboard has completed its work for starting said sending apparatus.

30. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate the selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, means automatically operated when said office keyboard has actuated said office selecting mechanism, for transferring said keyboard into operative relation to the second sending apparatus, and means automatically operated in such transfer for starting the operation of the first sending apparatus.

31. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus, adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, a relay 79 adapted when operated to transfer the office keyboard into operative relation to the other sending ap-

paratus, and a relay 270 actuated by said relay 79 adapted to start the operation of said sending apparatus.

32. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, a relay 79 adapted when operated to transfer the office keyboard into operative relation to the second sending apparatus, a circuit for said relay completed upon the operation of said office keyboard, a relay 270, a circuit for said relay completed while the office keyboard is in association with the first sending apparatus, means actuated by said relay 79 in operating for opening the circuit of said relay 270, and means actuated by said relay 270, when deenergized, for starting the operation of said first sending apparatus.

33. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, a signal device associated with said office keyboard, means for displaying said signal, operated when said keyboard is actuated, means operated when said keyboard has completed its work, for transferring the same into operative relation to said second sending apparatus, and thereby rendering said signaling device inert.

34. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism therefor, a pair of sending apparatuses adapted to operate selected line switching mechanisms, one of said sending apparatuses being adapted normally to serve said talking circuit, an office keyboard normally associated with said sending apparatus adapted to operate said office selecting mechanism and unite said talking circuit with line switching mechanism at a desired office, said keyboard having keys represent-

ing offices, each key when depressed being adapted to selectively operate said keyboard and office selecting mechanism to select the line switching mechanism at the office represented by said key, a signal device displayed upon the operation of said key, means automatically operated when said keyboard has served said talking circuit, for transferring the same to said second sending apparatus, and means automatically operated when said keyboard is so transferred for rendering inert said signaling device.

35. The combination with telephone lines extending to a number of central offices, of line switching mechanism at each of said central offices, a talking circuit, office selecting mechanism, an office keyboard associated with said talking circuit to operate said selecting mechanism to unite said talking circuit with the line switching mechanism at a desired office, and means actuated when the keyboard has operated said selecting mechanism, adapted to disassociate said keyboard from said talking circuit.

36. The combination with telephone lines extending to a number of central offices, said offices being divided into districts, of line switching mechanism at each of said offices, a talking circuit, district and office selecting devices adapted to unite said talking circuit with the line switching mechanism at a desired office, an office keyboard associated with said talking circuit adapted to actuate said selecting devices, and means actuated upon the operation of said keyboard for disassociating said keyboard from said talking circuit.

37. The combination with a talking circuit, of office selecting mechanism therefor, line switching mechanism at each of the central offices, a sending apparatus adapted to actuate line switching mechanism, an office keyboard for operating said office selecting mechanism, means for associating said sending apparatus with said talking circuit, and means thereby actuated for placing said keyboard in operative condition to serve said talking circuit.

38. In a semi-mechanical telephone exchange system, the combination with a talking circuit, of line switching mechanism at a plurality of central offices, office selecting mechanism associated with said talking circuit, sender apparatus adapted to operate said office selecting mechanism, a keyboard for controlling said sender apparatus, means for associating said sender apparatus with said talking circuit, and a source of current for supplying said keyboard adapted to be connected with said keyboard by said sender apparatus when placed in operative relation to said talking circuit.

39. The combination with a talking circuit, of office selecting mechanism therefor, line switching mechanism at each of a num-

ber of central offices, a sending apparatus for operating line switching mechanism, an office keyboard associated with said sending apparatus for operating office selecting mechanism, means for associating said sending apparatus with said talking circuit, and a source of current adapted to supply the sending apparatus and office keyboard, said source being connected therewith in the association of said sending apparatus with said talking circuit.

40. In a semi-mechanical switching system, the combination with a plurality of selecting controllers, each having a plurality of terminals, of a set of keys adapted to alter the electrical condition of said terminals, and means controlled by any key for causing a cycle of operations of one of the selecting controllers, and also a similar cycle of operations of the other controller to control a plurality of selections.

41. In a semi-mechanical telephone exchange system, the combination with a connecting circuit, of a sender apparatus, primary and subsidiary sender leads extending from said sender apparatus to said connecting circuit, and switching mechanism adapted to transfer said sender apparatus from one set of said sender leads to the other.

42. In a semi-mechanical switching system, the combination with an office sender adapted to govern selection of trunks to distant offices, of a plurality of sets of sending leads, transfer mechanism adapted to shift the office sender from one set of leads to another, and means controlled by the office sender in concluding its work in conjunction with one set of leads for actuating said transfer mechanism.

43. The combination with an office sender, of primary and subsidiary sender leads and a transfer relay governing the alternative connection of said office sender to either set of leads, means controlled by the office sender in concluding its operation over the primary leads for causing said transfer relay to shift said office sender to the subsidiary leads, and means controlled by said office sender in concluding its operation over the subsidiary leads for causing said transfer relay to shift said office sender to the primary leads.

