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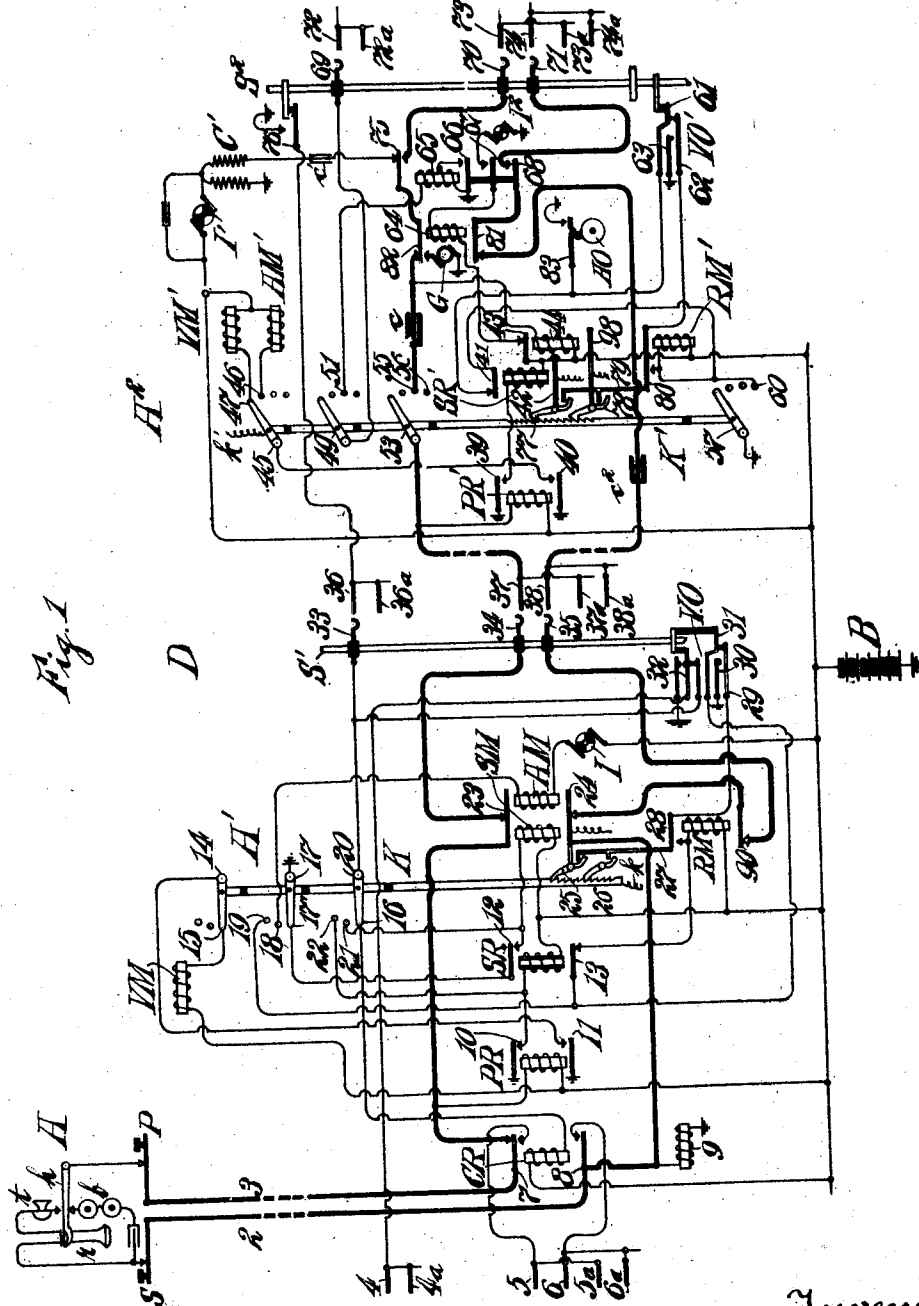
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H. G. WEBSTER

TELEPHONE SYSTEM

Filed Sept. 20, 1906

3 Sheets-Sheet 1



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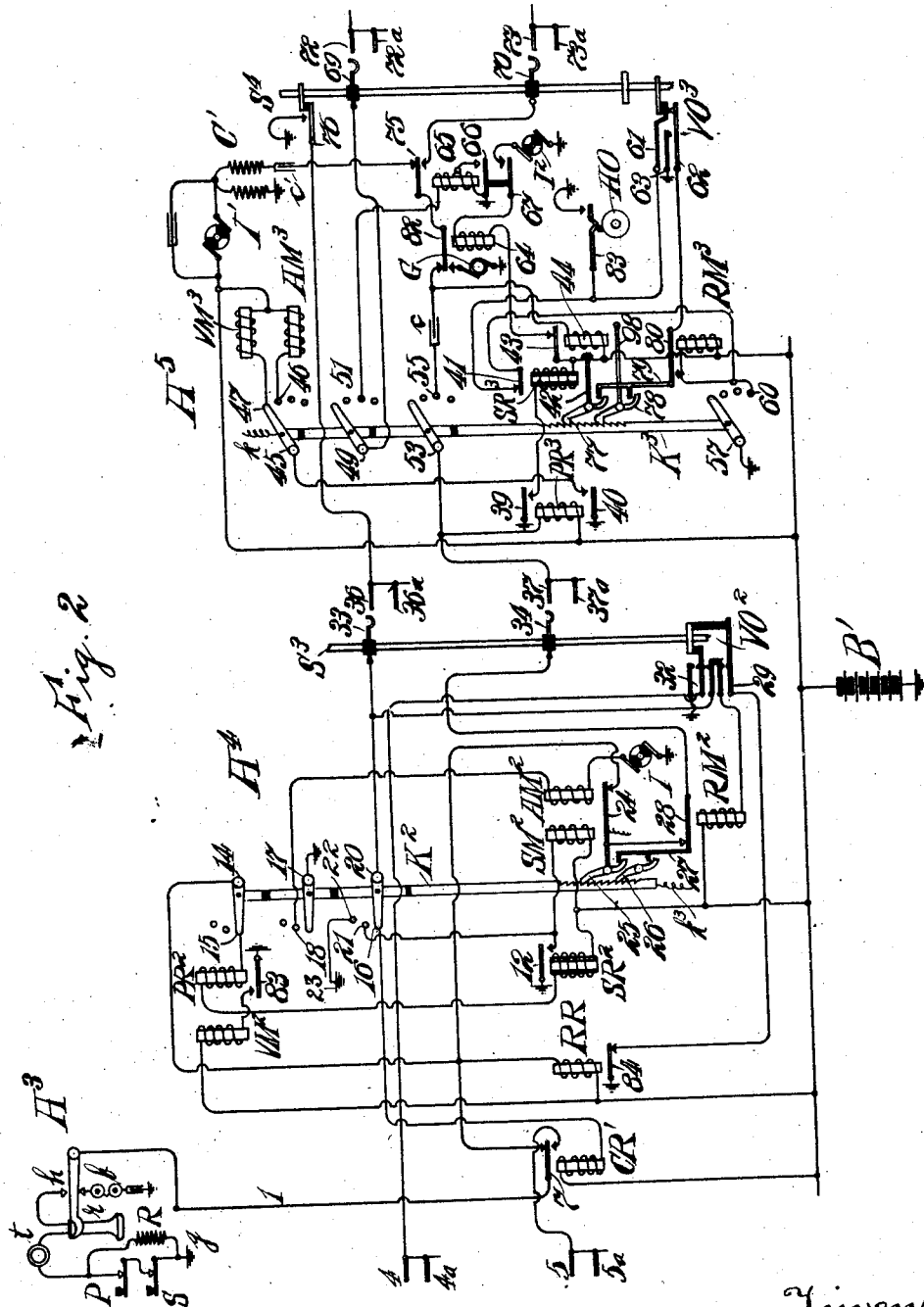
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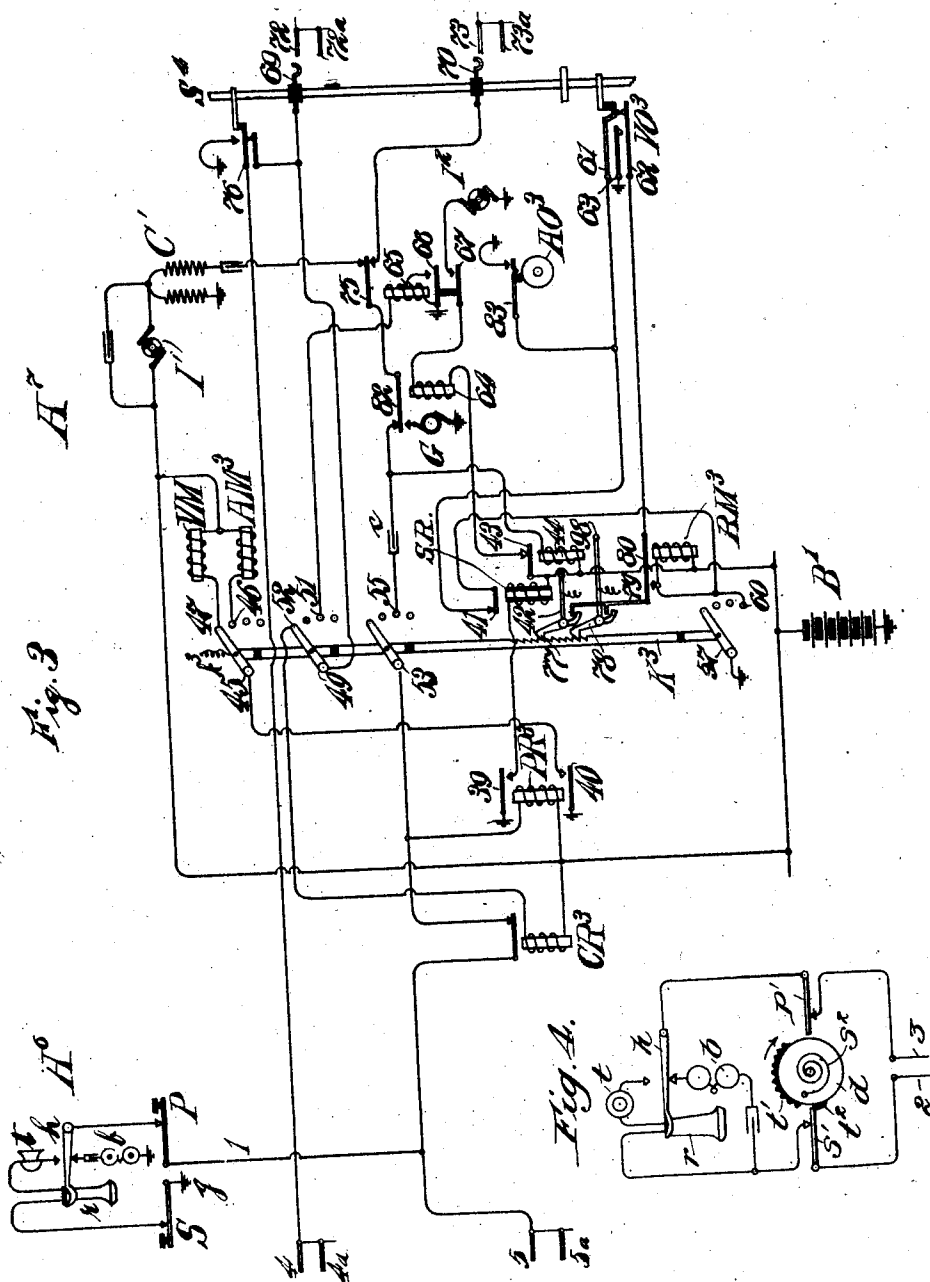
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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

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The present invention relates to telephone exchange systems of the so-called "automatic" type, in which electrically controlled switches are operated in response to current impulses controlled at a substation to connect the line of a calling subscriber to any other desired line.

In systems of this class now in common use, the automatic mechanism at the central exchange is controlled through the operation of two relays, one of which is associated with each line limb. When it is desired to establish connection with other lines, these relays are operated by grounding successively first one line limb and then the opposite line limb; and when connection is to be disestablished, the automatic mechanism is returned to its normal position by grounding both line limbs simultaneously, thus operating both relays at the same time. One object of my invention is to provide a system of the general character set forth in which the use of a ground or third conductor at the substation is unnecessary, and in which the impulses which control the automatic mechanism at the exchange are transmitted over the talking limbs of the line exclusively. Further objects of the invention are to provide a system in which the impulses which operate the central mechanism may be transmitted when the central battery is in bridge of the line limbs, and one in which the central mechanism is returned to its normal position by opening the circuit of the line limbs when the receiver is replaced at the conclusion of conversation. Another object of the invention is to provide an automatic system in which the controlling impulses may be transmitted over a single wire and earth return, rather than by two wires and earth return, as in previous systems. My invention looks further to the simplification of the central mechanism and to the provision of an organization which shall be positive and reliable in operation and of decreased cost for construction and maintenance.

