W. KAISLING.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED MAY 16, 1910.

1,158,927.

Patented Nov. 2, 1915.

3 SHEETS—SHEET 1.

Fig. 1 Part 1

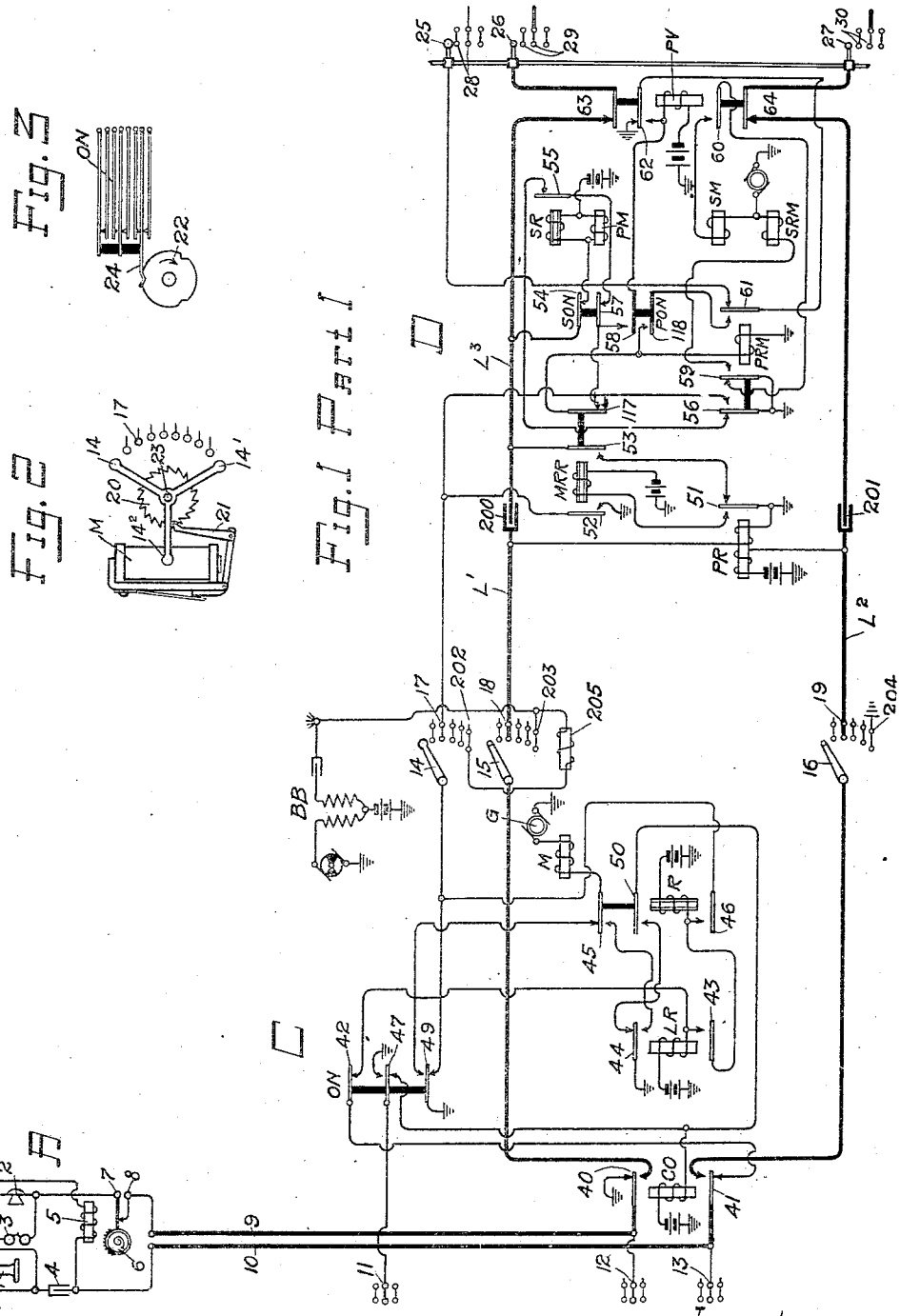

Fig. 2

Fig. 3

Fig. 4

Witnesses

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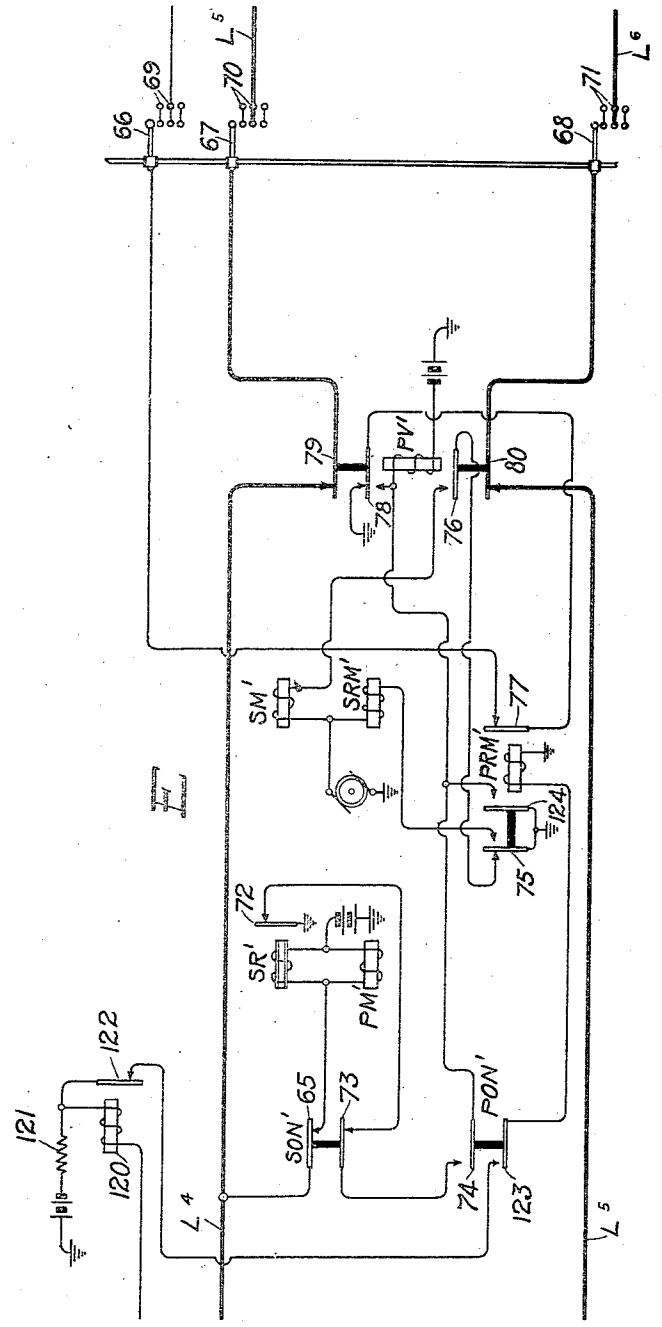
3 SHEETS—SHEET 2.

