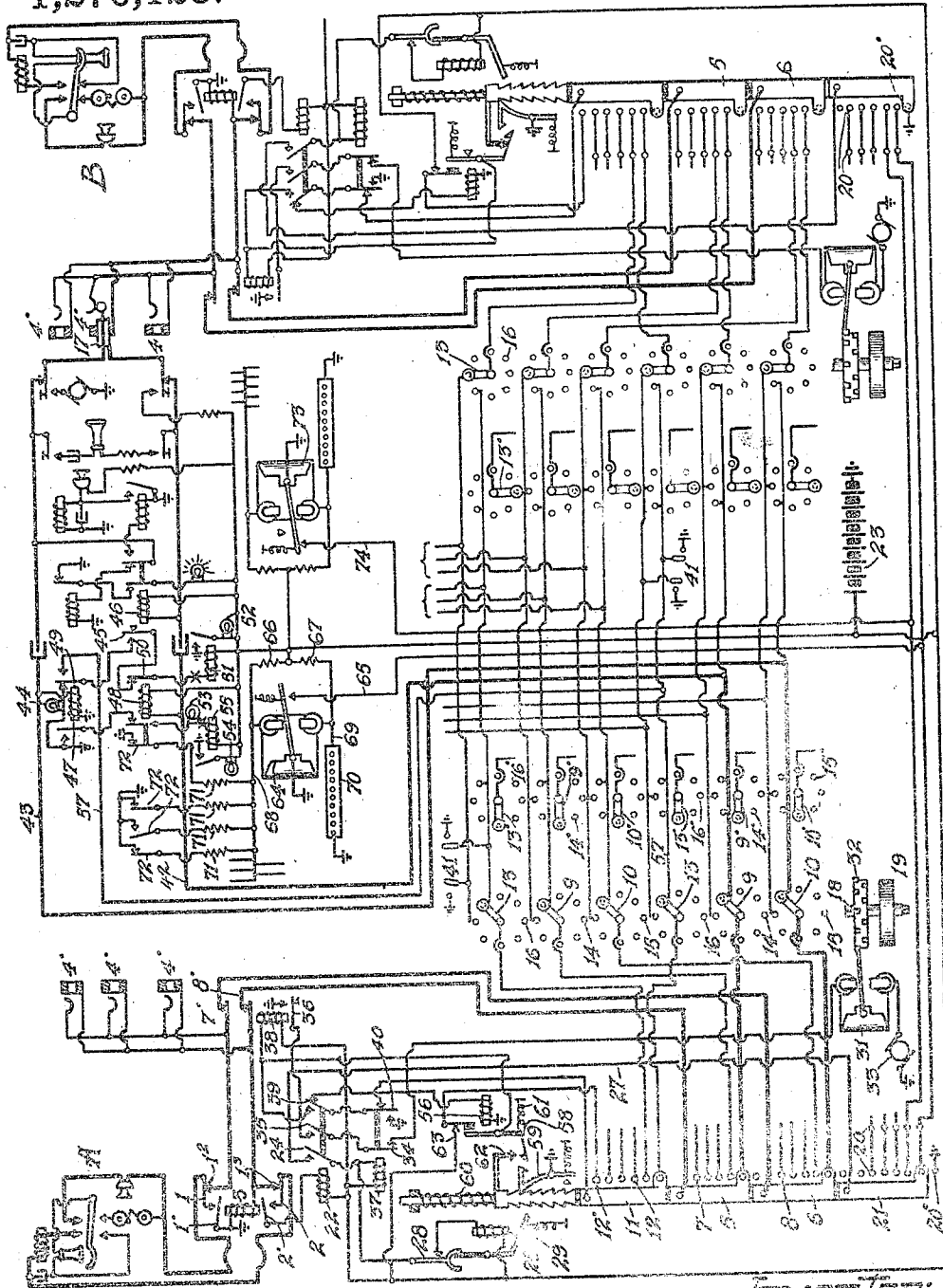


F. W. DUNBAR.
TELEPHONE SYSTEM.
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1,270,128.



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,270,128.

Specification of Letters Patent. Patented June 18, 1918.

Original application filed March 3, 1905, Serial No. 248,242. Divided and this application filed January 21, 1918. Serial No. 212,920.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, a citizen of the United States of America, residing in Manchester, county of Bennington, State of Vermont, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with systems of the type in which automatic switching devices are used in completing connections between subscribers' lines.

The present application is a divisional application of my application for Letters Patent, Serial No. 248,242, filed March 3, 1905.

The main object of my invention is to provide means for distributing calls from calling subscribers' lines to idle link circuits by means of successively operated automatic distributing devices. By using a plurality of automatic devices successively operable to connect a calling line to an idle link circuit, it will be readily seen that any one calling line is given access to a greater number of link circuits or trunks than if only one automatic switch was used to connect the calling line to a link circuit.

Other objects and features of my system will be hereinafter pointed out in the following specification and in the appended claims.

