

April 5, 1927.

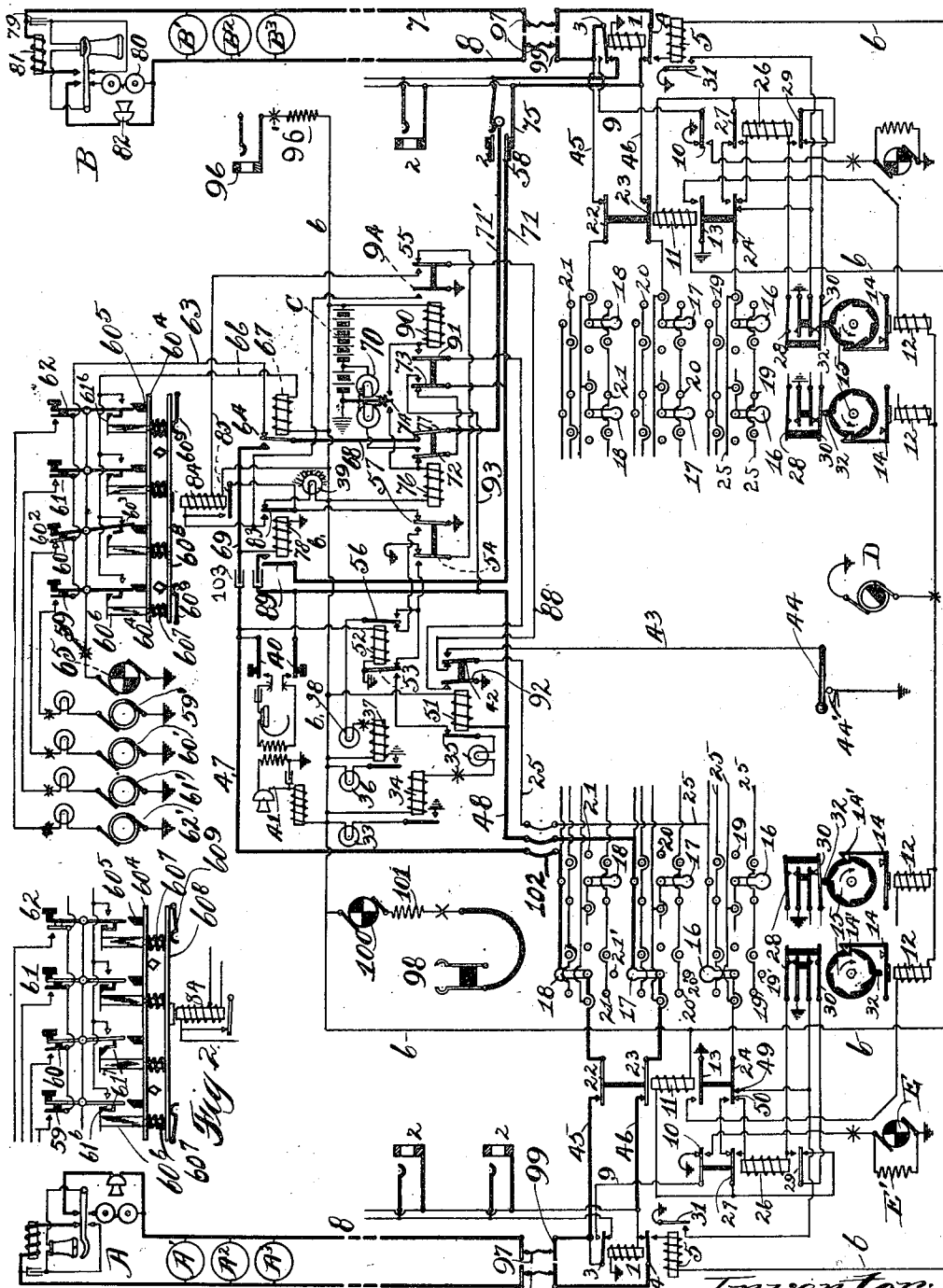
F. W. DUNBAR

1,623,337

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 9, 1905

2 Sheets-Sheet 1



Witnesses:

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Fig. 1

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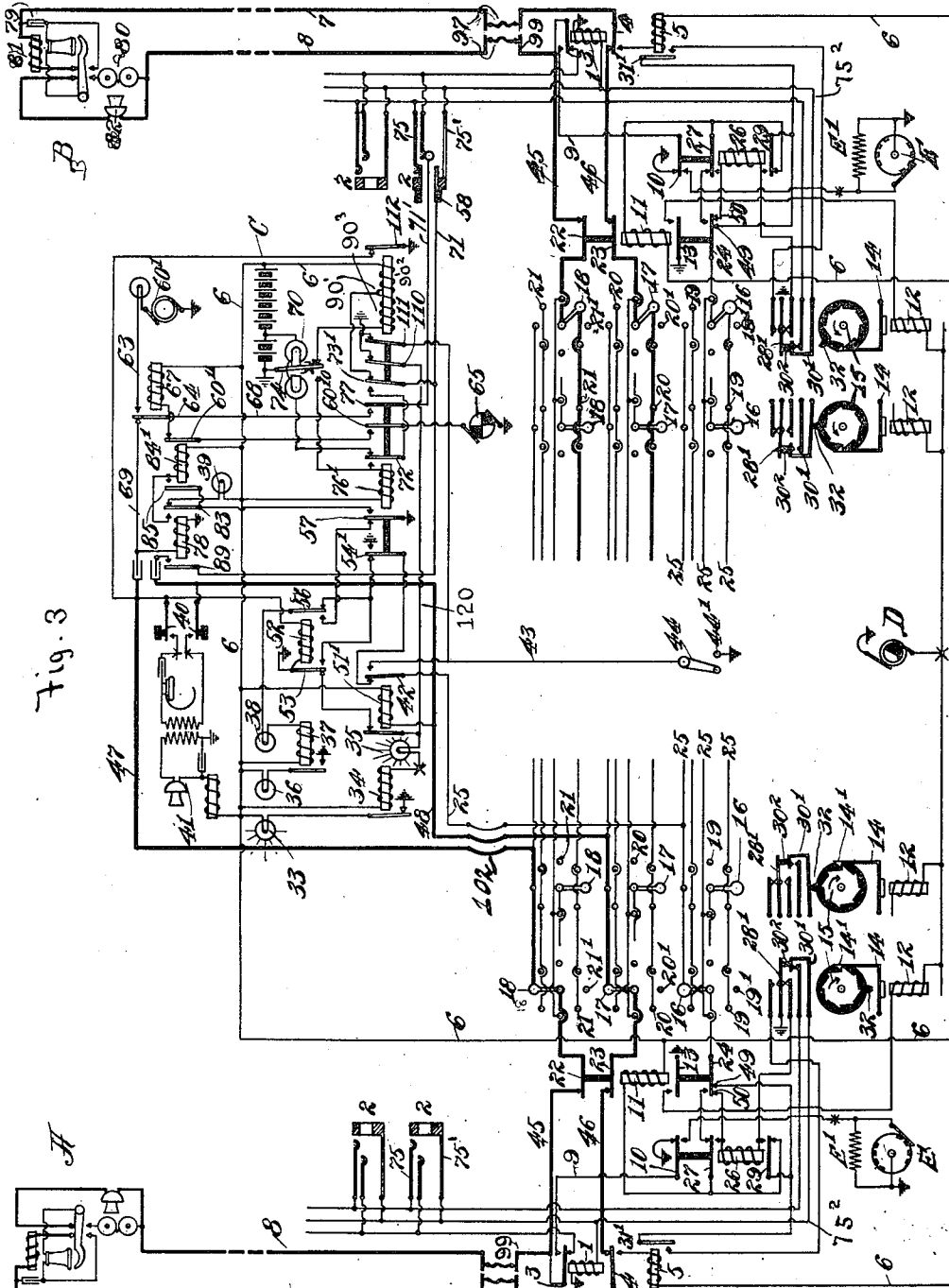


Fig. 3

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UNITED STATES PATENT OFFICE.

FRANCIS W. DUNBAR, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS,
TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

Application filed October 9, 1905. Serial No. 281,907.

My invention relates to telephone exchange systems, and has for its objects the simplification of the operator's duties and the improvement in uniformity, quickness and effectiveness of service.

Features of my invention are of particular service in connection with multiple switch-board systems, but my invention in all of its embodiments is not to be limited to such practice.

Hitherto in multiple switch-board practice, it has been customary for the operator, on receiving from the calling subscriber the number of the desired subscribers, manually to test a multiple-jack associated with the line of the called subscriber to determine whether or not the line is already busy. This test is usually made by applying the tip of the testing-plug to the ring or projecting contact of the jack, the busy indication being generally indicated by a "click" in the operator's telephone and the idle condition by the absence of such a "click". This requires that each operator shall test each line before making connection therewith, although only a small per cent. of the called-for lines are found busy. By my invention, it is no longer necessary for the operator to test the line of a called-for subscriber, but she may make connection with the jack of said line without waiting to make the busy test and without knowing whether or not the line be busy. If the line be idle, the called-for subscriber will preferably be automatically signaled and the connection automatically established without any further attention on the part of the operator. If, however, the line be busy, the calling subscriber will preferably be automatically and immediately connected to a source of characteristic disturbance instead of to the called busy line, thus preventing interference with the conversation which may be taking place upon the said busy line, and notifying the calling subscriber that the called line is busy. In the preferred form of my invention, the operator will be immediately advised if the line into which she has inserted her connecting-plug, be busy, by the immediate operation of the disconnecting-signal associated with said plug, and she may immediately withdraw it from the jack without waiting for the calling subscriber to replace his tele-

phone upon its hook. The operators thus establish all connections in the same manner without first determining the busy or idle condition of the called-for lines, and avoid the delay required by the testing of all called-for subscribers' lines. Moreover, in the preferred embodiment of my invention, the disconnecting-signal will be automatically given to the operator as soon as a plug has been inserted into a jack of a busy line, thus permitting such connection to be immediately taken down.

My invention is particularly applicable to multiple switch-boards involving the automatic distribution of the calling-signals.

In the accompanying drawings I have shown the preferred embodiment of my invention as applied to an automatic distributing system wherein the answering-ends of link-circuits are automatically connected with calling lines. Fig. 1 illustrates my preferred arrangement and includes as a distinct feature of my invention, novel means for automatically selectively signaling any one of a limited number of subscribers on a party line, and for automatically completing connection thereto from a calling subscriber's line if the line be idle. Should the called line be busy, the calling subscriber's line will be automatically released and restored to its normal condition, the disconnecting-signal will be automatically and preferably instantly given to the operator, and the calling subscriber's line will be automatically connected to a characteristic busy source of current variation.