In accordance with my invention, I associate with the circuit extending from the central office a primary relay which is responsive to both long and short interruptions of its energizing circuit, and a secondary relay which will not respond to a short or instantaneous interruption but will re-

spond to an interruption of definite duration. The substation is provided with switching mechanism, manually controlled, which will cause short and long interruptions of the line circuit in the proper sequence. The automatic mechanism at the central office, by which connection is established with a desired line, is controlled by the successive operation of the two relays. In one form of my invention, the mechanism is restored to its normal condition at the conclusion of conversation by the final de-energization of the secondary relay. In a modification of the invention, the line circuit includes a release relay and a high resistance at the substation, the release relay being energized by current through the high resistance during the sending of the controlling impulses, and operates, when the circuit through the line is entirely interrupted, to operate the restoring mechanism at the exchange. In this arrangement, the primary and secondary relays are operated by interruptions of a low resistance circuit in shunt of the high resistance at the substation. The above and other features and aspects of the invention will be more fully understood by reference to the following detailed description taken in connection with the accompanying drawings, and the scope of the invention will be particularly pointed out in the appended claims.

Referring to the drawings, Fig. 1 is a diagrammatic illustration of my invention as applied to systems in which each subscriber's line terminates in a so-called "first selector" switch which, when operated, selects and makes connection to a "connector" switch, which in turn selects and makes connection to the desired line. Fig. 2 is a diagrammatic illustration of a modification of my invention as applied to a similar structure the modification consisting in the use of a single wire and earth return for the line circuit; and in the employment of a high resistance at the substation and a special release relay at the first selector. Fig. 3 illustrates the invention as applied to a system in which the subscriber's line terminates directly in a "connector" switch, this embodiment of the invention being therefore limited to exchanges of such size that the multiple contacts of all lines may be present in the connector switch. As in Fig. 2, but one wire is

used between the central office and the substation. Fig. 4 is a mechanical diagram of the substation equipment of Fig. 1 illustrating dial mechanism for actuating the calling device contacts. Similar characters refer to corresponding parts in the several figures.

Referring to Fig. 1, a substation A is indicated as extending in two limbs 2 and 3 to a central office D. The usual bell *b* and condenser are included in normal bridge of the line limbs, and a receiver *r* and transmitter *t* are in an alternate bridge which is completed by the elevation of the switch-hook *h*. I am not limited, however, to the particular arrangement of these devices indicated by the diagram, as it is obvious that other well known arrangements may be equally well employed. The substation is also provided with means whereby the subscriber in making a call can cause the low resistance circuit including the transmitter to be interrupted momentarily any required number of times; and whereby any number of short interruptions will be automatically succeeded by an interruption of relatively long duration. Substation circuit changing mechanism of this general character is well known and is diagrammatically indicated by the switches S and P. The selector switch A' is associated with the line A and is provided with a moving member or wiper-shaft S' carrying moving contacts or wipers 33, 34 and 35. These wipers are associated with fixed or bank contacts 36, 37 and 38 which constitute the terminals of circuits leading to a connector switch A². These bank contacts are associated with other bank contacts of similar connector switches, so arranged in groups that, by the movement of the member S', the wipers may be moved in one direction until opposite any particular group of bank contacts, and then moved in a direction at an angle to the first motion whereby the wipers will successively engage the several contacts in the group. The wipers 34 and 35 are so arranged that, in passing over contacts 37 and 38 and other similar contacts, they will move out of engagement with one contact before engaging the next; while wiper 33 is so constructed that, in passing over contact 36 and other similar contacts, it will engage one contact before disengaging another. The wipers are normally out of engagement with the contacts. The first motion of the moving member or shaft S' is effected by the vertical magnet VM by means of step-by-step mechanism, operating to advance the shaft one step in a linear or vertical direction each time the magnet VM is energized, and it is to be understood that two such steps are required to bring the wipers opposite the first group of bank contacts. The angular motion of the shaft is secured by means of the angular magnet AM by similar step-by-step

mechanism, the arrangement being such that the wipers will engage the first contacts of a group the first time the magnet AM is energized, and another set of contacts with each succeeding energization. Associated with the shaft S' is a switch VO. This switch is so arranged that at the first vertical step of the shaft, the contact spring 32 will be shifted from its normal to its alternate contact, and contact springs 29 and 31 will be shifted to engage contact spring 30. At the second step of the shaft, contact spring 31 disengages spring 29, and this position of all springs is then maintained during subsequent motions of the shaft. The shaft is returned to its normal position by suitable mechanism actuated when the release magnet RM is energized. This mechanism, as well as that controlled by magnets AM and VM for securing the vertical and angular motions of the shaft, is omitted from the diagram for the sake of simplicity, but such mechanism is well known and may be of any desired character, it being understood that it is actuated in each case at the time the respective magnets are energized, rather than at the time they are de-energized. The connector switch is provided with a similar shaft S² controlled by vertical and angular magnets VM' and AM' and has a switch VO' having contacts corresponding to contacts 29, 30 and 31, which are operated in a similar manner. Its relation to the corresponding bank contacts 72, 73 and 74 is such that the wipers will not be brought opposite a group of contacts until the second step is made, but differs from that of the selector switch in that wiper 69 disengages one bank contact 72 before engaging another; and in that the wipers will not engage the first contacts of the group until the second step in the angular direction. A switch AO is associated with the shaft, which will close a contact at the first angular step of the wipers and interrupt the same contact at the second angular step, and this contact is closed and interrupted regardless of the number of vertical steps which the shaft may have made. The shaft and wipers are likewise restored to their normal positions when the release magnet RM' is energized. The bank contacts of this switch constitute the multiple terminals of other telephone lines. The magnet AM of the selector switch is energized preferably by a pulsating current from the battery B through the interrupter I, and its relation to the secondary magnet SM is such that at each pulsation by which the magnet AM is energized, the armatures 23 and 24 of magnet SM will be brought to their attracted positions. This action may be secured by any suitable mechanical or electrical arrangement and the illustration is diagrammatic only. The magnet SM controls, by its

armature 24, the moving member or switch shaft K. When armature 24 is attracted, the pawl 25 will engage a tooth of the member K; and when the magnet SM is subsequently de-energized, the retraction of armature 24 will advance the member K one step, when it will then be held by the retaining pawl 26; and the switch arms or levers 14, 17 and 20 are thus moved to their different positions. At the time of release, the energization of release magnet RM causes extension 27, of the armature 28, to engage pawls 25 and 26, throwing them out of engagement with member K, which is then returned to its normal position by the spring *k*.

The illustration of the member K and its associated mechanism is diagrammatic only and it will be understood that any suitable arrangement may be employed whereby the switch arms 14, 17 and 20 are advanced one step at each energization and subsequent de-energization of magnet SM, and by which the arms are restored to their normal positions through the energization of magnet RM. The connector switch A² is provided with a similar switch arm K', controlled by relays SR' and 44, and restored by the energization of the release magnet RM'. This arrangement is such that the advance of the levers 45, 49, 53 and 57 is secured by the operation of either relay.

Considering now the operation of the mechanism when the subscriber A desires connection; the removal of the receiver *r* closes circuit through limbs 2 and 3, resulting in a current flow over the circuit from the active terminal of battery B, through the winding of the primary relay PR, thence through the normal contact and armature contact 7 of the cut-off relay CR, thence through limb 3, the switches P—S, the receiver and transmitter, limb 2 and to the return side of the battery through the impedance 9. The primary relay PR is a relay which will release its armature in response to long or short interruptions of the circuit of the line limbs. As it is now energized, circuit is closed at armature contact 11, through switch lever 14, contact 15 and magnet VM, causing the shaft S' to move one step in the linear or vertical direction. Likewise, circuit is closed at armature contact 10, through the secondary relay SR to the battery B, energizing the secondary relay SR. The secondary relay is a slow-acting relay and its armature will only be retracted in response to interruptions of relatively long duration. It is indicated as being provided with a copper shell around its iron core to secure this slow release of its armature, but it is obvious that other methods may be employed for securing this action. As it is now energized, armature contact 12 completes a circuit for the secondary magnet

SM, which may be traced from the upper terminal of battery B, through the winding of magnet SM, contact 12 of relay SR and to the return side of the battery through contact 17' and switch lever 17. This energizes magnet SM, and the attraction of armature 24 causes the pawl 25 to engage the first tooth of the member K. It will be noted that limbs 2 and 3 of the line are normally connected to wipers 35 and 34 respectively of the shaft S'. The energization of magnet SM disconnects these wipers from the line limbs at contacts 23 and 24. To return now to the first step taken by the shaft S' in response to the initial energization of magnet VM; this first step causes the operation of the switch VO. Multiple or bank contacts of line A are shown at 4, 5 and 6. These are to be understood as bank contacts located upon a connector switch and corresponding to the contacts 72, 73 and 74 at the right of the drawing and constitute the multiple contacts of the line, whereby other lines may connect thereto. These contacts are multiply connected to similar contacts on other connector switches, such multiple contacts being indicated at 4^a, 5^a and 6^a. Contacts 5 and 6 are talking terminals of the line, and contact 4 is the terminal of a local or private circuit. As will be subsequently pointed out, the contact 4 of all lines which are in use will have a low resistance connection to the return side of the battery B; while, if the line be idle, this contact is connected to the active side of the battery through the winding of the cut-off relay CR. This normal connection may be traced from the upper terminal of the battery B through the winding of relay CR, thence through contact 16 and lever 20 and through spring 32 of the switch VO when in its normal position, and thence to the contact 4. When the first step of the switch was made, spring 32 disengages its normal contact and engages its alternate contact, thus disconnecting the bank contact 4 from the cut-off relay and from the wiper 33 and connecting it to the return side of the battery as indicated. Likewise the first step of the switch has caused springs 29 and 31 to be connected to the return side of the battery at contact 30. If now, instead of operating the interrupting switches S and P at the substation, the subscriber should replace his telephone, the shaft S' and its wipers would be returned to their normal position as follows: The interruption of the circuit through limbs 2 and 3 would de-energize relay PR; the retraction of contact 10 would de-energize relay SR; the retraction of contact 12 of relay SR would de-energize magnet SM; and the retraction of its armature 24 would move the member K one step; except for the retraction of contact 13 of relay SR. The retraction of this contact closes circuit through the re-

lease magnet RM however, this circuit being traced from the upper terminal of battery B through the winding of magnet RM, contact 13, springs 31, 29 and 30 of the switch VO, to the return side of the battery. The attraction of armature 28 closes a locking circuit for the magnet RM through springs 29 and 30; the armature extension 27 engages the pawls 25 and 26, thus throwing them out of engagement with the member K and preventing its forward motion; and mechanism associated with the magnet RM causes the shaft S' to return to its normal position and interrupt the locking circuit of magnet RM at contact springs 29 and 30.

Assume now that instead of immediately replacing his receiver, subscriber A proceeds with his call. The selector switch is then in a condition in which relays PR and SR are energized, magnets VM and SM are energized, and the shaft S' has taken one step in a vertical direction. The subscriber now manipulates his interrupting mechanism S—P so as to give a number of short interruptions to the circuit of the line limbs, corresponding to the group of bank contacts containing the terminals of the connector switch which is to be selected, followed by a single long interruption. At each short interruption, the armature of relay PR is released. As contact 11 is subsequently attracted each time, the magnet VM is energized, causing the shaft to take one step in the vertical direction; and spring 31 of the switch VO disengages spring 29 after the first short interruption. At each retraction of contact 10, the circuit of relay SR is interrupted, but the interruptions are of too short duration to allow the relay magnet to become de-energized and its armature therefore remains attracted and maintains the energizing circuit of magnet SM. When the long interruption takes place however, the circuit of relay SR is interrupted at contact 10 for a sufficient length of time to allow the retraction of its armature. The retraction of contact 13 does not now energize the release magnet RM for the reason that the circuit previously closed through contact 13 is now interrupted at spring 31. The retraction of contact 12 de-energizes the secondary magnet SM and its armature drops back, causing the advance of the member K one step. This motion causes switch lever 14 to interrupt the circuit of magnet VM; causes switch lever 20 to disconnect the wiper 33 from the cut-off relay CR at contact 16, and to connect the wiper to the winding of magnet SM at contact 21; and the motion of lever 17 disconnects contact 12 at contact 17' and connects the angular driving magnet AM to the return side of the battery at contact 18. The magnet AM will now be

energized the first time circuit is closed through the interrupter I. When so energized, the armature of magnet SM is brought into its attracted or alternate position disconnecting wipers 34 and 35, and the shaft and wipers are caused to take one step in the angular direction, bringing the wipers into engagement with the first set of bank contacts in the group. If the connector switch, associated with these first contacts, be busy, the contact 36 will be connected directly to ground at spring 76, and a circuit is thus closed from the upper terminal of battery B, through the winding of magnet SM, contact 21, lever 20, wiper 33, contact 36 and spring 76 to the return side of the battery, thus maintaining the armature of magnet SM in its attracted position. The bank contacts 36, 37 and 38 are contacts on the selector switch similar to contacts 4, 5 and 6 on the connector switches, and have multiple contacts 36^a, 37^a and 38^a on other selector switches. At the next pulsation of current through interrupter I, magnet AM is again energized, causing the shaft S to take another angular step, and this motion will continue, step by step, as long as the wiper 33 passes over grounded contacts. Its construction is such that it will remain in engagement with a contact 36 until after it engages the next succeeding contact, and the energizing circuit for magnet SM is thus maintained until a contact 36 is engaged which is not connected to the return side of the battery. When this occurs, the circuit of magnet SM is interrupted; its armature drops back, connecting the line limbs to the wipers 34 and 35; and the driving pawl 25 causes the member K to take a second step, shifting the switch levers 14, 17 and 20. This operation of lever 17 interrupts the circuit of magnet AM, preventing the further angular motion of the wiper shaft, and connects contact 13 to the return side of the battery at contact 19. The operation of lever 20 likewise disconnects the secondary magnet SM and connects the wiper 33 to the winding of the secondary relay SR. Circuit has meanwhile been closed through the line limbs by the re-engagement of the contacts indicated at S after the long interruption, and a new circuit condition results. Relay PR is now energized, but the circuit of armature contact 11 stands open at lever 14; wiper 33 and relay SR are connected to the return side of the battery at armature contact 10, and armature contact 13 is thus maintained attracted, preventing at this time the operation of the release magnet RM; while the circuit of magnet SM is now interrupted at contact 21 and the magnet SM thus remains inert, leaving the wipers 34 and 35 connected to the line limbs.