Fig. 1. Part 2



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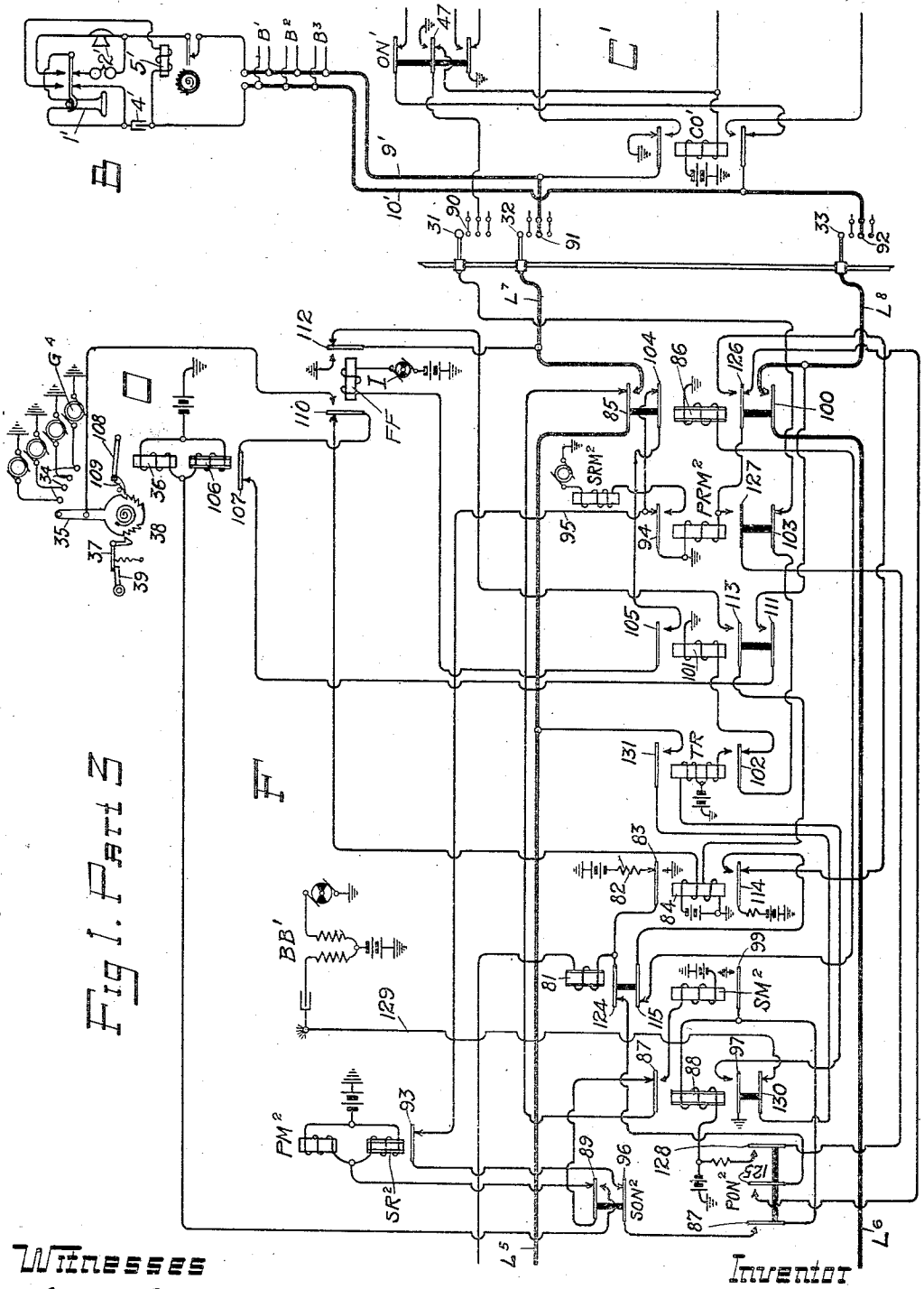

Fig. 1. Part 3

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AUTOMATIC TELEPHONE SYSTEM.

1,158,927. Specification of Letters Patent. Patented Nov. 2, 1915.

Application filed May 16, 1910. Serial No. 561,523.

To all whom it may concern:

Be it known that I, WILLIAM KAISLING, a citizen of the United States of America, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

The present invention relates to automatic telephone systems and more particularly to that type known as two-wire or metallic line systems in which the selectors and connectors are directively controlled by the subscriber without the use of any ground connections at the subscriber's telephone, the object being to provide a system which is both simple and efficient and positive in its operation.

In the system of my application, I use line switches, one individual to each line, the said line switches being very simple in construction, the wipers having a rotary movement and having access to a group of first selector switches. The said line switches are adapted upon the initiation of a call to automatically connect the calling line with the first idle first selector of the group to which it has access. The selected first selector and then a second selector and connector are operated to extend the line of the calling subscriber to the line of the called subscriber.

I have shown no mechanical drawing of a selector or connector switch in this application, the system of my application being adapted to preferably operate in connection with a switch such as is shown in my application filed April 27th, 1910, Serial No. 558,000, although it will operate equally well in connection with any switch having wipers adapted to coöperate with a bank having contacts arranged in groups, having a primary magnet to give the wipers a primary adjustment to select a group of contacts, a secondary magnet to give the wipers a secondary adjustment to select a contact in the selected group, and release magnets to control the release of the wipers. I also use a so-called primary off-normal switch associated with each selector and connector and having contacts moved to their alternate position upon the first primary movement of the wipers and a so-called secondary off-normal switch having contacts moved to their alternate position upon the first secondary movement of the wipers, the said switches being restored to normal upon the restoration of the wipers from their respective movements.

Referring now to the accompanying drawings, Figure 1, which comprises Part 1, Part 2 and Part 3, discloses a ten thousand line exchange system adapted to be used for interconnecting its substations in conversational circuits. Fig 2 shows diagrammatically the mechanical switch used in connection with the circuit of line switch C. Fig. 3 shows the off-normal spring arrangement used in connection with the switch of Fig. 2.

Assuming now a system of ten-thousand lines, there would be ten-thousand line switches, such as are shown at C, one for each line in the exchange, and assuming that the selector and connector switches each have one hundred sets of contacts, on a basis of ten per cent., trunking, there would be one-thousand first selectors D, one-thousand second selectors E, and one thousand connectors F. The subscribers' lines would be divided into groups of one-hundred lines each and there would be ten first selectors D for the use of each one hundred lines. Each subscriber's line would also be multipled to the bank contacts 11, 12 and 13 of the ten connectors which have access to the group of one hundred lines with which it is associated. The movable contacts or wipers of each line switch which comprise the two line and one so-called private wiper, have access to ten first selectors D. The wipers of the second selectors E are connected in multiple back before the bank contacts of first selectors, and since there are one thousand of each of these switches and each first selector has one hundred bank contacts, the wipers of each second selector are multiply connected to the corresponding bank contacts of one hundred first selectors. Similarly, the wipers of one thousand connectors are multiply connected to the corresponding bank contacts of one-hundred second selectors. The apportionment of values just given may be varied at will to suit the condition of any particular size exchange or to suit any different percentage of trunking.

Referring now to the system of Fig. 1, at A is shown a well known form of subscriber's telephone consisting of the receiver 1, transmitter 2, call-bell 3, condenser 4, im-

pedance coil 5 and the calling device which includes dial 6 and springs 7 and 8, the operation of the said dial being effective in its return when moved off normal to open and close the springs 7 and 8, to interrupt the circuit of the line of subscriber A when making a call. Connecting with the exchange are the two limbs 9 and 10 of the line which terminate at the armatures of the cut-off relay CO, the said relay being included in the line switch C, the said switch being individual to the line of the subscriber A. The multiple contacts 11, 12 and 13 are the bank contacts or terminals of connectors which have access to the line of subscriber at A. The line switch C is adapted upon the initiation of a call from the subscriber at A to automatically select the first idle one of a group of first selectors such as is shown at D. The line switch C also includes the off-normal springs ON, the line relay LR which is initially energized over the line of the calling subscriber with which it is associated, the release relay R and the motor magnet M, which is adapted to advance the wipers 14, 15 and 16 to connect with a set of contacts 17, 18 and 19.