I will explain my invention more fully by reference to the accompanying drawing, in which—

The drawing illustrates the adaptability of the invention to one well known type of multiple switchboard, the invention, however, not being limited to multiple switchboard practice.

Each subscriber's station, A, B, is provided with customary common battery subscriber's apparatus, a switch hook at each station serving operatively metallically to unite the sides of the line when the receiver is removed. I do not deem a detailed description of the subscriber's apparatus to be essential, as the illustration is sufficient to make the same understood by those skilled in the art. Although I have illustrated one arrangement of subscriber's station apparatus, it will be obvious to those skilled in the art that other arrangements may be employed at the substations, and I do not

wish to be limited to the arrangement and apparatus shown, nor do I wish to be limited in all embodiments of the invention to its application to a common battery system. The subscribers' lines are metallic lines (though the invention need not be limited to metallic circuits), said lines extending in two branches to the exchange, where they terminate in normal contacts 1—2 normally engaged by the armatures 1¹—2¹ of a cut-off relay 3. The contacts 1—2 are preferably in the form of spring arms that are adapted to engage contacts 1²—1³ when the armatures of said relay are attracted, such connection being broken when said armatures 1¹—2¹ are released. The contacts 1²—1³ constitute the terminals of the office end of the line, which is supplied with the line jack 4¹. The system illustrated being a multiple switchboard system, there are also provided upon other sections of the board than where jack 4 is located, other jacks 4¹ in similar connection with the contacts 1²—1³. That which in a multiple switchboard would correspond to an answering jack and in any other switchboard would correspond to a line jack, is found in the terminals 5—6 which are normally connected with a subscriber's line through the agency of the normal contacts of the armature switches 7¹—8¹ of the relay 38. The terminals 5—6 and associate parts are normally in the position indicated at the right hand of the figure, in readiness to be connected with an idle link circuit. The contacts or brushes 5—6 ride over contact buttons 7—8, which contact button 7 being connected with a link circuit selector switch element, has a rotating arm 9 connected thereto, there being one such arm 9 for each button 7, while the contact buttons 8 are similarly connected with arms 10 similar to the arms 9. Certain local control to be hereinafter specified, is obtained by the brush or contact 11. The active contacts 11—5—6 all move together. The brush 11 rides over contacts 12, each preferably connected with a rotating arm 13. All of the link circuits at an operator's position are in association with the arms 9, 10 and 13, the talking strands of said link circuits terminating in contact buttons 14—15 engaged by the arms 9—10, respectively, while local circuit conductors associated with said link

circuits are provided with contact buttons 16 engaged by the arm 13. When the brushes 5, 6 and 11 stop at one set of contacts including a button 7, a button 8, and a button 12, they are then adapted to effect a signal at a free operator's position, and in the preferred embodiment of the invention, are adapted automatically to be connected with a link circuit corresponding to said signal, there being desirably as many signals as there are link circuits.

In the system shown in the accompanying drawing, the link circuit terminates at one end in the contacts 16—14—15 and at the other end in a connecting plug, the arms 9—10—13 automatically selecting the link circuit in a manner to be hereinafter specified, the signal corresponding to said link circuit thereupon being effected, so that the operator thereupon uses the connecting plug 17 corresponding to the signal.

Each line of a group of subscribers' lines has as many buttons 7, as many buttons 8, and as many buttons 12, as there are operators assigned or corresponding to such group. Each subscriber has thus assigned to him as many groups of switches 9—10—13 (with their associate contact buttons) as there are operators, all of the switch arms 9—10—13 corresponding to a given subscriber, being desirably mounted upon a shaft 18 of a link circuit motor 19 that is brought into operation under conditions hereinafter to be set forth, when the subscribers' switches 5—6—11 have become connected with the arms 9—10—13 corresponding to a free operator. Each subscriber's line thus has a motor 19 that serves to operate the switches 9—10—13 corresponding to all of the operators, it being only such switches, however, that are connected with the switches 5—6—11 that perform any function as a consequence of their operation. The switches 9¹—10¹—13¹ correspond to another subscriber and extend to contact buttons similar to contact buttons 7—8—12 coöperating with another subscriber's switch including parts similar to parts 5—6—11. All of these arms 9¹—10¹—13¹ are adapted for simultaneous operation by a link circuit motor corresponding to the subscriber to whom the elements 9¹—10¹—13¹ belong. By apparatus to be specified, the switch elements 5—6—11 are brought into connection with the arms 9—10—13 that correspond to an operator who is free to take work, the said apparatus enabling the said switch elements 5—6—11 to pass by any arms 9—10—13 that are associated with the apparatus of an occupied operator. In order that the parts 5—6—11 may be arrested in their travel (their travel having been commenced by apparatus to be specified), the cord circuits or link circuits jointly control and effect a circuit condition that will cause the motor mechanism operat-

ing the parts 5—6—11 to cease such operation when all of the link circuits that an operator is given to use are not in service, the said link circuits effecting another circuit condition when they are in use up to the capacity of the operator.