Fig. 2 indicates an intermediate or indicating position of the party line ringing-keys illustrated in Fig. 1.

Fig. 3 illustrates another embodiment of my invention, as will be fully explained.

Like parts are indicated by corresponding characters in the figures.

As will appear, the preferred system includes apparatus for immediately disconnecting a calling subscriber's line from the answering-ends of a link-circuit connected with a busy called line, irrespective of the calling subscriber's apparatus, but I do not wish to be limited to this characteristic in all embodiments of my invention.

Referring particularly to Fig. 1, I have illustrated two subscribers' lines in process

of connection, the left hand subscriber, A, having called for the right hand subscriber, B, (in this case an idle line), and having been connected with a spring-jack belonging to the line of subscriber B. Subscriber B has not as yet removed his telephone from its hook in response to his call signal.

Each subscriber's station may be equipped with one of the customary arrangements of telephone instruments and needs no further description, and to which my invention is not limited. The circles A¹, A², A³ and the circles B¹, B², B³ represents other subscribers' stations which may be connected with the same lines as subscribers A and B, in the well known manner. Each subscriber's line is provided with cut-off relay 1, which may be permanently connected with the sleeve-rings of the multiple spring-jacks 2—2 of the corresponding subscriber's line. In the normal de-energized condition of the relay 1, its armature-switches 3—4 make contact with their normal-contacts, thus including, in circuit with the line, line-relay 5 and common battery C. When, therefore, the calling subscriber A removes his telephone from its hook, his line-relay 5 will be operated from grounded-battery C, over conductor 6, line-relay 5, line-limbs 7—8, conductor 9 and its normal-contact of armature-switch 10, to ground. The operation of relay 5 is, therefore, under the control of the subscriber during the normal condition of relay 1. Relay 5 governs the initial operation of relay 11 which controls the operation of the motor-magnet 12 through the contact of grounded armature-switch 13. Each line is provided with a motor-magnet 12, operated from the common source of pulsating or intermittent current D, and driving, by means of its spring-armature 14, driving-pawl 14¹ and toothed-wheel 15, a series of rotating-arms 16, 17 and 18, carried by the shaft of said wheel and arranged to make contact, respectively, with the series of buttons 19, 20 and 21. Each line is provided with a similar series of buttons 19, 20, 21, and with a similar set of arms 16, 17, 18, operated by their respective line motor-magnets. Each button 19, each button 20 and each button 21, represents, respectively, a connection or contact point extending to the local-conductor, the sleeve-strand and the tip-strand, respectively, of some cord-circuit, and it will be understood that all of the similarly designated or similarly arranged buttons of each of the line-switches may be connected together if there be but one group of lines in the exchange, or if the lines be divided into two or more groups, a corresponding grouping of the cord-circuits will be made and the multiple connections of the series of buttons 19, 20 and 21 will be similarly grouped. In other words, a group of telephone lines is associated with a group

of cord or link-circuits; each line being preferably adapted for connection with any cord-circuit of its said group.

One complete cord-circuit is represented in Fig. 1, and it will be understood that the conductors associated with the other buttons 19, 20 and 21, are extended to other similarly equipped cord-circuits. In their normal positions, the arms 16, 17 and 18 contact with the buttons 19¹, 20¹ and 21¹, respectively, which are disconnected from all other buttons. The left hand switch, which is that belonging to the left hand telephone line 7—8, has already selected, in response to subscriber A in calling, the first idle link-circuit—the fourth in the series in this particular case. Each arm 16 is provided with an enlarged contact-wiper capable of making contact with a button 19 before breaking contact with the immediately preceding button, or nearly so, whereby the circuit completed through the said arm 16, while the arm is rotating during selection, will not be opened a sufficient length of time to allow the de-energization of magnet 11, whose circuit is then completed through the said arm 16 and associated buttons 19, as will be set forth.

The magnet 11 by its operation, not only establishes circuit through the motor-magnet 12, by the closure of its armature-switch 13 with its contact to cause the rotation of the switch as previously set forth, but also opens all connection between the line and traveling-arms 17 and 18, by causing the armature-switches 22 and 23 to leave their contacts. In addition, magnet 11 completes a second circuit for itself through its winding, armature-switch 27 and its normal-contact, armature-switch 24 and its alternate-contact, the contact-arm 16, buttons 19 and the conductors 25, which are associated with busy cord-circuits and are, consequently, provided with ground connections, as will be explained at length later on. The magnet 26 is thrown into circuit when magnet 11 has been released to its normal position and when battery is thrown back over conductor 25 of the cord-circuit then engaged by arms 16, 17 and 18. Its operation effects a second operation of relay 11 through its armature-switch 27 and alternate-contact, the winding of said magnet 26, and either the contact of switch 28 to ground, if said switch be not in its normal position, or through alternate-contact of armature-switch 29, switch 30 and its contact, armature-switch 31 and its contact, to ground, if relay 5 be then energized and if said switch 30 be then in its normal position. The switches 28 and 30 are operated by the projection 32, carried by the wheel 15 (or by other convenient mechanism), when the said wheel reaches its normal position. In the normal position, as shown in the three right hand wheels,

switch 30 is closed to its contact and switch 28 is opened from its contact; whereas when the wheel 15 is moved from its normal position in selecting an idle link-circuit, switch 30 is opened from its contact and switch 28 closed to its contact, as shown in the left hand line-switch. It thus follows that when the release-magnet 26 has once been operated by current over conductor 25, in a manner which will later on be explained, it will lock the magnet 11 up through its own winding and either the ground on switch 28 present at all times when the switch-wheel is not in its normal position, or the ground of armature switch 31 when the wheel 15 is in its normal position and when said armature-switch 35 is attracted. The second energization of magnet 11 causes the continuous rotation of the wheel 15 until the normal position is reached, and, if the line-relay 5 be then energized, said wheel 15 and switch-arms 16, 17 and 18 carried thereby will continue to rotate during such energization; magnet 26 being maintained in its operated condition in this circuit, will cause its armature-switch 10 to make contact with its alternate-contact, thus closing circuit from the common battery C, over conductor 6, through line-relay 5, line-limbs 7 and 8, alternate contact of armature-switch 10, and through the interrupter E, bridged by the resistance coil E¹. The interrupter E causes a fluctuation of the current flowing through the calling subscriber's station apparatus and may be given any desired rate or period so as to be recognized by the subscriber as a busy indication. It is apparent that this busy indication, in the embodiment of the invention shown, will be received by the calling subscriber whenever magnet 26 is energized and as long as his telephone remains off its hook. The resistance E¹ is suitably proportioned to allow the continued energization of magnet 5 during the interruptions caused by the interrupter E and to graduate the strength of the disturbance in the line. When the calling subscriber's telephone is replaced upon its hook, the line-relay 5 will be de-energized because of the opening of its circuit at the substation and the opening of the circuit of its armature-switch 31 will allow the release of magnets 11 and 26 when the switch-wheel 15 reaches its normal positions and opens the ground contact at switch 28.

Lamp 33 and relay 34 are common to a group of cord-circuits and represent the pilot indication of the supervisory-lamp 35, individual to the particular cord or link-circuit shown. Lamp 36 and relay 37 may be common to a group of cord-circuits and represent the pilot indication of the call lamp 38, individual to the cord-circuit. Lamp 39 represents the supervisory-lamp associated with the called-for subscriber.

40 represents the customary operator's listening-in key, and 41 the operator's telephone apparatus. These parts of the circuit are so well illustrated as to need no further explanation.

Assuming now that subscriber A has removed his telephone from its hook in order to make a call for subscriber B, and has operated his line-relay 5 in the manner already described at length, it will be seen that a circuit will be established through magnet 11 to operate it over the circuit traceable from grounded battery C, conductor 6, magnet 11, normal-contact of armature-switch 29, closed contact of switch 30 and closed contact of armature-switch 31, to ground. The corresponding motor-magnet 12 is thus caused to operate from the intermittent or pulsating source of current D and causes the travel of the wheel 15 and the corresponding contact-arms 16, 17 and 18, as already fully described. The first step of the wheel 15 opens the circuit of magnet 11 through the contact of switch 30, but establishes a new path for the flow of current through said magnet 11 by the way of armature-switch 27, its normal-contact, armature-switch 24 and its alternate-contact, arm 16 and the button 19, if its associated conductor 25 be grounded. If said associated conductor 25 be associated with a busy cord or link-circuit, it will be provided with a ground at either one of several contact points in its associated link-circuit, as will be explained at length later on. It has been assumed that the first three buttons 19, over which the switch-arm 16 has rotated, were busy and that the fourth button 19 was found to be free from ground, thus representing an idle link-circuit. In the idle condition of the cord-circuit, conductor 25 is continued through armature-switch 42 of the link-circuit, and its normal contact, to conductor 43, extending to the chief operator or manager or other convenient point in the exchange room, where it remains normally open at key 44. Circuit through magnet 11 is therefore interrupted as soon as contact-arm 16 reaches button 19 unprovided with a ground connection. Relay 11 will thus permit the release of its armature-switches to their normal positions, thus closing the line-conductors 45-46, through the normal-contacts of armature-switches 22-23, through the switch-arms 18-17, to the cord-conductors 47-48 and the associated relays 52 and 51. The motor-magnet 12 will have its circuit opened at the armature-switch 13 and switch-arm 16 will be momentarily connected, through armature-switch 24 and its normal-contact 49, with the direct ground carried by the armature-switch 31, which is still attracted to close its contact. All flow of current is therefore momentarily prevented through magnet 26, switch 28 and

its ground contact—the former circuit through contact 49 forming a short-circuit of the path through contact 50 and said relay 26.