At Fig. 2 is shown diagrammatically the switch structure of the line switch C consisting of the motor magnet M which is adapted to attract its armature and rotate the ratchet 20 by means of the pawl 21, thereby advancing the wiper 14 to engage one of the contacts 17. To release the switch, the wiper 14 is again advanced until it reaches the position shown now occupied by the wiper 14′, the wiper 14′ then having advanced to the position now occupied by the wiper 14^2. The off-normal springs ON shown in Fig. 3 are moved to their alternate position by the advance of the disk 22 in its . step off-normal, the said disk being secured to the shaft 23 of the switch shown in Fig. 2, the springs again returning to their normal position when the switch is advanced to release the connection, the spring 24 then resting in the next notch. The motor magnet M which is used to move the wipers 14, 15 and 16 to select an idle first selector D is also used to release the switch to restore it to normal. The first selector switch D includes the primary relay PR, the said relay being controlled by the calling subscriber at A to transmit the primary impulses to operate the different switches. The first selector D also includes the primary magnet PM which is adapted to move the wipers 25, 26 and 27 to select a row or group of contacts such as 28, 29 and 30 and the secondary relay SR is then operated to energize the private relay PV which closes a circuit through the secondary magnet SM to advance the wipers along the selected row, the said relay PV controlling the selection of an idle set of contacts in the selected row which lead to a second selector such as is shown at E. Also included in the first selector D are the primary off-normal springs PON which are moved to their alternate position upon the first primary movement of the wipers 25, 26 and 27, and the secondary off-normal springs SON which are moved to their alternate position upon the first secondary movement of the wipers 25, 26, and 27. The secondary off-normal springs SON are restored to their normal position upon the return of the wipers 25, 26 and 27 from their secondary movement when the switch is released and the primary off-normal springs PON are restored to their normal position when the said wipers have been restored from their primary movement. To restore the wipers after they have connected to a set of contacts, the secondary release magnet SRM is operated to restore them from their secondary movement and the primary release magnet PRM is operated to allow the wipers to restore by a spring from their primary movement. The second selector E is operated in substantially the same manner as the first selector D and includes the same operating magnets as those shown in connection with the first selector D, the operating magnets of the second selector E having the same reference characters with the exponent ′ thereafter. The connector F includes the same operating magnets as the first and second selectors, but the secondary travel of its wipers 31, 32, and 33 is controlled by impulses from the calling subscriber. The connector F is arranged for selective party line signaling using the well known harmonic system. The switch O shown in connection with the connector F is operated to select a certain frequency of alternating current to ring the bell of the called subscriber. The switch O includes the contacts 34 which are adapted to be connected with by the wiper arm 35 which is advanced by the operation of the magnet 36. The pawl 37 is shown normally out of engagement with the teeth of the ratchet 38. Normally engaging the pawl 37 is the arm 39 which is secured to the secondary shaft of the switch F. Upon the first secondary movement of the wipers 31, 32 and 33 of the switch F the arm 39 moves away from the pawl 37, allowing it to engage the teeth of the ratchet 38, so that the wiper arm 35 is held in engagement with the selected contact 34. The called subscriber at B is connected to the line switch C′ by the line limbs 9′ and 10′ which terminate at the contacts of the cut-off relay CO′ and also connected with the multiple bank contacts of the connector switch F and the other connectors of the group having access to the line of the subscriber at B. The line switch C′ is similar to that shown at C but only part of the circuit is shown at C′. B′, B^2 and B^3 are terminals of subscribers' telephones similar

to that shown at B, it being assumed that the subscriber at B is one of four parties on the line.

Operation.—Assuming now that the subscriber at A desires to connect with the subscriber at B whose number we will assume is 54324, the subscriber at A removes the receiver 1 from its switch hook, closing an initial energizing circuit through the line relay LR from ground at normal contact 40 of relay CO, line limb 9, through the telephone of the subscriber at A, line limb 10, normal contact 41, normal contact 42 of the off-normal switch ON, the winding of relay LR to battery, energizing said relay, closing the contact 43, the circuit now dividing and part passing through the winding of relay R to battery, energizing the said relay R. A circuit is now traced through the motor magnet M from ground at alternate contact 44 of relay LR, alternate contact 45 of relay R, through the winding of the magnet M to the alternating generator G. The magnet M now attracts its armature to advance the wipers 14, 15 and 16 to engage the first set of contacts 17, 18 and 19. Assuming that these contacts are connected to a busy first selector as shown at D, there will be a direct ground upon the first contact 17 as will be hereinafter described, and the relays R and LR will remain energized over a circuit traced from ground at the multiple contact 17, wiper 14, alternate contact 46, dividing and passing through the windings of the relays LR and R to battery. Upon the first movement of the wipers of the switch C, the off-normal springs ON are moved to their alternate positions and a ground is placed upon the multiple contacts 11 traced from the alternate contact 47. The contact 42 disconnects the line relay LR from connection with the line of the subscriber at A, thereby removing the line control of the said relay which is now dependent upon the ground connection at wiper 14. The motor magnet M now advances wipers 14, 15 and 16 to engage the next set of contacts 17, 18 and 19, these being the contacts of the first selector D. This selector being idle, there will be no ground upon its private contact 17 and the line relay LR is deënergized opening the circuit for the magnet M at contact 44 and preventing any further advance of the wipers 14, 15 and 16. The relay R which is sluggish holds its armature 46 attracted until a new locking circuit is established from the first selector D, as will be now described. Upon the deënergization of the line relay LR, a circuit is established for the cut-off relay CO from ground at alternate contact 44 of the relay LR, alternate contact 50 of relay R, through the winding of the cut-off relay CO to battery, energizing the said cut-off relay and extending the circuit of the line of the calling subscriber at A to the first selector D. The primary relay PR is now energized over a circuit traced from ground through the right-hand winding of the said relay PR, conductor L′, alternate contact 40 of relay CO, line of subscriber at A, contact 41, line L^2, the left-hand winding of the relay PR to battery, energizing the said relay and closing a circuit from ground through alternate contact 51, the winding of the main release relay MRR to battery, energizing the said relay MRR. The contact 52 is now closed placing a ground upon the multiple contact 17, thence over wiper 14, alternate contact 46 of relay R to battery, locking the said relay R. The switch D by reason of the ground upon the multiple contact 17 is now busy to any other line switch which may seek connection thereto. The subscriber at A now operates the dial 6 in a clockwise direction until five projections on the periphery thereof have passed below the spring 7 but not opening the contact 7, 8 until its return. The dial is now released and returned to normal, by the spring shown in connection therewith, opening and closing the contact 7, 8, and interrupting the circuit through the primary relay PR five times, thereby vibrating its armature 51. The relay MRR being slow to release its armature holds the said armature attracted while the said armature 51 of the relay PR is vibrating. Upon the first deënergization of the said relay PR, a circuit is closed from ground at normal contact 51, alternate contact 53 of relay MRR, line L^3, normal contact 54 of the secondary off-normal switch SON, then dividing and passing through the windings of the secondary relay SR and the primary magnet PM to battery, energizing the said relay and magnet. The primary magnet PM is operated upon each deënergization of the primary relay PR which is effective to step the wipers 25, 26 and 27 to a point opposite the fifth row of contacts 28, 29 and 30 which are the bank contacts leading to the second selector E which has access to connector switches of the fourth hundred group of lines in the fifth thousand group of the exchange. The impulses just traced from the ground at normal contact 51 of the primary relay PR also hold the armature of the secondary relay SR in its attracted position, due to the said secondary relay SR being sluggish in its action.