A new circuit may now be traced from the

upper terminal of the battery through the winding of the primary relay PR' of the connector switch, contact 37, wiper 34, armature contact 23, armature contact 7, limbs 3 and 2 to the return side of the battery through the impedance 9. The relay PR' is thus energized at the instant the connector switch A² is selected. The attraction of armature contact 40 completes a circuit for the vertical magnet VM', causing the shaft S² to take one vertical step. The actuation of armature contact 39 closes the circuit of the secondary relay SR'; and the energization of this relay interrupts the circuit through the release magnet RM' at armature contact 41, which would otherwise be closed at springs 61, 62 and 63 of switch VO' at the first step of the wiper shaft S². The attraction of armature 42 of relay SR' causes the driving pawl 77 to engage the first tooth of the moving member K'. If now, instead of sending the proper impulses to cause the desired line to be selected, the subscriber should replace his receiver, the apparatus of the two switches would return to its normal position for the following reasons: The de-energization of relay PR' would interrupt the circuit of relay SR', and the retraction of contact 41 would complete a circuit for the release magnet RM' similar to that described for magnet RM of the selector switch, causing the wiper shaft to return to its normal position and preventing the retraction of armature 42 from causing a forward motion of the member K'. Relay SR of the selector switch has at this time been energized over the circuit closed at armature contact 10 of relay PR and also closed through contact 22, lever 20, wiper 33, contact 36, and contact 76 controlled by the wiper shaft S². This latter contact was completed at the first vertical step of the shaft. This shaft has now returned to its normal position and relay PR is de-energized. The circuit of relay SR is thus interrupted and the retraction of armature 13 energizes magnet RM and operates the restoring mechanism as previously described. The disengagement of the pawls 25 and 26 allows the switch levers 14, 17 and 20 to be returned to the normal position shown in the diagram. Assuming that the subscriber does not replace his receiver but proceeds to send the necessary impulses to cause the connector switch to pick the line desired, he then manipulates his apparatus S—P so as to give a number of short interruptions corresponding to the group of bank contacts containing the contacts of the desired line, and follows these short interruptions by a single long interruption. At the first interruption, the shaft S² takes its second vertical step, bringing its wipers 69, 70 and 71 opposite the first group of contacts, this motion being secured by the interrupting and closing of the circuit through vertical magnet VM' at armature contact 40, and these steps are continued until the desired group is reached. The corresponding interruptions at armature contact 39, of the circuit through relay SR', are of too short duration to allow the armature of the latter relay to be retracted. Relay SR of the selector switch is maintained at this time, and during the subsequent operation of the connector switch, by the circuit through wiper 33 and contact spring 76. After the desired group of bank contacts is reached, the long interruption is given, at which time relay SR' is de-energized and its armature retracted. The retraction of contact 41 does not now complete the release circuit of RM' for the reason that spring 61 has moved out of engagement with spring 62 at the second vertical step of the shaft; but the retraction of armature 42 causes the member K' to advance one step. The motion of lever 45 interrupts the circuit of magnet VM' and brings the angular driving magnet AM' under control of the armature of relay PR'. Relay PR' is now energized as circuit has been closed at the substation, after the long interruption; completes the circuit of relay SR' at contact 39; and energizes magnet AM' through the circuit completed at armature contact 40, thus causing the wiper shaft to take one step in the angular direction. It will be remembered that the wipers of the connector switch do not engage the contacts until the second angular step. At this first step, the movement of switch AO brings magnet RM' again under control of armature contact 41 of relay SR', by the circuit closed at spring 83 of the switch AO. If now the subscriber replace his telephone before sending the final set of impulses to select the particular line he desires, the retraction of contact 41 of relay SR' completes the release circuit through magnet RM' and the wiper shaft of the connector switch is restored to its normal position; and at the end of its movement, interrupts the circuit of relay SR at contact 76 thus causing the selector switch to return to its normal position, all as previously described. Assuming that the subscriber proceed with his call, he now gives a number of short interruptions corresponding to the position in the group of bank contacts, of the contact of the line he desires to connect with, following these short interruptions by a long interruption.

If the desired line be busy, the private or local contact 72 will have a low resistance connection to the return side of the battery; either that described for contact 4 through spring 32, if the line be busy through having initiated a call; or another low resistance connection to be subsequently described;

if it be busy through having been already called. At each short interruption, the attraction of armature 40 energizes magnet AM', causing the switch to take one angular step, and the circuit through spring 83 is interrupted at the second step as previously pointed out. The wipers 69, 70 and 71 pass over the corresponding contacts of the various lines in the group during these angular steps; they are each so arranged that they disengage one set of contacts before engaging a second set, and are open at this time at contact points 49, 75 and 68 respectively; and thus no interference will occur with those lines which may be in conversation. After the wipers have been brought into engagement with the contacts of the desired line, the long interruption causes the de-energization of relay SR'. The retraction of contact 41 does nothing at this time, but the retraction of armature 42 causes the member K' to take a second step. The corresponding movement of lever 45 interrupts the circuit of magnet AM', preventing the further motion of the wipers; the motion of lever 53 extends limb 3 of the line A to the condenser c; and relay 65 is connected to wiper 69 by the engagement of lever 49 with contact 51. If the line be busy, contact 72 will be connected to earth and relay 65 will not be energized. The subscriber will then get the busy indication, consisting of the ordinary "buzz" produced by current through the interrupter I' and the windings of the busy back induction coil C'. The circuit for this current may be traced from the coil C', through condenser c', contact 75, contact 82, condenser c, contact point 55, lever 53, bank contact 37, wiper 34, contact 23, contact 7, limbs 3—2 and impedance 9 to the ground or office return. He will thereupon replace his receiver, again de-energizing relays PR' and SR', which had been energized at the conclusion of the last long interruption. The retraction of armature 42 now causes the member K' to take a final step, completing a release circuit for magnet RM' through contact 60 and lever 57. The energization of this magnet again completes the locking circuit for itself, through armature contact 80 and spring 62 and 63; the engagement of extension 79 of armature contact 80 with pawls 77 and 78 allows levers 45, 49, 53 and 57 to return to their normal position; and other mechanism associated with the magnet restores the wiper shaft to its normal position, thus interrupting the locking circuit at spring 62 and releasing the selector switch at contact 76, as previously described. If the desired line be idle, contact 72 is connected to battery through the winding of the cut-off relay. This connection is shown for line A from the upper terminal of battery B, through the winding of relay CR, contact 16, switch lever 20, contact 32 of switch VO, and multiple contact 4. Current will therefore flow, after the last long interruption, from contact 72, through wiper 69, lever 49, contact 51 and the winding of relay 65 to the return side of the battery, energizing relay 65 and actuating its contacts. Relay CR of the called line is also energized and the actuation of its contacts 7—8 disconnects the line limbs from its relay PR and connects them to bank contacts 73 and 74. As contact 66 of relay 65 is actuated, it closes a short circuit about a portion of the relay winding, sufficient of the winding being left in circuit, however, to maintain the attraction of the relay armature. If, after this relay has been energized, contact 72^a should be engaged by the wiper 69 of another connector switch, the relay 65 of the other switch would not receive sufficient current to cause the attraction of its armature by reason of the shunt through relay 65 of the switch A²; and it is this means by which the low resistance earth connection to contact 72, previously referred to, is secured when the line is busy by reason of its having been selected by a calling subscriber. The actuation of contact 75 disconnects the busy back arrangement C' and completes the talking circuit of limb 3 to wiper 70 and contact 73, which contact corresponds to contact 5 of line A. The actuation of contact 68 completes the circuit of limb 2 to wiper 71 and contact 74 which corresponds to contact 6 of line A. The actuation of contact 67 completes a circuit for relay 64, which may be traced from the upper terminal of battery B, through armature contact 43 of relay 44, the winding of relay 64, armature contact 67, and through interrupter I² to the return side of the battery; and relay 64 is energized each time circuit is closed at the interrupter. When relay 64 is inert, the winding of relay 44 is included in circuit with battery B, and with the subscriber's line corresponding to contacts 73—74 which now stands open at the condenser and bell. At each energization of relay 64, the actuation of contacts 81 and 82 includes the signaling generator G in circuit with the line limbs, thus ringing the bell of the desired line. After the subscriber removes his receiver, relay 44 is energized at the first subsequent de-energization of relay 64, over the circuit through armature contact 82, armature contact 75, wiper 70, the line limbs and impedance 9 of the called line. The attraction of armature contact 43 interrupts the circuit of relay 64, thus preventing a subsequent application of ringing current, and the two subscribers are in condition for conversation, current being supplied to the transmitter of line A through the windings of relays PR and PR' and the impedance 9; and to the called line through the winding of relay 44 and its impedance 9. The talking circuit is

completed from the line limb 3 to the corresponding line limb of the called line, through contacts 7—23, wiper 34, contact 37, lever 53, contact 55, condenser c , contacts 82—75, wiper 70 and contact 73, and from line limb 2 to the corresponding limb of the called line, through contacts 24—90, wiper 35, contact 38, condenser c^2 , contacts 81—68, wiper 71 and contact 74.

restoration of the shaft from its vertical adjustment, until the calling subscriber replaces his receiver and causes de-energization of relay PR', thus interrupting the circuit thru VM' whereby it de-energizes allowing the shaft to restore.

Armature 98 of relay 44 is at this time attracted and the pawl 78 has engaged the next tooth in the moving member K'. If the called subscriber replaces his receiver before subscriber A, his line will be disconnected and the wiper shaft may return to its normal position and then make a first vertical step. This operation is secured as follows: When relay 44 is de-energized by the interruption of its circuit at the substation of the called subscriber, armature 98 is retracted, moving the member K' and the switch levers to the last position. The disengagement of lever 49 and contact 51 interrupts the circuit of relay 65 and its contacts return to normal, thus disconnecting the wipers 70 and 71 and the relay 64. The disengagement of lever 53 and contact 55 interrupts the circuit of limb 3 of the line A, preventing that subscriber from getting a busy indication at this time, and the engagement of lever 57 with contact 60 completes the circuit of magnet RM'. The energization of this magnet completes the locking circuit for its winding through armature 80 and springs 62—63 of switch VO'. The extension 79 of the armature throws the pawls 77 and 78 out of engagement with K', allowing the levers 45, 49, 53 and 57 to be returned to their normal positions by the spring k' . At the same time, the mechanical connection between magnet RM' and shaft S² has caused the shaft to return to its normal position, interrupting the circuit through the winding of RM' at spring 62 as it comes to rest. A circuit, due to the energization of relay PR' at this time by current through line A, was closed for magnet VM' when lever 45 engaged contact 47. As soon, therefore, as magnet RM' is de-energized by the interruption at spring 62, the shaft S' will be given the single vertical step by the energization of magnet VM'. If subscriber A now replaces his receiver, both the selector switch A' and connector switch A² will be restored to their normal positions, in that manner described under the assumption that the subscriber A replaced his receiver after making the first set of interruptions.

Returning now to the condition when the subscribers are talking, if subscriber A replace his receiver first, both switches will be immediately disconnected as follows: As has been already pointed out, circuit was closed through relay SR' at the end of the final long interruption at the substation A. Armature 42 is therefore in its attracted position, and armature 98 was attracted when the called subscriber answered. The release of either armature will throw the switch levers to their final positions. When subscriber A replaces his receiver, circuit is interrupted through relays PR and PR' and their armatures drop back. The energization of relay SR is at this time maintained by the circuit through contact 22, lever 20, wiper 33 and spring 76. The circuit through magnet SR' is, however, now interrupted by the retraction of armature contact 39. Armature 42 is therefore retracted, causing the interruption of the circuit through relay 65 and by the retraction of the armature of relay 65 interrupting the circuit through relay 44. The release circuit through magnet RM' is established as before at contact 60 and the member K' and the shaft S² return to their normal positions. When the circuit through relay SR is interrupted at spring 76 by the restoration of the shaft S², the retraction of armature contact 13 likewise closes the release circuit through magnet RM, thus restoring the shaft S' as previously described. As relay PR' is at this time de-energized, the circuit of magnet VM' is not closed and the shaft S² remains in its normal position. The apparatus is now ready for another connection. The relation between magnet AM and magnet RM is such that when magnet RM is energized at the time of release, the various pawls are moved out of operating position and magnet AM will therefore not operate to prevent the restoration of the shaft S' as lever 17 passes contact 18 when returning to its normal position; and a similar relation exists between magnet AM' and magnet RM'.