5 Suppose two or more subscribers had removed their telephones at exactly the same instant for the purpose of initiating a call; that is, so that two or more initiating subscribers' switch-wheels 15 and associated
10 arms 16, 17, 18 are in exact synchronism. Were the alternate-contact 49 of armature-switch 24 and conductor extending to the normally open contact of armature-switch 31 not provided, it will be perceived that
15 the latter unreleased one of two practically simultaneously releasing armature-switches 24 associated with two simultaneously calling subscribers' lines whose switches are thus in synchronism and which will, consequently, make simultaneous contact with
20 buttons 19 associated with the first idle cord-circuit, might cause the operation of the release-magnet 26 associated with the released armature-switches 24 by current flowing over the circuit traceable from the battery C, conductor 6, magnet 11 associated
25 with the latter armature-switch 24, armature-switch 27 and its normal-contact, said armature-switch 24 and its alternate-contact, switch-arm 16, buttons 19, its associated conductor 25, to the switch-arm 16 associated
30 with the released armature-switch 24, said armature-switch 24 and its normal-contact 50, its associated magnet 26, to ground through switch 28 associated with said released armature-switch 24. This might result
35 in the operation of the said release-magnet 26 and the consequent release of the line associated therewith and with the said released armature-switch 24, but would
40 nevertheless result in the selection by the line associated with the unreleased armature-switch 24 of the next idle cord-circuit; whereby the former line would receive the busy indication and its subscriber would
45 first replace his telephone upon its hook to allow his switch mechanism to assume its normal position before being able to again initiate his desired call, and whereby the
50 latter line would at once connect with an idle line circuit. The presence, however, of the said conductor extending from the normally closed contact 49 to the contact of the armature-switch 31, momentarily short-circuits
55 the said release-magnet 26 of the line which selects an idle cord-circuit; and at the instant when two synchronously moving switches attempt to select the same first idle link-circuit, the first of the two armature-switches 24 to be practically simultaneously released will prevent the operation
60 of its associated release-magnet and will cause the retention of the second armature-switch 24 in its attracted position, due to the ground immediately established on con-

ductor 25 of the selected link-circuit by the release of the said first armature switch 24 and thus insure the selection of the first
70 idle link-circuit by the line associated with the first released armature-switch 24 and the passage of the switch associated with the said second armature-switch 24 beyond the now selected and busy link-circuit to some subsequent idle link-circuit. In short, this
75 feature of my invention resides in means whereby one of two or more calling lines, whose selecting switches may simultaneously make contact with an idle link-circuit, is maintained in connection with a selected
80 link-circuit and the other calling line or other calling lines of this number, are caused to continue their seeking of another idle link-circuit or other idle link-circuits.

Immediately upon the closing of armature-switch 23 to its normal-contact, circuit is completed from battery C, conductor 6, supervisory-relay 51, sleeve-conductor 48, armature-switch 23, conductor 46 and cut-off relay 1, to ground, thus causing the energization of both relays 51 and 1, the
85 latter to disconnect the line-relay 5 and ground branch 9 from the subscriber's line: this opens the ground circuit through armature-switch 31 and removes the short-circuit about relay 26. The energization of relay
90 1 also causes its armature-switches to contact with their alternate-stops, thus continuing the flow of current from battery C in a circuit dividing at cut-off relay 1 and flowing over the alternate-contact of its
95 armature-switch 4, line-limbs 7 and 8, conductor 45, armature-switch 22, tip-conductor 47 and supervisory-relay 52, to ground. The operation of relays 51 and 52 places a ground connection on conductor 25 by the
100 circuit traceable from the ground of armature-switch 53 and its alternate-contact, through normally closed contact of armature-switch 54, normally closed contact of armature-switch 55, alternate-contact of
105 armature-switch 42, to conductor 25, which is now extended by way of arm 16, armature-switch 24, normal-contact 50, relay 26, to the ground of switch 28. Magnet 26 thus carries a ground on either end of its
110 circuit and can respond only when conductor 25 is connected with battery and freed from a direct ground connection. The operation of relay 52 causes the illumination of the calling-lamp 38 by current from
115 battery C flowing over conductor 6, through the said lamp 38, alternate-contact of armature-switch 56, and normal-contact of armature-switch 57, to ground. The illumination of the calling-lamp 38 (as well as its pilot-lamp 36) indicates to the operator that
120 a subscriber has selected and made a call on the corresponding cord-circuit. After determining the number of the desired subscriber in the ordinary manner, the oper-

ator inserts plug 58 into a jack 2 of the called-for line, having preferably previously completely depressed the ringing-key 60 corresponding to the party B of the desired line, assuming that the system includes a party line which is called. Keys 59, 61 and 62 represent three other similarly arranged party line ringing-keys corresponding to the other subscribers' stations B¹, B² and B³ of the party line, the number of keys corresponding to the number of selective stations on the line. 59¹, 60¹, 61¹ and 62¹ represent the ringing-generators of varying frequencies, say, 20, 40, 60 and 80 cycles per second, corresponding to and connected to the contacts of the ringing-keys 59, 60, 61 and 62, respectively. The depression of the ringing-key 60 not only connects the particular ringing-generator 60¹ through its contact 60² and conductor 63 to the normally open contact of the armature-switch 64, but also closes circuit from the common-interrupter 65, common to the entire set of ringing-keys, through contact 60³, conductor 66 and relay 67, to battery C, whereby the said magnet 67 alternately attracts and releases its armature-switch 64 at a speed determined by the interrupter 65, thus alternately engaging conductor 68 with the ringing-generator 60¹, or with the tip-strand 69 of the cord-circuit.

In order that the operator may know which subscriber of a party line she has last signaled, the actuated-key is made to furnish this indication until the connecting-plug is withdrawn from connection with the called subscriber's line. To this end, the actuated key is operated to an extreme position in order to impress the calling current upon the called line, in which position it is locked until the called subscriber responds, the called subscriber in responding causing a magnet to effect a shifting of the position of this key not to its normal position, but to a position that is neither the normal nor the extreme position, that is, to an indicating position which is preferably intermediate between the said normal and extreme positions. The key mechanism that I have preferably provided for this purpose comprises a strip 60⁴ carrying actuating-wedges 60⁵ and normally pressed against enlargements 60³ of the rods 60⁷ surrounded by coiled-springs, said rods 60⁷ being mounted upon a strip 60⁸ that is normally maintained in the position shown in Fig. 1 by the springs 60⁹. When a key corresponding to the generator and one of the party line subscribers is depressed, its lower free end rides over the corresponding wedge 60⁵, which wedge holds this key in the position to which it has been actuated. Any companion keys that were previously locked by similar wedges 60⁵ are by this operation released, for the plate 60⁴ is in this operation depressed so as to permit the wedges 60⁵ to escape any such companion key previously depressed. When, as will hereinafter be set forth, the magnet 84 is energized when the called subscriber responds (or when a busy line is plugged into), the plate 60⁴ is attracted and carries with it plate 60⁴: this movement of these plates, however, being limited by stops. Posts 60⁶ are moved downwardly by this operation of the magnet to bring the detents 61⁶ into position to engage any catch 61⁷ belonging to an actuated ringing-key, so that while an actuated ringing-key is released by the magnet, it is arrested before it is fully restored or otherwise left in an indicating position.

When a plug is removed from a jack after the conclusion of conversation or after connection has been made with a busy line, thus causing the de-energization of magnet 84 and the release of its armature-plate 60⁸, the coiled-springs will cause the restoration of plate 60⁴ also, and thus free any catch 61⁷ from engagement with its spring-detent 61⁶, thus allowing the key to resume its normal position. Should a key fail to restore to its normal position, as would occur after connection had been made with an idle line whose subscriber failed to respond to his calling signal, the operator may secure the complete restoration of the key by momentarily inserting the plug into a special jack 96 whose sleeve-conductor is connected with the battery C by the conductor 6 and common resistance-coil 96¹—thus corresponding to a busy line connection—or by awaiting the following call and depressing the key corresponding to the new called-for subscriber. The depression of any key will cause the complete release of any other previously depressed key or keys, due to the movement of plate 60⁴ and its associated wedges 60⁵ carried thereon. As the spring detents 61⁶ are not moved by bar 60⁴, the restored key cannot be retained in its indicating or intermediate position, but will be completely restored. In the device shown, the elements 61⁶—60⁶—60⁸ are fixed with respect to each other, but are movable with respect to the elements 60⁴—60⁵, which latter two elements are movable against the force of the springs 60⁷.

I have particularly described one diagrammatic representation of several forms of ringing-key outfits for accomplishing the purpose of my invention, but I do not wish to be limited thereto, nor do I wish to be limited to the intermediate position of an actuated key as its indicating positions.

If the line into which the plug 58 has been inserted be an idle line, it will be found that the conductor 68 will be connected with the tip of the plug 58. This arises from the following condition: The polarized-relay 70

being connected with the common battery C at a point, for example, that impresses one-fourth of the total potential of said battery and being normally connected with the sleeve-strand 71 by way of the normal-contact of the armature-switch 72 and normal-contact of the armature-switch 73, will have its armature-switch 74 deflected to the left upon the insertion of the plug into the spring-jack of an idle line, due to the flow of current over said path and to ground through the cutoff relay 1 of the called-for line. The closure of armature-switch 74 against its left hand contact will cause the energization of magnet 76 from the common source of current C, over conductor 6, through magnet 76 and said armature-switch 74, to the grounded terminal of said source C, thus causing said magnet 76 to attract its armature-switch 72 to make contact with its alternate-contact, thus locking said magnet 76 over a circuit extending from battery C, conductor 6, magnet 76, alternate-contact, of armature-switch 72, normal-contact of armature-switch 73, sleeve-strand 71 of the link-circuit, and cut-off relay 1 of the called-for line, to ground. The energization of magnet 76 will open the circuit of the polarized-relay 70 at the normal-contact of its armature-switch 72, thus allowing the armature-switch 74 of polarized-relay 70 to resume its normal neutral position.

Cut-off relay 1 is also energized by the current flowing through magnet 76, thus causing the attraction of its armature-switches 3 and 4 to disconnect the line-relay 5 and ground branch 9 from the line and to make contact with their alternate-contacts, thus continuing the link-strands 71 and 71¹ to the line-limbs 7 and 8, respectively, of the called-for subscriber's line. The energization of magnet 76 also causes its armature-switch 77 to close its contact and connect conductor 68 with limb 8 of the called-for telephone line. Limb 8 is alternately connected with the tip-conductor 69 (and tip-relay 78 of the cord-circuit) and with conductor 63 and the selected ringing-generator 60¹.