Without at the present time describing the apparatus by which the result presently to be stated is accomplished, I prefer to cause the link circuits belonging to each operator and the apparatus for the purpose governed thereby, to place grounds upon the contact buttons 20 when all of said link circuits are in service and to effect the removal of said grounds when all of said link circuits are not in service. The contacts 20 coöperate with a switch element or contact 21 that is mechanically coupled with the contacts 5—6—11 to move therewith. When a ground is placed upon a contact 20, a circuit including said contact and the element 21 is established, that permits a continuation of the movements of the parts 5—6—11, said movement continuing until the element 21 engages a contact button 20 from which the ground has been removed. For this reason there is provided in association with each group of buttons 20 a grounded button 20¹ with which the element 21 is normally engaged, so that the parts 5—6—11 may be moved at once upon the initiation of a call. The wiping portion of the element 21 is broad enough to engage one button before leaving the preceding, for an obvious reason. There is such a set of buttons 20 and a button 20¹ for each subscriber, each button of each set being associated with apparatus at one operator's position, there thus being as many buttons in each set as there are operators' positions or as there are sections of board. The buttons of the different sets (corresponding to the different lines) that are associated with the apparatus at one operator's position, are multiplied together, as indicated in the lower left-hand and lower right-hand corner of the drawing, so that any switch element corresponding to element 21 riding over a set of buttons corresponding to the buttons 20, by coming into contact with the first button from which the ground has been removed, will cause the operation of the parts similar to parts 5—6—11 to cease.

I will later explain how the parts 9—10—13 will stop when they engage buttons 14—15—16 that correspond to an idle link circuit, and will also later describe the calling signal that is then operated.

I will now describe the apparatus by which the operation of the elements 5, 6, 11 and 21 is controlled.

A calling subscriber, as subscriber A, by removing his receiver from its switch hook, establishes a circuit at the exchange which may be traced from the grounded armature

1¹, over the subscriber's line, to the contacts 2—2¹, the line relay 22, to the grounded battery 23, whereby the armature switches shown in association with said line relay are operated. One of said armature switches 24 thereupon establishes a circuit through a winding 25 of a corresponding subscriber's motor, which circuit may be traced from the ground at 20¹, the switch 21, the conductor 27 connecting said switch with the front contact of switch 24, the lazy arm 28, between the bifurcations of which a projection of the armature 29 is located, the winding 25, to the battery 23. The energization of this magnet 25 is intermittently effected by reason of the separable relation of the lazy arm 28 and its contact, so that the armature 29 is intermittently operated to engage the teeth 30 mechanically united with the switch parts 5—6—11—21. Thus, the first step is the movement of the part 21 from the grounded contact button 20¹ into engagement with the next button. Now, if the operator with whose apparatus the said next button is associated is not free, there will also be a ground upon said next button, thereby still maintaining the circuit through the magnet 25. If the next operator is fully occupied, the button 20 corresponding to her position or board section is also grounded and the movement of the parts 5—6—11—21 continued, this operation being carried on until the brush element 21 comes into contact with a button 20 that corresponds with a free operator, whereupon circuit through the magnet 25 is effectively opened, by the removal of the ground from the corresponding contact buttons 20, so that the parts 5—6—11—21 cannot be further moved thereby. In the instance illustrated at the left of Fig. 1, the very first button 20 encountered by the switch part 21 is supposed to be associated with an operator who is not fully occupied, but who is free to put up more connections, so that the circuit through the magnet 25 is opened to arrest the switch parts 5—6—11—21. The switch arms 9—10—13 that are thus connected with the parts 5—6—11 as indicated, are those switch arms that are associated with the apparatus of the operator corresponding to the button 20 shown in connection with the element 21, whereupon the prime mover 19 is brought into service to move the said switch parts 9—10—13 to connect the same with the answering terminal buttons 14—15—16 that may be connected or associated with the link circuit of the selected operator that may be used in effecting connection between the calling and called subscribers, as I prefer an automatic connection between the answering end of the link circuit and the calling subscriber, though that feature of my invention involving the automatic selection of the place at which the calling signal is to appear is in itself a very