The structure of Fig. 2 differs from that of Fig. 1 in the arrangement at the substation A²; and in the arrangement at the central office, whereby a primary relay PR² and a secondary relay SR² are normally included directly in circuit with the line, and a release relay RR is also in circuit with the line. In this structure, instead of connecting the subscribers and the central office with two metallic line limbs, but one wire to the substation is employed and the return

In restoring the connector due to the replacing of the called subscriber's receiver as just referred to, should the switch-arm return to normal before the wiper shaft, magnet VM' will again be energized. This will cause its pawl to engage and prevent

circuit is secured by the earth connection g . A relatively high resistance R is provided at the substation in that portion of the circuit closed by the elevation of the switch-hook h , and this resistance is normally in multiple with a low resistance circuit including the contacts of the interrupting switches P and S . The relay RR is sufficiently sensitive to be energized by current either through the low resistance path or through the resistance R . Relays PR^2 and SR^2 will attract their armatures when energized by current through that portion of the circuit including switches P and S ; but when this circuit is interrupted, armature contact 83 will be released by either a short or long interruption, and armature contact 12 of relay SR^2 will be released in response only to a long interruption. The connector switch A^5 is similar in its operation to the connector switch A^2 , the only difference in the structure being the omission from A^5 of contacts 74, 74^a, etc., wiper 71, armature contact 68, armature contact 81, condenser c^2 and their connecting wires, these being the parts which, in switch A^2 , controls the talking current of limb 2 and the corresponding limb of the circuit to the called subscriber. Likewise, the impedance 9, limb 2, armature contact 8, contact 24, contact 90, wiper 35, contact 38 and their connecting wires, which in selector switch A' were provided for controlling the talking circuit of the limb 2, are omitted from selector switch A^4 .

When subscriber A^3 removes his receiver to start a call, current will flow from the upper terminal of battery B' through relay RR and through relays SR^2 and PR^2 , contact 15 and lever 14, and thence through limb 1, switch-hook h , receiver r and transmitter t to ground g through the contacts of switches P and S . The energization of relay SR^2 completes a circuit of magnet SM^2 at armature contact 12, causing the attraction of armature 24, which interrupts the circuit through wiper 34 and brings pawl 25 into engagement with a tooth of the member K^2 . The energization of relay PR^2 closes a circuit for the vertical magnet VM^2 at armature contact 83. The energization of this magnet causes the wiper shaft S^3 to take one step in its vertical direction. This step operates switch VO^2 , bringing spring 29 into engagement with its contact and shifting spring 32 from its normal to its alternate contact. This operation of spring 32 disconnects the multiple contacts 4-4^a from the wiper 33 and cut-off relay CR' and connects the multiple contacts directly to earth, thus providing the condition necessary to prevent the selection of this line by another calling subscriber.

If, now, the subscriber A^3 replace his receiver without operating switches P and S , all three relays will be de-energized, and the retraction of armature contact 84 of relay RR will complete a circuit for release magnet RM^2 through spring 29. Armature 24 of relay SM^2 is simultaneously released. The attraction of armature 28 interrupts the circuit of wiper 34, and the armature extension 27 throws pawls 25 and 26 out of engagement with K^2 , thus preventing the advance of the levers 14, 17 and 20 through the retraction of armature 24. If, instead of replacing his receiver immediately, the subscriber operates his switches P and S to make a definite number of short interruptions followed by a single long interruption, the switch will select and make connection to those contacts 36 and 37 leading to an idle connector switch, as occurred in the structure of Fig. 1. When circuit is closed after each short interruption, the engagement of armature contact 83 with its contact energizes magnet VM^2 , causing the shaft S^3 to move one step in the vertical direction. When armature contact 12 of relay SR^2 is released at the long interruption, the consequent de-energization of magnet SM^2 allows the retraction of armature 24, thus shifting levers 14, 17 and 20 to their second position. The movement of the lever 14 interrupts the circuit through relays SR^2 and PR^2 . The movement of lever 20 disconnects wiper 33 from cut-off relay CR' and connects it to the winding of magnet SM^2 ; and the engagement of lever 17 with contact 18 completes the circuit through interrupter I and magnet AM^2 . The relation between magnet AM^2 and magnet RM^2 is similar to that in switch A' , whereby magnet AM^2 will not interfere with the restoration of shaft S^3 when magnet RM^2 is energized. When circuit is closed through magnet AM^2 at interrupter I , armature 24 of magnet SM^2 is thus brought into its attracted position and the wiper shaft S^3 is given one step in a direction at an angle to its first motion, causing wipers 33 and 34 to engage contacts 36 and 37 respectively. As long as wiper 33 engages contacts 36 of busy lines, the consequent energization of magnet SM^2 maintains the armature 24 in its attracted position and the wiper continues its travel. When an ungrounded contact 36 is engaged, the circuit through magnet SM^2 is interrupted and the retraction of armature 24 throws the levers 14, 17 and 20 to their third position, interrupting the circuit of magnet AM^2 at lever 17 and preventing a further motion of the wipers. As lever 20 disengages contact 21, the circuit of magnet SM^2 is interrupted, thus preventing its subsequent energization when wiper 33 and contact 36 are connected to ground at spring 76 by the operation of the connector switch A^5 . When armature 24 closes circuit at the back contact, a circuit is then completed for the connector switch A^5 , which may be traced from the

upper terminal of battery B' through the winding of relay PR³, contact 37, wiper 34, armature 28, armature 24 and thence through armature contact 7 and limb 1 to the return side of the battery through the ground connection g. Relay PR³ will attract its armature through the low resistance circuit around resistance R, but will release it when this low resistance circuit is interrupted. As the circuit has now been closed at the end of the long interruption, relay PR³ is energized and shaft S⁴ makes an initial vertical step in the same manner and with the same results as did the corresponding shaft S² in switch A². If the subscriber A³ were now to replace his receiver, the de-energization of relay PR³ would restore the connector switch A⁵ to its normal position; and the de-energization of relay RR would restore the selector switch A⁴ to normal. The structure of this figure, therefore, differs from that of Fig. 1 in that the restoration of the selector switch is not dependent upon the connector switch interrupting the circuit through spring 76. An obvious modification to secure the busy condition of contact 36 would be the omission of spring 76, and the connection of contact 22 to earth as indicated at 23. If, instead of replacing his receiver, subscriber A now makes the interruption necessary to select the desired line, the switch A⁵ will operate in the same manner as was described for connector switch A². At the conclusion of conversation, if the called subscriber replace his receiver first, his line will be disconnected and the switch A⁵ operate as did switch A², the shaft S⁴ being returned to normal and then taking the initial vertical step, and both switches would be restored when subscriber A³ replaced his receiver. If, at the conclusion of conversation, subscriber A³ be the first to replace his telephone, the consequent de-energization of relay PR³ will release switch A⁵, and the de-energization of relay RR will release switch A⁴.

Fig. 3 is a diagrammatic illustration of a structure different from that of Fig. 1 in having but one wire between the central office and the substation A⁶ and in the absence of a selector switch, the switch A⁷ being a connector switch directly associated with the subscriber's line, and operating to establish connection directly with the line of a desired subscriber, rather than through an intermediate link. The construction of switch A⁷ is similar to that of switch A⁵ of Fig. 2, and operates in a similar manner. When the subscriber removes his receiver, relay PR³ is energized, causing the energization of relay SR³ and the energization of magnet VM³, whereby the shaft S⁴ takes the initial vertical step. If the subscriber then immediately replace his receiver, the switch is restored by the circuit initially completed at contact 41, through magnet RM³. If, instead of immediately replacing his receiver, he operate the interrupting switches S and P, the short interruptions cause the wipers 69 and 70 to be brought opposite the group of contacts in which the contacts of the desired line are located; and the de-energization of relay SR³ at the long interruption shifts the levers associated with K³ to their second position. If at this time the subscriber replace his receiver, circuit will again be closed through the release magnet, RM³ at contact 41 and spring 83 of the switch AO³, which is at this time in engagement with its contact, by reason of the shaft having made one step in its angular direction when circuit was closed at the end of the long interruption. Likewise, the initial vertical step of the shaft S⁴ caused spring 76 to move from its normal contact to its alternate contact, thus disconnecting multiple contacts 4—4^a from the cut-off relay and wiper, and connecting them directly to ground. If, instead of replacing his receiver, the subscriber cause the necessary interruptions to select the desired line, the short interruptions will cause magnet AM³ to give shaft S⁴ the necessary number of steps to bring wipers 69—70 into engagement with the contacts 72—73 of the desired line. If the line be busy, the low resistance earth connection will then be present for contact 72, relay 65 will not be energized, and the busy condition will be indicated to the subscriber by current from the busy back arrangement C' through the condenser c. If the line be idle, current will flow through the cut-off relay CR³, contact 52 and lever 49, spring 76 and contact 72 of the desired line, corresponding to similar connections of line A⁶; thence through wiper 69 of switch A⁷, lever 49, contact 51 and relay 65, energizing both relays. The operation of the cut-off relay disconnects the desired line from its relay PR³, thus preventing the operation of the switch of that line when the subscriber answers or when ringing current is applied. The energization of relay 65 connects the line limb through contact 75 to armature contact 82 of relay 64. The operation of armature contact 66 completes the shunt circuit of a portion of the relay winding, thus preventing the operation of a relay 65 of another calling line, should it be brought into multiple therewith by another subscriber attempting to make connection with the same desired line. The operation of armature contact 67 completes the circuit of relay 64 through interrupter I². Each time circuit is closed through the interrupter I², the operation of armature contact 82 connects the ringing generator G to the limb of the desired line, thus actuating the signal of that line. When the line is answered, the first subsequent engagement of armature contact 82 with its normal contact com-

pletes the circuit of relay 44, thus interrupting the circuit of relay 64 at armature contact 43 and bringing armature 98 into its attracted position, whereby pawl 78 engages the tooth in member K³. The two subscribers are now connected for conversation.

If the called subscriber first replaces his receiver, the retraction of armature 98 completes the restoring circuit at lever 57 and contact 60; the shaft S⁴ is restored to its normal position as are switch levers 45, 49, 53 and 57; and then, by reason of the continued energization of relay PR³, the energization of magnet VM³ causes the shaft S⁴ to make the initial vertical step. If, now, subscriber A⁶ replace his receiver, the de-energization of relay PR³ causes the restoration of the shaft as was described in the case where the subscriber immediately replaced his receiver without operating the switches S and P. If, at the conclusion of conversation, subscriber A⁶ first replace his receiver, the consequent retraction of armature 42 causes the switch mechanism to be restored and rest in its normal position without the succeeding vertical step of shaft S⁴.

It will be seen by the foregoing description that in each structure the series of short interruptions causes the switch mechanism to bring moving contacts, associated with the calling line, into association with a desired group of fixed contacts; and that the long interruption produces a secondary switching operation of the central mechanism. This secondary switching operation in the structures of Figs. 1 and 2 results in automatically associating the line of the calling subscriber with the first idle connector switch in the predetermined group. In the structure of Fig. 3, the secondary operation places the mechanism in condition whereby the desired contacts in the selected group may be subsequently engaged. In the structures of Figs. 1 and 2, the second set of short interruptions causes the connector switch mechanism to associate the line with the group of contacts in which the contacts of the desired line are located; and as in the structure of Fig. 3, the long interruption causes a secondary switching operation whereby the switch may be subsequently controlled to bring the wipers into engagement with the contacts of the particular line desired. The final set of short interruptions selects the desired line, and the final long interruption causes a secondary switching operation whereby connection is established with the desired line and signaling current applied thereto; or whereby the calling subscriber is given a busy indication if the line be already connected. In each structure, if the calling subscriber replace his receiver immediately after a long interruption, the resulting interruption to the circuit causes the restoration of the switches to their normal

positions. If, after connection has been established, the calling subscriber replace his receiver, the switches will be restored to their normal positions; and if the called subscriber replace his receiver at any time after connection has been established the connector switch, which has connected to his line, will be restored to its normal position; and if at that time the circuit be closed through the line of the calling subscriber, the connector switch will make the initial step. The mechanism, diagrammatically indicated by the switches S and P, may be of any desired character whereby the subscriber may make any desired number of short interruptions to be followed by a single long interruption in each case. Mechanism of this character is in common use. In Fig. 4, I have shown a dial for operating the switches S', P', which take the place of, and are connected to the line in the same manner as, switches S and P, respectively, of Fig. 1. The switches S', P', are normally closed, and the dial *d* occupies the position illustrated. This dial is provided with a plurality of teeth *t'* which are adapted to co-operate with the primary switch P' in producing the short interruptions of current over line limb 3, and with an elongated tooth *t''* which is adapted to co-operate with switch S' in order to produce a prolonged interruption of current in line limb 2. In operation, the dial *d* is moved in the direction of the arrow until the desired number of teeth *t'* have passed beyond the end of the switch P'. During this movement, the elongated tooth *t''* also passes the end of the switch S'. When the dial is released after such movement, it is restored to normal by the retractile spring S²; and during this movement, the several teeth *t'*, which have passed beyond switch P', open the switch P' a corresponding number of times, and this is followed by tooth *t''* engaging switch S' and opening it. By reason of the relative lengths of the teeth *t'* and *t''*, short interruptions occur by the operation of switch P' and a prolonged interruption by the operation of switch S'.