Condenser 79 at the station of the called subscriber's line normally interrupts the flow of current from battery C, over conductor 6, sleeve-relay 76 and limb 7 of the telephone line, but permits the flow of current from the alternating current-generator 60¹, conductors 63, 68, line-limb 8, signal-bell 80, said condenser 79, limb 7, to the ground through the cut-off relay 1, and also to the ground of the common battery C through sleeve-strand 71 and sleeve-relay 76. Both of said relays 1 and 76 being now operated by battery current from source C, will not be effected by said ringing current. The bell 80 at the called-for subscriber's station will therefore give its selective-signal (the bells at stations B¹, B² and B³ being unresponsive to the par-

ticular rate of pulsations sent from generator 60¹). Upon the response of the called-for subscriber—that is, upon his removal of the telephone from its hook—circuit from the battery C will be established over conductor 6, sleeve-relay 76, sleeve-strand 71, line-limb 7, retardation-coil 81, transmitter 82, line-limb 8, tip-strand 71¹, conductor 68, tip-conductor 69 and tip-relay 78, to ground, when the armature-switch 64 of relay 67 makes contact with its normal-contact during its period of vibration governed by the interrupter 65. This flow of current will cause the energization of the said relay 78, thus closing contact between its armature-switch 83 and its alternate-contact to complete the circuit for the flow of current from battery C, through the winding of relay 84, alternate-contact of said armature switch 83 and alternate-contact of armature-switch 85, to ground, thus causing the attraction of the armature-switch 85 to close its contact and lock the said relay 84 over the said contact of armature-switch 85 and the ground carried by armature-switch 57. Relay 84 is thus locked through the armature-switch 57 of relay 76, and cannot be again released until the release of relay 76. The energization of magnet 84 also causes the attraction of its armature-plate 60² to withdraw the wedges 60³ and allow the release of the ringing-key 60 to its intermediate position, shown in Fig. 2. In this intermediate position, the key contacts are opened, but said key is left in an intermediate or indicating position. This indication now serves to notify the operator what key had been last depressed—that is, what party of the party line had been rung. Prior to the energization of relay 78, upon the response of the called-for subscriber, supervisory-lamp 39 was lighted—as shown in Fig. 1—by the closing of armature-switch 57 to its alternate-contact, thus indicating to the operator that the called-for party had not as yet responded. Upon the response of the called-for party, the circuit for said supervisory-lamp is opened by the opening of relay armature-switch 83 from its normal-contact. The energization of relay 76 has also caused the attraction of its armature-switch 54 to maintain the ground upon conductor 25 of the cord-circuit through the alternate-contact of armature-switch 42, conductor 88, normal-contact of armature-switch 55 and alternate-contact of armature-switch 54. During conversation, this condition of the apparatus is preserved—the sleeve-strand 71 of the cord-circuit being conductively closed to alternating-currents—that is, the voice-currents—by the attraction of armature-switch 89 to its contact. Upon the restoration of the telephone to its hook at the called-for subscriber's station, the tip-relay 78 will be released and its armature-switches

restored to their normal positions, thus again causing the illumination of the supervisory-lamp 39 over its circuit previously traced. The de-energization of magnet 84 is, however, prevented by its locking circuit through its armature-switch 85, already described. The ringing-current is thus prevented from being again thrown upon the subscriber's line, owing to the continued attraction of the armature-bar 60^a and continued opening of the circuit through relay 67.

Upon the replacement of the telephone of the calling subscriber upon its hook, supervisory-lamp 35 is illuminated, owing to the de-energization of relay 52, and the operator withdraws the plug from its spring-jack, thus causing the release of relay 76 and the closing of a circuit for the flow of current from battery C, over conductor 6, call-lamp 38, normal-contact of armature-switch 56, normal-contact of armature-switch 54, normal-contact of armature-switch 55, alternate-contact of armature-switch 42, conductor 25, normal-contact 50 of armature-switch 24, release-magnet 26, to ground at the switch 28. This causes the energization of the release-magnet 26 and the release of the calling subscriber's line in the manner already set forth at length.

When the operator withdraws the connecting-plug from the jack of the called line, magnet 84 has its circuit opened, as said circuit depends upon the ground connection of armature-switch 57 of relay 76—now released; said magnet 84 thereupon releasing its armature-plate 60^a, thereby permitting the catch 61^a to be disengaged from the detent 61^b as previously explained, whereby said key is restored to its normal idle position.

If the connecting-plug 58 had been inserted within the line-jack of a busy line, the greater section of the battery C would have been included in a circuit with the relay 70, which may be traced from the active terminal of said source C, over conductor 6, through relay 76 of the link first associated with the busy line, its armature-switch 72 and alternate-contact, armature-switch 73 and its normal-contact, link-strand 71, to sleeve-ring 75 of the busy line, thence to strand 71 of the link-circuit last connected to the busy line, armature-switch 73 and its normal-contact, armature-switch 72 and its normal-contact, through said polarized-relay 70 to said battery C, whereby current is directed through said relay 70 in such direction as to cause the armature-switch 74 to swing to the right, whereby the relay 90 is included in a circuit that may be traced from the armature-switch 74, through the winding of said relay, the battery C, back to the armature-switch. The relay 90 attracts its armature-switch 91, which is moved against a

contact that is in connection with the winding of the relay 90, thereby establishing a second circuit through said relay which may be traced from the grounded battery C, through said relay 90, through its armature-switch 91, the previously attracted armature-switch 92 and its contact, to ground; circuit through relay 90 is therefore maintained closed as long as the armature-switch 92 of relay 51 is attracted and the relay 51 is maintained in circuit to maintain attracted the armature-switch 92 as long as the plug 58 is within its jack, for, when the relay 90 is energized, a second circuit for the relay 51 is established, which circuit may be traced from the grounded-battery C, through the winding of relay 51, conductor 93, to the alternate-contact of armature-switch 73, thence by way of the sleeve-strand 71, to ground at the cut-off relay 1 of the called subscriber. The armature-switch 73 is thus maintained away from its normal-contact as long as plug 58 is inserted, so that the polarized-relay 70 is now included in open circuit. The relay 70 cannot therefore be re-operated until after the connecting-plug is withdrawn and again inserted and is independent of the withdrawal of any other plug from a jack of the busy line. The relay 90, by closing its armature-switch 55 upon its alternate-contact, effects the disconnection of the answering-end of the link from the calling subscriber's line (which, in the embodiment of the invention shown, is accomplished by rotating the traveling line-terminals of the calling line). This result is accomplished by the establishment of a circuit that may be traced from the grounded-battery C, conductor 6, to a portion of the relay 84 which includes, say, a fifth of the resistance of this relay (the relay measuring, for example, five hundred ohms or thereabouts), the alternate-contact of switch 55, the conductor 88, the alternate-contact of armature-switch 42, the conductor 25, the selector switch-arm 16, the armature-switch 24 and its normal-contact 50, the releasing or restoring-magnet 26, the switch 28 and its grounded-contact now engaging the same: the operation of the releasing apparatus and the circuits governing the same now occur as has hitherto been explained, and the calling subscriber will receive the busy indication and his selecting-motor will continue its operation until he replaces his telephone upon its hook, as has also been hitherto explained at length.

When the calling subscriber restores his telephone, circuit through magnet 5 is open at his telephone switch-hook, whereby the armature-switch 31 is removed from connection with the contact of switch 30, so that when the selecting-switch again reaches its normal position, it stops. The calling sub-

scriber should in response to the busy indication, restore his telephone, but should he fail to do so, the continued operation of his selecting-switch will in no way interfere with the correct operation of the other lines. While in the embodiment of the invention shown in Fig. 1 the operation of the traveling-switch for connecting the calling subscriber with a link-circuit does not cease until said subscriber restores his telephone, I do not wish to be limited to a system wherein this particular control is secured.

It will be seen that the circuit through the fifth of the winding of relay 84 is only momentarily closed, and, in order that said relay may be maintained in operation to shift and hold the actuated ringing-key to an indicating position, circuit through the entire winding of the relay is established from the grounded-battery C through said winding, to grounded armature-switch 94 and its contact, now closed. The armature-switch 85 is thereupon attracted to close circuit through the called subscriber's supervisory-lamp 39, which circuit may be traced from the grounded-battery C through the lamp 39, the released armature-switch 83, the attracted armature-switch 85, to the grounded armature-switch 94 and its contact. Supervisory-lamp 39 will therefore be lighted.

As will be understood from the previous description, the armature-switch 74 of polarized-relay 70 moves only to the left when the called subscriber's line is free and only to the right when the called subscriber's line is busy, and the armature-switch 83 therefore remains unattracted when the called line is busy, for the energization of the relay 78 carrying the said armature-switch 83 depends upon the connection of conductor 69 with the tip-strand 71¹, which can only be secured by the operation of relay 76 and the closing of its armature-switch 77 against its contact, which, in turn, can only be secured by the movement of armature-switch 74 to the left, which only occurs when the called line is idle.

Similarly, the establishment of the circuit for extending the ringing current to the subscriber's line depends upon the engagement of the said armature-switch 77 with its contact. By maintaining the said switch 77 out of engagement with its contact, excepting during the connection of its associated link-circuit with an idle line, the ringing current cannot find access to the line of a busy subscriber, nor can any other interference, as, for instance, conversation, be had with a busy line. The calling subscriber being immediately disconnected from the link-circuit, interference is further prevented with a busy line. The disconnection of the calling subscriber's line from the answering-end of the link-circuit also causes

the supervisory or disconnecting-signal 35 to flow and give its signal, due to the closing of its circuit by the release of the armature-switch 53 against its normal-contact,—the tip-relay 52, controlling said armature-switch 53, now having its circuit opened at rotating-arm 18 by the release of the said calling line. Moreover, the attracted armature-switches 22, 23 of relay 11 prevent any subsequent momentary closing of circuit through said relay 52 at times when, during the rotation of said arm 18 (which continues until the subscriber "hangs up"), it makes contact with conductor 47 of the link-circuit. Circuit through relay 51 is, however, maintained, as previously described, from grounded-battery C to the ground terminal of cut-off relay 1 of the busy subscriber's line, via conductor 93, alternate-contact of armature-switch 73 and sleeve-strand 71.

Both supervisory lamps 35 and 39 are therefore caused to light as soon as a plug has been inserted into a busy line and the operator will immediately disconnect the plug from the jack, thus restoring all apparatus to its normal condition—relay 51 being released by the opening of its circuit through conductor 93 and the cut-off relay of the busy line, and causing, by the release of its armature-switch 92, the opening of the circuit of relay 90, which, in turn, opens the circuit of relay 84 by the release of its armature-switch 94. The release of magnet 84 causes the complete restoration of the ringing-key to its normal position, as heretofore pointed out.