44. In a semi-mechanical switching system, the combination with operators' connecting circuits, of an office sender adapted to govern selection of a trunk to a distant office, primary and subsidiary number senders each adapted to govern selection of a line in such distant office, and each having individual sets of sending leads, a transfer relay normally connecting the office sender to the primary sender leads, and adapted when excited to shift said office sender to the subsidiary sender leads, sender-seizing mechanism for each connecting circuit

adapted to seize the primary or subsidiary sender according to which is idle, and means controlled by the seizure of the primary sender for causing the operation of said transfer relay.

45. In a semi-mechanical switching system, the combination with operators' connecting circuits of an office sender adapted to govern selection of a trunk to a distant office, primary and subsidiary number senders each adapted to govern selection of a line in such distant office, and each having individual sets of sending leads, a transfer relay normally connecting the office sender to the primary sender leads, and adapted when excited to shift said office sender to the subsidiary sender leads, sender-seizing mechanism for each connecting circuit adapted to seize the primary or subsidiary sender according to which is idle, means controlled by the seizure of the primary sender for causing the operation of said transfer relay, and means actuated by the office sender in completing its work with the primary sender for causing said transfer relay to be deenergized.

46. In a telephone exchange system, the combination with a connecting circuit, of automatic switching apparatus comprising a district selector and an office selector adapted to be associated with said connecting circuit, a sender apparatus comprising a plurality of keys, and means in said sender apparatus responsive to the depression of any one of said keys to control the selection by said selectors of an idle trunk line to the office indicated by the depressed key.

47. In a telephone exchange system, groups of mechanical telephone switches, conductors connecting the switches of one group interchangeably with the switches of another group, a set of keys, and means controlled by an actuated key for selectively operating a switch of each group in sequence.

48. In a telephone system, groups of automatic telephone switches, trunk lines connecting said groups of switches, a set of keys, and means controlled by an actuated key for operating in a definite manner a switch of the first group and a switch of a succeeding group in series therewith.

49. The combination with a line switching device having a contact member and a pair of operating magnets therefor, of a circuit including both said magnets, sources of current of different character, and means for applying the same, said circuit to operate said magnets, one of said magnets being unresponsive to the current operating the other, and adapted in response to its operating current, to render inoperative said other magnet.

50. The combination with a line switching device having a contact member and a

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- pair of operating magnets therefor, of a circuit including both said magnets, sources of current of different character and switching mechanism for alternately connecting said sources with said circuit, one of said sources being without effect upon one of said magnets, said magnet operating in response to said other source, and rendering the other magnet inoperative.
51. The combination with a line switching device having a contact member and a pair of operating magnets adapted to give said member different movements, said magnets responding to current of different character, of a circuit including both said magnets, sources of current of different character, and means for applying the same alternately to said circuit to operate either magnet.
52. The combination with a line switching device having a contact member and long and short step magnets therefor, of a circuit including both said magnets, and means for applying current to said circuit to selectively operate either of said magnets.
53. The combination with a line switching device having a contact member and a pair of operating magnets adapted to give said member characteristic movements, of a circuit including said magnets, said magnets requiring current of different strength for their operation, means controlled by the magnet requiring the higher strength of current, for rendering ineffective said other magnet, sources of current of proper strength and means for applying the same to said circuit.
54. The combination with a line switching device having a rotatable contact member and a pair of magnets adapted to advance said member in long and short steps, of a circuit including both said magnets, said magnets requiring currents of different strength for their operation, and means for applying current of proper strength to said circuit to selectively actuate either magnet without affecting the other.
55. The combination with a line switching device having a contact member, and a pair of operating magnets therefor, of a circuit having parallel branches including said magnets, said magnets requiring current of different strength for their operation, means for applying currents of different strength to said circuit to operate either magnet, and means controlled by the magnet requiring the higher strength of current, for opening the branch containing the other magnet.
56. The combination with a line switching device having a contact member and a pair of magnets adapted to give said member long and short steps, of a circuit having parallel branches including said magnets, said magnets requiring currents of different strength for their operation, contacts operated by the magnet requiring the higher strength for opening the branch containing the other magnet, and means for applying proper current to said circuit.
57. The combination with a line switching device having a contact member and a pair of magnets adapted to give said member long and short steps, of a circuit having parallel branches including said magnets, said magnets requiring currents of different strength for their operation, contacts operated by the magnet requiring the higher strength for opening the branch containing the other magnet, and controlling mechanism adapted to be set to apply current impulses of proper strength successively to said circuit.
58. The combination with a line switching device having a contact member and a pair of stepping magnets, of a polarized relay, a circuit including one of said magnets and said relay, and means for applying current to said circuit to operate only said magnet, means thereupon operated for applying current to said circuit to actuate said relay, and a circuit for said other stepping magnet controlled by said relay when operated.
59. The combination with a line switching device having a contact member, and a pair of stepping magnets therefor, a quick-acting polarized relay, a circuit including one of said magnets and said relay, means for applying current to said circuit to operate only said magnet, means thereupon automatically operated for applying current to said circuit to actuate said relay, a circuit for said other stepping magnet controlled by said relay, and means controlled by said relay for rendering inoperative said first-mentioned stepping magnet.
60. The combination with a line switching device having a contact member, and three stepping magnets adapted to give said member characteristic movements, of a polarized relay, a circuit including said relay and two of said magnets, said magnets requiring currents of different strength for their operation, the magnet requiring the highest strength current in operating rendering said other magnet inoperative, controlling mechanism adapted when set to supply currents of proper strength to successively actuate said magnets and thereupon supply current of proper polarity to said relay, and a circuit for said other stepping magnet controlled by said relay.
61. The combination with a line switching device having a rotatable and longitudinally-movable contact carrying member, of a pair of magnets adapted to rotate said member in long and short steps, a third magnet adapted to advance said member longitudinally, a polarized quick-acting re-

