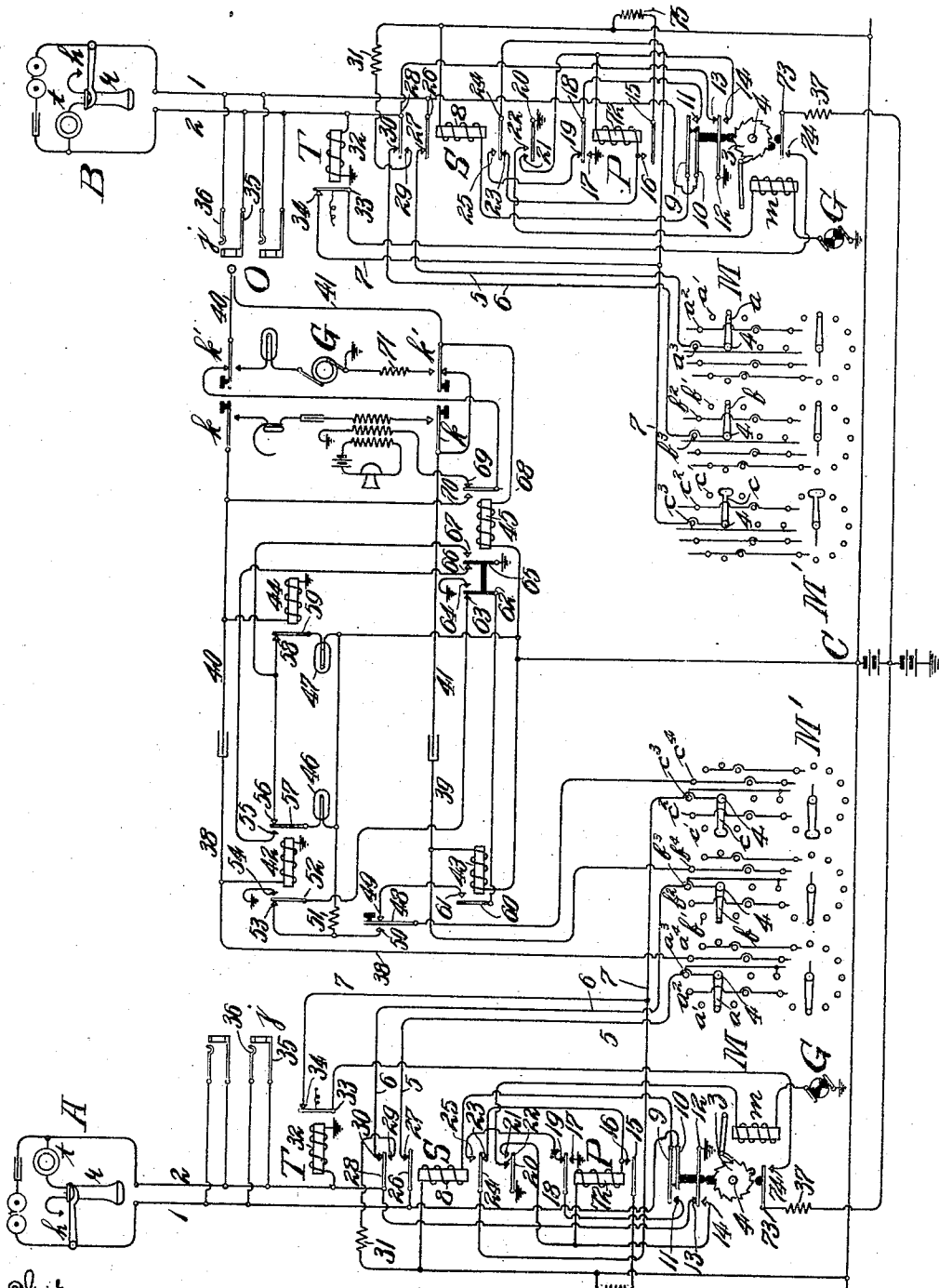


H. G. WEBSTER.
TELEPHONE SYSTEM.
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Patented Aug. 24, 1909.



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TELEPHONE SYSTEM.

931,905.

Specification of Letters Patent.

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To all whom it may concern:

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

My invention relates to telephone exchange systems and particularly to that type in which link-conductors are interchangeably associated with the subscribers' lines, mechanism being provided for each subscriber's line which is automatically actuated when the receiver is taken for use, to connect the subscriber's line to an idle link-circuit and cause the display of a calling signal associated with a manually controlled terminal of the link-circuit.

One object of my invention is to provide, in a structure of this character, means whereby the customary cut-off relay is dispensed with, a special action of the automatic mechanism serving to perform the functions hitherto performed by the cut-off relay.

A further object of my invention is to provide novel means for securing the connection and disconnection of the subscriber's line and the link-conductor, which is characterized by simplicity and economy of manufacture and by positive and efficient operation.