While I have illustrated switches A', A⁴ and A⁷ as being individual to the line of a calling subscriber, I do not wish to be limited to such individual relation, as it is obvious that my invention is applicable to structures in which corresponding switches are common to a number of lines; or are but temporarily associated with any line desired.

The several ground connections indicated are to be understood as connections to the return side of the battery or the office return, with the exception of the earth connection *g* which is a connection to earth or to a return conductor at the substation. While I have indicated certain of the magnets or relays as being operated by interrupters I and I², it is to be understood that the vibra-

tory action of the magnets thus controlled may be secured in any desired manner when circuit is closed. While I have indicated a particular busy back arrangement at I' and C, it is to be understood that any desired arrangement may be employed for producing a characteristic sound which may be transmitted to the substation of the calling line to indicate that the desired line is busy. It is to be understood that any desired form of construction may be employed for securing the necessary relations between the wiper shaft and the various magnets, and that the drawings throughout are diagrammatic only. Switches and mechanism of the character therein indicated are in common use, and are well known to those skilled in the art, one form of such a switch being illustrated in Patent No. 815,176, issued March 13th, 1906, to A. E. Keith et al.

Wherever in the description or claims I have referred to a "preliminary switching operation," I mean a switching operation controlled by the initial vertical motion of any wiper shaft, or by the initial angular motion of the wiper shaft of the connector switches A², A⁵ or A⁷. Wherever I have referred to a "primary operation" of the switch, I mean an operation resulting from a short interruption of the line circuit. Wherever I have referred to a "secondary operation" of the switch, I mean an operation resulting only from a long interruption of the line circuit. Wherever I have referred to a "long interruption," I mean an interruption of the low resistance circuit at the substation, of sufficient duration to allow the armatures of relays SR, SR', SR² or SR³ to be retracted. The phrase "short interruption" means an interruption of the same circuit, of insufficient duration to allow the retraction of the armatures of these relays, but of sufficient duration to operate the armatures of relays PR, PR', PR² or PR³. I have also used the terms "current variations" and "variations of current" in the claims in a broad sense to include changes of current to zero value as well as to other values.

It is obvious that various alterations and modifications may be made in the structures indicated without departing from the spirit of my invention, and I do not wish to be limited to those structures illustrated and described.

What I consider new and novel and desire to secure by Letters Patent of the United States is:—

1. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the cen-

tral office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive when the circuit of said line is initially closed at said distant point for causing a preliminary switching operation whereby an immediately succeeding long interruption of the circuit of said line will cause a secondary switching operation.

2. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive when the circuit of said line is initially closed at said distant point for causing a preliminary switching operation whereby an immediately succeeding long interruption of the circuit of said line will cause the operation of said restoring means.

3. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive to two directly succeeding long interruptions of the circuit of said line for causing the operation of said restoring means.

4. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled

switch having motion in two intersecting planes at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means for individual use of said switch responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive after connection is established with a desired line whereby a long interruption of the circuit of said line will cause a secondary operation of said switch.

5 A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch having motion in two intersecting planes at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means for individual use of said switch responsive after connection is established with a desired line whereby a long interruption of the circuit of said line will cause the operation of said restoring means.

6. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for bringing said active contacts into association with any desired passive contacts, and means responsive when the circuit of said line is initially closed at said distant point for causing a preliminary switching operation whereby an immediately succeeding long interruption of the circuit of said line will cause a secondary switching operation.

7. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually

controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for bringing said active contacts into association with any desired passive contacts, and means responsive when the circuit of said line is initially closed at said distant point for causing a preliminary switching operation whereby an immediately succeeding long interruption of the circuit of said line will cause the operation of said restoring means.

8. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for bringing said active contacts into association with any desired passive contacts, and means responsive to two directly succeeding long interruptions of the circuit of said line for causing the operation of said restoring means.

9. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for bringing said active contacts into association with any desired passive contacts, and means responsive after connection is established with a desired line whereby a long interruption of the circuit of said line will cause a secondary operation of said switch.

10. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of

current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for bringing said active contacts into association with any desired passive contacts, and means responsive after connection is established with a desired line whereby a long interruption of the circuit of said line will cause the operation of said restoring means.

11. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for causing a secondary operation of said switch.

12. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said

switch whereby said active contacts are brought into engagement with said passive contacts, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for rendering said selecting means unresponsive to said controlling means.

13. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for bringing said engaging means under control of said controlling means.

14. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for rendering said selecting means unresponsive to said controlling means and for bringing said engaging means under control of said controlling means.

15. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for rendering said selecting means unresponsive to said controlling means and for bringing said engaging means under control of said controlling means, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for rendering said engaging means unresponsive to said controlling means.

16. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office having motion in one plane to select groups and motion in another plane to select lines in the group for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for rendering same selecting means unresponsive to said controlling means and for causing an automatic operation of said engaging means, and release means including a slow

acting relay individual to the switch for releasing said switch.

17. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, controlling means for said switch responsive to short interruptions of the circuit of said line, selecting means for said switch normally responsive to said controlling means whereby said active contacts are brought into relation with any group of passive contacts, engaging means for said switch whereby said active contacts are brought into engagement with said passive contacts, means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for causing an automatic operation of said engaging means, and means for arresting the operation of said engaging means.

18. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for connecting the talking circuit of said line with the talking circuit of an idle other line, and means for transmitting a busy signal to the calling line if the line called is busy.

19. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office having selecting motions in two intersecting planes for establishing connection between said line and said other lines, active contacts for said switch con-

stituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch including a slow acting relay, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for connecting a source of signaling current to the line limb of an idle other line.

20. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for completing circuit to give a busy indication on said line when said active contacts come to rest on the passive contacts of a connected other line.

21. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch including a slow acting relay responsive to the opening of the line to release the switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and means responsive to a long interruption directly succeeding a short interruption of the circuit of said line for connecting the talking circuit of said line with the talking circuit of an idle other line and for connecting a source of signaling current to the line limb of an idle other line.

22. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for in-

terrupting the circuit of the line, other telephone lines, an electrically controlled switch having motion in two intersecting planes at the central office for establishing connection between said line and said other lines, and to automatically signal said other lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, and a controlling relay for said switch responsive only to long interruptions of the circuit of said line.

23. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch having motion in two intersecting planes at the central office for establishing connection between said line and said other lines and for signaling said lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch including a slow acting relay for restoring said switch, means responsive to short interruptions of the circuit of said line for causing a primary operation of said switch, a controlling relay for said switch responsive only to long interruptions of the circuit of said line, and means controlled by said relay for causing the operation of said restoring means.

24. A telephone exchange system comprising a telephone line extending from a central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other telephone lines, an electrically controlled switch having motion in one plane to select groups and motion in another plane to connect with lines in the group at the central office for establishing connection between said line and said other lines, and for signaling said lines, active contacts for said switch constituting terminals for said line, passive contacts for said switch constituting terminals for said other lines, restoring means for said switch, a controlling relay for said switch responsive to short interruptions of the circuit of said line, a second controlling relay for said switch responsive only to long interruptions of the circuit of said line, and means controlled by said relays for causing the operation of said switch.

25. A telephone exchange system comprising a telephone line extending from a

central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other
 5 telephone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive con-
 10 tacts for said switch constituting terminals for said other lines, ringing means and busy signalling means for said switch operative according to whether or not the passive con-
 15 tacts connected with are idle or busy, restoring means for said switch, a controlling relay for said switch responsive to short interruptions of the circuit of said line, a second controlling relay for said switch respon-
 20 sive only to long interruptions of the circuit of said line, and means controlled by said second relay for causing the operation of said restoring means.

26. A telephone exchange system comprising a telephone line extending from a
 25 central office to a distant point, a source of current in circuit with said line, manually controlled means at said distant point for interrupting the circuit of the line, other tele-
 30 phone lines, an electrically controlled switch at the central office for establishing connection between said line and said other lines, active contacts for said switch constituting terminals for said line, passive contacts for
 35 said switch constituting terminals for said other lines, ringing means and busy signalling means for said switch operative according to whether the passive contact connected with is idle or busy, restoring means for said
 40 switch, a controlling relay for said switch responsive to short interruptions of the circuit of said line, a second controlling relay for said switch responsive only to long inter-
 45 ruptions of the circuit of said line, means controlled by said relays for causing the operation of said switch, and means controlled by said second relay for causing the operation of said restoring means.

27. A telephone exchange system comprising a plurality of telephone lines extend-
 50 ing from subscribers' stations, automatic switch mechanism including selectors and connectors for interconnecting calling and called lines for conversation operated by series of interruptions of current in the calling
 55 line circuit, each series comprising short interruptions followed by a long interruption, means under the control of a calling subscriber for producing said long and short interruptions, and automatic signalling
 60 means for signalling called idle stations.

28. A telephone exchange system comprising a plurality of subscribers' lines, interconnecting switch mechanism including a selector and a connector for uniting said

lines for conversation, a control circuit there- 65
 for, and means for operating said mechanism in response to series of interruptions of current in said control circuit, each series comprising short interruptions and a single
 70 long interruption, and automatic ringing means and busy signalling means for said connector.

29. A telephone exchange system comprising a plurality of subscribers' lines, interconnecting switch mechanism including a
 75 selector and a connector for uniting said lines for conversation, a control circuit therefor, means for operating said mechanism by series of interruptions of current in said control circuit in establishing the conversa-
 80 tional circuits, each series comprising short interruptions and a single long interruption, automatic ringing means and busy signalling means for said connector operative according to the idle or busy condition of the
 85 called line, and means for restoring said mechanism to normal upon an interruption of current in said control circuit.

30. A telephone exchange system comprising a plurality of subscribers' lines, interconnecting switch mechanism including a
 90 selector and a connector having motion in intersecting planes for uniting said lines for conversation, a control circuit therefor, automatic ringing means and busy signalling means for said connector operative to signal
 95 the called subscriber or for advising the calling subscriber that the called line is busy, and means for operating said mechanism by series of interruptions of current in said control circuit to establish the conversational
 100 circuits, each series comprising short interruptions and a single long interruption, and means at the substations of said lines for causing said interruptions.

31. A telephone exchange system comprising a plurality of subscribers' lines, interconnecting switch mechanism including a
 105 selector and a connector having motion in two different planes for uniting said lines for conversation, a control circuit therefor, busy signalling means for said connector for connection with a calling line, means for
 110 operating said mechanism by series of interruptions of current in said control circuit to establish the conversational circuits, each series comprising short interruptions and a single long interruption, and means
 115 for restoring said mechanism to normal by a following long interruption of current in said control circuit.

32. A telephone exchange system comprising a plurality of telephone lines extending from subscribers' stations, auto-
 120 matic switch mechanism including a selector and a connector having motion in one plane to select groups and in another plane to connect with lines in the groups for in-
 125

terconnecting calling and called lines for conversation, automatic ringing means for said connector for intermittently signalling a called subscriber, and means under the control of the calling subscriber for operating said mechanism to establish conversational circuits by series of interruptions of current in the calling line, each series comprising short interruptions and a single long interruption.

33. A telephone exchange system comprising a plurality of two-conductor telephone lines extending from substations, automatic switch mechanism having motion in one direction to select groups of lines and motion in another direction to select lines in the groups for interconnecting calling and called lines for conversation, and means under the control of the calling subscriber for operating said mechanism to establish conversational circuits by series of interruptions of current in the calling line, each series comprising short interruptions and a single long interruption, automatic signalling means for the mechanism for signalling called lines, and a slow acting relay individual to said switch mechanism for controlling the release of the same.

34. A telephone exchange system comprising a plurality of telephone lines extending from substations, automatic switch mechanism having one motion to select groups and a second motion to select lines in the group for interconnecting calling and called lines for conversation, means under the control of the calling subscriber for operating said mechanism to establish conversational circuits by series of interruptions of current in the calling line, each series comprising short interruptions and a single long interruption, automatic intermittent ringing means for said mechanism for signalling the called subscribers, and means for restoring said mechanism to normal by a following long interruption of current in said line.

35. A telephone exchange system comprising a subscriber's station having a transmitter, receiver, call-bell, and call transmitting device, a two-conductor circuit extending from said station, a plurality of interconnecting link-circuits, other subscribers' lines, associated automatic step-by-step switch mechanism including a two motion selector and a two motion connector for selectively extending the two-conductor circuit through said link-circuits to said other subscribers' lines, means for advancing and releasing said mechanism by variations of current transmitted over said two-conductor circuit, means whereby conversation may be held over said circuit, and means for intermittently actuating said call-bell by current over said circuit, and means for preventing connection with the called line

to operate said call bell if said called line is busy.