A further purpose of the connection from the magnet 84 to the alternate-contact of switch 55, is to furnish a ground upon the conductor 25 by way of said switch 55, conductor 88 and the alternate-contact of switch 42, that will cause the link-circuit whose connecting-plug is inserted in a jack of a busy line, to correspond to a busy link-circuit even though the answering-end thereof is disconnected from the calling subscriber's line,—such busy condition of the link-circuit being thus maintained during the time the connecting-plug is in connection with the busy called line. This ground is traceable from the ground at switch 94 to the contact engaging the same, four-fifths or other fraction of the winding of magnet 84, to the alternate-contact of armature-switch 55, thence to the alternate-contact of armature-switch 42. It will thus appear that conductor 25 of a busy link-circuit will always be provided with a ground connection at some point, said point being at one time at armature-switch 53, at another time at armature-switch 54, and at another time at armature-switch 94, thereby causing the rotation of the arms 16, 17 and 18 past such busy link-circuits while calling lines are selecting idle link-circuits.

Switches 44 are provided to enable the chief-operator or other exchange manager whose duty it is to apportion the work of the various operators, to cause any of the link-circuits to correspond to busy link-circuits so that they will not be connected with calling lines, there being desirably one such switch 44 for each link-circuit. The contact 44¹ when the switch 44 is thrown, provides a ground connection to conductor 25 via normal-contact of armature-switch 42, provided the link-circuit be then idle, so that a traveling-terminal of the calling subscriber's selecting-motor upon connection with the button 19 in connection with conductor 25, will pass said button as if said link-circuit were already in service.

In case a line is crossed by outside trouble, or in case the receiver at the substation thereof is improperly off its hook, thus in either case causing the line to initiate a call and select an idle link-circuit, I provide means whereby such a line may be disconnected from the selected link-circuit, said means including a special jack 96 into which the operator may momentarily insert the connecting-plug 58 of the selected link-circuit, after finding she can get no response from the apparently calling subscriber. This jack 96 (of which a number may be provided) is provided with a battery connection to its sleeve-contact as previously described, thereby causing the release of the improperly calling subscriber's line and the continued rotation of its motor-switch. Other line troubles, such as low resistance ground connections to the line-limbs such as would occur were a cable water-soaked by some accident, would cause the continuous rotation of the motor switches associated with the affected lines without the intervention of the operator, due to the failure of the tip-relay 52 of a selected link-circuit to become energized, owing to the presence of the practical short-circuit to ground from the line-limbs, whereby the release-magnet 26 would be immediately operated by current over conductor 25 in the manner previously set forth at length, thus causing the continued operation of the motor-switch. Troubles of the above nature, therefore, indicate themselves by the continuous rotation of the motor-switches of the affected lines. The attendant may then remove the fuses 97 of each such affected line; thus causing the corresponding motor-switch to stop on reaching its normal position, owing to the opening of the circuit of its associated line-relay 5 at fuse 97, whereby armature-switch 31 is released and the circuit of magnets 11 and 26 opened when the switch reaches its normal position. Moreover, the attendant may then insert test-plug 98 so as to contact with spring 99 and thus connect the tip side of the line-circuit to a source of intermittent current—

such as the battery C via interrupter 100 and suitable resistance 101—whereby when connection is made to such line "in trouble" by the insertion of a plug 58 into a jack of said line, current from said intermittent source is sent over the tip-conductor of said jack to and through the relay 78 of the link-circuit causing it to intermittently respond and "wink" the supervisory-lamp 39 to indicate to the operator that the line is in trouble. The calling subscriber will likewise hear the characteristic intermittent current thus thrown on his line circuit through condenser 103 and will understand (even if not so informed by the operator) that the desired line is "in trouble".

It is apparent that should subscriber A have called for either of the subscribers A¹, A² or A³ associated with his own line, and neglected to so inform the operator then as the desired subscriber's line would be busy, the operator, on making the desired connection, would merely release the calling subscriber and pull down the connection in response to her disconnecting signal. My invention contemplates, therefore, the inclusion of a list of the other subscribers common to a particular line posted on each of the subscribers' instruments of that line, with instruction to the subscriber to call "My line No.——" in making calls for these particular telephones. Thus, subscriber A would be instructed "to call lines A¹, A² and A³ only call 'My line A¹', 'My line A²', or 'My line A³'." The operator would then, on receiving such a special call, instruct the calling subscriber A to hang up his receiver, thus causing the release of his line from the link-circuit, for relays 76 and 90 being then in their normal positions, the release of relay 52, by the opening of the line circuit at the substation would cause a flow of current over the release-wire 25 and magnet 26 from battery C and through lamp 38 in the manner already described at length. The operator is advised of the obedience to her instruction by the extinction of the call-lamp 38 and immediately inserts a plug 58 associated with one of her reserve link-circuits which the manager or chief-operator has made artificially busy by closing the contact of the switch 44, into a jack of the called line, having first set the proper ringing key to select the desired party—say, A¹. The line being now idle, the desired party will be called and, upon his response, the operator may manually momentarily depress the key corresponding to the calling subscriber thus giving him a short ring to notify him that his party has responded. It will be apparent from Figure 2 that the second key thus depressed will not lock itself in the ringing position but will return to the indicating position as soon as the operator removes

her finger from it, because magnet 84 is now energized and locked over relay armature-spring 57 as already described. The operator leaves the plug inserted until the conclusion of conversation—the supervisory lamp 39 then serving as a special disconnecting signal. The presence of the plug in the jack prevents the operation of the calling-relay 5 and motor-switch of the line in the same manner as described in connection with a regular called line. It is also apparent that the presence of the ground connection of switch 44 prevents the selection of the said reserve link-circuit by any other subscriber. 102 represents a section of a distributing board by means of which the various cord-circuits may be distributed to the different operator's positions.

It will be apparent that by means of the said distributing board and keys 44, the manager may secure a distribution of the link-circuits so that all calls will be concentrated toward one end of the switch-board, additional operators being placed in service in regular progression from right to left, or vice versa, as the business increases from hour to hour, and so that each operator on duty may receive as many calls as she is capable of efficiently attending to and no more. Thus, each position may be provided with fifteen link-circuits, but one or several may be normally made impotent to receive calls by means of their associated keys 44, whereby each operator may be assigned that number which she is capable of efficiently handling. It will also be apparent that as a large number of lines may be associated with a particular group of cords—say, one thousand lines for a group of eighty cords (thus requiring eighty-one points or buttons 19, 20 and 21 in each rotating switch) and as the several groups of cords may be so distributed as to give each group of lines equal access to each operator, it necessarily follows that the disconnection of any particular link-circuit, save one of those at the extreme end of the then busy operators' positions, will be immediately followed by its selection by another line for a new call. The operator need not restore the plug to its seat after withdrawing it from a jack, but may throw over her listening-in key to inquire the new number wanted, knowing a succeeding call will immediately occur on the disconnected link. Not having to test the called-for lines, the operator's duties are limited to the withdrawal of a plug upon receiving the disconnecting signal, and reinserting it into the jack of the next desired line, setting her selective ringing-key either previous to or subsequent to the insertion of the plug. It will be obvious that although I have described the preferable practice of setting the ringing-key prior to

the insertion of the plug in a jack, yet my invention contemplates also the setting of the key subsequent to this operation as an alternative. The operation of the apparatus is the same in either case, save where the plug is inserted into the jack of a busy line. In this case, as the magnet 84 is immediately operated, the ringing-key (should the operator attempt to depress it after inserting the plug instead of withdrawing the plug in response to her disconnecting signal) would not remain in its completely depressed position, but would assume the position shown in Figure 2, and would be restored as usual upon the withdrawal of the plug. In either method of operation, the released armature-switch 77 prevents any interference with the busy line, as already described at length. It will be apparent that where party lines are not employed, certain simplifications will result as the selective ringing-keys are not then required. My invention contemplates such simplifications and other modifications which will be apparent to those skilled in the art.

Figure 3 illustrates a system having many features in common with the system illustrated in Figure 1; and the parts of the system shown in Fig. 3 possessing functions similar to functions possessed by parts in the system of Figure 1, are given similar characters of reference. Certain characteristics of the system shown in Figure 3 are not disclosed in the system of Figure 1 and will now be set forth.

Fig. 1 illustrates the adaptation of my invention to the so-called two-wire system in which the spring-jacks have but two contact pieces and in which the link-circuit plugs have also but two contact pieces adapted to engage with the corresponding contact pieces of the jacks. In the system of Figure 3, however, the spring-jacks are provided with three contact pieces, although the plugs of the link-circuits are provided with but two contact pieces, one of them, the contact piece associated with the sleeve-strand 71, being adapted to cross two of the contact pieces of the jack into which it may be inserted. The cut-off relay 1 of each subscriber's line, instead of being connected directly to conductor 46 and to the sleeve-conductor 75 of each of the jacks, is normally disconnected therefrom but connected to a third contact piece 75' of each of the spring-jacks, and to a conductor 75" extending to a normally open contact switch 30' associated with the subscriber's motor-switch. During the use of the line, however, the said cut-off relay 1 is connected with one side of the talking circuit in either one of two ways. Whenever a plug is inserted into a jack, the sleeve-contact of said plug crosses contact pieces 75 and 75' of the jack, thus connect-

ing cut-off relay 1 with the sleeve-conductor of the line. Similarly, whenever a subscriber removes his telephone from its hook for the purpose of initiating a call and thus causes the operation of his motor-switch, its first step will cause its associated switch 30¹ to close its contact, thereby connecting cut-off relay 1 with the sleeve-side 46 of the subscriber's circuit and maintaining such connection until the motor-switch again resumes its normal position. The operation of the apparatus directly associated with each subscriber's line is the same in other particulars as that indicated in Figure 1, with the exception of a re-arrangement of the contacts associated with the switch 28¹, controlled by the subscriber's motor-switch; the modification merely consisting in transferring the ground connection of armature-switch 31 of Figure 1 to the switch lever 28¹ of Figure 2. This change in circuit arrangement involves no difference in the method of operation over that explained with reference to Figure 1, and requires no further explanation.