After the last impulse has been transmitted from the primary relay PR, the armature 51 remains in its attracted position and the secondary relay SR now retracts its armature 55 closing a circuit through the private relay PV from ground at normal contact 56 of relay PRM, normal contact 55, normal contact 57 of the secondary off-normal switch, alternate contact 58 of the primary off-normal switch which is now closed, through the winding

of the relay PV to battery, energizing the said relay. A circuit is now closed through the secondary magnet SM from ground at normal contact 59 of relay PRM, alternate contact 60, through the winding of the said secondary magnet SM to the alternating generator. The secondary magnet now receives impulses from the said generator and steps the wipers 25, 26 and 27 to engage the first set of contacts 28, 29 and 30 of the selected row, the said contacts leading to a second selector similar to that shown at E. Assuming that the first set of contacts are the contacts of a busy second selector E, there will be a direct ground upon the contact 28 as will be hereinafter described, and a locking circuit is now established for the private relay PV, from ground at multiple bank contact 28, through the wiper 25, normal contact 61 of relay PRM, alternate contact 62, and through the winding of the said relay PV to battery. The secondary magnet SM now steps the wipers to engage the second set of contacts, which are the contacts of the idle second selector E. There being no ground upon the private contact 28 of the second selector E, the relay PV deënergizes opening the circuit for the secondary magnet SM at contact 60 and the wipers 25, 26 and 27 remain in engagement with the contacts of the second selector E. While the wipers 26 and 27 are passing over the line contacts 29 and 30, their circuit is interrupted at contacts 63 and 64 of relay PV so that no interference will be had with any existing connections. On the first secondary movement of the switch D, the secondary off-normal springs SON moved to their alternate position, disconnecting the secondary relay and primary magnet from the line L^3 at the contact 54 and also opening the initial energizing circuit of private relay PV at the contact 57. Upon the deënergization of the relay PV, a ground is placed upon the multiple contacts 28 from normal contact 62 of relay PV, normal contact 61, and wiper 25, thus making the switch E busy and unselectable by any other switch such as D. This ground connection also serves to energize the relay 120 of switch E, the circuit being traced through the low resistance winding of the relay 120, the high resistance winding 121 to battery.

The subscriber at A now operates the dial 6 to open and close the contact 7, 8 four times, thereby transmitting four impulses from ground at normal contact 51 of the primary relay PR, alternate contact 53 of relay MRR, line L^3, normal contact 63, wiper 26, contact 29, line L^4, normal contact 65 of the secondary off-normal switch SON', then dividing and passing through the windings of the secondary relay SR' and the primary magnet PM' to battery, energizing the said relay and magnet. The four impulses from the primary relay PR operate the primary magnet PM' four times to step the wipers 66, 67 and 68 to a point opposite the fourth row of contacts 69, 70 and 71 in the bank, the said contacts leading to a connector switch having access to the group of one hundred lines with which the line of the subscriber at B is associated. The secondary relay SR' being a sluggish relay, the contact 72 remains open until the last impulse has been transmitted through the said relay and magnet and the relay SR' is then deënergized, closing a circuit through the private relay PV' from ground at normal contact 72 of relay SR', normal contact 73 of switch SON', alternate contact 74 of the primary off-normal switch PON', which is now moved to its alternate position, through the winding of the relay PV' to battery, energizing the said relay PV'. A circuit is now closed for the secondary magnet SM' from ground at normal contact 75 of relay PRM' alternate contact 76 of relay PV', through the winding of the secondary magnet SM' to the alternating generator. The secondary magnet SM' is now energized by an impulse from the said generator and steps the wipers 66, 67 and 68 to engage the first set to contacts 69, 70 and 71 in the selected row, which we will assume are the contacts of a busy connector switch similar to that shown at F. The first set of contacts being those of a busy connector F, there will be a direct ground upon the private contact 69 as will be hereinafter described, and a locking circuit will be established for the private relay PV' from the said ground at the said multiple contact 69, through wiper 66, normal contact 77 of relay PRM', alternate contact 78 of relay PV', through the winding of the said relay to battery. The secondary magnet SM' is again operated and steps the wipers 66, 67 and 68 to engage the second set of contacts which are the contacts 69, 70 and 71 of the idle connector F. There being no ground upon private contact 69 of the idle connector F, the relay PV' is deenergized, opening the circuit for the secondary magnet SM' at contact 76 and the wipers 66, 67 and 68 remain in engagement with the bank contacts leading to the connector F. The secondary off-normal switch SON' and the primary off-normal switch PON' are moved to their alternate position on the first corresponding movement of the switch. On the deënergization of the private relay PV', a direct ground is placed upon the private contact 69 from ground at normal contact 78 of the relay PV', contact 77 of relay PRM' to wiper 66, making this switch F busy. This ground connection also serves to energize the relay 81 of connector F which is of comparatively low

resistance, from battery through the high resistance winding 82 and normal contact 83 of relay 84.

The subscriber at A now operates the dial 6 to transmit three impulses from the ground at normal contact 51 of the primary relay PR over the before-traced path to wiper 67 of second selector E, thence over contact 70, line L^5, normal contact 85 of relay 86, normal contact 87 of relay 88, normal contact 89 of switch SON^2, then dividing and passing through the windings of the primary magnet PM^2 and the secondary relay SR^2 to battery, energizing the said magnet and relay. The three impulses which are transmitted from the primary relay PR operate the primary magnet PM^2 three times, which is effective to step the wipers 31, 32 and 33 to a point opposite the third row of contacts 90, 91 and 92 of the bank. The relay SR^2 which is sluggish, holds its armature 93 in an attracted position while the impulses were being transmitted through the winding of the said relay and after the last impulse has been sent, the said armature 93 is retracted. A circuit is now closed through the relay 88 from ground at normal contact 94 of relay PRM^2, line 95, normal contact 93 of relay SR^2, normal contact 96 of switch SON^2, alternate contact 87 of switch PON^2, which is now moved to its alternate position, through the winding of the said relay 88 to battery, energizing the said relay 88. Upon the energization of the said relay 88, a circuit is closed through the test relay TR from ground at alternate contact 97 of the relay 88, through the upper winding of relay TR, energizing the said test relay TR, and attracting its armatures. The energization of the said relay 88 also closes the alternate contact 87, thereby cutting off the primary magnet PM^2 and secondary relay SR^2 from connection with line L^5 and cutting in the secondary magnet SM^2, so that the next set of impulses transmitted will be effective to operate the said secondary magnet SM^2.