According to the preferred form of my invention, I provide for each subscriber's line a traveling switch which is preferably a rotary switch, provided with wipers or traveling contacts movable in one direction only. This switch is rotated by step-by-step mechanism, preferably actuated by current from a pulsating generator. The switch is provided with three wipers which constitute the terminals of the circuits individual to the line, and with fixed contacts adapted to be engaged by the wipers as they are rotated, and these fixed contacts are connected to wires individual to the various link-conductors. These link-conductors terminate preferably in cords and plugs at the various operators' positions of a multiple switchboard and the subscribers' lines are provided with multiple jacks at the various multiple sections. The wipers of the traveling switch normally rest upon "dead" contact pieces of the switch. When a connection is made to the line with which the switch is associated, the insertion of a plug into a spring-jack of the line causes the switch to take

one step and the wipers then engage contact pieces which are also "dead" or disconnected. This first step, however, serves to remove the normal battery connections of the line limbs and to prevent the further operation of the switch as long as the plug remains in the jack. When it is removed at the conclusion of conversation, the switch will then step ahead through the remainder of its range of motion and come to rest at the normal position.

When the subscriber desires to initiate a call, the removal of his receiver will cause his switch to travel over the first contact before mentioned and to come to rest at the first contacts engaged which are associated with an idle link-conductor. After passing the first "dead" contacts of the switch, the wipers will engage preferably, first, the contacts connected to a link-circuit at the first operator's position; then contacts connected to a link-circuit at the second operator's position; then those leading to the third operator's position, and so on; and these fixed contacts are multiply connected to similar switches individual to other subscribers' lines in a group. Other link-circuits terminating at the first, second, third and other operators' positions, may be similarly connected to the rotating switches of lines in other similar groups; the arrangement being such that if the link-conductor connected to the first terminals of a particular group of switches, and terminating in front of the first operator at the switchboard, be busy, the switch will step ahead to the second terminals leading to the second operator, and so on until an idle link-circuit is reached, when it will come to rest and the operation of associated mechanism will connect the line limbs to the talking conductors of the link-circuit. At the same, a call signal associated with a link-circuit will be displayed; and the operator, after ascertaining what connection is desired, will insert the plug, which constitutes the manual terminal of the link-circuit, into a multiple jack of the desired line. When conversation is finished, the removal of the connecting plug causes a further rotation of the switch to restore its wipers to their normal positions. To secure the proper operation of the apparatus and circuits, I provide three relays for each subscriber's line, and in this respect my system differs from those heretofore proposed. One of these relays is normally associated with that line limb leading

from the active terminal of the battery and serves, among other functions, to control the stopping and starting of the rotating switch.

A second relay is associated with that line limb leading from the grounded terminal of the battery and serves to partially control the movement of the switch when a connection is made to the spring-jack of its associated line. A third relay in a local circuit operates at the time of release and may be called a "release relay."

My invention will be more fully understood from the accompanying drawing in which—

A and B represent substations connected to a central office in accordance with the preferred form of my invention. The drawing shows, in diagrammatic form, two substations A and B connected, by suitable line limbs, with a central office and there provided with the rotating switches and controlling relays necessary for the preferred form of my invention. A single link-conductor is illustrated, connected at M with the contacts of the switch of station A, and its multiple connection to a similar switch of another line is indicated in partial diagram at M'. The substations are provided with the usual bell and condenser in permanent bridge of the line limbs, the receiver *r* and transmitter *t* being included in a normally open bridge closed at the upper contact of the switch-hook *h*. The limbs 1 and 2 extend to the central office and are there connected to the terminals of a battery C. Each line is provided with a tip relay T and a sleeve relay S associated with the line limbs, and also with a release relay P in a local circuit.

The rotating switch for the line is indicated at M and this switch is actuated by a step-by-step mechanism 3 in response to the energization of motor magnet *m* by current from the pulsating generator G. The switch is diagrammatically indicated as having a shaft 4 which carries the tooth-wheel of the stepping mechanism and also carries the three wipers, *a*, *b* and *c*, wipers *a* and *b* being associated with limbs 1 and 2 respectively, and wiper *c* being associated with a local circuit. Wipers *a* and *b* are provided with narrow terminals and, in traveling over the contact pieces *a'*, *a''*, *a'''*, *a''''*, and *b'*, *b''*, *b'''*, *b''''*, will move out of engagement with one contact piece before the following contact piece is engaged. Wiper *c* has a wide terminal and in traveling does not disengage one contact until the next contact has been engaged. Contacts *a'*, *b'* and *c'* are those which the wipers engage at the first step of the mechanism and are "dead" contacts. Contacts *a''*, *b''*, *c''*, are connected respectively to the tip, sleeve and local wires of the first link-conductor, contacts *a'''*, *b'''*, *c'''* to the corresponding wires of the sec-

ond link-conductor, and contacts *a''''*, *b''''*, *c''''* to corresponding wires of the third link-conductor. For convenience of illustration, this third link-conductor is the only one illustrated, and it will be understood that the link-conductors may be distributed—that of *a''* before the first operator, *a'''* before the second operator, *a''''* before the third operator, and so on—or that all of the link-conductors connected to the switch may terminate in front of the same operator if desired, or that other obvious methods of grouping may be employed.