important feature of the invention, particularly where the mechanism that is to govern this automatic selection of such location is jointly controlled by the link circuits. The motor that is employed for the operation of the parts 9—10—13 preferably includes a polarized operating magnet 31 whose armature oscillates alternately to engage teeth 32 in offset peripheral rows, so that a spring motor, which is desirably coupled with the shaft 18, may step the said shaft around, each movement of said shaft desirably bringing said parts 9—10—13 out of engagement with the contacting buttons into contact with the next buttons. The circuit including the electro-magnet winding of the element 31 may be traced from the grounded generator 33 to be employed for operating said magnet, which generator is preferably a source of alternating current, to the back contact of an armature switch 34, the armature switch 35 and its front contact, to the armature switch 36 and its front contact, which is grounded. This circuit is broken at 34, however, during the time circuit is established through the magnet 25 because the magnet 37 is included in circuit with switch 24, thereby removing the armature switch 34, preventing the closure of the circuit through the generator 33. This connection 34 is provided because the magnet 38 is preferably employed to operate the switches 7¹—8¹ temporarily to disconnect the parts 5—6 from the calling subscribers' line, circuit being established through said magnet 38 by the armature switch 39 engaging its front contact, the armature switch 40 engaging its front grounded contact, the magnet 38, the grounded battery 23. It might be stated that the armature switches 24—35—39 are governed by the relay 22 and the armature switches 34—40 are governed by the relay 37. When the circuit through magnet 37 is opened at 21, circuit through the elements 31—33 is established by the release of the armature switch 34 that thereupon engages its back contact, said circuit continuing from said back contact, through the armature switches 34—35, the front contact of armature switch 35, the armature switch 36, to the grounded contact of said latter armature switch. It is necessary to maintain the armature switch 36 in engagement with its grounded contact in the embodiment of the invention illustrated, while the motor 19 is in operation, in order that the ground at 36 may be maintained to continue the establishment of the circuit containing the generator 33, to which end the back or normal contact of armature switch 40 is connected with the switch element 11, which determines the location of the ground supplemental to the ground at the battery 23 to establish this circuit of said magnet 38. By conditions hereinafter

to be set forth, the contact buttons 12 connected with the apparatus at the different operators' positions or board sections, have grounds placed upon the same through the intermediation of the switch elements 13, the contact buttons 16 engaging said switch arms 13 being grounded when the corresponding cord or link circuits are busy, and being free of this ground when such circuits are idle; so long, therefore, as the arm 13 is in engagement with the buttons 16 that are grounded, the circuit through the magnet 38 is maintained, and which may readily be traced as hitherto indicated. As soon, however, as the first idle link circuit or the button 16 corresponding thereto, becomes associated with the arm 13, the ground is removed from the element 11, causing the deenergization of the magnet 38, thereby removing the armature 36 from its grounded contact and opening the circuit containing the elements 31—33, so that the parts 9—10—13 remain in the position they were brought to when the switch arm 13 engaged the button 16 from which the ground had been removed because of the idle condition of the link circuit associated with the said button 16 thus engaged. All of the operators may be provided with the same number of link circuits, but the number of those circuits that may be brought into service may be limited by providing artificial means for placing grounds upon the buttons 16 or otherwise throwing the link circuits out of operative relation with the operating mechanism of the exchange, there being indicated in the embodiment of the invention shown, manually operated switches 41 that may be moved into connection with grounded buttons when the link circuits associated with said switch arms are thrown out of service. When the arms 9—10 are arrested, conductors 42—43 of an idle link circuit belonging to a free operator, are connected with the arms 9—10 and thereby with the buttons 7—8 and the switch parts 5—6 engaging said buttons, so that the calling line is connected with said link conductors 42—43 for the armature switches 7¹—8¹ are released because of the deenergization of the magnet 38 accomplished as hitherto specified, permitting the said armature switches to engage their normal contacts and because the cut-off relay 3 has become energized to effect connection between the parts 1—1² and 2—1³. The circuit through the cut-off relay may be traced from the grounded terminal of said relay, to the armature switch 8¹, the switch element 5, the button 7, the traveling switch 9, the link conductor 42 (in this case the sleeve strand of a cord circuit), the relay 48 (which becomes thereby energized), to the grounded battery 23. The subscriber's apparatus now effects an operation of the calling signal 44, because the ar-

mature 45 of the supervisory relay 46 of the calling end of the cord is now unattracted, and because the relays 47—48 are energized, whereby circuit may be traced from the grounded terminal of the signal 44, preferably a small lamp, through the armature switch 49, the armature switch 45, the armature switch 50, to the grounded battery 23, this same circuit including a relay 51 common to a plurality of circuits containing the signals 44 to operate a common signal 52. The circuit through the relay 47 may be traced from its grounded terminal, over the link conductor 43 (in this case the tip strand of a cord circuit), to a button 15, the engaging arm 10, a button 8, the engaging switch element 6, thence by way of the armature switch 7¹ and its contact, over the telephone line of the calling subscriber, the armature switch 8¹, the switch part 5 and engaging button 7, the switch arm 9, and engaging button 14, the link conductor 42, to the battery 23 by way of the magnet 48. The supervising apparatus and the balance of the operator's apparatus associated with the connecting end of the cord circuit are well understood to those skilled in the art and need not have further description, except that the armature 45, when attracted upon the insertion of a connecting plug within a called subscriber's jack, serves to efface the calling signal at 44. The operation of the supervisory apparatus 53—54 and the signals supplemental to the magnet 55 will also be well understood from the illustration without requiring further description.

In order that the link circuit motors 19 may be prevented from stopping the arms 9—10—13 to connect the same with a link circuit already in service, the buttons 16—16¹ cooperating with the arms 13—13¹ are multiplied. In order that the arms 9—10 and 9¹—10¹ may be connected with any idle link circuit, the contact buttons 14—14¹ are multiplied, as are also the buttons 15—15¹. The ground is placed upon and removed from the buttons 16—16¹ through the agency of the switch element 11 and the button 12 engaging said element 11, which operation and attendant results will now be set forth.