The subscriber at A now operates the dial 6 to transmit two impulses from ground at normal contact 51 of the primary relay PR over the before-traced path to alternate contact 87 of relay 88 at connector F, then through the winding of the secondary magnet SM^2 to battery, energizing the said magnet, and stepping the wipers 31, 32 and 33 to engage the first set of contacts 90, 91 and 92 in the selected row. Upon the first secondary movement of the said wipers, the secondary off-normal switch SON^2 is moved to its alternate position, opening the before-traced energizing circuit for the relay 88 at contact 96 of the said switch SON^2, but the contact 99 of magnet SM^2 is closed holding the relay 88 energized and due to its sluggish action, holds its armatures attracted while the secondary magnet SM^2 is operating due to the second impulse, to step the wipers 31, 32 and 33 to engage the contacts 90, 91 and 92 of the line of the called subscriber at B. The relay TR has remained energized due to relay 88 being energized.

Called line idle.—Assuming now that the line of the called subscriber B is idle, there will be no ground upon the private bank contacts 90 and therefore no locking circuit will be established for the lower winding of relay TR. After the last energization of the secondary magnet SM^2 the relay 88 deenergizes opening the circuit for the test relay TR at the contact 97 of the said relay 88 and the said test relay TR deënergizes and retracts its armatures. The deënergization of the test relay TR closes a series circuit through the windings of the relay 101 of the connector F and the cut-off relay CO′ of the line switch C′. This circuit is traced over the following path: From ground through the winding of the said relay 101, normal contact 102 of the relay TR, normal contact 103 of relay PRM^2, wiper 31 and contact 90, normal contact 47′ of off-normal switch ON′, through the winding of the cut-off relay CO′, energizing the two said relays 101 and CO′. The energization of the cut-off relay CO′ removes the substation control of the line switch C′ so that should any subscriber on the line remove his telephone from its switch-hook, the line switch C′ will not be operated. The energization of the relay 101 closes a circuit through the so-called flip-flop relay FF from ground at normal contact 94 of relay PRM^2, normal contact 104 of relay 86, alternate contact 105 of relay 101, through the winding of the said relay FF and the interrupter I to battery. The relay FF is now alternately energized and deënergized but this has no effect upon the circuit or connection at this time. The line of the calling subscriber at A has now been extended from the heavily marked conductors to the line of the called subscriber at B, being open only at the contacts 85 and 100 of relay 86 of the connector F and connected through the condensers 200 and 201. The next step is to pick out the proper frequency of ringing current to operate the bell of the called subscriber at B. The calling subscriber at A now operates the dial 6 to transmit four impulses from the ground at normal contact 51 of the primary relay PR over the before-traced path along the above heavily marked conductor to normal contact 85 of relay 86 at connector F, normal contact 87 of relay 88, alternate contact 89 of the switch SON′, and then through the windings of the magnet 36 and relay 106 of the switch O, energizing the said magnet and said relay.

Four impulses are transmitted over the

path just traced and the relay 106 being sluggish, retains its armature 107 attracted while the impulses are being sent through its winding. The said four impulses serve to energize the magnet 36 four times attracting and retracting its armature 108 and the pawl 109 engaging the teeth of the ratchet 38, stepping the wiper 35 to engage the fourth contact 34 which is connected to the alternating generator of the proper frequency to ring the bell of the subscriber at B. The relay FF now sends interruptions of ringing current from the alternating generator G^4, thence over contact 34, wiper 35, alternate contact 110 of relay FF, assuming the relay FF is energized at this time, normal contact 107 of relay 106, alternate contact 111 of relay 101, line L^8, wiper 33, contact 92, line limb 10′, through the condenser, switch-hook and bell of the called subscriber at B, returning over line limb 9′, bank contact 91, wiper 32, line L^7 to ground at alternate contact 112 of the relay FF, ringing the bell of the subscriber at B. The circuit of the relay FF is opened at the interrupter I retracting its armatures and placing the windings of the relay 84 in bridge of the line of the called subscriber, over the following traced path: from ground through the lower winding of the said relay 84, alternate contact 113 of relay 101, normal contact 112 of relay FF, line L^7, contact 91, line limb 9′ to the telephone of the called subscriber at B, the said circuit being interrupted at the condenser 4′, then continuing over line limb 10′, contact 92, wiper 33, line L^8, alternate contact 111 of relay 101, normal contact 107, normal contact 110 of relay FF, through the upper winding of the relay 84 to battery. Thus, it will be seen that the relay FF alternately connects the ringing generator G^4 and the relay 84 in bridge of the line of the called subscriber B, but the path for the direct current through the relay 84 is interrupted at the condenser 4′ until the receiver 1′ is removed from the switch-hook. The subscriber at B now responds to the call by removing the telephone 1′ from the switch-hook and assuming at that time the relay FF is deënergized, the before-traced circuit through the windings of the relay 84 which was interrupted at the condenser 4′ is now closed through the transmitter 2′, the upper contact, switch-hook and the winding of impedance coil 5, energizing the said relay 84 and moving its contacts to their alternate position. Upon the attraction of the armature 83 of relay 84, battery is disconnected from the relay 81, deënergizing the said relay 81 and also upon the energization of the relay 84, alternate contact 114 is closed and an energizing circuit is established through the relay 86, from battery at the said alternate contact 114, normal contact 115 of relay 81, through the winding of the said relay 86 to ground, energizing the said relay and moving its armatures to their alternate B, talking current for the transmitter of the relay 86 now complete the connection between the subscriber at A and subscriber at B, talking current for the transmiter of the subscriber at A being supplied from battery through the relay PR of the first selector D, and talking current for the transmitter of the caller subscriber at B being supplied from battery through the relay 84 of the connector F, the conversational circuit connecting the two subscribers being traced over the heavily marked conductors. When the relay FF is operating to intermittently ring the bell of the called subscriber, upon the retraction of its armatures 110 and 112, the discharge of condensers at the four subscribers' stations on the line is apt to cause a momentary attraction of the armatures of relay 84, opening the circuit for relay 81 at contact 82 and the said relay 81 would deënergize and close the release circuit for connector switch F, but the said relay 81 being slow to release its armature, the armatures of relay 84 would retract and again close the circuit through the relay 81 at contact 82, preventing the release of the connector F.

Release.—The method of releasing the switches used in establishing the connection is as follows: The subscribers having finished their conversation, the subscriber at A now replaces his receiver upon its switch-hook, releasing the line switch C, first selector and second selector E. Upon the restoration of the receiver upon its switch-hook, the energizing circuit for the primary relay PR of the first selector D is broken by the opening of the upper contacts of the switch-hook and the relay PR is now deënergized and its armatures detracted. The main release relay MRR of the first selector D is now deënergized retracting its armatures for the first time since its initial energization when the first selector D was first connected with the line of the subscriber at A. Upon the release of the relay MRR, the primary release magnet PRM is energized over a path traced from ground through the winding of the said magnet PRM, normal contact 117 of relay MRR, alternate contact 58 of switch PON, through the winding of the relay PV to battery, energizing the said magnet PRM and the relay PV. The closing of the alternate contact 56 of the magnet PRM retains the relay R of the switch C in its energized condition, the said relay R being sluggish and retaining its armatures during the interval of the opening of contact 52 of relay MRR and the closing of alternate contact 56 of magnet PRM thus preventing the release of the line switch C until the first selector D has been restored. The closing of the alternate contact 61 of the magnet PRM establishes a