lay, a circuit including said long and short step magnets and said polarized relay, said magnets requiring currents of different strength for their operation, the magnet requiring the current of highest strength in operating rendering said other magnet ineffective, controlling mechanism adapted when set to supply currents of proper strength to successively actuate said long and short step magnets, said mechanism thereupon supplying current of proper polarity to said circuit to operate said relay, a circuit for said third magnet controlled by said relay, when energized, and means operated by said relay when energized for opening the circuit of said long and short step magnets.

62. In a telephone system the combination with a connector switch, of a test and release conductor independent of the talking circuit, said test conductor having a test potential thereon during conversation, means for momentarily removing the test potential while effecting the release of the switch, and means for again applying the test potential to said conductor.

63. In a telephone system the combination with a connecting switch and a trunk line leading thereto, means for placing a test potential on one of the conductors of said trunk during conversation, means for momentarily removing said potential from said conductor and for thereafter replacing the same.

64. In a telephone system the combination with a connecting switch adapted to be advanced to a desired terminal, of a trunk line leading thereto having a separate test conductor, means for placing a test potential on said test conductor during conversation, means for momentarily removing said test potential from, and replacing it upon, said conductor and simultaneously therewith releasing said switch.

65. The combination with a line switching device having a contact member adapted to be advanced to a desired terminal, of a retaining magnet adapted to hold said member in its operated position, a trunk line leading to said switching device and having a test wire, contact springs closed while the contact member is away from normal position, means controlled jointly by said contacts and said retaining magnet in releasing said contact member for applying a test potential to said test wire during the return of said contact member from an operated to normal position.

66. The combination with a line switching device having a contact member adapted to be advanced to a desired terminal, of a retaining magnet adapted when energized to hold said member in its operated position, a trunk line leading to said switching device and having a test wire, contact springs

closed while the contact member is away from normal position, an armature for said retaining magnet, and a source of current connected with said test wire when said contact springs are closed and said armature retracted; whereby a test potential is applied to said test wire, upon the deenergization of said retaining magnet during the return of the said member from an operated to normal position.

67. The combination with a line switching device, of an operating magnet therefor, a controller, an operating magnet for said controller and means for selectively operating the same, and means actuated by said last mentioned operating magnet for actuating said first mentioned magnet.

68. The combination with a line switching device, of an operating magnet therefor, a circuit for said magnet, a controller and its operating magnet, a circuit adapted to be established for said controller magnet for a period determined by said controller, and a source of current adapted to be intermittently applied by said controller magnet to the circuit of said first mentioned magnet.

69. The combination with a line switching device having a contact member and an operating magnet therefor, of a circuit for said magnet, a controller for said device having a contact member, a stepping magnet for said controller having a stepping pawl adapted to be operated thereby, a circuit adapted to be established for said stepping magnet, means for opening said circuit when said controller member has advanced a predetermined distance, a circuit for the operating magnet of said device, a source of current, and contacts operated by said stepping pawl adapted to apply current from said battery to said circuit.

70. The combination with a line switching device having a contact member adapted to be advanced to a desired terminal, of a trunk line leading to said switching device and having a test wire, means for maintaining the busy condition of said test wire while said contact member is displaced from normal, and separate means for maintaining the busy condition of said test wire during the return of said contact from such displaced position to a normal position.

71. The combination with a switchboard having spring jacks representing lines, of a plug adapted to make connection with said springjacks, a selector, a holding magnet therefor, connecting conductors extending from said plug to said selector, a relay in a circuit established by the insertion of a plug in any springjack, a circuit for the holding magnet of said selector, adapted to be completed by said relay, an off-normal switch for the selector also controlling said circuit, and means operated by said holding magnet for maintaining a circuit through itself in-

dependent of said off-normal switch; where-
by the holding magnet is excited when the
plug is inserted in a jack, but upon the re-
moval of the plug said holding magnet is de-
energized and cannot again be excited until
the selector is restored to normal.

72. The combination with a controller
having stepping and holding magnets, of a
circuit adapted to be completed when said
controller reaches a predetermined point in
its operation, means governed by the comple-
tion of such circuit for stopping the con-

troller, and a normally open contact adapted
to be closed by said holding magnet, control-
ling said circuit; whereby said circuit can-
not be closed while the controller is in the
act of returning to normal condition after
an operation thereof.

In witness whereof, I hereunto subscribe
my name this 28th day of March A. D., 1907.

ALBERT M. BULLARD.

Witnesses:

FRANK N. DAVIS,
ERNEST C. McDERMOTT.