The ground that is to be placed upon and removed from the contact buttons 16—16¹ is indicated at the grounded terminal of the relay 56. When the switch arm 13 (or 13¹, etc.) has encountered a button 16 (or 16¹, etc.) having no connection with a ground, (the windings 25 and 37 having been deenergized as hitherto stated) the energization of the cut-off relay 3 is permitted due to the deenergization of the magnet 38 effected at the engaged groundless button 16. As a consequence of the deenergization of the line relay 22 occasioned because of the attraction of the armature 2¹ in series with said magnet 22, the ground at 56 is thereupon at once

placed in connection with the armature switches 39—40 and the switch element 11, so that all of the contacts 16—16¹, etc., united by the conductor 57 are grounded, so that no other switch-arm similar to 13 will pause at any contact connected with the conductor 57. The conductor 57 thus becoming connected with the ground at 56, has its circuit discontinued because of the energization of the magnet 47, whereby the magnet 56 remains in open circuit. The magnets 56 in the exchange are of resistance that is low relatively to the magnets 38 of the exchange, so that if a magnet 56 associated with a busy cord is thrown into circuit with a magnet 38 of a calling line, said magnet 38 may remain operated without causing the operation of magnet 56.

If the calling subscriber restores his telephone before the operator has inserted the connecting plug 17, or if the operator has withdrawn the plug 17 after a completed conversation between connected subscribers, the calling subscriber then also having restored his receiver, said conductor 57 will have its circuit extended by way of the armature 49, now released, the armature 45, also released, the armature 50, still attracted, to the grounded battery 23, whereupon the magnet 56 will become energized to attract its armature and effect the engagement of the catch 58 in electrical connection with the armature of magnet 56 with the hook upon a grounded detent 59 preparatory to effecting the disengagement of said detent from the rack 30, to permit the spring 60 to restore the elements 5—6—11—21—30 to their normal positions. The actual disengagement of the detent 59 is preferably effected by means of a spring 61 connected with the armature magnet 56, to which end the circuit of said magnet should be opened, in order that its attraction may not overcome the force of said spring, the spring being upon one side of the armature pivot and the pole of the magnet upon the other. The spring 61 is permitted to operate because the magnet 38 is again included in circuit, by reason of the ground placed thereupon at 59, causing the operation of the switches 7¹—8¹, and thereby the deenergization of the magnet 48, whose armature 50 is released to open the circuit through the magnet 56, whereupon the spring 61 is free to effect withdrawal of the detent 59, so that the restoring spring 60 may move its associate switch parts to their initial positions, a post 62 engaging the hook 58 when such restoration is about completed to effect disengagement between said catch 58 and the said detent 59, placing this apparatus in position to take part in effecting a new connection. The circuit for the magnet 38 just mentioned may be traced from the ground at 59, the hook 58, the armature of magnet 56,

the winding of magnet 38, to the grounded battery 23. After the parts 58—59 are separated, this circuit is opened. In case the motor 25 should step the switch contacts 5—6—11—21 over their entire range without having effected connection of a link circuit with the line terminals 5—6, I provide a means for effecting the restoration of said elements, to permit a reoperation thereof. To this end, I preferably provide a supplemental contact button 12¹ that is not connected with any arm corresponding to arm 13, but is connected by way of a switch 63 with the battery 23, whereby said battery is connected with the switch element 11 when said element is in contact with the button 12¹. When the element 11 is thus connected with the battery 23, the circuit including said element contains the armature switch 40 (because the element 21 is not in connection with the grounded contact, the magnet 37 thereby being in open circuit) and its normal contact, the armature switch 39 and its back contact, and the magnet 56. The calling subscriber having manipulated his switch hook to secure this result, thus momentarily causing a deenergization of the line-relay 22 to permit of the engagement of the armature switch 39 with its normal or back contact, the armature of magnet 56 is thereupon operated to engage the hook 58 with the detent 59, whereupon the circuit including the magnet 56 is broken at 63 by the armature of said magnet, whereupon the spring 61 may withdraw the detent 59 to permit the spring 60 to restore the switch parts.

I have hitherto stated that before a cord or link circuit is to be automatically selected, a group of circuits belonging to a free operator is first to be selected, this in the embodiment of the invention being described having been effected through the agency of the buttons 20 and the conditions jointly imposed upon each of the same by its associate group of link or cord circuits, a group of occupied cords occasioning ground upon its button 20, whereas a group of cords not altogether occupied will cause its button 20 to be free of ground, with the results hitherto stated. The preferred instrumentality that I employ for controlling the application of a ground to each button 20 by its group of link or cord circuits, is that illustrated, including the apparatus operating under the laws of the Wheatstone bridge. The bridge of the Wheatstone circuit includes a polarized relay 64 whose polarized armature is grounded, such relay being common to a group of cord or link circuits and jointly controlled in its operation thereby. In the operation of the Wheatstone arrangement more fully to be set forth, said armature is maintained in the position illustrated in the drawing at the left when all of the service-