locking circuit for the said magnet through the said contact 61, and the alternate contact 118 of switch PON through the alternate contact 62 of the relay PV, and the winding of the said relay to battery, so that should the subscriber at A again remove his receiver from its switch-hook, the energizing circuit for the primary release relay PRM will not be broken, although the initial energizing circuit will be opened at contact 117 of relay MRR. Upon the energization of the primary release magnet PRM a circuit is also closed through the secondary release magnet SRM from ground at alternate contact 59 of relay PRM, through the winding of the secondary release magnet SRM to the alternating generator. Impulses of current are now transmitted from the said generator through the winding of the said magnet SRM which now restores the wipers 25, 26 and 27 by a step-by-step movement until they have been returned from their secondary movement. The primary release magnet PRM having upon its energization withdrawn a retaining pawl which held the wipers in their primary position, the said wipers are restored from their primary movement to normal by a spring. Upon the restoration of the said wipers to normal, the primary off-normal switch PON is moved to its normal position, opening the locking circuit for the primary release magnet PRM and the relay PV at the contact 118, thus deënergizing the said magnet and relay, the said magnet PRM opening the energizing circuit for the magnet SRM at contact 59. The switch D and all its associated mechanism is now at normal. Upon the deënergization of the magnet PRM, the locking circuit for the release relay R of the line switch C is opened at alternate contact 56 of the said magnet PRM. The release relay R now deënergizes and closes a circuit for the motor magnet M from ground at alternate contact 49 of off-normal switch ON through normal contact 45 of relay R and the winding of magnet M, to the alternating generator. Impulses are now transmitted through the winding of the said magnet M from the said generator and the said magnet M is now operated to advance the wipers 14, 15 and 16 until they have passed beyond the last contact in the bank, when the next notch in the disk 22 of Fig. 3 allows the contacts of the off-normal switch ON to move to their normal position, thereby opening the circuit through the motor magnet M at alternate contact 49. The cut-off relay CO deënergized upon the opening of contact 50 of relay R, and the line switch C and its associated mechanism is now at normal.

The release of the second selector E is accomplished as follows: At the time the primary release magnet PRM of the first selector D was energized to release the switch D, the circuit through the magnet 120 of the second selector E was opened at normal contact 61 of the said magnet PRM, deënergizing the said relay 120. An energizing circuit for the primary release magnet PRM′ of the second selector E is now established from battery through the high resistance winding 121, normal contact 122, alternate contact 123 of switch PON′ through the winding of the said magnet PRM′ to ground, energizing the said magnet. A circuit is now established through the secondary release magnet SRM′ from ground at alternate contact 75 of magnet PRM′ through the winding of the said magnet SRM′ to the alternating generator. Upon the energization of the primary release magnet PRM′ a circuit is established through the private relay PV′ from ground at alternate contact 124 of magnet PRM′, through the winding of the said relay PV′ to battery, energizing the said relay and opening the circuit for the wipers 67 and 68 at the contacts 79 and 80, so that in the return of the said wipers they will not interfere with any existing connections in passing over the bank contacts. Impulses are now transmitted over the before-traced path from generator through the secondary release magnet SRM′, the said magnet operating to restore the wipers 66, 67 and 68 from their secondary adjustment by a step-by-step movement. The primary release magnet PRM′ having withdrawn the retaining pawl which held the wipers 66, 67 and 68 in their primary adjustment, the said wipers upon their return from the secondary adjustment are restored from their primary adjustment to normal. The contact 123 of the switch PON′ now being open, the magnet PRM′ is deënergized opening the locking circuit for the relay PV′ at contact 124, and the said relay PV′ is deënergized. The secondary selector E with all of its associated mechanism has now been restored.

To prevent the second selector E being selected while it is restoring to normal, it is necessary to maintain the bank contact 28 in a busy condition, this being accomplished as follows: When the relay 120 of switch E is deënergized closing a circuit through the magnet PRM′, the ground at the winding of the magnet PRM′ is connected to the bank contact 28 through the low resistance winding of relay 120, and the winding 121 being of comparatively high resistance, the private relay PV of any first selector D seeking connection with a second selector E will be maintained energized, but sufficient current will not flow through the winding 121 to energize the relay 120.

The release of the connector F which is controlled by the called subscriber at B is accomplished in the following manner: The

subscriber at B having finished his conversation, restores the receiver 1′ on its switch hook, opening the before-traced circuit through the relay 84 at the upper contacts of the said switch-hook and the said relay 84 is now deënergized. Contact 114 is now restored to its normal position opening the before-traced circuit through the relay 86 which is now deënergized, restoring its contacts to their normal condition. A circuit through the primary release magnet PRM^2 is now established from battery through the resistance 82, normal contact 83 of relay 84, normal contact 124 of relay 81, alternate contact 125 of switch PON^2, normal contact 126 of relay 86 through the winding of the said magnet PRM^2 to ground, energizing the said magnet, moving its contacts to their alternate position and withdrawing the retaining pawl which held the wipers 31, 32 and 33 in their primary adjustment. A locking circuit for the said magnet PRM^2 is established through contact 127 of the said magnet, alternate contact 128 of switch PON^2, through the protective resistance to battery, this circuit remaining closed and maintaining the magnet PRM^2 energized until the primary off-normal switch PON^2 is restored. The opening of the contact 103 of magnet PRM^2 opens the series circuit through the relay 101 and the cut-off relay CO′ allowing the said relays to deënergize and retract their armatures. Upon the energization of the magnet PRM^2, a circuit is also closed through the secondary release magnet SRM^2 from ground at alternate contact 94, through the winding of the said magnet SRM^2 to the alternating generator. Impulses from the said generator are now transmitted through the winding of the said magnet SRM^2 operating the said magnet SRM^2 to restore the wipers 31, 32 and 33 from their secondary adjustment by a step-by-step movement and upon their return from their secondary adjustment, the primary release magnet PRM^2 having withdrawn the pawl which holds them in their primary adjustment, the said wipers are restored by spring tension to normal. The primary off-normal switch PON^2 having moved its contacts to their normal position upon the restoration of the wipers of the connector switch F, the locking circuit through the magnet PRM^2 is opened at contact 128 of the said switch PON^2, deënergizing the said magnet PRM^2 which now opens the energizing circuit for the magnet SRM^2 at contact 94. As previously described the arm 39 of the switch O is secured to the shaft which controls the secondary movement of the wipers 31, 32 and 33 and when the said shaft is restored, the arm 39 again engages the pawl 37, moving it out of engagement with the ratchet 38, and the wiper 35 is restored by the spring shown in connection therewith. The switch F with all its associated mechanism is now restored to normal and the cut-off relay CO′ of the line switch C′ being restored, the line of the subscriber at B is now in condition for another connection.