The arrangement of the link-circuits differs, however, from that shown in Fig. 1 in certain respects, which will now be described. In Figure 1, it was assumed that party line subscribers' circuits were employed; whereas in Figure 3 it is assumed that individual subscribers' lines only are employed, or that all subscribers associated with any particular line will be signaled when any subscriber's bell is rung. In the system of Figure 3, it therefore becomes unnecessary to employ selective party line ringing-keys, or, in fact, any ringing-key manually operated by the operator; the insertion of a plug into a jack of an idle line in itself automatically connecting the ringing-generator with the subscriber's line. To this end, an additional armature-spring 60¹⁰ is provided for relay 76¹ (corresponding to relay 76 of Figure 1) which will be closed to its contact when relay 76¹ is energized by the insertion of the plug 58 into an idle line, thus closing the circuit of interrupter 65 through the said contact of armature-spring 60¹⁰, through the normally closed contact of armature-spring 60¹¹, carried by relay 84¹ (corresponding to relay 84 of Figure 1) and through relay 67 to conductor 6 and battery C. Relay 67 is therefore caused to alternately attract and release its armature-switch 64 whenever a plug is inserted into an idle line, just as the corresponding relay 67 of Figure 1 was caused to alternately attract and release its armature-switch 64 as soon as a ringing-key was depressed either before or after the insertion of a plug into its jack. In Figure 3, the ringing-generator 60¹ is directly connected to conductor 63; whereas, in Figure 1, on account of a plurality of ringing-genera-

tors, said generator-circuit is closed to conductor 63 by a selecting-key. In other respects, the automatic ringing features of Figure 3 are similar to those already explained at length with respect to Figure 1, it being apparent that the energization of relay 84¹ of Figure 3, which is effected at the same time and by the same means as the energization of relay 84 of Figure 1, will cause the opening of the circuit through relay 67 at armature-switch 60¹¹ in Figure 3; just as in Figure 1, the circuit of the said magnet 67 will be correspondingly opened at the contact 60³ in the selective signaling-key.

A second difference in the circuit arrangement of the link-circuit illustrated in Figure 3, over that illustrated in Figure 1, consists in means for locking the relay 90¹ of Figure 3 (corresponding to relay 90 of Figure 1) over the sleeve strand 71 and cut-off relay 1 of the busy line into which a plug has been inserted, instead of locking the relay 51 over the corresponding circuit including the said cut-off relay 1 as shown in the system of Figure 1. To this end, relay 90¹ is preferably provided with a connection to an intermediate point of its winding whereby its initial energization, which is controlled by the movement of armature-switch 74 of the polarized-relay 70 to the right, is secured through both sections 90² and 90³ of said windings, and whereby the said relay 90¹, upon the attraction of its armature-spring 73¹, will lock itself through winding 90², alternate-contact of armature-switch 73¹, sleeve-strand 71 and cut-off relay 1 of the busy line.

It is to be understood that the condition of the apparatus, shown in Figure 3, is a transitory position, illustrates the connection of a calling subscriber A with a busy subscriber B, and that the polarized-relay 70, which has been momentarily attracted to close its armature-switch 74 with its right hand contact, has not as yet been retracted to its normal position, although the circuit through said magnet 70 has been already opened at the normal-contact of armature-switch 73¹. Similarly, it is to be understood in the said Figure 3 that although the releasing-current is now being sent through the release-magnet 26 of the calling subscriber's line to cause its energization and operation, yet the attraction of its armature-springs has not as yet taken place. The energization of relay 90¹, over the circuit already traced, caused the attraction of armature-spring 112 to close its contact and to place a direct ground connection on the tip-conductor 47 of the link-circuit, thus short-circuiting tip-relay 52 and causing the release of its armature-springs; whereby the releasing current is sent from common bat-

tery C over conductor 6, through lamp 38, armature-switch 56 and its normal-contact, armature-switch 54¹ and its normal-contact, armature-switch 42 and its alternate-contact, conductor 25, switch-arm 16, releasing magnet 26, and to the ground at switch 28¹, thus causing the release of the calling subscriber's line in the manner already set forth at length in connection with the system of Figure 1. The disconnection of sleeve-conductor 48 from the calling line at rotating switch-arm 17 will open the circuit of sleeve-relay 51¹ in the system of Figure 3, thus causing the release of its armature-springs; whereas, in the system of Figure 1, the corresponding relay 51 was maintained in an energized condition over the line and cutoff relay of the busy called-for subscriber's line. In the system of Figure 3 the illumination of the supervisory-lamp 35, now acting as a disconnecting signal, is secured by the closing of a circuit through said lamp from battery C, over conductor 120 and alternate-contact of armature-switch 110, to ground. The operator thus immediately secures the disconnecting signal by the illumination of the supervisory-lamp 35 associated with the calling subscriber's line (and by the supplemental illumination of the pilot disconnecting lamp 33), entirely independent of the condition of the supervisory lamp 39 associated with the called subscriber. The operator will therefore disconnect the link-circuit in response to the indication given by lamp 35. Prior to so doing, however, and as already pointed out, it is preferable to maintain the link-circuit now disconnected from the calling subscriber but still connected with a jack, in a "busy" condition. To this end, as soon as relay 51¹ has released its armature-switch 42 to make contact with its normal-contact, a ground connection is placed upon conductor 25 of said link-circuit by the armature-switch 111 and its alternate-contact, controlled by relay 90¹.

In other particulars, the arrangement of the link-circuit of Figure 3 is similar to that shown in Figure 1; and the operations of the relays 76¹, 84¹ and 78, when a plug is inserted into an idle line, are similar to the operations of the corresponding relays 76, 84 and 78 of Figure 1.

In the said system of Figure 3, it has been assumed that the line, into which the connecting plug 58 has been inserted, was a busy line. The heavy lines associated with said right hand subscriber's line in this case, indicate that the line was busy because its subscriber had initiated a call, (said subscriber having found the first link-circuit idle and having made connection thereto, as indicated by the position of the switch-arms 13, 17 and 18 associated with said right hand subscriber); whereas, in the description

given of a busy line in connection with Figure 1, it was assumed that a plug had previously been connected with the said busy line. It will be apparent that, in either case, the busy condition of the line is determined by the existence of a connection to the active terminal of the battery C (in one case through relay 76 and in the other through relay 51¹), rather than by any change of electrical condition of the line or local conductors associated therewith.

While I have shown two embodiments of my invention, it is obvious that the invention and various features thereof may be embodied in other telephone exchange equipments.

While selecting-switches are employed in the two embodiments of the invention shown for connecting the answering-ends of link-circuits with calling lines, there are features of my invention that need not be limited in their application to systems of the class illustrated. One of the features, for example, whose use need not be limited to systems of the class illustrated is the provision of means whereby a clearing-out signal may be conveyed to the operator when she makes connection with the multiple-jack of a busy line, so that she may immediately withdraw the plug without waiting for further signals. This is accomplished by the illumination of supervisory-lamp 35 in both systems. As described in connection with Fig. 1, both lamps 35—39 may light. As described in connection with Fig. 3, the clearing-out lamp 35 only lights. In exchange practice each clearing-out indicator is always subject to operation by the calling subscriber's switch-hook. It is now customary to provide another supervisory signal associated with the called subscriber's line, which will indicate prior to the called subscriber's response and which will therefore also indicate when he replaces his telephone upon its hook. The latter signal is not a clearing-out signal.

Another feature of my invention that is not limited to either of the exchange systems illustrated, resides in the automatic control of the association of the ringing-generator with a called line.

While the invention has been shown in connection with metallic circuit multiple switch-board systems, the invention need not be limited to metallic circuits nor to multiple switch-board systems, in all embodiments thereof.

I have shown two embodiments of the invention to illustrate the wide application thereof, but as other applications of the invention and various features thereof will be readily understood by those skilled in the art, I do not deem illustrations of other embodiments of the invention to be essential to an understanding thereof.

The busy indication placed upon the calling subscriber's line is obviously not limited to systems employing the apparatus for connecting lines in conversation, that is illustrated.

It will be seen that my improved clearing-out and busy indicating system as I preferably embody the same, does not require the addition of any strands to the link-conductors employed for the propagation of the voice-currents, the circuits of the clearing-out signaling-appliances and busy indicating appliances being determined over talking-strands of the link-circuits.

It will be also seen that the clearing-out feature of my invention need not be limited in its use to multiple switch-boards. For example, in the system shown it will be useful even though each line were provided with but one jack in addition to the automatic selecting-switch, for this feature of my invention would be operative if a plug were inserted into the jack of a called line that had been previously connected with the answering-end of some other link-circuit, whether or not the connecting-end of said other link-circuit were in service.

By a line already busy, as the expression is herein used, is meant a line with which the answering-end of a link-circuit is connected, or a line into a jack of which a connecting plug has been inserted.

It is obvious that changes may be made in the system of my invention as shown without departing from the spirit thereof, and I do not, therefore, wish to be limited to the same, but, having thus described my invention, I claim as new and desire to secure by Letters-Patent:

1. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, and means associated with said source of current for causing the operation of the clearing-out signaling appliances upon the connection of said manually operated terminals with said jacks only when the jack connected to is that of an already busy line.

2. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, and means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances

each including a signal-operating device associated with the answering-end of the corresponding link-circuit.

3. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, and means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliances associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, said signaling-appliances being controllable by the apparatus of the calling telephone line when the associate link-circuit is connected with said calling telephone line and prior to the connection of said link-circuit with the called telephone line already busy.

4. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, and means associated with said source of current for causing the operation of the clearing-out signaling appliances upon the connection of said manually operated terminals with said jacks only when the jack connected to is that of an already busy line.

5. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, and means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit.

6. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end

- of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuits, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, and mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism.
7. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, and mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism.
8. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, said signal-appliances being controllable by the apparatus of the calling telephone line when the associate link-circuit is connected with said calling telephone line and prior to the connection of said link-circuit with the called telephone line already busy, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, and mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism.
9. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, and mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism.
10. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, and mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism.
11. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of cur-

rent, means associated with said source of current operating when the connecting-end of a link circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

12. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

13. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connection-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, said signaling-appliances being controllable by the apparatus of the calling telephone line when the associate link-circuit is connected with said calling telephone line and prior to the connection of said link-circuit with the called telephone line already busy, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

14. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances

whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

15. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

16. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

17. A telephone exchange system including telephone lines extending to an exchange

and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with a line already busy.

18. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances in association with the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, said signaling-appliances being controllable by the apparatus of the calling telephone line when the associate link-circuit is connected with said calling telephone line and prior to the connection of said link-circuit with the called telephone line already busy, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling

line that has been connected with a line already busy.

19. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting-end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

20. A telephone exchange system including telephone lines extending to an exchange and there provided with jacks, link-circuits at the exchange provided with manually operated terminals for connection with said jacks, clearing-out signaling-appliances whose circuits are determined by talking-strands of the link-circuits, a source of current, means associated with said source of current operating when the connecting end of a link-circuit is connected with a line already busy for causing the operation of the clearing-out signaling-appliance associated with said link-circuit, said signaling-appliances each including a signal-operating device associated with the answering-end of the corresponding link-circuit, automatically operated selecting-mechanism for connecting the answering-ends of the link-circuits with calling telephone lines, automatically operated mechanism for effecting the disconnection between calling telephone lines and the answering-ends of the link-circuits, mechanism associated with said link-circuits operated after association with busy lines to effect the actuation of the disconnecting mechanism, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with the line already busy.

21. A telephone exchange system includ-

ing telephone lines extending to an exchange and provided with jacks, link-circuits provided with manually operated terminals for making connection with the jacks, automatically operating selecting mechanism for connecting the answering-ends of link-circuits with calling lines, automatically operating releasing mechanism for effecting disconnection between the answering-ends of link-circuits and calling lines, a source of current, and means associated with said source of current operating after the connecting end of a link-circuit is connected with a line already busy for causing the operation of the said releasing-mechanism associated with said link-circuit.

22. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits provided with manually operated terminals for making connection with the jacks, automatically operating selecting mechanism for connecting the answering-ends of link-circuits with calling lines, automatically operating releasing mechanism for effecting disconnection between the answering-ends of link-circuits and calling lines, a source of current, means associated with said source of current operating after the connecting end of a link-circuit is connected with a line already busy for causing the operation of the said releasing-mechanism associated with said link-circuit, means for producing characteristic disturbance, and switching mechanism operating to effect the application of said characteristic disturbance upon a calling line that has been connected with a line already busy.

23. A telephone exchange system including telephone lines extending to an exchange and provided with jacks, link-circuits provided with manually operated terminals for making connection with the jacks, automatically operating selecting mechanism for connecting the answering-ends of link-circuits with calling lines, automatically operating releasing mechanism for effecting disconnection between the answering-ends of link-circuits and calling lines, means for producing characteristic disturbance, and means associated with the link-circuits operating after the link-circuits have been connected with called lines already busy, for effecting the application of said means for producing characteristic disturbance upon calling telephone lines.

24. A telephone exchange system including telephone lines extending to an exchange and provided with two-contact jacks, link-circuits at the exchange provided with two-contact manually operated terminals for connecting with said jacks, automatic means for connecting calling ones of said lines with idle ones of said link circuits, a source of signaling current, a switching appliance

associated with said source of current operating, when the connecting end of a link-circuit is connected with an idle called line, to connect said source with said line to signal the substation thereof, and means for automatically extending a busy signal to a calling line that has been connected with a called line already busy.

25. A telephone system including a telephone line, terminal contacts therefor at the exchange including talking contacts for extending the conversational circuits of said line, a connection terminal having a contact adapted to engage one of said talking contacts, and electromagnetic means initially controlled over a circuit including said one of said talking contacts and said contact of said connection terminal to automatically connect a source of signaling current with said connection terminal.

26. A telephone system including a calling line and a called line, terminal contacts for said called line at the exchange including talking contacts for extending the conversational circuit of said line, a link-circuit temporarily connected with the calling line, a connection terminal therefor having a contact for engagement with one of said talking contacts, mechanism adapted for connection with the calling line to transmit a busy signal thereover, means for automatically connecting calling current to the called line and a circuit automatically controlling the transmission of said signal before the operation of said means if said called line is busy including said one of said talking contacts and said contact of said connection terminal.

27. A telephone system including a calling line and a called line, terminal contacts for each of said lines at the exchange including talking contacts, a link-circuit at the exchange for connecting talking contacts of each of said lines to form a conversational circuit between said lines, a source of calling current adapted for connection with the called line, mechanism adapted for connection with the calling line to transmit a busy signal thereover, and apparatus sensitive to the idle or busy condition of the called line controlled over a circuit including a portion of said link-circuit and said one of said talking contacts for automatically completing connection of said source or of said mechanism according to the idle or busy condition of the called line.

28. A telephone system including telephone lines, terminals for said lines at the exchange, a link-circuit for establishing connections between the terminals of calling and called lines, mechanism adapted to be operated to connect calling current to the called line if idle, and means for automatically transmitting a busy signal to a calling subscriber controlled over a circuit including a talking contact of a terminal of the

called line and means to prevent application of calling current to the called line if busy.

29. A telephone system including telephone lines, terminals for said lines at the exchange, a link-circuit for establishing connections with called lines, automatic means for connecting calling lines with said link circuit, a source of signalling current adapted for connection with a called line, and mechanism for automatically connecting said source in circuit with the called line controlled over a circuit including a talking contact of a terminal of said line.

30. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, supervisory signals associated with the calling and answering ends of said link-circuits, and means operative upon the extension of said circuit to a busy called line to display both of said supervisory signals.

31. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator's plug and jack connecting means for connecting a selected link-circuit to a called line, supervisory signals associated with the calling and answering ends of said link-circuits, and means operative upon the establishment of the plug and jack connection with a busy called line to display both of said supervisory signals.

32. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, automatic switch mechanism responsive to certain electrical conditions on said line to establish connection between said line and an idle link-circuit, and means under the control of an operator for displaying a signal to indicate the existence of the said actuating electrical conditions on the line.

33. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, automatic switch mechanism responsive to certain electrical conditions on said line to establish connection between said line and an idle link-circuit, other telephone lines, operator's means for extending the circuit of a selected link-circuit to a called line, and means under the control of the operator for displaying a signal to indicate the continued existence of the said actuating electrical conditions on the line.

34. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, automatic switch mechanism

responsive to certain electrical conditions on said line to establish connection between said line and an idle link-circuit, operator's means for answering a call, and means under the control of the operator for displaying a signal in the event of a false call.

35. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually operative in response to certain electrical conditions on a calling line to establish connection between that line and an idle link-circuit, and means under the control of an operator to indicate the existence of the actuating conditions on said calling line and to free the connected link-circuit so that it may be selected by other switch mechanisms.

36. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually operative in response to certain electrical conditions on a calling line to establish connection between that line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means under the control of the operator to indicate the existence of the continued actuating conditions on said calling line and to free the connected link-circuit so that it may be selected by other switch mechanism.

37. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually responsive to certain electrical conditions on a calling line to establish connection between that line and an idle link-circuit, operator's means for answering a call, and means under the control of the operator for displaying a signal in the event of a false call and for freeing the connected link-circuit so that it may be selected by other switch mechanisms.

38. In combination with an operator's link-circuit, a source of ringing current, a relay magnet individual to said link-circuit for periodically applying said source to a terminal of said circuit, means for causing such periodical operation of said relay, a second relay also controlling the circuit from said source to said terminal, and a third response supervisory relay for exercising control over said first-mentioned relay.

39. A telephone system including telephone lines, a link-circuit for interconnecting calling and called lines, a source of signalling current, a relay magnet individual to said circuit adapted for periodic operations and controlling the application of said source to called lines, means for causing such periodical operations of said relay, and a second response supervisory relay magnet

in a circuit having a contact controlled by said first magnet for controlling the operations of said first magnet.

40. A telephone system including telephone lines, a link-circuit for use in interconnecting said lines, mechanism including a source of current for signalling over called lines, a relay for applying said source to said link-circuit, means for periodically operating said relay whereby said source is intermittently applied to said circuit, and a second relay for operation over a called line for controlling dissociation of said first relay from said means, together with an automatic test device sensitive to the idle or busy condition of a called line for governing said mechanism.

41. A telephone system comprising a calling line, a link-circuit, automatic means for connecting said line to said link circuit, a plug terminal at the connecting end of said link-circuit, a called line having multiple jack terminals into one of which said plug terminal may be inserted, means for supplying busy signal current to the calling line and ringing current to the called line, and electromagnetically actuated means controlled over a portion of the talking circuit formed by the connected lines and link-circuit and sensitive to the idle or busy condition of the called line to automatically apply the ringing current or the busy signal current.

42. A telephone system comprising a calling line; a link-circuit having two talking strands for extending the talking circuit of said line; automatic means for connecting said line to said link circuit, a plug terminal for said link-circuit having two contacts only, one for each talking strand; a called line having multiple jack terminals into one of which said plug terminal may be inserted and each having only two contacts; means for supplying busy signal current to the calling line and ringing current to the called line; and electromagnetically actuated means sensitive to the idle or busy condition of the called line to automatically apply the ringing current or the busy signal current.

43. A telephone system comprising a calling line, a link-circuit for extending the circuit of said line, a plug terminal at the connecting end of said link-circuit, a called line having multiple jack terminals into one of which said plug terminal may be inserted, two control relays, means responsive to the operation of one of said relays to supply busy signal current to the calling line and to the operation of the other of said relays to supply ringing current to the called line, means for varying the polarity of the multiple jack contacts according to the busy or idle condition of the called line, and means responsive to a difference of polarity be-

tween mating plug and jack contacts to operate one of said control relays and responsive to no difference of polarity between the same contacts to operate the other of said control relays.

44. A telephone system comprising a calling line, a link circuit for extending the circuit of said line, a plug terminal at the connecting end of said link circuit, a called line having multiple jack terminals into one of which said plug terminal may be inserted, a ringing control relay, means responsive to the operation of said relay to supply ringing current to the called line, a busy control relay, means responsive to the operation of said busy control relay to supply busy signal current to the calling line, means for varying the polarity of the multiple jack contacts according to the busy or idle condition of the called line, and means responsive to a difference of polarity between mating plug and jack contacts to operate said busy control relay and responsive to no difference of polarity between the same contacts to operate said ringing control relay.

45. A telephone system comprising a calling line, a called line, means for linking said lines together, other means for rendering the called line busy, and means responsive to the connection of said calling line to a busy called line to automatically interrupt the connection thus established.

46. A telephone system comprising a calling line, a called line, means for linking said lines together, other means for rendering the called line busy, and means responsive to the connection of said calling line to a busy called line to automatically interrupt the connection thus established and to transmit a busy signal over the calling line.