36. A telephone exchange system comprising a subscriber's station having a transmitter, receiver, call-bell, and call transmitting device, a two-conductor circuit extending from said station, interconnecting link-circuits, other subscribers' lines, automatic step-by-step switch mechanism for selectively extending said two-conductor circuit through said link-circuits to said other subscribers' lines, a central source of current, means for advancing and releasing said mechanism by variations in said two-conductor circuit of current derived from said source, means for energizing said transmitter over said circuit from said source, and means for actuating said call-bell by current over said circuit.

37. A telephone exchange system comprising a two-conductor circuit, associated automatic step-by-step switch mechanism including a connector having waiting contacts divided into groups and a co-operating moving contact, means responsive to variations of current transmitted over said circuit to advance said moving contact in one direction to a desired group of waiting contacts and then in another direction to a desired contact in that group, a slow acting relay for changing the direction of travel of said moving contact, and a slow acting relay individual to said connector switch for restoring the same to normal.

38. A telephone exchange system comprising a two-conductor circuit, associated automatic step-by-step switch mechanism including a connector having waiting contacts divided into groups and a co-operating moving contact, means responsive to variations of current transmitted over said circuit to advance said moving contact in one direction to a desired group of waiting contacts and then in another direction to a desired contact in that group, a slow acting relay individual to said connector for effecting the change in direction of movement of said movable contact, and means responsive to a change in the current condition in said circuit to bring said moving contact to its normal position.

39. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, means outside of said mechanism for rendering some of said waiting contacts busy, means for advancing said moving contact to a desired group of waiting contacts in response to variations of current transmitted over said circuit, means for starting said moving contact in search of an idle contact in that group in response to another current variation in said circuit of a different character, and means for con-

continuing the movement of the moving contact in such search and stopping it only when an idle waiting contact is found.

40. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, and means responsive to two series of variations of current in said circuit each consisting of different characters given in a definite order to advance said moving contact in one direction to a desired group of said waiting contacts and then in a second direction in a different plane to a desired contact in that group, and a slow acting relay for solely controlling said switch.

41. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, and means responsive to two series of interruptions of current in said circuit, each consisting of short interruptions followed by a long interruption, to advance said moving contact in one direction to a desired group of waiting contacts and then in a second direction in a different plane to a desired contact in that group, and a slow acting relay exclusively for controlling said switch responsive to the long interruption to effect the change over.

42. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism controlled over the two sides of said circuits in series having waiting contacts divided into groups and a cooperating moving contact, means outside of said mechanism for rendering some of said waiting contacts busy, means for advancing said moving contact to a desired group of waiting contacts in response to variations of current transmitted over said circuit, means for starting said moving contact in search of an idle contact in that group in response to another current variation transmitted over said circuit, and means for continuing the movement of said moving contact in such search and stopping it only when an idle waiting contact is reached, a connector switch for completing a connection, and quick and slow acting relays individual to said connector switch for controlling the same.

43. A telephone exchange system comprising a control circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, a primary magnet and associated means for stepping said moving contact to a desired group of waiting contacts, a secondary magnet and associated means for stepping said moving contact to a desired contact in that group, quick and sluggish relays for controlling said magnets, means for energizing and de-energizing said relays

by closing and opening said control circuit to operate said primary and secondary magnets to bring about the desired movements of said moving contact, and a second automatic switch mechanism for use with said first switch mechanism in completing a connection, and quick and slow acting relays for said second switch mechanism for controlling the same.

44. A telephone exchange system comprising a control circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, a primary magnet and associated means for stepping said moving contact to a desired group of waiting contacts, a secondary magnet and associated means for stepping said moving contact to a desired contact in that group, a sluggish relay for controlling the operating circuit of said secondary magnet, a quick-acting relay for controlling said primary magnet and said sluggish relay, means for energizing and de-energizing said quick-acting relay by making and breaking said control circuit to operate said primary stepping magnet and energize and maintain said sluggish relay energized during such operation and then to de-energize said sluggish relay to operate said secondary magnet, and a second automatic switch mechanism for use with said first switch mechanism in completing a connection, and quick and slow acting relays for said second automatic switch mechanism for controlling the same.

45. A telephone exchange system comprising a control circuit, associated automatic switching mechanism having waiting contacts divided into groups and a co-operating waiting contact, primary means for stepping said moving contact to a desired group of waiting contacts, secondary means for stepping said moving contact to a desired waiting contact in that group, and quick and sluggish relays for use with said switching mechanism exclusively and controlled over said control circuit, the former to cause the operation of said primary means and the latter to initiate the operation of said secondary means.

46. A telephone exchange system comprising a subscriber's station having a transmitter, receiver, call bell, and call transmitting device, a two-conductor circuit extending from said station, a plurality of interconnecting link-circuits, other subscribers' lines, associated automatic step-by-step switch mechanism for selectively extending the two-conductor circuit through said link-circuits to said other subscribers' lines, means for advancing said mechanism in response to current variations transmitted over said two-conductor circuit, means for releasing said mechanism by opening said circuit, means for holding conversation over

said circuit, automatic means for actuating said call bell by current over said circuit, each of said automatic step by step switch mechanisms having individual quick and slow acting relays for controlling the same.

47. A telephone exchange system comprising a two-conductor telephone circuit, associated automatic switch mechanism having waiting contacts divided into groups and a co-operating moving contact, means outside of said mechanism for rendering some of said waiting contacts busy, means for advancing said moving contact to a desired group of waiting contacts in response to successive intermittent current variations transmitted over the two talking conductors of said circuit, means for starting said moving contact in search of an idle contact in that group, means for continuing the movement of said moving contact in such search and stopping it only when an idle waiting contact is reached, and an automatic connector switch mechanism in cooperation with said automatic switch mechanism for completing connections, and a slow acting relay individual to said connector switch for controlling the operations of the same.

48. A telephone exchange system comprising a plurality of telephone lines extending from subscribers' stations, automatic step-by-step switch mechanisms for inter-connecting the calling and called lines for conversation, operated by interruptions of current in the calling line circuit of long and short durations respectively, and means under the control of a calling subscriber for producing said long and short interruptions, automatic signalling means for said switch mechanism for automatically signalling called subscribers, and a slow acting relay individual to each of said step by step mechanisms for controlling the same.

49. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism having waiting contacts divided into groups and a cooperating movable contact, means outside of said mechanism for rendering some of said waiting contacts busy, a primary electromagnet, a secondary electromagnet, and means for causing interruptions of said two-conductor circuit, whereby said electromagnets step said movable contact to a desired group and then to an idle waiting contact in the group.

50. A telephone exchange system comprising a two-conductor circuit, associated automatic switch mechanism having waiting contacts divided into groups and a cooperating movable contact, means outside of said mechanism for rendering some of said waiting contacts busy, a primary electromagnet, a secondary electromagnet, means for causing interruptions of said two-conductor circuit, whereby said electromagnets step said movable contact to a desired group and then to

an idle waiting contact in the group, and means for causing restoration of said switch mechanism responsive to a further interruption of said two-conductor circuit.

51. A telephone system including a calling subscriber's line and a called subscriber's line, a selector switch mechanism having motion in two intersecting planes and a connector switch mechanism having motion in two intersecting planes for establishing a connection between said lines, quick and slow acting relays for said selector switch, and quick and slow acting relays individual to said connector switch, said quick and slow acting relays of said selector and connector switches being controlled over the two sides of the calling subscriber's line in series.

52. A telephone system including a calling subscriber's line and a called subscriber's line, a selector switch mechanism having motion in two intersecting planes and a connector switch mechanism having motion in two intersecting planes for establishing a connection between said lines, quick and slow acting relays for said selector switch and quick and slow acting relays individual to said connector switch, said quick and slow acting relays of said selector and connector switches being controlled over the two sides of the calling subscriber's line in series, and automatic ringing mechanism and busy signalling mechanism for said connector switch.

53. The combination with a telephone line, of multiple test terminals therefor, a connection terminal having a test contact adapted to be temporarily applied to one of said multiple terminals, a test relay and a source of current for operating the same over a circuit including said test contact and terminal, means controlled by the operation of said relay for decreasing the resistance of that portion of its circuit extending from the source of current, through the relay to said test contact, a second connection terminal having a test contact adapted to be thereafter applied to another of said multiple terminals, and a test relay therefor then placed in parallel with the first test relay, the decreased resistance serving to shunt sufficient current from the test relay of the second connection terminal to prevent its operation.

54. The combination in a telephone system, with movable connection terminals having testing contacts, of a test relay for each said terminal, a telephone circuit having multiple terminals adapted for engagement by said test contacts, means for operating the test relay of a connection terminal applied to a multiple terminal when said circuit is idle, apparatus for shunting a portion of the winding of said relay when it is operated, the portion of said winding re-

maintaining in circuit being then adapted to serve as a low resistance shunt to prevent operation of the test relay of any other connection terminal that may be applied to a multiple terminal of said circuit.

55. A telephone system including a telephone line, a plurality of connectors each adapted for directive operation to select said line, a test relay for each connector sensitive to the idle or busy condition of said line, means for initially energizing the winding of the test relay of a connector when connected to the circuit of said line when it is idle, and means for establishing a circuit of relatively low resistance when said line is rendered busy, adapted to serve as a low resistance shunt about the test relay of a connector when connected to the circuit of said line when busy.

56. A telephone system including a telephone line, a connector adapted for connection with the line circuit thereof, a test relay for said connector operated on connection made with said line when idle, means controlled by said relay when operated for shunting a portion of its winding to establish a circuit of relatively low resistance, a second connector provided with a test relay adapted for connection with the circuit of said line, said circuit of relatively low resistance when established being adapted to act as a shunt to prevent sufficient current being received by the test relay of the second connector to effect its operation.

57. In a telephone system, the combination of a plurality of switches each adapted for both vertical and rotary step-by-step motion, in response to one or more impulses for the called number, telephone lines, line circuits for successively controlling the said switches to extend connection from a calling line to a called line, said line circuits each including the two sides of the calling line in series, means for supplying current over the telephone lines to operate said switches, and for talking purposes also, and a slow acting relay for each of the switches involved in the connections between calling and called lines.

58. In a telephone system, a called line, a connector provided with an element having vertical and rotary step-by-step motion to find the called line, release mechanism for restoring the connector to normal position, a single line relay operative to control the vertical and rotary motion and the release of said connector, and a slow acting relay individual to said connector for controlling operation and release thereof.

59. In a telephone system, a called line, a connector provided with line wipers having vertical and rotary step-by-step motion to find the called line, a single line relay operative to control the vertical and rotary motion, a slow acting relay individual to

said connector for controlling both the operation and the release of the same, and automatic ringing and busy signalling means for said connector operative according to the idle or busy condition of the called line.

60. In a telephone system, a line, a switch therefor having a wiper, lines provided with terminals accessible to said wiper, said terminals divided into groups, said switch provided with means for moving said wiper to select a group of terminals and for advancing the wiper to locate a terminal in the elected group, said means including a relay which is energized when the group electing operation begins and which de-energized to permit the operation that locates the terminal of the elected group, a switching relay for connecting the line with the wiper when the terminal is located, and a circuit for maintaining the switching relay energized during talking.

61. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with means for moving said wiper to a particular one of said groups of terminals and for advancing the wipers to locate a terminal in the particular group, said means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and a circuit for maintaining the switching relay energized during talking.

62. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a magnet for moving said wipers to a particular one of said groups of terminals and provided with a second magnet for advancing the wipers to locate a terminal in the particular group, a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and a circuit for maintaining the switching relay energized during talking.

63. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a motor magnet for moving said wipers to a particular one of said groups of terminals, and provided with a second motor magnet for advancing the wipers to locate a terminal in the particular group, a relay which is energized when the wipers are ad-

vanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and a circuit for maintaining the switch relay energized during talking.

64. In a telephone system, a line, a switch therefor having a wiper, lines provided with terminals accessible to said wiper, said terminals divided into groups, said switch provided with means for moving said wiper to elect a group of terminals and for advancing the wiper to locate a terminal in the elected group, said means including a relay which is energized when the group electing operation begins and which de-energizes to permit the operation that locates the terminal in the elected group, a switching relay for connecting the line with the wiper when the terminal is located, and means for maintaining said switching relay energized during talking.

65. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with means for moving said wiper to a particular one of said groups of terminals and for advancing the wipers to locate a terminal in the particular group, said means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and means for maintaining said switching relay energized during talking.

66. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a magnet for moving said wipers to a particular one of said groups of terminals and provided with a second magnet for advancing the wipers to locate a terminal in the particular group, a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminals in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and means for maintaining said switching relay energized during talking.

67. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a motor magnet for moving said wipers to a particular one of said groups of terminals, and provided with a second motor magnet for advancing the

wipers to locate a terminal in the particular group, a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, a switching relay for connecting the line with the wipers when the terminal is located, and means for maintaining said switching relay energized during talking.

68. In a telephone system, a line, a switch with a wiper having a vertical and rotary motion, a relay in the switch for controlling the rotary motion, energized during the vertical motion, means for de-energizing said relay to start the rotary motion, a line, means for controlling the two sides of said line in series to control the switch, and a switching relay for connecting said line with said wiper.