Called line busy.—Assuming now that the called subscriber at A has extended his line circuit to the connector and has so far transmitted impulses corresponding to the digits 5, 4, 3 and 2 connecting the wipers 31, 32 and 33 of connector F with the contacts 90, 91 and 92 of the line of the subscriber at B, and assuming that the line of the called subscriber at B is busy, there will be a ground upon the private contact 90, either from the ground at alternate contact 47′ of the line switch C′ if the subscriber at B is making a call, or from the ground through a relay corresponding to the relay 101 of the connector F, if the line of the subscriber at B be a called line. This being so, as soon as the secondary magnet SM^2 of the connector F has been operated for the last time and moved the wipers 31, 32 and 33 into engagement with the contacts 90, 91 and 92 of the line of the subscriber at B, the armature 99 of the said magnet SM^2 remains in its retracted position and the relay 88 is now deenergized. It will be remembered that the test relay TR was energized through its upper winding from ground through alternate contact 97 of relay 88, this circuit being now broken when the relay 88 is deënergized, but a locking circuit is now established through the lower winding of the test relay TR from the ground upon the multiple contacts 90, over wiper 31, normal contact 103 of magnet PRM^2, alternate contact 102 of relay TR, through the lower winding of the said relay TR to battery, the said relay remaining energized and holding its contacts in their alternate position. The subscriber at A being unaware at this time that the line of the subscriber at B is busy, operates the dial 6 to transmit four impulses from the ground at normal contact 51 of relay PR over the before-traced path along the upper heavily marked conductor to normal contact 85 of relay 86, connector F, normal contact 87 of relay 88, alternate contact 89 of switch SON^2, then through the windings of the magnet 36 and relay 106 to battery, these impulses being to select the proper ringing current. The said magnet and relay are now operated, the magnet stepping the wiper 35 around to the fourth contact 34 to select the proper frequency to ring the bell of the called subscriber. The test relay TR having remained energized due to the connector F connecting with a busy line, the relay 101 is not energized and consequently the flip-flop relay FF also is not energized, so that the selection of the ringing current has no effect upon the line

of the subscriber at B. The subscriber at A now takes up his receiver to await the answer of the called subscriber B, but receives a characteristic busy signal, notifying him that the subscriber wanted is busy. This busy signal is transmitted over the following described path: from the busy back circuit BB′ at connector F, over line 129, normal contact 130 of relay 88, alternate contact 131 of the test relay TR, back over the upper heavily marked conductor to limb 9, through the receiver 1 of the calling subscriber at A, back over limb 10 over the lower heavily marked conductor and through the left-hand winding of the primary relay PR and the battery to ground. The subscriber at A now replaces his receiver upon its switch-hook, interrupting the circuit through the relay PR of the first selector D at the contacts of the switch-hook. In this case, the subscriber at A controls the release of all of the switches including the connector F, this release being accomplished in the following manner: Upon the deënergization of the relay PR the main release relay MRR is deënergized releasing the first selector D and then the line switch C as previously described. The second selector E is also released as previously described.

Referring now to the connector F, the relay 101 having failed to energize when the connector F connected with the busy line of the subscriber at B, the relay 84 remained disconnected from the line of the said called subscriber at B, its circuit being interrupted at the contacts 113 and 111 of the relay 101. Therefore, the relay 84 not having energized, the relay 81 remained energized over the path traced from battery through the protective resistance 82, normal contact 83 of relay 84, the winding of relay 81, bank contact 69, wiper 66, normal contact 77 to ground at normal contact 78 of relay PV′. Upon the energization of the relay PV′ the primary magnet PRM′ at the release of the second selector E, the circuit just traced through the relay 81 of connector F is broken at the contact 77 of the magnet PRM′ and the said relay 81 is deënergized, retracting its armature. A release circuit for the connector F is now established through the primary release magnet PRM² over a path traced from battery, through resistance 82 to normal contact 83 of relay 84, normal contact 124 of relay 81, alternate contact 125 of switch PON², normal contact 126 of relay 86, through the winding of the said primary release magnet PRM² to ground, energizing the said magnet which is now locked up through the alternate contact 127 and alternate contact 128 of switch PON² to battery as previously described. The energization of the primary release magnet PRM² closes an energizing circuit through the secondary release magnet SRM² and the connector switch F and switch C are restored as previously described.

Shown in connection with the line switch C is the busy back circuit BB, the purpose of this being to transmit a busy signal back to the calling subscriber should all the first selectors D to which the said line switch C has access be busy, this being accomplished in the following manner: Upon the initiation of a call by the subscriber at A, the line switch C automatically operates to connect the line of the calling subscriber A with an idle first selector D as previously described. Should all of the first selectors D to which the line switch C has access be busy, the wipers 14, 15 and 16 are advanced until they engage an extra set of contacts 202, 203 and 204 in the bank. There being no ground upon the contact 202, the line relay LR is immediately deënergized opening a circuit through the motor-magnet M and closing a circuit through the cut-off relay from ground at normal contact 44 of relay LR, alternate contact 50 of relay R which has retained its armatures in an attracted position, through the winding of the said cut-off relay CO to battery, energizing the said relay CO. A circuit is now established from ground at contact 204 over wiper 16, alternate contact 41 of relay CO, line limb 10, through the telephone of the calling subscriber at A, line limb 9, alternate contact 40 of relay CO, wiper 15, contact 203, resistance coil 205, contact 202, wiper 14, alternate contact 46, through the winding of the relay R to battery, retaining the said relay R in its energized condition. Should the subscriber at A now operate the dial 6 to complete connection to a called subscriber, the last traced circuit would be opened at the contact 7, 8, but the relay R being sluggish would retain its armatures in their attracted position. The subscriber at A would now take up the receiver 1 and receive a characteristic busy signal traced from the busy back circuit BB to contact 203, wiper 15, alternate contact 40, line limb 9, through the receiver of the calling subscriber at A, line limb 10, alternate contact 41, wiper 16 and contact 204 to ground. The subscriber would now replace the receiver 1 upon its switch hook opening the circuit for the relay R which would deënergize and close a release circuit through the motor magnet M, restoring the switch C as previously described.

While I have shown a number of batteries, it will be understood that they are all one and the same battery, having been shown in this manner for convenience in making the drawing and describing the operation of the system. The same is also true of the alternating generators used for operating the motor magnets, but I preferably employ four separate alternating generators

for supplying ringing current as shown in connection with the ringing switch O.

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

1. In an automatic telephone system, the combination of a calling subscriber's telephone line with a line switch for said line, a source of current, a plurality of selector switches, a line relay and a release relay for said switch energized by said current upon the initiation of a call from said subscriber, and means for thereafter operating said line switch to select an idle one of said selector switches, substantially as described.

2. In an automatic telephone system, the combination of a calling subscriber's telephone line with a line switch for said line, a plurality of selector switches, a line relay and a release relay for said switch adapted to be energized upon the initiation of a call from said subscriber, means for thereafter operating said line switch to select an idle one of said selector switches, means for deenergizing said line relay and retaining said release relay energized upon the said selection of an idle selector, and means under the control of the calling subscribers to thereafter deënergize said release relay, whereby said line switch is restored, substantially as described.

3. In an automatic telephone system, the combination with a calling subscriber's metallic circuit telephone line, of a selector switch connected to said line, bank contacts for said switch arranged in groups, movable wipers adapted to coöperate with said contacts, a primary magnet for said switch, a secondary magnet for said switch, means under the control of the subscriber to operate said primary magnet, whereby said wipers select a group of contacts, means for thereafter operating said secondary magnet whereby said wipers connect with a contact in the selected group, a primary release magnet for controlling the restoration of the wipers from their primary movement, a secondary release magnet for controlling the restoration of the wipers from their secondary movement, and means under the control of the subscriber for interrupting the metallic circuit of the telephone line for operating said release magnets, whereby said wipers are restored, substantially as described.