At M', I have indicated the wipers and fixed contacts of the switch associated with another line to show the multiple connection of the wires leading from the link-conductor with the contact point of the switches. It is to be understood that the subscribers' lines and their switches are arranged in groups and that a group of link-conductors is multiply connected to the contacts of all of the line switches of a group of lines; and that this group of link-conductors, each of which terminates in a calling plug O, may be distributed, as desired, before the various operators of the switch board. In addition to the fixed contacts and wipers, each switch is provided with a contact 9 which is in engagement with the contact 10 in the normal position of the switch, and is disconnected from contact 10 and connected to contact 11 at all other times during the operation of the switch; with a contact 12 which normally engages contact 13 and is disconnected therefrom and in engagement with contact 14 when the switch is off normal; and with a contact 73 which engages contact 74 at the first step of the shaft 4, but is disengaged therefrom at all other times.

When a subscriber, as A, desires to initiate a call, the removal of his receiver closes a circuit which may be traced from the upper terminal of battery C, through winding 8 of relay S, contacts 9—10 of the switch, thence through limb 1, the receiver and transmitter and limb 2, and through contacts 13—12 of the switch to ground or the lower terminal of the battery. Wipers *a* and *b* which are at this time connected with limbs 1 and 2 respectively, are in their normal position and thus out of engagement with any connected fixed contacts of the switch. Relay T, which is connected from limb 2 of the line to ground, is unenergized at this time on account of the direct earth connection of limb 2 at contact 13—12. The current flowing over the circuit traced energized the relay S with the following result: the attraction of armature 28 disconnects limb 2 from wiper *b* at contact 30 and connects limb 2 to the upper terminal of battery C, through high resistance 31 at contact 29. This connection serves to raise the potential of contact 35 of jack *j*, thus providing the

necessary condition for a busy test, but the resistance 31 is sufficiently high to prevent the operation of relay T at this time.

The attraction of armature 26 disengages limb 1 from wiper *a* at contact 27. The attraction of armature 24 disconnects the relay P from its normal connection with wiper *c* and connects wiper *c* at contact 25, through contact 19 and armature 18 of relay P, to contact 11 of the switch. The attraction of armature 20 connects winding 72 of relay P to ground at contact 21, and at contact 22 closes circuit from pulsating generator G through the motor magnet *m*. The energization of this magnet starts the rotating mechanism and, as has been pointed out, the wipers *a* and *b* are at this time disconnected from the line limbs and also from the central battery and ground. As the switch makes its first step, contact 12 disengages contact 13 and engages contact 14; contact 9 engages contact 11 and disengages contact 10; and contact 73 engages contact 74. The operation of contact 12 removes the earth connection from limb 2, the operation of contact 9 disconnects relay S from the line limb and connects it to wiper *c* through contact 11 of the switch, armature 18 and contact 19 of relay P, contact 25 and armature 24 of relay S and thence by wire 7 to wiper *c*; and the engagement of contact 73 completes a circuit to maintain the energization of relay S, which may be traced by wire 7 to contact 34 and armature 33 of relay T and thence by contact 74 and contact 73 through resistance 37 to the intermediate terminal of the battery C. The removal of the ground from limb 2 of the line at contacts 12—13 has removed the short circuit from relay T; but limb 1 being now disconnected from battery C at contact 10, the relay T remains unenergized and the necessary potential for a busy test is present at contact 35 of a jack *j*. As will be subsequently explained, the wires leading from the fixed multiple contacts *c*², *c*³ and *c*⁴ are connected to ground or the return side of the battery when their associated link-conductor is busy and are open during the idle condition of the link-circuit, and the presence or absence of this ground connection is what determines the further rotation of the switch. It being assumed that the link-conductors associated with contacts *c*² and *c*³ are busy at this time and that the link-circuit shown in association with contact *c*⁴ is idle, the next movement of the stepping mechanism brings wiper *c* into engagement with contact *c*² and interrupts the energizing circuit of relay S (just traced) at contact 74. A new energizing circuit now exists through wire 7, wiper *c*, contact *c*² and to ground through the wires leading from this contact, and the switch continues to rotate. The wire leading from contact *c*³ being also grounded and contact *c*³ being en-

gaged before contact *c*² is disengaged, the switch takes a further step, bringing wiper *c* into engagement with contact *c*⁴ and out of engagement with contact *c*³. The wire connected with contact *c*⁴ leads through key lever 48 and contact 49 of the link-conductor and now stands open at contact 61 of relay 43. The circuit of relay S is thus interrupted; the consequent release of its armature 20 interrupts the circuit of motor magnet *m* at contact 22, thus preventing the further rotation of the switch; the retraction of armature 24 connects release relay P to wiper *c*, through wire 7, armature 24, contact 23, winding 72 and to ground through contact 14 and contact 12 of the switch, and the retraction of armatures 26 and 28 connects wipers *a* and *b* to their respective line limbs. Current will now flow from battery C, through relay 43, contact *b*⁴, wiper *b*, wire 6, contact 30 and armature 28 through relay T to ground, energizing relays 43 and T, and also from armature 28 through limb 2, the transmitter and receiver, limb 1, armature 26, contact 27, wire 5, wiper *a*, contact *a*⁴, wire 38 and relay 42 to ground, energizing relay 42 and the substation transmitter. The consequent attraction of armature 57 of relay 42 closes a circuit of lamp 46, through contact 55, and contact 66 and armature 65 of relay 45, and the illumination of this lamp constitutes the calling signal to the operator. At the same time, the attraction of armature 52 of relay 42 and armature 60 of relay 43 has connected contact *c*⁴ to ground through key lever 48, contact 49, contact 61 and armature 60 of relay 43, armature 62 and contact 63 of relay 45, and armature 52 and contact 54 of relay 42, thus preventing other switches from stopping at the terminals of this link-conductor. The attraction of armature 33 of relay T has no function in the operation at this time. The operator answers and tests in the usual way and inserts her calling plug O into the spring-jack of the desired line.