69. In a telephone system, a line, a switch with a wiper having motion in two intersecting planes, an operating magnet for controlling one motion of said switch, an energizing circuit for said magnet, a line relay for said switch, means including an auxiliary magnet for closing the energizing circuit for said operating magnet, by first energizing, then de-energizing and then again energizing said line relay, and a switching relay for connecting said line with said wiper.

70. In a telephone system, a line, a switch with a wiper having vertical and rotary motions, an operating magnet for controlling the rotary motion of said wiper, an energizing circuit for said magnet, a line relay for said switch, means including an auxiliary magnet for closing the energizing circuit of said operating magnet by first energizing said line relay and then de-energizing the same one or more times momentarily and then again energizing the same, and a switching relay for connecting said line to said wiper.

71. In a telephone system, a line, a switch with a wiper having vertical and rotary motions, an operating magnet for controlling the rotary motion of said wiper, an energizing circuit for said magnet, a line relay for said switch, means for closing the energizing circuit of said magnet by first energizing said line relay and then de-energizing the same one or more times momentarily and then again energizing the same, a switching relay for connecting said line with said wiper, and means for controlling the operation of said switch over two sides of the line circuit in series.

72. In a telephone system, a line, a switch therefor having a wiper, lines provided with terminals accessible to said wiper, said terminals divided into groups, said switch provided with means for moving said wiper to elect a group of terminals and for advancing the wiper to locate a terminal in the elected

group, said means including a relay which is energized when the group electing operation begins and which de-energizes to permit the operation that locates the terminal in the elected group, and a switching relay for connecting the line with the wiper when the terminal is located.

73. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with means for moving said wiper to a particular one of said groups of terminals and for advancing the wipers to locate a terminal in a particular group, said means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located.

74. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a magnet for moving said wipers to a particular one of said groups of terminals and provided with a second magnet for advancing the wipers to locate a terminal in the particular group, said means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminals in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located.

75. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with means for moving said wipers to elect a group of terminals and means for then advancing the wipers to locate a terminal in the elected group, said second means including a relay which is energized during the electing operation and then de-energized to permit the operation which locates the terminal in the elected group, and a switching relay for connecting the lines with the wipers when said terminal is located.

76. In a telephone system, a line, a switch therefor having a wiper, lines provided with terminals accessible to said wiper, said terminals divided into groups, said switch provided with means for moving said wiper to elect a group of terminals and for advancing the wiper to locate a terminal in the elected group, said means including a relay which is energized when the group electing operation begins and which de-energizes to permit the operation that locates the terminal in the

elected group, and a switching relay for connecting the line with the wiper when the terminal is located, said switching relay having a circuit controlled through one of said terminals.

77. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a motor magnet for moving said wipers to a particular one of said groups of terminals, and provided with a second motor magnet for advancing the wipers to locate a terminal in the particular group, said means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located.

78. In a telephone system, a line, a switch therefor, having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with means for moving said wiper to a particular one of said groups of terminals and for advancing the wipers to locate a terminal in the particular group, and means including a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminal in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located, said switching relay having a circuit controlled through one of said terminals.

79. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a magnet for moving said wipers to a particular one of said groups of terminals and provided with a second magnet for advancing the wipers to locate a terminal in the particular group, a relay which is energized when the wipers are advanced to locate the particular group and which de-energizes to permit the operation that locates the terminals in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located, said switching relay having a circuit controlled through one of said terminals.

80. In a telephone system, a line, a switch therefor having wipers, lines provided with terminals accessible to said wipers, said terminals divided into groups, said switch provided with a motor magnet for moving said wipers to a particular one of said groups of terminals, and provided with a second motor magnet for advancing the

wipers to locate a terminal in the particular group and which de-energizes to permit the operation that locates a terminal in the particular group, and a switching relay for connecting the line with the wipers when the terminal is located, said switching relay having a circuit controlled through one of said terminals.

81. In an automatic telephone system including an electrically adjustable selective switch, another selective switch adapted for selection by said first mentioned switch, an electromagnet for said other switch for use in restoring the same, means for energizing said electromagnet on selection made and thereafter continuously holding it energized, and switching means for de-energizing and restoring said electromagnet, and means whereby any restoration of said electromagnet will restore said other switch when disconnection is desired.

82. In a telephone exchange system, the combination of subscribers' telephone lines, automatic means for extending connection from a calling telephone line to a called telephone line including a wiper having vertical and rotary motion, disconnecting or releasing means including a slow acting magnet energized during talking, and means for operating said disconnecting or releasing means by the opening of a subscriber's line and the consequent de-energizing of said magnet, without grounding the line.

83. In a telephone exchange system, the combination of subscribers' telephone lines, automatic means for extending connection from a calling telephone line to a called telephone line, including a wiper having vertical and rotary motion, disconnecting or releasing means adapted to be operated by the opening of a telephone line, and means by which a subscriber when through talking opens his line to thereby operate the said disconnecting or releasing means, without grounding the line, said means including a slow-acting relay held energized during conversation.

84. A telephone system including a selector switch and a connector switch, a release magnet for said selector switch, a slow-acting relay for said selector switch, a circuit for said release magnet controlled by said slow-acting relay, a circuit for said slow-acting relay including a trunk conductor extending from said selector switch to said connector switch, and means located at said connector switch for opening the circuit of said slow-acting relay to cause its de-energization and the subsequent energization of said release magnet.

85. A telephone system including a calling and a called subscriber's telephone line, a selector switch and a connector switch controllable over the

two sides of the calling subscriber's line in series for connecting said subscriber's lines in conversational circuit, a release magnet for said selector switch, a release relay for said selector switch, a circuit for said release magnet controllable by said release relay, and a circuit for said release relay extending over a trunk conductor to said connector switch, and means included in said connector switch for opening the circuit of said relay to bring about the release of said selector switch.

86. A telephone system including a pair of telephone lines, selective switches connecting said lines, a release magnet for one of said switches, a release relay for said switch connected to a trunk release conductor extending to another of said switches, a circuit for said release magnet controllable by said release relay, means for energizing and maintaining said relay energized while connection exists, and switching means located at said last switch for opening the circuit of said release conductor to de-energize said release relay, thereby closing the circuit of said release magnet for releasing the associated switch.

87. A telephone system including a pair of telephone lines, selective switches connecting said lines operable and releasable over the two sides of the calling one of said lines in series, a release magnet for one of said switches, a release relay for said switch connected to a trunk release conductor extending to another of said switches, a circuit for said release magnet controllable by said release relay, means for energizing and maintaining said relay energized while connection exists, and switching means located at said last switch for opening the circuit of said release conductor to de-energize said release relay, thereby closing the circuit of said release magnet for releasing the associated switch.

88. In an automatic telephone system, a switch for extending a talking circuit from a calling to a called line, means in said switch controlled over the two sides of the talking circuit in series for first electing the group of the called subscriber and for then locating the line of the called subscriber in the elected group, said switch provided also with electromagnetic means for preventing the extension of the talking circuit of the called line if the called line is busy, releasing mechanism for said switch, and means under the control of the talking circuit for releasing the switch after the busy line has been located.

89. In a telephone exchange system, the combination with a step by step automatic switch, of motor means for said switch comprising a magnet, a primary relay for operating said magnet, shifting means for said

switch, a slow acting secondary relay for controlling said shifting means, said secondary relay rendered operable by the initial operation of the primary relay over a circuit independent of said magnet.

90. In a telephone exchange system, the combination with a step by step automatic switch, of motor means for said switch including a magnet, shifting means for said step by step switch comprising a slow acting relay controlled independently of said magnet, additional means whereby the initial operation of the motor means renders the slow acting relay operable for actuating said shifting means.

91. In a telephone exchange system, the combination with a selective automatic switch having associated cam springs which are operated by the primary movement of the switch, of primary stepping means for said switch, secondary stepping means for said switch, means including a slow acting relay whereby after the operation of the primary stepping means the said secondary stepping means is rendered operable through said cam springs.

92. In a telephone exchange system, the combination with an automatic switch having motion in two intersecting planes, of a primary relay responsive to current impulses for actuating said switch, a secondary relay responsive to said primary relay over a circuit independent of that for actuating said switch, a plurality of control relays, means under control of the secondary relay for operating said control relays in a predetermined order.

93. In an automatic telephone exchange system, the combination with an automatic switch having motion in two intersecting planes, of current impulses for operating said switch, a primary relay associated with said switch and responsive to all of said impulses, a slow acting secondary relay controlled by a contact in said primary relay, a plurality of control relays associated with said switch, said control relays being operated in a certain order by the co-operation of the primary and secondary relays, the operation of said controlling relays serving to change the operating conditions of said switch.

94. A telephone system including telephone lines, an electromagnetically controlled connector for connecting to a called line responsive to directive current impulses, contact wipers for said connector including a talking wiper and a test wiper, a test relay, a contact in the circuit of said talking wiper controlled by said test relay, test contacts for said lines for engagement by said test wiper, means for rendering said test relay sensitive to the idle or busy condition of the test contact of the wanted line while said test wiper is engaging said con-

tact, and mechanism controlled by said test relay for extending a busy signal or completing a portion of the talking circuit, according to the idle or busy condition of said test contact.

95. In a telephone system, an automatic progressively movable switch having a plurality of operating magnets, means for switching a connection from one to the other of said operating magnets, means for controlling said operating magnet by impulses of one character, means for controlling said switching operation by impulses of a second character, and means for producing said impulses by interrupting the line circuit.

96. In a telephone exchange system, the combination with an automatic progressively movable switch, means for directing the action of said switch in response to current impulses of a certain frequency, of means for said switch responsive to current impulses of a different frequency for shifting the directive means.

97. In a telephone system, calling and called lines divided into groups, a connector responsive to the calling subscriber to seize the called line to establish a talking circuit between two subscribers, automatic means operative to release the connector if the called subscriber hangs up his telephone ahead of the calling subscriber, and means for controlling the connector over two sides of the talking circuit in series, said connector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group.

98. A telephone system comprising telephone lines, a plurality of step by step connector switches less in number than said telephone lines, locking means dependent upon the use of said connector switches for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said connector switches when thrown into an off-normal position while idle.

99. A telephone system comprising trunk lines, a step-by-step selector switch adapted to select idle trunk lines, locking means dependent upon the use of said selector switch for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said selector when thrown into an off-normal position while idle.

100. A telephone system comprising trunk lines, a subscriber's step-by-step individual switch adapted to select idle trunk lines, locking means dependent upon the use of said individual switch for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said individual switch when thrown into an off-normal position while idle.

101. A telephone system comprising telephone lines, a plurality of connector switches less in number than said telephone lines, provided with means having vertical motion to select different operative levels depending on the number called, and rotary step-by-step motion to connect with a line in a selected level, locking means dependent upon the use of said connector switches for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said connector switches when thrown into an off-normal position while idle.
102. A telephone system comprising trunk lines, a first-selector switch adapted to select idle trunk lines, provided with means having vertical step-by-step motion to select different operative levels depending on the number called, and rotary step-by-step motion to connect with a line in the selected level, locking means dependent upon the use of said selector switch for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said first selector when thrown into an off-normal position while idle.
103. A telephone system comprising trunk lines, a progressively movable selector switch adapted to select idle trunk lines provided with means having vertical step-by-step motion to select different operative levels depending on the number called, and rotary motion controlled by step by step magnets to connect with a line in the selected level, locking means dependent upon the use of said selector switch for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said selector when thrown into an off-normal position while idle.
104. A telephone exchange system comprising a calling telephone line, a called telephone line, means including a selector and a connector for extending connection from the calling line to the called line, calling mechanism requiring a separate manual operation thereof for each digit of the called number, operative to transmit suitable controlling current for one digit before the said mechanism is manually operated for the next digit, a line circuit for controlling the selector, and a line circuit for controlling the connector, each line circuit including said mechanism and the two sides of the calling line in series.
105. A telephone exchange system comprising a calling telephone line, a called telephone line, calling mechanism requiring a separate manual operation thereof for each digit of the called number, operative to transmit suitable controlling current for one digit before the said mechanism is manually operated for the next digit, means including a selector and connector for extending connection from the calling line to the called line, provided with means having vertical motion to select different operative levels, depending on the number called, and rotary motion to connect with a line in the selected level, line circuits for controlling the selector, and a line circuit for controlling the connector, each line circuit including said mechanism and the two sides of the calling line in series.
106. In a telephone system, a connector switch, a side switch, a release magnet, and another electromagnet therefor: an energizing circuit for the said release magnet controlled by said other electromagnet while the side switch is in second position, the said other electromagnet retaining its armature attracted while the side switch is in second position to prevent the release of said connector switch.
107. In a telephone system, a connector switch; a side switch, a release magnet and another electromagnet therefor; an energizing circuit for said release magnet controlled by said other electromagnet while the side switch is in second position, said circuit established by de-energizing said other electromagnet.
108. A telephone system comprising a connector switch having motion in one plane to select groups and motion in another plane to select lines in a group, a line relay therefor, a release magnet, means whereby if the line relay is de-energized momentarily the release magnet is prevented from energizing, and means whereby if the line relay de-energizes for a greater length of time the release magnet energizes and releases the said connector switch.
109. A telephone system comprising a connector switch for connecting with and signalling a called subscriber, a release magnet therefor, a slow acting relay, a line relay, and a shaft for said switch, an energizing circuit for said slow acting relay controlled by said line relay, and an energizing circuit for said release magnet controlled by said slow acting relay and by said shaft, means whereby if said line relay de-energizes said slow acting relay de-energizes and sets up an energizing circuit through said release magnet to release said shaft to in turn destroy the energizing circuit for said release magnet.
110. In a telephone system, subscribers' lines arranged in groups, a connector switch for electing a group of said lines and picking out the desired line in that group, a release magnet, another electromagnet and an energizing circuit for said release magnet controlled by said other electromagnet while said switch is picking out the desired line, said circuit established by de-energizing said other electromagnet.
111. In an automatic telephone system, an

automatic progressively movable switch, a plurality of lines accessible to said switch, said lines divided into groups, means for operating said switch to elect a group and means for thereafter operating the switch to establish connection with a line in the elected group; means for releasing said switch after it has been operated, said means including a release magnet, a circuit for said release magnet, said switch comprising a magnet auxiliary to said release magnet, said circuit controlled by said auxiliary magnet to maintain the circuit of the release magnet open while the switch is being operated in the elected group to find any particular line in the elected group.