4. In an automatic telephone system, the combination with a calling subscriber's telephone line, of a selector switch connected to said line, bank contacts for said switch arranged in groups, movable wipers adapted to coöperate with said contacts, a pair of release magnets for said switch, a primary relay in bridge of said telephone line, and energized over said line, a secondary relay relatively slow to release its armature, a third relay relatively slow to release its armature, means controlled by the subscriber for causing said primary relay to rapidly vibrate its armature while said second and third relays hold their armatures attracted, means for adjusting said wipers responsive to said vibrations to select a group of contacts, means controlled by said secondary relay operating responsive to cessation of said vibrations to adjust said wipers to select a contact in the group, and means under the control of the subscriber to deënergize said primary relay, whereby said third relay is deënergized, and means operated by the deënergization of said third relay to successively operate said release magnets whereby said wipers are restored, substantially as described.

5. In an automatic telephone system, the combination with a calling subscriber's telephone line, of a plurality of selector switches, a line switch for said line, bank contacts for said switch connected to said selector switches, wipers for said switch adapted to coöperate with said contacts, means operative upon the initiation of a call from said subscriber to move said wipers to test all of said contacts, a release relay for said switch energized while said wipers are testing said contacts, means for including said release relay in circuit of said telephone line, a characteristic signal transmitted to the calling subscriber to notify said subscriber that all of the contacts have been tested, and means controlled by the said subscriber to deënergize said release relay, whereby said wipers are restored.

6. In a telephone system, the combination of a calling subscriber's telephone line with a line switch for said line, a plurality of trunk lines leading therefrom, means for operating said switch upon the initiation of a call from said subscriber to automatically test said trunk lines to seek connection with an idle one, a release relay for said line switch energized over a local circuit while said switch is testing said trunks, and means for thereafter opening said local circuit and including said relay in circuit with said telephone line.

7. In a telephone system, the combination of a calling subscriber's telephone line with a line switch for said line, a plurality of trunk lines leading therefrom, means for operating said switch upon the initiation of a call from said subscriber to automatically test all of said trunk lines, a characteristic signal thereafter transmitted to said subscriber to notify said subscriber that all of said trunk lines are busy, a release relay for said line switch energized over a local circuit while said switch is testing said trunks, and means for thereafter opening said local circuit and including said relay in circuit with said telephone line.

8. In a telephone system, the combination of a calling subscriber's telephone line with a

connector switch operated to connect said telephone line to the line of a called subscriber, said called line having a plurality of subscribers' telephones connected thereto, an auxiliary switch associated with said connector switch, operated to select the proper ringing current to ring the bell of the desired subscriber on the called line, and holding means mechanically connected to a movable element of the connector switch whereby the restoration of said connector restores said auxiliary switch.

9. In a telephone system, the combination of a calling subscriber's telephone line with a connector switch operated to connect said telephone line to the line of a called subscriber, said called line having a plurality of subscribers' telephones connected thereto, an auxiliary switch associated with said connector switch, a magnet and a relatively slow relay for said auxiliary switch, means controlled by the calling subscriber to vibrate the armature of the said magnet while the relay holds its armature attracted, a wiper for said auxiliary switch actuated responsive to said vibrations to select the proper ringing current to ring the bell of the desired subscriber on the line, the said relay thereafter retracting its armature, whereby said ringing current is applied to said called line.

10. A telephone system including a telephone line extending from a substation to a line-switch at the exchange, trunks leading from said switch, means for operating said switch upon initiation of a call over said line to successively test said trunks, a relay energized upon initiation of the call, means for maintaining said relay energized by current over said line if all of the trunks are busy and release means for said switch controlled by said relay.

11. A telephone system including a telephone line extending from a substation to a line-switch at the exchange, trunks leading from said switch, means for operating said switch upon initiation of a call over said line to successively test said trunks, a relay energized upon initation of the call, means for maintaining said relay energized by current over said line if all of the trunks are busy, and means for releasing said switch, controlled by said relay when thus maintained energized.

12. A telephone system including a telephone line extending from a substation to a line-switch at the exchange, trunks leading from said switch, means for operating said switch upon initiation of a call over said line to successively test said trunks, a relay energized upon initiation of the call, means for maintaining said relay energized by current over said line if all of the trunks are busy, means for transmitting a characteristic signal to the calling substation if all of said trunks are busy, and means for restoring said switch after thus testing said trunks, controlled by said relay.

13. In a telephone system, the combination of a calling subscriber's telephone line with a connector switch operated to connect said telephone line to the line of a called subscriber, said called line having a plurality of subscribers' telephones connected thereto, an auxiliary switch associated with said connector switch, operated to select the proper ringing current to ring the bell of the desired subscriber on the called line, and mechanical means linking said connector and said ringing switch whereby the restoration of said connector restores said ringing switch.

14. An automatic switch including suitable talking conductors, a ringing switch having a plurality of ringing contacts and an associated wiper, a driving magnet for operating said wiper to select one of said contacts, an impulse circuit for said magnet, a slow-acting relay connected in multiple with said magnet and adapted to hold its armature attracted during the operation of said magnet, and a connection extending from said wiper through a normally closed contact of said relay to one of the talking conductors of said switch.

15. A ringing switch comprising a plurality of ringing contacts and a coöperating wiper, a magnet for operating said wiper to select one of said contacts, a slow-acting relay connected in multiple circuit with said magnet, and a ringing circuit extending from said wiper through a normally closed contact on said relay.

16. A telephone system comprising a calling telephone line, a line switch individual thereto, trunks extending from said line switch, a line relay and a release relay for said switch energized by current from said source upon initiation of a call over said line, an operating magnet for said switch having a circuit including normally open contacts on both the said relays and effective responsive to said energization thereof, and means for deënergizing said line relay and placing said release relay under control of the calling substation upon selection of an idle one of said trunks.

17. A line switch for telephone systems comprising contacts and coöperating wipers, a line relay, a release relay adapted to be energized responsive to the line relay, a motor magnet for said switch, a circuit for said motor magnet including normally open contacts of said relays, and a release circuit for said switch including said magnet, a normally closed contact of said release relay and an off-normal contact.

18. A telephone system comprising a calling substation telephone line having a line switch connected therewith, a source of cur-

rent, a plurality of selector switches, a line relay and a release relay for said switch energized by said current upon initial closure of said calling line at the substation thereof, and means controlled through normally opened contacts of both of said relays for operating said line switch to select an idle one of said selector switches.

19. A telephone system comprising a calling substation telephone line having a line switch connected therewith, a plurality of selector switches, a line relay and a release relay for said switch energized upon initial closure of the calling line circuit at the substation thereof, means for thereafter operating said line switch to select an idle one of said selector switches, means for deënergizing said line relay and maintaining said release relay energized upon said selection of an idle switch, means for deënergizing said release relay responsive to interruption of the line circuit for restoring said line switch.

20. A telephone system comprising a calling substation telephone line having a connector switch operated to connect said line to a called line, a plurality of substations associated with said called line, an auxiliary switch for said connector operated to select the proper ringing current to ring the bell of the desired substation on the called line, holding means for said auxiliary switch, means whereby said connector switch is restored, and a mechanical link from said holding means to the wiper shaft of said connector whereby the restoration of said connector will bring about the restoration of said auxiliary switch.

21. An individual line switch for telephone systems comprising contacts and cooperating wipers, a line relay, a release relay adapted to be energized responsive to energization of the line relay, a motor magnet for said switch, an operating circuit for said motor magnet including normally open contacts of said relays, and a release circuit for said switch including said magnet, a normally closed contact of said release relay and a normally open off-normal contact.

Signed by me at Chicago, county of Cook, and State of Illinois, in the presence of two witnesses.

WILLIAM KAISLING.

Witnesses:
GEORGE E. MUELLER,
MARJORIE E. GRIER.