Immediately upon the insertion of the plug, current will flow from battery C, through relay 45, strand 41, contact 35 of jack *j*, and to ground through contacts 13—12 of the switch M associated with line B. The ensuing attraction of armature 62 of relay 45 substitutes a ground for contact *c*⁴ at contact 64, for that previously established at 54; the attraction of armature 65 interrupts the circuit of lamp 46 at contact 66 and establishes a circuit for lamp 47 at contact 67, this circuit including the armature 59 and contact 58 of relay 44; and the attraction of armature 68 completes the circuit of strand 40 at contact 70. At the same time, current will flow from battery C, through relay S of line B, contact 9—10 of the switch, and thence to contact 36 of spring-jack *j*, strand 40 and relay 44 to the

return side of the battery. The ensuing energization of relay S disconnects wipers *a* and *b* from the line limbs and closes the circuit of the motor magnet *m*, causing the switch to start. As the switch makes its first step, the shifting of contact 12 removes the ground from limb 2 at contact 13, thus allowing relay T to be energized by the current flowing through relay 45 and contact 35 of the spring-jack, and connects the winding of relay P to ground at contact 14. The shifting of contact 9 disconnects the winding of relay S from the line limb and connects it to wire 7 leading to contact 34 as previously described in connection with line A, but the engagement of contact 73 and contact 74 does not now provide an energizing circuit for relay S for the reason that the energizing circuit (as described for line A at this time) is interrupted in the present case at armature 33 and contact 34 of relay T. The switch thus makes but one step, its wipers now resting on the "dead" contacts *a'*, *b'*, *c'*, and the two line limbs are thus disconnected from their normal association with battery C by the movement of the switch. The operator rings in the usual manner, relay T being energized by current through relay 45 during the operation of ringing; and when the subscriber answers, additional current flows through relay 45, the line limbs and substation, and through contact 36 of jack *j*, strand 40 and relay 44 to the return side of the battery. This current energizes the substation transmitter, extinguishes lamp 47 by the attraction of armature 59, and the two subscribers are in condition for conversation. If either subscriber hang up his receiver, the consequent interruption of current through relay 42 or 44 causes the illumination of the associated lamp 46 or 47, and the simultaneous illumination of both lamps constitutes the ordinary disconnect signal.

Upon the removal of plug O at the termination of conversation, both switches will rotate and come to rest in their normal position, and the various relays will assume the normal position shown in the diagram.

Upon the removal of plug O, the energizing circuit for relay T of the called line is interrupted. The consequent retraction of its armature closes a circuit which may be traced from the intermediate terminal of battery C, through resistance 37, contact 73—74, armature 33, contact 34, wire 7, armature 24 and contact 23 of relay S, winding 72 of relay P, and to the grounded terminal of the battery through contact 14 and contact 12 of the switch. This is the first time that relay P has been energized. The attraction of armature 15 closes a circuit through protective resistance 75, armature 15, contact 16, winding 72, to the return side of the battery through contacts 14—12 of the switch,

which serves to maintain the energization of relay P until the circuit is interrupted at contacts 14—12 when the switch reaches normal; and the attraction of armature 18 closes a circuit of relay S which may be traced from the upper terminal of battery C, through winding 8, contacts 9—11, armature 18 and contact 17 to the return side of the battery, and this circuit is also maintained until interrupted at contacts 9—11, when the switch reaches normal. The energization of relay S at this time disconnects the line wipers *a* and *b* from the line and closes circuit through the motor magnet *m*, thus starting the switch and continuing its rotation until the normal position is reached. The removal of plug O from the spring-jack *j* has also interrupted the circuit of relay 45, and the circuit of relay 42 was previously interrupted by the restoration of the receiver at station A.

The restoration of armature 68 restores the normal busy test circuit for the plug O, the restoration of armature 65 extinguishes lamps 46 and 47, and the restoration of armature 62 removes the ground connection of contact *c'* and connects that contact to the active terminal of the battery, through key 48, contact 49, contact 61, armature 60, armature 62, contact 63, armature 52, and contact 53 and protective resistance 51. Current will now flow over this circuit and thence from contact *c'* through wiper *c* and by wire 7 to armature 24 and contact 23 to relay S, thence through winding 72 of the release relay P of the calling line to ground through contacts 14—12 of the switch. The relay P is thus energized, and the attraction of its armature 15, engaging contact 16, completes a second energizing circuit for its winding, which energizing circuit is thus maintained until it is interrupted at contacts 14—12 when the switch reaches normal. The attraction of armature 18, engaging contact 17, completes an energizing circuit for relay S, which may be traced from the upper terminal of battery C, through contacts 9—11 and through armature 18 and contact 17 to the return side of the battery, and this energization of relay S is also maintained until the circuit is interrupted at contacts 9—11 when the switch reaches normal. The energization of relay S disconnects the wipers *a* and *b* from the line limbs and closes a circuit for motor magnet *m* at armature 20 of contact 22, thus causing the required rotation. The circuit of relay 43 and relay T, through wiper *b'*, is thus interrupted, allowing the relay armatures to resume their normal positions, thus opening the wire leading from contact *c'* and leaving the link-conductor in readiness for another connection. The key shown at 48 is provided in order that the operator may manually cause the switch of a calling subscriber to restore to