able link circuits of a given operator are not in use, so that the conductor 65 terminating at one end in a contact button 20 and at the other end in a contact for the said armature, is under such condition free of ground connection, but when all of the serviceable cords are in use, the said armature is swung to its alternative position into engagement with its contact, the terminal of the conductor 65, so that ground is placed upon the contact 20 corresponding to said group of link circuits, forcing the switch elements 5-6-11-21 to continue their movement as hitherto set forth. The direction of movement of the armature of relay 64 depends upon the direction of current through said relay from the battery 23, this battery 23 being connected between two adjacent sides 66-67 of the Wheatstone bridge containing the fixed resistances. The other two sides 68-69 of the Wheatstone bridge are grounded, and, as the battery 23 is grounded, the Wheatstone bridge arrangement that I have described is completed, for there is included in the side 68 resistance that is automatically adjustable through the agency of the link circuits, such adjustment being effected as said link circuits are put into and withdrawn from service, the other side 69 containing a resistance 70 that is to be adjusted manually according to the capacity of the operator using the cord circuits associated with the relay 64. The resistance of the side 68 is preferably composed of a number of sections 71, each cord circuit of a group having one such section. The relay 48 of each link circuit has an armature switch 72 that engages a grounded contact when operated by said relay to include the corresponding resistance sections 71 in ground connection. The resistances 71 are thus connected in circuit as their associate link circuits are busy and are excluded from circuit when said circuits are restored to their normal or idle conditions. The resistance 70 is adjusted by hand to determine the time at which the current through the relay 64 shall be so directed as to effect an application of the relay armature to the terminal of conductor 65 associated therewith. Each operator may have ten link circuits, but the resistance 70 may be so adjusted that the moment six, for example, of the resistance sections 71 are connected to ground, the armature of relay 64 will be connected with conductor 65, so that the selecting mechanism of the subscriber calling will pass the button 20 connected with conductor 65 thus grounded, until the element 21 of said selecting mechanism will engage a button 20 from which the ground has been removed. Thus, the operator having the relay 64 cannot attend to more than six connections at a time. If the capacity of the operator is greater than

six connections, say 8, the resistance 70 is correspondingly adjusted to permit the inclusion of eight sections 71 abreast before the conductor 65 is grounded through the armature of the relay 64. As soon as the predetermined number of sections that may be included abreast is diminished, the current through the winding of relay 64 is reversed to remove the relay armature from connection with the conductor 65. A relay 73 belonging to another group of link circuits is illustrated, the armature thereof being shown applied to a conductor 74 (as the serviceable link circuits corresponding to said relay are occupied), said conductor being connected with a button 20 of a group.

A non-numerical switch is one that does not operate in response to a series of impulses transmitted by a calling device, but operates in response to the transmission of an impulse or upon the closure of a circuit, such as the closure of a subscriber's substation circuit.

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

1. A telephone system including a calling subscriber's line and a called subscriber's line, a non-numerical individual trunking switch for said calling subscriber's line, trunk lines for selection by said individual switch, a secondary non-numerical trunking switch for each of said trunk lines, connecting circuits for selection by said secondary switches, subscriber controlled means for initiating the operation of his said individual switch and a selected one of said secondary switches to extend the subscriber's line to one of said connecting circuits, and means for then extending the connection to said called subscriber's line.

2. A telephone system including a subscriber's telephone line, a primary switch for said line, a secondary switch accessible to said primary switch, trunking means accessible to said secondary switch, and mechanism for said primary and secondary switches responsive to the removal of a receiver at the substation of said telephone line to connect said telephone line with said trunking means.

3. A telephone system including a calling and a called subscriber's line, connecting circuits, individual primary and non-numerical secondary trunking switches, a line relay individual to the calling subscriber's line for initiating the operation of one of said primary and one of said secondary switches for connecting said calling subscriber's line to an idle one of said connecting circuits, and means for then extending the connection to said called subscriber's line.

4. A telephone system including a calling and a called subscriber's line, trunk lines, non-numerical primary and secondary trunking switches, the primary switches being in-

dividual to the subscribers' lines, a line relay individual to the calling subscriber's line and controlled over the two sides of said line in series for causing the successive operation of one of said primary and one of said secondary switches to extend a call from the calling subscriber's line to an idle one of said trunk circuits, and means for then connecting with and signaling the called subscriber's line.

5. A telephone system including subscribers' telephone lines, groups of primary switches for said lines, secondary switches accessible to said primary switches, a group of connecting circuits accessible to said secondary switches, and means controlled over the two sides of a calling line in series to operate one of said primary switches and one of said secondary switches to connect to one of said connecting circuits, and operator controlled means for extending connection from said connecting circuit to a called one of said lines.

6. The combination with a selector carrying groups of line terminals, of a cooperating movable contact therefor adapted to test said lines by groups, and means, actuated in case all the lines in a tested group are unselectable, for advancing said movable contact in a single step to the next group.