112. The combination of an automatic switch and a plurality of lines, said lines divided into groups, said automatic switch having means whereby it may be operated to elect a group and whereby it may thereafter be operated to pick out a line in the elected group, said switch having a release magnet and an auxiliary magnet, a circuit for the release magnet, said auxiliary magnet having control over the circuit of the release magnet to maintain the same open while the switch is operating to pick out a line in the elected group.

113. The combination of an automatic switch and a plurality of lines, said lines divided into groups, said automatic switch having means whereby it may be operated to elect a group and whereby it may thereafter be operated to pick out a line in the elected group, said switch having a release magnet and an auxiliary magnet, a circuit for the release magnet, said auxiliary magnet having control over the circuit of the release magnet to maintain the same open while the switch is operating to pick out a line in the elected group, and means for energizing said auxiliary magnet during the interval that it is holding the release circuit open.

114. In a telephone system, the combination of a progressively movable step by step connector switch provided with a release magnet, a two motion shaft for said switch having motion in two intersecting planes, a pair of springs controlled by said shaft, a battery, said shaft controlling the connection between said release magnet and a terminal of said battery at a point between the shaft controlled springs, and means for supplying current over the subscribers' lines to operate said connector switch substantially as set forth.

115. In a telephone system, a progressively movable step by step connector having motion in two intersecting planes and provided with a release magnet, and having quick and slow acting relays controlling said magnet, the quick acting relay holding circuit open through said magnet during

conversation, and the slow acting relay holding said circuit open while the operating impulses are being transmitted.

116. A telephone system comprising trunk lines, a step by step first selector switch adapted to select idle trunk lines, locking means dependent upon the use of said selector switch for connecting purposes to hold the same in an off-normal position, and automatic means for restoring said first-selector when thrown into an off-normal position while idle.

117. In a telephone system, a switch having motion in two intersecting planes to select contacts by groups and then by contacts in the selected group, means for releasing the same including a relay slow to release controlling a release magnet during the operation of the switch, and a quick acting relay controlling the release independently of said slow relay after the switch has operated, and means for controlling the two sides of a calling line in series to operate said switch.

118. In a telephone system, a selector provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, the slow acting relay holding said circuit open while operating impulses are being transmitted, and automatic ringing means and busy signalling means for said connector operative according to the condition of the contact tested by the switch.

119. In a telephone system, a switch adapted to be operated in a straight line direction to select groups of lines and to be rotated to select lines in the group, means for releasing the same including a release magnet and a relay slow to release its armature, said relay controlling the release magnet during the operation of the switch, a quick-acting relay controlling the release magnet after the switch has operated independently of said slow relay, and a central source of talking and operating current for said system.

120. In a telephone system, a switch adapted to be operated in a straight line direction and to be rotated to select a line, means including a release magnet and a release magnet circuit for releasing the same, a slow-acting relay controlling the release magnet circuit during the operation of the switch, and a quick-acting relay controlling the release magnet circuit independently of said slow-acting relay after the switch has operated.

121. In a telephone system, a trunk accessible to a plurality of switches, a switch for extending connection therefrom, releasing means for said switch including a release magnet and a relay slow to release its

armature, said relay controlling the release magnet while the switch is operating, a quick-acting relay controlling the release magnet after connection has been established from the trunk independently of said slow relay, and a central source of talking and operating current for said system.

122. In a telephone system, a trunk accessible to a plurality of switches, a switch for extending connection therefrom, releasing means for said switch including a release magnet and a relay slow to release its armature, said relay controlling the release magnet while the switch is operating, a quick-acting relay controlling the release magnet independently of said slow relay after connection has been established from the trunk, and means for controlling the two sides of a calling line in series to operate said switch.

123. In a telephone system, an automatic switch having bank terminals divided into groups, the groups being disposed in parallel planes, movable arms having motion in one direction to find a group and motion in another direction to find a terminal in the selected group, a line relay for controlling the operation of said arms, an electromagnet, a trunk adapted by a single movement of the armature of said magnet to connect with said arms, means for controlling said switch over the two sides of said trunk in series, and mechanism operative under substation control to find the called subscriber's line.

124. In a telephone system, an automatic switch having bank terminals divided into groups, the groups being disposed in parallel planes, movable arms having motion in one direction to find a group and motion in another direction to find a terminal in the selected group, an electromagnet for producing the first motion, an electromagnet for producing the second motion, a relay, a line adapted by a single movement of the armature of said relay to connect with said arms, means for controlling said switch over two sides of said line in series, and mechanism operative under substation control to find the called subscriber's line.

125. In a telephone system, an automatic progressively movable switch having motion in intersecting planes and provided with a line relay for controlling the operation of said switch, a release magnet, quick and slow-acting relays controlling the circuit of said magnet to prevent a premature release, said quick relay when energized holding open the circuit of the release magnet, and a central source of talking and operating current for said system.

126. In a telephone system, a selector provided with a line relay for controlling the operation of said selector having a lineal and a rotary movement to select lines and a release magnet, quick and slow acting re-

lays for controlling the circuit of said magnet to prevent a premature release, and a central source of talking and operating current for said system, said quick relay when energized operating to open the circuit of the release magnet.

127. In a telephone system, a trunk, a switch for extending connection thereto, releasing means for said switch including a relay slow to release its armature, said relay controlling the release before connection is extended to the trunk, a quick-acting relay controlled over said trunk for controlling the release after the switch has established the connection, and a central source of talking and operating current for said system.

128. In a telephone system, a trunk, a switch for extending connection thereto, releasing means for said switch including a slow-acting relay controlling the release before connection is extended to the trunk, and a quick acting relay controlled over the trunk for controlling the release after the switch has established the connection, and means for controlling the two sides of a calling line in series to operate said switch.

129. In a telephone system, a trunk, a switch for extending connection thereto, releasing means for said switch including a relay slow to release its armature, said relay controlling the release while the switch is operating, and a quick acting relay controlled over said trunk for controlling the release of said switch after connection has been established with said trunk.

130. In a telephone system, a progressively movable automatic switch having a rotary and a lineal movement for selecting lines and provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, and the slow acting relay holding said circuit open while operating impulses are being transmitted.

131. In a telephone system an automatic switch having motion in one direction to select the groups and motion in another direction to select contacts in the group and provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, and the slow acting relay holding said circuit open while operating impulses are being transmitted.

132. In a telephone system, a progressively movable automatic switch having wipers adapted to be moved to a group of contacts and to a contact in the group and provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, and the slow acting relay hold-

ing said circuit open while operating impulses are being transmitted.

133. A telephone exchange system comprising a selector provided with a side switch, a trunk line including a pair of talking conductors leading to said selector, a circuit including said talking conductors in series for controlling the operation of said selector, a release relay for releasing said selector while the side switch is in first or second position, and a release relay for releasing the said selector when the side switch is in third position.

134. In a telephone system, an automatic switch provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, and the slow acting relay holding said circuit open while operating impulses are being transmitted, said switch having means for connecting with a called line and signalling thereover if the line is idle or for transmitting a busy signal if the line is busy.

135. In a telephone system, a vertical and rotary motion switch, electromagnet mechanism in the switch for producing said motion, relay mechanism in the switch for controlling said electromagnet mechanism, a line, and means for controlling the two sides of said line in series to control said relay mechanism, said electromagnet mechanism having a local circuit that is in normal condition while the switch is in operated position.

136. In a telephone system, a vertical and rotary motion switch, having an operating magnet the circuit of which is in normal condition while the switch is in operated position, a line, and means for controlling the two sides of said line in series to control said switch.

137. In a telephone system, a vertical and rotary motion selector provided with a release magnet, and having quick and slow acting relays controlling the said magnet, the quick acting relay holding circuit open through said magnet during conversation, and the slow acting relay holding said circuit open while operating impulses are being transmitted.

138. In a telephone system, a vertical and rotary motion switch, means including a release magnet and a release magnet circuit for releasing the same, a slow-acting relay controlling the release magnet circuit during the operation of the switch, and a quick-acting relay controlling the release magnet circuit independently of said slow-acting relay after the switch has operated.

139. In a telephone system, a switch, a line circuit, means for controlling the two sides of said circuit in series to operate said switch, a release magnet for said switch, a slow relay for preventing operation of said

magnet during the operation of the switch, a quick relay for preventing a release during conversation over said circuit, either relay adapted to operate the release magnet when the line circuit is opened by the hanging up of the receiver, but the slow relay remaining energized during control of the circuit to operate the switch, and after operation of the switch the release being independent of the slow relay and under the control of the quick relay.

140. In a telephone system, a vertical and rotary motion selector provided with a release magnet, a line relay controlled over two sides of a calling line in series for operating the said selector, said selector having quick and slow acting relays controlling the said magnet, the quick acting relay while energized holding circuit open through said magnet during conversation, and means for holding said quick acting relay energized.

141. In a telephone system, a switch, means for releasing the same including a release magnet and a relay slow to release its armature, said relay controlling the release magnet during the operation of the switch, a quick-acting relay controlling the release magnet after the switch has operated independently of said slow relay, a central source of talking and operating current for said system, and automatic ringing means and busy signalling means for said switch.

142. In a telephone system, a trunk, a switch for extending connection therefrom, releasing means for said switch including a release magnet and a relay slow to release its armature, said relay controlling the release magnet while the switch is operating, a quick-acting relay controlling the release magnet after connection has been established from the trunk independently of said slow relay, and a central source of talking and operating current for said system.

143. In a telephone system, an automatic switch having bank terminals divided into groups, the groups being disposed in parallel planes, movable arms having motion in one direction to find a group and motion in another direction to find a terminal in the selected group, an electromagnet for producing the first motion, an electromagnet for producing the second motion, a line, a relay for connecting said line with said arms by a single movement of its armature, means for controlling said switch over the two sides of said line in series, a third arm, release mechanism for said switch, and release circuits therefor including contacts of said bank and said third arm.

144. In a telephone system, an automatic switch having bank terminals divided into groups, the groups being disposed in parallel planes, movable arms having motion in one direction to find a group and motion in another direction to find a terminal in the se-

lected group, an electromagnet for producing the first motion, an electromagnet for producing the second motion, a line relay for controlling the operation of said magnets
 5 connected to a line, a relay for connecting said line with said arms by a single movement of its armature and also for disconnecting said line relay from said line, means for controlling said switch over the
 10 two sides of said line in series, a central source of operating current for said switch, and a substation telephone deriving talking current from said source.

145. In a telephone system, an automatic
 15 switch, means including a selector for extending a talking circuit connection to said automatic switch, said selector being provided with a release magnet, and quick and slow acting relays for controlling said magnet,
 20 the quick acting relay being controlled from said automatic switch for holding the circuit open through said magnet during conversation, said slow relay disconnected from the talking circuit.

25 146. In a telephone system, means for establishing a call, means for releasing the call including a release magnet and relays slow to release their armatures, said relays controlling the release magnet during the establish-
 30 ment of the call, quick acting relays for controlling the release magnet during conversa-

tion independently of said slow acting relays, a central source of talking and operating current for said system, and automatic ringing means and busy signalling means
 35 associated with said relays.

147. A telephone system including a subscriber's telephone line, a selector switch and a connector switch for extending a connection from said line, each of said switches being provided with quick and slow acting
 40 relays for controlling the operation thereof.

148. A telephone system including a calling telephone line and a called telephone
 45 line, a selector switch and a connector switch having means for selecting lines by groups and then lines in the groups for establishing a connection between said calling and called lines, quick and slow acting relays individual to each of said switches for controlling their
 50 operations.

149. A telephone system including a subscriber's telephone line, a numerical automatic trunk selecting switch provided with a line relay controllable over the two sides
 55 of said line in series, and a slow acting relay for said switch for exclusively controlling the same.

In witness whereof, I hereunto subscribe my name this 17th day of September, 1906.

HARRY G. WEBSTER.