normal without manipulating the plug O; the depression of this key causing lever 48 to engage contact 50 and thus connect contact c⁴ with the upper terminal of battery C, with the same result as that which followed the retraction of armature 62 of relay 45 upon the removal of the plug O from the spring-jack j. It is thus seen that any time after the switch has moved from its normal position and come to rest, the connection of wire 7 to an active terminal of battery C will result in the establishment of a restoring circuit for the switch. This restoring circuit may be traced from the upper terminal of battery C, through winding 8 of relay S, contacts 9—11 of the switch and armature 18 and contact 17 of relay P. This circuit once completed is maintained until interrupted at contacts 9—11 by the ensuing rotation of the switch, which is thus stopped at its normal position.

While I have described one arrangement of grouping the link-conductors or cord circuits in their relation to the various switches and to the several operators' positions of the system, and the grouping of the subscribers' lines with relation to the various groups of cord circuits, it is obvious that other methods of grouping may be employed and I do not therefore wish to be limited to the particular arrangement described. It is also obvious that various means may be employed for causing the rotation of the switch and its wipers, than that indicated; that the various grounds indicated may be a common return and connected with the grounded or return side of the central battery; that the invention is not limited to a structure in which current is supplied from a single battery; and that various modifications and alterations of my invention may be made without departing from its spirit.

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

1. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current, normal battery connections therefrom to the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, an electromagnet for the line, mechanism controlled by said magnet to prevent the operation of the switch when the magnet is inert and to allow said operation when the magnet is energized, and means whereby the insertion of a plug into the spring-jack energizes said electromagnet to

cause a movement of the switch to remove the normal battery connections of the line limbs.

2. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current, normal battery connections therefrom to the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, an electromagnet for the line, mechanism controlled by said magnet to prevent the operation of the switch when the magnet is inert and to allow said operation when the magnet is energized, means whereby the insertion of a plug into the spring-jack energizes said electromagnet to cause a movement of the switch to remove the normal battery connections of the line limbs, and means whereby the removal of the plug causes the switch to restore to normal and restore the battery connections of the line limbs.

3. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, an electromagnet for the line, mechanism controlled by said magnet to prevent the operation of the switch when the magnet is inert and to allow said operation when the magnet is energized, and means whereby the insertion of a connecting plug energizes said electromagnet to cause an initial movement of the switch.

4. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, an electromagnet for the line, mechanism controlled by said magnet to prevent the operation of the switch when the magnet is inert and to allow said

operation when the magnet is energized, means whereby the insertion of a connecting plug energizes said electromagnet to cause an initial movement of the switch, and means whereby the initial movement of the switch disconnects said magnet from the line and connects the magnet in a local controlling circuit.

5. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current, normal battery connections therefrom to the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, means whereby the insertion of a plug into a spring-jack causes a movement of the switch to remove the normal battery connections of the line limbs, and means whereby the removal of the plug causes the switch to restore to normal and restore the battery connection of the line limbs.

6. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current, normal battery connections therefrom to the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, means whereby the insertion of a plug into the spring-jack causes a movement of the switch to remove the normal battery connections of the line limbs, a release relay normally connected to the local wiper operating, when energized, to complete a restoring circuit for the switch, and means whereby the removal of the plug from the spring-jack causes the completion of an energizing circuit for the release relay.

7. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicator for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a circuit controlled at the substation for causing an initial movement of the

switch, means whereby the initial movement of the switch when thus produced is normally continued until the contacts of an idle link-circuit are engaged, alternative means for causing an initial movement of said switch by the insertion of the connecting plug into said springjack, means whereby the initial movement of the switch when produced by the insertion of the plug is stopped at a definite contact, and means whereby the removal of the plug causes the establishment of a restoring circuit for the switch.

8. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, means whereby the insertion of a connecting plug causes an initial movement of the switch, means whereby the initial movement of the switch when thus produced is discontinued at a definite point, means whereby the removal of the plug causes the establishment of a restoring circuit for the switch, and alternative means for starting said switch and continuing its movement until the contacts of an idle link-circuit are engaged.

9. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, means whereby the insertion of a plug into the spring-jack causes the switch to move to a pre-determined point and come to rest, and means whereby the removal of the plug causes the establishment of a restoring circuit for the switch.

10. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current, normal battery connections therefrom to the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-

circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a circuit controlled at the substation for causing an initial movement of the switch, means whereby the initial movement of the switch interrupts the normal battery connections of the line limbs, means whereby the initial movement of the switch is normally continued until the contacts of an idle link-circuit are engaged, a restoring circuit for the switch, and means whereby the normal battery connections of the line limbs are restored when the switch restores to normal.

11. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a circuit for causing an initial movement of the switch, and a relay operating, when energized, to cause the switch to stop at a pre-determined point, and when subsequently deenergized, to complete a restoring circuit for said switch.

12. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a line relay for said line, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, means whereby the switch is caused to make an initial movement when connection is made to a spring-jack of the line and thus interrupt the normal circuit of the line and of the line relay, and means associated with said line and switch whereby the removal of said connection causes the establishment of a restoring circuit for said switch.

13. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch

engaging said fixed contacts when the switch is operated, a line relay, normally in circuit with the line limbs, means whereby the switch is caused to make an initial movement when connection is made to a spring-jack of the line and thus interrupt the normal circuit of the line and of the line relay, and means associated with said line and switch whereby the removal of said connection causes the establishment of a restoring circuit for said switch.

14. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally in circuit with the line limbs, an auxiliary energizing circuit for the line relay controlled through the engagement of a connecting plug with the spring-jack.

15. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally responsive to current in the line limbs and to current in a circuit completed at the spring-jack and a connecting plug, a circuit controlled at the substation for causing an initial movement of the switch, and the disconnection of the line relay from the line and its connection to the local wiper of the switch, means whereby the initial movement of the switch interrupts the normal battery connections of the line limbs, and a restoring circuit for the switch.

16. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engag-

ing said fixed contacts when the switch is operated, a line relay normally responsive to current in the line limbs and to current in a circuit completed at the spring-jack and a connecting plug, means whereby the insertion of a plug into the spring-jack causes a movement of the switch to remove the normal battery connections of the line limbs, and means whereby the removal of the plug causes the switch to restore to normal and restore the battery connections of the line limbs.

17. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally responsive to current in the line limbs and to current in a circuit completed at the spring-jack and a connecting plug, means whereby the removal of the substation receiver causes the line relay to be disconnected from the line and connected to the local wiper of the switch, a release relay normally connected to the local wiper operating, when energized, to complete a restoring circuit for the switch, and means whereby the normal battery connections of the line limbs are restored when the switch restores to normal.

18. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally responsive to current in the line limbs and to current in a circuit completed at the spring-jack and a connecting plug, a release relay normally connected to the local wiper operating, when energized, to complete a restoring circuit for the switch, and a relay operating, when energized, to cause the switch to stop at a pre-determined point, and when subsequently deenergized, to complete a restoring circuit for said switch.

19. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting

plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally in circuit with the line limbs, means whereby the switch is caused to make an initial movement when connection is made to a spring-jack of the line and thus interrupt the normal circuit of the line and of the line relay, and means associated with said line and switch whereby the removal of said connection causes the establishment of a restoring circuit for said switch.

20. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay normally in circuit with the line limbs, an auxiliary energizing circuit for the line relay controlled through the engagement of a connecting plug with the spring-jack, a circuit controlled at the substation for causing an initial movement of the switch, means whereby the initial movement of the switch is normally continued until the contacts of an idle link-circuit are engaged, and a release relay normally connected to the local wiper operating, when energized, to complete a restoring circuit for the switch.

21. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay responsive to current in a circuit completed through the spring-jack and a connecting plug, means whereby the insertion of a plug into the spring-jack causes a movement of the switch to remove the normal battery

connections of the line limbs, and means whereby the removal of the plug causes the switch to restore to normal and restore the battery connections of the line limbs.

22. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay responsive to current in a circuit completed through the spring-jack and a connecting plug, means whereby the insertion of a connecting plug causes an initial movement of the switch, means, when a plug is in the spring-jack, whereby the motion of the switch is interrupted at a pre-determined point, and means whereby the removal of the plug causes the establishment of a restoring circuit for the switch.

23. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a line relay responsive to current in a circuit completed through the spring-jack and a connecting plug, means whereby the insertion of a plug into the spring-jack causes the switch to move to a pre-determined point and come to rest, means whereby the initial movement of the switch disconnects said magnet from the line and connects the magnet in a local controlling circuit, means whereby the initial movement of the switch interrupts the normal battery connections of the line limbs, means whereby the removal of the plug causes the establishment of a restoring circuit for the switch, and means whereby the normal battery connections of the line limbs are restored when the switch restores to normal.

24. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits terminating in connecting plugs at a plurality of operators' positions, a subscriber's line extending in two limbs from a substation to the exchange, a spring-jack terminal for the line, a source

of current for the line, signal indicators for the link-circuits, a traveling switch, fixed contacts for said switch constituting terminals of line and local conductors for said link-circuits, line and local wipers for said switch engaging said fixed contacts when the switch is operated, a circuit controlled at the substation for causing an initial movement of the switch, means whereby the initial movement of the switch interrupts the normal battery connections of the line limbs, means whereby the initial movement of the switch is normally continued until the contacts of an idle link-circuit are engaged, a release relay normally connected to the local wiper operating, when energized, to complete a restoring circuit for the switch, and means whereby the normal battery connections of the line limbs are restored when the switch restores to normal.