7. The combination with groups of lines, of a selector carrying terminals for said groups, a test contact for each group of line terminals, a source of current associated with each group, a conductor connecting said source with the test contact of each group, and means for varying the continuity of said conductor according to the selectability or non-selectability of the line terminals in that group.

8. The combination with a number of groups of trunk line terminals, of selective apparatus for connecting therewith adapted to test said groups of terminals one after the other to select a group containing an idle trunk line.

9. The combination with groups of trunk lines, of a selector carrying terminals for said groups, a test contact for each group of trunk line terminals, a source of busy current associated with each group, and a conductor connecting said source with the test contact of said group, the continuity of said conductor being completed when all the lines in said group are busy.

10. The combination with a selector carrying groups of trunk line terminals, of a contact arm therefor adapted to test said trunk lines by groups, and means, actuated in case all the trunk lines in a tested group are busy, for advancing said arm in a single step to the next group.

11. The combination with a selector carrying groups of line terminals, of a cooperating movable contact therefor adapted to test said

lines by groups, and means, actuated in case all the lines in a tested group are unselectable, for advancing said movable contact in a single step to the next group.

12. A telephone system including a subscriber's telephone line, an automatic switch individual thereto, a secondary automatic trunking switch accessible to said first automatic switch, trunk lines accessible to said secondary automatic switch, and means controlled by the calling subscriber over the two sides of the subscriber's line in series for operating said automatic switches to extend a connection from said subscriber's line to an idle one of said trunk circuits.

13. A telephone system including a plurality of subscribers' telephone lines, automatic trunking switches one for each of said lines, secondary trunking switches accessible to said first trunking switches, groups of link circuits accessible to said secondary switches, and means controlled by a calling one of said subscribers over the two sides of the subscriber's line in series for operating the switch individual to the subscriber's line and one of said secondary trunking switches to connect said subscriber's line to an idle one of said link circuits.

14. A telephone system including a plurality of subscribers' telephone lines, automatic trunking switches one for each of said lines, secondary trunking switches accessible to said first trunking switches, groups of link circuits accessible to said secondary switches, means controlled by a calling one of said subscribers over the two sides of the subscriber's line in series for operating the switch individual to the subscriber's line and one of said secondary trunking switches to connect said subscriber's line to an idle one of said link circuits, and means for extending a connection from said link circuit to a called one of said subscribers' lines.

15. A telephone system including a plurality of subscribers' telephone lines, an automatic trunking switch individual to each of said subscribers' lines, secondary trunking switches accessible to said first trunking switches, trunk circuits accessible to said secondary trunking switches, subscriber controlled means for successively operating his individual trunk switch and one of said secondary trunking switches to extend a connection from the calling one of said lines to an idle one of said trunk circuits, and means for then completing the connection to a called one of said lines.

16. A telephone system including a subscriber's telephone line, a non-numerical automatic trunking switch individual to said subscriber's line, a secondary non-numerical trunking switch accessible to said first trunking switch, wipers for said secondary switch, groups of trunk circuits accessible

to the wipers of said secondary switch, and subscriber controlled means for operating said switches to extend a connection from said subscriber's line to an idle one of said trunking circuits.

17. A telephone system including a subscriber's telephone line, a non-numerical automatic trunking switch individual to said subscriber's line, a secondary non-numerical trunking switch accessible to said first trunking switch, wipers for said secondary switch, groups of trunk circuits accessible to the wipers of said secondary switch, and subscriber controlled means for successively operating said switches to extend a connection from said subscriber's line to an idle one of said trunking circuits, said means being controlled over two sides of the subscriber's line in series.

18. A telephone system including a subscriber's telephone line, an individual non-numerical trunking switch therefor, a secondary non-numerical trunking switch terminating in bank contacts of said first trunking switch, a plurality of trunk circuits terminating in bank contacts of said secondary switch, and subscriber controlled means for operating said switches to extend a connection from said subscriber's line to an idle one of said trunk circuits.

19. A telephone system including a calling and a called subscriber's telephone line, a non-numerical trunking switch individual to said calling subscriber's line, a secondary non-numerical trunking switch accessible to said first trunking switch, trunk lines accessible to said secondary switch, subscriber controlled means for successively operating said switches to extend a connection from the calling subscriber's line to an idle one of said trunk circuits, and means for extending a connection from the selected trunk circuit to the said called subscriber's line.

20. A telephone system including a plurality of subscriber's telephone lines, a non-numerical progressively movable trunking switch for each of said subscribers' telephone lines, secondary non-numerical trunking switches terminating in bank contacts of said first trunking switches, and accessible thereto, trunk circuits terminating in bank contacts of said secondary trunking switches and accessible thereto, and means controlled by a calling one of said subscribers for operating his individual trunking switch and one of said secondary switches to extend a connection from the subscriber's telephone line to an idle one of said trunk circuits.