47. A telephone system comprising a calling line, a called line, means including a link-circuit and automatic switch for linking said lines together, other means for rendering the called line busy, and means responsive to the connection of said calling line to a busy called line to automatically release said switch and thereby interrupt the connection thus established.

48. A telephone system comprising a calling line, a called line, means including a link-circuit and automatic switch for linking said lines together, other means for rendering the called line busy, and means responsive to the connection of said calling line to a busy called line to transmit a busy signal over the calling line and to automatically release said switch and thereby interrupt the connection thus established.

49. A telephone system comprising a calling line, a called line, means including a subscriber controlled automatic switch for extending the circuit of the calling line to the called line, other means for rendering

said called line busy, a single electromagnetic device movable upon the extension of the circuit to the called line to either one of two positions dependent upon the idle or busy condition of the called line, and means responsive to the movement of said device to one position to transmit a busy signal over the calling line and to its movement to the other position to transmit ringing current over the called line.

50. A telephone system comprising a calling line, a called line having multiple terminals, a link-circuit having contacts adapted to engage certain of said terminals, a progressively movable automatic switch for connecting said calling line to said link circuit, other means for rendering said called line busy, a single electromagnetic device movable upon the connection of said link-circuit contacts and said certain terminals to either of two positions according to the idle or busy condition of the called line, a busy signal connection established in response to one movement of said device and a ringing signal connection in response to its other movement.

51. A telephone system comprising a calling line, a called line having multiple terminals, a link-circuit, automatic means controlled by the calling subscriber for connecting said calling line to said link circuit, said link circuit having contacts adapted to engage certain of said terminals, other means for rendering said called line busy, a single electromagnetic device responsive to the connection of the link-circuit contacts to said certain called line terminals to assume either of two operative conditions according to the idle or busy condition of the called line, and link-circuit apparatus controlled by said device.

52. A telephone system comprising a called line having multiple terminals, a link-circuit having contacts adapted to engage certain of said terminals, other means for rendering said called line busy, a signal electromagnetic device responsive to the connection of the link-circuit contacts to said certain called line terminals to assume either of two operative conditions according to the idle or busy condition of the called line, and an automatic switch controlled by said device.

53. A telephone system comprising a called line having multiple terminals, a link-circuit having contacts adapted to engage certain of said terminals, other means for rendering said called line busy, a polarized relay responsive to connection of the link-circuit contacts to said certain terminals to establish either of two circuit connections according to the idle or busy condition of the called line, an automatic switch operated upon the establishment of one of said cir-

cuit connections and signal apparatus operated upon the establishment of the other of said circuit connections.

54. A telephone system including telephone lines, terminals including talking contacts for said lines at the exchange, an automatic switch and a link circuit for establishing connection between terminal contacts of calling and called lines, a busy control circuit including a terminal talking contact of the called line, means adapted to be controlled over said busy circuit for automatically transmitting a busy signal to a calling substation, a calling current control circuit also including a terminal talking contact of the called line, means adapted to be controlled over said calling circuit for automatically connecting calling current with the terminal of the called line, and means to prevent the operation of said busy control circuit when connecting said link circuit to the terminals of the called line when idle.

55. A telephone system including telephone lines, terminals including talking contacts for said lines at the exchange, an automatic switch and a link circuit for establishing connection between the terminals of the calling and called lines, a busy control circuit including a terminal talking contact of the called line, means adapted to be controlled over said busy circuit for automatically transmitting a busy signal to a calling substation, a calling current control circuit also including a terminal talking contact of the called line, means adapted for automatically connecting calling current with the terminal of the called line, means adapted to be controlled over said calling circuit for automatically connecting calling current with the terminal of the called line, and means to prevent the operation of said calling current control circuit when connecting said link circuit to the terminals of the called line when busy.

56. A telephone system including telephone lines, terminals including talking contacts for said lines at the exchange, an automatic switch and a link circuit for establishing connection between terminal contacts of calling and called lines, a busy control circuit including a terminal talking contact of the called line, means adapted to be controlled over said busy circuit for automatically transmitting a busy signal to a calling substation, a calling current control circuit also including a terminal talking contact of the called line, means adapted to be controlled over said calling circuit for automatically connecting calling current with the terminal of the called line, and means to prevent the operation of one of said control circuits upon connecting said link circuit to the terminals of the called line, de-

pending upon the idle or busy condition of said called line.

57. A telephone system including a calling and a called line, a link circuit, an automatic switch for connecting said calling line and link circuit, other means for rendering said called line busy, means for connecting said link circuit to said busy called line, and release means for said automatic switch effective responsive to said latter connection.

58. A telephone system comprising telephone lines, link circuits, automatic means effective upon initiation of a call to select an idle link, means whereby an operator may extend said link circuit to a called line, and means effective responsive to connection to the called line to transmit a signal over said called line if idle or a busy signal over the calling line if called line is busy.

59. A telephone system comprising telephone lines, operator controlled link circuits, automatic means effective upon initiation of a call to connect the calling line to an idle link circuit, a party line ringing key for said link circuit, operator controlled means for extending said link circuit to a called line, and means effective if connection is made to the called line when idle to transmit a signal over said called line, or a busy signal over the calling line if the called line is busy.

60. In a telephone system, a plurality of lines extending by their limbs from substations to an exchange, a progressively movable switch and a cord circuit at the exchange for connecting said lines together, a source of signaling current at the exchange, circuit connections and switch contacts for connecting said source to the system, a switch adapted to sever said cord circuit when the signaling current is connected to said system, means for preventing the sending of signaling current from said source to a line already in talking communication, and a locking circuit for said preventive means independent of said switch.

61. In a telephone system, a plurality of lines extending by their limbs from substations to an exchange, a step by step switch and a cord circuit at the exchange for connecting said lines together, a source of signaling current at the exchange, circuit connections and switch contacts for connecting said source to the system, a switch adapted to sever said cord circuit when the signaling current is connected to said system, a relay for preventing the sending of signaling current from said source to a line already in talking communication, and a locking circuit for said relay independent of said switch.

62. In a telephone system, a plurality of telephone lines extending by their limbs

from substations to an exchange, switching mechanisms at the exchange including a progressively movable automatic switch and a link circuit for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such switching mechanisms, and means for preventing the closure manually of such signaling circuit to one of such switching mechanisms when such switching mechanism is connected to a busy line.

63. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, switching mechanisms at the exchange including a progressively movable automatic switch and a link circuit for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such switching mechanisms, means for manually controlling the signaling circuit when the switching mechanism is connected to one of the lines in signaling condition, and means for preventing the closure manually of the signaling circuit when such line is in talking condition.

64. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits and non-numerical switches at the exchange for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such cord circuits, a key associated with each of such cord circuits by which an exchange operator may complete the signaling circuit to the corresponding cord circuit after such cord circuit has been connected with one of the lines in ringing condition, and means for preventing the closure of the signaling circuit by means of such key when such line is placed in talking condition.

65. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits and non-numerical switches at the exchange for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such cord circuits, a key associated with each of such cord circuits by which an exchange operator may complete the signaling circuit to the corresponding cord circuit after such cord circuit has been connected with one of the lines in ringing condition, and means for rendering such key inoperative when such cord is connected to a busy line.

66. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits and progressively movable automatic switches at the exchange for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such

cord circuits, and a non-marginal supervisory relay under the control of the called substation for interrupting the continuity of the signaling circuit.

67. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits at the exchange and non-numerical switches for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such cord circuits, and a supervisory relay for controlling the continuity of such signaling circuit to one of the cord circuits when such cord circuit is connected to one of the lines, such relay connected so as to be operated only by direct current.

68. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits at the exchange and non-numerical switches for connecting the lines for conversation, a signaling circuit adapted to be manually connected to such cord circuits, a first relay adapted to place a supervisory signal in condition to operate when the associated cord circuit is connected with one of the lines, and a second relay adapted to render such supervisory signal inoperative when the called subscriber responds, the energization of the first relay serving to close a break in the energizing circuit of the second relay and the energization of such second relay serving to interrupt the continuity of the signaling circuit to such cord circuit.

69. In a telephone system, a plurality of telephone lines extending by their limbs from substations to an exchange, cord circuits and progressively movable non-numerical switches at the exchange for connecting the lines for conversation, a signaling circuit adapted to manually be connected to such cord circuits, a first relay connected to one talking strand of one of the cord circuits, and a second relay connected to the other talking strand of such cord circuit, the energization of the first relay serving to close a break in the energizing circuit of the second relay and the energization of such second relay serving to interrupt the continuity of the signaling circuit to such cord circuit.

70. In a telephone system, the combination with telephone lines, of a plurality of trunk circuits adapted for the common use of said lines, automatic switches for connecting calling lines with idle trunks, means for extending a call from a selected trunk in

the direction of the desired line, and means responsive to the busy condition of a desired line for freeing said trunk for common use.

71. In a telephone system, the combination with telephone lines, of a plurality of trunk circuits adapted for the common use of said lines, automatic switches for connecting calling lines with idle trunks, means for extending a call from a selected trunk in the direction of a desired line, and means responsive to the busy condition of a desired line for releasing the switch through which connection was made from the calling line to said trunk, and freeing said trunk for the use of another line.

72. In a telephone system, a subscriber's line, a link circuit provided with a manual terminal, a progressively movable non-numerical switch individual to said line for extending connection therefrom to said link circuit, means for establishing a connection to said line, an operating magnet in said switch normally connected to said line, a cut-off relay, and means for energizing said cut-off relay to disconnect said operating magnet from the line when said line is calling or is being called.

73. In a telephone system, a subscriber's line, a link circuit provided with a manual terminal, a progressively movable switch individual to said line for connection to said link circuit, means for establishing a connection from or to said line, an operating magnet in said switch normally connected to said line, a cut-off relay, and means for energizing said cut-off relay to disconnect said operating magnet from the line when said line is calling or is being called.

74. In a telephone system, a subscriber's telephone line, a link circuit provided with a manual connection terminal, a progressively movable non-numerical switch individual to said line for connecting to said link circuit, means for establishing a connection from or to said line, a line relay individual to said line and normally connected thereto, a cut-off relay individual to said line and having relay contacts for disconnecting said line relay from said line, means for energizing said cut-off relay to disconnect said line relay when said line is used for calling purposes, and means for energizing said cut-off relay to disconnect said line relay at the time a connection is extended to said line as a called line.

In witness whereof, I hereunto subscribe my name this seventh day of October, A. D., 1905.

FRANCIS W. DUNBAR.