25. A telephone exchange system comprising a plurality of telephone lines, line relays one for each of said lines, a plurality of associated link-circuits, automatic switching means for establishing connection between a calling line and an idle link-circuit, means under the control of the line relay of the calling party for initially setting said switching means in operation, means dependent only upon the switching means itself to continue its operation for a further period and means dependent upon the condition of the engaging contacts of said switching means for still further continuing its operation.

26. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, automatic switching means for establishing connection between a calling line and an idle link-circuit, a controlling relay individual to a calling line, means for keeping said switching means in motion during the energization of said relay, means under the control of the calling party for initially energizing said relay, means actuated by the switching means for continuing its energization during a definite period, and means for further continuing its energization according to the condition of the engaging contacts of said switching means.

27. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a selecting switch having traveling and relatively fixed contacts and operative to establish connection between a calling line and an idle link-circuit, a controlling relay for said switch normally in circuit with said line, means for keeping said traveling switch contacts in motion during the energization of said relay, means under the control of the calling party for completing an energizing circuit for said relay over the calling line, means responsive to the movements of the switch to interrupt said initial energizing circuit, and provide

a second energizing circuit therefor, and finally interrupt the second energizing circuit and provide a third energizing circuit therefor including one of the traveling switch contacts, and means for deenergizing said relay when an idle link-circuit is encountered.

28. A telephone exchange system comprising a plurality of telephone lines, a link-circuit for interconnecting calling and called lines, a manually controlled terminal for establishing connection with a called line, automatic traveling switching means associated with said called line, and means responsive to the connection of the link-circuit to the called line to operate said switching means to change the normal circuit connections of the called line.

29. A telephone exchange system comprising a plurality of telephone lines, a link-circuit for interconnecting calling and called lines, a manually controlled terminal for establishing connection with a called line, automatic traveling switching means associated with said called line, means responsive to the connection of the link-circuit to the called line to operate said switching means to change the normal circuit connections of the called line, and means responsive to the disconnection of the link-circuit and called line to cause said switching means to return to normal.

30. A telephone exchange system comprising a plurality of telephone lines, a link-circuit for interconnecting calling and called lines, a manually controlled terminal for establishing connection with a called line, automatic switching means associated with said called line, a relay for controlling the operation of said switching means, and means responsive to the connection of the link-circuit to the called line to energize said relay to cause the operation of said switching means, and means actuated upon the said operation of said switching means to deenergize said relay to thereby discontinue further movement of said switching means.

31. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection between said line and said latter link-circuit, means responsive to the establishment of said manual connection to cause said switching means to change the normal line connections.

32. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection between said line and said latter link-circuit, means responsive to the establishment of said manual connection to

cause said switching means to change the normal line connections, and means responsive to the taking down of said manual connection to cause said switching means to return to normal.

33. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means normally under the control of a party associated with said line and operative to establish connection between said line and said latter link-circuit, means responsive to the establishment of said manual connection to cause said switching means to advance and thereby remove the party's normal control over it.

34. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means normally under the control of a party associated with said line and operative to establish connection between said line and said latter link-circuit, means responsive to the establishment of said manual connection to cause said switching means to advance and thereby remove the party's normal control over it, and means responsive to the taking down of said manual connection to cause said switching means to return to normal.

35. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, automatic switching means associated with said line and operative to extend the circuit of said line, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the control of a party associated with said line to close an energizing circuit for said relay, and an auxiliary energizing circuit for said relay closed upon the establishment of the manual connection with the line.

36. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, automatic switching means associated with said line and operative to extend the circuit of said line, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the control of a party associated with said line to close an energizing circuit for said relay, an auxiliary energizing circuit for said relay closed upon the establishment of the manual connection with the line, and means actuated by the subsequent operation of said switch to interrupt said auxiliary circuit.

37. A telephone exchange system comprising

ing a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection between said line and said latter link circuit, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the normal control of a party associated with said line to energize said relay, means actuated by the consequent operation of said switching means to provide a second energizing circuit for said relay, means responsive to the normal manual connection to said line, to close an auxiliary energizing circuit for said relay and to interrupt the said second energizing circuit to thereby limit the movement of said switching means.

38. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection between said line and said latter link-circuit, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the normal control of a party associated with said line to energize said relay, means actuated by the consequent operation of said switching means to provide a second energizing circuit for said relay, means responsive to the normal manual connection to said line, to close an auxiliary energizing circuit for said relay and to interrupt the said second energizing circuit to thereby limit the movement of said switching means, and means responsive to the taking down of said manual connection to cause said switching means to return to normal.

39. A telephone exchange system comprising a telephone line, a link-circuit having a manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection between said line and said latter link-circuit, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the normal control of a party associated with said line to energize said relay, means actuated by the consequent operation of said switching means to provide successively a second and a third energizing circuit for said relay, means responsive to the normal manual connection to said line to close an auxiliary energizing circuit for said relay and to interrupt the said second energizing circuit for said relay to thereby limit the movement of said switching means.