21. A telephone system including a plurality of subscribers' telephone lines, a non-numerical progressively movable trunking switch for each of said subscribers' telephone lines, secondary non-numerical trunking switches terminating in bank contacts

of said first trunking switches and accessible thereto, trunk circuits terminating in bank contacts of said secondary trunking switches and accessible thereto, means controlled by a calling one of said subscribers for operating his individual trunking switch and one of said secondary switches to extend a connection from the subscriber's telephone line to an idle one of said trunk circuits, and means for then extending the connection from the selected trunk circuit to a called one of said subscribers' lines.

22. A telephone system including a telephone line, selective switch mechanism, a plurality of operators' cord circuits having terminals associated with said switch mechanism arranged in groups, means outside of said switch mechanism for rendering some of said groups busy, means for operating said switch mechanism on initiation of a call over said telephone line whereby said switch mechanism automatically tests said cord circuits by groups avoiding busy groups, and means for causing said switch mechanism to move automatically over the terminals of the first idle group to extend said line to an idle cord circuit therein.

23. A telephone exchange system comprising a group of conductors, groups of automatic switch passive contacts, each group having contacts forming terminals of said conductors, means associated with each group of passive contacts for automatically selecting the passive contact of an idle one of said conductors, means for selecting said group of conductors, and means responsive to the selection of all the conductors in the group to control said group selecting means.

24. A telephone exchange system comprising a group of conductors, groups of automatic switch passive contacts, each group having contacts forming terminals of said conductors, means associated with each group of passive contacts for automatically selecting the passive contact of an idle one of said conductors, means for selecting said group of conductors, and means responsive to the selection of all the conductors in the group to cause the selecting means to move by that group.

25. A telephone exchange system comprising a group of conductors, groups of automatic switch passive contacts, each group having contacts forming terminals of said conductors, means associated with each group of passive contacts for automatically selecting the passive contact of an idle one of said conductors, means for selecting said group of conductors, control switch contacts for said group selecting means, and means for actuating said contacts in response to the selection of all the conductors in the group.

26. A telephone exchange system comprising a group of conductors, groups of auto-

matic switch passive contacts, each group having contacts forming terminals of said conductors, means associated with each group of passive contacts for automatically selecting the passive contact of an idle one of said conductors, means for selecting said group of conductors, control switch contacts for said group selecting means, an electromagnet for each conductor, means for energizing each conductor's magnet upon the selection of that conductor, and means responsive to the energization of the magnets of all the conductors to actuate said switch.

27. In a telephone system, a subscriber's line, an automatic switch connected to said line provided with a contact maker capable of assuming a plurality of selective positions, trunk lines for selection by said automatic switch, a second subscriber's line, means including said automatic switch for extending a call from said first to said second subscriber's line, means for extending a call from said second to said first subscriber's line, operating means for said switch bridged across said line, and a magnet for disconnecting said operating means from across the line when said first connection is established, said magnet also being operable to disconnect said operating means from across the line when said second connection is established.

28. A telephone system including a subscriber's line, an automatic switch individual thereto, a second subscriber's line, means including said individual switch for extending a connection from said first subscriber's line to said second subscriber's line, means for extending a connection from said second subscriber's line to said first subscriber's line, an operating relay for said switch connected to said first line, and a cut-off relay for disconnecting said operating relay from said first subscriber's line when said switch is used to extend the connection to the second subscriber's line, said cut-off relay also being operable to disconnect said operating relay from said subscriber's line when the second subscriber's line is connected to the said first subscriber's line.

29. In a telephone system, a subscriber's line, a progressively movable non-numerical switch individual to said line for extending connection therefrom, means for establishing a connection to said line, an oper-

ating 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.

30. A telephone system including a subscriber's line, a progressively movable switch individual to said line, means for extending a connection from said subscriber's line including said switch, an operating magnet for said switch normally connected to said subscriber's line, a cut-off relay, means for energizing said cut-off relay to disconnect said operating magnet from the subscriber's line when said switch is operated for calling purposes, and means for energizing said cut-off relay to disconnect said operating magnet from the subscriber's line when said line is used as a called line.

31. A telephone line having before it multiple terminals of link circuits, said link circuits having before them multiple terminals of other circuits, and non-numerical switch mechanism for said lines and link circuits adapted to extend said line by means of a selected idle link circuit terminal and a selected idle terminal of one of said other circuits.

32. A telephone system including a subscriber's telephone line, a primary switch for said line, a secondary switch accessible to said primary switch, operator's answering means accessible to said secondary switch, and mechanism for said primary and secondary switches responsive to the removal of a receiver at the substation of said telephone line to connect said telephone line with said answering means.

33. A telephone line and automatic switching means provided with a contact maker capable of assuming a plurality of selective positions individual to said line, an electromagnet individual to said telephone line operating responsive to a control over said line to disconnect said automatic switch, and means for controlling said magnet to disconnect said automatic switch when connection is made to said line as a called line.

Signed by me at Scarsdale, in the county of Westchester, and State of New York, this 16th day of January, 1918.

FRANCIS W. DUNBAR.