40. A telephone exchange system comprising a telephone line, a link-circuit having a

manually controlled terminal for establishing connection with said line, another link-circuit, automatic switching means for establishing connection with said latter link-circuit, a controlling relay for said switching means, means for maintaining said switching means in operation during the energization of said relay, means under the normal control of a party associated with said line to energize said relay, means actuated by the consequent operation of said switching means to provide a subsequent energizing circuit for said relay, means responsive to the normal manual connection to said line to close an auxiliary energizing circuit for said relay, a second relay actuated upon the establishment of said manual connection to interrupt the aforesaid subsequent energizing circuit for the first-mentioned relay and operative when deenergized to cause a reenergization of said relay and means for subsequently deenergizing said relay when said switching means reaches normal.

41. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of interconnecting link-circuits, automatic switching mechanism normally under subscribers' control for establishing connection between a calling line and an idle link-circuit, means responsive to the connection of a link-circuit with a called line to give the switch mechanism associated with said called line a definite movement, and means actuated by such movement to remove said called line switch mechanism from the control of the called party.

42. A telephone system comprising a telephone line, a selective switch therefor, link-circuits at the exchange for selection thereby, a line relay normally operatively connected with said line and responsive to current thereover to initiate travel of said switch, a movable test contact to control travel thereof in search of an idle link-circuit, an off-normal switch shifted on initial movement of said selective switch to connect said line relay with said test contact, other telephone lines and manually operated terminals for said link-circuits for extending connections thereto.

43. A telephone system including a calling line, a link-circuit at the exchange, automatic selective mechanism individual to said line and responsive to currents thereover to interconnect said link-circuit and line, a relay connected with said line, a normal short circuit extending about said relay, and an off-normal switch actuated on initial movement of said mechanism to open said circuit.

44. A telephone system including a calling line, a link-circuit at the exchange, automatic selective mechanism individual to said line and responsive to currents thereover to interconnect said link-circuit and

line, a relay connected with said line, a normal short circuit extending about said relay, and an off-normal switch actuated on initial movement of said mechanism to open said normal short circuit.

45. A telephone system including a subscriber's line, a link-circuit at the exchange, a normally short-circuited relay connected with said line, a selective switch individual to said line to interconnect said link-circuit and line and mechanism controlled by said switch in its operation to terminate the short-circuited condition of said relay.

46. A telephone system including a calling line, an operator's cord-circuit connected therewith, a called line, a selective switch, associated with said called line, means for normally controlling the operation of said switch over said called line, means controlled by the operator for causing travel of said switch and to establish a talking circuit between said link-circuit and said called line exclusive of contacts of said switch, and means controlled by the operator for restoring said switch to normal.

47. A telephone system including a calling line, an operator's cord-circuit for connection therewith, a called line, a selective switch, associated with said called line, means for normally controlling the operation of said switch over said called line, a spring-jacket terminal connected with said switch, a connecting plug for said circuit for connection therewith, means for electromagnetically causing travel of said switch and for completing a talking circuit between said cord-circuit and said called line exclusive of the contacts of said switch, means for restoring said switch to normal.

48. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, a traveling switch, a relay normally connected to one limb of said line and operative to control said switch, means for operating said relay to start said switch, means for operating said relay to stop said switch in connection with an idle link-circuit whenever said line is used as a calling line, and a relay connected with said other line limb for operating said former relay to stop said switch at a predetermined point whenever said line is used as a called line.

49. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, a traveling switch, a relay normally connected to one limb of said line and operative to control said switch, means for operating said relay to start said switch, means for operating said relay to stop said switch in connection with an idle link-circuit whenever said line is used as a calling line, a relay connected with said other line limb for operating said former relay to stop said switch at a predetermined point whenever said line is used as a called line, and a circuit controlling contacts operative upon the initial movement of said switch to disconnect said former relay from said line.

50. A telephone exchange system comprising a plurality of telephone lines, associated link-circuits fewer in number than said lines, switches and manually operated terminals for uniting calling and called lines for conversation, a control relay, off-normal contacts, and a release relay for each switch, means for operating said control relay upon taking down the connection, to close a circuit for said release relay, means for closing a maintaining circuit for said release relay through off-normal contacts of the associated switch, and means for operating said switch until said release relay circuit is broken at its off-normal contacts upon its return to normal.

51. A telephone exchange system comprising a plurality of telephone lines, associated link-circuits fewer in number than said lines, switches and manually operated terminals for uniting calling and called lines for conversation, a release relay for each switch, a control relay for said release relay, an energizing circuit for said control relay including normally closed contacts of said release relay, and means responsive to the disconnection of the conversational circuit to operate said control relay to operate said release relay.

In witness whereof, I hereunto subscribe my name this 25th day of July, 1906.

HARRY G. WEBSTER.

Witnesses:

GEO. E. MUELLER,
H. C. OLMSTEAD.

Corrections in Letters Patent No. 931,905.

It is hereby certified that in Letters Patent No. 931,905, granted August 24, 1909, upon the application of Harry G. Webster, of Chicago, Illinois, for an improvement in "Telephone Systems," errors appear in the printed specification requiring correction, as follows: On page 4, line 99, the word "to" second occurrence should read *of*; page 7, line 20, and page 12, line 32, the compound word "spring-jacket" should read *spring-jack*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of October, A. D., 1909.

[SEAL.]

C. C. BILLINGS,

Acting Commissioner of Patents.